Core Components of Model-driven Telemetry Streaming

The core components used in streaming model-driven telemetry data are described in this chapter.

Session

A telemetry session can be initiated using:

Dial-in Mode

In a dial-in mode, an MDT receiver dials in to the router, and subscribes dynamically to one or more sensor paths or subscriptions. The router acts as the server and the receiver is the client. The router streams telemetry data through the same session. The dial-in mode of subscriptions is dynamic. This dynamic subscription terminates when the receiver cancels the subscription or when the session terminates.

There are two methods to request sensor-paths in a dynamic subscription:

- **OpenConfig RPC model:** The `subscribe RPC` defined in the model is used to specify sensor-paths and frequency. In this method, the subscription is not associated with an existing configured subscription. A subsequent `cancel` RPC defined in the model removes an existing dynamic subscription.

- **IOS XR MDT RPC:** IOS XR defines RPCs to subscribe and to cancel one or more configured subscriptions. The sensor-paths and frequency are part of the telemetry configuration on the router. A subscription is identified by its configured subscription name in the RPCs.

Dial-out Mode

In a dial-out mode, the router dials out to the receiver. This is the default mode of operation. The router acts as a client and receiver acts as a server. In this mode, sensor-paths and destinations are configured and bound together into one or more subscriptions. The router continually attempts to establish a session with each destination in the subscription, and streams data to the receiver. The dial-out mode of subscriptions is persistent. When a session terminates, the router continually attempts to re-establish a new session with the receiver every 30 seconds.

Sensor Path

The sensor path describes a YANG path or a subset of data definitions in a YANG model with a container. In a YANG model, the sensor path can be specified to end at any level in the container hierarchy.

An MDT-capable device, such as a router, associates the sensor path to the nearest container path in the model. The router encodes and streams the container path within a single telemetry message. A receiver receives data about all the containers and leaf nodes at and below this container path.

The router streams telemetry data for one or more sensor-paths, at the configured frequency (cadence-based streaming) or when the sensor-path content changes (event-based streaming), to one or more receivers through subscribed sessions.

Sensor Paths Supported for EDT in NCS 1001

The following sensor paths are supported for Event-based telemetry in NCS 1001.

EDT Sensor Path	Description
`Cisco-IOS-XR-controller-optics-oper:optics-oper/optics-ports/optics-port/optics-info`	This event is triggered when the configuration changes for optics/ots controller (say shutdown / no shutdown) or when the configuration changes for Transport Admin State (say sec-admin-state maintenance).
`Cisco-IOS-XR-pmengine-oper:performance-management-history/global/periodic/optics-history/optics-port-histories/optics-port-history/optics-second30-history`	This event is triggered when the 30 seconds historical PM is completed. It returns latest bucket for all optics/ots controllers.
`Cisco-IOS-XR-pmengine-oper:performance-management-history/global/periodic/optics-history/optics-port-histories/optics-port-history/optics-minute15-history`	This event is triggered when the 15 minutes historical PM is completed. It returns latest bucket for all optics/ots controllers.
`Cisco-IOS-XR-pmengine-oper:performance-management-history/global/periodic/optics-history/optics-port-histories/optics-port-history/optics-hour24-history`	This event is triggered when the 24 hours historical PM is completed. It returns latest bucket for all optics/ots controllers.

OpenConfig Sensor Paths Supported for MDT in NCS 1001

The following OpenConfig sensor paths are supported for Model-based telemetry in NCS 1001.

MDT Sensor Path	Description
`opencnfig-optical-amplifier:optical-amplifier/ amplifiers/amplifier`	Sensor path related to EDFA objects (ots controllers)
`opencnfig-transport-line-protectionaps/ aps-modules/aps-module`	Sensor path related to PSM objects (ots controllers)
`opencnfig-channel-monitor:channel-monitors/ channel-monitor/channels`	Sensor path related to EDFA objects (ots-och controllers and spectrum information)

Sensor Paths Supported in NCS 1004

The following sensor paths are supported in NCS 1004.

