OcNOS®

Open Compute Network Operating System
for Service Providers
for Data Centers

Streaming Telemetry

Version 6.6.0

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| PREFACE

| About this Guide

This guide describes how to configure Streaming Telemetry in OcNOS.

| IP Maestro Support

Monitor devices running OcNOS Release 6.3.4-70 and above using IP Maestro software.
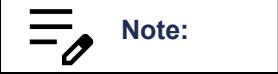
| Audience

This guide is intended for network administrators and other engineering professionals who configure OcNOS.

| Conventions

The Table 1 table shows the conventions used in this guide.

Table 1. Conventions

Convention	Description
Italics	Emphasized terms; titles of books
Note:	Special instructions, suggestions, or warnings
`monospaced type`	Code elements such as commands, parameters, files, and directories

| Chapter Organization

The chapters in command references are organized as described in Command Description Format (page 18).

The chapters in configuration guides are organized into these major sections:

- An overview that explains a configuration in words
- Topology with a diagram that shows the devices and connections used in the configuration
- Configuration steps in a table for each device where the left-hand side shows the commands you enter and the right-hand side explains the actions that the commands perform
- Validation which shows commands and their output that verify the configuration

Related Documentation

For information about installing OcNOS, see the *Installation Guide* for your platform.

Feature Availability

The features described in this document that are available depend upon the OcNOS SKU that you purchased. See the *Feature Matrix* for a description of the OcNOS SKUs.

Migration Guide

Check the *Migration Guide* for configuration changes to make when migrating from one version of OcNOS to another.

Support

For support-related questions, contact support@ipinfusion.com.

Comments

If you have comments, or need to report a problem with the content, contact techpubs@ipinfusion.com.

Command Line Interface

This chapter introduces the OcNOS Command Line Interface (CLI) and how to use its features.

Command Line Interface Help

You access the CLI help by entering a full or partial command string and a question mark "?". The CLI displays the command keywords or parameters along with a short description. For example, at the CLI command prompt, type:

```
> show ?
```

The CLI displays this keyword list with short descriptions for each keyword:

```
show ?
  application-priority        Application Priority
  arp                         Internet Protocol (IP)
  bfd                         Bidirectional Forwarding Detection (BFD)
  bgp                         Border Gateway Protocol (BGP)
  bi-lsp                      Bi-directional lsp status and configuration
  bridge                      Bridge group commands
  ce-vlan                     COS Preservation for Customer Edge VLAN
  class-map                   Class map entry
  cli                         Show CLI tree of current mode
  clns                        Connectionless-Mode Network Service (CLNS)
  control-adjacency           Control Adjacency status and configuration
  control-channel             Control Channel status and configuration
  cspf                        CSPF Information
  customer                    Display Customer spanning-tree
  cvlan                       Display CVLAN information
  debugging                   Debugging functions
  etherchannel                LACP etherchannel
  ethernet                    Layer-2
...
```

If you type the ? in the middle of a keyword, the CLI displays help for that keyword only.

```
> show de?
debugging  Debugging functions
```

If you type the ? in the middle of a keyword, but the incomplete keyword matches several other keywords, OcNOS displays help for all matching keywords.

```
> show i? (CLI does not display the question mark).
interface  Interface status and configuration
ip         IP information
isis       ISIS information
```

Command Completion

The CLI can complete the spelling of a command or a parameter. Begin typing the command or parameter and then press the tab key. For example, at the CLI command prompt type **sh**:

```
> sh
```

Press the tab key. The CLI displays:

```
> show
```

If the spelling of a command or parameter is ambiguous, the CLI displays the choices that match the abbreviation. Type **show i** and press the tab key. The CLI displays:

```
> show i
  interface  ip         ipv6       isis
> show i
```

The CLI displays the **interface** and **ip** keywords. Type **n** to select **interface** and press the tab key. The CLI displays:

```
> show in
> show interface
```

Type ? and the CLI displays the list of parameters for the **show interface** command.

```
> show interface
  IFNAME  Interface name
  |       Output modifiers
  >       Output redirection
  <cr>
```

The CLI displays the only parameter associated with this command, the **IFNAME** parameter.

Command Abbreviations

The CLI accepts abbreviations that uniquely identify a keyword in commands. For example:

```
> sh int xe0
```

is an abbreviation for:

```
> show interface xe0
```

Command Line Errors

Any unknown spelling causes the CLI to display the error **Unrecognized command** in response to the ?. The CLI displays the command again as last entered.

```
> show dd?
```

```
% Unrecognized command
> show dd
```

When you press the Enter key after typing an invalid command, the CLI displays:

```
(config)#router ospf here
                         ^
% Invalid input detected at '^' marker.
```

where the **^** points to the first character in error in the command.

If a command is incomplete, the CLI displays the following message:

```
> show
% Incomplete command.
```

Some commands are too long for the display line and can wrap mid-parameter or mid-keyword, as shown below. This does *not* cause an error and the command performs as expected:

```
area 10.10.0.18 virtual-link 10.10.0.19 authentication-key 57393
```

Command Negation

Many commands have a **no** form that resets a feature to its default value or disables the feature. For example:

- The **ip address** command assigns an IPv4 address to an interface
- The **no ip address** command removes an IPv4 address from an interface

Syntax Conventions

Table 2 describes the conventions used to represent command syntax in this reference.

Table 2. Syntax conventions

Convention	Description	Example
monospaced font	Command strings entered on a command line	**show ip ospf**
lowercase	Keywords that you enter exactly as shown in the command syntax.	show ip ospf
UPPERCASE	See Variable Placeholders (page 17)	IFNAME
()	Optional parameters, from which you must select one. Vertical bars delimit the selections. Do not enter the parentheses or vertical bars as part of the command.	(A.B.C.D|<0-4294967295>)
()	Optional parameters, from which you select one or none. Vertical bars delimit the selections. Do not enter the parentheses or vertical bars as part of the command.	(A.B.C.D|<0-4294967295>|)
()	Optional parameter which you can specify or omit. Do not enter the parentheses or vertical bar as part of the command.	(IFNAME|)

Table 2. Syntax conventions (continued)

Convention	Description	Example
{}	Optional parameters, from which you must select one or more. Vertical bars delimit the selections. Do not enter the braces or vertical bars as part of the command.	`{intra-area <1-255>|inter-area <1-255>|external <1-255>}`
[]	Optional parameters, from which you select zero or more. Vertical bars delimit the selections. Do not enter the brackets or vertical bars as part of the command.	`[<1-65535>|AA:NN|internet|local-AS| no-advertise|no-export]`
?	Nonrepeatable parameter. The parameter that follows a question mark can only appear once in a command string. Do not enter the question mark as part of the command.	`?route-map WORD`
.	Repeatable parameter. The parameter that follows a period can be repeated more than once. Do not enter the period as part of the command.	`set as-path prepend .<1-65535>`

Variable Placeholders

Table 3 shows the tokens used in command syntax use to represent variables for which you supply a value.

Table 3. Variable placeholders

Token	Description
`WORD`	A contiguous text string (excluding spaces)
`LINE`	A text string, including spaces; no other parameters can follow this parameter
`IFNAME`	Interface name whose format varies depending on the platform; examples are: **eth0**, **Ethernet0**, **ethernet0**, **xe0**
`A.B.C.D`	IPv4 address
`A.B.C.D/M`	IPv4 address and mask/prefix
`X:X::X:X`	IPv6 address
`X:X::X:X/M`	IPv6 address and mask/prefix
`HH:MM:SS`	Time format
`AA:NN`	BGP community value
`XX:XX:XX:XX:XX:XX`	MAC address
`<1-5>` `<1-65535>` `<0-2147483647>` `<0-4294967295>`	Numeric range

Command Description Format

The Table 4 table explains the sections used to describe each command in this reference.

Table 4. Command descriptions

Section	Description
Command Name	The name of the command, followed by what the command does and when should it be used
Command Syntax	The syntax of the command
Parameters	Parameters and options for the command
Default	The state before the command is executed
Command Mode	The mode in which the command runs; see Command Modes (page 21)
Example	An example of the command being executed

Keyboard Operations

The Table 5 table lists the operations you can perform from the keyboard.

Table 5. Keyboard operations

Key combination	Operation
Left arrow or Ctrl+b	Moves one character to the left. When a command extends beyond a single line, you can press left arrow or Ctrl+b repeatedly to scroll toward the beginning of the line, or you can press Ctrl+a to go directly to the beginning of the line.
Right arrow or Ctrl-f	Moves one character to the right. When a command extends beyond a single line, you can press right arrow or Ctrl+f repeatedly to scroll toward the end of the line, or you can press Ctrl+e to go directly to the end of the line.
Esc, b	Moves back one word
Esc, f	Moves forward one word
Ctrl+e	Moves to end of the line
Ctrl+a	Moves to the beginning of the line
Ctrl+u	Deletes the line
Ctrl+w	Deletes from the cursor to the previous whitespace
Alt+d	Deletes the current word
Ctrl+k	Deletes from the cursor to the end of line
Ctrl+y	Pastes text previously deleted with Ctrl+k, Alt+d, Ctrl+w, or Ctrl+u at the cursor
Ctrl+t	Transposes the current character with the previous character
Ctrl+c	Ignores the current line and redisplays the command prompt
Ctrl+z	Ends configuration mode and returns to exec mode
Ctrl+l	Clears the screen

Table 5. Keyboard operations (continued)

Key combination	Operation
Up Arrow or Ctrl+p	Scroll backward through command history
Down Arrow or Ctrl+n	Scroll forward through command history

Show Command Modifiers

You can use two tokens to modify the output of a **show** command. Enter a question mark to display these tokens:

```
# show users ?
  | Output modifiers
  > Output redirection
```

You can type the | (vertical bar character) to use output modifiers. For example:

```
> show rsvp | ?
  begin     Begin with the line that matches
  exclude   Exclude lines that match
  include   Include lines that match
  last      Last few lines
  redirect  Redirect output
```

Begin Modifier

The **begin** modifier displays the output beginning with the first line that contains the input string (everything typed after the **begin** keyword). For example:

```
# show running-config | begin xe1
...skipping
interface xe1
ipv6 address fe80::204:75ff:fee6:5393/64
!
interface xe2
ipv6 address fe80::20d:56ff:fe96:725a/64
!
line con 0
login
!
end
```

You can specify a regular expression after the **begin** keyword, This example begins the output at a line with either "xe2" or "xe4":

```
# show running-config | begin xe[2-4]

...skipping
interface xe2
 shutdown
!
interface xe4
 shutdown
!
interface svlan0.1
 no shutdown
!
route-map myroute permit 2
!
route-map mymap1 permit 10
!
route-map rmap1 permit 2
```

```
!
line con 0
 login
line vty 0 4
 login
!
end
```

Include Modifier

The **include** modifier includes only those lines of output that contain the input string. In the output below, all lines containing the word "input" are included:

```
# show interface xe1 | include input
    input packets 80434552, bytes 2147483647, dropped 0, multicast packets 0
    input errors 0, length 0, overrun 0, CRC 0, frame 0, fifo 1, missed 0
```

You can specify a regular expression after the **include** keyword. This examples includes all lines with "input" or "output":

```
#show interface xe0 | include (in|out)put
    input packets 597058, bytes 338081476, dropped 0, multicast packets 0
    input errors 0, length 0, overrun 0, CRC 0, frame 0, fifo 0, missed 0
    output packets 613147, bytes 126055987, dropped 0
    output errors 0, aborted 0, carrier 0, fifo 0, heartbeat 0, window 0
```

Exclude Modifier

The **exclude** modifier excludes all lines of output that contain the input string. In the following output example, all lines containing the word "input" are excluded:

```
# show interface xe1 | exclude input
Interface xe1
  Scope: both
  Hardware is Ethernet, address is 0004.75e6.5393
  index 3 metric 1 mtu 1500 <UP,BROADCAST,RUNNING,MULTICAST>
  VRF Binding: Not bound
  Administrative Group(s): None
  DSTE Bandwidth Constraint Mode is MAM
  inet6 fe80::204:75ff:fee6:5393/64
    output packets 4438, bytes 394940, dropped 0
    output errors 0, aborted 0, carrier 0, fifo 0, heartbeat 0, window 0
    collisions 0
```

You can specify a regular expression after the **exclude** keyword. This example excludes lines with "output" or "input":

```
show interface xe0 | exclude (in|out)put
Interface xe0
  Scope: both
  Hardware is Ethernet  Current HW addr: 001b.2139.6c4a
  Physical:001b.2139.6c4a  Logical:(not set)
  index 2 metric 1 mtu 1500 duplex-full arp ageing timeout 3000
  <UP,BROADCAST,RUNNING,MULTICAST>
  VRF Binding: Not bound
  Bandwidth 100m
  DHCP client is disabled.
  inet 10.1.2.173/24 broadcast 10.1.2.255
  VRRP Master of :  VRRP is not configured on this interface.
  inet6 fe80::21b:21ff:fe39:6c4a/64
    collisions 0
```

Redirect Modifier

The **redirect** modifier writes the output into a file. The output is not displayed.

```
# show cli history | redirect /var/frame.txt
```

The output redirection token (>) does the same thing:

```
# show cli history >/var/frame.txt
```

Last Modifier

The **last** modifier displays the output of last few number of lines (As per the user input). The last number ranges from 1 to 9999.

For example:

```
#show running-config | last 10
```

String Parameters

The restrictions in Table 6 apply for all string parameters used in OcNOS commands, unless some other restrictions are noted for a particular command.

Table 6. String parameter restrictions

Restriction	Description
Input length	1965 characters or less
Restricted special characters	"?", ",", ">", "|", and "=" The "|" character is allowed only for the **description** command in interface mode.

Command Modes

Commands are grouped into modes arranged in a hierarchy. Each mode has its own set of commands. The table below lists the command modes common to all protocols.

Table 7. Common Command Modes

Name	Description
Execution mode	Also called *view* mode, this is the first mode to appear after you start the CLI. It is a base mode from where you can perform basic commands such as show, exit, quit, help, and enable.
Privileged execution mode	Also called *enable* mode, in this mode you can run additional basic commands such as debug, write, and show.
Configure mode	Also called *configure terminal* mode, in this mode you can run configuration commands and go into other modes such as interface, router, route map, key chain, and address family. Configure mode is single user. Only one user at a time can be in configure mode.
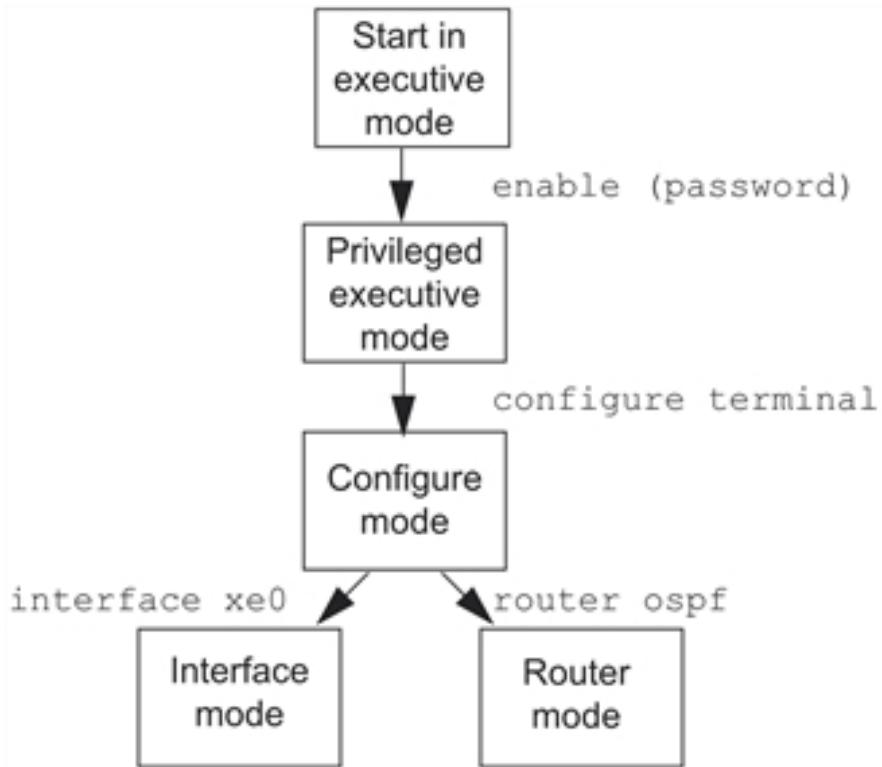
Table 7. Common Command Modes (continued)

Name	Description
Interface mode	In this mode you can configure protocol-specific settings for a particular interface. Any setting you configure in this mode overrides a setting configured in router mode.
Router mode	This mode is used to configure router-specific settings for a protocol such as BGP or OSPF.

Command Mode Tree

The diagram below shows the common command mode hierarchy.

Figure 1. Common command modes

To change modes:

1. Enter privileged executive mode by entering **enable** in Executive mode.

2. Enter configure mode by entering **configure terminal** in Privileged Executive mode.

The example below shows moving from executive mode to privileged executive mode to configure mode and finally to router mode:

```
> enable mypassword
# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
(config)# router ospf
(config-router)#
```

> **Note:** Each protocol can have modes in addition to the common command modes. See the command reference for the respective protocol for details.

Transaction-based Command-line Interface

The OcNOS command line interface is transaction based:

- Any changes done in configure mode are stored in a separate *candidate* configuration that you can view with the command.

- When a configuration is complete, apply the candidate configuration to the running configuration with the command.

- If a fails, no configuration is applied as the entire transaction is considered failed. You can continue to change the candidate configuration and then retry the .

- Discard the candidate configuration with the `abort transaction` command.

- Check the last aborted transaction with the `show transaction last-aborted` command.

- Multiple configurations cannot be removed with a single . You must remove each configuration followed by a commit.

> **Note:** All commands MUST be executed only in the default CML shell (`cmlsh`). If you log in as root and start **imish**, then the system configurations will go out of sync. The **imish** shell is not supported and should not be started manually.

STREAMING TELEMETRY

Overview

Streaming telemetry allows users to monitor network health by efficiently streaming operational data of interest from OcNOS routers. This structured data is transmitted to remote management systems for proactive network monitoring and understanding CPU and memory usage in managed devices for troubleshooting.

A machine learning (ML) database can be created with telemetry data to establish a baseline for normal network operation and predict or mitigate network issues.

Feature Characteristics

In OcNOS various gRPC Network Management Interface (gNMI) Subscription Modes, Telemetry Modes, and Encoding Types are supported, providing efficient network management capabilities.

gNMI Subscription Modes

: In this mode, the collector initiates a connection to the target device (OcNOS) and subscribes to receive telemetry data from OcNOS devices.

(Persistent Subscriptions): In this mode, the target (OcNOS) initiates the gRPC tunnel connection to the collector. Once the connection is established, the collector invokes the "Publish" RPC on the target. Subscriptions configured on the target are then streamed on that connection at the specified sample interval. These subscriptions remain active on OcNOS devices as long as the corresponding configuration on the target exists. If the gRPC tunnel connection is interrupted or the target reboots, the gNMI server on the target re-establishes the connection to the gNMI collector, ensuring continued streaming.

Streaming Telemetry Modes

Stream Mode: Enables continuous and real-time transmission of telemetry data from OcNOS devices to the monitoring system. The stream mode applies to both the dial-in and dial-out gNMI subscription modes.

Poll Mode: Poll mode subscriptions allow for on-demand data retrieval through a long-lived RPC. Subscribers initiate this mode by sending a Subscribe request message, followed by sending an empty Poll message to receive the desired data.

> **Note:** The system supports **Poll mode** only in Dial-in subscription mode.

Once Mode: In Once mode subscription, the OcNOS device responds to a subscribe request with a one-time data retrieval, similar to a get request. Upon receiving the Once mode subscribe request, the device sends back the subscribe response for all subscriptions in the list and terminates the RPC.

> **Note:** The system supports **Once mode** only in Dial-in subscription mode.

gNMI In-Band Support

OcNOS supports streaming telemetry data transmission across multiple **VRF**[1] instances, enabling users to manage data for up to four VRFs simultaneously. If users do not define a VRF, the system automatically allows streaming telemetry in the default VRF.

This improves efficiency and monitoring capabilities within the network.

Encoding Types

Protocol Buffers (protobuf): Offers a compact binary serialization format for efficient encoding and transmission of structured telemetry data. Protobuf is optimized for performance and bandwidth efficiency.

JavaScript Object Notation (JSON): Provides a human-readable data interchange format commonly used for telemetry data representation. JSON encoding facilitates interoperability and ease of integration with various applications and tools. It adheres to the JSON specification outlined in RFC7159, employing relevant quoting. Consequently, string values are quoted while number values remain unquoted.

JSON-IETF: This variant of JSON encoding adheres to the IETF standards, ensuring consistency and compatibility with industry specifications. `JSON_IETF` encoded data conforms the rules outlined in RFC7951 for JSON serialization.

> **Note:** OcNOS supports the protobuf, JSON, and JSON-IETF encoding types for both the dial-in and dial-out gNMI subscription modes.

Support for IPI Native Data Models and OpenConfig Data Models

Streaming Telemetry Data Models: OcNOS supports IPI native data models and OpenConfig data models, providing standardized representations of network configurations and telemetry data. This support enhances interoperability and facilitates consistent management across heterogeneous network environments.

Wildcard Support in Sensor Paths

OcNOS supports wildcard characters in sensor paths (XPaths) to simplify subscription requests and minimize the number of XPaths needed to monitor multiple instances. The following wildcard types are supported:

Explicit Wildcard for Key Names

Allows selecting all instances of a keyed list.

Example

The XPath below explicitly uses asterisk (`*`) for the name key in the interface list, which means it retrieves counters for all interfaces regardless of their names. This is useful when user do not need to specify individual interface names and want to subscribe to all available interfaces.

```
ipi:/interfaces/interface[name=*]/state/counters
```

---

[1]Virtual Routing and Forwarding

Implicit Wildcard (Omission of Key Name)

Automatically selects all instances when a key is not explicitly mentioned.

Example

Here, the name key is completely omitted, which implies that the query applies to all interfaces. This method functions similarly to using an explicit wildcard (`*`), but it assumes that the key name is optional, applying to all list instances automatically.

```
ipi:/interfaces/interface/state/counters
```

Partial Wildcard for Key Name

Matches instances with a key name that starts with a given prefix.

Example

The wildcard `*` is applied at the end of the key name, meaning this XPath matches all interfaces whose names start with `xe`. For instance, it will match `xe0, xe1, xe100`, etc. However, it will not match `eth0, ge1`, etc. This is useful for filtering a subset of interfaces with a common prefix, reducing the number of specific XPaths required.

```
ipi:/interfaces/interface[name=xe*]/state
```

Partial Wildcard for Multiple Keys

Partial wildcard applies to the first key when multiple keys exist.

Valid Example

This example allows retrieving information from all CMIS components while still applying filters for specific lanes and flags.

```
ipi:/components/component[name=CMIS*]/transceiver/cmis-module/media-monitors/lanes/lane
[number=2]/flags/flag[id=*]/state
```

- **component[name=CMIS*]:** Matches all components where the name starts with "CMIS" (e.g., CMIS-1, CMIS-module-10, etc).
- **lane[number=2]:** Applies only to lane number 2.
- **flag[id=*]:** Retrieves all flags within lane number 2.

Invalid Example

The wildcard is at the beginning of the key (`*CMIS`), which is not supported. Only suffix-based (**CMIS***) wildcarding is allowed.

```
ipi:/components/component[name=*CMIS]/transceiver/cmis-module/media-monitors/lanes/lane
[number=2]/flags/flag[id=*]/state
```

Use case 1: Wildcard Support in Dial-In Mode

In this example, the explicit wildcard `name=*` in **ipi:/components/component[name=*]/state/memory** XPath allows real-time monitoring of memory usage for all components without needing to specify individual component names. The `gnmic` command subscribes to this data stream to retrieve available and utilized memory

for components like **HARD-DISK** and **RAM** from the target at `10.12.162.22:9339`. With a `90-seconds` sampling interval, the system collects data efficiently while minimizing the complexity of manual configuration. This approach simplifies network monitoring by dynamically including all relevant components, making it easier to track system performance in real time.

```
OcNOS# ./gnmic -a 10.12.162.22:9339 -u admin -p admin --insecure --mode STREAM --stream-mode sample -
-sample-interval 90s sub --path '/components/component[name=*]/state/memory' --encoding json_ietf
{
  "source": "10.12.162.22:9339",
  "subscription-name": "default-1729755066",
  "timestamp": 1729774623040087176,
  "time": "2024-10-24T12:57:03.040087176Z",
  "updates": [
    {
      "Path": "components/component[name=\"HARD-DISK\"]/state/memory",
      "values": {
        "components/component/state/memory": {
          "available": 118183952384,
          "utilized": 5681184768
        }
      }
    }
  ]
}
{
  "source": "10.12.162.22:9339",
  "subscription-name": "default-1729755066",
  "timestamp": 1729774623040734590,
  "time": "2024-10-24T12:57:03.04073459Z",
  "updates": [
    {
      "Path": "components/component[name=\"RAM\"]/state/memory",
      "values": {
        "components/component/state/memory": {
          "available": 33637269504,
          "utilized": 1130364928
        }
      }
    }
  ]
}
```

Use case 2: Wildcard Support in Dial-Out Mode

This example uses a partial wildcard for key names in Dial-Out mode to subscribe to telemetry data for all components whose names start with `PORT`, eliminating the need to list them individually. The XPath `ipi:/components/component[name=PORT*]/state` ensures the system automatically monitors all port-related components, such as `PORT-SFP-5`, `PORT-SFP-7`, and `PORT-SFP-11`. The system sends telemetry data to the target at `10.12.66.160:11161` every `90 seconds`, dynamically retrieving information on memory, board FRU, and temperature for matching components.

```
OcNOS#show running-config streaming-telemetry
!
feature streaming-telemetry vrf management
!
sensor-group interface vrf management
 sensor-path ipi:/components/component[name=PORT*]/state
!
destination-group tunnel-1 vrf management
 tunnel-server ip 10.12.66.160 port 11161
!
subscription-name sub-1 vrf management
```

```
 destination-group tunnel-1
 sensor-group interface sample-interval 90
!
!
```

```
OcNOS#show streaming-telemetry

Number of telemetry instances : 1 (management)
Platform type                 : High range
Maximum sensor-paths          : 100
Minimum sample-interval       : 10
Number of active sensor-paths : 30 (Dial-In : 0, Dial-out : 30)

SI          : Sampling Interval in seconds
Enc-Type    : Encoding type
Origin:Path : Sensor Path


1. Subscription Details (VRF-Name: default):
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  Port        : 9339
  TLS         : Disabled
  insecure-tls : False

Dial-Out Subscription Details:
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
1. Subscription-name   : sub-1
   Status              : ACTIVE
   Enc-Type            : JSON
   Tunnel-server details:
   ~~~~~~~~~~~~~~~~~~~~~~
   Tunnel-server Retry-interval  : Default-60 (seconds)

    Destination-group       Status          Tunnel-IP:Port
    -----------------       ------          --------------
    tunnel-1                ACTIVE          10.12.66.160:11161
    Sensor-group details:
    ~~~~~~~~~~~~~~~~~~~~~~
    Sensor-group        SI              Origin:Path
    -----------         ----            -----------
      interface         90              ipi:/components/component[name=PORT*]/state
                                        [*]ipi:/components/component[name=PORT*]/state/memory
                                        [*]ipi:/components/component[name=PORT*]/state/board-fru
                                        [*]ipi:/components/component[name=PORT*]/state/temperature

 [*]-> Indicates child path learnt from parent config, not configured by user
```

gnmic Output

The gnmic output confirms that telemetry updates include firmware, hardware version, location, operational status, and parent chassis details for each matching port component.

By using a partial wildcard, the system improves scalability by automatically incorporating new port components without modifying the sensor path configuration, reducing manual effort and ensuring real-time network monitoring.

```
#./gnmic --config abc.yaml --use-tunnel-server publish --insecure
{
  "source": "e8:c5:7a:8f:98:26",
  "subscription-name": "sub-1",
  "timestamp": 1725361959730514173,
  "time": "2024-09-03T11:12:39.730514173Z",
  "updates": [
    {
      "Path": "ipi:components/component[name=\"PORT-SFP-5\"]/state",
      "values": {
        "components/component/state": {
```

```
            "description": "NA",
            "empty": false,
            "firmware-version": "NA",
            "hardware-version": "NA",
            "location": "17",
            "mfg-name": "NA",
            "name": "PORT-SFP-17",
            "oper-status": "NA",
            "parent": "CHASSIS",
            "part-no": "NA",
            "product-name": "NA",
            "removable": false,
            "serial-no": "NA",
            "software-version": "NA",
            "type": "port"
          }
        }
      }
    ]
  }
  {
    "source": "e8:c5:7a:8f:98:26",
    "subscription-name": "sub-1",
    "timestamp": 1725361959731082952,
    "time": "2024-09-03T11:12:39.731082952Z",
    "updates": [
      {
        "Path": "ipi:components/component[name=\"PORT-SFP-7\"]/state",
        "values": {
          "components/component/state": {
            "description": "NA",
            "empty": false,
            "firmware-version": "NA",
            "hardware-version": "NA",
            "location": "5",
            "mfg-name": "NA",
            "name": "PORT-SFP-5",
            "oper-status": "NA",
            "parent": "CHASSIS",
            "part-no": "NA",
            "product-name": "NA",
            "removable": false,
            "serial-no": "NA",
            "software-version": "NA",
            "type": "port"
          }
        }
      }
    ]
  }
  {
    "source": "e8:c5:7a:8f:98:26",
    "subscription-name": "sub-1",
    "timestamp": 1725361959731795490,
    "time": "2024-09-03T11:12:39.73179549Z",
    "updates": [
      {
        "Path": "ipi:components/component[name=\"PORT-SFP-11\"]/state",
        "values": {
          "components/component/state": {
            "description": "NA",
            "empty": false,
            "firmware-version": "NA",
            "hardware-version": "NA",
            "location": "7",
            "mfg-name": "NA",
            "name": "PORT-SFP-7",
            "oper-status": "NA",
```

```
                "parent": "CHASSIS",
                "part-no": "NA",
                "product-name": "NA",
                "removable": false,
                "serial-no": "NA",
                "software-version": "NA",
                "type": "port"
              }
            }
          }
        ]
      }
      {
        "source": "e8:c5:7a:8f:98:26",
        "subscription-name": "sub-1",
        "timestamp": 1725361959732153620,
        "time": "2024-09-03T11:12:39.73215362Z",
        "updates": [
          {
            "Path": "ipi:components/component[name=\"PORT-SFP-13\"]/state",
            "values": {
              "components/component/state": {
                "description": "NA",
                "empty": false,
                "firmware-version": "NA",
                "hardware-version": "NA",
                "location": "11",
                "mfg-name": "NA",
                "name": "PORT-SFP-11",
                "oper-status": "NA",
                "parent": "CHASSIS",
                "part-no": "NA",
                "product-name": "NA",
                "removable": false,
                "serial-no": "NA",
                "software-version": "NA",
                "type": "port"
              }
            }
          }
        ]
      }
      {
        "source": "e8:c5:7a:8f:98:26",
        "subscription-name": "sub-1",
        "timestamp": 1725361959731446131,
        "time": "2024-09-03T11:12:39.731446131Z",
        "updates": [
          {
            "Path": "ipi:components/component[name=\"PORT-SFP-9\"]/state",
            "values": {
              "components/component/state": {
                "description": "NA",
                "empty": false,
                "firmware-version": "NA",
                "hardware-version": "NA",
                "location": "13",
                "mfg-name": "NA",
                "name": "PORT-SFP-13",
                "oper-status": "NA",
                "parent": "CHASSIS",
                "part-no": "NA",
                "product-name": "NA",
                "removable": false,
                "serial-no": "NA",
                "software-version": "NA",
                "type": "port"
              }
```

```
        }
      }
    ]
  }
  {
    "source": "e8:c5:7a:8f:98:26",
    "subscription-name": "sub-1",
    "timestamp": 1725361959731621187,
    "time": "2024-09-03T11:12:39.731621187Z",
    "updates": [
      {
        "Path": "ipi:components/component[name=\"PORT-SFP-10\"]/state",
        "values": {
          "components/component/state": {
            "description": "NA",
            "empty": false,
            "firmware-version": "NA",
            "hardware-version": "NA",
            "location": "14",
            "mfg-name": "NA",
            "name": "PORT-SFP-14",
            "oper-status": "NA",
            "parent": "CHASSIS",
            "part-no": "NA",
            "product-name": "NA",
            "removable": false,
            "serial-no": "NA",
            "software-version": "NA",
            "type": "port"
          }
        }
      }
    ]
  }
```

XPath Formatting Rules for gnmic Subscription

OcNOS enforces specific formatting rules for XPath in gNMIc subscription commands.

- Xpath with string keys must be enclosed in double quotes (`""`).

  Here is an example for the Xpath with string keys:

  ```
  --path '/components/component[name="TEMPERATURE-MAC"]/state'

  --path /components/component[name=\"TEMPERATURE-MAC\"]/state
  ```

- Xpath with integer keys must be provided without double quotes.

  Here is an example for the Xpath with integer keys:

  ```
  --path ipi:/bgp/bgp-instances/bgp-instance[bgp-as=100]/peers/peer[peer-
  address=\"1.1.1.1\"]/state

  --path  'ipi:/bgp/bgp-instances/bgp-instance[bgp-as=100]/peers/peer[peer-
  address="1.1.1.1"]/state'
  ```

- Xpath with implicit wildcard keys can be provided with or without single quotes.

  Here is an example for the Xpath with implicit wildcard keys:

  ```
  --path '/components/component/state'

  --path /components/component/state
  ```

Scale and Minimum Sample Interval Supported

To limit the impact of telemetry on critical features of the OcNOS target device, certain limits have been implemented for different platform types.

High End Platforms: A system is considered high range if it has eight or more CPU cores and is not based on an "Intel Atom" processor.

Standard Range Platforms: A system is considered standard range if it has fewer than eight CPU cores or is based on an "Intel Atom" processor.

Notes:

- If telemetry subscribe paths are not explicitly configured using the command telemetry maximum-subscribe-paths (page 60), the system sets them to `100 sensor paths for high-end platforms` and `50 sensor paths for standard platforms`.

- If telemetry mimum sample intervals are not explicitly configured using the command telemetry minimum-sample-interval (page 61), the system sets them to `10 seconds for high-end platforms` and `90 seconds for standard platforms`.

- The total count of sensor paths includes the child paths of a subscribe request. For instance, if a subscribe request has four child paths, the total sensor paths count equals five (the given path plus four child paths). Use the show streaming-telemetry (page 50) command to display the minimum sample interval and the maximum number of sensor paths configured.

Scale Scenarios

New Subscribe RPC Request Makes Total Paths To Not Exceed Max Allowed

When new paths are added to the existing paths already handled by the gNMI server, the total number does not exceed the Default (page 60) limit or the user-configured value. Consequently, the gNMI server accepts this subscribe request and proceeds with the processing.

New Subscribe RPC Request Makes Total Paths To Reach Allowed Max:

With the new Subscribe RPC Request, the total paths handled would be exactly equal to its Default (page 60) or the user-configured values. When the gNMI server accepts the new subscribe request, it processes it but logs a warning that the maximum number of paths has been reached. This warning indicates that it will not handle any new subscribe RPC stream mode requests until the number of currently handled paths drops below 100 or below the user-configured subscribe path values.

New Subscribe RPC Request Makes Total Paths To Exceed Allowed Max

With the new Subscribe RPC request, the gNMI server returns an error if the total paths exceed its Default (page 60) or the user-configured values. The RPC request is not closed but will be accepted and responded to when the total number of paths handled drops to a level that can accommodate this RPC request.

Minimum Sample Interval

Any sampling mode request with a sample interval of less than the minimum allowed will result in an error. However, if a sample interval is 0, it defaults to the minimum sample interval supported by the gNMI server for that platform

---

type.

gnmic Installation

gNMI Specification can be found at: https://github.com/openconfig/reference/blob/master/rpc/gnmi/gnmi-specification.md.

gNMI Collector Tool

- For dial-in subscription mode, except when using "proto" encoding, use the open-source gNMI collector tool (gnmic). Install the open-source gNMI collector tool (gnmic) with the command:

  ```
  bash -c "$(curl -sL https://get-gnmic.openconfig.net)
  ```

- For dial-out subscription mode or when "proto" encoding is needed, use the gnmic tool from the gNMI collector package. It is delivered with the OcNOS installer, named OcNOS-<SKU NAME>-<version>-telemetry-client-bin.tar, and includes the gNMI Client collector application (gnmic) and the IPI_OC.proto files.

Streaming Telemetry Commands

This section lists the telemetry commands.

debug cml

Use this command to enable or disable debugging information for CML streaming telemetry.

Command Syntax

```
debug cml enable telemetry
debug cml disable telemetry
```

Parameters

None

Default

By default, debugging information is disabled.

Command Mode

Exec Mode

Applicability

This command was introduced in OcNOS version 6.4.1.

Examples

The following example illustrates how to enable and disable the telemetry debugging information.

```
OcNOS#debug cml enable telemetry
OcNOS#debug cml disable telemetry
```

debug telemetry gnmi

Use this command to enable or disable gNMI server debugging logs with severity levels.

Command Syntax

```
debug telemetry gnmi (enable) (severity (debug|info|warning|error|fatal|panic|d-panic)|)
debug telemetry gnmi (disable) (severity (debug|info|warning|error|fatal|panic|d-panic)|)
```

Parameters

debug
>   Logs a message at debug level

info
>   Logs a message at info level

warning
>   Logs a message at warning level

error
>   Logs a message at error level

fatal
>   Logs a message and causes the program to exit with return code 1.

panic
>   Logs a message and triggers the program to generate a traceback.

d-panic
>   Logs at the Panic level

d-panic
>   Logs at the Panic level

d-panic
>   Logs at the Panic level

Default

Disabled. The gNMI server debugging level in the disabled state is set to the Error level.

Command Mode

Configure mode

Applicability

Introduced in OcNOS version 6.4.1 and added the `vrf (NAME|management)` parameter in the OcNOS version 6.5.2.

Removed the `vrf (NAME|management)` parameter in the OcNOS version 6.6.0.

Examples

The following example illustrates how to enable and disable the telemetry debug logs and their corresponding show output.

```
OcNOS(config)#feature streaming-telemetry
OcNOS(feature-telemetry-config)#commit
OcNOS(feature-telemetry-config)#exit
OcNOS(config)#debug telemetry gnmi enable severity warning
OcNOS(config)#commit
OcNOS(config)#show running-config streaming-telemetry
!
feature streaming-telemetry
debug telemetry gnmi enable severity warning
!
OcNOS(config)#debug telemetry gnmi disable severity warning
OcNOS(config)#commit
OcNOS(config)#show running-config streaming-telemetry
!
feature streaming-telemetry
!
```

destination-group

Use this command to create a destination-group for persistent subscriptions on the OcNOS device. The **VRF**[1] parameter must match the VRF specified in the [feature streaming-telemetry (page 42)](#) command. Can create and attach multiple destination-groups to activate streaming telemetry subscriptions.

Use the no form of this command to delete a destination-group.

Command Syntax

```
destination-group TUNNEL-NAME (vrf (management|NAME)|)
no destination-group TUNNEL-NAME (vrf (management|NAME)|)
```

Parameters

TUNNEL-NAME
Specify the name assigned to the tunnel server or collector endpoint used for telemetry data transmission.

vrf NAME
(Optional) Creates a destination-group for persistent subscriptions in a user-defined VRF.

vrf management
(Optional) Creates a destination-group for persistent subscriptions in the management VRF.

Default

None

Command Mode

Configure mode

Applicability

Introduced in OcNOS version 6.5.2.

Example

The following example creates a destination group named `tunnel-1` in a default VRF for transmitting telemetry data.

```
OcNOS(config)#destination-group tunnel-1
OcNOS(telemetry-grpc-tunnel-group)#commit
```

---

[1]Virtual Routing and Forwarding

destination-group GRPC

Use this command to add a destination-group under subscriptions. Can create multiple destination-groups within a subscription mode.

Use `no` parameter of this command to remove the destination-groups.

> **Note:** Ensure that the GRPC-GROUP-NAME is configured in the device's configuration mode before adding it to a subscription mode.

Command Syntax

```
destination-group GRPC-GROUP-NAME
no destination-group GRPC-GROUP-NAME
```

Parameters

GRPC-GROUP-NAME
    Specify the name assigned to the tunnel server or collector endpoint used for telemetry data transmission.

Default

None

Command Mode

Telemetry-subscription Mode

Applicability

Introduced in OcNOS version 6.5.2.

Example

Ensure that the GRPC-GROUP-NAME (`tunnel-1`) is already configured in the current configuration mode.

```
OcNOS#configure terminal
OcNOS(config)#show running-config streaming-telemetry
!
feature streaming-telemetry
 grpc-tunnel-server retry-interval 60
!
sensor-group stream-1
 sensor-path ipi:/interfaces/interface[name="eth0"]/state/counters
!
destination-group tunnel-1
 tunnel-server ip 10.12.66.160 port 11163
!
subscription-name sub-1
 sensor-group stream-1 sample-interval 1000
!
!
```

The following commands illustrates how to add a destination group (`tunnel-1`) under subscription mode (`sub-1`) and verify the configuration using the show command output.

```
OcNOS(config)#subscription-name sub-1
OcNOS(telemetry-subscription)#destination-group tunnel-1
OcNOS(telemetry-subscription)#commit
OcNOS(telemetry-subscription)#exit
OcNOS(config)#show running-config streaming-telemetry
!
feature streaming-telemetry
 grpc-tunnel-server retry-interval 60
!
sensor-group stream-1
 sensor-path ipi:/interfaces/interface[name="eth0"]/state/counters
!
destination-group tunnel-1
 tunnel-server ip 10.12.66.160 port 11163
!
subscription-name sub-1
 destination-group tunnel-1
 sensor-group stream-1 sample-interval 1000
!
!
```

encoding

Use this command to specify or modify encoding types for subscriptions in streaming telemetry.

Use `no` parameter of this command to remove the encoding option.

> **Note:** Modifying the encoding type is not allowed for active subscriptions.

Command Syntax

```
encoding (json-ietf|json|proto)
no encoding
```

Parameters

json-ietf
Specifies the JSON encoding based on the IETF draft standard.

json
Specifies the default JSON encoding type.

proto
Specifies the Protocol Buffers v3 encoding type.

Default

None

Command Mode

Telemetry-subscription Mode

Applicability

Introduced in OcNOS version 6.5.2.

Example

The following commands demonstrate how to create a telemetry subscription named `sub-3` using the JSON encoding type.

