Integrating Third-Party Endpoints in the Cisco IoT FND through CSMP

The CoAP Simple Management Protocol (CSMP) stack is open sourced as Open CSMP which allows the Cisco partners to register their endpoint devices in the Cisco IoT FND. The CSMP stack is a preferred lightweight communication protocol that encourages the community and vendors to use FND as their preferred NMS. While registering their devices, the partners can define their own set of metadata files for capturing metric, property, event, or issue types for the new device type.

Table 1: Feature History

Feature Name	Release Information	Description
Full Open CoAP Simple Management Protocol Support	Cisco IoT FND Release 5.0	A Vendor TLV 127 value support is added to the Full Open CoAP Simple Management Protocol (CSMP) for the Cisco IoT FND devices. A new tab **Vendor TLV Info** is introduced where you can add the TLV details for a selected device. You can modify and retrieve Vendor TLV details and push the modified configuration to new endpoints. You can also upgrade and manage the firmware with supported TLVs.

Registering Third-Party Devices in IoT FND

For each device type to be added, multiple separate metadata files are available as templates under the endpoint-meta-templates directory. This directory is available when you install or upgrade to the latest Cisco IoT FND 4.8.1 version.

Procedure

Step 1 In the `opt/cgms/server/cgms/conf` directory, you can view the list of required templates to create an endpoint.

- defaultdeviceTypeTemplate.json.template
- defaultdeviceTypeTemplateNoIPRoute.json.template
- deviceTypeEventTypes.xml.template
- deviceTypeIssueTypes.xml.template
- deviceTypeMeta.json.xml.template
- deviceTypeMetricTypes.xml.template
- deviceTypePropertyTypes.xml.template
- deviceTypeSystemRules.xml.template

Step 2 Run the `addGenericEndpoints.sh` script in `opt/cgms/bin` directory. The system prompts for the device type name.

Step 3 Provide the device type name. The script creates the endpoint-meta directory under `opt/cgms/server/cgms/conf` directory, if not present already. If the name of the new device type is provided as endpointdevice1, then the sub directory is created under endpoint-meta directory:

opt/cgms/server/cgms/conf/endpoint-meta/endpointdevice1

The `addGenericEndpoints.sh` script copies all the template files from endpoint-meta-templates directory, renames them as per the device type name provided and moves it under new device type directory. The below example shows how the files will be renamed when the device type name is provided as endpointdevice1:

- defaultendpointdevice1Template.json
- defaultendpointdevice1TemplateNoIPRoute.json
- endpointdevice1EventTypes.xml
- endpointdevice1IssueTypes.xml
- endpointdevice1Meta.json.xml
- endpointdevice1MetricTypes.xml
- endpointdevice1PropertyTypes.xml

- endpointdevice1SystemRules.xml

Note
Addition of new template files or removal of existing set of template files is not allowed.

Step 4 Edit the `endpointdevice1Meta.json` file for registration of new device by providing values in the required fields.

```
{
 “device_info”: {
 “device_type”: “ ”,
 “device_function”: “ “,
 “device_description”: “ “,
 “display_string”: “ “,
 “pids”: [ ] ,
 “vendorId”: “ “,
 “vendorName”: “ “,
 “device_actions”: [
 “reboot”,
  “ping”,
 “traceroute”,
 “inventory”,
     ]
“configure_vendortlv”: ““,
 “hw_info”: “ “
   }
}
```

The description for each field is provided below.

Field	Description
device_type	Enter alphanumeric characters for the name of the device type to be registered (for example, endpointdevice1).
device_function	Mention any of the existing mesh functions. The list of device functions currently supported in IoT FND are meter, extender, gateway, cge, root, controller, sensor, networknode, gasmeter.
device_description	Provide a brief information about the device type.
display_string	Enter only the display name for the endpoint device as it is displayed in the left side tree in Field Devices page under Endpoint category. The display string is in the format of <device function>-<display string> (for example, METER-ENDPOINTDEVICE1). The device function is obtained from the function entered by you.
pids	Enter the device pids as comma separated values (for example, “spid1”, “spid2”).
vendorId	Enter the vendorId which is used in Vendor TLV 127
vendorName	Enter the vendor name which corresponds to the vendorId.
device_actions	The actions that can be performed on the Device Details page are Show on Map, Ping, Traceroute, Refresh Metrics, Reboot, Sync Config Membership.
configure_vendortlv	By default, it is set to false. Enter true for FND to support config push of vendor TLV 127.

