# Enhancements to Data Models

This section provides an overview of the enhancements made to data models.



# OpenConfig Data Model Enhancements

***Table 1: Feature History Table***

| Feature Name | Release Information | Description |
|---|---|---|
| Revised OpenConfig MPLS Model to Version 3.0.1 for Streaming Telemetry | Release 7.3.3 | The OpenConfig MPLS data model provides data definitions for Multiprotocol Label Switching (MPLS) configuration and associated signaling and traffic engineering protocols. In this release, the following data models are revised for streaming telemetry from OpenConfig version 2.3.0 to version 3.0.1:<br>• openconfig-mpls<br>• openconfig-mpls-te<br>• openconfig-mpls-rsvp<br>• openconfig-mpls-igp<br>• openconfig-mpls-types<br>• openconfig-mpls-sr<br>You can access this data model from the Github repository. |

# OAM for MPLS and SR-MPLS in mpls-ping and mpls-traceroute Data Models

*Table 2: Feature History Table*

| Feature Name | Release Information | Description |
|---|---|---|
| YANG Data Models for MPLS OAM RPCs | Release 7.3.2 | This feature introduces the `Cisco-IOS-XR-mpls-ping-act` and `Cisco-IOS-XR-mpls-traceroute-act` YANG data models to accommodate operations, administration and maintenance (OAM) RPCs for MPLS and SR-MPLS.<br>You can access these Cisco IOS XR native data models from the Github repository. |

The Cisco-IOS-XR-mpls-ping-act and Cisco-IOS-XR-mpls-traceroute-act YANG data models are introduced to provide the following options:

- Ping for MPLS:
  - MPLS IPv4 address
  - MPLS TE
  - FEC-129 Pseudowire
  - FEC-128 Pseudowire
  - Multisegment Pseudowire
- Ping for SR-MPLS:
  - SR policy name or BSID with LSP end-point
  - SR MPLS IPv4 address
  - SR Nil-FEC labels
  - SR Flexible Algorithm
- Traceroute for MPLS:
  - MPLS IPv4 address
  - MPLS TE
- Traceroute for SR-MPLS:
  - SR policy name or BSID with LSP end-point

- SR MPLS IPv4 address
- SR Nil-FEC labels
- SR Flexible Algorithm

The following example shows the ping operation for an SR policy and LSP end-point:

```
<mpls-ping xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-mpls-ping-act">
  <sr-mpls>
  <policy>
    <name>srte_c_10_ep_10.10.10.1</name>
      <lsp-endpoint>10.10.10.4</lsp-endpoint>
  </policy>
  </sr-mpls>
  <request-options-parameters>
    <brief>true</brief>
  </request-options-parameters>
</mpls-ping>
```

**Response:**

```
<?xml version="1.0"?>
 <mpls-ping-response xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-mpls-ping-act">
  <request-options-parameters>
   <exp>0</exp>
   <fec>false</fec>
   <interval>0</interval>
   <ddmap>false</ddmap>
   <force-explicit-null>false</force-explicit-null>
   <packet-output>
    <interface-name>None</interface-name>
    <next-hop>0.0.0.0</next-hop>
   </packet-output>
   <pad>abcd</pad>
   <repeat>5</repeat>
   <reply>
    <dscp>255</dscp>
    <reply-mode>default</reply-mode>
    <pad-tlv>false</pad-tlv>
   </reply>
   <size>100</size>
   <source>0.0.0.0</source>
   <destination>127.0.0.1</destination>
   <sweep>
    <minimum>100</minimum>
    <maximum>100</maximum>
    <increment>1</increment>
   </sweep>
   <brief>true</brief>
   <timeout>2</timeout>
   <ttl>255</ttl>
  </request-options-parameters>
  <replies>
   <reply>
    <reply-index>1</reply-index>
    <return-code>3</return-code>
    <return-char>!</return-char>
    <reply-addr>14.14.14.3</reply-addr>
    <size>100</size>
   </reply>
   <reply>
    <reply-index>2</reply-index>
```

```
    <return-code>3</return-code>
    <return-char>!</return-char>
    <reply-addr>14.14.14.3</reply-addr>
    <size>100</size>
   </reply>
   <reply>
    <reply-index>3</reply-index>
    <return-code>3</return-code>
    <return-char>!</return-char>
    <reply-addr>14.14.14.3</reply-addr>
    <size>100</size>
   </reply>
   <reply>
    <reply-index>4</reply-index>
    <return-code>3</return-code>
    <return-char>!</return-char>
    <reply-addr>14.14.14.3</reply-addr>
    <size>100</size>
   </reply>
   <reply>
    <reply-index>5</reply-index>
    <return-code>3</return-code>
    <return-char>!</return-char>
    <reply-addr>14.14.14.3</reply-addr>
    <size>100</size>
   </reply>
  </replies>
 </mpls-ping-response>
```