Table 1:

Model Type	Sensor Path	Description
Native	Cisco-IOS-XR-show-fpd-loc-ng-oper:show-fpd/hw-module-fpd	Provides the details of the FPGA versions of various hardware components and the packaged FPGAs with the ISO such as, BP_FPGA, XGE_FLASH.
Native	Cisco-IOS-XR-mediasvr-linux-oper:media-svr/all	Provides details of available space and occupied space in the various directory structures.
Native	Cisco-IOS-XR-alarmgr-server-oper:alarms/brief/brief-system/active	Provides the list of all active system alarms on the node.
Native	Cisco-IOS-XR-alarmgr-server-oper:alarms/brief/brief-system/suppressed	Provides the list of all suppressed system alarms on the node.
Native	Cisco-IOS-XR-alarmgr-server-oper:alarms/brief/brief-system/conditions	Provides the list of all conditional system alarms on the node.

Model Type	Sensor Path	Description
Native	Cisco-IOS-XR-controller-optics-oper:optics-oper/optics-ports	Provides the details of all the trunk or client ports of optics controller such as Baud rate, TX-RX power admin state, and LED state
Native	Cisco-IOS-XR-pmengine-oper:performance-management/otu/otu-ports/otu-port/otu-current/otu-second30/otu-second30fecs	Provides the details of OTU FEC PM counters for 30 second bucket such as, OSNR, PDL, PSR.
Native	Cisco-IOS-XR-pmengine-oper:performance-management/otu/otu-ports/otu-port/otu-current/otu-second30/otu-second30otns	Provides the details of OTU OTN PM counters for 30 second bucket such as, BBER-FE, FC-FE.
Native	Cisco-IOS-XR-pmengine-oper:performance-management/optics/optics-ports/optics-port/optics-current/optics-second30/optics-second30-optics	Provides the details of Optics PM counters for 30 second bucket such as, LB+E4C, OPT, OPR.
Native	Cisco-IOS-XR-pmengine-oper:performance-management/ethernet/ethernet-ports/ethernet-port/ethernet-current/ethernet-second30/second30-ethers	Provides the details of Ethernet PM counters for 30 second bucket such as, STAT-PKT, TX-PKT.
Native	Cisco-IOS-XR-wdsysmon-fd-oper:system-monitoring/cpu-utilization	Provides the snapshot of current CPU utilization of the node.
Native	Cisco-IOS-XR-nto-misc-oper:memory-summary/nodes/node/summary	Provides the snapshot of memory utilization of the node.
Native	Cisco-IOS-XR-osa-oper:osa/node-ids/node-id/mxponder-slices	Provides the details of muxponder slices that are configured on the node.
Native	Cisco-IOS-XR-spirit-install-instmgr-oper:software-install/active	Provides the details of the current active ISO and RPMs on the node.

Model Type	Sensor Path	Description
OpenConfig	opencofig-system:system	Checks for the alarms, host name, SSH configuration, and gRPC configuration.
OpenConfig	opencofig-platform:components/component	Checks for the inventory of the node such as subcomponents and field replaceable units such as, QSFP-100G-LR4-S, QSFP-100G-CWDM4-S.
OpenConfig	opencofig-platform:components/component/opencofig-platform-transceiver:transceiver	Provides operational data for each configured lane of pluggables that is added or removed from the chassis, such as FEC corrected bits, form factor during removal and state, channel data during insertion.
OpenConfig	opencofig-terminal-device:terminal-device	Provides the supported operational modes of the OC terminal device configuration.
OpenConfig	opencofig-terminal-device:terminal-device/logical-channels/channel/otn/state	Provides the details of PM counters for 10 second history bucket for OTN/ODU logical channels trunk ports such as, ES-NE, ESR-NE, BBE-FE.
OpenConfig	opencofig-terminal-device:terminal-device/logical-channels/channel/ethernet/state	Provides the details of PCS counters for 10 second history bucket and all the other packet counters as cumulative for the ethernet logical channel client ports such as, STAT-MULTICAST-PKT, TX-PKT, IN-MCAST.

Sensor Paths Supported in NCS 1010 and NCS 1020

Table 2: Feature History

Feature Name	Release	Description
Sensor paths supported for EDT	Cisco IOS XR Release 7.9.1	New native YANG model sensor paths and an OpenConfig sensor path are introduced for Event Driven Telemetry (EDT) in NCS 1010. EDT streams data only when a state transition occurs and thus avoids excess data collection at the receiver. EDT streams data about interface state transitions, controller shutdown, and failure, removal and insertion of the components such as power module, fan, line card, and passive modules into the NCS 1010 chassis.
Sensor paths supported for MDT	Cisco IOS XR Release 7.9.1	Model Driven Telemetry (MDT) is now supported by NCS 1010 for the native YANG models and OpenConfig sensor paths. MDT performs continuous data streaming and provides near real-time access to operational statistics.