Field	Description
hw_info	Enter the hardware info for the device type which is present in the firmware image header.

Step 5 Start Cisco IoT FND after adding or updating the metadata files. The Cisco IoT FND reads the endpoint-meta directory and creates the appropriate tables for each device type. If any issues occur during startup, it logs the errors in server.log and continues with the startup process.

Step 6 After you restart the Cisco IoT FND, import the CSV file to add devices. For more information on adding endpoints, seenAdding Routers, Head-End Routers, IC3000 Gateway, Endpoint and Extenders and IR500 in Bulk. On addition, the device gets listed under Endpoints Category in the Field Devices page.

Registering Devices in Cluster Environment

The devices are registered in IoT FND by executing the `addGenericEndpoints.sh` script and creating the endpoint-meta directory. You can edit the **devicetypeMeta.json** file in the endpoint-meta directory to add the device details and restart IoT FND. In a cluster,

- Run the script and add the device types in various IoT FND instances.
- Restart the service of all IoT FND instances that are part of the cluster.

On restart, IoT FND picks up the device types that are added in all the IoT FND instances.

Adding Property Types, Metric Types, and Issue Types

To add mesh property types, mesh metric types, event types, and issue types for the newly registered device:

Procedure

Step 1 Create a new device type using the script, if not done already.

Step 2 Edit the json or xml files present in the new device type directory for newer metric, property, event, or issue types.

For example, if you want to include other metric types apart from the available list, you can edit the existing template and include other metric types. The same applies for property types, event types, issue types, and system rules as well.

Note
Restart IoT FND after editing the metadata files.