The following example shows the ping operation for an SR policy BSID and LSP end-point:

```
<mpls-ping xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-mpls-ping-act">
<sr-mpls>
<policy>
    <bsid>1000</bsid>
    <lsp-endpoint>10.10.10.4</lsp-endpoint>
</policy>
</sr-mpls>
<request-options-parameters>
    <brief>true</brief>
</request-options-parameters>
</mpls-ping>
```

**Response:**

```
<?xml version="1.0"?>
 <mpls-ping-response xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-mpls-ping-act">
  <request-options-parameters>
   <exp>0</exp>
   <fec>false</fec>
   <interval>0</interval>
   <ddmap>false</ddmap>
   <force-explicit-null>false</force-explicit-null>
   <packet-output>
    <interface-name>None</interface-name>
    <next-hop>0.0.0.0</next-hop>
   </packet-output>
   <pad>abcd</pad>
   <repeat>5</repeat>
   <reply>
    <dscp>255</dscp>
    <reply-mode>default</reply-mode>
    <pad-tlv>false</pad-tlv>
```

```
   </reply>
   <size>100</size>
   <source>0.0.0.0</source>
   <destination>127.0.0.1</destination>
   <sweep>
    <minimum>100</minimum>
    <maximum>100</maximum>
    <increment>1</increment>
   </sweep>
   <brief>true</brief>
   <timeout>2</timeout>
   <ttl>255</ttl>
  </request-options-parameters>
  <replies>
   <reply>
    <reply-index>1</reply-index>
    <return-code>3</return-code>
    <return-char>!</return-char>
    <reply-addr>14.14.14.3</reply-addr>
    <size>100</size>
   </reply>
   <reply>
    <reply-index>2</reply-index>
    <return-code>3</return-code>
    <return-char>!</return-char>
    <reply-addr>14.14.14.3</reply-addr>
    <size>100</size>
   </reply>
   <reply>
    <reply-index>3</reply-index>
    <return-code>3</return-code>
    <return-char>!</return-char>
    <reply-addr>14.14.14.3</reply-addr>
    <size>100</size>
   </reply>
   <reply>
    <reply-index>4</reply-index>
    <return-code>3</return-code>
    <return-char>!</return-char>
    <reply-addr>14.14.14.3</reply-addr>
    <size>100</size>
   </reply>
   <reply>
    <reply-index>5</reply-index>
    <return-code>3</return-code>
    <return-char>!</return-char>
    <reply-addr>14.14.14.3</reply-addr>
    <size>100</size>
   </reply>
  </replies>
 </mpls-ping-response>
```

The following example shows the traceroute operation for an SR policy and LSP end-point:

```
<mpls-traceroute xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-mpls-traceroute-act">
<sr-mpls>
<policy>
    <name>srte_c_10_ep_10.10.10.1</name>
    <lsp-endpoint>10.10.10.4</lsp-endpoint>
</policy>
</sr-mpls>
<request-options-parameters>
    <brief>true</brief>
</request-options-parameters>
```

```
</mpls-traceroute>
```