```
OcNOS#configure terminal
OcNOS(config)#subscription-name sub-3
OcNOS(telemetry-subscription)#encoding json
OcNOS(telemetry-subscription)#commit
```

feature streaming-telemetry

Use this command to enable the streaming telemetry and, upon configuration, to start the gNMI server. The gNMI server initiates listening for incoming gRPC connections on port 9339 if a custom <u>port (page 45)</u> value is not configured.

> **Notes:**
>
> - OcNOS supports streaming telemetry data transmission across multiple **VRF**[1] instances, enabling users to manage data for up to four VRFs simultaneously. If users do not define a VRF, the system automatically allows streaming telemetry in the default VRF.
>
> - After configuring the `feature streaming-telemetry` command, the system enters the feature telemetry configuration mode.

Use the `no` parameter of this command to disable the streaming telemetry, it will stop the gNMI server.

Command Syntax

```
feature streaming-telemetry (vrf (NAME|management)|)
no feature streaming-telemetry (vrf (NAME|management)|)
```

Parameters

vrf NAME
> (Optional) Defines streaming telemetry in a user-defined VRF. Specify the VRF instance name.

vrf management
> (Optional) Defines streaming telemetry in the management VRF.

Default

By default, the streaming-telemetry feature is disabled.

Command Mode

Configure mode

Applicability

Introduced in OcNOS version 6.4.1 and added the `vrf (NAME|management)` parameter in the OcNOS version 6.5.2. Introduces multiple VRFs support in theOcNOS version 6.6.0.

Examples

The following example illustrates how to enable the streaming telemetry on the default, management, user-defined VRFs, and multiple VRFs.

---

[1]Virtual Routing and Forwarding

Default VRF

```
OcNOS#configure terminal
OcNOS(config)#feature streaming-telemetry
OcNOS(feature-telemetry-config)#commit
OcNOS(feature-telemetry-config)#exit
```

Management VRF

```
OcNOS#configure terminal
OcNOS(config)#feature streaming-telemetry vrf management
OcNOS(feature-telemetry-config)#commit
OcNOS(feature-telemetry-config)#exit
```

User-defined VRF

```
OcNOS#configure terminal
OcNOS(config)#ip vrf VRF1
OcNOS(config-vrf)#exit
OcNOS(config)#feature streaming-telemetry vrf VRF1
OcNOS(feature-telemetry-config)#commit
OcNOS(feature-telemetry-config)#exit
```

Multiple VRFs

```
OcNOS(config)#ip vrf management
OcNOS(config-vrf)#exit
OcNOS(config)#ip vrf user1
OcNOS(config-vrf)#exit
OcNOS(config)#ip vrf user2
OcNOS(config-vrf)#exit

OcNOS(config)#feature streaming-telemetry vrf management
OcNOS(feature-telemetry-config)#port 32768
OcNOS(feature-telemetry-config)#exit
OcNOS(config)#feature streaming-telemetry
OcNOS(feature-telemetry-config)#exit
OcNOS(config)#feature streaming-telemetry vrf user1
OcNOS(feature-telemetry-config)#port 42768
OcNOS(feature-telemetry-config)#exit
OcNOS(config)#feature streaming-telemetry vrf user2
OcNOS(feature-telemetry-config)#port 52768
OcNOS(feature-telemetry-config)#commit
OcNOS(feature-telemetry-config)#exit

OcNOS#show running-config streaming-telemetry
!
feature streaming-telemetry
!
feature streaming-telemetry vrf management
 port 32768
!
feature streaming-telemetry vrf user1
 port 42768
!
feature streaming-telemetry vrf user2
 port 52768
!
!
```

grpc-tunnel-server retry-interval

Use this command to set the interval for retry attempts when establishing a connection for the GNMI server to the tunnel-server.

Use `no` parameter of this command to unset the retry-interval timer.

Command Syntax

```
grpc-tunnel-server retry-interval <30-3000>
no grpc-tunnel-server retry-interval
```

Parameters

retry-interval <30-3000>
> Specifies the duration between retry attempts. The default retry-interval is 60 seconds.

Default

None

Command Mode

Feature telemetry configure mode

Applicability

Introduced in the OcNOS version 6.5.2. Changed the command mode support from configure mode to feature telemetry configure mode (`feature-telemetry-config`) and removed the **VRF**[1] parameters in OcNOS version 6.6.0.

Example

The following configuration illustrates how to set the retry-interval timer for the gNMI server to the tunnel-server with a value of 80 seconds in a default VRF.

```
OcNOS#configure terminal
OcNOS(config)#feature streaming-telemetry
OcNOS(feature-telemetry-config)#grpc-tunnel-server retry-interval 80
OcNOS(feature-telemetry-config)#commit
```

---

[1]Virtual Routing and Forwarding

port

Use this command to configure a non-TLS port for streaming-telemetry.

Use the no parameter of this command to reset the non-TLS port to its default value.

Command Syntax

```
port <32768-60999>
no port <32768-60999>
```

Parameters

port <32768-60999>

Specifies the port number range for the insecure TLS gRPC connection.

Default

The non-TLS port is set to 9339.

Command Mode

Feature telemetry configure mode

Applicability

Introduced in OcNOS version 6.6.0

Examples

```
OcNOS(config)#feature streaming-telemetry vrf management
OcNOS(feature-telemetry-config)#port 54321
OcNOS(feature-telemetry-config)#commit

OcNOS(config)#show running-config streaming-telemetry
!
feature streaming-telemetry vrf management
 port 54321
!
```

sensor-group

Use this command to create a sensor group for persistent subscriptions in an OcNOS device. Multiple sensor groups can be created to specify the paths of interest for streaming telemetry. The **VRF**[1] parameter must match the VRF specified in the [feature streaming-telemetry (page 42)](#) command. These sensor groups are attached to subscriptions to activate streaming telemetry.

Use `no` parameter of this command to remove a created sensor group.

Command Syntax

```
sensor-group SENSOR-NAME (vrf (management|NAME)|)
no sensor-group SENSOR-NAME (vrf (management|NAME)|)
```

Parameters

SENSOR-NAME
　　Specifies the name of the sensor group.

vrf management
　　(Optional) Creates a sensor group in the management VRF.

vrf NAME
　　(Optional) Creates a sensor group in a user-defined VRF.

Default

None

Command Mode

Configure mode

Applicability

Introduced in OcNOS version 6.5.2.

Example

The following commands demonstrate how to create a sensor group named `stream-1` for persistent telemetry subscriptions in a default VRF on an OcNOS device:

```
OcNOS#configure terminal
OcNOS(config)#sensor-group stream-1
OcNOS(telemetry-sensor-group)#commit
OcNOS(telemetry-sensor-group)#exit
```

---

[1]Virtual Routing and Forwarding

sensor-group sample-interval

Use this command to to associate a sensor group with a specific sampling interval under subscriptions for activating streaming telemetry. Multiple sensor groups can be created.

Use `no` parameter of this command to remove the sensor-groups from a subscription.

> **Note:** Before adding a SENSOR-GROUP-NAME to a subscription, ensure the sensor group is already configured in the configuration mode.

Command Syntax

```
sensor-group SENSOR-GROUP-NAME sample-interval <10-3600>
no sensor-group SENSOR-GROUP-NAME
```

Parameters

SENSOR-GROUP-NAME
    Specifies the name of the sensor group to be associated with the subscription.

sample-interval <10-3600>
    Defines the sampling interval in seconds for the sensor group. The interval can range from 10 to 3600 seconds.

Default

None

Command Mode

Telemetry-subscription Mode

Applicability

Introduced in OcNOS version 6.5.2.

Example

Ensure that the SENSOR-GROUP-NAME (`stream-1`) is already configured in the current configuration mode.

```
OcNOS#configure terminal
OcNOS(config)#show running-config streaming-telemetry
!
feature streaming-telemetry
 grpc-tunnel-server retry-interval 60
!
sensor-group stream-1
 sensor-path ipi:/interfaces/interface[name="eth0"]/state/counters
!
subscription-name sub-1
!
!
```

The following commands illustrates how to add a sensor group (`stream-1`) under subscription mode (`sub-1`) and verify the configuration using the show command output.

```
OcNOS(config)#subscription-name sub-1
OcNOS(telemetry-subscription)#sensor-group stream-1 sample-interval 1000
OcNOS(telemetry-subscription)#commit
OcNOS(telemetry-subscription)#exit
OcNOS(config)#show running-config streaming-telemetry
!
feature streaming-telemetry
 grpc-tunnel-server retry-interval 60
!
sensor-group stream-1
 sensor-path ipi:/interfaces/interface[name="eth0"]/state/counters
!
subscription-name sub-1
 sensor-group stream-1 sample-interval 1000
!
!
```

sensor-path

Use this command to add sensor paths under sensor-groups. Can add multiple sensor paths to a single sensor group.

Use `no` parameter of this command to remove sensor paths.

Command Syntax

```
sensor-path SENSOR-PATH
no sensor-path SENSOR-PATH
```

Parameters

SENSOR-PATH
Specifies the path of the telemetry data to include in the sensor group.

Default

None

Command Mode

Telemetry-sensor-group Mode

Applicability

Introduced in OcNOS version 6.5.2.

Example

The following example demonstrates how to configure a sensor group (`stream-1`) and add multiple sensor paths to it for streaming telemetry.

```
OcNOS#configure terminal
OcNOS(config)#sensor-group stream-1
OcNOS(telemetry-sensor-group)#sensor-path ipi:/interfaces/interface[name="eth0"]/state/counters
OcNOS(telemetry-sensor-group)#sensor-path /interfaces/interface[name="xe2"]/state/counters
OcNOS(telemetry-sensor-group)#sensor-path openconfig:/interfaces/interface[name="xe3"]/state/counters
OcNOS(telemetry-sensor-group)#commit
OcNOS(telemetry-sensor-group)#exit
```

show streaming-telemetry

Use this command to display the streaming-telemetry details of persistent (dial-out) and dynamic (dial-in) subscription connection details, including the POLL mode subscriptions per **VRF**[1].

The `show streaming-telemetry` and all its sub-commands also shows the maximum sensor-paths and minimum sample-interval for that platform.

Command Syntax

```
show streaming-telemetry (vrf (NAME|management)|)
```

Parameters

vrf NAME
   (Optional) Defines streaming telemetry in a user-defined VRF. Specify the VRF instance name.

vrf management
   (Optional) Defines streaming telemetry in the management VRF.

Command Mode

Execution mode

Applicability

Introduced in OcNOS version 6.5.2 and added the `vrf (NAME|management)` parameters in the OcNOS version 6.6.0.

Examples

The following example displays the streaming telemetry details.

```
OcNOS#show streaming-telemetry

Number of telemetry instances : 3 (default,VRF1,management)
Platform type                 : High range
Maximum sensor-paths          : 100
Minimum sample-interval       : 10
Number of active sensor-paths : 6 (Dial-In : 0, Dial-out : 6)

SI          : Sampling Interval in seconds
Enc-Type    : Encoding type
Origin:Path  : Sensor Path


1. Subscription Details (VRF-Name: default):
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  Port        : 9339
  TLS         : Disabled
  insecure-tls : False

Dial-Out Subscription Details:
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
1. Subscription-name    : storage
```

---

[1]Virtual Routing and Forwarding

```
    Status              : ACTIVE
    Enc-Type            : JSON
    Tunnel-server details:
    ~~~~~~~~~~~~~~~~~~~~~~
    Tunnel-server Retry-interval  : Default-60 (seconds)

     Destination-group         Status         Tunnel-IP:Port
     -----------------         ------         --------------
     Collector1                ACTIVE     10.12.101.72:11161
    Sensor-group details:
    ~~~~~~~~~~~~~~~~~~~~
    Sensor-group        SI           Origin:Path
    ------------        ----         -----------
       Platform         10           ipi:/components/component[name="RAM"]/ram/state
                                     ipi:/components/component[name="HARD-DISK"]/storage/state

2. Subscription Details (VRF-Name: VRF1):
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  Port       : 50000
  TLS        : Disabled
  insecure-tls : False

Dial-Out Subscription Details:
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
1. Subscription-name   : storage
    Status              : ACTIVE
    Enc-Type            : JSON
    Tunnel-server details:
    ~~~~~~~~~~~~~~~~~~~~~~
    Tunnel-server Retry-interval  : Default-60 (seconds)

     Destination-group         Status         Tunnel-IP:Port
     -----------------         ------         --------------
     Collector3                ACTIVE     10.21.3.4:11123
    Sensor-group details:
    ~~~~~~~~~~~~~~~~~~~~
    Sensor-group        SI           Origin:Path
    ------------        ----         -----------
       Platform         95           ipi:/components/component[name="RAM"]/ram/state
                                     ipi:/components/component[name="HARD-DISK"]/storage/state

3. Subscription Details (VRF-Name: management):
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  Port       : 60000
  TLS        : Disabled
  insecure-tls : False

Dial-Out Subscription Details:
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
1. Subscription-name   : storage2
    Status              : ACTIVE
    Enc-Type            : JSON
    Tunnel-server details:
    ~~~~~~~~~~~~~~~~~~~~~~
    Tunnel-server Retry-interval  : Default-60 (seconds)

     Destination-group         Status         Tunnel-IP:Port
     -----------------         ------         --------------
     Collector2                ACTIVE     10.21.3.4:11123
    Sensor-group details:
    ~~~~~~~~~~~~~~~~~~~~
    Sensor-group        SI           Origin:Path
    ------------        ----         -----------
       Platform         95           ipi:/interfaces/interface/state
                                     [*]ipi:/interfaces/interface/state/counters

  [*]-> Indicates child path learnt from parent config, not configured by user
```

The below table explains the output fields.

Table 8. show streaming-telemetry output details

Field	Description
Number of telemetry instances	Displays the total telemetry instances configured, including VRFs like management, user-defined, and default.
Platform type	Displays the platform type is standard or high range.
Maximum sensor-paths	Shows the maximum number of sensor paths configured. For more details, refer to the telemetry maximum-subscribe-paths (page 60) command.
Minimum sample-interval	Indicates the minimum sampling interval in seconds. For more details, refer to the telemetry minimum-sample-interval (page 61) command.
Number of active sensor-paths	Shows the total number of active sensor paths for Dial-In and Dial-Out subscriptions.
SI[1]	Represents the sampling interval (SI) in seconds at which telemetry data is collected.
Enc-Type	Indicates the encoding type (Enc-type) used for each subscription.
Origin:Path	Displays the origin and path of the data being monitored.
Port	Specifies the port (page 45) number range for the TLS gRPC connection.
TLS	Indicates whether the TLS connection is enabled or disabled.
insecure-tls	Indicates the TLS connection is secure (false) or not (true).
Subscription-name	Shows the name of the Dial-Out subscription.
Status	Indicates whether the subscription is ACTIVE or INACTIVE.
Tunnel-server details	Provides details about the tunnel server, including destination group, status, tunnel-server retry interval, and tunnel-IP:Port.
Tunnel-server Retry-interval	Displays the duration between retry attempts in seconds.
Sensor-group details	Show the details about the sensor group, including the sampling interval (SI) and origin:path.

---

[1]Signal integrity in networking refers to the reliability and fidelity of electrical signals as they propagate through various components of a network infrastructure.

show streaming-telemetry dynamic-subscriptions

Use this command to display the streaming telemetry dial-in configurations.

Command syntax

```
show streaming-telemetry (vrf (NAME|management)|) dynamic-subscriptions
```

Parameters

vrf NAME
    (Optional) Defines streaming telemetry in a user-defined **VRF**[1]. Specify the VRF instance name.

vrf management
    (Optional) Defines streaming telemetry in the management VRF.

Command Mode

Execution mode

Applicability

This command was introduced in OcNOS version 6.4.1. Added the `vrf (NAME|management)` parameter in the OcNOS version 6.6.0.

Examples

The following example displays the streaming telemetry dial-in configuration output.

```
OcNOS#show streaming-telemetry vrf management dynamic-subscriptions

Number of telemetry instances : 1 (management)
Platform type               : High range
Maximum sensor-paths        : 100
Minimum sample-interval     : 10
Number of active sensor-paths : 3 (Dial-In : 3, Dial-out : 0)

SI         : Sampling Interval in seconds
Enc-Type   : Encoding type
Origin:Path  : Sensor Path


1. Subscription Details (VRF-Name: management):
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  Port        : 60000
  TLS         : Disabled
  insecure-tls : False

Dial-In STREAM Mode Subscription Details:
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
ClientIP:Port        ID     SI     Enc-Type     Origin:Path
-------------        ------  ----   --------     ------------
10.16.12.10:48290    16525  91     JSON_IETF    openconfig:/components/component
[name="TEMPERATURE-HWM_Heater"]/state

                                                openconfig:/components/component
[name="TEMPERATURE-HWM_Heater"]/state/temperature
```

---

[1]Virtual Routing and Forwarding

```
                                                        openconfig:/components/component
  [name="TEMPERATURE-HWM_Heater"]/state/memory
```

Here is the explanation of the output fields.

Table 9. show streaming-telemetry dynamic-subscriptions output details

Field	Description
Number of telemetry instances	Displays the total telemetry instances configured, including VRFs like management, user-defined, and default.
Platform type	Displays the platform type is standard or high range.
Maximum sensor-paths	Shows the maximum number of sensor paths configured. For more details, refer to the telemetry maximum-subscribe-paths (page 60) command.
Minimum sample-interval	Indicates the minimum sampling interval in seconds. For more details, refer to the telemetry minimum-sample-interval (page 61) command.
Number of active sensor-paths	Shows the total number of active sensor paths for Dial-In and Dial-Out subscriptions.
SI[1]	Represents the sampling interval (SI) in seconds at which telemetry data is collected.
Enc-Type	Indicates the encoding type (Enc-type) used for each subscription.
Origin:Path	Displays the origin and path of the data being monitored.
Port	Specifies the port (page 45) number range for the TLS gRPC connection.
TLS	Indicates whether the TLS connection is enabled or disabled.
insecure-tls	Indicates the TLS connection is secure (false) or not (true).
Subscription-name	Shows the name of the Dial-Out subscription.
Status	Indicates whether the subscription is ACTIVE or INACTIVE.
Dial-In Subscription Details	Check the Dial-in subscription details.
ClientIP: Port	Verify that the client IP and port listed matches the client that should be receiving telemetry data.
SI: Sampling-interval	Confirm that the sampling interval matches the desired frequency at which data is collected and sent.
Enc-type: Encoding-type	Ensure that the encoding type (e.g., JSON_IETF) matches the expected format for telemetry data.
Origin:Path	Review the sensor paths to ensure that they correspond to the specific data sources or paths of interest.

[1]Signal integrity in networking refers to the reliability and fidelity of electrical signals as they propagate through various components of a network infrastructure.

show streaming-telemetry persistent-subscriptions

Use this command to display a brief summary of the streaming-telemetry dial-out configurations. This command provides a concise view of the persistent subscription settings configured on the device.

Command Syntax

```
show streaming-telemetry (vrf (NAME|management)|) persistent-subscriptions brief
show streaming-telemetry (vrf (NAME|management)|) persistent-subscriptions details (SUBSCRIPTION-
NAME|)
```

Parameters

SUBSCRIPTION-NAME
    Displays detailed configuration information specific to the named persistent subscription.

vrf NAME
    (Optional) Defines streaming telemetry in a user-defined **VRF**[1]. Specify the VRF instance name.

vrf management
    (Optional) Defines streaming telemetry in the management VRF.

Default

None

Command Mode

Execution mode

Applicability

Introduced in OcNOS version 6.5.2. Added the `vrf (NAME|management)` parameter in the OcNOS version 6.6.0.

Example

The command output lists each persistent subscription with its associated details.

```
OcNOS#show streaming-telemetry persistent-subscriptions details

Number of telemetry instances : 1 (default)
Platform type                 : High range
Maximum sensor-paths          : 100
Minimum sample-interval       : 10
Number of active sensor-paths : 2 (Dial-In : 0, Dial-out : 2)

SI        : Sampling Interval in seconds
Enc-Type  : Encoding type
Origin:Path : Sensor Path


1. Subscription Details (VRF-Name: default):
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  Port        : 9339
```

---

[1]Virtual Routing and Forwarding

```
   TLS         : Disabled
   insecure-tls : False

Dial-Out Subscription Details:
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
1. Subscription-name   : storage
   Status              : ACTIVE
   Enc-Type            : JSON
   Tunnel-server details:
   ~~~~~~~~~~~~~~~~~~~~~~
   Tunnel-server Retry-interval  : Default-60 (seconds)

    Destination-group       Status         Tunnel-IP:Port
    -----------------       ------         --------------
    Collector1              ACTIVE      10.12.101.72:11161
   Sensor-group details:
   ~~~~~~~~~~~~~~~~~~~~~~
   Sensor-group        SI           Origin:Path
   ------------        ----         -----------
    Platform           10           ipi:/components/component[name="RAM"]/ram/state
                                    ipi:/components/component[name="HARD-DISK"]/storage/state
```

```
OcNOS#show streaming-telemetry vrf VRF1 persistent-subscriptions brief

Number of telemetry instances : 3 (default,VRF1,management)
Platform type              : High range
Maximum sensor-paths       : 100
Minimum sample-interval    : 10
Number of active sensor-paths : 27 (Dial-In : 3, Dial-out : 24)

DG          : Destination Group
SG          : Sensor Group
SI          : Sampling Interval in seconds
Enc-Type    : Encoding type

1. Subscription Details (VRF-Name: VRF1):
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  Port        : 50000
  TLS         : Disabled
  insecure-tls : False

Dial-out subscription in brief:
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Tunnel-server Retry-interval  : Default-60 (seconds)

Subscription-Name  Status    Enc-Type       DG         SG-SI
-----------------  ------    --------       --         -----
    storage        ACTIVE     JSON        Collector3   Platform - 95
```

Here is the explanation of the output fields.

Table 10. `show streaming-telemetry persistent-subscriptions details` output fields

Field	Description
Number of telemetry instances	Displays the total telemetry instances configured, including VRFs like management, user-defined, and default.
Platform type	Displays the platform type is standard or high range.
Maximum sensor-paths	Shows the maximum number of sensor paths configured. For more details, refer to the telemetry maximum-subscribe-paths (page 60) command.
Minimum sample-interval	Indicates the minimum sampling interval in seconds. For more details, refer to the telemetry minimum-sample-interval (page 61) command.

Table 10. show streaming-telemetry persistent-subscriptions details output fields (continued)

Field	Description
Number of active sensor-paths	Shows the total number of active sensor paths for Dial-In and Dial-Out subscriptions.
Destination Group (DG)	Define the tunnel server settings to which telemetry data is sent for dial-out subscriptions.
Sensor Group (SG)	Sensor group associated with the subscription.
SI[1]	Represents the sampling interval (SI) in seconds at which telemetry data is collected.
Enc-Type	Indicates the encoding type (Enc-type) used for each subscription.
Origin:Path	Displays the origin and path of the data being monitored.
Port	Specifies the port (page 45) number range for the TLS gRPC connection.
TLS	Indicates whether the TLS connection is enabled or disabled.
insecure-tls	Indicates the TLS connection is secure (false) or not (true).
Subscription-name	Shows the name of the Dial-Out subscription.
Status	Indicates whether the subscription is ACTIVE or INACTIVE.
Tunnel-server details	Provides details about the tunnel server, including destination group, status, tunnel-server retry interval, and tunnel-IP:Port.
Tunnel-server Retry-interval	Displays the duration between retry attempts in seconds.
Sensor-group details	Show the details about the sensor group, including the sampling interval (SI) and origin:path.

---

[1]Signal integrity in networking refers to the reliability and fidelity of electrical signals as they propagate through various components of a network infrastructure.

show running-config streaming-telemetry

Use this command to display streaming telemetry status in the running configuration.

Command Syntax

```
show running-config streaming-telemetry
```

Parameters

None

Command Mode

Execution mode and Configure mode

Applicability

This command was introduced in OcNOS version 6.4.1.

Examples

The following example shows the streaming telemetry status in the `show running-config` output.

```
OcNOS#configure terminal
OcNOS(config)#feature streaming-telemetry
OcNOS(config)#commit
OcNOS(config)#show running-config streaming-telemetry
!
feature streaming-telemetry
!
OcNOS(config)#exit
```

subscription-name

Use this command to create named subscriptions for persistent telemetry configurations in an OcNOS device. The **VRF**[1] parameter must match the VRF specified in the [feature streaming-telemetry (page 42)](page 42) command. Multiple subscriptions can be created. These subscriptions are essential for activating streaming telemetry, as they define specific settings such as associated destination groups and sensor groups.

Use `no` parameter of this command to delete a subscription.

Command Syntax

```
subscription-name NAME (vrf (management|NAME)|)
no subscription-name NAME (vrf (management|NAME)|)
```

Parameters

subscription-name NAME
> Specifies the unique name to the persistent subscription.

vrf NAME
> (Optional) Creates named subscriptions in a user-defined VRF.

vrf management
> (Optional) Creates named subscriptions in the management VRF.

Default

None

Command Mode

Configure mode

Applicability

Introduced in OcNOS version 6.5.2.

Example

The following command demonstrates configuring a subscription (`sub-1`) on an OcNOS device. The subscription remains `in-active` because the sensor groups and destination groups have not been added to it.

```
OcNOS#configure terminal
OcNOS(config)#subscription-name sub-1
OcNOS(telemetry-subscription)#commit
Subscription sub-1 is "in-active": sensor-group(s) and destination-group(s) are not configured.
OcNOS(telemetry-subscription)#exit

OcNOS(config)#show running-config streaming-telemetry
!
feature streaming-telemetry
!
subscription-name sub-1
!
```

---

[1]Virtual Routing and Forwarding

telemetry maximum-subscribe-paths

Use this command to set the maximum number of telemetry subscription paths. Users can control how many sensor paths they can subscribe to at a time.

Use no form of the command to reset the telemetry subscribe path count to its default value.

Command Syntax

```
telemetry maximum-subscribe-paths <10-1000>
no telemetry maximum-subscribe-paths
```

Parameters

```
maximum-subscribe-paths <10-1000>
```

   Specifies the range of supported telemetry subscription paths to configure across all VRFs.

Default

If telemetry subscribe paths are not explicitly configured, the system sets it to **100 sensor paths for <u>high-end platforms</u>** and **50 sensor paths for <u>standard platforms</u>**.

Command Mode

Configure mode

Applicability

Introduced in OcNOS version 6.6.0

Examples

The show command output below displays the available configuration on a device.

```
OcNOS(config)#show running-config streaming-telemetry
!
feature streaming-telemetry vrf management
!
!
```

Here, the maximum subscription paths are set to 200, and the show command output confirms the configuration.

```
OcNOS(config)#telemetry maximum-subscribe-paths 200
OcNOS(config)#commit
```

```
OcNOS(config)#show running-config streaming-telemetry
!
feature streaming-telemetry vrf management
telemetry maximum-subscribe-paths 200
!
!
```

telemetry minimum-sample-interval

Use this command to set the minimum sample interval in seconds between telemetry data samples. Prevents excessive network and system resource consumption by ensuring telemetry updates are not sent too frequently.

Use no form of the command to reset the minimum sample interval to its default value.

Command Syntax

```
telemetry minimum-sample-interval <10-3600>
no telemetry minimum-sample-interval
```

Parameters

minimum-sample-interval <10-3600>

   Specifies the range in seconds for the minimum sampling interval across all VRFs.

Default

If telemetry mimum sample intervals are not explicitly configured, the system sets it to `10 seconds for high-end platforms` and `90 seconds for standard platforms`.

Command Mode

Configure mode

Applicability

Introduced in OcNOS version 6.6.0

Examples

This example sets the telemetry minimum sampling interval to `12 seconds`, and the show command output confirms the configuration.

```
OcNOS(config)#telemetry minimum-sample-interval 12
OcNOS(config)#commit

OcNOS(config)#show running-config streaming-telemetry
!
feature streaming-telemetry vrf management
telemetry minimum-sample-interval 12
!
!
```

tls tls-port

Use this command to enable secure or insecure TLS connection for streaming-telemetry.

Use the no parameter of this command to disable the secure or insecure TLS and restart the telemetry with a non-TLS connection.

> ✏️ **Note:** In OcNOS, streaming telemetry over TLS secures incoming packets for dial-in connections. TLS is not supported for dial-out mode subscriptions.

Command Syntax

```
tls tls-port <32768-60999>
no tls tls-port <32768-60999>

tls tls-port <32768-60999> insecure
no tls tls-port <32768-60999> insecure
no insecure
```

Parameters

tls-port <32768-60999>

Specifies the port number range for the secure TLS gRPC connection.

insecure

Disables certificate validation in a TLS-enabled connection.

Default

Disabled

Command Mode

Feature telemetry configure mode

Applicability

Introduced in OcNOS version 6.6.0

Examples

Secure TLS

Enable or disable the TLS connection on the desired port.

To verify the TLS connection status, check the `TLS` and `insecure-tls` fields in the show output. If the `TLS` field shows `enabled`, the TLS connection is active. If the `insecure-tls` field is marked as `false`, it means that the provided certificates are validated.

```
OcNOS(config)#feature streaming-telemetry vrf management
OcNOS(feature-telemetry-config)#tls tls-port 34567
OcNOS(feature-telemetry-config)#commit
```

```
OcNOS(config)#show running-config streaming-telemetry
!
feature streaming-telemetry vrf management
tls tls-port 34567
!

OcNOS#show streaming-telemetry vrf management

 Number of telemetry instances : 1 (management)
 Platform type                 : High range
 Maximum sensor-paths          : 100
 Minimum sample-interval       : 10
 Number of active sensor-paths : 1 (Dial-In : 1, Dial-out : 0)

 SI          : Sampling Interval in seconds
 Enc-Type    : Encoding type
 Origin:Path : Sensor Path


 1. Subscription Details (VRF-Name: management):
 ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
   Port        : 34567
   TLS         : Enabled
   insecure-tls : False

 Dial-In STREAM Mode Subscription Details:
 ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 ClientIP:Port        ID      SI      Enc-Type    Origin:Path
 ------------        ------   ----    --------    ------------
 10.12.42.10:49828   53207   90        JSON      ipi:/interfaces/interface[name="eth0"]/state

OcNOS(config)#feature streaming-telemetry vrf management
OcNOS(feature-telemetry-config)#no tls tls-port 34567
OcNOS(feature-telemetry-config)#commit
```

Insecure TLS

Enable or disable insecure TLS connection on the desired port. In the show output fields, if the `insecure-tls` field is marked as `true`, it means that the provided certificates are not validated.

```
OcNOS(config)#feature streaming-telemetry vrf management
OcNOS(feature-telemetry-config)#tls tls-port 34567 insecure
OcNOS(feature-telemetry-config)#commit

OcNOS(config)#show running-config streaming-telemetry
!
feature streaming-telemetry vrf management
tls tls-port 34567 insecure
!
!

OcNOS#show streaming-telemetry vrf management

 Number of telemetry instances : 1 (management)
 Platform type                 : High range
 Maximum sensor-paths          : 100
 Minimum sample-interval       : 10
 Number of active sensor-paths : 2 (Dial-In : 2, Dial-out : 0)

 SI          : Sampling Interval in seconds
 Enc-Type    : Encoding type
 Origin:Path : Sensor Path


 1. Subscription Details (VRF-Name: management):
 ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
```

```
   Port        : 34567
   TLS         : Enabled
   insecure-tls : True

 Dial-In STREAM Mode Subscription Details:
 ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 ClientIP:Port          ID     SI     Enc-Type     Origin:Path
 -------------          ------ ----   --------     ------------
 10.14.105.105:47938    13085  90              JSON  ipi:/interfaces/interface[name="eth0"]/state
                                                     ipi:/interfaces/interface
[name="eth0"]/state/counters
```

```
OcNOS(config)#feature streaming-telemetry vrf management
OcNOS(feature-telemetry-config)#no tls tls-port 34567 insecure
OcNOS(feature-telemetry-config)#commit

OR

OcNOS(config)#feature streaming-telemetry vrf management
OcNOS(feature-telemetry-config)#no insecure
OcNOS(feature-telemetry-config)#commit
```

tunnel-server

Use this command to add tunnel-servers under destination groups. Can create multiple tunnel servers within a destination group.

Use `no` parameter of this command to remove a tunnel server from the destination group.

Command Syntax

```
tunnel-server ip A.B.C.D port <1-65535>
no tunnel-server ip A.B.C.D port <1-65535>
```

Parameters

ip A.B.C.D
> Specifies the tunnel server IP address.

port <1-65535>
> Specifies the tunnel server port-number.

Default

None

Command Mode

Telemetry-GRPC-tunnel-group Mode

Applicability

Introduced in OcNOS version 6.5.2.

Example

The following command demonstrates how to add a tunnel server within the destination group.

```
OcNOS#configure terminal
OcNOS(config)#destination-group tunnel-1
OcNOS(telemetry-grpc-tunnel-group)#tunnel-server ip 10.12.66.160 port 11163
OcNOS(telemetry-grpc-tunnel-group)#commit
OcNOS(telemetry-grpc-tunnel-group)#exit
```

Troubleshooting

Follow the below troubleshooting steps, to debug telemetry related issues:

Verify Collector (gnmic) Command Options: Verify the input parameters, such as the sensor path, prefix and origin `"ipi:"`.

Check the Encoding Method Compatibility: Check that the request conforms to the supported encoding methods.

Ensure Proper Connectivity: Validate the connectivity between the router and the remote management system. This involves verifying network settings, ports, firewalls, and any potential disruptions in communication.

Collector: If `gnmic` does not receive a response or not receiving expected response, restart the request using the "`--log`" option. If more verbose debug output is needed, consider adding the "`--debug`" option as well. The gnmic tool displays the possible cause for any error, which helps in debugging the issue.

gNMI Server: If the issue is on server side, follow the steps below to troubleshoot telemetry issues on the OcNOS target. Enable debug and verify the logs in `/var/log/messages` file.

1. In configure mode, enable debug with a specific severity level either "`info`" or "`debug`" level, using the debug telemetry gnmi (page 36) command.

   > **Note:** To disable the debug telemetry, configure `debug telemetry gnmi (disable)` command.

2. In Exec mode, enable telemetry related debugs, using the debug cml (page 35) command.

   > **Note:** To disable telemetry related debugs, configure "`debug cml disable telemetry`" command.

3. To check the state of streaming telemetry, collect the output of the following commands based on the telemetry mode:

   - For Dial-in mode, use: `show streaming-telemetry dynamic-subscriptions (page 53)`.
   - For Dial-out mode, use: `show streaming-telemetry persistent-subscriptions (page 55)`.

> **Notes:**
>
> - For Dial-out mode, Subscription status could become inactive for the following reasons:
>   - Sensor group(s) and destination group(s) are not configured
>   - Destination group(s) are not configured
>   - Sensor group(s) are not configured
>   - Sensor-group(s) doesn't have any sensor-path(s) configured, and destination-group(s) doesn't have any tunnel-server(s) configured.
>   - Destination-group(s) doesn't have any tunnel-server(s) configured
>   - Sensor-group(s) doesn't have any sensor-path(s) configured
> - If telemetry is in "`disabled`" state, then telemetry feature need to enabled.

4. Collect the output of the **`show techsupport gnmi`** command to gather diagnostic information and the logs in `/var/log/messages` file, to triage further.

GNMI GET RPC MODE

Overview

The gNMI Get RPC in OcNOS enables on-demand retrieval of network configuration, state, or operational data. It allows clients to fetch real-time state or configuration snapshots without requiring continuous monitoring.

> **Notes:**
>
> - The system supports IPI and OpenConfig (OC) XPaths and uses `JSON_IETF` encoding for responses.
> - Implicit wildcard paths (`e.g., /interfaces/interface/state`) are supported, simplifying data retrieval, but explicit wildcard paths are not.

Feature Characteristics

The and illustrates the gNMI Get RPC workflow in OcNOS, where a gNMI client requests specific telemetry data from a gNMI server (OcNOS target), which then processes the request and retrieves data from the Centralized Management and Logging Daemon (CMLd) and Protocol Modules (PM) or SQL Database. The response is converted into `JSON_IETF` format and sent back to the client.

Figure 2. Sample Get RPC Request
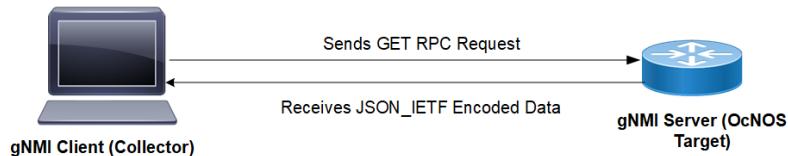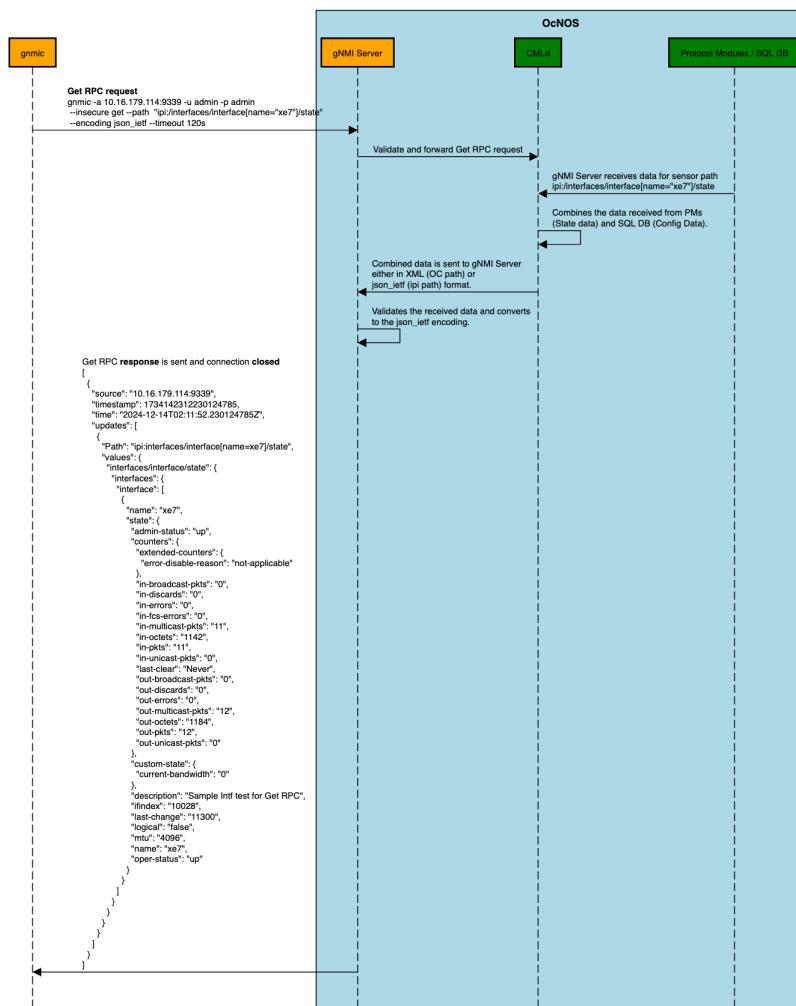
Figure 3. gNMI Get Mode Data Flow

1. The gNMI client sends a Get RPC request to the OcNOS device with the required sensor path, data type (`State`, `Configuration`, or `All`), and encoding type (JSON_IETF).

2. The gNMI server validates the request and forwards it to CMLd. It performs validations on XPath correctness, encoding type (`JSON_IETF`), requested data type (`State`, `Configuration`, or `All`). Once validated, the gNMI server forwards the request to CMLd.

3. CMLd fetches state data from PMs and configuration data from the SQL database. The retrieved data is combined before being sent back to the gNMI server.

4. The gNMI server processes the response, converts it into `JSON_IETF` format, and sends it to the gNMI client (`gnmic`).

5. The Get RPC response is received, and the connection is closed.

Benefits

Reduced Network Overhead: Fetches only requested data, minimizing unnecessary telemetry traffic.

On-Demand Data Access: Eliminates the need for continuous monitoring while providing real-time insights.

Configuration

This section explains how to send and receive Get RPC requests for three use cases: Configuration data, State data, and All data types.

Prerequisites
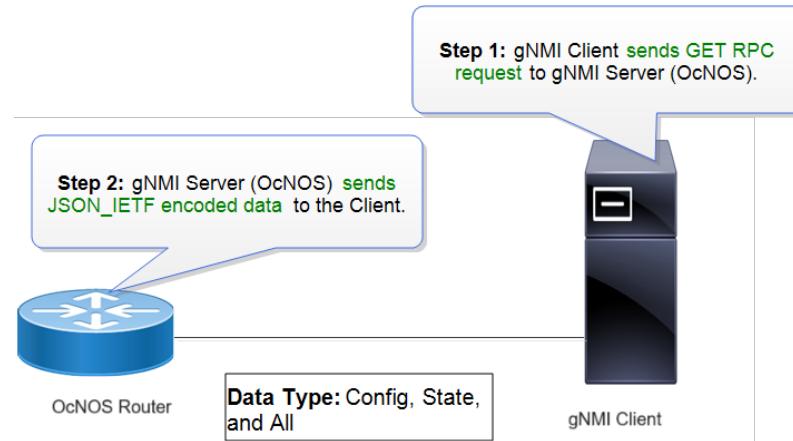
Before configuring streaming telemetry with TLS, ensure the following:

- A supported OcNOS router running a compatible release.
- Access to the management interface of the router.
- Any gNMI client that complies with gNMI specifications can be used as a client.
- Download and install the gNMI collector package by referring to the Streaming Telemetry (page 25) section.
- Generate the server and client certificates following the Certificate Management for OcNOS and gNMI (page 111) process to enable secure communication.

Topology

The Figure 4. Get RPC Connection (page 70) illustrates how the gNMI client connects to the OcNOS router to send all data type Get RPC request.

Figure 4. Get RPC Connection

Step 1: gNMI Client sends GET RPC request to gNMI Server (OcNOS).

Step 2: gNMI Server (OcNOS) sends JSON_IETF encoded data to the Client.

OcNOS Router

Data Type: Config, State, and All

gNMI Client

> **Note:** Before configuring, meet all Prerequisites (page 70).

Use Case 1: Get RPC Requests for Configuration Data Type

The `gnmic` command retrieves `configuration data` from the specified device. The **`--type config`** flag specifies that the data is of type `configuration`. The response includes configuration settings for the interface named `po1`, such as the `MTU` value and the `enable-switchport` setting, which are part of the device's configuration.

```
  ./gnmic -a 10.12.162.22:9339 -u admin -p admin --insecure get  --path "ipi:/interfaces/interface
[name="po1"]" --encoding json_ietf --type config --timeout 120s
[
  {
    "source": "10.12.162.22:9339",
    "timestamp": 1730122009406462625,
    "time": "2024-10-28T13:26:49.406462625Z",
    "updates": [
      {
        "Path": "ipi:interfaces/interface[name=\"po1\"]",
        "values": {
          "interfaces/interface": {
            "interfaces": {
              "interface": [
                {
                  "config": {
                    "enable-switchport": "",
                    "mtu": "300",
                    "name": "po1"
                  },
                  "name": "po1"
                }
              ]
            }
          }
        }
      }
    ]
  }
]
```

Use Case 2:Get RPC Requests for State Data Type

The gnmic command retrieves state data from the specified device. The **--type state** flag specifies that the data being retrieved is of type state. The response includes various operational details for the interface named ge1, such as its admin-status, oper-status, and various packet counters, which reflect the current state of the interface. This data provides information on the interface's operational condition, such as whether it is up or down, and details like in-packets, out-packets, and error-disable-reason, which monitors and troubleshoots the interface's performance.