Mesh Property Types

The following is a sample list of mesh property types for the end point device.

```
<?xml version="1.0" encoding="UTF-8" ?>
<cgms xmlns="http://www.w3schools.com"
```

```
      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
      xsi:schemaLocation="http://www.w3schools.com propertyTypes.xsd">
  <propertyTypes kind="cgmesh">
    <propertyType>
      <name>meshAddress</name>
      <displayName>Mesh Link IP Address</displayName>
     <description>The IP address of the mesh link. Assigned automatically by the NMS during
 registration</description>
    </propertyType>
    <propertyType>
      <name>meshLocalAddress</name>
      <displayName>Mesh Link Local Address</displayName>
      <description>The local WPAN address of the mesh link. Assigned automatically by the
NMS during registration</description>
    </propertyType>
    <propertyType>
      <name>meshPrefix</name>
      <displayName>Mesh Link Prefix</displayName>
      <description>The subnet prefix address</description>
    </propertyType>
    <propertyType>
      <name>meshPrefixLength</name>
      <displayName>Mesh Link Prefix Length</displayName>
      <description>The subnet prefix address length</description>
    </propertyType>
    <propertyType>
      <name>meshSsid</name>
      <displayName>SSID</displayName>
      <description>The mesh SSID</description>
    </propertyType>
    <propertyType>
      <name>meshPanid</name>
      <displayName>PANID</displayName>
      <description>The subnet PAN ID</description>
    </propertyType>
    <propertyType>
      <name>meshTxPower</name>
      <displayName>Transmit Power</displayName>
      <description>The mesh transmit power</description>
    </propertyType>
    <propertyType>
      <name>meshSecMode</name>
      <displayName>Security Mode</displayName>
      <description>Mesh Security mode: 0 indicates none, 1 indicates 802.1x with 802.11i
key management</description>
    </propertyType>
    <propertyType>
      <name>meterId</name>
      <displayName>Meter Id</displayName>
      <description>The Meter Id of comm module</description>
    </propertyType>
    <propertyType>
      <name>meterCert</name>
      <displayName>Meter Certificate</displayName>
      <description>The subject name of the meter certificate</description>
    </propertyType>
    <propertyType>
      <name>toneMapFwdModulation</name>
      <displayName>Mesh Tone Map Forward Modulation</displayName>
      <description>Mesh tone map forward modulation: 0 = 'Robo', 1 = 'DBPSK', 2 = 'DQPSK',
 3 = 'D8PSK'</description>
    </propertyType>
    <propertyType>
      <name>toneMapFwdMap</name>
```

```
      <displayName>Mesh Tone Map Forward Map</displayName>
      <description>Mesh tone map forward map bit vector, e.g.,
"0011000011100111"</description>
    </propertyType>
    <propertyType>
      <name>toneMapRevModulation</name>
      <displayName>Mesh Tone Map Reverse Modulation</displayName>
      <description>Mesh tone map reverse modulation: 0 = 'Robo', 1 = 'DBPSK', 2 = 'DQPSK',
 3 = 'D8PSK'</description>
    </propertyType>
    <propertyType>
      <name>toneMapRevMap</name>
      <displayName>Mesh Tone Map Reverse Map</displayName>
      <description>Mesh tone map reverse map bit vector, e.g.,
"0011000011100111"</description>
    </propertyType>
    <propertyType>
      <name>manufacturer</name>
      <displayName>Manufacturer of the Endpoints</displayName>
      <description>Manufacturer of the endpoint as reported through CSMP from the
mesh</description>
    </propertyType>
    <propertyType>
      <name>physicalDescr</name>
      <displayName>Physical Description</displayName>
      <description>Description of the hardware</description>
    </propertyType>
    <propertyType>
   <name>bbuPresent</name>
      <displayName>BBU Present</displayName>
      <description>Battery Backup is present.</description>
    </propertyType>
    <propertyType>
      <name>bbuReady</name>
      <displayName>BBU Ready</displayName>
      <description>Battery Backup Unit is ready.</description>
    </propertyType>
    <propertyType>
      <name>powerSource</name>
      <displayName>Power Source</displayName>
      <description>The current power source of the device.</description>
    </propertyType>
    <propertyType>
      <name>batteryState</name>
      <displayName>Battery State</displayName>
      <description>The current battery state of the device.</description>
    </propertyType>
    <propertyType>
      <name>lastRegReason</name>
      <displayName>Last Registration Reason</displayName>
      <description>Reason for the most recent device registration</description>
      <propertyValueMap text="unknown" value="0"/>
      <propertyValueMap text="Cold boot" value="1"/>
      <propertyValueMap text="Manual re-registration" value="2"/>
      <propertyValueMap text="Rejoined with new IP" value="3"/>
      <propertyValueMap text="NMS address changed" value="4"/>
      <propertyValueMap text="Redirected NMS address" value="5"/>
      <propertyValueMap text="NMS error" value="6"/>
      <propertyValueMap text="Certificate changed" value="7"/>
      <propertyValueMap text="Power restoration" value="8"/>
      <propertyValueMap text="Parent node changed" value="9"/>
      <propertyValueMap text="Firmware updated" value="10"/>
    </propertyType>
    <propertyType>
```

```
      <name>previousMeshPanid</name>
      <displayName>Previous PANID</displayName>
      <description>The previous subnet PAN ID</description>
    </propertyType>
    <propertyType>
      <name>useCoap6</name>
      <displayName>Use CoAP Version 6</displayName>
      <description>Device is using CoAP version 6 for management messages</description>
    </propertyType>
    <propertyType>
      <name>meshProtocol</name>
      <displayName>Mesh Protocol</displayName>
      <description>Display the Mesh Protocol</description>
          <propertyValueMap text="Pre Wi-SUN" value="0"/>
          <propertyValueMap text="Wi-SUN 1.0" value="1"/>
    </propertyType>
    <propertyType>
      <name>sdkVersion</name>
      <displayName>SDK Version</displayName>
      <description>SDK version of the device</description>
    </propertyType>
    <propertyType>
      <name>patchCapability</name>
      <displayName>Patch Capability</displayName>
      <description>Patch Capability including patch support, version, window size and
lookahead size</description>
    </propertyType>
    <propertyType>
      <name>patchChopSize</name>
      <displayName>Patch Chop Size</displayName>
      <description>Maximum Chop Size nodes can support</description>
    </propertyType>
    <propertyType>
      <name>patchVolumeSize</name>
      <displayName>Patch Volume Size</displayName>
      <description>Patch Volume size</description>
    </propertyType>
    <propertyType>
      <name>certAutoRenewSettings</name>
      <displayName>Certificate Auto Renew Settings</displayName>
      <description>Display the Certificate Renew Settings</description>
    </propertyType>
    <propertyType>
      <name>aclInterfaceNameLp</name>
      <displayName>Interface Name</displayName>
      <description>Interface Name for Low Pan Interface</description>
    </propertyType>
    <propertyType>
      <name>aclDroppedCounterLp</name>
      <displayName>Dropped Counter</displayName>
      <description>Dropped Counter for Low Pan Interface</description>
    </propertyType>
    <propertyType>
      <name>aclDroppedSrcIpLp</name>
      <displayName>Dropped Source IP</displayName>
      <description>Dropped Source IP for Low Pan Interface</description>
    </propertyType>
    <propertyType>
      <name>aclDroppedDstIpLp</name>
      <displayName>Dropped Destination IP</displayName>
      <description>Dropped Destination IP for Low Pan Interface</description>
    </propertyType>
    <propertyType>
      <name>aclProtocolLp</name>
```

```
      <displayName>Protocol</displayName>
      <description>Protocol for Low Pan Interface</description>
    </propertyType>
    <propertyType>
      <name>aclDirectionLp</name>
      <displayName>Direction</displayName>
      <description>Direction for Low Pan Interface</description>
    </propertyType>
    <propertyType>
      <name>aclSrcPortLp</name>
      <displayName>Source Port</displayName>
      <description>Source Port for Low Pan Interface</description>
    </propertyType>
    <propertyType>
      <name>aclDstPortLp</name>
      <displayName>Destination Port</displayName>
      <description>Destination Port for Low Pan Interface</description>
    </propertyType>
    <propertyType>
      <name>aclMaxRateLimit</name>
      <displayName>ACL Max Rate Limit (kb/s)</displayName>
      <description>ACL Max Rate Limit used for Rate Limit validation</description>
    </propertyType>
  </propertyTypes>
</cgms>
```