**Response:**

```
<?xml version="1.0"?>
 <mpls-traceroute-response xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-mpls-traceroute-act">

  <request-options-parameters>
   <exp>0</exp>
   <fec>false</fec>
   <ddmap>false</ddmap>
   <force-explicit-null>false</force-explicit-null>
   <packet-output>
    <interface-name>None</interface-name>
    <next-hop>0.0.0.0</next-hop>
   </packet-output>
   <reply>
    <dscp>255</dscp>
    <reply-mode>default</reply-mode>
   </reply>
   <source>0.0.0.0</source>
   <destination>127.0.0.1</destination>
   <brief>true</brief>
   <timeout>2</timeout>
   <ttl>30</ttl>
  </request-options-parameters>
  <paths>
   <path>
    <path-index>0</path-index>
    <hops>
    <hop>
        <hop-index>0</hop-index>
        <hop-origin-ip>11.11.11.1</hop-origin-ip>
        <hop-destination-ip>11.11.11.2</hop-destination-ip>
        <mtu>1500</mtu>
        <dsmap-label-stack>
            <dsmap-label>
                <label>16003</label>
            </dsmap-label>
        </dsmap-label-stack>
        <return-code>0</return-code>
        <return-char> </return-char>
    </hop>
    <hop>
        <hop-index>1</hop-index>
        <hop-origin-ip>11.11.11.2</hop-origin-ip>
        <hop-destination-ip>14.14.14.3</hop-destination-ip>
        <mtu>1500</mtu>
        <dsmap-label-stack>
            <dsmap-label>
                <label>3</label>
            </dsmap-label>
        </dsmap-label-stack>
        <return-code>8</return-code>
        <return-char>L</return-char>
    </hop>
    <hop>
        <hop-index>2</hop-index>
        <hop-origin-ip>14.14.14.3</hop-origin-ip>
        <hop-destination-ip></hop-destination-ip>
        <mtu>0</mtu>
        <dsmap-label-stack/>
        <return-code>3</return-code>
        <return-char>!</return-char>
```

```
  </hop>
  </hops>
 </path>
</paths>
</mpls-traceroute-response>
```

# Automatic Resynchronization of OpenConfig Configuration

*Table 3: Feature History Table*

| Feature Name | Release Information | Feature Description |
|---|---|---|
| View Inconsistent OpenConfig Configuration | Release 24.1.1 | OpenConfig infrastructure now provides an operational data YANG model, `Cisco-IOS-XR-yiny-oper`, which can be queried to view the inconsistent OpenConfig configuration caused due to activities such as interface breakout operations, installation activities or insertion of a new line card.<br>See GitHub, YANG Data Models Navigator |
| Automatic Resynchronization of OpenConfig Configuration | Release 7.11.1 | OpenConfig infrastructure can now reapply all the OpenConfig configurations automatically if there are any discrepancies in the running configuration.<br>With this feature, there is no need for manual replacement of the OpenConfig configuration using Netconf or gNMI.<br>The re-sync operation is triggered if the running configurations and the OpenConfig configuration go out of sync after any system event that removes some running configurations from the system. A corresponding system log gets generated to indicate the re-sync status. |

In the earlier releases, when activities such as interface breakout operations, installation activities or insertion of a new line card took place, there was a risk of OpenConfig configuration and the running configuration going out of sync. A full replacement of the OpenConfig configuration was required in order to get the OpenConfig configurations back in sync using Netconf or gNMI.

From the Cisco IOS XR Software Release 7.11.1, if the OpenConfig configurations and running configurations go out of sync, or any activities takes place which may result in the two configurations to go out of sync, the

system automatically reapplies all the OpenConfig configurations and resolve the sync issue. If there is a synchronization issue between the running configuration and the OpenConfig configuration, a corresponding system log is generated to indicate it. Similarly, a corresponding system log is generated indicating the status of the re-synchronization attempt.

This feature is enabled by default. This process is completely automated.