```
  ./gnmic -a 10.12.162.22:9339 -u admin -p admin --insecure get --path  "ipi:/interfaces/interface
[name=\"ge1\"]/state" --encoding json_ietf --type state --timeout 120s
[
  {
    "source": "10.12.162.22:9339",
    "timestamp": 1730123321680355567,
    "time": "2024-10-28T13:48:41.680355567Z",
    "updates": [
      {
        "Path": "ipi:interfaces/interface[name=\"ge1\"]/state",
        "values": {
          "interfaces/interface/state": {
            "interfaces": {
              "interface": [
                {
                  "name": "ge1",
                  "state": {
                    "admin-status": "up",
                    "counters": {
                      "extended-counters": {
                        "error-disable-reason": "not-applicable"
                      },
                      "in-broadcast-pkts": "0",
                      "in-discards": "0",
                      "in-errors": "0",
```

```
                              "in-fcs-errors": "0",
                              "in-multicast-pkts": "0",
                              "in-octets": "0",
                              "in-pkts": "0",
                              "in-unicast-pkts": "0",
                              "last-clear": "2024 Oct 28 11:59:43 (01:48:58 ago)",
                              "out-broadcast-pkts": "0",
                              "out-discards": "0",
                              "out-errors": "0",
                              "out-multicast-pkts": "0",
                              "out-octets": "0",
                              "out-pkts": "0",
                              "out-unicast-pkts": "0"
                            },
                            "custom-state": {
                              "current-bandwidth": "0"
                            },
                            "enable-switchport": "",
                            "ifindex": "5001",
                            "last-change": "103900",
                            "logical": "false",
                            "name": "ge1",
                            "oper-status": "down"
                          }
                        }
                      ]
                    }
                  }
                }
              }
            ]
          }
        }
      ]
```

Use Case 3:Get RPC Requests for All Data Types

The `gnmic` command retrieves `all data` types for the specified BGP instance. In this case, the **`--type`** flag is not used, meaning that the command will retrieve both configuration and state data related to the BGP instance with AS number `100`. The response includes the configuration and state information for the BGP instance and its peers, such as:

• **Configuration Data:**

   a. `bgp-as: 100` confirms the AS number for the BGP instance.

   b. `peer-address: 4.4.4.1` and `peer-as: 100` show the configuration of BGP peers.

• **State Data:**

   a. `bgp-peer-state: idle` indicates the state of the BGP peer (idle in this case).

   b. The counters, such as `notification-in: 0`, `update-message-in: 0`, and `update-message-out: 0`, reflect the number of BGP notifications and update messages received and sent.

   c. `total-prefixes: 0` indicates that no prefixes are being exchanged yet.

```
# ./gnmic -a 10.12.162.22:9339 -u admin -p admin --insecure get  --path "ipi:/bgp/bgp-instances/bgp-
instance[bgp-as=100]" --encoding json_ietf --timeout 120s
[
  {
    "source": "10.12.162.22:9339",
    "timestamp": 1730120826528664430,
    "time": "2024-10-28T13:07:06.52866443Z",
```

```
    "updates": [
      {
        "Path": "ipi:bgp/bgp-instances/bgp-instance[bgp-as=100]",
        "values": {
          "bgp/bgp-instances/bgp-instance": {
            "bgp": {
              "bgp-instances": {
                "bgp-instance": [
                  {
                    "bgp-as": "100",
                    "config": {
                      "bgp-as": "100"
                    },
                    "peers": {
                      "peer": [
                        {
                          "config": {
                            "peer-address": "4.4.4.1",
                            "peer-as": "100"
                          },
                          "peer-address": "4.4.4.1",
                          "state": {
                            "bgp-peer-state": "idle",
                            "counters": {
                              "notification-in": "0",
                              "notification-out": "0",
                              "update-message-in": "0",
                              "update-message-out": "0"
                            },
                            "dynamically-configured": "false",
                            "peer-address": "4.4.4.1",
                            "peer-as": "100",
                            "peer-type": "ibgp"
                          }
                        },
                        {
                          "config": {
                            "peer-address": "4.4.4.5",
                            "peer-as": "100"
                          },
                          "peer-address": "4.4.4.5",
                          "state": {
                            "bgp-peer-state": "idle",
                            "counters": {
                              "notification-in": "0",
                              "notification-out": "0",
                              "update-message-in": "0",
                              "update-message-out": "0"
                            },
                            "dynamically-configured": "false",
                            "peer-address": "4.4.4.5",
                            "peer-as": "100",
                            "peer-type": "ibgp"
                          }
                        }
                      ]
                    },
                    "rib": {
                      "address-family": [
                        {
                          "afi": "link-state",
                          "safi": "link-state",
                          "state": {
                            "afi": "link-state",
                            "safi": "link-state"
                          }
                        }
                      ]
```

```
                        },
                        "state": {
                          "bgp-as": "100",
                          "router-run-time-ip-address": "0.0.0.0",
                          "scan-remain-time": "35",
                          "table-version": "1",
                          "total-prefixes": "0",
                          "version": "4"
                        }
                      }
                    ]
                  }
                }
              }
            }
          }
        ]
      }
    ]
```

STREAMING TELEMETRY DIAL-IN MODE

Overview

Dial-in mode in streaming telemetry enables collectors to initiate connections with OcNOS routers to receive operational data of interest. In this mode, the collector sends a Subscribe Remote Procedure Call (RPC) request to the gNMI server (OcNOS target device), specifying the data paths to monitor. The server then streams the requested telemetry data to the collector, facilitating proactive network monitoring and troubleshooting.
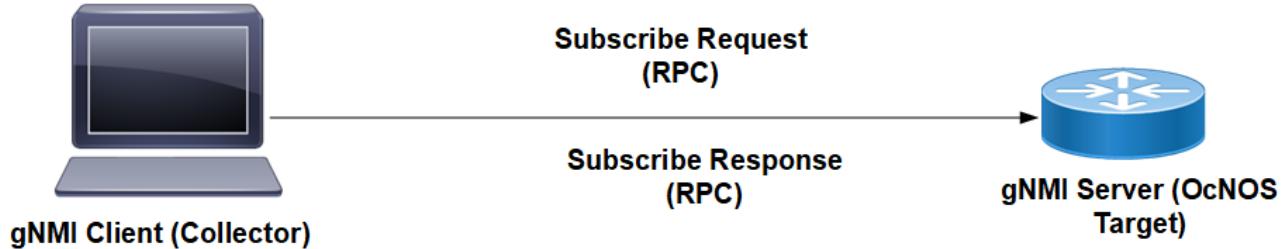
Feature Characteristics

The gNMI-based Dial-in mode telemetry for the management plane supports three types of telemetry subscriptions: **Poll, Once, and Stream**. It enables the "STREAM" type subscription with "SAMPLING" mode for the Subscribe RPC. The gNMI-based collector connects to the OcNOS target device and invokes the Subscribe RPC, specifying the set of path(s) of interest. Two key components are involved in this process:

- **gNMI Server (OcNOS Target):** The gNMI server operates within the OcNOS device, serving as the source of telemetry data. It supports the gNMI protocol, allowing gNMI-based clients (collectors) to request and receive streaming data. The server streams the requested data to the client according to the specified parameters.

- **gNMI Client (Collector):** The gNMI client, also known as the collector, runs outside the OcNOS target device and is responsible for receiving and gathering telemetry data. In this context, it is the entity that connects to the OcNOS target device to collect data using the gNMI protocol. The collector initiates the Subscribe RPC to specify the data of interest.

Figure 5 illustrates the gNMI client's (Collector) Subscribe request and response (RPC) interaction with the gNMI server (OcNOS Target).

Figure 5. Sample Subscribe Request

Example Message Flow: Subscribe Request and Response

Figure 6 illustrates a sample gnmic Subscribe Request and Subscribe Response between the collector and the OcNOS target device.

Step 1: Subscription Request Initiation

- The gnmic collector server initiates a Subscribe Request by sending a Subscribe RPC in Stream type.

- This subscription request aims explicitly to gather data related to interface state counters and CPU state.
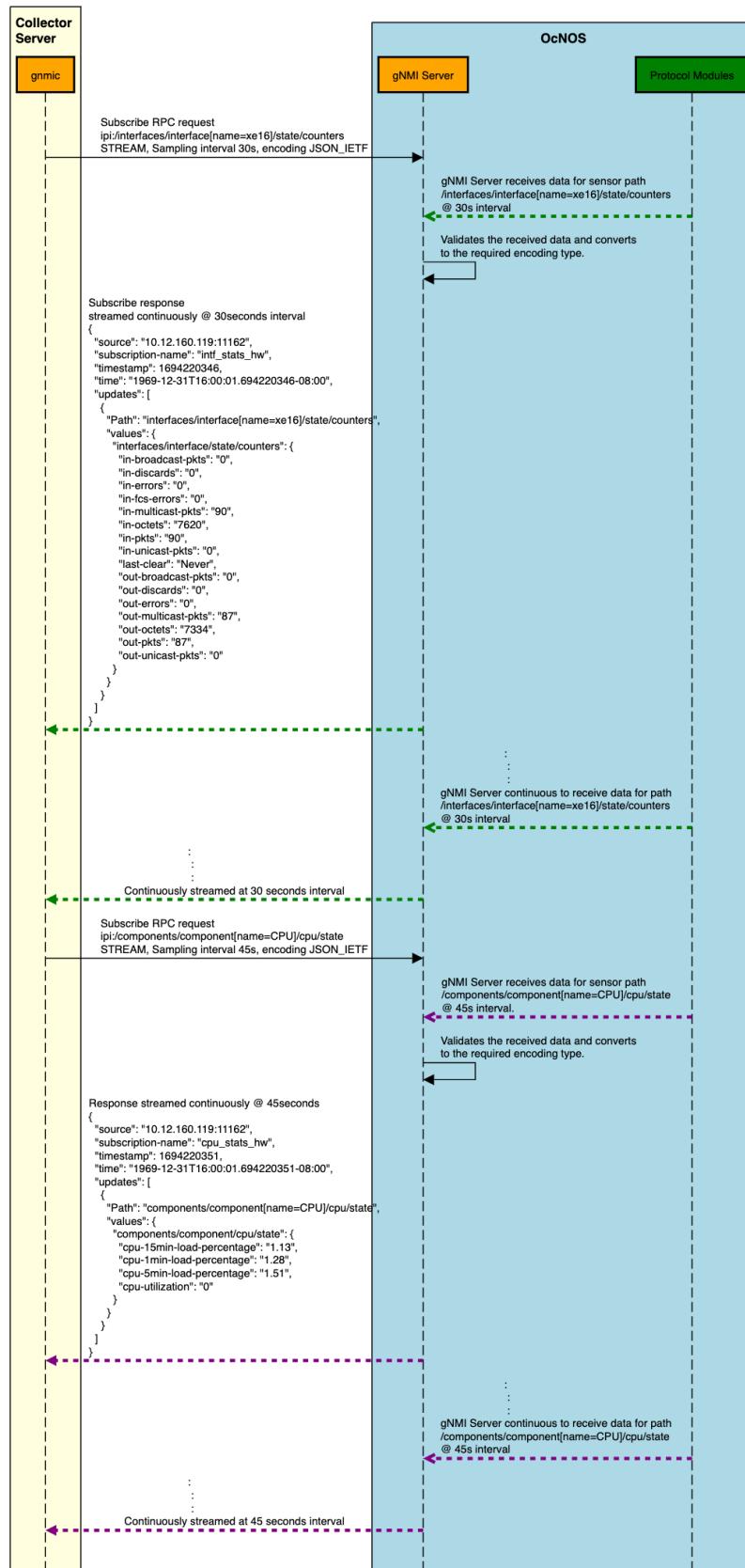
- A fixed 30/45-second sampling interval is set for data collection.

Step 2: Data Collection and Processing

- The gNMI server, within the OcNOS router, is responsible for data collection.
- At regular 30/45-second intervals, it retrieves data from the sensor path, focusing on interface state counters and CPU State.
- The received data undergoes a validation process, and the data is transformed into the required encoding type.

Step 3: Continuous Subscription Response Streaming

- The gNMI Server responds to the subscription request by continuously streaming Subscribe Response data.
- This streaming process maintains the same 30/45-second interval as the data collection.
- The collected data is streamed in real-time to the gnmic collector server.

Figure 6. Message Flow: Subscribe Request and Response

Benefits

Proactive Network Monitoring: Obtain real-time insights into network health and performance, and how to enable quicker response to issues.

Resource Utilization Monitoring: Monitor CPU and memory utilization to optimize resource allocation and performance.

Predictive Troubleshooting: Identify patterns and potential issues before they impact the network, reducing downtime.

**Automation and Resilience:** Use telemetry data to automate network management tasks and design a more resilient network.

Prerequisites

Before configuring Dial-In mode, ensure that:

- A supported OcNOS router running a compatible release.
- Access to the management interface of the router.
- Any gNMI client that complies with gNMI specifications can be used as a client.
- Refer to the Streaming Telemetry (page 25) to download the gNMI collector package.
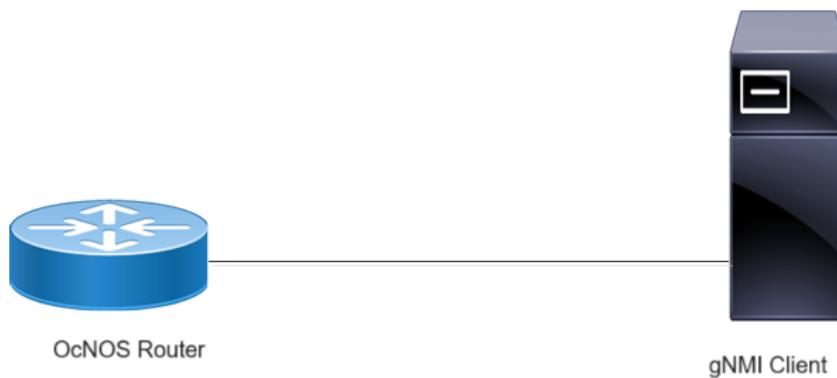
Configuration

In this example, streaming telemetry with OcNOS is demonstrated, using 'gnmic' as the gNMI Client.

> **Note:** To install the gnmic tool for managing network devices using gNMI, refer to the Streaming Telemetry (page 25).

Figure 7. Dial-In Streaming Telemetry Topology

OcNOS Router   gNMI Client

> **Note:** Before configuring Dial-In, meet all Prerequisites (page 78).

Enable streaming telemetry in a default **VRF**[1] on OcNOS:

```
OcNOS#configure terminal
OcNOS(config)#feature streaming-telemetry
OcNOS(feature-telemetry-config)#commit
OcNOS(feature-telemetry-config)#exit
```

Telemetry Subscription Request via gnmic Command and YAML Input

Use the gnmic command with a YAML file input to request telemetry subscriptions with multiple paths.

```
gnmic -a <ipaddress:port> -u <UserName> -p <Password> --insecure  --config <path to config file>
subscribe
```

This command establishes a telemetry subscription with the specified paths defined in the YAML file.

Telemetry Subscription Request via gnmic Command with a Single Path Option

Use the gnmic command with a single path option to request a telemetry subscription for a specific data path.

```
gnmic -a  <ipaddress:port> -u <UserName> -p <Password> --encoding [json, json_ietf] --insecure --mode
STREAM --stream-mode sample --sample-interval sample-interval-value sub --path <path>
```

```
gnmic -a  <ipaddress:port> -u <UserName> -p <Password> --encoding [json, json_ietf] --insecure --mode
[POLL, ONCE] sub --path <path>
```

```
gnmic -a <ipaddress:port> -u <UserName> -p <Password> --encoding proto --insecure --mode STREAM --
stream-mode sample --sample-interval sample-interval-value sub --path <path> --proto-file IPI_
OC.proto
```

This command creates a telemetry subscription for the specified path with the chosen sample interval and encoding format.

Supported gnmic Options

The following table explains the option fields.

Table 11. gnmic Option Details

Option	Description
--encoding	Specifies the encoding format as either `json`, `proto`, or `json_ietf`. The default encoding format is `json`.
--mode	Sets the mode of operation `(STREAM, POLL, and ONCE).`
--insecure	Allows insecure connections.
--stream-mode	Sets the stream mode `(Sample)`.
--sample-interval	Sets the sample interval `(10s)`.

---

[1]Virtual Routing and Forwarding

Table 11. gnmic Option Details (continued)

Option	Description
	Note: Interval should be 10s or more.
--config	Specifies the YAML configuration file path (Example: `input_path.yaml`).
--path	Sets the path to subscribe to specific data (Example: `'ipi:/interfaces/interface[name]/state'`). Note: For multiple paths specify each path with --path option.
--prefix	Defines a common prefix for all specified paths (Example: `'ipi:/interfaces'`).
--proto-file	Path to Proto file (Example: `IPI_OC.proto`).

Invoking Subscribe RPC with gnmic

Use Case 1: Monitoring Interface State with Single Path Option

In this use case, gnmic subscribes to a specific path using the Subscribe RPC, monitoring the state of an interface with the path `'ipi:/interfaces/interface[name="ce51"]/state'`.

```
#gnmic -a 10.12.91.111:9339 -u ocnos -p ocnos --encoding json_ietf --insecure   --mode STREAM --
stream-mode sample --sample-interval 10s sub --path 'ipi:/interfaces/interface[name="ce51"]/state'

{
  "source": "10.12.91.111:9339",
  "subscription-name": "default-1695368813",
  "timestamp": 1550833401338910123,
  "time": "2019-02-22T11:03:21.388930123Z",
  "updates": [
    {
      "Path": "ipi:interfaces/interface[name=\"ce51\"]/state",
      "values": {
        "interfaces/interface/state": {
          "admin-status": "up",
          "counters": {
            "in-broadcast-pkts": "0",
            "in-discards": "0",
            "in-errors": "0",
            "in-fcs-errors": "0",
            "in-multicast-pkts": "23",
            "in-octets": "2126",
            "in-pkts": "23",
            "in-unicast-pkts": "0",
            "last-clear": "Never",
            "out-broadcast-pkts": "0",
            "out-discards": "0",
            "out-errors": "0",
            "out-multicast-pkts": "28",
            "out-octets": "2552",
            "out-pkts": "28",
            "out-unicast-pkts": "0"
          },
          "ifindex": 10051,
          "last-change": 15500,
          "logical": false,
          "oper-status": "up"
        }
      }
    }
  ]
}
```

The output of the Subscribe RPC includes the following information:

Table 12. Subscribe RPC Output details

Option	Description
source	The source IP address and port of the gNMI server.
subscription-name	The name of the subscription.
timestamp	Indicates the exact time when the source (protocol modules) collects the telemetry data, not when the gNMI server sends the response packet.
time	The timestamp in a human-readable format.
updates	An array of updates, each containing Path and Values.
Path	The path to the subscribed data.
values	The values of the subscribed data.

Validation

The below show command provides details about the subscriptions that have been established, including the client ID, sampling interval, encoding type, and the sensor paths that are being monitored.

```
OcNOS#show streaming-telemetry dynamic-subscriptions

Number of telemetry instances : 1 (default)
Platform type              : High range
Maximum sensor-paths       : 100
Minimum sample-interval    : 10
Number of active sensor-paths : 2 (Dial-In : 2, Dial-out : 0)

SI         : Sampling Interval in seconds
Enc-Type   : Encoding type
Origin:Path  : Sensor Path


1. Subscription Details (VRF-Name: default):
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  Port        : 9339
  TLS         : Disabled
  insecure-tls : False

Dial-In STREAM Mode Subscription Details:
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
ClientIP:Port         ID    SI    Enc-Type       Origin:Path
-------------        ------ ----  --------       ------------
10.12.43.165:59304   4148   10    JSON_IETF    ipi:interfaces/interface
[name="ce51"]/state/counters

                                         ipi:interfaces/interface[name="ce51"]/state
```

Use Case 2: Monitoring Interface State with Multiple Path Option

In this use case, gnmic subscribes to a specific path using the Subscribe RPC, monitoring the state of an interface with the multiple path `'ipi:/interfaces/interface[name="ce51"]/state'` and `'ipi:/interfaces/interface[name="ce52"]/state'`.

```
#gnmic -a  10.12.91.111:9339 -u ocnos -p ocnos --encoding json_ietf  --insecure   --mode STREAM --
stream-mode sample --sample-interval 11s sub --path 'ipi:interfaces/interface[name="ce51"]/state' --
path 'ipi:interfaces/interface[name="ce52"]/state'
```

```
{
  "source": "10.12.91.111:9339",
  "subscription-name": "default-1695377304",
  "timestamp": 1550833401384910124,
  "time": "2019-02-22T11:03:21.388940124Z",
  "updates": [
    {
      "Path": "ipi:interfaces/interface[name=\"ce51\"]/state",
      "values": {
        "interfaces/interface/state": {
          "admin-status": "up",
          "counters": {
            "in-broadcast-pkts": "0",
            "in-discards": "0",
            "in-errors": "0",
            "in-fcs-errors": "0",
            "in-multicast-pkts": "10",
            "in-octets": "1060",
            "in-pkts": "10",
            "in-unicast-pkts": "0",
            "last-clear": "Never",
            "out-broadcast-pkts": "0",
            "out-discards": "0",
            "out-errors": "0",
            "out-multicast-pkts": "10",
            "out-octets": "1020",
            "out-pkts": "10",
            "out-unicast-pkts": "0"
          },
          "ifindex": 10051,
          "last-change": 22500,
          "logical": false,
          "oper-status": "up"
        }
      }
    }
  ]
}

{
  "source": "10.12.91.111:9339",
  "subscription-name": "default-1695377304",
  "timestamp": 1550833401385910125,
  "time": "2019-02-22T11:03:21.388950125Z",
  "updates": [
    {
      "Path": "ipi:interfaces/interface[name=\"ce52\"]/state",
      "values": {
        "interfaces/interface/state": {
          "admin-status": "up",
          "counters": {
            "in-broadcast-pkts": "0",
            "in-discards": "0",
            "in-errors": "0",
            "in-fcs-errors": "0",
            "in-multicast-pkts": "13",
            "in-octets": "1664",
            "in-pkts": "13",
            "in-unicast-pkts": "0",
            "last-clear": "Never",
            "out-broadcast-pkts": "0",
            "out-discards": "0",
            "out-errors": "0",
            "out-multicast-pkts": "10",
            "out-octets": "1020",
            "out-pkts": "10",
            "out-unicast-pkts": "0"
```

```
            },
            "ifindex": 10052,
            "last-change": 22500,
            "logical": false,
            "oper-status": "up"
          }
        }
      }
    ]
  }
```

Validation

The below show command provides details about the subscriptions that have been established, including the client ID, sampling interval, encoding type, and the sensor paths that are being monitored.

```
OcNOS#show streaming-telemetry dynamic-subscriptions

Number of telemetry instances : 1 (default)
Platform type                 : High range
Maximum sensor-paths          : 100
Minimum sample-interval       : 10
Number of active sensor-paths : 4 (Dial-In : 4, Dial-out : 0)

SI          : Sampling Interval in seconds
Enc-Type    : Encoding type
Origin:Path : Sensor Path


1. Subscription Details (VRF-Name: default):
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  Port        : 9339
  TLS         : Disabled
  insecure-tls : False

Dial-In STREAM Mode Subscription Details:
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
ClientIP:Port         ID     SI    Enc-Type     Origin:Path
-------------         ------ ----  --------     ------------
10.12.43.145:59334    42000  11    JSON_IETF    ipi:interfaces/interface
[name="ce52"]/state/counters

                                               ipi:interfaces/interface[name="ce52"]/state
                                               ipi:interfaces/interface
[name="ce51"]/state/counters

                                               ipi:interfaces/interface[name="ce51"]/state
```

Use Case 3: Monitoring Interface State Using Proto Encoding for IPI Xpath

In this use case, gnmic subscribes to the specified path using the Subscribe RPC, monitoring the state of an interface `ipi:/interfaces/interface[name="eth0"]/state` using the proto encoding.

```
./gnmic -a 10.12.160.119:9339 -u admin -p admin --insecure --mode STREAM --stream-mode sample --
sample-interval 10s subscribe --path 'ipi:/interfaces/interface[name="eth0"]/state' --encoding proto
--proto-file IPI_OC.proto

{
  "source": "10.12.160.119:9339",
  "subscription-name": "default-1713864599",
  "timestamp": 1550833401388910124,
  "time": "2019-02-22T11:03:21.388910124Z",
  "updates": [
    {
      "Path": "ipi:interfaces/interface[name=\"eth0\"]/state",
      "values": {
        "interfaces/interface/state": {
```

```
          "adminStatus": "up",
          "counters": {
            "inMulticastPkts": "159435",
            "inOctets": "902863924",
            "inPkts": "732970",
            "lastClear": "Never",
            "outOctets": "8931839",
            "outPkts": "105457"
          },
          "ifindex": 3,
          "lastChange": 8000,
          "operStatus": "up"
        }
      }
    }
  ]
}
```

Validation

The below show command provides details about the subscriptions that have been established, including the client ID, sampling interval, encoding type, and the sensor paths that are being monitored.

```
OcNOS#show streaming-telemetry dynamic-subscriptions

Number of telemetry instances : 1 (default)
Platform type                 : High range
Maximum sensor-paths          : 100
Minimum sample-interval       : 10
Number of active sensor-paths : 2 (Dial-In : 2, Dial-out : 0)

SI          : Sampling Interval in seconds
Enc-Type    : Encoding type
Origin:Path : Sensor Path


1. Subscription Details (VRF-Name: default):
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  Port        : 9339
  TLS         : Disabled
  insecure-tls : False

Dial-In STREAM Mode Subscription Details:
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
ClientIP:Port        ID    SI    Enc-Type    Origin:Path
-------------        ------ ----  --------    ------------
10.12.66.120:53246   14087  10        PROTO   ipi:/interfaces/interface[name="eth0"]/state
                                              ipi:/interfaces/interface
[name="eth0"]/state/counters
```

Use Case 4: Monitoring Interface State Using JSON Encoding for IPI Xpath

In this use case, gnmic subscribes to the specified path using the Subscribe RPC, monitoring the state of an interface 'ipi:/interfaces/interface[name="eth0"]/state' using the JSON encoding.

```
./gnmic -a 10.12.160.119:9339 -u admin -p admin --insecure --mode STREAM --stream-mode sample --
sample-interval 10s subscribe --path 'ipi:/interfaces/interface[name="eth0"]/state' --encoding json

{
  "source": "10.12.160.119:9339",
  "subscription-name": "default-1713864619",
  "timestamp": 1550833421055660410,
  "time": "2019-02-22T11:03:41.05566041Z",
```

```
  "updates": [
    {
      "Path": "ipi:interfaces/interface[name=\"eth0\"]/state",
      "values": {
        "interfaces/interface/state": {
          "admin-status": "up",
          "counters": {
            "in-broadcast-pkts": 0,
            "in-discards": 0,
            "in-errors": 0,
            "in-multicast-pkts": 159470,
            "in-octets": 902867237,
            "in-pkts": 733016,
            "in-unicast-pkts": 0,
            "last-clear": "Never",
            "out-broadcast-pkts": 0,
            "out-discards": 0,
            "out-errors": 0,
            "out-multicast-pkts": 0,
            "out-octets": 8938196,
            "out-pkts": 105490,
            "out-unicast-pkts": 0
          },
          "ifindex": 3,
          "last-change": 8000,
          "logical": false,
          "oper-status": "up"
        }
      }
    }
  ]
}
```

Validation

The below show command provides details about the subscriptions that have been established, including the client ID, sampling interval, encoding type, and the sensor paths that are being monitored.

```
OcNOS#show streaming-telemetry dynamic-subscriptions

Number of telemetry instances : 1 (default)
Platform type                 : High range
Maximum sensor-paths          : 100
Minimum sample-interval       : 10
Number of active sensor-paths : 2 (Dial-In : 2, Dial-out : 0)

SI          : Sampling Interval in seconds
Enc-Type    : Encoding type
Origin:Path : Sensor Path


1. Subscription Details (VRF-Name: default):
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  Port        : 9339
  TLS         : Disabled
  insecure-tls : False

Dial-In STREAM Mode Subscription Details:
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
ClientIP:Port          ID    SI    Enc-Type    Origin:Path
-------------        ------  ----  --------    ------------
10.12.66.120:53340   50687   10    JSON         ipi:/interfaces/interface[name=eth0]/state
                                                ipi:/interfaces/interface
[name=eth0]/state/counters
```

Use Case 5: Monitoring Interface State Using JSON Encoding for OpenConfig Xpath

In this use case, gnmic subscribes to the specified path using the Subscribe RPC, monitoring the state of an interface `'/interfaces/interface[name="eth0"]/state'` using the JSON encoding for OpenConfig Xpath.

```
./gnmic -a 10.12.160.119:9339 -u admin -p admin --insecure --mode STREAM --stream-mode sample --
sample-interval 10s subscribe --path '/interfaces/interface[name="eth0"]/state' --encoding json

{
  "source": "10.12.160.119:9339",
  "subscription-name": "default-1713864712",
  "timestamp": 1550833514789102094,
  "time": "2019-02-22T11:05:14.789102094Z",
  "updates": [
    {
      "Path": "interfaces/interface[name=\"eth0\"]/state",
      "values": {
        "interfaces/interface/state": {
          "AdminStatus": "UP",
          "Counters": {
            "InBroadcastPkts": 0,
            "InDiscards": 0,
            "InErrors": 0,
            "InFcsErrors": null,
            "InMulticastPkts": 159643,
            "InOctets": 902872585,
            "InPkts": 733096,
            "InUnicastPkts": 0,
            "LastClear": 0,
            "OutBroadcastPkts": 0,
            "OutDiscards": 0,
            "OutErrors": 0,
            "OutMulticastPkts": 0,
            "OutOctets": 8944684,
            "OutPkts": 105520,
            "OutUnicastPkts": 0
          },
          "Ifindex": 3,
          "LastChange": 8000,
          "Logical": false,
          "Name": "eth0",
          "OperStatus": "UP"
        }
      }
    }
  ]
}
```

Validation

The below show command provides details about the subscriptions that have been established, including the client ID, sampling interval, encoding type, and the sensor paths that are being monitored.

```
OcNOS#show streaming-telemetry dynamic-subscriptions

Number of telemetry instances : 1 (default)
Platform type               : High range
Maximum sensor-paths        : 100
Minimum sample-interval     : 10
Number of active sensor-paths : 2 (Dial-In : 2, Dial-out : 0)

SI          : Sampling Interval in seconds
Enc-Type    : Encoding type
Origin:Path : Sensor Path
```

```
  1. Subscription Details (VRF-Name: default):
  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
    Port        : 9339
    TLS         : Disabled
    insecure-tls : False

  Dial-In STREAM Mode Subscription Details:
  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  ClientIP:Port          ID     SI    Enc-Type     Origin:Path
  -------------          ------ ----  --------     ------------
  10.12.66.120:53390   16340   10    JSON         openconfig:/interfaces/interface
  [name='eth0']/state
                                                   openconfig:/interfaces/interface
  [name='eth0']/state/counters
```

YAML File Input for Multiple Path Subscription

Use Case 1: Configuring One Subscription Requests with Multiple Path Option

This use case illustrates the configuration of a subscription request with multiple paths using a YAML file input. It streamlines the subscription setup process by specifying the desired paths and subscription parameters directly in the YAML file.

YAML File Content (single_request.yaml)

```
#cat single_request.yaml
subscriptions:                                          #Container for subscriptions
 RAM_stats_hw:                                          #A named subscription for RAM statistics
  prefix: "ipi:"                                        #Common prefix for paths in this subscription
  paths: "/components/component[name=\"RAM\"]/ram/state"        #List of subscription paths for
the RAM_stats_hw subscription
    stream-mode: sample                                 #Stream mode for RAM statistics
    sample-interval: 11s                                #Sampling interval for RAM statistics (e.g.,
11 seconds)
    encoding: json_ietf                                 #Encoding format for RAM statistics (e.g.,
JSON_IETF)


  intf-tray_stats_hw:                                   #A named subscription for interface tray
statistics
    prefix: "ipi:"                                      #Common prefix for paths in this
subscription
    paths:                                              #List of subscription paths for the intf-tray_
stats_hw subscription
     "ipi:/interfaces/interface[name=\"xe1\"]/state"
     "ipi:/interfaces/interface[name=\"vlan1.8\"]/state"

    stream-mode: sample                                 #Stream mode for interface tray statistics
    sample-interval: 14s                                #Sampling interval for interface tray
statistics (e.g., 14 seconds)
    encoding: json_ietf                                 #Encoding format for interface tray
statistics (e.g., JSON_IETF)
```

gnmic Command

```
# gnmic -a  10.12.91.111:9339 -u ocnos -p ocnos  --insecure  --config single_request.yaml subscribe

{
```

```
    "source": "10.12.91.111:9339",
    "subscription-name": "interface_stats_hw",
    "timestamp": 1550833401388910121,
    "time": "2019-02-22T11:03:21.388910184Z",
    "updates": [
      {
        "Path": "ipi:interfaces/interface[name=\"xe1\"]/state",
        "values": {
          "interfaces/interface/state": {
            "admin-status": "up",
            "counters": {
              "in-broadcast-pkts": "0",
              "in-discards": "0",
              "in-errors": "0",
              "in-fcs-errors": "0",
              "in-multicast-pkts": "0",
              "in-octets": "0",
              "in-pkts": "0",
              "in-unicast-pkts": "0",
              "last-clear": "Never",
              "out-broadcast-pkts": "0",
              "out-discards": "0",
              "out-errors": "0",
              "out-multicast-pkts": "2",
              "out-octets": "164",
              "out-pkts": "2",
              "out-unicast-pkts": "0"
            },
            "ifindex": 10001,
            "last-change": 0,
            "logical": false,
            "oper-status": "down"
          }
        }
      }
    ]
  }

  {
    "source": "10.12.91.111:9339",
    "subscription-name": "interface_stats_hw",
    "timestamp": 1550833401388910129,
    "time": "2019-02-22T11:03:21.388110124Z",
    "updates": [
      {
        "Path": "ipi:interfaces/interface[name=\"vlan1.10\"]/state",
        "values": {
          "interfaces/interface/state": {
            "admin-status": "up",
            "counters": {
              "in-broadcast-pkts": "0",
              "in-discards": "0",
              "in-errors": "0",
              "in-fcs-errors": "0",
              "in-multicast-pkts": "0",
              "in-octets": "0",
              "in-pkts": "0",
              "in-unicast-pkts": "0",
              "last-clear": "Never",
              "out-broadcast-pkts": "0",
              "out-discards": "0",
              "out-errors": "0",
              "out-multicast-pkts": "0",
              "out-octets": "0",
              "out-pkts": "0",
              "out-unicast-pkts": "0"
            },
            "ifindex": 25010,
```

```
            "last-change": 22500,
            "logical": false,
            "oper-status": "up"
          }
        }
      }
    ]
  }
```

Validation

The below show command provides details about the subscriptions that have been established, including the client ID, sampling interval, encoding type, and the sensor paths that are being monitored.

```
OcNOS#show streaming-telemetry dynamic-subscriptions

Number of telemetry instances : 1 (default)
Platform type               : High range
Maximum sensor-paths        : 100
Minimum sample-interval     : 10
Number of active sensor-paths : 4 (Dial-In : 4, Dial-out : 0)

SI          : Sampling Interval in seconds
Enc-Type    : Encoding type
Origin:Path  : Sensor Path


1. Subscription Details (VRF-Name: management):
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  Port        : 9339
  TLS         : Disabled
  insecure-tls : False

Dial-In STREAM Mode Subscription Details:
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
ClientIP:Port            ID      SI      Enc-Type        Origin:Path
-------------           ------   ----    --------        ------------

 10.12.43.135:58208        45333   12     JSON_IETF      ipi:interfaces/interface
[name="xe1"]/state/counters

                                                         ipi:interfaces/interface[name="xe1"]/state
                                                         ipi:interfaces/interface
[name="vlan1.10"]/state/counters

                                                         ipi:interfaces/interface
[name="vlan1.10"]/state
```

Use Case 2: Configuring Multiple Subscription Requests with Multiple Path Option

This use case illustrates the configuration of multiple subscription request with multiple paths using a YAML file input. It streamlines the subscription setup process by specifying the desired paths and subscription parameters directly in the YAML file.

YAML File Content (multiple_subs.yaml)

```
#cat multiple_subs.yaml
subscriptions:                                                    # Container for subscriptions

RAM_stats_hw:                                                     # A named subscription for RAM
statistics
```

```
paths: "ipi:/components/component[name=\"RAM\"]/ram/state"                    # List of
subscription paths for the RAM_stats_hw subscription

stream-mode: sample                                                # Stream mode for RAM
statistics

sample-interval: 11s                                               # Sampling interval for RAM
statistics (e.g., 11 seconds)

encoding: json_ietf                                                # Encoding format for RAM
statistics (e.g., JSON_IETF)

storage_stats_hw:                                                  # A named subscription for
storage statistics

paths: "ipi:/components/component[name=\"HARD-DISK\"]/storage/state"          # List of
subscription paths for the storage_stats_hw subscription

stream-mode: sample                                                # Stream mode for storage
statistics

sample-interval: 12s                                               # Sampling interval for
storage statistics (e.g., 12 seconds)

encoding: json_ietf                                                # Encoding format for
storage statistics (e.g., JSON_IETF)

power-supply_stats_hw:                                             # A named subscription for
power supply statistics

paths:                                                            # List of subscription paths for
the power-supply_stats_hw subscription
    "ipi:/components/component[name=\"PSU-1\"]/power-supply/state"
    "ipi:/components/component[name=\"PSU-2\"]/power-supply/state"


stream-mode: sample                                                # Stream mode for power
supply statistics

sample-interval: 13s                                               # Sampling interval for power
supply statistics (e.g., 13 seconds)

encoding: json_ietf                                                # Encoding format for power
supply statistics (e.g., JSON_IETF)

intf-tray_stats_hw:                                                # A named subscription for
interface tray statistics

paths:                                                            # List of subscription paths for
the intf-tray_stats_hw subscription
    "ipi:/interfaces/interface[name=\"xe1\"]/state"
    "ipi:/interfaces/interface[name=\"vlan1.8\"]/state"

stream-mode: sample                                                # Stream mode for interface
tray statistics

sample-interval: 14s                                               # Sampling interval for
interface tray statistics (e.g., 14 seconds)

encoding: json_ietf                                                # Encoding format for
interface tray statistics (e.g., JSON_IETF)
```

gnmic Command

```
# gnmic -a  10.12.91.111:9339 -u ocnos -p ocnos  --insecure  --config multiple_subs.yaml subscribe
```

```
{
  "source": "10.12.91.111:9339",
  "subscription-name": "ram_stats_hw",
  "timestamp": 1550833401388910128,
  "time": "2019-02-22T11:03:21.388910128Z",
  "updates": [
    {
      "Path": "ipi:components/component[name=\"RAM\"]/ram/state",
      "values": {
        "components/component/ram/state": {
          "available-high-memory": "0",
          "available-memory": "14743",
          "buffers": "15",
          "current-process-count": 232,
          "free-swap": "0",
          "shared-memory": "8",
          "total-high-memory": "0",
          "total-memory": "16012",
          "total-swap": "0",
          "used-memory": "1269"
        }
      }
    }
  ]
}

{
  "source": "10.12.91.111:9339",
  "subscription-name": "storage_stats_hw",
  "timestamp": 1550833401388910127,
  "time": "2019-02-22T11:03:21.388910127Z",
  "updates": [
    {
      "Path": "ipi:components/component[name=\"HARD-DISK\"]/storage/state",
      "values": {
        "components/component/storage/state": {
          "free-memory": "16908",
          "total-memory": "30208",
          "used-memory": "5020"
        }
      }
    }
  ]
}

{
  "source": "10.12.91.111:9339",
  "subscription-name": "power-supply_stats_hw",
  "timestamp": 1550833401388910126,
  "time": "2019-02-22T11:03:21.388910126Z",
  "updates": [
    {
      "Path": "ipi:components/component[name=\"PSU-1\"]/power-supply/state",
      "values": {
        "components/component/power-supply/state": {
          "capacity": "650",
          "fan1-rpm": 24288,
          "operational-status": "not-present",
          "output-current": "8.28",
          "output-voltage": "12.07",
          "power-consumption": "99",
          "temperature-sensor1": "22",
          "temperature-sensor2": "28",
          "temperature-sensor3": "24"
        }
      }
    }
  ]
```

```
    }

    {
      "source": "10.12.91.111:9339",
      "subscription-name": "power-supply_stats_hw",
      "timestamp": 1550833401388910125,
      "time": "2019-02-22T11:03:21.388910125Z",

      "updates": [
        {
          "Path": "ipi:components/component[name=\"PSU-2\"]/power-supply/state",
          "values": {
            "components/component/power-supply/state": {
              "operational-status": "running",
              "temperature-sensor1": "0",
              "temperature-sensor2": "0",
              "temperature-sensor3": "0"
            }
          }
        }
      ]
    }

    {
      "source": "10.12.91.111:9339",
      "subscription-name": "intf-tray_stats_hw",
      "timestamp": 1550833401388910123,
      "time": "2019-02-22T11:03:21.388910123Z",
      "updates": [
        {
          "Path": "ipi:interfaces/interface[name=\"xe1\"]/state",
          "values": {
            "interfaces/interface/state": {
              "admin-status": "up",
              "counters": {
                "in-broadcast-pkts": "0",
                "in-discards": "0",
                "in-errors": "0",
                "in-fcs-errors": "0",
                "in-multicast-pkts": "0",
                "in-octets": "0",
                "in-pkts": "0",
                "in-unicast-pkts": "0",
                "last-clear": "Never",
                "out-broadcast-pkts": "0",
                "out-discards": "0",
                "out-errors": "0",
                "out-multicast-pkts": "5",
                "out-octets": "410",
                "out-pkts": "5",
                "out-unicast-pkts": "0"
              },
              "ifindex": 10001,
              "last-change": 0,
              "logical": false,
              "oper-status": "down"
            }
          }
        }
      ]
    }

    {
      "source": "10.12.91.111:9339",
      "subscription-name": "intf-tray_stats_hw",
      "timestamp": 1550833401388910122,
      "time": "2019-02-22T11:03:21.388910122Z",
      "updates": [
```

```json
    {
      "Path": "ipi:interfaces/interface[name=\"vlan1.8\"]/state",
      "values": {
        "interfaces/interface/state": {
          "admin-status": "up",
          "counters": {
            "in-broadcast-pkts": "0",
            "in-discards": "0",
            "in-errors": "0",
            "in-fcs-errors": "0",
            "in-multicast-pkts": "0",
            "in-octets": "0",
            "in-pkts": "0",
            "in-unicast-pkts": "0",
            "last-clear": "Never",
            "out-broadcast-pkts": "0",
            "out-discards": "0",
            "out-errors": "0",
            "out-multicast-pkts": "0",
            "out-octets": "0",
            "out-pkts": "0",
            "out-unicast-pkts": "0"
          },
          "ifindex": 25008,
          "last-change": 22500,
          "logical": false,
          "oper-status": "up"
        }
      }
    }
  ]
}
```

Validation

The below show command provides details about the subscriptions that have been established, including the client ID, sampling interval, encoding type, and the sensor paths that are being monitored.