Mesh Metric Types

The following is a sample list of mesh metric types for the end point device.

```
<?xml version="1.0" encoding="UTF-8" ?>
<cgms xmlns="http://www.w3.org"
      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <metricTypes kind="cgmesh">
    <metricType>
      <name>uptime</name>
      <valueType>gauge</valueType>
      <displayName>Uptime</displayName>
      <unit>sec</unit>
      <description>The amount of time in seconds that the element has been running since
last boot</description>
      <lowerBound>0</lowerBound>
      <upperBound>31536000</upperBound>
      <displayFormat>secondsToTime</displayFormat>
    </metricType>
    <metricType>
      <name>meshTxSpeed</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Link Transmit Speed</displayName>
      <unit>bits/sec</unit>
     <description>The current speed of data transmission over the uplink network interface,
 measured in bits per second, averaged over a short element-specific time period (e.g. an
hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
      <displayFormat>###,###</displayFormat>
    </metricType>
    <metricType>
      <name>meshTxDrops</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Link Transmit Packet Drops</displayName>
      <unit>drops/sec</unit>
      <description>The rate of packets that were dropped while trying to transmit on the
```

```
uplink interface because the outbound queue was full</description>
      <lowerBound>0</lowerBound>
      <upperBound>1</upperBound>
      <displayFormat>###,###</displayFormat>
    </metricType>
    <metricType>
      <name>meshRxSpeed</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Link Receive Speed</displayName>
      <unit>bits/sec</unit>
     <description>The rate of data that has been received by the uplink network interface,
 measured in bits per second, averaged over a short element-specific time period (e.g. an
hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
      <displayFormat>###,###</displayFormat>
    </metricType>
    <metricType>
      <name>meshRxReassemblyDrops</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Link Receive Packet Reassembly Drops</displayName>
      <unit>drops/sec</unit>
      <description>The rate of incoming packet fragments that were dropped because there
was no space in the reassembly buffer</description>
      <lowerBound>0</lowerBound>
      <upperBound>1</upperBound>
    </metricType>
    <metricType>
      <name>meshHops</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Route RPL Hops</displayName>
      <unit>hops</unit>
      <description>The number of hops that the element is from the root of its RPL routing
 tree</description>
      <lowerBound>1</lowerBound>
      <upperBound>8</upperBound>
      <displayFormat>###</displayFormat>
    </metricType>
    <metricType>
      <name>meshLinkCost</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Route RPL Link Cost</displayName>
      <unit></unit>
      <description>The RPL cost value for the link between the element and its uplink
neighbor</description>
      <lowerBound>1</lowerBound>
      <upperBound>3</upperBound>
      <invalidValue>65535</invalidValue>
      <displayFormat>###.##</displayFormat>
    </metricType>
    <metricType>
      <name>meshAbsolutePhase</name>
      <valueType>gauge</valueType>
      <displayName>Mesh absolute phase of power</displayName>
      <unit></unit>
      <description>Relative position of current and voltage waveforms for a PLC
Node</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
    </metricType>
    <metricType>
      <name>meshPathCost</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Route RPL Path Cost</displayName>
```

```
      <unit></unit>
      <description>The RPL path cost value between the element and the root of the routing
tree</description>
      <lowerBound>1</lowerBound>
      <upperBound>24</upperBound>
      <invalidValue>65535</invalidValue>
      <displayFormat>###.##</displayFormat>
    </metricType>
    <metricType>
      <name>meshRssi</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Route RSSI</displayName>
      <unit>dBm</unit>
      <description>The measured RSSI value of the primary mesh RF uplink</description>
      <lowerBound>-80</lowerBound>
      <upperBound>20</upperBound>
      <invalidValue>-128</invalidValue>
    </metricType>
    <metricType>
      <name>meshReverseRssi</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Route Reverse RSSI</displayName>
      <unit>dBm</unit>
     <description>The RSSI value measured by the element's mesh uplink neighbor</description>

      <lowerBound>-80</lowerBound>
      <upperBound>20</upperBound>
      <invalidValue>-128</invalidValue>
    </metricType>
    <metricType>
      <name>toneMapFwdTxResRaw</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Tone Map Forward Tx Res Raw</displayName>
      <unit></unit>
      <description>The txres field integer value in tone map forward message</description>
      <lowerBound>-1000</lowerBound>
      <upperBound>1000</upperBound>
    </metricType>
    <metricType>
      <name>toneMapFwdTxGainRaw</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Tone Map Forward Tx Gain Raw</displayName>
      <unit></unit>
      <description>The txres gain integer value in tone map forward message</description>