From the Cisco IOS XR Software Release 24.1.1, the new `Cisco-IOS-XR-yiny-oper` YANG model displays the OpenConfig configuration which is out of sync with the running configuration, including the error associated with each out of sync configuration.

The `Cisco-IOS-XR-yiny-oper` operational data is a snapshot of the current system status, rather than a record of all past failures. That is, if an item of configuration is out of sync and is later resolved, such as through a resynchronization or another configuration operation, then this configuration is no longer considered out of sync and is removed from the snapshot.

### Operations that Remove Running Configuration

Here are three types of operation that can have the effect of removing running configuration from the system. Running configurations are either affected because they directly remove configuration in the system or because they result in configuration failing to be accepted by the system during start-up.

- **Install operations**: Running configuration can be removed during non-reload and reload install operations. During non-reload install, running configuration is removed when it is incompatible with the new software. In this case, it is directly removed by the Install infra. The configuration is removed during reload install operations if the attempt to restore the startup configuration is partially successful.
- **Breakout interfaces configuration**: When breakout interfaces are configured or de-configured, all the existing configuration on interfaces is affected. The affect may be creation or deletion of the parent and child interfaces. This results in an inconsistency between the running configuration and the OpenConfig datastore for any of the removed configurations that was mapped from OpenConfig configuration.

  The automatic restoration of OpenConfig configuration resolves this inconsistency by re-adding that removed configuration.
- **New line card insertion**: On insertion of a new line card into the system, any pre-configuration for that card is verified for the first time and may be rejected, causing it to be removed. This results in an inconsistency between the running configuration and the OpenConfig datastore.

In any of the above scenarios, if there is a sync issue, system logs are generated and the system tries to reapply all the OpenConfig configurations. If the re-sync attempt is successful, the configurations which were removed earlier, are re-applied. If the re-sync attempt fails, this means that some of the OpenConfig configuration is no longer valid.

**Note** The above scenarios are invalid if there are no OpenConfig configuration present in the system.

### System Logs Indicating Out-of-Sync Configuration

System log messages are generated due to the above operations that can lead to discrepancies in configurations on the router. Listed are examples of system log messages raised if any such discrepancies occur.

*Table 4: Examples of system log messages generated due to Out-of-Sync Configurations :*

| Event Name Displayed in the System Log | Description |
|---|---|
| **unexpected commit errors** | When an unexpected commit errors in case of a SysDB server crash. |
| **config rollback (to a commit ID created using a different software version)** | When a configuration rollbacks back to a commit ID created using a different software version. |
| **inconsistent configuration** | This system log is generated when an inconsistency alarm is raised due to failure in restoring the start-up configurations after activities like system reload or insertion of a new line card. Re-synchronization of the configuration is triggered only after the alarm is cleared. |
| **configuration removal (triggered on 0/2/CPU0 by the last config operation for interface GigabitEthernet0/2/0/0 and 6 other interfaces)** | When interface configuration is removed in response to a change in interface breakout configuration. |
| **configuration removal (to prepare for an install operation)** | Configuration is removed from the system during a non-reload install operation due to incompatibility with the new software. |

### Alarms Related to Out-of-Sync OpenConfig Configuration

- **Inconsistency alarm**: When a there is a failure in restoring the start-up configurations after a system reload or insertion of a new line card, inconsistency alarm is raised. If the inconsistency alarm is raised, you can see an informational system log is generated which indicates that the OpenConfig configuration and running configuration may be out of sync. A re-sync attempt will be made when the configuration inconsistency alarm is cleared. This system log is an early warning that the system is potentially out of sync.

  Inconsistency alarm message:

  ```
  NMI OpenConfig configuration is potentially out of sync with the running configuration (details: system configuration become inconsistent during OIR restore on 0/0/CPU0). An automatic reapply of the OpenConfig configuration will be performed when the inconsistency alarm is cleared.
  ```

- **Missing item in the OpenConfig datastore alarm**: If there are missing items in the configurations which could not be added to the OpenConfig datastore while loading in a snapshot from disk, you can see an error system log is raised which indicates that there are some items which are absent in the running OpenConfig configuration. This scenario occurs when the yang schema is changed from the time the snapshot was created.