```
OcNOS#show streaming-telemetry dynamic-subscriptions

Number of telemetry instances : 1 (default)
Platform type              : High range
Maximum sensor-paths       : 100
Minimum sample-interval    : 10
Number of active sensor-paths : 8 (Dial-In : 8, Dial-out : 0)

SI         : Sampling Interval in seconds
Enc-Type   : Encoding type
Origin:Path  : Sensor Path


1. Subscription Details (VRF-Name: management):
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  Port       : 9339
  TLS        : Disabled
  insecure-tls : False

Dial-In STREAM Mode Subscription Details:
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
ClientIP:Port          ID     SI     Enc-Type      Origin:Path
-------------        ------   ----   --------     -----------
 10.12.43.155:58267     9453    14    JSON_IETF    ipi:interfaces/interface
[name="xe1"]/state/counters
                                                   ipi:interfaces/interface[name="xe1"]/state
                                                   ipi:interfaces/interface
 [name="vlan1.8"]/state/counters
```

```
                                                    ipi:interfaces/interface
[name="vlan1.8"]/state
 10.12.43.155:58114        31533    11    JSON_IETF    ipi:components/component
[name="RAM"]/ram/state
 10.12.43.155:58345        3374     12    JSON_IETF    ipi:components/component[name="HARD-
DISK"]/storage/state
 10.12.43.155:58222        35994    13    JSON_IETF    ipi:components/component[name="PSU-
1"]/power-supply/state
                                                    ipi:components/component[name="PSU-
2"]/power-supply/state
```

Use Case 3: Configuring Multiple Subscription Requests with Prefix Option

This use case illustrates the configuration of multiple subscription request with prefix option using a YAML file input.
It streamlines the subscription setup process by specifying the desired paths and subscription parameters directly in
the YAML file.

YAML File Content (prefix_path.yaml)

```
#cat prefix_path.yaml
subscriptions:                                              #Container for
subscriptions

RAM_stats_hw:                                               #A named subscription for
RAM statistics

prefix: "ipi:"                                              #Common prefix for paths in
this subscription

paths:"/components/component[name=\"RAM\"]/ram/state"                 #List of
subscription paths for the RAM_stats_hw subscription

stream-mode: sample                                        #Stream mode for RAM
statistics

sample-interval: 11s                                       #Sampling interval for RAM
statistics (e.g., 11 seconds)

encoding: json_ietf                                        #Encoding format for RAM
statistics (e.g., JSON_IETF)

intf-tray_stats_hw:                                        #A named subscription for
interface tray statistics

prefix: "ipi:"                                              #Common prefix for paths in
this subscription

paths:                                                     #List of subscription paths
for the intf-tray_stats_hw subscription
   "ipi:/interfaces/interface[name=\"xe1\"]/state"
   "ipi:/interfaces/interface[name=\"vlan1.8\"]/state"


stream-mode: sample                                        #Stream mode for
interface tray statistics

sample-interval: 14s                                       #Sampling interval for
interface tray statistics (e.g., 14 seconds)

encoding: json_ietf                                        #Encoding format for
interface tray statistics (e.g., JSON_IETF)
```

gnmic Command

```
# gnmic -a  10.12.91.111:9339 -u ocnos -p ocnos  --insecure  --config prefix_path.yaml subscribe
{
  "source": "10.12.91.111:9339",
  "subscription-name": "ram_stats_hw",
  "timestamp": 1550833401188910121,
  "time": "2019-02-22T11:03:21.388910121Z",

  "updates": [
    {
      "Path": "components/component[name=\"RAM\"]/ram/state",
      "values": {
        "components/component/ram/state": {
          "available-high-memory": "0",
          "available-memory": "14793",
          "buffers": "16",
          "current-process-count": 231,
          "free-swap": "0",
          "shared-memory": "8",
          "total-high-memory": "0",
          "total-memory": "16012",
          "total-swap": "0",
          "used-memory": "1219"
        }
      }
    }
  ]
}

{
  "source": "10.12.91.111:9339",
  "subscription-name": "intf-tray_stats_hw",
  "timestamp": 1550830401388910120,
  "time": "2019-02-22T11:03:21.388900120Z",
  "updates": [
    {
      "Path": "interfaces/interface[name=\"xe1\"]/state",
      "values": {
        "interfaces/interface/state": {
          "admin-status": "up",
          "counters": {
            "in-broadcast-pkts": "0",
            "in-discards": "0",
            "in-errors": "0",
            "in-fcs-errors": "0",
            "in-multicast-pkts": "0",
            "in-octets": "0",
            "in-pkts": "0",
            "in-unicast-pkts": "0",
            "last-clear": "Never",
            "out-broadcast-pkts": "0",
            "out-discards": "0",
            "out-errors": "0",
            "out-multicast-pkts": "9",
            "out-octets": "738",
            "out-pkts": "9",
            "out-unicast-pkts": "0"
          },
          "ifindex": 10001,
          "last-change": 0,
          "logical": false,
          "oper-status": "down"
        }
      }
    }
  ]
}
```

```
{
  "source": "10.12.91.111:9339",
  "subscription-name": "intf-tray_stats_hw",
  "timestamp": 1550833401288910122,
  "time": "2019-02-22T11:03:21.388912122Z",
  "updates": [
    {
      "Path": "interfaces/interface[name=\"vlan1.8\"]/state",
      "values": {
        "interfaces/interface/state": {
          "admin-status": "up",
          "counters": {
            "in-broadcast-pkts": "0",
            "in-discards": "0",
            "in-errors": "0",
            "in-fcs-errors": "0",
            "in-multicast-pkts": "0",
            "in-octets": "0",
            "in-pkts": "0",
            "in-unicast-pkts": "0",
            "last-clear": "Never",
            "out-broadcast-pkts": "0",
            "out-discards": "0",
            "out-errors": "0",
            "out-multicast-pkts": "0",
            "out-octets": "0",
            "out-pkts": "0",
            "out-unicast-pkts": "0"
          },
          "ifindex": 25008,
          "last-change": 22500,
          "logical": false,
          "oper-status": "up"
        }
      }
    }
  ]
}
```

Validation

The below show command provides details about the subscriptions that have been established, including the client ID, sampling interval, encoding type, and the sensor paths that are being monitored.

```
OcNOS#show streaming-telemetry dynamic-subscriptions

Number of telemetry instances : 1 (default)
Platform type                 : High range
Maximum sensor-paths          : 100
Minimum sample-interval       : 10
Number of active sensor-paths : 5 (Dial-In : 5, Dial-out : 0)

SI          : Sampling Interval in seconds
Enc-Type    : Encoding type
Origin:Path : Sensor Path


1. Subscription Details (VRF-Name: management):
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  Port        : 9339
  TLS         : Disabled
  insecure-tls : False

Dial-In STREAM Mode Subscription Details:
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
```

```
ClientIP:Port            ID     SI       Enc-Type      Origin:Path
-------------          ------   ----     --------      ------------
 10.12.43.154:50167      32137   11      JSON_IETF       ipi:components/component
[name="RAM"]/ram/state

 10.12.43.154:50614      36412   14      JSON_IETF       ipi:interfaces/interface
[name="vlan1.8"]/state/counters

[name="vlan1.8"]/state                                ipi:interfaces/interface

                                                      ipi:interfaces/interface
[name="xe1"]/state/counters

                                                      ipi:interfaces/interface[name="xe1"]/state
```

Implementation Examples

Typical Use Cases

- Enable Streaming Telemetry to monitor interface counters and the health of the OcNOS target device, including memory, CPU usage, fan speed, and temperature.
- Use telemetry data to trigger automated network tasks based on specific conditions.

Integration with Existing Features

Streaming Telemetry can be used in conjunction with other network monitoring and management features.

Dial-In Mode Command

The Streaming Telemetry introduces the configuration command.

Glossary

The following provides definitions for key terms or abbreviations and their meanings used throughout this document:

Key Terms/Acronym	Description
JSON	JavaScript Object Notation
RPC	Remote Procedure Call
gNMI	gRPC Network Management Interface
JSON-Internet Engineering Task Force (JSON-IETF)	JSON-IETF is a data interchange format that follows the specifications defined by the IETF. It is a lightweight, text-based format used for representing structured data. JSON-IETF is commonly used for configuration and data exchange in various network and Internet-related protocols.

Streaming Telemetry	A monitoring approach that efficiently transmits operational data from OcNOS routers to remote management systems in real-time for analysis, troubleshooting, and network monitoring.
Telemetry Data	Structured operational data generated by routers that is transmitted in real-time to external systems for analysis.
Remote Management System	An external system responsible for monitoring, managing, and analyzing data received from network devices.
Network Health	The overall condition and performance of a network, including factors like stability, resource utilization, and data flow.
Resilient Network	A network designed to withstand failures or disruptions, maintaining functionality even in challenging conditions.

STREAMING TELEMETRY DIAL-OUT MODE

Overview
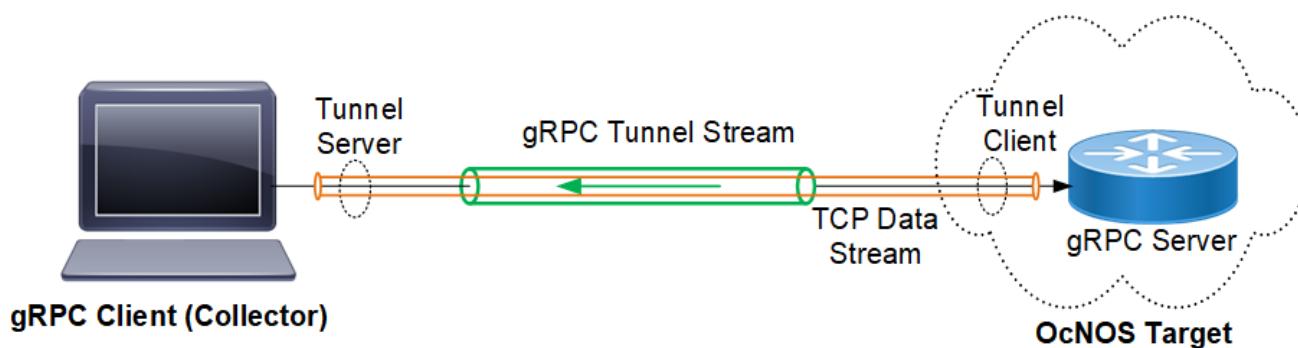
In OcNOS, dial-out telemetry subscriptions, also known as persistent subscriptions, ensure continuous data streaming, even if the Remote Procedure Call (gRPC) session terminates unexpectedly. With persistent subscriptions, the OcNOS device continuously retries to establish a gRPC connection to the collector server, thus maintaining persistent data streaming.

Feature Characteristics

The dial-out telemetry feature in OcNOS comprises several key aspects ensuring seamless data streaming and connectivity with collector servers:

The described topology outlines a system architecture that utilizes gRPC-based tunneling for persistent streaming telemetry.

Figure 8. Dial-Out Subscription Mode

Here is a detailed explanation of the components and data flow:

- **gNMI Client (gRPC Client):** The gNMI client, which acts as the gRPC client in this scenario, is responsible for handling telemetry data and connecting to the OcNOS target device.

- **Tunnel Server:** The tunnel server, part of the gNMI collector process, listens for incoming gRPC tunnel streams from the gRPC server.

- **gRPC Tunnel Stream:** Represents the persistent communication channel established between the tunnel client (OcNOS) and the tunnel server (collector).

- **Tunnel Client:** The gRPC tunnel client operates on the OcNOS device and connects to the tunnel server. It manages the tunneling of telemetry data.

- **gRPC Server:** Interacts with the tunnel client to establish and manage the tunnel.

> **Note:** Ensure that the tunnel server is reachable over the network from the tunnel client, and configure both the tunnel client and tunnel server with compatible authentication mechanisms.

Data Flow

The Figure 9 flow chart illustrates streaming telemetry in Dial-out Mode.
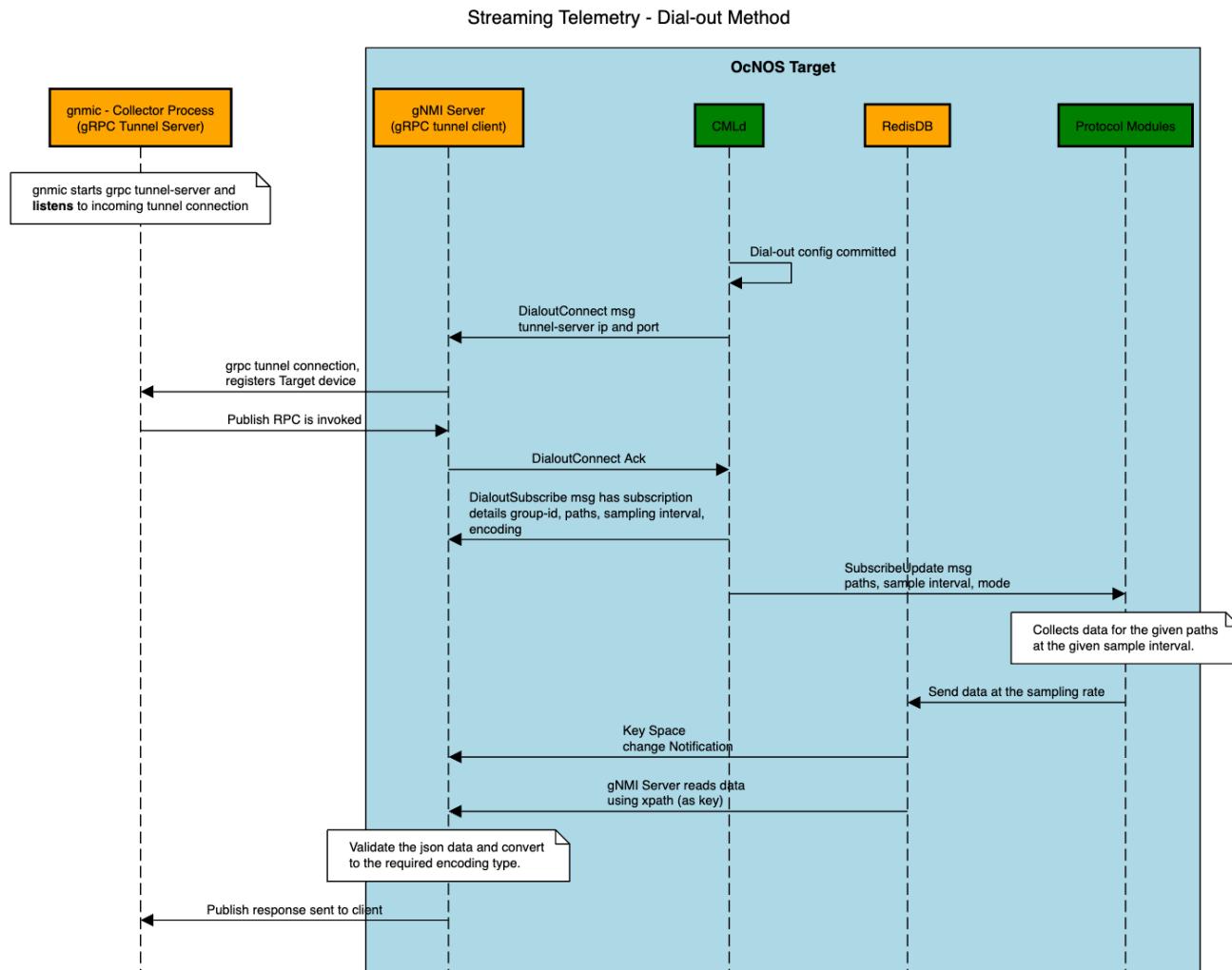
- **Initialization:** When the dial-out command subscription-name (page 59) is applied successfully, the tunnel client on the OcNOS device initiates a connection to the tunnel server hosted on the collector.

- **Tunnel Establishment:** Upon successful connection, the gRPC client and server establish a persistent tunnel stream. This tunnel facilitates the continuous transmission of telemetry data.

> **Note:** OcNOS supports insecure tunnel connections.

- **Telemetry Data Transmission:** When telemetry data needs to be transmitted from the OcNOS device, the gNMI client sends a Publish RPC request over the established tunnel.

- **Subscription Configuration:** Telemetry commands follow the OpenConfig telemetry model, standardizing the configuration of telemetry subscriptions and related entities.

Figure 9. Data Flow: Dial-Out Mode

Benefits

- Ensures continuous data streaming even in the event of gRPC session termination, enhancing network monitoring and troubleshooting capabilities.

- Simplifies configuration and management of telemetry subscriptions using standard OpenConfig models.

- Facilitates secure and reliable communication between the OcNOS device and the collector server.

- Enhances interoperability by enabling integration with third-party gRPC client applications like gNMI client, expanding telemetry options for network operators.

Prerequisites

Before configuring Dial-Out mode, ensure that:

- A supported OcNOS router running a compatible release is required.

- Access to the management interface of the router is necessary.

- Refer to the to download the gNMI collector package.

Configuration

Set up the OcNOS router to transmit streaming telemetry data to a gNMI client using the dial-out method.

The sample configuration on the OcNOS router sets up streaming telemetry subscriptions using gNMI to monitor specific paths related to the state of Hard Disk, RAM, and Chassis. The router sends telemetry data to the specified collector over a configured tunnel connection. The gNMI client subscribed to these paths will receive updates regarding the state of RAM and Hard Disk at the specified intervals. This setup enables proactive monitoring and management of key hardware components on the network device.

Topology

In this setup, an OcNOS router functions as the data source for streaming telemetry, while a gNMI client acts as the receiver of telemetry data. The OcNOS router sends telemetry data to the gNMI client over a dial-out connection.

Figure 10. Dial-out Streaming Telemetry Topology

OcNOS Router   gNMI Client

Use Case 1: Configure Telemetry on Management VRF

> **Note:** Before configuring Dial-out, meet all Prerequisites (page 101).

1. Enable Streaming Telemetry on a management **VRF**[1].

```
OcNOS(config)#feature streaming-telemetry vrf management
OcNOS(feature-telemetry-config)#exit
```

2. Create Sensor Group

Create a sensor group (`Platform`) where sensor paths will be specified for dial-out subscriptions. Specify sensor paths within the sensor group (`Platform`) to monitor the chassis state.

```
OcNOS(config)#sensor-group Platform vrf management
OcNOS(telemetry-sensor-group)#sensor-path ipi:/components/component[name="CHASSIS"]/state
OcNOS(telemetry-sensor-group)#exit
```

3. Create Destination Group

Create a destination group (`Collector2`) where tunnel server settings will be configured for dial-out subscriptions. Specify the tunnel server (`gNMI Client`) IP address (`10.21.3.4`) and port (`11123`) within the destination group (`Collector2`).

```
OcNOS(config)#destination-group Collector2 vrf management
OcNOS(telemetry-grpc-tunnel-group)#tunnel-server ip 10.21.3.4 port 11123
OcNOS(telemetry-grpc-tunnel-group)#exit
```

4. Create Persistent Subscription

Create a persistent subscription (`storage2`), encoding type (`JSON-IETF`), and associate it with the destination group (`Collector2`), and sensor group (`Platform`) to monitor the chassis state with a sample interval (`95 seconds`).

```
OcNOS(config)#subscription-name storage2 vrf management
OcNOS(telemetry-subscription)#encoding json-ietf
OcNOS(telemetry-subscription)#destination-group Collector2
OcNOS(telemetry-subscription)#sensor-group Platform sample-interval 95
OcNOS(telemetry-subscription)#commit
OcNOS(telemetry-subscription)#exit
```

Streaming Telemetry Snippet Configurations on Management VRF

To verify the telemetry configuration and view the overall commands used for dial-out subscriptions, use the `show running-config streaming-telemetry` command on the router.

```
OcNOS#show running-config streaming-telemetry
!
feature streaming-telemetry vrf management
!
sensor-group Platform vrf management
 sensor-path ipi:/components/component[name="CHASSIS"]/state
!
destination-group Collector2 vrf management
 tunnel-server ip 10.21.3.4 port 11123
!
subscription-name storage2 vrf management
```

[1]Virtual Routing and Forwarding

```
  destination-group Collector2
  sensor-group Platform sample-interval 95
  !
```

Use Case 2: Configure Telemetry on User-defined VRF

> **Note:** Before configuring Dial-out, meet all [Prerequisites (page 101)](#).

1. Enable Streaming Telemetry in a user-defined VRF on an OcNOS router.

```
OcNOS(config)#ip vrf VRF1
OcNOS(config-vrf)#exit
OcNOS(config)#feature streaming-telemetry vrf VRF1
OcNOS(feature-telemetry-config)#exit
```

2. Create Sensor Group

Create a sensor group (`Platform`) where sensor paths will be specified for dial-out subscriptions. Specify sensor paths within the sensor group (`Platform`) to monitor the state of RAM and Hard Disk.

```
OcNOS(config)#sensor-group Platform vrf VRF1
OcNOS(telemetry-sensor-group)#sensor-path ipi:/components/component[name="RAM"]/ram/state
OcNOS(telemetry-sensor-group)#sensor-path ipi:/components/component[name="HARD-
DISK"]/storage/state
OcNOS(telemetry-sensor-group)#exit
```

3. Create Destination Group

Create a destination group (`Collector3`) where tunnel server settings will be configured for dial-out subscriptions. Specify the tunnel server (`gNMI Client`) IP address (`10.21.3.4`) and port (`11123`) within the destination group (`Collector3`).

```
OcNOS(config)#destination-group Collector3 vrf VRF1
OcNOS(telemetry-grpc-tunnel-group)#tunnel-server ip 10.21.3.4 port 11123
OcNOS(telemetry-grpc-tunnel-group)#exit
```

4. Create Persistent Subscription

Create a persistent subscription (`storage`), encoding type (`JSON-IETF`), and associate it with the destination group (`Collector3`), and sensor group (`Platform`) to monitor the state of RAM and Hard Disk with a sample interval (`95 seconds`).

```
OcNOS(config)#subscription-name storage vrf VRF1
OcNOS(telemetry-subscription)#encoding json-ietf
OcNOS(telemetry-subscription)#destination-group Collector3
OcNOS(telemetry-subscription)#sensor-group Platform sample-interval 95
OcNOS(telemetry-subscription)#commit
OcNOS(telemetry-subscription)#exit
```

Streaming Telemetry Snippet Configurations on User-defined VRF

To verify the telemetry configuration and view the overall commands used for dial-out subscriptions, use the `show running-config streaming-telemetry` command on the router.

```
 OcNOS#show running-config streaming-telemetry
 !
 feature streaming-telemetry vrf VRF1
```

```
!
debug telemetry gnmi enable severity debug
!
sensor-group Platform vrf VRF1
 sensor-path ipi:/components/component[name="RAM"]/ram/state
 sensor-path ipi:/components/component[name="HARD-DISK"]/storage/state
!
destination-group Collector3 vrf VRF1
 tunnel-server ip 10.21.3.4 port 11123
!
subscription-name storage vrf VRF1
 destination-group Collector3
 sensor-group Platform sample-interval 95
!
```

Use Case 3: Configure Telemetry on Default VRF

> **Note:** Before configuring Dial-out, meet all .

1. Enable Streaming Telemetry in a default VRF on an OcNOS router.

   ```
   OcNOS(config)#feature streaming-telemetry
   OcNOS(feature-telemetry-config)#exit
   ```

2. Create Sensor Group

   Create a sensor group (`Platform`) where sensor paths will be specified for dial-out subscriptions. Specify sensor paths within the sensor group (`Platform`) to monitor the state of RAM and Hard Disk.

   ```
   OcNOS(config)#sensor-group Platform
   OcNOS(telemetry-sensor-group)#sensor-path ipi:/components/component[name="RAM"]/ram/state
   OcNOS(telemetry-sensor-group)#sensor-path ipi:/components/component[name="HARD-
   DISK"]/storage/state
   OcNOS(telemetry-sensor-group)#exit
   ```

3. Create Destination Group

   Create a destination group (`Collector1`) where tunnel server settings will be configured for dial-out subscriptions. Specify the tunnel server (`gNMI Client`) IP address (`10.12.101.72`) and port (`11161`) within the destination group (`Collector1`).

   ```
   OcNOS(config)#destination-group Collector1
   OcNOS(telemetry-grpc-tunnel-group)#tunnel-server ip 10.12.101.72 port 11161
   OcNOS(telemetry-grpc-tunnel-group)#exit
   ```

4. Create Persistent Subscription

   Create a persistent subscription (`storage`), encoding type (`JSON-IETF`), and associate it with the destination group (`Collector1`), and sensor group (`Platform`) to monitor the state of RAM and Hard Disk with a sample interval (`10 seconds`).

   ```
   OcNOS(config)#subscription-name storage
   OcNOS(telemetry-subscription)#encoding json-ietf
   OcNOS(telemetry-subscription)#destination-group Collector1
   OcNOS(telemetry-subscription)#sensor-group Platform sample-interval 10
   OcNOS(telemetry-subscription)#commit
   OcNOS(telemetry-subscription)#exit
   ```

Streaming Telemetry Snippet Configurations on default VRF

To verify the telemetry configuration and view the overall commands used for dial-out subscriptions, use the `show running-config streaming-telemetry` command on the router.

```
OcNOS#show running-config streaming-telemetry
!
feature streaming-telemetry
!
debug telemetry gnmi enable severity debug
!
sensor-group Platform
 sensor-path ipi:/components/component[name="RAM"]/ram/state
 sensor-path ipi:/components/component[name="HARD-DISK"]/storage/state
!
destination-group Collector1
 tunnel-server ip 10.12.101.72 port 11161
!
subscription-name storage
 destination-group Collector1
 sensor-group Platform sample-interval 10
!
!
```

Validation

To verify persistent telemetry configurations and monitor the telemetry data transmission settings on the router, check the output of the `show streaming-telemetry persistent-subscriptions details` command.

Use Case 1: Validate Telemetry on Management VRF

```
OcNOS#show streaming-telemetry persistent-subscriptions details

Number of telemetry instances : 1 (management)
Platform type             : High range
Maximum sensor-paths      : 100
Minimum sample-interval   : 10
Number of active sensor-paths : 4 (Dial-In : 0, Dial-out : 4)

SI          : Sampling Interval in seconds
Enc-Type    : Encoding type
Origin:Path : Sensor Path


1. Subscription Details (VRF-Name: management):
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  Port       : 9339
  TLS        : Disabled
  insecure-tls : False

Dial-Out Subscription Details:
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
1. Subscription-name    : storage2
   Status             : ACTIVE
   Enc-Type           : JSON
   Tunnel-server details:
   ~~~~~~~~~~~~~~~~~~~~~~~
   Tunnel-server Retry-interval  : Default-60 (seconds)

    Destination-group         Status          Tunnel-IP:Port
    -----------------         ------          -------------
    Collector2                ACTIVE          10.21.3.4:11123
```

```
   Sensor-group details:
   ~~~~~~~~~~~~~~~~~~~~
   Sensor-group          SI          Origin:Path
   ------------          ----        -----------
      Platform           95          ipi:/components/component[name="CHASSIS"]/state
                                      [*]ipi:/components/component[name="CHASSIS"]/state/memory
                                      [*]ipi:/components/component[name="CHASSIS"]/state/board-fru
                                      [*]ipi:/components/component
[name="CHASSIS"]/state/temperature

  [*]-> Indicates child path learnt from parent config, not configured by user
```

Use Case 2: Validate Telemetry on User-defined VRF

```
OcNOS#show streaming-telemetry persistent-subscriptions details

Number of telemetry instances : 1 (VRF1)
Platform type                 : High range
Maximum sensor-paths          : 100
Minimum sample-interval       : 10
Number of active sensor-paths : 2 (Dial-In : 0, Dial-out : 2)

SI          : Sampling Interval in seconds
Enc-Type    : Encoding type
Origin:Path : Sensor Path


1. Subscription Details (VRF-Name: VRF1):
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  Port       : 9339
  TLS        : Disabled
  insecure-tls : False

Dial-Out Subscription Details:
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
1. Subscription-name   : storage
   Status              : ACTIVE
   Enc-Type            : JSON
   Tunnel-server details:
   ~~~~~~~~~~~~~~~~~~~~~~~
   Tunnel-server Retry-interval  : Default-60 (seconds)

    Destination-group       Status        Tunnel-IP:Port
    -----------------       ------        --------------
    Collector3              ACTIVE     10.21.3.4:11123
   Sensor-group details:
   ~~~~~~~~~~~~~~~~~~~~~
   Sensor-group          SI          Origin:Path
   ------------          ----        -----------
      Platform           95          ipi:/components/component[name="RAM"]/ram/state
                                     ipi:/components/component[name="HARD-DISK"]/storage/state
```

Use Case 3: Validate Telemetry on Default VRF

```
#show streaming-telemetry persistent-subscriptions details

Number of telemetry instances : 1 (default)
Platform type                 : High range
Maximum sensor-paths          : 100
Minimum sample-interval       : 10
Number of active sensor-paths : 2 (Dial-In : 0, Dial-out : 2)

SI          : Sampling Interval in seconds
Enc-Type    : Encoding type
Origin:Path : Sensor Path
```

```
  1. Subscription Details (VRF-Name: default):
  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
    Port         : 9339
    TLS          : Disabled
    insecure-tls : False

  Dial-Out Subscription Details:
  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  1. Subscription-name   : storage
     Status              : ACTIVE
     Enc-Type            : JSON
     Tunnel-server details:
     ~~~~~~~~~~~~~~~~~~~~~~~
     Tunnel-server Retry-interval  : Default-60 (seconds)

      Destination-group        Status          Tunnel-IP:Port
      -----------------        ------          --------------
      Collector1               ACTIVE      10.12.101.72:11161
     Sensor-group details:
     ~~~~~~~~~~~~~~~~~~~~~~
     Sensor-group          SI             Origin:Path
     ------------          ----           -----------
        Platform           10             ipi:/components/component[name="RAM"]/ram/state
                                          ipi:/components/component[name="HARD-DISK"]/storage/state
```

Telemetry Subscription Invoked via gnmic Command and YAML Input

Start the gNMI collector with the `--use-tunnel-server` and `publish` options to receive the streamed gRPC responses. Execute the following command to start the gRPC tunnel server in listening mode, enabling it to accept incoming connections from gRPC tunnel clients (OcNOS target).

```
./gnmic --insecure --config <path to Tunnel-server yaml file> --use-tunnel-server publish
```

Invoke Publish RPC on OcNOS Target

The following output represents telemetry data published by the `gnmic` command, monitoring the state of Hard Disk and RAM on the specified OcNOS router.

```
# ./gnmic --insecure --config abc.yaml --use-tunnel-server publish
2024/04/12 11:22:50.516313 [gnmic] version=dev, commit=none, date=unknown, gitURL=,
docs=https://gnmic.openconfig.net
2024/04/12 11:22:50.516377 [gnmic] using config file "abc.yaml"
2024/04/12 11:22:50.517770 [gnmic] starting output type file
2024/04/12 11:22:50.517971 [file_output:default-stdout] initialized file output: {"Cfg":
{"FileName":"","FileType":"stdout","Format":"json","Multiline":true,"Indent":"  ","Separator":"\n","O
verrideTimestamps":false,"AddTarget":"","TargetTemplate":"","EventProcessors":null,"MsgTemplate":"","
ConcurrencyLimit":1000,"EnableMetrics":false,"Debug":false}}
2024/04/12 11:22:50.518018 [gnmic] StartPublishCollector is invoked
2024/04/12 11:22:50.518446 [gnmic] Initializing error chan
2024/04/12 11:22:54.508410 [gnmic] tunnel server discovered target {ID:e8:c5:7a:fe:fd:32 Type:GNMI_
GNOI}
2024/04/12 11:22:54.508720 [gnmic] adding target
{"name":"e8:c5:7a:fe:fd:32","address":"e8:c5:7a:fe:fd:32","username":"root","password":"****","timeou
t":10000000000,"insecure":true,"skip-verify":false,"buffer-size":100,"retry-timer":10000000000,"log-
tls-secret":false,"gzip":false,"token":"","tunnel-target-type":"GNMI_GNOI"}
2024/04/12 11:22:54.508756 [gnmic] calling publishStream
2024/04/12 11:22:54.508772 [gnmic] publishStream is invoked
2024/04/12 11:22:54.508779 [gnmic] targetPublishStream is invoked
2024/04/12 11:22:54.508830 [gnmic] a.targetsChan: 0xc0004eb1a0
2024/04/12 11:22:54.508840 [gnmic] t.Config.Outputs: []
```

```
2024/04/12 11:22:54.508850 [gnmic] starting target "e8:c5:7a:fe:fd:32" listener
2024/04/12 11:22:54.508879 [gnmic] queuing target "e8:c5:7a:fe:fd:32"
2024/04/12 11:22:54.508902 [gnmic] subscribing to target: "e8:c5:7a:fe:fd:32"
2024/04/12 11:22:54.508918 [gnmic] calling clientPublish
2024/04/12 11:22:54.508930 [gnmic] targetDialOpts: []grpc.DialOption
2024/04/12 11:22:54.508968 [gnmic] a.targetsChan: 0xc0004eb1a0
2024/04/12 11:22:54.508976 [gnmic] t.Config.Outputs: []
2024/04/12 11:22:54.509402 [gnmic] dialing tunnel connection for tunnel target "e8:c5:7a:fe:fd:32"
Publish Request sent to e8:c5:7a:fe:fd:32{
  "source": "e8:c5:7a:fe:fd:32",
  "subscription-name": "storage",
  "timestamp": 1712920892603436151,
  "time": "2024-04-12T16:51:32.603436151+05:30",
  "updates": [
    {
      "Path": "ipi:components/component[name=\"HARD-DISK\"]/storage/state",
      "values": {
        "components/component/storage/state": {
          "free-memory": 0,
          "total-memory": 61057,
          "used-memory": 0
        }
      }
    }
  ]
}
{
  "source": "e8:c5:7a:fe:fd:32",
  "subscription-name": "storage",
  "timestamp": 1712920892603253590,
  "time": "2024-04-12T16:51:32.60325359+05:30",
  "updates": [
    {
      "Path": "ipi:components/component[name=\"RAM\"]/ram/state",
      "values": {
        "components/component/ram/state": {
          "available-high-memory": 0,
          "available-memory": 15084,
          "buffers": 101,
          "current-process-count": 227,
          "free-swap": 0,
          "shared-memory": 28,
          "total-high-memory": 0,
          "total-memory": 16010,
          "total-swap": 0,
          "used-memory": 926
        }
      }
    }
  ]
}
```

The output of the Publish RPC includes the following information:

Table 13. Publish RPC Output details

Option	Description
source	Displays the MAC address associated with the management port of the target. Each gNMI device have a unique target ID, allowing the collector to distinguish responses between various targets.

Table 13. Publish RPC Output details (continued)

Option	Description
subscription-name	The name of the subscription.
timestamp	The timestamp of the response.
time	The timestamp in a human-readable format.
updates	An array of updates, each containing Path and Values.
Path	The path to the published data.
values	The values of the published data.

The telemetry data output includes detailed fields for monitoring the state of the Hard Disk and RAM, offering insights into the memory and storage utilization of the OcNOS router.

1. Hard Disk State

   - **Free Memory:** The amount of free memory available on the hard disk.

   - **Total Memory:** The total capacity of memory on the hard disk.

   - **Used Memory:** The amount of memory currently in use on the hard disk.

2. RAM State

   - **Available High Memory:** The available high memory in the RAM.

   - **Available Memory:** The total available memory in the RAM.

   - **Buffers:** The number of buffer processes running in the RAM.

   - **Current Process Count:** The count of active processes in the RAM.

   - **Free Swap:** The amount of free swap space in the RAM.

   - **Shared Memory:** The shared memory usage in the RAM.

   - **Total High Memory:** The total high memory capacity in the RAM.

   - **Total Memory:** The total memory capacity in the RAM.

   - **Total Swap:** The total swap space available in the RAM.

   - **Used Memory:** The amount of memory currently in use in the RAM.

Implementation Examples

Real-time Visibility: Operators have real-time visibility into network device health and performance metrics.

Proactive Maintenance: Early detection of issues allows for proactive maintenance and troubleshooting.

Optimized Resource Allocation: Insights from telemetry data help optimize resource allocation and capacity planning.

Enhanced Network Reliability: Continuous monitoring enhances network reliability and reduces downtime.

Dial-Out Commands

Refer to the streaming telemetry dial-out mode commands in the section.

Revised CLI Commands

The following is the revised command for telemetry.

show techsupport

- The existing syntax now includes the newly added parameter for telemetry, namely `gnmi`.

- The command **`show techsupport gnmi`** collects gNMI-related information for technical support. For more details, refer to the **`show techsupport`** command in the ***Software Monitoring and Reporting*** section in the ***OcNOS Sysytem Management Guide***.

Glossary

The following provides definitions for key terms or abbreviations and their meanings used throughout this document:

Key Terms/Acronym	Description
gRPC	Remote Procedure Call
Persistent Subscription	Telemetry subscription that maintains continuous data streaming even after interruptions in connectivity.
gRPC Network Management Interface (gNMI)	A standardized protocol for network management using gRPC and protocol buffers.
Destination Group	Specifies the collector server's details and connection parameters for telemetry subscriptions.
Sensor Group	Contains sensor paths that define the specific data to be monitored and transmitted.
OpenConfig	Standardized model for network configuration and telemetry using a vendor-neutral approach.

STREAMING TELEMETRY OVER TRANSPORT LAYER SECURITY

Overview

Transport Layer Security (TLS) is a cryptographic protocol that secures communication over networks by encrypting data exchanged between systems. TLS ensures confidentiality and integrity, which prevents unauthorized access and data tampering.

Streaming telemetry with TLS secures the real-time transmission of network monitoring data between gNMI Server (OcNOS Target) and gNMI Client (Collector). By encrypting telemetry streams, TLS prevents data interception, manipulation, and unauthorized access, ensuring that only trusted endpoints can exchange sensitive network performance metrics.

Feature Characteristics

To secure networks, configure and copy the TLS server, client, and CA certificates to the OcNOS device, following the telemetry certificate generation process. The session between the gNMI server and the gNMI client remains encrypted using TLS. The system validates connections with the certificates used by the server and client.

Insecure TLS: Allows users to enable an insecure option where client certificates are validated only if provided.

> **Note:** In OcNOS, streaming telemetry over TLS secures incoming packets for dial-in connections. TLS is not supported for dial-out mode subscriptions.

Benefits

Enhanced Security: Encrypts telemetry data in transit, preventing unauthorized access and data interception. TLS ensures confidentiality, integrity, and authentication, making sure only trusted endpoints exchange telemetry data.

Real-Time Secure Monitoring: Ensures telemetry insights are securely delivered to collectors without risk of interception.

Scalability: Supports high-frequency telemetry streams with minimal performance overhead.

Flexibility: Supports both secure (TLS-enabled) and insecure (optional) modes based on deployment needs.

Certificate Management for OcNOS and gNMI

> **Note:** Before proceeding with certificate generation, ensure that the date and time on the OcNOS device matches those on the virtual machine (VM) where all certificates are generated. A discrepancy can result in errors such as `certificate is expired`, which may hinder connection establishment.

Generate CA certificates

To create a Certificate Authority (CA) certificate and its corresponding private key, use the following OpenSSL command:

```
openssl req -newkey rsa:2048 -new -nodes -x509 -days 3650 -keyout rootCAKey.pem -out rootCACert.pem
```

Generate Server Certificates

1. To generate the server key, server certificate request (CSR), and certificate authority (CA) certificate, follow the below steps at the OcNOS cmlsh prompt:

   - Use the following command, replacing `<server-ip>` with the server's actual IPv4 address:

     ```
     crypto pki generate rsa common-name ipv4 <server-ip>
     ```

2. After generating, view the CSR with:

   ```
   show crypto csr
   ```

   - Copy the output from the `show crypto csr` command and paste it into a file named `ServerCert.csr`.

3. **Subject Alternative Name Requirement:** For the gNMI server, it is important to include the Subject Alternative Name (SAN) in the server certificate. To incorporate SAN into the server certificate, use the `san.ext` extension file.

   ```
   cat san.ext

   subjectAltName = @alt_names

   [alt_names]
   DNS.1 = OcNOS
   ```

   Utilize the san.ext file and the CSR to generate the server certificate using the following `OpenSSL` command:

   ```
   openssl x509 -req -sha256 -in ServerCert.csr -extfile san.ext -CA rootCACert.pem -CAkey
   rootCAKey.pem -CAcreateserial -out ServerCert.pem -days 365
   ```

Generate Client Certificates

1. Create a configuration file named `ClientCertReq.config` with the following content:

   ```
   [req]
   distinguished_name = dn
   prompt = no

   [dn]
   CN = <common-name>
   C = IN
   L = BNG
   O = IPI
   ```

   > **Note:** The client's IP address can be used as a common name. Separate client certificates can be generated for more than one client, but it's important to use the same CA certificate to generate all client certificates.

2. Generate the client certificate and key with the following commands:

```
openssl req -newkey rsa:2048 -keyout ClientKey.pem -out ClientCert.csr -config
./ClientCertReq.config -nodes -days 365
```

```
openssl x509 -req -sha256 -in ClientCert.csr -CA rootCACert.pem -CAkey rootCAKey.pem -
CAcreateserial -out ClientCert.pem -days 365
```

Rename and Copy Certificates

1. Rename and prepare the certificates for deployment as follows:

```
cp ClientKey.pem client.pem

cp ServerCert.pem cert_gnmid.pem

cp rootCACert.pem ca.pem

cat ClientCert.pem >> client.pem
```

2. Copy the server certificate and CA certificate to the OcNOS device using:

```
scp cert_gnmid.pem root@<mgmtIP>:/cfg/usr/local/etc/tls/certs/

scp ca.pem root@<mgmtIP>:/cfg/usr/local/etc/tls/certs/
```

3. Copy Client Certificates where gnmic can access `copy ClientCert.pem client.pem and ca.pem`

4. Enable TLS for dial-in and dial-out configurations by placing client certificates in the `/cfg/usr/local/etc/tls/client/` directory on the OcNOS device.

> **Note:** Create a directory named `client` within the `/cfg/usr/local/etc/tls/` directory on the OcNOS device. Then, copy the client certificates (`ClientCert.pem, client.pem, and ca.pem`) into the `client` folder at `/cfg/usr/local/etc/tls/client/`.

Insecure TLS Configuration

TLS encryption secures the session between the gNMI server and client, with both parties validating the provided certificates. Users can enable TLS with the insecure option but note that the system will only verify client certificates if they are provided. Here is an example for the insecure TLS setup.

gNMI Client

> **Note:** In OcNOS, streaming telemetry over TLS secures incoming packets for dial-in connections. TLS is not supported for dial-out mode subscriptions.

To authenticate a certificate, `gnmic` utilizes the client certificate, key, and CA certificate. Below are the command syntax and examples for dial-in subscription mode to establish secure and insecure TLS connections using the gNMI client, providing flexibility depending on the user's security requirements.

Syntax: Secure TLS

```
gnmic -a <ipaddress:port> -u <UserName> -p <Password> --mode STREAM --stream-mode sample --sample-
```

```
interval <sample-interval-value> sub --path <path> --tls-cert ClientCert.pem --tls-key client.pem --
tls-ca ca.pem --tls-server-name "<subject-alt-name>"
```

Example to establish a secure TLS dial-in connection:

```
./gnmic -a 10.12.160.33:55545 -u admin -p admin --mode STREAM --stream-mode sample --sample-interval
90s sub  --path "ipi:/interfaces/interface[name=\"eth0\"]/state" --tls-cert ClientCert.pem --tls-key
client.pem --tls-ca ca.pem --tls-server-name "OcNOS" --debug
```

Syntax: Insecure TLS

```
./gnmic -a <ipaddress:port> -u <UserName> -p <Password> --mode STREAM --stream-mode sample --sample-
interval <sample-interval-value> sub  --path <path> --tls-server-name "<subject-alt-name>" --debug --
skip-verify
```

Example to subscribe using an insecure TLS connection:

```
./gnmic -a 10.12.160.33:55545 -u admin -p admin --mode STREAM --stream-mode sample --sample-interval
90s sub  --path "ipi:/interfaces/interface[name=\"eth0\"]/state" --tls-server-name "OcNOS" --debug --
skip-verify

./gnmic -a 10.12.160.33 -u admin -p admin --mode STREAM --stream-mode sample --sample-interval 10s
sub --path "ipi:/interfaces/interface[name=\"eth0\"]/state/counters" --skip-verify
```

TLS Configuration

This section outlines the sample configuration for streaming telemetry over TLS in dial-out subscription mode.
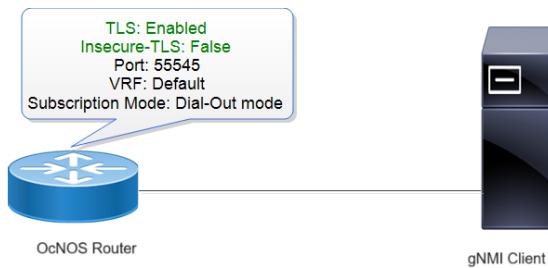
Prerequisites

Before configuring streaming telemetry with TLS, ensure the following:

- A supported OcNOS router running a compatible release.
- Access to the management interface of the router.
- Any gNMI client that complies with gNMI specifications can be used as a client.
- Download and install the gNMI collector package by referring to the Streaming Telemetry (page 25) section.
- Generate the server and client certificates following the Certificate Management for OcNOS and gNMI (page 111) process to enable secure communication.

Topology

In the following topology (Figure 11), the gNMI Server (OcNOS Target) establishes a telemetry session with the gNMI Client (Collector). TLS encrypts the telemetry stream, ensuring secure, real-time monitoring of network performance data.

Figure 11. TLS Connection

> **Note:** Before configuring, meet all [Prerequisites (page 114)](navigation).

1. Enable TLS Connection

   Enable streaming telemetry in a default **VRF**[1] and TLS to encrypt and protect the data transmitted during dial-in sessions with the TLS port number `55545`.

   ```
   OcNOS(config)#feature streaming-telemetry
   OcNOS(feature-telemetry-config)#tls tls-port 55545
   OcNOS(feature-telemetry-config)#commit
   OcNOS(feature-telemetry-config)#exit
   ```

2. Create Sensor Group

   Create a sensor group (`Platform`) where sensor paths will be specified for dial-out subscriptions. Specify sensor paths within the sensor group (`Platform`) to monitor the platform states.

   ```
   OcNOS(config)#sensor-group Platform
   OcNOS(telemetry-sensor-group)#sensor-path ipi:/interfaces/interface[name="lo.management"]/state
   OcNOS(telemetry-sensor-group)#sensor-path ipi:/interfaces/interface
   [name="lo.management"]/state/counters
   OcNOS(telemetry-sensor-group)#sensor-path ipi:/components/component[name="PSU-0"]/state
   OcNOS(telemetry-sensor-group)#sensor-path ipi:/components/component[name="PSU-0"]/state/memory
   OcNOS(telemetry-sensor-group)#sensor-path ipi:/components/component[name="PSU-0"]/state/board-fru
   OcNOS(telemetry-sensor-group)#sensor-path ipi:/components/component[name="PSU-
   0"]/state/temperature
   OcNOS(telemetry-sensor-group)#exit
   ```

3. Create Destination Group

   Create a destination group (`Collector1`) where tunnel server settings will be configured for dial-out subscriptions. Specify the tunnel server (`gNMI Client`) IP address (`5.5.5.4`) and port (`5313`) within the destination group (`Collector1`).

   ```
   OcNOS(config)#destination-group Collector1
   OcNOS(telemetry-grpc-tunnel-group)#tunnel-server ip 5.5.5.4 port 5313
   OcNOS(telemetry-grpc-tunnel-group)#exit
   ```

4. Create Persistent Subscription

   Create a persistent subscription (`storage`), encoding type (`JSON`), and associate it with the destination group (`Collector1`), and sensor group (`Platform`) to monitor the platform states with a sample interval (`90 seconds`).

---

[1]Virtual Routing and Forwarding

```
OcNOS(config)#subscription-name storage
OcNOS(telemetry-subscription)#encoding json
OcNOS(telemetry-subscription)#destination-group Collector1
OcNOS(telemetry-subscription)#sensor-group Platform sample-interval 90
OcNOS(telemetry-subscription)#commit
OcNOS(telemetry-subscription)#exit
```

Streaming Telemetry Running Configuration

To verify the telemetry configuration and view the overall commands used for TLS configuration, use the `show running-config streaming-telemetry` command on the OcNOS router.