      <lowerBound>-1000</lowerBound>
      <upperBound>1000</upperBound>
    </metricType>
    <metricType>
      <name>toneMapFwdTxGain</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Tone Map Forward Tx Gain</displayName>
      <unit></unit>
      <description>Equals to txResRaw * txResGain</description>
      <lowerBound>-1000000</lowerBound>
      <upperBound>1000000</upperBound>
    </metricType>
    <metricType>
      <name>toneMapFwdToneQuality</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Tone Map Forward Tone Quality</displayName>
      <unit></unit>
      <description>The number of bits set in the tone map forward vector</description>
      <lowerBound>0</lowerBound>
      <upperBound>24</upperBound>
```

```
    </metricType>
    <metricType>
      <name>toneMapRevTxResRaw</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Tone Map Reverse Tx Res Raw</displayName>
      <unit></unit>
      <description>The txres field integer value in tone map reverse message</description>
      <lowerBound>-1000</lowerBound>
      <upperBound>1000</upperBound>
    </metricType>
    <metricType>
      <name>toneMapRevTxGainRaw</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Tone Map Reverse Tx Gain Raw</displayName>
      <unit></unit>
      <description>The txres gain integer value in tone map reverse message</description>
      <lowerBound>-1000</lowerBound>
      <upperBound>1000</upperBound>
    </metricType>
    <metricType>
      <name>toneMapRevTxGain</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Tone Map Reverse Tx Gain</displayName>
      <unit></unit>
      <description>Equals to txResRaw * txResGain</description>
      <lowerBound>-1000000</lowerBound>
      <upperBound>1000000</upperBound>
    </metricType>
    <metricType>
      <name>toneMapRevToneQuality</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Tone Map Reverse Tone Quality</displayName>
      <unit></unit>
      <description>The number of bits set in the tone map reverse vector</description>
      <lowerBound>0</lowerBound>
      <upperBound>24</upperBound>
    </metricType>
    <metricType>
      <name>meshRank</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Route RPL Rank</displayName>
      <unit></unit>
      <description>Rank is a representation of the location of the node within the RPL
tree</description>
      <lowerBound>0</lowerBound>
      <upperBound>100</upperBound>
    </metricType>
    <metricType>
      <name>meshActiveLinkType</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Active Link Type</displayName>
      <unit></unit>
      <description>Most recent device link type.
      Metric is populated only when RPL info is pulled from the associated router.
      </description>
      <lowerBound>0</lowerBound>
      <upperBound>4</upperBound>
      <displayFormat>valueToEnum</displayFormat>
    </metricType>
    <metricType>
      <name>meshRfPhyRxSpeed</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Receive Speed (RF)</displayName>
      <unit>bits/sec</unit>
```

```
      <description>The rate of data that has been received by the network interface over
RF, measured in bits per second, averaged over a short element-specific time period (e.g.
an hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
      <displayFormat>###,###</displayFormat>
    </metricType>
    <metricType>
      <name>meshRfPhyTxSpeed</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Transmit Speed (RF)</displayName>
      <unit>bits/sec</unit>
     <description>The rate of data that has been transmitted by the network interface over
 RF, measured in bits per second, averaged over a short element-specific time period (e.g.
 an hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
      <displayFormat>###,###</displayFormat>
</metricType>
    <metricType>
      <name>meshPlcPhyRxSpeed</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Receive Speed (PLC)</displayName>
      <unit>bits/sec</unit>
      <description>The rate of data that has been received by the network interface over
PLC, measured in bits per second, averaged over a short element-specific time period (e.g.
 an hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
      <displayFormat>###,###</displayFormat>
    </metricType>
    <metricType>
      <name>meshPlcPhyTxSpeed</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Transmit Speed (PLC)</displayName>
      <unit>bits/sec</unit>
     <description>The rate of data that has been transmitted by the network interface over
 PLC, measured in bits per second, averaged over a short element-specific time period (e.g.
 an hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
      <displayFormat>###,###</displayFormat>
    </metricType>
    <metricType>
      <name>meshPlcRoboLinkUsage</name>
      <valueType>gauge</valueType>
      <displayName>Modulation Robo link usage</displayName>
      <unit></unit>
      <description>Cumulative link usage of modulation Robo</description>
      <lowerBound>0</lowerBound>
    </metricType>
    <metricType>
      <name>meshPlcBpskLinkUsage</name>
      <valueType>gauge</valueType>
      <displayName>Modulation Bpsk link usage</displayName>
      <unit></unit>
      <description>Cumulative link usage of modulation Bpsk</description>
      <lowerBound>0</lowerBound>
    </metricType>
    <metricType>