Sensor Paths Supported for EDT in NCS 1010 and NCS 1020

These sensor paths are supported for event-based telemetry in NCS 1010 and NCS 1020.

Model Type	EDT Sensor Path	Description
Native	`Cisco-IOS-XR-platform-oper:platform/racks/rack/slots/slot/state`	This event is triggered whenever the state changes in the inventory modules. It returns the admin-state and oper-state status.
Native	`Cisco-IOS-XR-platform-oper:platform/racks/rack/slots/slot/instances/instance/state`	This event is triggered whenever the state changes in the inventory modules. It returns the admin-state and oper-state status per instance.

Model Type	EDT Sensor Path	Description
Native	`Cisco-IOS-XR-alarmgr-server-oper:alarms/brief/alarm-id/active-alarms/active-alarm`	This event is triggered whenever a new alarm is generated in the system. It returns the alarm, alarm-id, and a few other status values whenever a node turns active.
Native	`Cisco-IOS-XR-pmengine-oper:performance-management-history/global/periodic/optics-history/optics-port-histories/optics-port-history/optics-minute15-history/optics-minute15-optics-histories/optics-minute15-optics-history/`	This event is triggered when the 15-minutes historical PM is completed. It returns the latest bucket for all optics/ots controllers.
Native	`Cisco-IOS-XR-pmengine-oper:performance-management-history/global/periodic/optics-history/optics-port-histories/optics-port-history/optics-second30-history`	This event is triggered when the 30-minutes historical PM is completed. It returns the latest bucket for all optics/ots controllers.
Native	`Cisco-IOS-XR-pmengine-oper:performance-management-history/global/periodic/optics-history/optics-port-histories/optics-port-history/optics-hour24-history`	This event is triggered when the 24-hours historical PM is completed. It returns the latest bucket for all optics/ots controllers.
Native	`Cisco-IOS-XR-pfi-im-cmd-ctrlr-oper:controllers/controllers/controller`	This event is triggered when there is a change in state in the optical controllers for shutdown or no-shutdown states, such as in OTS, OTS-OCH, OMS,OCH, OSC and DFB controllers.
Native	`Cisco-IOS-XR-ethernet-lldp-oper:lldp/nodes/node/neighbors`	This event is triggered when the state of any neighboring node changes in the system. It returns state values like UP or DOWN during peer interface state changes.

Model Type	EDT Sensor Path	Description
OpenConfig	`openconfig-platform:/components/component/state`	This event is triggered when there is an online insertion and removal of any component, such as the power module, fan, and line card (OLT or ILA cards), and the NCS 1000 passive modules (NCS 1000 Breakout modules, and NCS 1000 32-Channel mux/demux patch panel). This event is also triggered whenever there is a change in the state of the component, such as failure of the power module and fan.

Sensor Paths Supported for MDT in NCS 1010 and NCS 1020

These sensor paths are supported for model-based telemetry in NCS 1010 and NCS 1020.

Model Type	MDT Sensor Path	Description
Native	`Cisco-IOS-XR-controller-ots-oper:ots-oper/ots-ports/ots-port`	Provides the details of the ots controllers such as ingress/egress gain or tilt values along with others.
Native	`Cisco-IOS-XR-controller-ots-och-oper:ots-och-oper/ots-och-ports/ots-och-port`	Provides the details of all the ots-och controllers, such as total TX-RX power, add/drop channel and other states.
Native	`Cisco-IOS-XR-controller-osc-oper:osc-oper/osc-ports/osc-port/osc-info`	Provides the details of all the osc controllers, such as total TX-RX power and other states.
Native	`Cisco-IOS-XR-controller-dfb-oper:dfb-oper/dfb-ports/dfb-port/dfb-info`	Provides the details of all the DFB controllers, such as total TX-RX power states.
Native	`Cisco-IOS-XR-controller-oms-oper:oms-oper/oms-ports/oms-port/oms-info`	Provides the details of all the OMS controllers, such as total TX-RX power and other states.
Native	`Cisco-IOS-XR-controller-och-oper:och-oper/och-ports/och-port/och-info`	Provides the details of all the och controllers, such as total TX-RX power and other states.