```
OcNOS#show running-config streaming-telemetry
!
feature streaming-telemetry
 tls tls-port 55545
!
sensor-group Platform
 sensor-path ipi:/interfaces/interface[name="lo.management"]/state
 sensor-path ipi:/interfaces/interface[name="lo.management"]/state/counters
 sensor-path ipi:/components/component[name="PSU-0"]/state
 sensor-path ipi:/components/component[name="PSU-0"]/state/memory
 sensor-path ipi:/components/component[name="PSU-0"]/state/board-fru
 sensor-path ipi:/components/component[name="PSU-0"]/state/temperature
!
destination-group Collector1
 tunnel-server ip 5.5.5.4 port 5313
!
subscription-name storage
 destination-group Collector1
 sensor-group Platform sample-interval 90
!
```

Validation

To verify the TLS connection status, check the `TLS` and `insecure-tls` fields in the show output. If the `TLS` field shows `enabled`, the TLS connection is active. If the `insecure-tls` field is marked as `false`, it confirms that it is a secure TLS connection.

```
OcNOS#show streaming-telemetry

 Number of telemetry instances : 1 (default)
 Platform type                 : High range
 Maximum sensor-paths          : 100
 Minimum sample-interval       : 10
 Number of active sensor-paths : 6 (Dial-In : 0, Dial-out : 6)

 SI          : Sampling Interval in seconds
 Enc-Type    : Encoding type
 Origin:Path : Sensor Path


 1. Subscription Details (VRF-Name: default):
 ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
   Port        : 55545
   TLS         : Enabled
   insecure-tls : False

 Dial-Out Subscription Details:
 ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 1. Subscription-name   : storage
    Status              : ACTIVE
```

```
    Enc-Type             : JSON
    Tunnel-server details:
    ~~~~~~~~~~~~~~~~~~~~~~
    Tunnel-server Retry-interval  : Default-60 (seconds)

     Destination-group        Status        Tunnel-IP:Port
     -----------------        ------        --------------
     Collector1               ACTIVE        5.5.5.4:5313
    Sensor-group details:
    ~~~~~~~~~~~~~~~~~~~~~~
    Sensor-group            SI          Origin:Path
    ------------            ----        -----------
       Platform             90          ipi:/interfaces/interface[name="lo.management"]/state
                                        [*]ipi:/interfaces/interface
[name="lo.management"]/state/counters
                                        ipi:/components/component[name="PSU-0"]/state
                                        [*]ipi:/components/component[name="PSU-0"]/state/memory
                                        [*]ipi:/components/component[name="PSU-0"]/state/board-fru
                                        [*]ipi:/components/component[name="PSU-0"]/state/temperature

  [*]-> Indicates child path learnt from parent config, not configured by user
```

gnmic Response

The gNMI client collects and processes real-time telemetry data from the gNMI server (OcNOS router), ensuring secure and efficient data transmission over TLS. Below is a sample response illustrating how gnmic retrieves telemetry metrics from the configured sensor paths using the YAML file input (tunnel_server_config.yaml).

```
#./gnmic --config tunnel_server_config.yaml --use-tunnel-server publish --tls-cert ClientCert.pem --
tls-key client.pem --tls-ca ca.pem --tls-server-name "OcNOS" --debug

{
  "source": "e8:c5:7a:fe:fd:32",
  "subscription-name": "storage",
  "timestamp": 1730949133814708751,
  "time": "2024-11-07T03:12:13.814708751Z",
  "updates": [
    {
      "Path": "ipi:interfaces/interface[name=\"lo.management\"]/state",
      "values": {
        "interfaces/interface/state": {
          "admin-status": "up",
          "counters": {
            "in-broadcast-pkts": 0,
            "in-discards": 0,
            "in-errors": 0,
            "in-multicast-pkts": 0,
            "in-octets": 5445325,
            "in-pkts": 69299,
            "in-unicast-pkts": 0,
            "last-clear": "Never",
            "out-broadcast-pkts": 0,
            "out-discards": 0,
            "out-errors": 0,
            "out-multicast-pkts": 0,
            "out-octets": 5445325,
            "out-pkts": 69299,
            "out-unicast-pkts": 0
          },
          "ifindex": 15002,
          "last-change": 0,
          "logical": false,
          "oper-status": "up"
        }
      }
```

```
      }
    ]
  }
}
{
  "source": "e8:c5:7a:fe:fd:32",
  "subscription-name": "storage",
  "timestamp": 1730949133815809357,
  "time": "2024-11-07T03:12:13.815809357Z",
  "updates": [
    {
      "Path": "ipi:components/component[name=\"PSU-0\"]/state",
      "values": {
        "components/component/state": {
          "description": "NA",
          "empty": false,
          "firmware-version": "NA",
          "hardware-version": "NA",
          "location": "0",
          "mfg-name": "NA",
          "name": "PSU-0",
          "oper-status": "NA",
          "parent": "CHASSIS",
          "part-no": "NA",
          "product-name": "NA",
          "removable": true,
          "serial-no": "NA",
          "software-version": "NA",
          "type": "power-supply"
        }
      }
    }
  ]
}


{
  "source": "e8:c5:7a:fe:fd:32",
  "subscription-name": "storage",
  "timestamp": 1730949222816535762,
  "time": "2024-11-07T03:13:42.816535762Z",
  "updates": [
    {
      "Path": "ipi:interfaces/interface[name=\"lo.management\"]/state",
      "values": {
        "interfaces/interface/state": {
          "admin-status": "up",
          "counters": {
            "in-broadcast-pkts": 0,
            "in-discards": 0,
            "in-errors": 0,
            "in-multicast-pkts": 0,
            "in-octets": 5479285,
            "in-pkts": 69739,
            "in-unicast-pkts": 0,
            "last-clear": "Never",
            "out-broadcast-pkts": 0,
            "out-discards": 0,
            "out-errors": 0,
            "out-multicast-pkts": 0,
            "out-octets": 5479285,
            "out-pkts": 69739,
            "out-unicast-pkts": 0
          },
          "ifindex": 15002,
          "last-change": 0,
          "logical": false,
          "oper-status": "up"
        }
```

```
      }
    }
  ]
}


{
  "source": "e8:c5:7a:fe:fd:32",
  "subscription-name": "storage",
  "timestamp": 1730949312820273687,
  "time": "2024-11-07T03:15:12.820273687Z",
  "updates": [
    {
      "Path": "ipi:components/component[name=\"PSU-0\"]/state",
      "values": {
        "components/component/state": {
          "description": "NA",
          "empty": false,
          "firmware-version": "NA",
          "hardware-version": "NA",
          "location": "0",
          "mfg-name": "NA",
          "name": "PSU-0",
          "oper-status": "NA",
          "parent": "CHASSIS",
          "part-no": "NA",
          "product-name": "NA",
          "removable": true,
          "serial-no": "NA",
          "software-version": "NA",
          "type": "power-supply"
        }
      }
    }
  ]
}
{
  "source": "e8:c5:7a:fe:fd:32",
  "subscription-name": "storage",
  "timestamp": 1730949312817706107,
  "time": "2024-11-07T03:15:12.817706107Z",
  "updates": [
    {
      "Path": "ipi:interfaces/interface[name=\"lo.management\"]/state",
      "values": {
        "interfaces/interface/state": {
          "admin-status": "up",
          "counters": {
            "in-broadcast-pkts": 0,
            "in-discards": 0,
            "in-errors": 0,
            "in-multicast-pkts": 0,
            "in-octets": 5508685,
            "in-pkts": 70103,
            "in-unicast-pkts": 0,
            "last-clear": "Never",
            "out-broadcast-pkts": 0,
            "out-discards": 0,
            "out-errors": 0,
            "out-multicast-pkts": 0,
            "out-octets": 5508685,
            "out-pkts": 70103,
            "out-unicast-pkts": 0
          },
          "ifindex": 15002,
          "last-change": 0,
          "logical": false,
          "oper-status": "up"
        }
```

```
        }
      }
    ]
  }
```

Implementation Examples

Secure Network Monitoring in a Data Center

Scenario: A data center is tasked with monitoring the health and performance of various network devices, including switches, routers, and servers, across a large-scale infrastructure. The network administrators need to securely stream telemetry data in real time to ensure smooth operations, prevent failures, and guarantee secure access to sensitive performance data.

Solution: Using gNMI with Transport Layer Security (TLS), the administrators configure the gNMI server (the network router) and the gNMI client (a telemetry collector system) for streaming telemetry. The telemetry streams include performance metrics from multiple sensors, such as interface states and component statuses, collected in real-time for analysis.

Step-by-Step Implementation

> **Note:** Before configuring, meet all Prerequisites (page 114).

1. Network Devices Configuration

    • Enable streaming telemetry in the data center router (gNMI Server) running OcNOS.

    • Enable TLS to ensure all telemetry data transmitted is encrypted. The configuration includes setting the TLS port, generating required certificates for secure communication, and validating server-client connections.

2. Sensor Group and Data Path Setup

    • Create a sensor group to monitor key system metrics.

    • Define telemetry paths to capture performance data.

3. Destination Group Configuration

    • Configure a destination group in the telemetry system to connect to the gNMI client (telemetry collector) by specifying the IP address and the port for communication.

4. Persistent Subscription and Sampling Interval

    • Set up a persistent subscription with an encoding type and a sample interval for real-time data monitoring.

5. Telemetry Stream

    • Once the configuration is complete, the telemetry data is transmitted in real-time using the gNMI client (gnmic). The data is encrypted using TLS, ensuring that only authorized endpoints can access the sensitive network performance metrics.

6. Monitoring and Analysis

    • The monitoring system continuously receives telemetry data, enabling network administrators to proactively monitor network performance and ensure any issues are detected and addressed promptly.

- This system ensures secure real-time monitoring with encryption through TLS, protecting sensitive data from unauthorized access.

Troubleshooting TLS Issues in OcNOS

When TLS is enabled for streaming telemetry in OcNOS, various certificate-related errors may occur. The following are common issues and their resolutions:

1. `%% TLS is enabled but certificates are not present. Please generate key and certificates to enable tls for streaming-telemetry`

   Resolution: Follow all the steps from [Certificate Management for OcNOS and gNMI (page 111)](#) to generate and copy certificates to OcNOS.

2. `%% TLS is enabled but client certificates are not present. Please upload client key and certificates to "/cfg/usr/local/etc/tls/client"`

   Resolution: When TLS is enabled before configuring the dial-out configurations, copy the client certificates `ca.pem, ClientCert.pem, and client.pem` to `/cfg/usr/local/etc/tls/client` on OcNOS.

3. `Failed to load TLS credentials: tls: private key does not match public key`

   Resolution: This means the `/cfg/usr/local/etc/tls/certs/cert_gnmid.pem` file is not matching with `/cfg/usr/local/etc/tls/keys/key.pem`. Generate the server certificate again by copying the output of the `show crypto csr` command into the `ServerCert.csr` file. Restart the gnmid to load the new certificates.

4. `authentication handshake failed: tls: failed to verify certificate: x509: certificate signed by unknown authority`

   Resolution: The CA certificate on the server (OcNOS) is not matching with the CA certificate on the client side. Use the same CA certificate to generate the server and client certificates.

5. `authentication handshake failed: tls: failed to verify certificate: x509: certificate is valid for OcNOS, not Admin`

   Resolution: `--tls-server-name` in the gnmic command should be the same as the `subjectAltName` defined in the `san.ext` file.

6. `authentication handshake failed: tls: failed to verify certificate: x509: certificate is not valid for any names, but wanted to match Admin`

   Resolution: The error means `san.ext` is not used (`subjectAltName` is not defined) while generating the server certificate `ServerCert.pem`. Define a SAN and use it while generating the server certificate, and use the same SAN for the flag `--tls-server-name` in gnmic.

TLS Commands

To configure the system for secure and insecure TLS connections, use the commands [tls tls-port (page 62)](#) and [port (page 45)](#).

TLS Glossary

The following provides definitions for key terms or abbreviations and their meanings used throughout this document:

Key Terms/Acronym	Description
Transport Layer Security (TLS)	A cryptographic protocol that secures telemetry data transmission by encrypting the communication channel.
gNMI Server (Target)	The network device (e.g., router) that generates and streams telemetry data to the gNMI Client.
gNMI Client (Collector)	The software that collects telemetry data from the gNMI Server.
Encryption	The process of converting telemetry data into a secure format to prevent unauthorized access during transmission.
gRPC Network Management Interface (gNMI)	A protocol used for streaming telemetry data between a network device (Target) and a monitoring system (Collector).
Authentication	The process of verifying the identity of a client or server before establishing a secure telemetry connection.
Certificate Authority Certificate (CA Certificate)	A digital certificate issued by a trusted entity to authenticate the identity of servers and clients in TLS-secured telemetry.
Insecure TLS Mode	A configuration that allows telemetry streaming with optional client certificate validation for flexibility.
TLS Port	The network structure illustrating the connection between a gNMI Server and a gNMI Client using TLS.

STREAMING TELEMETRY IPI DATA MODELS

Overview

Streaming telemetry incrementally supports all IPI data models, listed in this section. Telemetry supports only operational containers and a subset of leaf attributes.

Telemetry IPI Pyang Tree

The Pyang tree output illustrates the supported containers or leaf, along with a list of supported container-level paths.

Container Level Sensor Paths and Leaf Attributes

Lists the container level sensor paths and leaf attributes supported for IPI data models.

> **Note:** For details on wildcard support, refer to the Wildcard Support in Sensor Paths (page 26) and XPath Formatting Rules for gnmic Subscription (page 32) sections.

IPI-Platform

Pyang Tree: ipi-platform

```
   +--rw components {feature-list:HAVE_CMMD}?
      +--ro component* [name]
         +--ro name                     -> ../state/name
         +--ro state
         |  +--ro name?                        string
         |  +--ro type?                         ipi-platform-types:cmm_component_type_t
{feature-list:NOT_HAVE_TIBIT}?
         |  +--ro location?                    string {feature-list:NOT_HAVE_TIBIT}?
         |  +--ro mfg-name?                    string {feature-list:NOT_HAVE_TIBIT}?
         |  +--ro mfg-date?                    yang:date-and-time {feature-list:NOT_HAVE_
TIBIT}?
         |  +--ro description?                 string {feature-list:NOT_HAVE_TIBIT}?
         |  +--ro hardware-version?            string {feature-list:NOT_HAVE_TIBIT}?
         |  +--ro firmware-version?            string {feature-list:NOT_HAVE_TIBIT}?
         |  +--ro software-version?            string {feature-list:NOT_HAVE_TIBIT}?
         |  +--ro serial-no?                   string {feature-list:NOT_HAVE_TIBIT}?
         |  +--ro part-no?                     string {feature-list:NOT_HAVE_TIBIT}?
         |  +--ro removable?                   boolean {feature-list:NOT_HAVE_TIBIT}?
         |  +--ro oper-status?                 ipi-platform-types:cmm_component_oper_status_t
{feature-list:NOT_HAVE_TIBIT}?
         |  +--ro product-name?                string {feature-list:NOT_HAVE_TIBIT}?
         |  +--ro asset-tag?                   string {feature-list:NOT_HAVE_TIBIT}?
         |  +--ro component-additional-details*  string {feature-list:NOT_HAVE_TIBIT}?
         |  +--ro parent?                      -> /components/component/state/name {feature-
list:NOT_HAVE_TIBIT}?
         |  +--ro empty?                       boolean {feature-list:NOT_HAVE_TIBIT}?
         |  +--ro memory {feature-list:NOT_HAVE_TIBIT}?
         |  |  +--ro available?   uint64
         |  |  +--ro utilized?    uint64
         |  +--ro board-fru {feature-list:NOT_HAVE_TIBIT}?
         |  |  +--ro board-name?       string
         |  |  +--ro board-serial-no?  string
         |  |  +--ro board-mfg-name?   string
         |  |  +--ro board-mfg-date?   yang:date-and-time
         |  +--ro temperature {feature-list:HAVE_CMMD}?
         |     +--ro instant?                     decimal64
         |     +--ro min?                         decimal64
         |     +--ro max?                         decimal64
         |     +--ro avg?                         decimal64
         |     +--ro interval?                    uint32
         |     +--ro sensor-name?                 string
         |     +--ro sensor-index?                uint8
         |     +--ro alarm-status?                boolean
         |     +--ro alarm-threshold?             decimal64
         |     +--ro alarm-severity?              cml_alarm_severity_t
         |     +--ro minimum-emergency-temperature?  decimal64
         |     +--ro maximum-emergency-temperature?  decimal64
         |     +--ro minimum-alert-temperature?   decimal64
         |     +--ro maximum-alert-temperature?   decimal64
         |     +--ro minimum-critical-temperature?  decimal64
         |     +--ro maximum-critical-temperature?  decimal64
         +--ro bmc-sensor-data-record {feature-list:NOT_HAVE_TIBIT}?
         |  +--ro state
         |     +--ro sensor-name?           string
         |     +--ro value?                 ipi-platform-types:cmm_bmc_value_t
         |     +--ro units?                 string
         |     +--ro lower-non-recoverable?  decimal64
         |     +--ro lower-non-critical?    decimal64
         |     +--ro lower-critical?        decimal64
         |     +--ro upper-non-critical?    decimal64
```

```
            |      +--ro upper-critical?           decimal64
            |      +--ro upper-non-recoverable?    decimal64
            |      +--ro operational-status?       string
            |      +--ro threshold?                decimal64
            |      +--ro event-type?               ipi-platform-types:cmm_bmc_event_type_t
        +--ro cpu {feature-list:HAVE_CMMD}?
        |  +--ro state
        |      +--ro cpu-1min-load-percentage?     decimal64
        |      +--ro cpu-5min-load-percentage?     decimal64
        |      +--ro cpu-15min-load-percentage?    decimal64
        |      +--ro cpu-utilization?              decimal64
        +--ro storage {feature-list:HAVE_CMMD}?
        |  +--ro state
        |      +--ro total-memory?   uint64
        |      +--ro used-memory?    uint64
        |      +--ro free-memory?    uint64
        +--ro ram {feature-list:HAVE_CMMD}?
        |  +--ro state
        |      +--ro total-memory?            uint64
        |      +--ro used-memory?             uint64
        |      +--ro available-memory?        uint64
        |      +--ro shared-memory?           uint64
        |      +--ro buffers?                 uint64
        |      +--ro total-swap?              uint64
        |      +--ro free-swap?               uint64
        |      +--ro current-process-count?   uint16
        |      +--ro total-high-memory?       uint64
        |      +--ro available-high-memory?   uint64
        +--ro transceiver {feature-list:HAVE_CMMD,feature-list:NOT_HAVE_TIBIT}?
        |  +--ro state
        |  |  +--ro grid-spacing?              decimal64
        |  |  +--ro first-frequency?           decimal64
        |  |  +--ro last-frequency?            decimal64
        |  |  +--ro transceiver-temperature?   decimal64
        |  |  +--ro presence?                  ipi-platform-transceiver-types:ddm_cmm_trans_
presence_t
        |  |  +--ro transceiver-voltage?       decimal64
        |  |  +--ro type?                      ipi-platform-transceiver-types:ddm_cmm_trans_
type_t
        |  |  +--ro transceiver-identifier?    ipi-platform-transceiver-types:ddm_cmm_trans_
identifier_t
        |  |  +--ro connector-type?            ipi-platform-transceiver-types:ddm_cmm_trans_
connector_type_t
        |  |  +--ro vendor-name?               string
        |  |  +--ro vendor-part-number?        string
        |  |  +--ro vendor-revision-number?    string
        |  |  +--ro vendor-serial-number?      string
        |  |  +--ro vendor-manufacturing-date?   string
        |  +--ro sfp
        |  |  +--ro state
        |  |      +--ro transmit-status?                  ipi-platform-transceiver-types:ddm_tx_
rx_state_t
        |  |      +--ro recieve-loss-status?              ipi-platform-transceiver-types:ddm_tx_
rx_state_t
        |  |      +--ro sfp-identifier?                   ipi-platform-transceiver-types:ddm_cmm_
trans_sfp_extended_identifier_t
        |  |      +--ro sfp-options-implemented?          ipi-platform-transceiver-types:ddm_cmm_
trans_sfp_options_implemented_t
        |  |      +--ro fiber-channel-sfp-speed?          ipi-platform-transceiver-types:ddm_cmm_
trans_fiber_channel_speed_t
        |  |      +--ro sfp-infiniband-compliance-code?   ipi-platform-transceiver-types:ddm_cmm_
trans_sfp_infiniband_compliance_t
        |  |      +--ro sfp-escon-compliance-code?        ipi-platform-transceiver-types:ddm_cmm_
trans_sfp_escon_compliance_t
        |  |      +--ro sfp-plus-cable-technology?        ipi-platform-transceiver-types:ddm_cmm_
trans_sfp_plus_cable_tech_t
        |  +--ro xfp
        |  |  +--ro state
```

```
        |  |      +--ro transmit-status?                                ipi-platform-transceiver-
types:ddm_tx_rx_state_t
        |  |      +--ro recieve-loss-status?                  ipi-platform-transceiver-
types:ddm_tx_rx_state_t
        |  |      +--ro xsfp-identifier?                      ipi-platform-transceiver-
types:ddm_cmm_trans_xfp_extended_identifier_t
        |  |      +--ro xfp-10g-ethernet-compliance-code?     ipi-platform-transceiver-
types:ddm_cmm_trans_xfp_10g_eth_compliance_t
        |  |      +--ro xfp-10g-fiber-channel-compliance-code?  ipi-platform-transceiver-
types:ddm_cmm_trans_xfp_10g_fiber_chn_compliance_t
        |  |      +--ro xfp-10g-copper-link-compliance-code?  ipi-platform-transceiver-
types:ddm_cmm_trans_xfp_10g_copper_links_rsvd_t
        |  |      +--ro xfp-lower-speed-link-compliance-code?  ipi-platform-transceiver-
types:ddm_cmm_trans_xfp_lower_speed_links_t
        |  |      +--ro xfp-sonet-interconnect-compliance-code?  ipi-platform-transceiver-
types:ddm_cmm_trans_xfp_sonet_interconnect_t
        |  |      +--ro xfp-sonet-short-haul-compliance-code?  ipi-platform-transceiver-
types:ddm_cmm_trans_xfp_sonet_short_haul_t
        |  |      +--ro xfp-sonet-long-haul-compliance-code?  ipi-platform-transceiver-
types:ddm_cmm_trans_xfp_sonet_long_haul_t
        |  |      +--ro xfp-sonet-very-long-haul-compliance-code?  ipi-platform-transceiver-
types:ddm_cmm_trans_xfp_sonet_very_long_haul_t
        |  |      +--ro xfp-serial-encoding-algorithm?        ipi-platform-transceiver-
types:ddm_cmm_trans_xfp_encoding_t
        |  |      +--ro xsfp-options-implemented?             ipi-platform-transceiver-
types:ddm_cmm_trans_xfp_options_implemented_t
        |  |      +--ro xfp-auxillary-voltage?                ipi-platform-transceiver-
types:ddm_cmm_trans_xfp_voltage_aux_monitor_t
        | +--ro qsfp
        | |  +--ro state
        | |      +--ro reset-status?              ipi-platform-transceiver-types:ddm_cmm_trans_
reset_t
        | |      +--ro power?                     ipi-platform-transceiver-types:ddm_cmm_trans_
power_t
        | |      +--ro lane1-transmission?        ipi-platform-transceiver-types:ddm_tx_rx_
state_t
        | |      +--ro lane1-transmission-loss?   ipi-platform-transceiver-types:ddm_tx_rx_
state_t
        | |      +--ro lane1-recieve-loss?        ipi-platform-transceiver-types:ddm_tx_rx_
state_t
        | |      +--ro lane2-transmission?        ipi-platform-transceiver-types:ddm_tx_rx_
state_t
        | |      +--ro lane2-transmission-loss?   ipi-platform-transceiver-types:ddm_tx_rx_
state_t
        | |      +--ro lane2-recieve-loss?        ipi-platform-transceiver-types:ddm_tx_rx_
state_t
        | |      +--ro lane3-transmission?        ipi-platform-transceiver-types:ddm_tx_rx_
state_t
        | |      +--ro lane3-transmission-loss?   ipi-platform-transceiver-types:ddm_tx_rx_
state_t
        | |      +--ro lane3-recieve-loss?        ipi-platform-transceiver-types:ddm_tx_rx_
state_t
        | |      +--ro lane4-transmission?        ipi-platform-transceiver-types:ddm_tx_rx_
state_t
        | |      +--ro lane4-transmission-loss?   ipi-platform-transceiver-types:ddm_tx_rx_
state_t
        | |      +--ro lane4-recieve-loss?        ipi-platform-transceiver-types:ddm_tx_rx_
state_t
        | |      +--ro qsfp-identifier?           ipi-platform-transceiver-types:ddm_cmm_qsfp_
extended_identifier_t
        | |      +--ro fiber-channel-qsfp-speed?  ipi-platform-transceiver-types:ddm_cmm_trans_
fiber_channel_speed_t
        | |      +--ro qsfp-options-implemented?  ipi-platform-transceiver-types:ddm_cmm_trans_
qsfp_options_implemented_t
        | +--ro channels
        | |  +--ro channel* [index]
        | |      +--ro index    -> ../state/index
        | |      +--ro state
        | |        +--ro index?                                uint8
```

```
| |          +--ro input-power?                              decimal64
| |          +--ro input-power-alert-max-threshold?          decimal64
| |          +--ro input-power-critical-max-threshold?       decimal64
| |          +--ro input-power-critical-min-threshold?       decimal64
| |          +--ro input-power-alert-min-threshold?          decimal64
| |          +--ro output-power?                             decimal64
| |          +--ro output-power-alert-max-threshold?         decimal64
| |          +--ro output-power-critical-max-threshold?      decimal64
| |          +--ro output-power-critical-min-threshold?      decimal64
| |          +--ro output-power-alert-min-threshold?         decimal64
| |          +--ro laser-bias-current?                       decimal64
| |          +--ro laser-bias-current-alert-max-threshold?   decimal64
| |          +--ro laser-bias-current-critical-max-threshold?  decimal64
| |          +--ro laser-bias-current-critical-min-threshold?  decimal64
| |          +--ro laser-bias-current-alert-min-threshold?   decimal64
| +--ro cmis-module {feature-list:HAVE_CMMD,feature-list:NOT_HAVE_TIBIT}?
|    +--ro eeprom
|    | +--ro state
|    |    +--ro identifier?                  ipi-platform-sff8024-types:cmm_sff8024_
identifier_t
|    |    +--ro vendor-name?                 string
|    |    +--ro vendor-oui?                  string
|    |    +--ro part-number?                 string
|    |    +--ro revision-level?              string
|    |    +--ro serial-number?               string
|    |    +--ro manufacturing-date?          string
|    |    +--ro clei-code?                   string
|    |    +--ro module-power-class?          ipi-platform-cmis-types:cmm_cmis_module_
power_class_t
|    |    +--ro module-max-power?            decimal64
|    |    +--ro cooling-implemented?         ipi-platform-cmis-types:cmm_cmis_yes_no_
t
|    |    +--ro temperature-max?             int16
|    |    +--ro temperature-min?             int16
|    |    +--ro operatin-voltage-min?        decimal64
|    |    +--ro optical-detector?            ipi-platform-cmis-types:cmm_cmis_
optical_detector_t
|    |    +--ro rx-power-measurement?        ipi-platform-cmis-types:cmm_cmis_rx_
power_measur_t
|    |    +--ro tx-disable-module-wide?      ipi-platform-cmis-types:cmm_cmis_yes_no_
t
|    |    +--ro cable-assembly-link-length?  int16
|    |    +--ro connector-type?              ipi-platform-sff8024-types:cmm_sff8024_
connector_type_t
|    |    +--ro cca-5ghz?                    uint8
|    |    +--ro cca-7ghz?                    uint8
|    |    +--ro cca-12p9ghz?                 uint8
|    |    +--ro cca-25p8ghz?                 uint8
|    |    +--ro media-interface-technology?  ipi-platform-cmis-types:cmm_cmis_media_
intf_tech_t
|    |    +--ro cmis-revision?               string
|    |    +--ro memory-model?                ipi-platform-cmis-types:cmm_cmis_memory_
model_t
|    |    +--ro mci-max-speed?               ipi-platform-cmis-types:cmm_cmis_mci_
max_speed_t
|    |    +--ro active-firmware-revision?    string
|    |    +--ro inactive-firmware-revision?  string
|    |    +--ro hardware-revision?           string
|    |    +--ro media-type?                  ipi-platform-cmis-types:cmm_cmis_media_
type_t
|    |    +--ro max-smf-link-length?         decimal64
|    |    +--ro max-mmf-om2-link-length?     uint8
|    |    +--ro max-mmf-om3-link-length?     uint16
|    |    +--ro max-mmf-om4-link-length?     uint16
|    |    +--ro max-mmf-om5-link-length?     uint16
|    |    +--ro wavelength-nominal?          decimal64
|    |    +--ro wavelength-tolerance?        decimal64
|    +--ro advertisement
```

```
        |      |  +--ro applications
        |      |  |  +--ro application* [id]
        |      |  |     +--ro id        -> ../state/id
        |      |  |     +--ro state
        |      |  |     |  +--ro id?   uint8
        |      |  |     +--ro host
        |      |  |     |  +--ro state
        |      |  |     |     +--ro interface-type?        ipi-platform-cmis-types:cmm_cmis_
interface_type_t
        |      |  |     |     +--ro application-bitrate?    ipi-platform-cmis-types:cmm_cmis_
bit_rate_t
        |      |  |     |     +--ro lane-count?             uint8
        |      |  |     |     +--ro signal-bitrate?         ipi-platform-cmis-types:cmm_cmis_
bit_rate_t
        |      |  |     |     +--ro modulation-format?      ipi-platform-cmis-types:cmm_cmis_
modulation_format_t
        |      |  |     |     +--ro bits-per-unit-interval? decimal64
        |      |  |     |     +--ro lane-assignment?        ipi-platform-cmis-types:cmm_cmis_
lane_assignment_t
        |      |  |     |     +--ro host-config?            string
        |      |  |     +--ro media
        |      |  |        +--ro state
        |      |  |           +--ro interface-type?        ipi-platform-cmis-types:cmm_cmis_
interface_type_t
        |      |  |           +--ro application-bitrate?    ipi-platform-cmis-types:cmm_cmis_
bit_rate_t
        |      |  |           +--ro lane-count?             uint8
        |      |  |           +--ro signal-bitrate?         ipi-platform-cmis-types:cmm_cmis_
bit_rate_t
        |      |  |           +--ro modulation-format?      ipi-platform-cmis-types:cmm_cmis_
modulation_format_t
        |      |  |           +--ro bits-per-unit-interval? decimal64
        |      |  |           +--ro lane-assignment?        ipi-platform-cmis-types:cmm_cmis_
lane_assignment_t
        |      |  +--ro controls
        |      |  |  +--ro state
        |      |  |     +--ro wavelength-control?          ipi-platform-cmis-types:cmm_cmis_
yes_no_t
        |      |  |     +--ro tunable-transmitter?         ipi-platform-cmis-types:cmm_cmis_
yes_no_t
        |      |  |     +--ro tx-output-squelching-method? ipi-platform-cmis-types:cmm_cmis_
tx_squelch_method_t
        |      |  |     +--ro forced-tx-output-squelching? ipi-platform-cmis-types:cmm_cmis_
yes_no_t
        |      |  |     +--ro tx-output-squelching-disable? ipi-platform-cmis-types:cmm_cmis_
yes_no_t
        |      |  |     +--ro tx-output-disable?           ipi-platform-cmis-types:cmm_cmis_
yes_no_t
        |      |  |     +--ro input-polarity-flip-tx?      ipi-platform-cmis-types:cmm_cmis_
yes_no_t
        |      |  |     +--ro rx-output-squelching-disable? ipi-platform-cmis-types:cmm_cmis_
yes_no_t
        |      |  |     +--ro rx-output-disable?           ipi-platform-cmis-types:cmm_cmis_
yes_no_t
        |      |  |     +--ro output-polarity-flip-rx?     ipi-platform-cmis-types:cmm_cmis_
yes_no_t
        |      +--ro diagnostics
        |      |  +--ro module
        |      |  |  +--ro state
        |      |  |     +--ro simultaneous-host-and-media-loobpack?  ipi-platform-cmis-
types:cmm_cmis_yes_no_t
        |      |  |     +--ro report-bit-error-ratio?               ipi-platform-cmis-
types:cmm_cmis_yes_no_t
        |      |  |     +--ro count-bits-and-errors?                ipi-platform-cmis-
types:cmm_cmis_yes_no_t
        |      |  +--ro host
        |      |  |  +--ro state
        |      |  |     +--ro output-loopack?       ipi-platform-cmis-types:cmm_cmis_yes_
no_t
```

```
        |      |   |   |       +--ro input-loopack?              ipi-platform-cmis-types:cmm_cmis_yes_
no_t
        |      |   |   |       +--ro per-lane-loopack?           ipi-platform-cmis-types:cmm_cmis_yes_
no_t
        |      |   |   |       +--ro report-input-snr?           ipi-platform-cmis-types:cmm_cmis_yes_
no_t
        |      |   |   |       +--ro report-fec?                 ipi-platform-cmis-types:cmm_cmis_yes_
no_t
        |      |   |   |       +--ro prbs-checker-post-fec?      ipi-platform-cmis-types:cmm_cmis_yes_
no_t
        |      |   |   |       +--ro prbs-checker-pre-fec?       ipi-platform-cmis-types:cmm_cmis_yes_
no_t
        |      |   |   |       +--ro prbs-checker-types?         ipi-platform-cmis-types:cmm_cmis_
prbs_support_type_t
        |      |   |   |       +--ro prbs-generator-post-fec?    ipi-platform-cmis-types:cmm_cmis_yes_
no_t
        |      |   |   |       +--ro prbs-generator-pre-fec?     ipi-platform-cmis-types:cmm_cmis_yes_
no_t
        |      |   |   |       +--ro prbs-generator-types?       ipi-platform-cmis-types:cmm_cmis_
prbs_support_type_t
        |      |   |   +--ro media
        |      |   |      +--ro state
        |      |   |         +--ro output-loopack?              ipi-platform-cmis-types:cmm_cmis_yes_
no_t
        |      |   |         +--ro input-loopack?               ipi-platform-cmis-types:cmm_cmis_yes_
no_t
        |      |   |         +--ro per-lane-loopack?            ipi-platform-cmis-types:cmm_cmis_yes_
no_t
        |      |   |         +--ro report-input-snr?            ipi-platform-cmis-types:cmm_cmis_yes_
no_t
        |      |   |         +--ro report-fec?                  ipi-platform-cmis-types:cmm_cmis_yes_
no_t
        |      |   |         +--ro prbs-checker-post-fec?       ipi-platform-cmis-types:cmm_cmis_yes_
no_t
        |      |   |         +--ro prbs-checker-pre-fec?        ipi-platform-cmis-types:cmm_cmis_yes_
no_t
        |      |   |         +--ro prbs-checker-types?          ipi-platform-cmis-types:cmm_cmis_
prbs_support_type_t
        |      |   |         +--ro prbs-generator-post-fec?     ipi-platform-cmis-types:cmm_cmis_yes_
no_t
        |      |   |         +--ro prbs-generator-pre-fec?      ipi-platform-cmis-types:cmm_cmis_yes_
no_t
        |      |   |         +--ro prbs-generator-types?        ipi-platform-cmis-types:cmm_cmis_
prbs_support_type_t
        |      | +--ro durations
        |      | | +--ro state
        |      | |    +--ro modsel-wait-time?              uint8
        |      | |    +--ro dpinit-maximun-duration?       ipi-platform-cmis-types:cmm_cmis_
durations_t
        |      | |    +--ro dpdeinit-maximun-duration?     ipi-platform-cmis-types:cmm_cmis_
durations_t
        |      | |    +--ro dptxturnon-maximum-duration?   ipi-platform-cmis-types:cmm_cmis_
durations_t
        |      | |    +--ro dptxturnoff-maximum-duration?  ipi-platform-cmis-types:cmm_cmis_
durations_t
        |      | |    +--ro modulepwrup-maximum-duration?  ipi-platform-cmis-types:cmm_cmis_
durations_t
        |      | |    +--ro modulepwrdn-maximum-duration?  ipi-platform-cmis-types:cmm_cmis_
durations_t
        |      | |    +--ro npinit-maximum-duration?       ipi-platform-cmis-types:cmm_cmis_
durations_t
        |      | |    +--ro npdeinit-maximum-duration?     ipi-platform-cmis-types:cmm_cmis_
durations_t
        |      | |    +--ro nptxturnon-maximum-duration?   ipi-platform-cmis-types:cmm_cmis_
durations_t
        |      | |    +--ro nptxturnoff-maximum-duration?  ipi-platform-cmis-types:cmm_cmis_
durations_t
        |      | +--ro laser
        |      | | +--ro state
        |      | | | +--ro supported-grids?                    ipi-platform-cmis-types:cmm_
```

```
cmis_laser_grid_support_t
        |      |  |  |  +--ro fine-tune-supported?                    ipi-platform-cmis-types:cmm_
cmis_yes_no_t
        |      |  |  |  +--ro fine-tune-resolution?           decimal64
        |      |  |  |  +--ro fine-tune-low-offset?           decimal64
        |      |  |  |  +--ro fine-tune-high-offset?          decimal64
        |      |  |  |  +--ro per-lane-programmable-output-power?  ipi-platform-cmis-types:cmm_
cmis_yes_no_t
        |      |  |  |  +--ro minimum-programmable-output-power?   decimal64
        |      |  |  |  +--ro maximum-programmable-output-power?   decimal64
        |      |  |  +--ro grids
        |      |  |     +--ro grid* [id]
        |      |  |        +--ro id        -> ../state/id
        |      |  |        +--ro state
        |      |  |           +--ro id?                        ipi-platform-cmis-types:cmm_
cmis_laser_grid_spacing_t
        |      |  |           +--ro lowest-channel-frequency?    decimal64
        |      |  |           +--ro highest-channel-frequency?   decimal64
        |      |  |           +--ro channel-count?               uint16
        |      |  +--ro monitoring
        |      |  |  +--ro module
        |      |  |  |  +--ro monitors
        |      |  |  |  |  +--ro monitor* [id]
        |      |  |  |  |     +--ro id        -> ../state/id
        |      |  |  |  |     +--ro state
        |      |  |  |  |        +--ro id?         ipi-platform-cmis-types:cmm_cmis_module_
monitor_id_t
        |      |  |  |  |        +--ro supported?   ipi-platform-cmis-types:cmm_cmis_yes_no_t
        |      |  |  +--ro host
        |      |  |  |  +--ro monitors
        |      |  |  |  |  +--ro monitor* [id]
        |      |  |  |  |     +--ro id        -> ../state/id
        |      |  |  |  |     +--ro state
        |      |  |  |  |        +--ro id?             ipi-platform-cmis-types:cmm_cmis_host_
monitor_id_t
        |      |  |  |  |        +--ro supported?      ipi-platform-cmis-types:cmm_cmis_yes_no_
t
        |      |  |  |  |        +--ro lanes-assigned?   ipi-platform-cmis-types:cmm_cmis_lane_
assignment_t
        |      |  |  |  +--ro flags
        |      |  |  |     +--ro flag* [id]
        |      |  |  |        +--ro id        -> ../state/id
        |      |  |  |        +--ro state
        |      |  |  |           +--ro id?             ipi-platform-cmis-types:cmm_cmis_host_
flag_id_t
        |      |  |  |           +--ro supported?      ipi-platform-cmis-types:cmm_cmis_yes_no_
t
        |      |  |  |           +--ro lanes-assigned?   ipi-platform-cmis-types:cmm_cmis_lane_
assignment_t
        |      |  +--ro media
        |      |  |     +--ro monitors
        |      |  |     |  +--ro monitor* [id]
        |      |  |     |     +--ro id        -> ../state/id
        |      |  |     |     +--ro state
        |      |  |     |        +--ro id?             ipi-platform-cmis-types:cmm_cmis_media_
monitor_id_t
        |      |  |     |        +--ro supported?      ipi-platform-cmis-types:cmm_cmis_yes_no_
t
        |      |  |     |        +--ro lanes-assigned?   ipi-platform-cmis-types:cmm_cmis_lane_
assignment_t
        |      |  |     +--ro flags
        |      |  |        +--ro flag* [id]
        |      |  |           +--ro id        -> ../state/id
        |      |  |           +--ro state
        |      |  |              +--ro id?             ipi-platform-cmis-types:cmm_cmis_media_
flag_id_t
        |      |  |              +--ro supported?      ipi-platform-cmis-types:cmm_cmis_yes_no_
t
        |      |  |              +--ro lanes-assigned?   ipi-platform-cmis-types:cmm_cmis_lane_
```