      <name>meshPlcQpskLinkUsage</name>
      <valueType>gauge</valueType>
      <displayName>Modulation Qpsk link usage</displayName>
      <unit></unit>
```

```
      <description>Cumulative link usage of modulation Qpsk</description>
      <lowerBound>0</lowerBound>
    </metricType>
    <metricType>
      <name>meshPlcPsk8LinkUsage</name>
      <valueType>gauge</valueType>
      <displayName>Modulation 8PSK link usage</displayName>
      <unit></unit>
      <description>Cumulative link usage of modulation 8PSK</description>
      <lowerBound>0</lowerBound>
    </metricType>
    <metricType>
      <name>meshPlcOpskLinkUsage</name>
      <valueType>gauge</valueType>
      <displayName>Modulation Opsk link usage</displayName>
      <unit></unit>
      <description>Cumulative link usage of modulation Opsk</description>
      <lowerBound>0</lowerBound>
    </metricType>
    <metricType>
      <name>meshRfFsk2C150WFecLU</name>
      <valueType>gauge</valueType>
      <displayName>Modulation Classic 2FSK 150 with FEC link usage</displayName>
      <unit></unit>
     <description>Cumulative link usage of modulation Classic 2FSK 150 with FEC</description>

      <lowerBound>0</lowerBound>
    </metricType>
    <metricType>
      <name>meshRfFsk2C150WtFecLU</name>
      <valueType>gauge</valueType>
      <displayName>Modulation Classic 2FSK 150 without FEC link usage</displayName>
      <unit></unit>
      <description>Cumulative link usage of modulation Classic 2FSK 150 without
FEC</description>
      <lowerBound>0</lowerBound>
    </metricType>
    <metricType>
      <name>meshRfFsk2Dr50WtFecLU</name>
      <valueType>gauge</valueType>
      <displayName>Modulation 2FSK 50 without FEC link usage</displayName>
      <unit></unit>
      <description>Cumulative link usage of modulation 2FSK 50 without FEC</description>
      <lowerBound>0</lowerBound>
    </metricType>
    <metricType>
      <name>meshRfFsk2Dr150WtFecLU</name>
      <valueType>gauge</valueType>
      <displayName>Modulation 2FSK 150 without FEC link usage</displayName>
      <unit></unit>
      <description>Cumulative link usage of modulation 2FSK 150 without FEC</description>
      <lowerBound>0</lowerBound>
    </metricType>
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      <name>meshRfFsk2Dr150WFecLU</name>
      <valueType>gauge</valueType>
      <displayName>Modulation 2FSK 150 with FEC link usage</displayName>
      <unit></unit>
      <description>Cumulative link usage of modulation 2FSK 150 with FEC</description>
      <lowerBound>0</lowerBound>
    </metricType>
    <metricType>
      <name>meshLowpanTxSpeed</name>
      <valueType>gauge</valueType>
```

```
      <displayName>Mesh Link Transmit Speed for Lowpan</displayName>
      <unit>bits/sec</unit>
     <description>The current speed of data transmission over the uplink network interface,
 measured in bits per second, averaged over a short element-specific time period (e.g. an
hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
      <displayFormat>###,###.##</displayFormat>
    </metricType>
    <metricType>
      <name>meshLowpanTxDrops</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Link Transmit Packet Drops for Lowpan</displayName>
      <unit>drops/sec</unit>
      <description>The rate of packets that were dropped while trying to transmit on the
uplink interface because the outbound queue was full</description>
      <lowerBound>0</lowerBound>
      <upperBound>1</upperBound>
      <displayFormat>###,###.##</displayFormat>
    </metricType>
    <metricType>
      <name>meshLowpanRxSpeed</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Link Receive Speed for Lowpan</displayName>
      <unit>bits/sec</unit>
     <description>The rate of data that has been received by the uplink network interface,
 measured in bits per second, averaged over a short element-specific time period (e.g. an
hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
      <displayFormat>###,###.##</displayFormat>
    </metricType>
    <metricType>
      <name>meshLowpanPhyTxSpeed</name>
      <valueType>gauge</valueType>
      <displayName>Physical Mesh Link Transmit Speed</displayName>
      <unit>bits/sec</unit>
     <description>The current speed of data transmission over the physical layer, measured
 in bits per second, averaged over a short element-specific time period (e.g. an
hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
      <displayFormat>###,###.##</displayFormat>
    </metricType>
    <metricType>
      <name>meshLowpanPhyRxSpeed</name>
      <valueType>gauge</valueType>
      <displayName>Physical Mesh Link Receive Speed</displayName>
      <unit>bits/sec</unit>
      <description>The rate of data that has been received by the phyical layer, measured
in bits per second, averaged over a short element-specific time period (e.g. an
hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
      <displayFormat>###,###.##</displayFormat>
    </metricType>
    <metricType>
      <deviceType>loopback</deviceType>
      <name>txSpeed</name>
      <valueType>counter</valueType>
      <displayName>Transmit Speed</displayName>
      <unit>bits/sec</unit>
      <description>The current speed of data transmission over the interface, measured in
bits per second, averaged over a short element-specific time period (e.g. an
```