Model Type	MDT Sensor Path	Description
Native	Cisco-IOS-XR-pmengine-oper:performance-management/optics/optics-ports/optics-port/optics-current/optics-second30	Provides the details of optical controllers such as ots, ots-och, osc, dfb, oms, and och PM counters for the 30-seconds bucket.
Native	Cisco-IOS-XR-platform-oper:platform/racks/rack/slots/slot	Provides the details of all the inventory modules that are connected to NCS1010.
Native	Cisco-IOS-XR-alarmgr-server-oper:alarms/brief/brief-system/active	Provides the list of all active system alarms on a node.
Native	Cisco-IOS-XR-olc-oper:olc	Provides the details of optical applications such as raman-tuning, span-loss, PSD, and others.
OpenConfig	openconfig-optical-amplifierr:optical-amplifier/amplifiers	Provides the details of ingress/egress gain, tilt, gain-range, and OSRI.
Native	Cisco-IOS-XR-invmgr-oper:inventory/entities/entity	
Native	Cisco-IOS-XR-platform-oper:platform/racks/rack/slots/slot/instances/instance/state	
Native	Cisco-IOS-XR-infra-syslog-oper	
Native	Cisco-IOS-XR-envmon-oper:environmental-monitoring Cisco-IOS-XR-envmon-oper:power-management	
Native	Cisco-IOS-XR-invmgr-diag-oper:diag/racks/rack	
Native	Cisco-IOS-XR-ledmgr-oper:led-management/locations	

Subscription

A subscription binds one or more sensor paths and destinations. An MDT-capable device streams data for each sensor path at the configured frequency (cadence-based streaming) or when the sensor-path content changes (event-based streaming) to the destination.

The following example shows subscription SUB1 that associates a sensor-group, sample interval and destination group.

```
Router(config)#telemetry model-driven
Router(config-model-driven)#subscription SUB1
Router(config-model-driven-subs)#sensor-group-id SGROUP1 sample-interval 10000
Router(config-model-driven-subs)#strict-timer
```

Note With a `strict-timer` configured for the sample interval, the data collection starts exactly at the configured time interval allowing a more deterministic behavior to stream data.

In 32-bit platforms, `strict-timer` can be configured only under the subscription. Whereas, 64-bit platforms support configurtion at global level in addition to the subscription level. However, configuring at the global level will affect all configured subscriptions.

```
Router(config)#telemetry model-driven
Router(config-model-driven)#strict-timer
```

Transport and Encoding

The router streams telemetry data using a transport mechanism. The generated data is encapsulated into the desired format using encoders.

Model-Driven Telemetry (MDT) data is streamed through these supported transport mechanisms:

- **Google Protocol RPC (gRPC):** used for both dial-in and dial-out modes.

- **Transmission Control Protocol (TCP):** used for only dial-out mode.

- **User Datagram Protocol (UDP):** used for only dial-out mode.

Note UDP for Telemetry is not recommended for production networks. It doesn't support models that send messages larger than the UDP size limit of 65507 bytes.

The data to be streamed can be encoded into Google Protocol Buffers (GPB) or JavaScript Object Notation (JSON) encoding. In GPB, the encoding can either be compact GPB (for optimising the network bandwidth usage) or self-describing GPB. The encodings supported are:

- **GPB encoding:** configuring for GPB encoding requires metadata in the form of compiled .proto files. A .proto file describes the GPB message format, which is used to stream data. The .proto files are available in the Github repository.

  - **Compact GPB encoding:** data is streamed in compressed and non self-describing format. A .proto file corresponding to each sensor-path must be used by the receiver to decode the streamed data.

  - **Key-value (KV-GPB) encoding:** data of each sensor path streamed is in a self-describing formatted ASCII text. A single .proto file `telemetry.proto` is used by the receiver to decode any sensor path data. Because the key names are included in the streamed data, the data on the wire is much larger as compared to compact GPB encoding.

- **JSON encoding**

Note Telemetry data is streamed out of the router using an Extensible Manageability Services Deamon (emsd) process. The data of interest is subscribed through subscriptions and streamed through gRPC, TCP or UDP sessions. However, a combination of gRPC, TCP and UDP sessions with more than 150 active sessions leads to emsd crash or process restart.