```
assignment_t
        |     |  +--ro pages
        |     |     +--ro state
        |     |        +--ro network-path-pages-supported?   ipi-platform-cmis-types:cmm_cmis_
yes_no_t
        |     |        +--ro vdm-pages-supported?             ipi-platform-cmis-types:cmm_cmis_
yes_no_t
        |     |        +--ro vdm-groups?                      ipi-platform-cmis-types:cmm_cmis_
vdm_pages_support_t
        |     |        +--ro diagnostics-pages-supported?     ipi-platform-cmis-types:cmm_cmis_
yes_no_t
        |     |        +--ro user-page-supported?             ipi-platform-cmis-types:cmm_cmis_
yes_no_t
        |     |        +--ro banks-per-page?                  ipi-platform-cmis-types:cmm_cmis_
bank_per_page_support_t
        |     +--ro module-state
        |     |  +--ro state
        |     |  |  +--ro fault-state?     ipi-platform-cmis-types:cmm_cmis_module_fault_state_t
        |     |  |  +--ro current-state?   ipi-platform-cmis-types:cmm_cmis_module_state_t
        |     |  +--ro datapaths
        |     |     +--ro datapath* [lane]
        |     |        +--ro lane     -> ../state/lane
        |     |        +--ro state
        |     |           +--ro lane?            uint8
        |     |           +--ro current-state?   ipi-platform-cmis-types:cmm_cmis_datapath_
states_t
        |     |           +--ro host-rate?       decimal64
        |     |           +--ro media-rate?      decimal64
        |     |           +--ro interface-name?  string
        |     +--ro module-monitors
        |     |  +--ro monitors
        |     |  |  +--ro monitor* [id]
        |     |  |     +--ro id        -> ../state/id
        |     |  |     +--ro state
        |     |  |        +--ro id?              ipi-platform-cmis-types:cmm_cmis_module_monitor_
id_t
        |     |  |        +--ro description?     string
        |     |  |        +--ro value?           decimal64
        |     |  |        +--ro high-alarm?      decimal64
        |     |  |        +--ro high-warning?    decimal64
        |     |  |        +--ro low-warning?     decimal64
        |     |  |        +--ro low-alarm?       decimal64
        |     |  +--ro monitor-alarm
        |     |     +--ro state
        |     |        +--ro alarm-id?            ipi-platform-cmis-types:cmm_cmis_module_
monitor_id_t
        |     |        +--ro alarm-type?          ipi-platform-cmis-types:cmm_cmis_threshold_
alarm_t
        |     |        +--ro current-value?       decimal64
        |     |        +--ro threshold-minimum?   decimal64
        |     |        +--ro threshold-maximum?   decimal64
        |     +--ro host-monitors
        |     |  +--ro lanes
        |     |     +--ro lane* [number]
        |     |        +--ro number              -> ../state/number
        |     |        +--ro state
        |     |        |  +--ro number?        uint8
        |     |        |  +--ro dp-assigned?   boolean
        |     |        +--ro monitors
        |     |        |  +--ro monitor* [id]
        |     |        |     +--ro id        -> ../state/id
        |     |        |     +--ro state
        |     |        |        +--ro id?              ipi-platform-cmis-types:cmm_cmis_host_
monitor_id_t
        |     |        |        +--ro description?     string
        |     |        |        +--ro value?           decimal64
        |     |        |        +--ro high-alarm?      decimal64
        |     |        |        +--ro high-warning?    decimal64
```

```
|       |       |           +--ro low-warning?    decimal64
|       |       |           +--ro low-alarm?      decimal64
|       |       +--ro flags
|       |       | +--ro flag* [id]
|       |       |    +--ro id       -> ../state/id
|       |       |    +--ro state
|       |       |       +--ro id?            ipi-platform-cmis-types:cmm_cmis_host_flag_
id_t
|       |       |       +--ro description?   string
|       |       |       +--ro value?         boolean
|       |       +--ro monitor-alarm
|       |       | +--ro state
|       |       |    +--ro alarm-id?          ipi-platform-cmis-types:cmm_cmis_host_
monitor_id_t
|       |       |    +--ro alarm-type?        ipi-platform-cmis-types:cmm_cmis_
threshold_alarm_t
|       |       |    +--ro current-value?     decimal64
|       |       |    +--ro threshold-minimum? decimal64
|       |       |    +--ro threshold-maximum? decimal64
|       |       +--ro flag-alarm
|       |          +--ro state
|       |             +--ro alarm-id?  ipi-platform-cmis-types:cmm_cmis_host_flag_id_t
|       +--ro media-monitors
|          +--ro lanes
|             +--ro lane* [number]
|                +--ro number          -> ../state/number
|                +--ro state
|                | +--ro number?   uint8
|                +--ro monitors
|                | +--ro monitor* [id]
|                |    +--ro id       -> ../state/id
|                |    +--ro state
|                |       +--ro id?            ipi-platform-cmis-types:cmm_cmis_media_
monitor_id_t
|                |       +--ro description?   string
|                |       +--ro value?         decimal64
|                |       +--ro high-alarm?    decimal64
|                |       +--ro high-warning?  decimal64
|                |       +--ro low-warning?   decimal64
|                |       +--ro low-alarm?     decimal64
|                +--ro flags
|                | +--ro flag* [id]
|                |    +--ro id       -> ../state/id
|                |    +--ro state
|                |       +--ro id?            ipi-platform-cmis-types:cmm_cmis_media_
flag_id_t
|                |       +--ro description?   string
|                |       +--ro value?         boolean
|                +--ro monitor-alarm
|                | +--ro state
|                |    +--ro alarm-id?          ipi-platform-cmis-types:cmm_cmis_media_
monitor_id_t
|                |    +--ro alarm-type?        ipi-platform-cmis-types:cmm_cmis_
threshold_alarm_t
|                |    +--ro current-value?     decimal64
|                |    +--ro threshold-minimum? decimal64
|                |    +--ro threshold-maximum? decimal64
|                +--ro flag-alarm
|                   +--ro state
|                      +--ro alarm-id?  ipi-platform-cmis-types:cmm_cmis_media_flag_id_t
+--ro power-supply {feature-list:HAVE_CMMD}?
| +--ro state
|    +--ro operational-status?   cml_cmm_power_supply_operstatus_t
|    +--ro capacity?             decimal64
|    +--ro power-consumption?    decimal64
|    +--ro input-power?          decimal64
|    +--ro input-voltage?        decimal64
```

```
|        +--ro output-voltage?       decimal64
|        +--ro input-current?        decimal64
|        +--ro output-current?       decimal64
|        +--ro temperature-sensor1?  decimal64
|        +--ro temperature-sensor2?  decimal64
|        +--ro temperature-sensor3?  decimal64
|        +--ro fan1-rpm?             uint32
|        +--ro fan2-rpm?             uint32
|        +--ro fan3-rpm?             uint32
|        +--ro fan4-rpm?             uint32
+--ro fan {feature-list:HAVE_CMMD}?
|  +--ro state
|        +--ro rpm?           uint32
|        +--ro minimum-rpm?   uint32
|        +--ro maximum-rpm?   uint32
|        +--ro fan-status?    cml_cmm_fan_status_t
|        +--ro fan-location?  cml_cmm_fan_location_t
+--ro fan-tray {feature-list:HAVE_CMMD}?
   +--ro state
      +--ro status?   cml_cmm_fan_tray_status_t
```

Sensor Paths: ipi-platform

The paths listed below represent telemetry paths for monitoring the state of various components, including CPU, storage, RAM, power supply, fans, fan trays, CMIS, and transceivers.

CPU

```
Sensor Path
        ipi:/components/component[name]/cpu/state

Leaf Attributes
        /components/component[name]/cpu/state/cpu-1min-load-percentage
        /components/component[name]/cpu/state/cpu-5min-load-percentage
        /components/component[name]/cpu/state/cpu-15min-load-percentage
        /components/component[name]/cpu/state/cpu-utilization
```

Storage

```
Sensor Path
        ipi:/components/component[name]/storage/state/

Leaf Attributes
        /components/component[name]/storage/state/total-memory
        /components/component[name]/storage/state/used-memory
        /components/component[name]/storage/state/free-memory
```

RAM

```
Sensor Path
        ipi:/components/component[name]/ram/state/

Leaf Attributes
        /components/component[name]/ram/state/total-memory
        /components/component[name]/ram/state/used-memory
        /components/component[name]/ram/state/available-memory
        /components/component[name]/ram/state/shared-memory
        /components/component[name]/ram/state/buffers
```

```
        /components/component[name]/ram/state/total-swap
        /components/component[name]/ram/state/free-swap
        /components/component[name]/ram/state/current-process-count
        /components/component[name]/ram/state/total-high-memory
        /components/component[name]/ram/state/available-high-memory
```

Power-Supply

```
Sensor Path
        ipi:/components/component[name]/power-supply/state/

Leaf Attributes
        /components/component[name]/power-supply/state/capacity
        /components/component[name]/power-supply/state/power-consumption
        /components/component[name]/power-supply/state/input-power
        /components/component[name]/power-supply/state/input-voltage
        /components/component[name]/power-supply/state/input-current
        /components/component[name]/power-supply/state/output-voltage
        /components/component[name]/power-supply/state/output-current
        /components/component[name]/power-supply/state/operational-status
        /components/component[name]/power-supply/state/fan1-rpm
        /components/component[name]/power-supply/state/fan2-rpm
        /components/component[name]/power-supply/state/fan3-rpm
        /components/component[name]/power-supply/state/fan4-rpm
        /components/component[name]/power-supply/state/temperature-sensor1
        /components/component[name]/power-supply/state/temperature-sensor2
        /components/component[name]/power-supply/state/temperature-sensor3
```

Fan

```
Sensor Path
        ipi:/components/component[name]/fan/state/

Leaf Attributes
        /components/component[name]/fan/state/rpm
        /components/component[name]/fan/state/fan-status
        /components/component[name]/fan/state/fan-location
```

Fan-Tray

```
Sensor Path
        ipi:/components/component[name]/fan-tray/state/

Leaf Attributes
        /components/component[name]/fan-tray/state/status
```

Transceiver State

```
Sensor Path
        ipi:/components/component[name]/transceiver/state/

Leaf Attributes
        /components/component[name]/transceiver/state/grid-spacing
        /components/component[name]/transceiver/state/first-frequency
        /components/component[name]/transceiver/state/last-frequency
        /components/component[name]/transceiver/state/transceiver-temperature
```

```
        /components/component[name]/transceiver/state/transceiver-voltage
        /components/component[name]/transceiver/state/presence
        /components/component[name]/transceiver/state/type
        /components/component[name]/transceiver/state/transceiver-identifier
        /components/component[name]/transceiver/state/connector-type
        /components/component[name]/transceiver/state/vendor-name
        /components/component[name]/transceiver/state/vendor-part-number
        /components/component[name]/transceiver/state/vendor-revision-number
        /components/component[name]/transceiver/state/vendor-serial-number
        /components/component[name]/transceiver/state/vendor-manufacturing-date
```

Transceiver SFP State

```
Sensor Path
        ipi:/components/component[name]/transceiver/sfp/state/

Leaf Attributes
        /components/component[name]/transceiver/sfp/state/transmit-status
        /components/component[name]/transceiver/sfp/state/recieve-loss-status
        /components/component[name]/transceiver/sfp/state/sfp-identifier
        /components/component[name]/transceiver/sfp/state/sfp-options-implemented
        /components/component[name]/transceiver/sfp/state/fiber-channel-sfp-speed
        /components/component[name]/transceiver/sfp/state/sfp-infiniband-compliance-code
        /components/component[name]/transceiver/sfp/state/sfp-escon-compliance-code
        /components/component[name]/transceiver/sfp/state/sfp-plus-cable-technology
```

Transceiver XFP State

```
Sensor Path
        ipi:/components/component[name]/transceiver/xfp/state/

Leaf Attributes
        /components/component[name]/transceiver/xfp/state/transmit-status
        /components/component[name]/transceiver/xfp/state/recieve-loss-status
        /components/component[name]/transceiver/xfp/state/xsfp-identifier
        /components/component[name]/transceiver/xfp/state/xfp-10g-ethernet-compliance-code
        /components/component[name]/transceiver/xfp/state/xfp-10g-fiber-channel-compliance-code
        /components/component[name]/transceiver/xfp/state/xfp-10g-copper-link-compliance-code
        /components/component[name]/transceiver/xfp/state/xfp-lower-speed-link-compliance-code
        /components/component[name]/transceiver/xfp/state/xfp-sonet-interconnect-compliance-code
        /components/component[name]/transceiver/xfp/state/xfp-sonet-short-haul-compliance-code
        /components/component[name]/transceiver/xfp/state/xfp-sonet-long-haul-compliance-code
        /components/component[name]/transceiver/xfp/state/xfp-sonet-very-long-haul-compliance-
code
        /components/component[name]/transceiver/xfp/state/xfp-serial-encoding-algorithm
        /components/component[name]/transceiver/xfp/state/xsfp-options-implemented
        /components/component[name]/transceiver/xfp/state/xfp-auxillary-voltage
```

Transceiver QSFP State

```
Sensor Path
        ipi:/components/component[name]/transceiver/qsfp/state/

Leaf Attributes
        /components/component[name]/transceiver/qsfp/state/reset-status
        /components/component[name]/transceiver/qsfp/state/power
        /components/component[name]/transceiver/qsfp/state/lane1-transmission
        /components/component[name]/transceiver/qsfp/state/lane1-transmission-loss
        /components/component[name]/transceiver/qsfp/state/lane1-recieve-loss
```

```
/components/component[name]/transceiver/qsfp/state/lane2-transmission
/components/component[name]/transceiver/qsfp/state/lane2-transmission-loss
/components/component[name]/transceiver/qsfp/state/lane2-recieve-loss
/components/component[name]/transceiver/qsfp/state/lane3-transmission
/components/component[name]/transceiver/qsfp/state/lane3-transmission-loss
/components/component[name]/transceiver/qsfp/state/lane3-recieve-loss
/components/component[name]/transceiver/qsfp/state/lane4-transmission
/components/component[name]/transceiver/qsfp/state/lane4-transmission-loss
/components/component[name]/transceiver/qsfp/state/lane4-recieve-loss
/components/component[name]/transceiver/qsfp/state/qsfp-identifier
/components/component[name]/transceiver/qsfp/state/fiber-channel-qsfp-speed
/components/component[name]/transceiver/qsfp/state/qsfp-options-implemented
```

Transceiver Channels

```
Sensor Path
        ipi:/components/component[name]/transceiver/channels/channel[index]/state/

Leaf Attributes
        /components/component[name]/transceiver/channels/channel[index]/state/index
        /components/component[name]/transceiver/channels/channel[index]/state/input-power
        /components/component[name]/transceiver/channels/channel[index]/state/input-power-alert-
max-threshold
        /components/component[name]/transceiver/channels/channel[index]/state/input-power-
critical-max-threshold
        /components/component[name]/transceiver/channels/channel[index]/state/input-power-
critical-min-threshold
        /components/component[name]/transceiver/channels/channel[index]/state/input-power-alert-
min-threshold
        /components/component[name]/transceiver/channels/channel[index]/state/output-power
        /components/component[name]/transceiver/channels/channel[index]/state/output-power-
alert-max-threshold
        /components/component[name]/transceiver/channels/channel[index]/state/output-power-
critical-max-threshold
        /components/component[name]/transceiver/channels/channel[index]/state/output-power-
critical-min-threshold
        /components/component[name]/transceiver/channels/channel[index]/state/output-power-
alert-min-threshold
        /components/component[name]/transceiver/channels/channel[index]/state/laser-bias-current
        /components/component[name]/transceiver/channels/channel[index]/state/laser-bias-
current-alert-max-treshold
        /components/component[name]/transceiver/channels/channel[index]/state/laser-bias-
current-critical-max-threshold
        /components/component[name]/transceiver/channels/channel[index]/state/laser-bias-
current-critical-min-threshold
        /components/component[name]/transceiver/channels/channel[index]/state/laser-bias-
current-alert-min-threshold
```

Platform State

```
Sensor Path
        ipi:/components/component[name]/state/

Leaf Attributes
            /components/component[name]/state/name
            /components/component[name]/state/type
            /components/component[name]/state/location
            /components/component[name]/state/mfg-name
            /components/component[name]/state/description
            /components/component[name]/state/hardware-version
            /components/component[name]/state/firmware-version
            /components/component[name]/state/software-version
            /components/component[name]/state/serial-no
            /components/component[name]/state/part-no
```

```
        /components/component[name]/state/removable
        /components/component[name]/state/oper-status
        /components/component[name]/state/product-name
        /components/component[name]/state/asset-tag
        /components/component[name]/state/component-additional-details
        /components/component[name]/state/parent
        /components/component[name]/state/empty
```

Platform State: Memory

```
Sensor Path
        ipi:/components/component[name]/state/memory
Leaf Attributes
        /components/component[name]/state/memory/available
        /components/component[name]/state/memory/utilized
```

Platform State: Board FRU

```
Sensor Path
        ipi:/components/component[name]/state/board-fru
Leaf Attributes
        /components/component[name]/state/board-fru/board-name
        /components/component[name]/state/board-fru/board-serial-no
        /components/component[name]/state/board-fru/board-mfg-name
        /components/component[name]/state/board-fru/board-mfg-date
```

Platform State: Temperature

```
Sensor Path
        ipi:/components/component[name]/state/temperature
Leaf Attributes
        /components/component[name]/state/temperature/instant
        /components/component[name]/state/temperature/min
        /components/component[name]/state/temperature/max
        /components/component[name]/state/temperature/avg
        /components/component[name]/state/temperature/interval
        /components/component[name]/state/temperature/sensor-name
        /components/component[name]/state/temperature/sensor-index
        /components/component[name]/state/temperature/alarm-status
        /components/component[name]/state/temperature/alarm-threshold
        /components/component[name]/state/temperature/alarm-severity
        /components/component[name]/state/temperature/minimum-emergency-temperature
        /components/component[name]/state/temperature/maximum-emergency-temperature
        /components/component[name]/state/temperature/minimum-alert-temperature
        /components/component[name]/state/temperature/maximum-alert-temperature
        /components/component[name]/state/temperature/minimum-critical-temperature
        /components/component[name]/state/temperature/maximum-critical-temperature
```

IPI-INTERFACE

Pyang Tree: ipi-interface

```
   +--rw interfaces
      +--rw interface* [name]
         +--rw name                      -> ../config/name
         +--rw config
         | +--rw name?   string
         +--ro state
         | +--ro ifindex?        uint32
         | +--ro admin-status?   ipi-if-types:if_interface_admin_status_t
         | +--ro oper-status?    ipi-if-types:if_interface_oper_status_t
         | +--ro last-change?    yang:timeticks
         | +--ro logical?        boolean
         | +--ro counters
         |    +--ro in-octets?            yang:counter64
         |    +--ro in-pkts?              yang:counter64
         |    +--ro in-unicast-pkts?      yang:counter64 {feature-list:HAVE_BROADCOM,feature-
list:HAVE_HAL,feature-list:NOT_HAVE_SWFWDR}?
         |    +--ro in-broadcast-pkts?    yang:counter64 {feature-list:HAVE_BROADCOM,feature-
list:HAVE_HAL,feature-list:NOT_HAVE_SWFWDR}?
         |    +--ro in-multicast-pkts?    yang:counter64
         |    +--ro in-discards?          yang:counter64
         |    +--ro in-errors?            yang:counter64
         |    +--ro in-fcs-errors?        yang:counter64 {feature-list:HAVE_BROADCOM,feature-
list:HAVE_HAL,feature-list:NOT_HAVE_SWFWDR}?
         |    +--ro out-octets?           yang:counter64
         |    +--ro out-pkts?             yang:counter64
         |    +--ro out-unicast-pkts?     yang:counter64 {feature-list:HAVE_BROADCOM,feature-
list:HAVE_HAL,feature-list:NOT_HAVE_SWFWDR}?
         |    +--ro out-broadcast-pkts?   yang:counter64 {feature-list:HAVE_BROADCOM,feature-
list:HAVE_HAL,feature-list:NOT_HAVE_SWFWDR}?
         |    +--ro out-multicast-pkts?   yang:counter64 {feature-list:HAVE_BROADCOM,feature-
list:HAVE_HAL,feature-list:NOT_HAVE_SWFWDR}?
         |    +--ro out-discards?         yang:counter64
         |    +--ro out-errors?           yang:counter64
         |    +--ro last-clear?           ipi-if-types:if_last_clear_time_t
         +--rw ipi-if-ethernet:ethernet
            +--ro ipi-if-ethernet:state
            +--ro ipi-if-ethernet:counters
               +--ro ipi-if-extended:extended-ethernet-counters {feature-list:HAVE_
BROADCOM,feature-list:HAVE_HAL,feature-list:NOT_HAVE_SWFWDR,feature-list:NOT_HAVE_POND}?
                  +--ro ipi-if-extended:receive-pkt-rate?   yang:counter64
                  +--ro ipi-if-extended:receive-bit-rate?   yang:counter64
                  +--ro ipi-if-extended:send-pkt-rate?      yang:counter64
                  +--ro ipi-if-extended:send-bit-rate?      yang:counter64
```

Sensor Paths: ipi-interface

Interface State

```
Sensor Path
        ipi:/interfaces/interface[name]/state

Leaf Attributes
        /interfaces/interface[name]/state/name
        /interfaces/interface[name]/state/ifindex
        /interfaces/interface[name]/state/admin-status
        /interfaces/interface[name]/state/oper-status
        /interfaces/interface[name]/state/last-change
```

```
        /interfaces/interface[name]/state/logical
```

Interface Counters

```
Sensor Path
        ipi:/interfaces/interface[name]/state/counters

Leaf Attributes
        /interfaces/interface[name]/state/counters/in-octets
        /interfaces/interface[name]/state/counters/in-pkts
        /interfaces/interface[name]/state/counters/in-unicast-pkts
        /interfaces/interface[name]/state/counters/in-broadcast-pkts
        /interfaces/interface[name]/state/counters/in-multicast-pkts
        /interfaces/interface[name]/state/counters/in-discards
        /interfaces/interface[name]/state/counters/in-errors
        /interfaces/interface[name]/state/counters/in-fcs-errors
        /interfaces/interface[name]/state/counters/out-octets
        /interfaces/interface[name]/state/counters/out-pkts
        /interfaces/interface[name]/state/counters/out-unicast-pkts
        /interfaces/interface[name]/state/counters/out-broadcast-pkts
        /interfaces/interface[name]/state/counters/out-multicast-pkts
        /interfaces/interface[name]/state/counters/out-discards
        /interfaces/interface[name]/state/counters/out-errors
        /interfaces/interface[name]/state/counters/last-clear
```

Extended Ethernet Counters

```
Sensor Path
        ipi:/interfaces/interface[name]/ethernet/state/counters/extended-ethernet-counters

Leaf Attributes
        /interfaces/interface[name]/ethernet/state/counters/extended-ethernet-
counters/receive-pkt-rate
        /interfaces/interface[name]/ethernet/state/counters/extended-ethernet-
counters/send-pkt-rate
        /interfaces/interface[name]/ethernet/state/counters/extended-ethernet-
counters/receive-bit-rate
        /interfaces/interface[name]/ethernet/state/counters/extended-ethernet-
counters/send-bit-rate
```

Interface Ethernet State

```
Sensor Path
        ipi:/interfaces/interface[name]/ethernet/state

Leaf Attributes
        /interfaces/interface[name]/ethernet/state/negotiated-port-speed
```

IPI-VXLAN

Pyang Tree: ipi-vxlan

```
+--rw vxlan {feature-list:HAVE_VXLAN}?
    +--ro tunnel* [destination-vtep-ip]
        +--ro destination-vtep-ip    -> ../state/destination-vtep-ip
        +--ro state
            +--ro destination-vtep-ip?   inet:ipv4-address
            +--ro counters
                +--ro out-bytes?     yang:counter64
                +--ro out-packets?   yang:counter64
                +--ro in-bytes?      yang:counter64
                +--ro in-packets?    yang:counter64
```

Sensor Paths: ipi-vxlan

VXLAN State

```
Sensor Path
        ipi:/vxlan/tunnel[destination-vtep-ip]/state/counters

Leaf Attributes
        /vxlan/tunnel[destination-vtep-ip]/state/counters/out-bytes
        /vxlan/tunnel[destination-vtep-ip]/state/counters/out-packets
        /vxlan/tunnel[destination-vtep-ip]/state/counters/in-bytes
        /vxlan/tunnel[destination-vtep-ip]/state/counters/in-packets
```

IPI-Platform-CMIS

Pyang Tree: ipi-platform-cmis

```
+--rw components {feature-list:HAVE_CMMD}?
    +--ro component* [name]
        +--ro name                          -> ../state/name
        +--ro state
        |  +--ro name?                       string
        |  +--ro type?                       ipi-platform-types:cmm_component_type_t
{feature-list:NOT_HAVE_TIBIT}?
        |  +--ro location?                   string {feature-list:NOT_HAVE_TIBIT}?
        |  +--ro mfg-name?                   string {feature-list:NOT_HAVE_TIBIT}?
        |  +--ro mfg-date?                   yang:date-and-time {feature-list:NOT_HAVE_
TIBIT}?
        |  +--ro description?                string {feature-list:NOT_HAVE_TIBIT}?
        |  +--ro hardware-version?           string {feature-list:NOT_HAVE_TIBIT}?
        |  +--ro firmware-version?           string {feature-list:NOT_HAVE_TIBIT}?
        |  +--ro software-version?           string {feature-list:NOT_HAVE_TIBIT}?
        |  +--ro serial-no?                  string {feature-list:NOT_HAVE_TIBIT}?
        |  +--ro part-no?                    string {feature-list:NOT_HAVE_TIBIT}?
        |  +--ro removable?                  boolean {feature-list:NOT_HAVE_TIBIT}?
        |  +--ro oper-status?                ipi-platform-types:cmm_component_oper_status_t
{feature-list:NOT_HAVE_TIBIT}?
        |  +--ro product-name?               string {feature-list:NOT_HAVE_TIBIT}?
        |  +--ro asset-tag?                  string {feature-list:NOT_HAVE_TIBIT}?
        |  +--ro component-additional-details*  string {feature-list:NOT_HAVE_TIBIT}?
        |  +--ro parent?                     -> /components/component/state/name {feature-
list:NOT_HAVE_TIBIT}?
        |  +--ro empty?                      boolean {feature-list:NOT_HAVE_TIBIT}?
        +--ro transceiver {feature-list:HAVE_CMMD,feature-list:NOT_HAVE_TIBIT}?
            +--ro state
            |  +--ro grid-spacing?             decimal64
            |  +--ro first-frequency?          decimal64
            |  +--ro last-frequency?           decimal64
            |  +--ro transceiver-temperature?  decimal64
            |  +--ro transceiver-voltage?      decimal64
            +--ro cmis-module {feature-list:HAVE_CMMD,feature-list:NOT_HAVE_TIBIT}?
                +--ro eeprom
                |  +--ro state
                |     +--ro identifier?                   ipi-platform-sff8024-types:cmm_sff8024_
identifier_t
                |     +--ro vendor-name?                  string
                |     +--ro vendor-oui?                   string
                |     +--ro part-number?                  string
                |     +--ro revision-level?               string
                |     +--ro serial-number?                string
                |     +--ro manufacturing-date?           string
                |     +--ro clei-code?                     string
                |     +--ro module-power-class?           ipi-platform-cmis-types:cmm_cmis_module_
power_class_t
                |     +--ro module-max-power?             decimal64
                |     +--ro cooling-implemented?          ipi-platform-cmis-types:cmm_cmis_yes_no_
t
                |     +--ro temperature-max?              int16
                |     +--ro temperature-min?              int16
                |     +--ro operatin-voltage-min?         decimal64
                |     +--ro optical-detector?             ipi-platform-cmis-types:cmm_cmis_
optical_detector_t
                |     +--ro rx-power-measurement?         ipi-platform-cmis-types:cmm_cmis_rx_
power_measur_t
                |     +--ro tx-disable-module-wide?       ipi-platform-cmis-types:cmm_cmis_yes_no_
t
                |     +--ro cable-assembly-link-length?   int16
                |     +--ro connector-type?               ipi-platform-sff8024-types:cmm_sff8024_
```

```
connector_type_t
          |       +--ro cca-5ghz?                    uint8
          |       +--ro cca-7ghz?                    uint8
          |       +--ro cca-12p9ghz?                 uint8
          |       +--ro cca-25p8ghz?                 uint8
          |       +--ro media-interface-technology?  ipi-platform-cmis-types:cmm_cmis_media_
intf_tech_t
          |       +--ro cmis-revision?               string
          |       +--ro memory-model?                ipi-platform-cmis-types:cmm_cmis_memory_
model_t
          |       +--ro mci-max-speed?               ipi-platform-cmis-types:cmm_cmis_mci_
max_speed_t
          |       +--ro active-firmware-revision?    string
          |       +--ro inactive-firmware-revision?  string
          |       +--ro hardware-revision?           string
          |       +--ro media-type?                  ipi-platform-cmis-types:cmm_cmis_media_
type_t
          |       +--ro max-smf-link-length?         decimal64
          |       +--ro max-mmf-om2-link-length?     uint8
          |       +--ro max-mmf-om3-link-length?     uint16
          |       +--ro max-mmf-om4-link-length?     uint16
          |       +--ro max-mmf-om5-link-length?     uint16
          |       +--ro wavelength-nominal?          decimal64
          |       +--ro wavelength-tolerance?        decimal64
          +--ro advertisement
          |  +--ro applications
          |  |  +--ro application* [id]
          |  |     +--ro id        -> ../state/id
          |  |     +--ro state
          |  |     |  +--ro id?   uint8
          |  |     +--ro host
          |  |     |  +--ro state
          |  |     |     +--ro interface-type?        ipi-platform-cmis-types:cmm_cmis_
interface_type_t
          |  |     |     +--ro application-bitrate?   ipi-platform-cmis-types:cmm_cmis_
bit_rate_t
          |  |     |     +--ro lane-count?            uint8
          |  |     |     +--ro signal-bitrate?        ipi-platform-cmis-types:cmm_cmis_
bit_rate_t
          |  |     |     +--ro modulation-format?     ipi-platform-cmis-types:cmm_cmis_
modulation_format_t
          |  |     |     +--ro bits-per-unit-interval? decimal64
          |  |     |     +--ro lane-assignment?       ipi-platform-cmis-types:cmm_cmis_
lane_assignment_t
          |  |     +--ro media
          |  |        +--ro state
          |  |           +--ro interface-type?        ipi-platform-cmis-types:cmm_cmis_
interface_type_t
          |  |           +--ro application-bitrate?   ipi-platform-cmis-types:cmm_cmis_
bit_rate_t
          |  |           +--ro lane-count?            uint8
          |  |           +--ro signal-bitrate?        ipi-platform-cmis-types:cmm_cmis_
bit_rate_t
          |  |           +--ro modulation-format?     ipi-platform-cmis-types:cmm_cmis_
modulation_format_t
          |  |           +--ro bits-per-unit-interval? decimal64
          |  |           +--ro lane-assignment?       ipi-platform-cmis-types:cmm_cmis_
lane_assignment_t
          |  +--ro controls
          |  |  +--ro state
          |  |     +--ro wavelength-control?          ipi-platform-cmis-types:cmm_cmis_
yes_no_t
          |  |     +--ro tunable-transmitter?         ipi-platform-cmis-types:cmm_cmis_
yes_no_t
          |  |     +--ro tx-output-squelching-method? ipi-platform-cmis-types:cmm_cmis_
tx_squelch_method_t
          |  |     +--ro forced-tx-output-squelching? ipi-platform-cmis-types:cmm_cmis_
yes_no_t
          |  |     +--ro tx-output-squelching-disable? ipi-platform-cmis-types:cmm_cmis_
```

```
yes_no_t
              |  |       +--ro tx-output-disable?                ipi-platform-cmis-types:cmm_cmis_
yes_no_t
              |  |       +--ro input-polarity-flip-tx?           ipi-platform-cmis-types:cmm_cmis_
yes_no_t
              |  |       +--ro rx-output-squelching-disable?     ipi-platform-cmis-types:cmm_cmis_
yes_no_t
              |  |       +--ro rx-output-disable?                ipi-platform-cmis-types:cmm_cmis_
yes_no_t
              |  |       +--ro output-polarity-flip-rx?          ipi-platform-cmis-types:cmm_cmis_
yes_no_t
              | +--ro diagnostics
              | | +--ro module
              | | | +--ro state
              | | |    +--ro simultaneous-host-and-media-loopback?   ipi-platform-cmis-
types:cmm_cmis_yes_no_t
              | | |    +--ro report-bit-error-ratio?                 ipi-platform-cmis-
types:cmm_cmis_yes_no_t
              | | |    +--ro count-bits-and-errors?                  ipi-platform-cmis-
types:cmm_cmis_yes_no_t
              | | +--ro host
              | | | +--ro state
              | | |    +--ro output-loopack?          ipi-platform-cmis-types:cmm_cmis_yes_
no_t
              | | |    +--ro input-loopack?           ipi-platform-cmis-types:cmm_cmis_yes_
no_t
              | | |    +--ro per-lane-loopack?        ipi-platform-cmis-types:cmm_cmis_yes_
no_t
              | | |    +--ro report-input-snr?        ipi-platform-cmis-types:cmm_cmis_yes_
no_t
              | | |    +--ro report-fec?              ipi-platform-cmis-types:cmm_cmis_yes_
no_t
              | | |    +--ro prbs-checker-post-fec?   ipi-platform-cmis-types:cmm_cmis_yes_
no_t
              | | |    +--ro prbs-checker-pre-fec?    ipi-platform-cmis-types:cmm_cmis_yes_
no_t
              | | |    +--ro prbs-checker-types?      ipi-platform-cmis-types:cmm_cmis_
prbs_support_type_t
              | | |    +--ro prbs-generator-post-fec? ipi-platform-cmis-types:cmm_cmis_yes_
no_t
              | | |    +--ro prbs-generator-pre-fec?  ipi-platform-cmis-types:cmm_cmis_yes_
no_t
              | | |    +--ro prbs-generator-types?    ipi-platform-cmis-types:cmm_cmis_
prbs_support_type_t
              | | +--ro media
              | |   +--ro state
              | |      +--ro output-loopack?          ipi-platform-cmis-types:cmm_cmis_yes_
no_t
              | |      +--ro input-loopack?           ipi-platform-cmis-types:cmm_cmis_yes_
no_t
              | |      +--ro per-lane-loopack?        ipi-platform-cmis-types:cmm_cmis_yes_
no_t
              | |      +--ro report-input-snr?        ipi-platform-cmis-types:cmm_cmis_yes_
no_t
              | |      +--ro report-fec?              ipi-platform-cmis-types:cmm_cmis_yes_
no_t
              | |      +--ro prbs-checker-post-fec?   ipi-platform-cmis-types:cmm_cmis_yes_
no_t
              | |      +--ro prbs-checker-pre-fec?    ipi-platform-cmis-types:cmm_cmis_yes_
no_t
              | |      +--ro prbs-checker-types?      ipi-platform-cmis-types:cmm_cmis_
prbs_support_type_t
              | |      +--ro prbs-generator-post-fec? ipi-platform-cmis-types:cmm_cmis_yes_
no_t
              | |      +--ro prbs-generator-pre-fec?  ipi-platform-cmis-types:cmm_cmis_yes_
no_t
              | |      +--ro prbs-generator-types?    ipi-platform-cmis-types:cmm_cmis_
prbs_support_type_t
              | +--ro durations
```

```
            |  |  +--ro state
            |  |     +--ro modsel-wait-time?              uint8
            |  |     +--ro dpinit-maximun-duration?       ipi-platform-cmis-types:cmm_cmis_
durations_t
            |  |     +--ro dpdeinit-maximun-duration?     ipi-platform-cmis-types:cmm_cmis_
durations_t
            |  |     +--ro dptxturnon-maximum-duration?   ipi-platform-cmis-types:cmm_cmis_
durations_t
            |  |     +--ro dptxturnoff-maximum-duration?  ipi-platform-cmis-types:cmm_cmis_
durations_t
            |  |     +--ro modulepwrup-maximum-duration?  ipi-platform-cmis-types:cmm_cmis_
durations_t
            |  |     +--ro modulepwrdn-maximum-duration?  ipi-platform-cmis-types:cmm_cmis_
durations_t
            |  |     +--ro npinit-maximum-duration?       ipi-platform-cmis-types:cmm_cmis_
durations_t
            |  |     +--ro npdeinit-maximum-duration?     ipi-platform-cmis-types:cmm_cmis_
durations_t
            |  |     +--ro nptxturnon-maximum-duration?   ipi-platform-cmis-types:cmm_cmis_
durations_t
            |  |     +--ro nptxturnoff-maximum-duration?  ipi-platform-cmis-types:cmm_cmis_
durations_t
            |  +--ro laser
            |  |  +--ro state
            |  |  |  +--ro supported-grids?                  ipi-platform-cmis-types:cmm_
cmis_laser_grid_support_t
            |  |  |  +--ro fine-tune-supported?              ipi-platform-cmis-types:cmm_
cmis_yes_no_t
            |  |  |  +--ro fine-tune-resolution?             decimal64
            |  |  |  +--ro fine-tune-low-offset?             decimal64
            |  |  |  +--ro fine-tune-high-offset?            decimal64
            |  |  |  +--ro per-lane-programmable-output-power?  ipi-platform-cmis-types:cmm_
cmis_yes_no_t
            |  |  |  +--ro minimum-programmable-output-power?   decimal64
            |  |  |  +--ro maximum-programmable-output-power?   decimal64
            |  |  +--ro grids
            |  |     +--ro grid* [id]
            |  |        +--ro id       -> ../state/id
            |  |        +--ro state
            |  |           +--ro id?                       ipi-platform-cmis-types:cmm_
cmis_laser_grid_spacing_t
            |  |           +--ro lowest-channel-frequency?   decimal64
            |  |           +--ro highest-channel-frequency?  decimal64
            |  |           +--ro channel-count?              uint16
            |  +--ro monitoring
            |  |  +--ro module
            |  |  |  +--ro monitors
            |  |  |     +--ro monitor* [id]
            |  |  |        +--ro id       -> ../state/id
            |  |  |        +--ro state
            |  |  |           +--ro id?       ipi-platform-cmis-types:cmm_cmis_module_
monitor_id_t
            |  |  |           +--ro supported?   ipi-platform-cmis-types:cmm_cmis_yes_no_t
            |  |  +--ro host
            |  |  |  +--ro monitors
            |  |  |  |  +--ro monitor* [id]
            |  |  |  |     +--ro id       -> ../state/id
            |  |  |  |     +--ro state
            |  |  |  |        +--ro id?             ipi-platform-cmis-types:cmm_cmis_host_
monitor_id_t
            |  |  |  |        +--ro supported?      ipi-platform-cmis-types:cmm_cmis_yes_no_
t
            |  |  |  |        +--ro lanes-assigned?   ipi-platform-cmis-types:cmm_cmis_lane_
assignment_t
            |  |  |  +--ro flags
            |  |  |     +--ro flag* [id]
            |  |  |        +--ro id       -> ../state/id
            |  |  |        +--ro state
            |  |  |           +--ro id?             ipi-platform-cmis-types:cmm_cmis_host_
```

```
flag_id_t
              | | |              +--ro supported?        ipi-platform-cmis-types:cmm_cmis_yes_no_
t
              | | |              +--ro lanes-assigned?   ipi-platform-cmis-types:cmm_cmis_lane_
assignment_t
              | | +--ro media
              | |    +--ro monitors
              | |    | +--ro monitor* [id]
              | |    |    +--ro id        -> ../state/id
              | |    |    +--ro state
              | |    |       +--ro id?               ipi-platform-cmis-types:cmm_cmis_media_
monitor_id_t
              | |    |       +--ro supported?        ipi-platform-cmis-types:cmm_cmis_yes_no_
t
              | |    |       +--ro lanes-assigned?   ipi-platform-cmis-types:cmm_cmis_lane_
assignment_t
              | |    +--ro flags
              | |       +--ro flag* [id]
              | |          +--ro id        -> ../state/id
              | |          +--ro state
              | |             +--ro id?               ipi-platform-cmis-types:cmm_cmis_media_
flag_id_t
              | |             +--ro supported?        ipi-platform-cmis-types:cmm_cmis_yes_no_
t
              | |             +--ro lanes-assigned?   ipi-platform-cmis-types:cmm_cmis_lane_
assignment_t
              | +--ro pages
              |    +--ro state
              |       +--ro network-path-pages-supported?   ipi-platform-cmis-types:cmm_cmis_
yes_no_t
              |       +--ro vdm-pages-supported?            ipi-platform-cmis-types:cmm_cmis_
yes_no_t
              |       +--ro vdm-groups?                     ipi-platform-cmis-types:cmm_cmis_
vdm_pages_support_t
              |       +--ro diagnostics-pages-supported?    ipi-platform-cmis-types:cmm_cmis_
yes_no_t
              |       +--ro user-page-supported?            ipi-platform-cmis-types:cmm_cmis_
yes_no_t
              |       +--ro banks-per-page?                 ipi-platform-cmis-types:cmm_cmis_
bank_per_page_support_t
              +--ro module-state
              | +--ro state
              | | +--ro fault-state?     ipi-platform-cmis-types:cmm_cmis_module_fault_state_t
              | | +--ro current-state?   ipi-platform-cmis-types:cmm_cmis_module_state_t
              | +--ro datapaths
              |    +--ro datapath* [lane]
              |       +--ro lane     -> ../state/lane
              |       +--ro state
              |          +--ro lane?            uint8
              |          +--ro current-state?   ipi-platform-cmis-types:cmm_cmis_datapath_
states_t
              |          +--ro host-rate?       decimal64
              |          +--ro media-rate?      decimal64
              |          +--ro interface-name?  string
              +--ro module-monitors
              | +--ro monitors
              | | +--ro monitor* [id]
              | |    +--ro id        -> ../state/id
              | |    +--ro state
              | |       +--ro id?               ipi-platform-cmis-types:cmm_cmis_module_monitor_
id_t
              | |       +--ro description?    string
              | |       +--ro value?          decimal64
              | |       +--ro high-alarm?     decimal64
              | |       +--ro high-warning?   decimal64
              | |       +--ro low-warning?    decimal64
              | |       +--ro low-alarm?      decimal64
              | +--ro monitor-alarm
```