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hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
    </metricType>
    <metricType>
      <deviceType>loopback</deviceType>
      <name>txDrops</name>
      <valueType>counter</valueType>
      <displayName>Transmit Packet Drops</displayName>
      <unit>drops/sec</unit>
      <description>The rate of packets that were dropped while trying to transmit on the
interface because the outbound queue was full</description>
      <lowerBound>0</lowerBound>
      <upperBound>1</upperBound>
    </metricType>
    <metricType>
      <deviceType>loopback</deviceType>
      <name>rxSpeed</name>
      <valueType>counter</valueType>
      <displayName>Receive Speed</displayName>
      <unit>bits/sec</unit>
     <description>The rate of data that has been received by the network interface, measured
 in bits per second, averaged over a short element-specific time period (e.g. an
hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
    </metricType>
    <metricType>
      <deviceType>loopback</deviceType>
      <name>txUnicastPackets</name>
      <valueType>counter</valueType>
      <displayName>Transmit Unicast Packets</displayName>
      <unit>packets/sec</unit>
     <description>The current packet send rate over the interface, measured in packets per
 second, averaged over a short element-specific time period (e.g. an hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
    </metricType>
    <metricType>
      <deviceType>loopback</deviceType>
      <name>rxUnicastPackets</name>
      <valueType>counter</valueType>
      <displayName>Receive Unicast Packets</displayName>
      <unit>packets/sec</unit>
      <description>The current packet receive rate over the interface, measured in packets
 per second, averaged over a short element-specific time period (e.g. an hour)</description>