  Item missing alarm message:

  ```
  gNMI OpenConfig configuration is potentially out of sync with the running configuration: 3 failed to be applied to the system (details: snapshot 2 was created with a different schema version). The system may contain config items mapped from OC that no longer exist in the OC datastore. Automatic attempts to reapply OC will not remove these items, even if they otherwise succeed. Config should be replaced manually using a GNMI Replace operation.
  ```

### System Logs Generated During Configuration Resynchronization:

When an attempt to re-apply OpenConfig (resynchronization) is complete, the following informational system logs are generated to indicate the user that the OpenConfig and running configuration were out of sync, and whether the attempt to resolve this was successful.

- Successful re-sync:

```
As a result of configuration removal (to prepare for an install operation), the gNMI
OpenConfig configuration has been successfully reapplied.
```

- Unsuccessful re-sync:

```
As a result of configuration removal (to prepare for an install operation), an attempt
to reapply the gNMI OpenConfig configuration was made, but some items remain out of
sync with the running configuration. Out of sync configuration can be viewed using the
Cisco-IOS-XR-yiny-oper model.
```

- Re-sync failure during mapping of OpenConfig configurations to XR configurations:

```
As a result of configuration removal (to prepare for an install operation), the attempt
to reapply the gNMI OpenConfig configuration failed, and the out of sync configuration
could not be updated. gNMI OpenConfig configuration is potentially out of sync with the
running configuration. Configuration should be reapplied manually using a GNMI Replace
operation
```

Re-sync failure during mapping of OpenConfig configurations to XR configurations is a rare scenario. When there is a failure in the re-sync process while mapping the OpenConfig configuration to XR items, it causes the re-sync request to aborted. This scenario is only possible after an install which changes the OpenConfig mappings such that some configuration is no longer supported.

### Resolve Out of Sync Configuration

An automatic resynchronization fails if the out-of-sync scenario is unresolved or the OpenConfig configuration and running XR configuration are out of sync.

Here are the two scenarios with steps to resolve the out-of-sync configuration if an attempt for automatic resynchronization fails.

**Resync Fails Partially**:

1. Query the items of configuration which are out of sync using the `Cisco-IOS-XR-yiny-oper` YANG model
2. For each out-of-sync configuration item:
    - Delete the OpenConfig items that are out of sync.
    - Re-add the deleted OpenConfig items in a separate request.

**Resync Fails Completely**:

Perform a full replace of the OpenConfig configuration using Netconf or gNMI.

By successfully completing these steps, you can now ensure that all configurations are in sync.

### YANG Model Data for Inconsistent Configuration

Each configuration of the `Cisco-IOS-XR-yiny-oper` YANG model has a list entry with the following fields:

- **Path**: The path of the XR configuration, in YPath format.
- **Input paths**: The OpenConfig paths of the items from which the XR configuration is mapped.

  **Activity**: If last occurrence of this failure was:

  - in a user-initiated commit operation.
  - in a system-initiated resynchronization attempt, after an install operation, breakout interfaces being configured, or line card insertion.

- **Operation**: If a configuration being `set` or `delete`:

  For a configuration that is out of sync because it failed during a resynchronization attempt, the operation is always `set`, but for a user-initiated commit operation, the operation is whichever the user was attempting during the commit.

- **Latest failure type**: If the latest failure is a `verify` failure or an `apply` failure.

  Only `verify` errors are currently tracked as out of sync and reported in the operational data, but this field is present in the model for potential future usage if `apply` errors are also tracked.

  - For configuration that fails during startup, both `verify` and `apply` failures can make the configurations out of sync.
  - For configuration that fails during a commit operation, only `apply` failures can make the configuration out of sync. This is because configuration is not allowed in the datastore if `verify` failures occur during a commit operation.

- **Latest error**: The latest error message describing the error.