```
             |       +--ro state
             |          +--ro alarm-id?         ipi-platform-cmis-types:cmm_cmis_module_
monitor_id_t
             |          +--ro alarm-type?        ipi-platform-cmis-types:cmm_cmis_threshold_
alarm_t
             |          +--ro current-value?     decimal64
             |          +--ro threshold-minimum?  decimal64
             |          +--ro threshold-maximum?  decimal64
             +--ro host-monitors
             |  +--ro lanes
             |     +--ro lane* [number]
             |        +--ro number            -> ../state/number
             |        +--ro state
             |        |  +--ro number?       uint8
             |        |  +--ro dp-assigned?   boolean
             |        +--ro monitors
             |        |  +--ro monitor* [id]
             |        |     +--ro id        -> ../state/id
             |        |     +--ro state
             |        |        +--ro id?              ipi-platform-cmis-types:cmm_cmis_host_
monitor_id_t
             |        |        +--ro description?    string
             |        |        +--ro value?          decimal64
             |        |        +--ro high-alarm?     decimal64
             |        |        +--ro high-warning?   decimal64
             |        |        +--ro low-warning?    decimal64
             |        |        +--ro low-alarm?      decimal64
             |        +--ro flags
             |        |  +--ro flag* [id]
             |        |     +--ro id        -> ../state/id
             |        |     +--ro state
             |        |        +--ro id?              ipi-platform-cmis-types:cmm_cmis_host_flag_
id_t
             |        |        +--ro description?    string
             |        |        +--ro value?          boolean
             |        +--ro monitor-alarm
             |        |  +--ro state
             |        |     +--ro alarm-id?            ipi-platform-cmis-types:cmm_cmis_host_
monitor_id_t
             |        |     +--ro alarm-type?          ipi-platform-cmis-types:cmm_cmis_
threshold_alarm_t
             |        |     +--ro current-value?     decimal64
             |        |     +--ro threshold-minimum?  decimal64
             |        |     +--ro threshold-maximum?  decimal64
             |        +--ro flag-alarm
             |           +--ro state
             |              +--ro alarm-id?  ipi-platform-cmis-types:cmm_cmis_host_flag_id_t
             +--ro media-monitors
                +--ro lanes
                   +--ro lane* [number]
                      +--ro number            -> ../state/number
                      +--ro state
                      |  +--ro number?   uint8
                      +--ro monitors
                      |  +--ro monitor* [id]
                      |     +--ro id        -> ../state/id
                      |     +--ro state
                      |        +--ro id?              ipi-platform-cmis-types:cmm_cmis_media_
monitor_id_t
                      |        +--ro description?    string
                      |        +--ro value?          decimal64
                      |        +--ro high-alarm?     decimal64
                      |        +--ro high-warning?   decimal64
                      |        +--ro low-warning?    decimal64
                      |        +--ro low-alarm?      decimal64
                      +--ro flags
                      |  +--ro flag* [id]
```

```
                        |      +--ro id       -> ../state/id
                        |      +--ro state
                        |         +--ro id?           ipi-platform-cmis-types:cmm_cmis_media_
flag_id_t
                        |         +--ro description?   string
                        |         +--ro value?        boolean
                        +--ro monitor-alarm
                        |  +--ro state
                        |     +--ro alarm-id?          ipi-platform-cmis-types:cmm_cmis_media_
monitor_id_t
                        |     +--ro alarm-type?        ipi-platform-cmis-types:cmm_cmis_
threshold_alarm_t
                        |     +--ro current-value?     decimal64
                        |     +--ro threshold-minimum?  decimal64
                        |     +--ro threshold-maximum?  decimal64
                        +--ro flag-alarm
                           +--ro state
                              +--ro alarm-id?   ipi-platform-cmis-types:cmm_cmis_media_flag_id_t
```

Sensor Paths: ipi-platform-cmis

Transceiver EEPROM State

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-module/eeprom/state

Leaf Attributes
        /components/component[name]/transceiver/cmis-module/eeprom/state/identifier
        /components/component[name]/transceiver/cmis-module/eeprom/state/vendor-name
        /components/component[name]/transceiver/cmis-module/eeprom/state/vendor-oui
        /components/component[name]/transceiver/cmis-module/eeprom/state/part-number
        /components/component[name]/transceiver/cmis-module/eeprom/state/revision-level
        /components/component[name]/transceiver/cmis-module/eeprom/state/serial-number
        /components/component[name]/transceiver/cmis-module/eeprom/state/manufacturing-date
        /components/component[name]/transceiver/cmis-module/eeprom/state/clei-code
        /components/component[name]/transceiver/cmis-module/eeprom/state/module-power-class
        /components/component[name]/transceiver/cmis-module/eeprom/state/module-max-power
        /components/component[name]/transceiver/cmis-module/eeprom/state/cooling-
implemented
        /components/component[name]/transceiver/cmis-module/eeprom/state/temperature-max
        /components/component[name]/transceiver/cmis-module/eeprom/state/temperature-min
        /components/component[name]/transceiver/cmis-module/eeprom/state/operatin-voltage-
min
        /components/component[name]/transceiver/cmis-module/eeprom/state/optical-detector
        /components/component[name]/transceiver/cmis-module/eeprom/state/rx-power-
measurement
        /components/component[name]/transceiver/cmis-module/eeprom/state/tx-disable-module-
wide
        /components/component[name]/transceiver/cmis-module/eeprom/state/cable-assembly-
link-length
        /components/component[name]/transceiver/cmis-module/eeprom/state/connector-type
        /components/component[name]/transceiver/cmis-module/eeprom/state/cca-5ghz
        /components/component[name]/transceiver/cmis-module/eeprom/state/cca-7ghz
        /components/component[name]/transceiver/cmis-module/eeprom/state/cca-12p9ghz
        /components/component[name]/transceiver/cmis-module/eeprom/state/cca-25p8ghz
        /components/component[name]/transceiver/cmis-module/eeprom/state/media-interface-
technology
        /components/component[name]/transceiver/cmis-module/eeprom/state/cmis-revision
        /components/component[name]/transceiver/cmis-module/eeprom/state/memory-model
        /components/component[name]/transceiver/cmis-module/eeprom/state/mci-max-speed
        /components/component[name]/transceiver/cmis-module/eeprom/state/active-firmware-
revision
        /components/component[name]/transceiver/cmis-module/eeprom/state/inactive-firmware-
revision
```

```
            /components/component[name]/transceiver/cmis-module/eeprom/state/hardware-revision
            /components/component[name]/transceiver/cmis-module/eeprom/state/media-type
            /components/component[name]/transceiver/cmis-module/eeprom/state/max-smf-link-
length
            /components/component[name]/transceiver/cmis-module/eeprom/state/max-mmf-om2-link-
length
            /components/component[name]/transceiver/cmis-module/eeprom/state/max-mmf-om3-link-
length
            /components/component[name]/transceiver/cmis-module/eeprom/state/max-mmf-om4-link-
length
            /components/component[name]/transceiver/cmis-module/eeprom/state/max-mmf-om5-link-
length
            /components/component[name]/transceiver/cmis-module/eeprom/state/wavelength-nominal
            /components/component[name]/transceiver/cmis-module/eeprom/state/wavelength-
tolerance
```

CMIS State

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/state

Leaf Attributes
            /components/component[name]/state/name
            /components/component[name]/state/type
            /components/component[name]/state/location
            /components/component[name]/state/description
            /components/component[name]/state/mfg-name
            /components/component[name]/state/mfg-date
            /components/component[name]/state/hardware-version
            /components/component[name]/state/firmware-version
            /components/component[name]/state/serial-no
            /components/component[name]/state/part-no
            /components/component[name]/state/removable
            /components/component[name]/state/parent
```

Transceiver Advertisement Control

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-
module/advertisement/controls/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-
module/advertisement/controls/state/forced-tx-output-squelching
            /components/component[name]/transceiver/cmis-
module/advertisement/controls/state/input-polarity-flip-tx
            /components/component[name]/transceiver/cmis-
module/advertisement/controls/state/output-polarity-flip-rx
            /components/component[name]/transceiver/cmis-
module/advertisement/controls/state/rx-output-disable
            /components/component[name]/transceiver/cmis-
module/advertisement/controls/state/rx-output-squelching-disable
            /components/component[name]/transceiver/cmis-
module/advertisement/controls/state/tunable-transmitter
            /components/component[name]/transceiver/cmis-
module/advertisement/controls/state/tx-output-disable
            /components/component[name]/transceiver/cmis-
module/advertisement/controls/state/tx-output-squelching-disable
            /components/component[name]/transceiver/cmis-
module/advertisement/controls/state/tx-output-squelching-method
            /components/component[name]/transceiver/cmis-
module/advertisement/controls/state/wavelength-control
```

Transceiver Advertisement Diagnostics Module

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-
module/advertisement/diagnostics/module/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/module/state/count-bits-and-errors
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/module/state/report-bit-error-ratio
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/module/state/simultaneous-host-and-media-loobpack
```

Transceiver Advertisement Diagnostics Host

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-
module/advertisement/diagnostics/host/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/host/state/input-loopack
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/host/state/output-loopack
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/host/state/per-lane-loopack
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/host/state/prbs-checker-post-fec
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/host/state/prbs-checker-pre-fec
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/host/state/prbs-checker-types
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/host/state/prbs-generator-post-fec
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/host/state/prbs-generator-pre-fec
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/host/state/prbs-generator-types
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/host/state/report-fec
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/host/state/report-input-snr
```

Transceiver Advertisement Diagnostics Media

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-
module/advertisement/diagnostics/media/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/media/state/input-loopack
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/media/state/output-loopack
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/media/state/per-lane-loopack
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/media/state/prbs-checker-post-fec
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/media/state/prbs-checker-pre-fec
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/media/state/prbs-checker-types
```

```
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/media/state/prbs-generator-post-fec
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/media/state/prbs-generator-pre-fec
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/media/state/report-fec
            /components/component[name]/transceiver/cmis-
module/advertisement/diagnostics/media/state/report-input-snr
```

Transceiver Advertisement Duration

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-
module/advertisement/durations/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-
module/advertisement/durations/state/dpdeinit-maximun-duration
            /components/component[name]/transceiver/cmis-
module/advertisement/durations/state/dpinit-maximun-duration
            /components/component[name]/transceiver/cmis-
module/advertisement/durations/state/dptxturnoff-maximum-duration
            /components/component[name]/transceiver/cmis-
module/advertisement/durations/state/dptxturnon-maximum-duration
            /components/component[name]/transceiver/cmis-
module/advertisement/durations/state/modsel-wait-time
            /components/component[name]/transceiver/cmis-
module/advertisement/durations/state/modulepwrdn-maximum-duration
            /components/component[name]/transceiver/cmis-
module/advertisement/durations/state/modulepwrup-maximum-duration
```

Transceiver Advertisement Laser

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-
module/advertisement/laser/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-
module/advertisement/laser/state/supported-grids
            /components/component[name]/transceiver/cmis-module/advertisement/laser/state/fine-
tune-high-offse
            /components/component[name]/transceiver/cmis-module/advertisement/laser/state/fine-
tune-low-offset
            /components/component[name]/transceiver/cmis-module/advertisement/laser/state/fine-
tune-resolution
            /components/component[name]/transceiver/cmis-module/advertisement/laser/state/fine-
tune-supported
            /components/component[name]/transceiver/cmis-
module/advertisement/laser/state/maximum-programmable-output-power
            /components/component[name]/transceiver/cmis-
module/advertisement/laser/state/minimum-programmable-output-power
            /components/component[name]/transceiver/cmis-module/advertisement/laser/state/per-
lane-programmable-output-power
```

Transceiver Advertisement Laser Grid

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-
module/advertisement/laser/grids/grid[id=SPACING TYPE]/state
```

```
Leaf Attributes
          /components/component[name]/transceiver/cmis-
module/advertisement/laser/grids/grid/state/channel-count
          /components/component[name]/transceiver/cmis-
module/advertisement/laser/grids/grid/state/highest-channel-frequency
          /components/component[name]/transceiver/cmis-
module/advertisement/laser/grids/grid/state/id
          /components/component[name]/transceiver/cmis-
module/advertisement/laser/grids/grid/state/lowest-channel-frequency
```

Transceiver Advertisement Monitoring

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-
module/advertisement/monitoring/module/monitors/monitor[id=APP Id]/state

Leaf Attributes
          /components/component[name]/transceiver/cmis-
module/advertisement/monitoring/module/monitors/monitor/state/id
          /components/component[name]/transceiver/cmis-
module/advertisement/monitoring/module/monitors/monitor/state/supported
```

Transceiver Advertisement Host Monitoring

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-
module/advertisement/monitoring/host/monitors/monitor[id= APP Id]/state

Leaf Attributes
          /components/component[name]/transceiver/cmis-
module/advertisement/monitoring/host/monitors/monitor/state/id
          /components/component[name]/transceiver/cmis-
module/advertisement/monitoring/host/monitors/monitor/state/supported
```

Transceiver Advertisement Host Flags Monitoring

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-
module/advertisement/monitoring/host/flags/flag[id=APP Id]/state

Leaf Attributes
          /components/component[name]/transceiver/cmis-
module/advertisement/monitoring/host/flags/flag/state/id
          /components/component[name]/transceiver/cmis-
module/advertisement/monitoring/host/flags/flag/state/supported
```

Transceiver Advertisement Media Monitoring

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-
module/advertisement/monitoring/media/monitors/monitor[id=APP Id]/state

Leaf Attributes
          /components/component[name]/transceiver/cmis-
module/advertisement/monitoring/media/monitors/monitor/state/id
          /components/component[name]/transceiver/cmis-
module/advertisement/monitoring/media/monitors/monitor/state/supported
```

Transceiver Advertisement Media Flags Monitoring

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-
module/advertisement/monitoring/media/flags/flag[id = APP Id]/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-
module/advertisement/monitoring/media/flags/flag/state/id
            /components/component[name]/transceiver/cmis-
module/advertisement/monitoring/media/flags/flag/state/supported
```

Transceiver Advertisement Pages

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-
module/advertisement/pages/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-
module/advertisement/pages/state/banks-per-page
            /components/component[name]/transceiver/cmis-
module/advertisement/pages/state/network-path-pages-supported
            /components/component[name]/transceiver/cmis-module/advertisement/pages/state/user-
page-supported
            /components/component[name]/transceiver/cmis-module/advertisement/pages/state/vdm-
groups
            /components/component[name]/transceiver/cmis-module/advertisement/pages/state/vdm-
pages-supported
            /components/component[name]/transceiver/cmis-
module/advertisement/pages/state/diagnostics-pages-supported
```

Transceiver Advertisement Host Application

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-
module/advertisement/applications/application[id=APP_ID]/host/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-
module/advertisement/applications/application[id]/host/state/interface-type
            /components/component[name]/transceiver/cmis-
module/advertisement/applications/application[id]/host/state/application-bitrate
            /components/component[name]/transceiver/cmis-
module/advertisement/applications/application[id]/host/state/lane-count
            /components/component[name]/transceiver/cmis-
module/advertisement/applications/application[id]/host/state/signal-bitrate
            /components/component[name]/transceiver/cmis-
module/advertisement/applications/application[id]/host/state/modulation-format
            /components/component[name]/transceiver/cmis-
module/advertisement/applications/application[id]/host/state/bits-per-unit-interval
            /components/component[name]/transceiver/cmis-
module/advertisement/applications/application[id]/host/state/lane-assignment
```

Transceiver Advertisement Media Application

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-
module/advertisement/applications/application[id=APP_ID]/media/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-
module/advertisement/applications/application[id]/media/state/interface-type
            /components/component[name]/transceiver/cmis-
module/advertisement/applications/application[id]/media/state/application-bitrate
            /components/component[name]/transceiver/cmis-
module/advertisement/applications/application[id]/media/state/lane-count
            /components/component[name]/transceiver/cmis-
module/advertisement/applications/application[id]/media/state/signal-bitrate
            /components/component[name]/transceiver/cmis-
module/advertisement/applications/application[id]/media/state/modulation-format
            /components/component[name]/transceiver/cmis-
module/advertisement/applications/application[id]/media/state/bits-per-unit-interval
            /components/component[name]/transceiver/cmis-
module/advertisement/applications/application[id]/media/state/lane-assignment
```

Transceiver CMIS Module State

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-module/module-
state/datapaths/datapath[lane=LANE_ID]/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-module/module-state/datapaths/datapath
[lane]/state/current-state
            /components/component[name]/transceiver/cmis-module/module-state/datapaths/datapath
[lane]/state/host-rate
            /components/component[name]/transceiver/cmis-module/module-state/datapaths/datapath
[lane]/state/interface-name
            /components/component[name]/transceiver/cmis-module/module-state/datapaths/datapath
[lane]/state/lane
            /components/component[name]/transceiver/cmis-module/module-state/datapaths/datapath
[lane]/state/media-rate
```

Transceiver CMIS Module Monitor States

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-module/module-
monitors/monitors/monitor[id=MONITOR_ID]/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-module/module-
monitors/monitors/monitor[id]/state/description
            /components/component[name]/transceiver/cmis-module/module-
monitors/monitors/monitor[id]/state/high-alarm
            /components/component[name]/transceiver/cmis-module/module-
monitors/monitors/monitor[id]/state/high-warning
            /components/component[name]/transceiver/cmis-module/module-
monitors/monitors/monitor[id]/state/id
            /components/component[name]/transceiver/cmis-module/module-
monitors/monitors/monitor[id]/state/low-alarm
            /components/component[name]/transceiver/cmis-module/module-
monitors/monitors/monitor[id]/state/low-warning
            /components/component[name]/transceiver/cmis-module/module-
monitors/monitors/monitor[id]/state/value
```

Transceiver CMIS Module Monitor Alarms

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-module/module-
monitors/monitor-alarm/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-module/module-monitors/monitor-
alarm/state/alarm-id
            /components/component[name]/transceiver/cmis-module/module-monitors/monitor-
alarm/state/alarm-type
            /components/component[name]/transceiver/cmis-module/module-monitors/monitor-
alarm/state/current-value
            /components/component[name]/transceiver/cmis-module/module-monitors/monitor-
alarm/state/threshold-minimum
            /components/component[name]/transceiver/cmis-module/module-monitors/monitor-
alarm/state/threshold-maximum
```

Transceiver CMIS Host Monitor States

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-module/host-
monitors/lanes/lane[number=LANE_NUMBER]/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-module/host-monitors/lanes/lane
[number]/state/dp-assigned
            /components/component[name]/transceiver/cmis-module/host-monitors/lanes/lane
[number]/state/number
```

Transceiver CMIS Host Monitoring for Monitors

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-module/host-
monitors/lanes/lane[number=LANE_NUMBER]/monitors/monitor[id=MONITOR_ID]/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-module/host-monitors/lanes/lane
[number]/monitors/monitor[id]/state/description
            /components/component[name]/transceiver/cmis-module/host-monitors/lanes/lane
[number]/monitors/monitor[id]/state/id
            /components/component[name]/transceiver/cmis-module/host-monitors/lanes/lane
[number]/monitors/monitor[id]/state/value
```

Transceiver CMIS Host Monitoring for Flags

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-module/host-
monitors/lanes/lane[number=LANE_NUMBER]/flags/flag[id=FLAG_ID]/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-module/host-monitors/lanes/lane
[number]/flags/flag[id]/state/description
            /components/component[name]/transceiver/cmis-module/host-monitors/lanes/lane
[number]/flags/flag[id]/state/id
            /components/component[name]/transceiver/cmis-module/host-monitors/lanes/lane
[number]/flags/flag[id]/state/value
```

Transceiver CMIS Host Monitoring for Alarms

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-module/host-
monitors/lanes/lane[number=LANE_NUMBER]/monitor-alarm/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-module/host-monitors/lanes/lane
[number]/monitor-alarm/state/alarm-id
            /components/component[name]/transceiver/cmis-module/host-monitors/lanes/lane
[number]/monitor-alarm/state/alarm-type
            /components/component[name]/transceiver/cmis-module/host-monitors/lanes/lane
[number]/monitor-alarm/state/current-value
            /components/component[name]/transceiver/cmis-module/host-monitors/lanes/lane
[number]/monitor-alarm/state/threshold-minimum
            /components/component[name]/transceiver/cmis-module/host-monitors/lanes/lane
[number]/monitor-alarm/state/threshold-maximum
```

Transceiver CMIS Host Monitoring for Alarm Flags

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-module/host-
monitors/lanes/lane[number=LANE_NUMBER]/flag-alarm/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-module/host-monitors/lanes/lane
[number]/flag-alarm/state/alarm-id
```

Transceiver CMIS Media Monitoring for State

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-module/media-
monitors/lanes/lane[number=LANE_NUMBER]/monitor/monitor[id=MONITOR_ID]/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-module/media-monitors/lanes/lane
[number]/monitors/monitor[id]/state/description
            /components/component[name]/transceiver/cmis-module/media-monitors/lanes/lane
[number]/monitors/monitor[id]/state/high-alarm
            /components/component[name]/transceiver/cmis-module/media-monitors/lanes/lane
[number]/monitors/monitor[id]/state/high-warning
            /components/component[name]/transceiver/cmis-module/media-monitors/lanes/lane
[number]/monitors/monitor[id]/state/id
            /components/component[name]/transceiver/cmis-module/media-monitors/lanes/lane
[number]/monitors/monitor[id]/state/low-alarm
            /components/component[name]/transceiver/cmis-module/media-monitors/lanes/lane
[number]/monitors/monitor[id]/state/low-warning
            /components/component[name]/transceiver/cmis-module/media-monitors/lanes/lane
[number]/monitors/monitor[id]/state/value
```

Transceiver CMIS Media Monitoring for Flags

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-module/media-
monitors/lanes/lane[number=LANE_NUMBER]/flags/flag[id=FLAG_ID]/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-module/media-monitors/lanes/lane
[number]/flags/flag[id]/state/description
            /components/component[name]/transceiver/cmis-module/media-monitors/lanes/lane
```

```
[number]/flags/flag[id]/state/id
            /components/component[name]/transceiver/cmis-module/media-monitors/lanes/lane
[number]/flags/flag[id]/state/value
```

Transceiver CMIS Media Monitoring for Alarms

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-module/media-
monitors/lanes/lane[number=LANE_NUMBER]/monitor-alarm/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-module/media-monitors/lanes/lane
[number]/monitor-alarm/state/alarm-id
            /components/component[name]/transceiver/cmis-module/media-monitors/lanes/lane
[number]/monitor-alarm/state/alarm-type
            /components/component[name]/transceiver/cmis-module/media-monitors/lanes/lane
[number]/monitor-alarm/state/current-value
            /components/component[name]/transceiver/cmis-module/media-monitors/lanes/lane
[number]/monitor-alarm/state/threshold-minimum
            /components/component[name]/transceiver/cmis-module/media-monitors/lanes/lane
[number]/monitor-alarm/state/threshold-maximum
```

Transceiver CMIS Media Monitoring for Alarm Flags

```
Sensor Path
        ipi:/components/component[name=CMIS-MODULE-NAME]/transceiver/cmis-module/media-
monitors/lanes/lane[number=LANE_NUMBER]/flag-alarm/state

Leaf Attributes
            /components/component[name]/transceiver/cmis-module/media-monitors/lanes/lane
[number]/flag-alarm/state/alarm-id
```

IPI-RIB-VRF

Pyang Tree: ipi-rib-vrf

```
+--ro ribs {feature-list:HAVE_VRF,feature-list:HAVE_RIBD}?
     +--ro ipv4
     |  +--ro state
     |     +--ro counters
     |        +--ro total-routes?    yang:counter32
     +--ro ipv6 {feature-list:HAVE_IPV6}?
        +--ro state
           +--ro counters
              +--ro total-routes?    yang:counter32
```

Sensor Paths: ipi-rib-vrf

RIB Routes

```
Sensor Path
        ipi:/network-instances/network-instance[instance-name instance-
type]/vrf/ribs/ipv4/state/counters

Leaf Attributes
            /network-instances/network-instance[instance-name instance-
type]/vrf/ribs/ipv4/state/counters/total-routes
            /network-instances/network-instance[instance-name instance-
type]/vrf/ribs/ipv6/state/counters/total-routes
```

IPI-RIB

Pyang Tree: ipi-rib

```
+--rw network-instances
   +--rw network-instance* [instance-name instance-type]
      +--rw instance-name    -> ../config/instance-name
      +--rw instance-type    -> ../config/instance-type
      +--rw config
      |  +--rw instance-name?   string
      |  +--rw instance-type?   ipi-network-instance-types:net_inst_type_t
      +--ro state
      |  +--ro instance-name?   string
      |  +--ro instance-type?   ipi-network-instance-types:net_inst_type_t
      +--rw ipi-vrf:vrf {feature-list:HAVE_VRF}?
         +--ro ipi-rib-vrf:ribs {feature-list:HAVE_VRF,feature-list:HAVE_RIBD}?
            +--ro ipi-rib-vrf:ipv4
            |  +--ro ipi-rib-vrf:state
            |     +--ro ipi-rib-vrf:counters
            |        +--ro ipi-rib-vrf:total-routes?   yang:counter32
            +--ro ipi-rib-vrf:ipv6 {feature-list:HAVE_IPV6}?
               +--ro ipi-rib-vrf:state
                  +--ro ipi-rib-vrf:counters
                     +--ro ipi-rib-vrf:total-routes?   yang:counter32
```

Sensor Paths: ipi-rib

VRF State

```
Sensor Path
        ipi:/network-instances/:network-instance[instance-name instance-type]/vrf/state/

Leaf Attributes
           /network-instances/:network-instance[instance-name instance-type]/vrf/state/vrf-
name
```

IPI-IS-IS

Pyang Tree: ipi-is-is

```
+--rw isis {feature-list:HAVE_ISISD}?
   +--rw isis-instances
   |  +--rw isis-instance* [instance]
   |     +--rw instance          -> ../config/instance
   |     +--rw config
   |     |  +--rw instance?   string
   |     +--ro state
   |     |  +--ro counters
   |     |  |  +--ro system-level-1-adjacency-count?   uint32
   |     |  |  +--ro system-level-2-adjacency-count?   uint32
   |     |  |  +--ro system-total-adjacency-count?     uint32
   |     |  +--ro next-global-update-level-1?   uint32
   |     |  +--ro next-global-update-level-2?   uint32
   |     |  +--ro overload?                     ipi-isis-types:isis_overload_state_t
   |     |  +--ro instance?                     string
   |     +--ro level-runtime* [type] {feature-list:HAVE_ISISD}?
   |        +--ro type    -> ../state/type
   |        +--ro state
   |           +--ro counters
   |           |  +--ro authentication-type-fails?                   uint32
   |           |  +--ro authentication-fails?                        uint32
   |           |  +--ro corrupted-lsps?                              uint32
   |           |  +--ro database-overloads?                          uint32
   |           |  +--ro manual-address-drop-from-areas?              uint32
   |           |  +--ro attempt-to-exceed-maximum-sequence-numbers?  uint32
   |           |  +--ro sequence-number-skips?                       uint32
   |           |  +--ro own-lsp-purges?                              uint32
   |           |  +--ro lsp-sourced?                                 uint32
   |           |  +--ro maximum-area-address-mismatches?             uint32
   |           |  +--ro id-length-mismatch?                          uint32
   |           |  +--ro partition-changes?                           uint32
   |           |  +--ro spf-runs?                                    uint32
   |           |  +--ro partial-route-calculation-count?             uint32
   |           |  +--ro lan-designated-is-changes?                   uint32
   |           +--ro type?           ipi-isis-types:isis_level2_t
   |           +--ro topology-type?   uint8
   +--rw interfaces {feature-list:HAVE_ISISD}?
      +--rw interface* [name]
         +--rw name                -> ../config/name
         +--ro neighbor-lan* [system-id]
         |  +--ro system-id    -> ../state/system-id
         |  +--ro adjacency* [level]
         |  |  +--ro level    -> ../state/level
         |  |  +--ro state
         |  |     +--ro level?            ipi-isis-types:isis_level_t
         |  |     +--ro adjacency-state?   ipi-isis-types:isis_state_t
         |  +--ro state
         |     +--ro system-id?       string
         |     +--ro neighbor-snpa?   string
         |     +--ro up-time?         string
         +--rw config
         |  +--rw name?   -> /ipi-interface:interfaces/interface/name
         +--ro neighbor-P2P
            +--ro state
               +--ro adjacency-state?   ipi-isis-types:isis_state_t
               +--ro up-time?          string
```

Sensor Paths: ipi-is-is

IS-IS State

```
Sensor Path
        ipi:/isis/isis-instances/isis-instance[instance]/state

Leaf Attributes
        /isis/isis-instances/isis-instance/state/next-global-update-level-1
        /isis/isis-instances/isis-instance/state/next-global-update-level-2
      /isis/isis-instances/isis-instance/state/overload
```

IS-IS Counters

```
Sensor Path
        ipi:/isis/isis-instances/isis-instance[instance]/state/counters

Leaf Attributes
        /isis/isis-instances/isis-instance/state/counters/system-level-1-adjacency-count
        /isis/isis-instances/isis-instance/state/counters/system-level-2-adjacency-count
        /isis/isis-instances/isis-instance/state/counters/system-total-adjacency-count
```

IS-IS LSP State

```
Sensor Path
        ipi:/isis/isis-instances/isis-instance[instance]/level-runtime[type]/state

Leaf Attributes
        /isis/isis-instances/isis-instance[instance]/level-runtime[type]/state/topology-type
```

IS-IS LSP Counters

```
Sensor Path
        ipi:/isis/isis-instances/isis-instance[instance]/level-runtime[type]/state/counters

Leaf Attributes
        /isis/isis-instances/isis-instance[instance]/level-runtime
[type]/state/counters/attempt-to-exceed-maximum-sequence-numbers
        /isis/isis-instances/isis-instance[instance]/level-runtime
[type]/state/counters/authentication-fails
        /isis/isis-instances/isis-instance[instance]/level-runtime
[type]/state/counters/authentication-type-fails
        /isis/isis-instances/isis-instance[instance]/level-runtime
[type]/state/counters/corrupted-lsps
        /isis/isis-instances/isis-instance[instance]/level-runtime
[type]/state/counters/database-overloads
        /isis/isis-instances/isis-instance[instance]/level-runtime[type]/state/counters/id-
length-mismatch
        /isis/isis-instances/isis-instance[instance]/level-runtime[type]/state/counters/lan-
designated-is-changes
        /isis/isis-instances/isis-instance[instance]/level-runtime[type]/state/counters/lsp-
sourced
        /isis/isis-instances/isis-instance[instance]/level-runtime
[type]/state/counters/manual-address-drop-from-areas
        /isis/isis-instances/isis-instance[instance]/level-runtime
[type]/state/counters/maximum-area-address-mismatches
        /isis/isis-instances/isis-instance[instance]/level-runtime[type]/state/counters/own-
lsp-purges
        /isis/isis-instances/isis-instance[instance]/level-runtime
[type]/state/counters/partial-route-calculation-count
        /isis/isis-instances/isis-instance[instance]/level-runtime
[type]/state/counters/partition-changes
```

```
        /isis/isis-instances/isis-instance[instance]/level-runtime
[type]/state/counters/sequence-number-skips
        /isis/isis-instances/isis-instance[instance]/level-runtime[type]/state/counters/spf-
runs
```

IS-IS Interface State

```
Sensor Path
        ipi:/isis/interfaces/interface[name]/neighbor-lan[system-id]/state

Leaf Attributes
        /isis/interfaces/interface[name]/neighbor-lan[system-id]/state/neighbor-snpa
        /isis/interfaces/interface[name]/neighbor-lan[system-id]/state/system-id
        /isis/interfaces/interface[name]/neighbor-lan[system-id]/state/up-time
```

IS-IS Interface Adjacency State

```
Sensor Path
        ipi:/isis/interfaces/interface[name]/neighbor-lan[system-id]/adjacency[level]/state

Leaf Attributes
        /isis/interfaces/interface[name]/neighbor-lan[system-id]/adjacency
[level]/state/adjacency-state
```

IS-IS Interface Neighbor State

```
Sensor Path
        ipi:/isis/interfaces/interface[name]/neighbor-P2P/state

Leaf Attributes
        /isis/interfaces/interface[name]/neighbor-P2P/state/up-time
        /isis/interfaces/interface[name]/neighbor-P2P/state/adjacency-state
```

IPI-BGP

Pyang Tree: ipi-bgp

```
+--rw bgp {feature-list:HAVE_BGPD}?
   +--rw bgp-instances {feature-list:HAVE_BGPD}?
      +--rw bgp-instance* [bgp-as]
         +--rw bgp-as                -> ../config/bgp-as
         +--rw config
         |  +--rw bgp-as?   uint32
         +--rw peers {feature-list:HAVE_BGPD}?
         |  +--rw peer* [peer-address]
         |     +--rw peer-address       -> ../config/peer-address
         |     +--rw config
         |     |  +--rw peer-address?   ipi-bgp-types:bgp_ip_addr_t
         |     +--ro state
         |     |  +--ro counters
         |     |  |  +--ro notification-in?       int32
         |     |  |  +--ro notification-out?      int32
         |     |  |  +--ro update-message-in?     int32
         |     |  |  +--ro update-message-out?    int32
         |     |  +--ro peer-address?                   ipi-bgp-types:bgp_ip_addr_t
         |     |  +--ro connection-established-count?   int32
         |     |  +--ro bgp-peer-state?                 ipi-bgp-types:bgp_peer_status_t
         |     +--rw address-families
         |        +--rw address-family* [afi safi]
         |           +--rw afi        -> ../config/afi
         |           +--rw safi       -> ../config/safi
         |           +--rw config
         |           |  +--rw afi?    ipi-bgp-types:bgp_afi_type_t
         |           |  +--rw safi?   ipi-bgp-types:bgp_safi_type_t
         |           +--ro state
         |              +--ro counters
         |              |  +--ro keepalive-in-messages?        int32
         |              |  +--ro keepalive-out-messages?       int32
         |              |  +--ro open-messages-in?             int32
         |              |  +--ro open-messages-out?            int32
         |              |  +--ro as-path-count?                int32
         |              |  +--ro as-path-extended-count?       int32
         |              |  +--ro received-packet-count?        int32
         |              |  +--ro packet-in-queue?              int32
         |              |  +--ro packet-out-queue?             int32
         |              |  +--ro sent-packet-count?            int32
         |              |  +--ro refresh-received-packet-count?  int32
         |              |  +--ro refresh-sent-packet-count?    int32
         |              +--ro prefix-count?                       int32
         |              +--ro send-prefix-count?                  int32
         |              +--ro bgp-established-up-time?            string
         +--rw address-family-vrfs {feature-list:HAVE_BGPD}?
            +--rw address-family-vrf* [afi safi vrf-name]
               +--rw afi           -> ../config/afi
               +--rw safi          -> ../config/safi
               +--rw vrf-name      -> ../config/vrf-name
               +--rw config
               |  +--rw afi?                              ipi-bgp-types:bgp_vrf_afi_type_t
               |  +--rw safi?                             ipi-bgp-types:bgp_vrf_safi_type_
t
               |  +--rw vrf-name?                         string
               +--ro state
               |  +--ro afi?                              ipi-bgp-types:bgp_vrf_afi_type_t
               |  +--ro safi?                             ipi-bgp-types:bgp_vrf_safi_type_
t
               |  +--ro vrf-name?                         string
               +--rw vrf-peers
                  +--rw vrf-peer* [peer-address]
```

```
                              +--rw peer-address    -> ../config/peer-address
                              +--rw config
                              |  +--rw peer-address?                  inet:ip-address
                              +--ro state
                                 +--ro counters
                                 |  +--ro keepalive-in-messages?       int32
                                 |  +--ro keepalive-out-messages?      int32
                                 |  +--ro open-messages-in?            int32
                                 |  +--ro open-messages-out?           int32
                                 |  +--ro as-path-count?               int32
                                 |  +--ro as-path-extended-count?      int32
                                 |  +--ro received-packet-count?       int32
                                 |  +--ro packet-in-queue?             int32
                                 |  +--ro packet-out-queue?            int32
                                 |  +--ro sent-packet-count?           int32
                                 |  +--ro refresh-received-packet-count?  int32
                                 |  +--ro refresh-sent-packet-count?   int32
                                 |  +--ro notification-in?             int32
                                 |  +--ro notification-out?            int32
                                 |  +--ro update-message-in?           int32
                                 |  +--ro update-message-out?          int32
                                 +--ro connection-established-count?    int32
                                 +--ro bgp-peer-state?                  ipi-bgp-types:bgp_peer_
status_t
                                 +--ro community-count?                 int32
                                 +--ro peer-address-family-table-version?  int32
                                 +--ro address-family-table-version?    int32
                                 +--ro send-prefix-count?               int32
                                 +--ro flag-shut-down?                  ipi-bgp-types:bgp_
peerflag_shutdown_t
                           +--ro count?                              int32
                                 +--ro connection-type?                 ipi-bgp-types:bgp_
connection_type_t
                                 +--ro graceful-restart-time?           int32
                                 +--ro link-type?                       ipi-bgp-types:bgp_link_
type_t
                                 +--ro router-id?                       inet:ipv4-address
                                 +--ro advertisement-interval?          int32
                                 +--ro calculated-hold-time?            int32
                                 +--ro calculated-keepalive?            int32
```

Sensor Paths: ipi-bgp

BGP State

```
Sensor Path
        ipi:/bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/state

Leaf Attributes
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/state/connection-
established-count
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/state/bgp-peer-state
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/state/local-as
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/state/local-ip
```

BGP Counters

```
Sensor Path
        ipi:/bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/state/counters

Leaf Attributes
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-
address]/state/counters/notification-in
```

```
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-
address]/state/counters/notification-out
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/state/counters/update-
message-in
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/state/counters/update-
message-out
```

BGP Address Family State

```
Sensor Path
        ipi:/bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/address-
families/address-family[afi=AFI][safi=SAFI]/state

Leaf Attributes
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/address-
families/address-family[afi][safi]/state/bgp-established-up-time
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/address-
families/address-family[afi][safi]/state/prefix-count
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/address-
families/address-family[afi][safi]/state/send-prefix-count
```

BGP Address Family Counters

```
Sensor Path
        ipi:/bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/address-
families/address-family[afi=AFI][safi=SAFI]/state/counters

Leaf Attributes
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/address-
families/address-family[afi][safi]/state/counters/keepalive-in-messages
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/address-
families/address-family[afi][safi]/state/counters/keepalive-out-messages
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/address-
families/address-family[afi][safi]/state/counters/open-messages-in
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/address-
families/address-family[afi][safi]/state/counters/open-messages-out
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/address-
families/address-family[afi][safi]/state/counters/as-path-count
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/address-
families/address-family[afi][safi]/state/counters/as-path-extended-count
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/address-
families/address-family[afi][safi]/state/counters/received-packet-count
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/address-
families/address-family[afi][safi]/state/counters/packet-in-queue
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/address-
families/address-family[afi][safi]/state/counters/packet-out-queue
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/address-
families/address-family[afi][safi]/state/counters/sent-packet-count
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/address-
families/address-family[afi][safi]/state/counters/refresh-received-packet-count
        /bgp/bgp-instances/bgp-instance[bgp-as]/peers/peer[peer-address]/address-
families/address-family[afi][safi]/state/counters/refresh-sent-packet-count
```

BGP Address Family VRF State

```
Sensor Path
        ipi:/bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state

Leaf Attributes
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/address-family-table-version
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/advertisement-interval
```

```
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/bgp-peer-state
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/calculated-hold-time
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/calculated-keepalive
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/community-count
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/connection-type
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/count
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/flag-shut-down
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/graceful-restart-time
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/link-type
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/peer-address-family-table-version
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/router-id
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/send-prefix-count
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi safi
vrf-name]/vrf-peers/vrf-peer[peer-address]/state/connection-established-count
```

BGP Address Family VRF Counters

```
Sensor Path
        ipi:/bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/counters

Leaf Attributes
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/counters/keepalive-in-messages
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/counters/keepalive-out-messages
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/counters/open-messages-in
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/counters/open-messages-out
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/counters/as-path-count
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/counters/as-path-extended-count
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/counters/received-packet-count
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/counters/packet-in-queue
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/counters/packet-out-queue
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/counters/sent-packet-count
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/counters/refresh-received-packet-count
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/counters/refresh-sent-packet-count
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/counters/notification-in
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/counters/notification-out
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/counters/update-message-in
        /bgp/bgp-instances/bgp-instance[bgp-as]/address-family-vrfs/address-family-vrf[afi]
[safi][vrf-name]/vrf-peers/vrf-peer[peer-address]/state/counters/update-message-out
```

IPI-BFD

Pyang Tree: ipi-bfd

```
 +--rw bfd {feature-list:HAVE_BFD}?
    +--rw global
    |  +--ro state
    |     +--ro start-time?                    yang:timeticks {feature-list:HAVE_BFD_MONO}?
    |     +--ro administrative-state?          ipi-bfd-types:oambfd_admin_state_t {feature-
list:HAVE_BFD_MONO}?
    |     +--ro image-type?                    ipi-bfd-types:oambfd_image_type_t {feature-
list:HAVE_BFD_MONO}?
    |     +--ro next-session-discriminator?  string {feature-list:HAVE_BFD_MONO}?
    |     +--ro counters
    |        +--ro total-sessions?   yang:counter32
    +--rw interfaces {feature-list:HAVE_BFD}?
    |  +--rw interface* [name]
    |     +--rw name        -> ../config/name
    |     +--rw config
    |     |  +--rw name?   -> /ipi-interface:interfaces/interface/name
    |     +--ro state
    |        +--ro interface-index?   uint32
    |        +--ro interface-state?   ipi-bfd-types:oambfd_if_state_t
    +--ro sessions {feature-list:HAVE_BFD}?
       +--ro session* [local-discriminator vrf-name]
          +--ro local-discriminator    -> ../state/local-discriminator
          +--ro vrf-name               -> ../state/vrf-name
          +--ro state
          |  +--ro counters
          |  |  +--ro packets
          |  |  |  +--ro ipv4
          |  |  |  |  +--ro received?          yang:counter64
          |  |  |  |  +--ro transmitted?       yang:counter64
          |  |  |  |  +--ro echo-transmitted?  yang:counter64
          |  |  |  +--ro ipv6 {feature-list:HAVE_IPV6}?
          |  |  |     +--ro received?          yang:counter64
          |  |  |     +--ro transmitted?       yang:counter64
          |  |  |     +--ro echo-transmitted?  yang:counter64
          |  |  +--ro up-transitions?   yang:counter32
          |  +--ro lower-layer-type?                  ipi-bfd-types:oambfd_sess_lower_layer_t
          |  +--ro uptime?                            yang:timeticks
          |  +--ro version?                           uint32
          |  +--ro local-port?                        inet:port-number
          |  +--ro remote-port?                       inet:port-number
          |  +--ro negotiated-detection-multiplier?   uint8
          |  +--ro forward-hello-timer-hits?          uint32
          |  +--ro remote-heard?                      boolean
          |  +--ro fate-shared?                       boolean
          |  +--ro remote-administrative-down?        boolean
          |  +--ro remote-demand-mode-enabled?        boolean
          |  +--ro remote-echo-enabled?               boolean
          |  +--ro poll-bit?                          boolean
          |  +--ro storage-type?                      ipi-bfd-types:bfd_storage_type_t
          |  +--ro downtime?                          yang:timeticks
          |  +--ro discontinuity-time?                yang:timeticks
          |  +--ro authentication-key-id?             uint32
          |  +--ro last-up-time?                      yang:timeticks
          |  +--ro hold-down-timer?                   uint32
          |  +--ro hold-down-timer-hits?              uint32
          |  +--ro session-type-status?               ipi-bfd-types:oambfd_session_type_status_
t
          |  +--ro remote-address?                    inet:ip-address
          |  +--ro local-address?                     inet:ip-address
          |  +--ro vrf-name?                          string
```

```
          | +--ro interface-index?                    uint32
          | +--ro interface-name?                     string
          | +--ro remote-discriminator?              string
          | +--ro local-discriminator?               string
          | +--ro session-state?                      ipi-bfd-types:oambfd_session_state_t
          | +--ro session-type?                       ipi-bfd-types:bfd_session_type_state_t
          | +--ro session-diagnostics?                ipi-bfd-types:oambfd_perform_diag_t
          | +--ro negotiated-tx-interval?             uint32
          | +--ro negotiated-rx-interval?             uint32
        +--ro micro-bfd-sessions {feature-list:HAVE_BFD_HW_OFFLOAD}?
        | +--ro interface* [member-interface] {feature-list:HAVE_BFD_HW_OFFLOAD}?
        |    +--ro member-interface    -> ../state/member-interface
        |    +--ro state
        |       +--ro member-interface?               -> /ipi-
interface:interfaces/interface/name
        |       +--ro remote-session-state?           ipi-bfd-types:oambfd_session_state_t
        |       +--ro remote-session-diagnostics?     ipi-bfd-types:oambfd_perform_diag_t
        |       +--ro interface-index?                uint32
        |       +--ro interface-name?                 string
        |       +--ro remote-discriminator?           string
        |       +--ro local-discriminator?            string
        |       +--ro session-state?                  ipi-bfd-types:oambfd_session_state_t
        |       +--ro session-type?                   ipi-bfd-types:bfd_session_type_state_t
        |       +--ro session-diagnostics?            ipi-bfd-types:oambfd_perform_diag_t
        |       +--ro negotiated-tx-interval?         uint32
        |       +--ro negotiated-rx-interval?         uint32
        +--ro echo
        | +--ro state
        |    +--ro local-echo-port?                        inet:port-number
        |    +--ro echo-desired-minimum-tx-interval?    uint32
        |    +--ro echo-required-minimum-rx-interval?    uint32
        |    +--ro negotiated-interval?                 uint32
        +--ro mpls {feature-list:HAVE_CUSTOM1_MPLS_BFD}?
        | +--ro state {feature-list:HAVE_MPLS_OAM}?
        | | +--ro fec-address?          inet:ipv4-address
        | | +--ro lsp-type?             ipi-bfd-types:oambfd_mpls_lsp_type_t
        | | +--ro tunnel-name?          string
        | | +--ro tunnel-label?         uint32
        | | +--ro ftn-index?            uint32
        | | +--ro lsp-ping-interval?    uint32
        | | +--ro minimum-tx?           uint32
        | | +--ro minimum-rx?           uint32
        | | +--ro detection-multiplier?  uint8
        | +--ro virtual-circuit-connectivity-verification
        |    +--ro state {feature-list:HAVE_VCCV}?
        |       +--ro vc-identifier?                uint32
        |       +--ro incoming-vc-label?            uint32
        |       +--ro outgoing-vc-label?            uint32
        |       +--ro control-channel-type?         ipi-bfd-types:oambfd_mpls_cc_type_t
        |       +--ro connectivity-verification-type?  ipi-bfd-types:oambfd_mpls_cv_type_t
        |       +--ro attachment-circuit-index?     uint32
        |       +--ro tunnel-label?                 uint32
        |       +--ro peer-address?                 inet:ipv4-address
        +--ro packet
           +--ro state {feature-list:NOT_HAVE_BFD_HW_OFFLOAD}?
              +--ro packet-version?                      uint32
              +--ro packet-diagnostics?                  ipi-bfd-types:oambfd_perform_diag_
t
              +--ro packet-state?                        ipi-bfd-types:oambfd_session_
state_t
              +--ro demand-enabled?                      boolean
              +--ro poll-sequence-initiated?             boolean
              +--ro final-bit?                           boolean
              +--ro detection-multiplier?                uint8
              +--ro length?                              uint32
              +--ro packet-local-discriminator?          string
              +--ro packet-remote-discriminator?         string
```

```
+--ro packet-desired-minimum-tx-interval?    uint32
+--ro packet-required-minimum-rx-interval?   uint32
+--ro required-minimum-echo-rx-interval?     uint32
```

Sensor Paths: ipi-bfd

BFD State

```
Sensor Path
        ipi:/bfd/global/state

Leaf Attributes
        ipi:/bfd/global/state/start-time
        ipi:/bfd/global/state/administrative-state
        ipi:/bfd/global/state/image-type
        ipi:/bfd/global/state/next-session-discriminator
```

BFD State Counters

```
Sensor Path
        ipi:/bfd/global/state/counters

Leaf Attributes
        ipi:/bfd/global/state/counters/total-sessions
```

BFD Interface

```
Sensor Path
        ipi:/bfd/interfaces/interface[name=INTERFACE_NAME]

Leaf Attributes
        ipi:/bfd/interfaces/interface[name]/state/interface-index
        ipi:/bfd/interfaces/interface[name]/state/interface-state
```

BFD Sessions

```
Sensor Path
        ipi:/bfd/sessions/session[local-discriminator=NAME][vrf-name=default]

Leaf Attributes
        ipi:/bfd/sessions/session[local-discriminator][vrf-name]/vrf-name
        ipi:/bfd/sessions/session[local-discriminator][vrf-name]/local-discriminator
```

BFD Session State

```
Sensor Path
        ipi:/bfd/sessions/session[local-discriminator=NAME][vrf-name=default]/state

Leaf Attributes
        ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/lower-layer-type
        ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/uptime
        ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/version
        ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/local-port
```

```
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/remote-port
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/negotiated-
detection-multiplier
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/forward-hello-timer-
hits
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/remote-heard
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/fate-shared
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/remote-
administrative-down
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/remote-demand-mode-
enabled
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/remote-echo-enabled
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/poll-bit
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/storage-type
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/downtime
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/discontinuity-time
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/authentication-key-
id
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/last-uptime
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/hold-down-timer
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/hold-down-timer-hits
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/session-type-status
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/remote-address
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/local-address
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/vrf-name
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/interface-name
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/remote-discriminator
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/local-discriminator
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/session-state
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/session-type
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/session-diagnostics
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/negotiated-
detection-multiplier
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/negotiated-tx-
interval
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/negotiated-rx-
interval
```

BFD Session State Counters

```
Sensor Path
        ipi:/bfd/sessions/session[local-discriminator=NAME][vrf-name=default]/state/counters

Leaf Attributes
          ipi:/bfd/sessions/session[local-discriminator][vrf-name]/state/counters/up-
transitions
```

BFD Session State Counter IPv4 Packets

```
Sensor Path
        ipi:/bfd/sessions/session[local-discriminator=NAME][vrf-
name=default]/state/counters/packets/ipv4

Leaf Attributes
            ipi:/bfd/sessions/session[local-discriminator][vrf-
name]/state/counters/packets/ipv4/received
            ipi:/bfd/sessions/session[local-discriminator][vrf-
name]/state/counters/packets/ipv4/transmitted
            ipi:/bfd/sessions/session[local-discriminator][vrf-
name]/state/counters/packets/ipv4/echo-transmitted
```

BFD Session State Counter IPv6 Packets

```
Sensor Path
        ipi:/bfd/sessions/session[local-discriminator=NAME][vrf-
name=default]/state/counters/packets/ipv6

Leaf Attributes
            ipi:/bfd/sessions/session[local-discriminator][vrf-
name]/state/counters/packets/ipv6/received
            ipi:/bfd/sessions/session[local-discriminator][vrf-
name]/state/counters/packets/ipv6/transmitted
            ipi:/bfd/sessions/session[local-discriminator][vrf-
name]/state/counters/packets/ipv6/echo-transmitted
```

Micro-BFD Sessions State

```
Sensor Path
        ipi:/bfd/sessions/session[local-discriminator=NAME][vrf-name=default]/micro-bfd-
sessions/interface[member-interface=NAME]/state

Leaf Attributes
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/micro-bfd-
sessions/interface[member-interface]/state/member-interface
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/micro-bfd-
sessions/interface[member-interface]/state/remote-session-state
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/micro-bfd-
sessions/interface[member-interface]/state/remote-session-diagnostics
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/micro-bfd-
sessions/interface[member-interface]/state/interface-index
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/micro-bfd-
sessions/interface[member-interface]/state/remote-discriminator
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/micro-bfd-
sessions/interface[member-interface]/state/local-discriminator
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/micro-bfd-
sessions/interface[member-interface]/state/session-state
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/micro-bfd-
sessions/interface[member-interface]/state/session-type
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/micro-bfd-
sessions/interface[member-interface]/state/session-diagnostics
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/micro-bfd-
sessions/interface[member-interface]/state/negotiated-tx-interval
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/micro-bfd-
sessions/interface[member-interface]/state/negotiated-rx-interval
```

BFD Session Echo State

```
Sensor Path
        ipi:/bfd/sessions/session[local-discriminator=NAME][vrf-name=default]/echo/state

Leaf Attributes
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/echo/state/local-echo-port
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/echo/state/echo-desired-
minimum-tx-interval
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/echo/state/echo-required-
minimum-rx-interval
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/echo/state/negotiated-
interval
```

BFD Session MPLS State

```
Sensor Path
        ipi:/bfd/sessions/session[local-discriminator=NAME][vrf-name=default]/mpls/state

Leaf Attributes
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/mpls/state/fec-address
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/mpls/state/lsp-type
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/mpls/state/tunnel-name
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/mpls/state/tunnel-label
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/mpls/state/ftn-index
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/mpls/state/lsp-ping-
interval
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/mpls/state/minimum-tx
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/mpls/state/minimum-rx
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/mpls/state/detection-
multiplier
```

BFD Session VCCV State

```
Sensor Path
        ipi:/bfd/sessions/session[local-discriminator=NAME][vrf-name=default]/mpls/virtual-
circuit-connectivity-verification/state

Leaf Attributes
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/mpls/virtual-circuit-
connectivity-verification/state/vc-identifier
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/mpls/virtual-circuit-
connectivity-verification/state/incoming-vc-label
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/mpls/virtual-circuit-
connectivity-verification/state/outgoing-vc-label
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/mpls/virtual-circuit-
connectivity-verification/state/control-channel-type
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/mpls/virtual-circuit-
connectivity-verification/state/connectivity-verification-type
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/mpls/virtual-circuit-
connectivity-verification/state/attachment-circuit-index
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/mpls/virtual-circuit-
connectivity-verification/state/tunnel-label
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/mpls/virtual-circuit-
connectivity-verification/state/peer-address
```

BFD Session Packet State

```
Sensor Path
        ipi:/bfd/sessions/session[local-discriminator=NAME][vrf-name=default]/packet/state/

Leaf Attributes
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/packet/state/packet-
version
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/packet/state/packet-
diagnostics
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/packet/state/packet-state
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/packet/state/demand-
enabled
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/packet/state/poll-
sequence-initiated
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/packet/state/final_bit
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/packet/state/detection-
multiplier
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/packet/state/length
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/packet/state/packet-local-
discriminator
            ipi:/bfd/sessions/session[local-discriminator][vrf-name]/packet/state/packet-
remote-discriminator
```

```
                 ipi:/bfd/sessions/session[local-discriminator][vrf-name]/packet/state/packet-
desired-minimum-tx-interval
                 ipi:/bfd/sessions/session[local-discriminator][vrf-name]/packet/state/packet-
required-minimum-rx-interval
                 ipi:/bfd/sessions/session[local-discriminator][vrf-name]/packet/state/required-
minimum-echo-rx-interval
```

IPI-LLDPv2

Pyang Tree: ipi-lldpv2

```
+--rw lldp
   +--rw global
   |  +--ro state
   |     +--ro notification-interval?        uint16 {feature-list:HAVE_SNMP}?
   |     +--ro system-capabilities-enabled?  cml-data-types:cml_line_t
   |     +--ro host-name-information?         string
   |     +--ro counters
   |        +--ro remote-inserts?   yang:counter32
   |        +--ro remote-deletes?   yang:counter32
   |        +--ro remote-drops?     yang:counter32
   |        +--ro remote-ageouts?   yang:counter32
   +--rw interfaces
      +--rw interface* [name]
         +--rw name            -> ../config/name
         +--rw config
         |  +--rw name?                   -> /ipi-interface:interfaces/interface/name
         +--ro neighbors
            +--ro agent* [agent-type]
               +--ro agent-type    ipi-lldp-types:lldp_agent_t
               +--ro neighbor* [mac-address]
                  +--ro mac-address    -> ../state/mac-address
                  +--ro state
                     +--ro system-name?                  string
                     +--ro chassis-component?            string
                     +--ro chassis-id-type?              uint8
                     +--ro port-component?               string
                     +--ro port-id?                      string
                     +--ro port-description?             string
                     +--ro port-sub-type?                uint16
                     +--ro ttl?                          uint16
                     +--ro port-vlan-id?                 uint16
                     +--ro pp-vlanid?                    uint16
                     +--ro protocol?                     ipi-lldp-types:lldp_protoid_t
                     +--ro vid-usage-digest?             uint32
                     +--ro management-vlan?              uint16
                     +--ro auto-negotiation-support?     uint8
                     +--ro auto-negotiation-capability?  uint16
                     +--ro operational-mau-type?         uint16
                     +--ro link-aggregate-capability?    cml-data-types:cml_line_t
                     +--ro max-frame-size?               uint16
                     +--ro system-description?           string
                     +--ro system-capabilities?          cml-data-types:cml_line_t
                     +--ro system-capabilities-enabled?  cml-data-types:cml_line_t
                     +--ro vlan-list* [vlan-id]
                     |  +--ro vlan-id     uint16
                     |  +--ro vlan-name?  string
                     +--ro management-list* [address]
                        +--ro address                    string
                        +--ro address-sub-type?          cml-data-types:cml_line_t
                        +--ro interface-number-sub-type? string
                        +--ro interface-number?          uint32
                        +--ro oid?                       string
```

Sensor Paths: ipi-lldpv2

LLDP State

```
Sensor Path
        ipi:/lldp/global/state/

Leaf Attributes
            ipi:/lldp/global/state/host-name-information
            ipi:/lldp/global/state/notification-interval
            ipi:/lldp/global/state/system-capabilities-enabled
            ipi:/lldp/global/state/counters*
```

LLDP Counters

```
Sensor Path
        ipi:/lldp/global/state/counters

Leaf Attributes
            ipi:/lldp/global/state/counters/remote-ageouts
            ipi:/lldp/global/state/counters/remote-deletes
            ipi:/lldp/global/state/counters/remote-drops
            ipi:/lldp/global/state/counters/remote-inserts
```

LLDP Interface State

```
Sensor Path
        ipi:/lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state

Leaf Attributes
            ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/auto-negotiation-capability
            ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/auto-negotiation-support
            ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/chassis-component
            ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/chassis-id-type
            ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/link-aggregate-capability
            ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/mac-address
            ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/management-vlan
            ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/max-frame-size
            ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/operational-mau-type
            ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/port-description
            ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/port-id
            ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/port-sub-type
            ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/port-vlan-id
            ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/pp-vlanid
            ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/protocol
            ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/system-capabilities
            ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
```

```
address]/state/system-capabilities-enabled
          ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/system-description
          ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/system-name
          ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/ttl
          ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/vid-usage-digest
```

LLDP Interface State VLAN

```
Sensor Path
        ipi:/lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/vlan-list[vlan-id]

Leaf Attributes
          ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/vlan-list[vlan-id]/vlan-id
          ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/vlan-list[vlan-id]/vlan-name
```

LLDP Interface State Management

```
Sensor Path
        ipi:/lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/management-list[address]

Leaf Attributes
          ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/management-list[address]/address
          ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/management-list[address]/address-sub-type
          ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/management-list[address]/interface-number-sub-type
          ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/management-list[address]/interface-number
          ipi:lldp/interfaces/interface[name]/neighbors/agent[agent-type]/neighbor[mac-
address]/state/management-list[address]/oid
```

IPI-QoS

Pyang Tree: ipi-qos

```
+--rw qos {feature-list:HAVE_QOS}?
   +--rw global
   | +--rw config
   |    +--rw enable-qos?   cml-data-types:cml_enable_disable_t
   +--rw ipi-qos-if:interfaces {feature-list:HAVE_QOS}?
      +--rw ipi-qos-if:interface* [name]
         +--rw ipi-qos-if:name              -> ../config/name
         +--rw ipi-qos-if:config
         | +--rw ipi-qos-if:name?  -> /ipi-interface:interfaces/interface/name
         +--rw ipi-qos-if:service-policy
            +--rw ipi-qos-if:ingress
            | +--ro ipi-qos-if:class-maps-level-1
            |    +--ro ipi-qos-if:class-map-level-1* [class-map-name-level-1]
            |       +--ro ipi-qos-if:class-map-name-level-1    -> ../state/class-map-name-
level-1
            |       +--ro ipi-qos-if:state
            |       | +--ro ipi-qos-if:class-map-name-level-1?   string
            |       | +--ro ipi-qos-if:counters
            |       |    +--ro ipi-qos-if:matched-packets?      yang:counter64
            |       |    +--ro ipi-qos-if:matched-octets?       yang:counter64
            |       |    +--ro ipi-qos-if:transmitted-packets?  yang:counter64
            |       |    +--ro ipi-qos-if:transmitted-octets?   yang:counter64
            |       |    +--ro ipi-qos-if:dropped-packets?      yang:counter64
            |       |    +--ro ipi-qos-if:dropped-octets?       yang:counter64
            |       +--ro ipi-qos-if:class-maps-level-2
            |          +--ro ipi-qos-if:class-map-level-2* [class-map-name-level-2]
            |             +--ro ipi-qos-if:class-map-name-level-2   -> ../state/class-map-
name-level-2
            |             +--ro ipi-qos-if:state
            |             | +--ro ipi-qos-if:class-map-name-level-2?   string
            |             | +--ro ipi-qos-if:counters
            |             |    +--ro ipi-qos-if:matched-packets?      yang:counter64
            |             |    +--ro ipi-qos-if:matched-octets?       yang:counter64
            |             |    +--ro ipi-qos-if:transmitted-packets?  yang:counter64
            |             |    +--ro ipi-qos-if:transmitted-octets?   yang:counter64
            |             |    +--ro ipi-qos-if:dropped-packets?      yang:counter64
            |             |    +--ro ipi-qos-if:dropped-octets?       yang:counter64
            |             +--ro ipi-qos-if:class-maps-level-3
            |                +--ro ipi-qos-if:class-map-level-3* [class-map-name-level-3]
            |                   +--ro ipi-qos-if:class-map-name-level-3    -> ../state/class-
map-name-level-3
            |                   +--ro ipi-qos-if:state
            |                      +--ro ipi-qos-if:class-map-name-level-3?   string
            |                      +--ro ipi-qos-if:counters
            |                         +--ro ipi-qos-if:matched-packets?      yang:counter64
            |                         +--ro ipi-qos-if:matched-octets?       yang:counter64
            |                         +--ro ipi-qos-if:transmitted-packets?  yang:counter64
            |                         +--ro ipi-qos-if:transmitted-octets?   yang:counter64
            |                         +--ro ipi-qos-if:dropped-packets?      yang:counter64
            |                         +--ro ipi-qos-if:dropped-octets?       yang:counter64
            +--rw ipi-qos-if:egress
               +--ro ipi-qos-if:class-maps-level-1
                  +--ro ipi-qos-if:class-map-level-1* [class-map-name-level-1]
                     +--ro ipi-qos-if:class-map-name-level-1    -> ../state/class-map-name-
level-1
                     +--ro ipi-qos-if:state
                     | +--ro ipi-qos-if:class-map-name-level-1?   string
                     | +--ro ipi-qos-if:queues
                     |    +--ro ipi-qos-if:queue* [id]
                     |       +--ro ipi-qos-if:id         uint8
```

```
                      |            +--ro ipi-qos-if:counters
                      |               +--ro ipi-qos-if:total-transmitted-
packets?        yang:counter64
                      |               +--ro ipi-qos-if:total-transmitted-
octets?         yang:counter64
                      |               +--ro ipi-qos-if:total-dropped-
packets?            yang:counter64
                      |               +--ro ipi-qos-if:total-dropped-
octets?            yang:counter64
                      |               +--ro ipi-qos-if:green-transmitted-
packets?        yang:counter64
                      |               +--ro ipi-qos-if:non-green-transmitted-
packets?    yang:counter64
                      |               +--ro ipi-qos-if:green-dropped-
packets?            yang:counter64
                      |               +--ro ipi-qos-if:yellow-dropped-
packets?          yang:counter64
                      |               +--ro ipi-qos-if:red-dropped-
packets?              yang:counter64
                      |               +--ro ipi-qos-if:rate-kbps?                     decimal64
                      |               +--ro ipi-qos-if:rate-mbps?                     decimal64
                      |               +--ro ipi-qos-if:rate-gbps?                     decimal64
                   +--ro ipi-qos-if:class-maps-level-2
                      +--ro ipi-qos-if:class-map-level-2* [class-map-name-level-2]
                         +--ro ipi-qos-if:class-map-name-level-2   -> ../state/class-map-
name-level-2
                         +--ro ipi-qos-if:state
                         | +--ro ipi-qos-if:class-map-name-level-2?   string
                         | +--ro ipi-qos-if:queues
                         |    +--ro ipi-qos-if:queue* [id]
                         |       +--ro ipi-qos-if:id         uint8
                         |       +--ro ipi-qos-if:counters
                         |          +--ro ipi-qos-if:total-transmitted-
packets?        yang:counter64
                         |          +--ro ipi-qos-if:total-transmitted-
octets?         yang:counter64
                         |          +--ro ipi-qos-if:total-dropped-
packets?          yang:counter64
                         |          +--ro ipi-qos-if:total-dropped-
octets?         yang:counter64
                         |          +--ro ipi-qos-if:green-transmitted-
packets?        yang:counter64
                         |          +--ro ipi-qos-if:non-green-transmitted-
packets?    yang:counter64
                         |          +--ro ipi-qos-if:green-dropped-
packets?          yang:counter64
                         |          +--ro ipi-qos-if:yellow-dropped-
packets?          yang:counter64
                         |          +--ro ipi-qos-if:red-dropped-
packets?          yang:counter64
                         |          +--ro ipi-qos-if:rate-
kbps?                     decimal64
                         |          +--ro ipi-qos-if:rate-
mbps?                     decimal64
                         |          +--ro ipi-qos-if:rate-
gbps?                     decimal64
                          +--ro ipi-qos-if:class-maps-level-3
                            +--ro ipi-qos-if:class-map-level-3* [class-map-name-level-3]
                               +--ro ipi-qos-if:class-map-name-level-3   -> ../state/class-
map-name-level-3
                               +--ro ipi-qos-if:state
                                  +--ro ipi-qos-if:class-map-name-level-3?   string
                                  +--ro ipi-qos-if:queues
                                     +--ro ipi-qos-if:queue* [id]
                                        +--ro ipi-qos-if:id         uint8
                                        +--ro ipi-qos-if:counters
                                           +--ro ipi-qos-if:total-transmitted-
packets?        yang:counter64
                                           +--ro ipi-qos-if:total-transmitted-
```

```
octets?        yang:counter64
                                                    +--ro ipi-qos-if:total-dropped-
packets?            yang:counter64
                                                    +--ro ipi-qos-if:total-dropped-
octets?            yang:counter64
                                                    +--ro ipi-qos-if:green-transmitted-
packets?          yang:counter64
                                                    +--ro ipi-qos-if:non-green-transmitted-
packets?    yang:counter64
                                                    +--ro ipi-qos-if:green-dropped-
packets?          yang:counter64
                                                    +--ro ipi-qos-if:yellow-dropped-
packets?          yang:counter64
                                                    +--ro ipi-qos-if:red-dropped-
packets?              yang:counter64
                                                    +--ro ipi-qos-if:rate-
kbps?                  decimal64
                                                    +--ro ipi-qos-if:rate-
mbps?                  decimal64
                                                    +--ro ipi-qos-if:rate-
gbps?                  decimal64
```

Sensor Paths: ipi-qos

QoS Interface State Counters

```
Sensor Path
        ipi:/qos/interfaces/interface[name=INTERFACE_NAME]/service-policy/ingress/class-maps-
level-1/class-map-level-1[class-map-name-level-1=NAME1]/state/counters

Leaf Attributes
            ipi:/qos/interfaces/interface[name]/service-policy/ingress/class-maps-level-
1/class-map-level-1[class-map-name-level-1]/state/counters/matched-packets
            ipi:/qos/interfaces/interface[name]/service-policy/ingress/class-maps-level-
1/class-map-level-1[class-map-name-level-1]/state/counters/matched-octets
            ipi:/qos/interfaces/interface[name]/service-policy/ingress/class-maps-level-
1/class-map-level-1[class-map-name-level-1]/state/counters/transmitted-packets
            ipi:/qos/interfaces/interface[name]/service-policy/ingress/class-maps-level-
1/class-map-level-1[class-map-name-level-1]/state/counters/transmitted-octets
            ipi:/qos/interfaces/interface[name]/service-policy/ingress/class-maps-level-
1/class-map-level-1[class-map-name-level-1]/state/counters/dropped-packets
            ipi:/qos/interfaces/interface[name]/service-policy/ingress/class-maps-level-
1/class-map-level-1[class-map-name-level-1]/state/counters/dropped-octets
```

QoS Interface Ingress Class-Map State

```
Sensor Path
        ipi:/qos/interfaces/interface[name=INTERFACE_NAME]/service-policy/ingress/class-maps-
level-1/class-map-level-1[class-map-name-level-1=NAME1]/class-maps-level-2/class-map-level-2
[class-map-name-level-2=NAME2]/state/counters

Leaf Attributes
            ipi:/qos/interfaces/interface[name]/service-policy/ingress/class-maps-level-
1/class-map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-
level-2]/state/counters/matched-packets
            ipi:/qos/interfaces/interface[name]/service-policy/ingress/class-maps-level-
1/class-map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-
level-2]/state/counters/matched-octets
            ipi:/qos/interfaces/interface[name]/service-policy/ingress/class-maps-level-
1/class-map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-
level-2]/state/counters/transmitted-packets
            ipi:/qos/interfaces/interface[name]/service-policy/ingress/class-maps-level-
1/class-map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-
level-2]/state/counters/transmitted-octets
```

```
            ipi:/qos/interfaces/interface[name]/service-policy/ingress/class-maps-level-
1/class-map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-
level-2]/state/counters/dropped-packets
            ipi:/qos/interfaces/interface[name]/service-policy/ingress/class-maps-level-
1/class-map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-
level-2]/state/counters/dropped-octets
```

QoS Interface Ingress Class-Map State Counters

```
Sensor Path
        ipi:/qos/interfaces/interface[name=INTERFACE_NAME]/service-policy/ingress/class-maps-
level-1/class-map-level-1[class-map-name-level-1=NAME1]/class-maps-level-2/class-map-level-2
[class-map-name-level-2=NAME2]/class-maps-level-3/class-map-level-3[class-map-name-level-
3=NAME3]/state/counters

Leaf Attributes
            ipi:/qos/interfaces/interface[name]/service-policy/ingress/class-maps-level-
1/class-map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-
level-2]/class-maps-level-3/class-map-level-3[class-map-name-level-3]state/counters/matched-
packets
            ipi:/qos/interfaces/interface[name]/service-policy/ingress/class-maps-level-
1/class-map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-
level-2]/class-maps-level-3/class-map-level-3[class-map-name-level-3]state/counters/matched-
octets
            ipi:/qos/interfaces/interface[name]/service-policy/ingress/class-maps-level-
1/class-map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-
level-2]/class-maps-level-3/class-map-level-3[class-map-name-level-3]state/counters/transmitted-
packets
            ipi:/qos/interfaces/interface[name]/service-policy/ingress/class-maps-level-
1/class-map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-
level-2]/class-maps-level-3/class-map-level-3[class-map-name-level-3]state/counters/transmitted-
octets
            ipi:/qos/interfaces/interface[name]/service-policy/ingress/class-maps-level-
1/class-map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-
level-2]/class-maps-level-3/class-map-level-3[class-map-name-level-3]state/counters/dropped-
packets
            ipi:/qos/interfaces/interface[name]/service-policy/ingress/class-maps-level-
1/class-map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-
level-2]/class-maps-level-3/class-map-level-3[class-map-name-level-3]state/counters/dropped-
octets
```

QoS Interface Egress Class-Map (Level 1) State Counters

```
Sensor Path
        ipi:/qos/interfaces/interface[name=INTERFACE_NAME]/service-policy/egress/class-maps-
level-1/class-map-level-1[class-map-name-level-1=NAME1]/state/queues/queue[id=QUEUE_ID]/counters

Leaf Attributes
            ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/state/queues/queue[id]/counters/total-transmitted-packets
            ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/state/queues/queue[id]/counters/total-transmitted-octets
            ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/state/queues/queue[id]/counters/total-dropped-packets
            ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/state/queues/queue[id]/counters/total-dropped-octets
            ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/state/queues/queue[id]/counters/green-transmitted-packtes
            ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/state/queues/queue[id]/counters/non-green-transmitted-
packtes
            ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/state/queues/queue[id]/counters/green-dropped-packets
            ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/state/queues/queue[id]/counters/yellow-dropped-packets
            ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/state/queues/queue[id]/counters/red-dropped-packets
```

```
        ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/state/queues/queue[id]/counters/rate-kbps
        ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/state/queues/queue[id]/counters/rate-mbps
        ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/state/queues/queue[id]/counters/rate-gbps
```

QoS Interface Egress Class-Map (Level 1-2) State Counters

```
Sensor Path
        ipi:/qos/interfaces/interface[name=INTERFACE_NAME]/service-policy/egress/class-maps-
level-1/class-map-level-1[class-map-name-level-1=NAME1]/class-maps-level-2/class-map-level-2
[class-map-name-level-2=NAME2]/state/queues/queue[id=QUEUE_ID]/counters

Leaf Attributes
        ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/state/queues/queue[id]/counters/total-transmitted-packets
        ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/state/queues/queue[id]/counters/total-transmitted-octets
        ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/state/queues/queue[id]/counters/total-dropped-packets
        ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/state/queues/queue[id]/counters/total-dropped-octets
        ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/state/queues/queue[id]/counters/green-transmitted-packtes
        ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/state/queues/queue[id]/counters/non-green-transmitted-packtes
        ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/state/queues/queue[id]/counters/green-dropped-packets
        ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/state/queues/queue[id]/counters/yellow-dropped-packets
        ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/state/queues/queue[id]/counters/red-dropped-packets
        ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/state/queues/queue[id]/counters/rate-kbps
        ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/state/queues/queue[id]/counters/rate-mbps
        ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/state/queues/queue[id]/counters/rate-gbps
```

QoS Interface Egress Class-Map (Level 1-3) State Counters

```
Sensor Path
        ipi:/qos/interfaces/interface[name=INTERFACE_NAME]/service-policy/egress/class-maps-
level-1/class-map-level-1[class-map-name-level-1=NAME1]/class-maps-level-2/class-map-level-2
[class-map-name-level-2=NAME2]/class-maps-level-3/class-map-level-3[class-map-name-level-
3=NAME3]/state/queues/queue[id=QUEUE_ID]/counters

Leaf Attributes
        ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/class-maps-level-3/class-map-level-3[class-map-name-level-3]state/queues/queue
[id]/counters/total-transmitted-packets
        ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
```

```
2]/class-maps-level-3/class-map-level-3[class-map-name-level-3]state/queues/queue
[id]/counters/total-transmitted-octets
            ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/class-maps-level-3/class-map-level-3[class-map-name-level-3]state/queues/queue
[id]/counters/total-dropped-packets
            ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/class-maps-level-3/class-map-level-3[class-map-name-level-3]state/queues/queue
[id]/counters/total-dropped-octets
            ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/class-maps-level-3/class-map-level-3[class-map-name-level-3]state/queues/queue
[id]/counters/green-transmitted-packtes
            ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/class-maps-level-3/class-map-level-3[class-map-name-level-3]state/queues/queue
[id]/counters/non-green-transmitted-packtes
            ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/class-maps-level-3/class-map-level-3[class-map-name-level-3]state/queues/queue
[id]/counters/green-dropped-packets
            ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/class-maps-level-3/class-map-level-3[class-map-name-level-3]state/queues/queue
[id]/counters/yellow-dropped-packets
            ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/class-maps-level-3/class-map-level-3[class-map-name-level-3]state/queues/queue
[id]/counters/red-dropped-packets
            ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/class-maps-level-3/class-map-level-3[class-map-name-level-3]state/queues/queue
[id]/counters/rate-kbps
            ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/class-maps-level-3/class-map-level-3[class-map-name-level-3]state/queues/queue
[id]/counters/rate-mbps
            ipi:/qos/interfaces/interface[name]/service-policy/egress/class-maps-level-1/class-
map-level-1[class-map-name-level-1]/class-maps-level-2/class-map-level-2[class-map-name-level-
2]/class-maps-level-3/class-map-level-3[class-map-name-level-3]state/queues/queue
[id]/counters/rate-gbps
```

STREAMING TELEMETRY OPENCONFIG DATA MODELS

Overview

Streaming telemetry incrementally supports all listed OpenConfig data models, providing standardized representations of network configurations and telemetry data.

Telemetry OpenConfig Pyang Tree

The Pyang tree output illustrates the supported containers or leaf, along with a list of supported container-level paths.

Container Level Sensor Paths and Leaf Attributes

Lists the container level sensor paths and leaf attributes supported for OpenConfig data models.

> **Note:** For details on wildcard support, refer to the Wildcard Support in Sensor Paths (page 26) and XPath Formatting Rules for gnmic Subscription (page 32) sections.

OpenConfig-Platform

Pyang Tree: openconfig-platform

```
+--rw components
   +--rw component* [name]
      +--rw name                          -> ../config/name
      +--rw config
      |  +--rw name?   string
      +--ro state
      |  +--ro name?               string
      |  +--ro id?                 string
      |  x--ro location?           string
      |  +--ro description?        string
      |  +--ro mfg-name?           string
      |  +--ro mfg-date?           oc-yang:date
      |  +--ro hardware-version?   string
      |  +--ro firmware-version?   string
      |  +--ro software-version?   string
      |  +--ro serial-no?          string
      |  +--ro part-no?            string
      |  +--ro removable?          boolean
      |  +--ro oper-status?        identityref
      |  +--ro empty?              boolean
      |  +--ro parent?             -> ../../../component/config/name
      |  +--ro temperature
      |  |  +--ro instant?         decimal64
      |  |  +--ro avg?             decimal64
      |  |  +--ro min?             decimal64
      |  |  +--ro max?             decimal64
      |  |  +--ro interval?        oc-types:stat-interval
      |  |  +--ro alarm-status?    boolean
      |  |  +--ro alarm-threshold? decimal64
      |  |  +--ro alarm-severity?  identityref
      |  +--ro memory
      |  |  +--ro available?  uint64
      |  |  +--ro utilized?   uint64
      |  +--ro allocated-power?    decimal64
      +--rw power-supply
      |  +--ro state
      |     +--ro oc-platform-psu:enabled?          boolean
      |     +--ro oc-platform-psu:capacity?         decimal64
      |     +--ro oc-platform-psu:input-current?    decimal64
      |     +--ro oc-platform-psu:input-voltage?    decimal64
      |     +--ro oc-platform-psu:output-current?   decimal64
      |     +--ro oc-platform-psu:output-voltage?   decimal64
      |     +--ro oc-platform-psu:output-power?     decimal64
      +--rw fan
      |  +--ro state
      |     +--ro oc-fan:speed?   uint32
      +--rw cpu
      |  +--rw oc-cpu:utilization
      |     +--ro oc-cpu:state
      |        +--ro oc-cpu:instant?    decimal64
      |        +--ro oc-cpu:avg?        decimal64
      |        +--ro oc-cpu:interval?   oc-types:stat-interval
      +--rw oc-transceiver:transceiver
      |  +--ro oc-transceiver:state
      |     +--ro oc-transceiver:module-functional-type?   identityref
      |     +--ro oc-transceiver:form-factor?              identityref
      |     +--ro oc-transceiver:connector-type?           identityref
      |     +--ro oc-transceiver:vendor?                   string
      |     +--ro oc-transceiver:vendor-part?              string
      |     +--ro oc-transceiver:vendor-rev?               string
```

```
       |      +--ro oc-transceiver:serial-no?              string
       |      +--ro oc-transceiver:date-code?              string
       |      +--ro oc-transceiver:supply-voltage
       |      |  +--ro oc-transceiver:instant?   decimal64
       |      +--ro oc-transceiver:output-power
       |      |  +--ro oc-transceiver:instant?   decimal64
       |      +--ro oc-transceiver:input-power
       |      |  +--ro oc-transceiver:instant?   decimal64
       |      +--ro oc-transceiver:laser-bias-current
       |         +--ro oc-transceiver:instant?   decimal64
     +--rw oc-opt-term:optical-channel
        +--ro oc-opt-term:state
           +--ro oc-opt-term:output-power
           |  +--ro oc-opt-term:instant?   decimal64
           +--ro oc-opt-term:input-power
           |  +--ro oc-opt-term:instant?   decimal64
           +--ro oc-opt-term:laser-bias-current
              +--ro oc-opt-term:instant?   decimal64
```

Sensor Paths: openconfig-platform

The listed paths below represent telemetry OpenConfig paths for monitoring the platform state of various components, including CPU, RAM, power supply, fans, CMIS, and transceivers.

CPU

```
Sensor Path
        /components/component[name]/cpu/utilization/state

Leaf Attributes
        /components/component[name]/cpu/utilization/state/avg
        /components/component[name]/cpu/utilization/state/instant
        /components/component[name]/cpu/utilization/state/interval
```

RAM

```
Sensor Path
        /components/component[name]/state/memory/

Leaf Attributes
        /components/component[name]/state/memory/available
        /components/component[name]/state/memory/utilized
```

Power-Supply

```
Sensor Path
        /components/component[name]/power-supply/state/

Leaf Attributes
        /components/component[name]/power-supply/state/capacity
        /components/component[name]/power-supply/state/output-power
        /components/component[name]/power-supply/state/input-voltage
        /components/component[name]/power-supply/state/input-current
        /components/component[name]/power-supply/state/output-voltage
        /components/component[name]/power-supply/state/output-current
        /components/component[name]/power-supply/state/enabled
```

Fan

```
Sensor Path
        /components/component[name]/fan/state

Leaf Attributes
            /components/component[name]/fan/state/speed
```

Platform State

```
Sensor Path
        /components/component[name]/state

Leaf Attributes
            /components/component[name]/state/id
            /components/component[name]/state/type
            /components/component[name]/state/location
            /components/component[name]/state/mfg-date
            /components/component[name]/state/description
            /components/component[name]/state/hardware-version
            /components/component[name]/state/firmware-version
            /components/component[name]/state/software-version
            /components/component[name]/state/serial-no
            /components/component[name]/state/part-no
            /components/component[name]/state/removable
            /components/component[name]/state/oper-status
            /components/component[name]/state/parent
            /components/component[name]/state/empty
```

Platform State: Memory

```
Sensor Path
        /components/component[name]/state/memory

Leaf Attributes
            /components/component[name]/state/memory/available
            /components/component[name]/state/memory/utilized
```

Platform State: Temperature

```
Sensor Path
        /components/component[name]/state/temperature

Leaf Attributes
            /components/component[name]/state/temperature/instant
            /components/component[name]/state/temperature/min
            /components/component[name]/state/temperature/max
            /components/component[name]/state/temperature/avg
            /components/component[name]/state/temperature/interval
            /components/component[name]/state/temperature/alarm-status
            /components/component[name]/state/temperature/alarm-threshold
            /components/component[name]/state/temperature/alarm-severity
```

CMIS State

```
Sensor Paths: ipi-platform-cmisTransceiver EEPROM StateSensor Path
```

```
                opasconfig:/components/component[name=CMIS-MODULE-NAME]/state

Leaf Attributes
            /components/component[name]/state/name
            /components/component[name]/state/type
            /components/component[name]/state/id
            /components/component[name]/state/description
            /components/component[name]/state/mfg-name
            /components/component[name]/state/mfg-date
            /components/component[name]/state/hardware-version
            /components/component[name]/state/firmware-version
            /components/component[name]/state/software-version
            /components/component[name]/state/serial-no
            /components/component[name]/state/part-no
            /components/component[name]/state/model-name
            /components/component[name]/state/clei-code
            /components/component[name]/state/removable
            /components/component[name]/state/oper-status
            /components/component[name]/state/empty
            /components/component[name]/state/parent
            /components/component[name]/state/last-poweroff-time
```

CMIS Temperature

```
Sensor Paths: ipi-platform-cmisTransceiver EEPROM StateSensor Path
        openconfig:/components/component[name=CMIS-MODULE-NAME]/state/temperature

Leaf Attributes
            /components/component[name]/state/temperature/instant
```

CMIS Transceiver State

```
Sensor Paths: ipi-platform-cmisTransceiver EEPROM StateSensor Path
        openconfig:/components/component[name=CMIS-MODULE-NAME]/transceiver/state

Leaf Attributes
            /components/component[name]/transceiver/state/form-factor
            /components/component[name]/transceiver/state/connector-type
            /components/component[name]/transceiver/state/vendor
            /components/component[name]/transceiver/state/vendor-part
            /components/component[name]/transceiver/state/vendor-rev
            /components/component[name]/transceiver/state/serial-no
            /components/component[name]/transceiver/state/date-code
            /components/component[name]/transceiver/state/module-functional-type
            /components/component[name]/transceiver/state/supply-voltage/instant
```

CMIS Optical Channel State

```
Sensor Paths: ipi-platform-cmisTransceiver EEPROM StateSensor Path
        openconfig:/components/component[name='OCH-0/<CMIS-PORT>']/optical-channel/state

Leaf Attributes
            /components/component[name]/optical-channel/state/input-power/instant
            /components/component[name]/optical-channel/state/output-power/instant
            /components/component[name]/optical-channel/state/laser-bias-current/instant
```

OpenConfig-Interface

Pyang Tree: openconfig-interfaces

```
+--rw interfaces
    +--rw interface* [name]
        +--rw name       -> ../config/name
        +--rw config
        |  +--rw name?   string
        +--ro state
            +--ro name?          string
            +--ro ifindex?       uint32
            +--ro admin-status   enumeration
            +--ro oper-status    enumeration
            +--ro last-change?   oc-types:timeticks64
            +--ro logical?       boolean
            +--ro counters
                +--ro in-octets?           oc-yang:counter64
                +--ro in-pkts?             oc-yang:counter64
                +--ro in-unicast-pkts?     oc-yang:counter64
                +--ro in-broadcast-pkts?   oc-yang:counter64
                +--ro in-multicast-pkts?   oc-yang:counter64
                +--ro in-errors?           oc-yang:counter64
                +--ro in-discards?         oc-yang:counter64
                +--ro out-octets?          oc-yang:counter64
                +--ro out-pkts?            oc-yang:counter64
                +--ro out-unicast-pkts?    oc-yang:counter64
                +--ro out-broadcast-pkts?  oc-yang:counter64
                +--ro out-multicast-pkts?  oc-yang:counter64
                +--ro out-discards?        oc-yang:counter64
                +--ro out-errors?          oc-yang:counter64
                +--ro last-clear?          oc-types:timeticks64
```

Sensor Paths: openconfig-interface

The listed paths below represent telemetry OpenConfig paths for monitoring the interface and counters state.

Interface State

```
Sensor Path
        /interfaces/interface[name]/state

Leaf Attributes
            /interfaces/interface[name]/state/name
            /interfaces/interface[name]/state/ifindex
            /interfaces/interface[name]/state/admin-status
            /interfaces/interface[name]/state/oper-status
            /interfaces/interface[name]/state/last-change
            /interfaces/interface[name]/state/logical
```

Counters State

```
Sensor Path
        /interfaces/interface[name]/state/counters

Leaf Attributes
            /interfaces/interface[name]/state/counters/in-octets
            /interfaces/interface[name]/state/counters/in-pkts
```

```
/interfaces/interface[name]/state/counters/in-unicast-pkts
/interfaces/interface[name]/state/counters/in-broadcast-pkts
/interfaces/interface[name]/state/counters/in-multicast-pkts
/interfaces/interface[name]/state/counters/in-discards
/interfaces/interface[name]/state/counters/in-errors
/interfaces/interface[name]/state/counters/in-fcs-errors
/interfaces/interface[name]/state/counters/out-octets
/interfaces/interface[name]/state/counters/out-pkts
/interfaces/interface[name]/state/counters/out-unicast-pkts
/interfaces/interface[name]/state/counters/out-broadcast-pkts
/interfaces/interface[name]/state/counters/out-multicast-pkts
/interfaces/interface[name]/state/counters/out-discards
/interfaces/interface[name]/state/counters/out-errors
/interfaces/interface[name]/state/counters/last-clear
```