      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>txSpeed</name>
      <valueType>counter</valueType>
      <displayName>Transmit Speed</displayName>
      <unit>bits/sec</unit>
      <description>The current speed of data transmission over the interface, measured in
bits per second, averaged over a short element-specific time period (e.g. an
hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
```

```
        <name>queueJumpRate</name>
        <valueType>counter</valueType>
        <displayName>Rate of queue jump</displayName>
        <unit>packets/sec</unit>
       <description>The rate at which the packets were dropped from the queue due to higher
 priority network traffic</description>
        <lowerBound>0</lowerBound>
        <upperBound>1000000000</upperBound>
        <displayFormat>###,###</displayFormat>
    </metricType>
    <metricType>
        <deviceType>wpan</deviceType>
        <name>queueEvictionRate</name>
        <valueType>counter</valueType>
        <displayName>Rate of queue evictions</displayName>
        <unit>packets/sec</unit>
        <description>The rate at which the packets were enqueued due to lower priority
network traffic</description>
        <lowerBound>0</lowerBound>
        <upperBound>1000000000</upperBound>
        <displayFormat>###,###</displayFormat>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>txDrops</name>
      <valueType>counter</valueType>
      <displayName>Transmit Packet Drops</displayName>
      <unit>drops/sec</unit>
      <description>The rate of packets that were dropped while trying to transmit on the
interface because the outbound queue was full</description>
      <lowerBound>0</lowerBound>
      <upperBound>1</upperBound>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>rxSpeed</name>
      <valueType>counter</valueType>
      <displayName>Receive Speed</displayName>
      <unit>bits/sec</unit>
     <description>The rate of data that has been received by the network interface, measured
 in bits per second, averaged over a short element-specific time period (e.g. an
hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>txUnicastPackets</name>
      <valueType>counter</valueType>
      <displayName>Transmit Unicast Packets</displayName>
      <unit>packets/sec</unit>
     <description>The current packet send rate over the interface, measured in packets per
 second, averaged over a short element-specific time period (e.g. an hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>rxUnicastPackets</name>
      <valueType>counter</valueType>
      <displayName>Receive Unicast Packets</displayName>
      <unit>packets/sec</unit>
      <description>The current packet receive rate over the interface, measured in packets
 per second, averaged over a short element-specific time period (e.g. an hour)</description>
```

```
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>rfPhyRxSpeed</name>
      <valueType>counter</valueType>
      <displayName>Receive Speed on RF link</displayName>
      <unit>bits/sec</unit>
      <description>The rate of data that has been received by the network interface over
RF, measured in bits per second, averaged over a short element-specific time period (e.g.
an hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>rfPhyTxSpeed</name>
      <valueType>counter</valueType>
      <displayName>Transmit Speed on RF link</displayName>
      <unit>bits/sec</unit>
      <description>The rate of data that has been transmitted by the network interface over
 RF, measured in bits per second, averaged over a short element-specific time period (e.g.
 an hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
</metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>plcPhyRxSpeed</name>
      <valueType>counter</valueType>
      <displayName>Receive Speed on PLC link</displayName>
      <unit>bits/sec</unit>
      <description>The rate of data that has been received by the network interface over
PLC, measured in bits per second, averaged over a short element-specific time period (e.g.
 an hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>plcPhyTxSpeed</name>
      <valueType>counter</valueType>
      <displayName>Transmit Speed on PLC link</displayName>
      <unit>bits/sec</unit>
      <description>The rate of data that has been transmitted by the network interface over
 PLC, measured in bits per second, averaged over a short element-specific time period (e.g.
 an hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
</metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>rfFsk150LinkUsage</name>
      <valueType>cumulative</valueType>
      <displayName>Modulation Fsk150 link usage</displayName>
      <unit></unit>
      <description>Cumulative link usage of modulation fsk150</description>
      <lowerBound>0</lowerBound>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>plcRoboLinkUsage</name>
```

```
      <valueType>cumulative</valueType>
      <displayName>Modulation Robo link usage</displayName>
      <unit></unit>
      <description>Cumulative link usage of modulation Robo</description>
      <lowerBound>0</lowerBound>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>plcBpskLinkUsage</name>
      <valueType>cumulative</valueType>
      <displayName>Modulation Bpsk link usage</displayName>
      <unit></unit>
      <description>Cumulative link usage of modulation Bpsk</description>
      <lowerBound>0</lowerBound>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>plcQpskLinkUsage</name>
      <valueType>cumulative</valueType>
      <displayName>Modulation Qpsk link usage</displayName>
      <unit></unit>
      <description>Cumulative link usage of modulation Qpsk</description>
      <lowerBound>0</lowerBound>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>plcOpskLinkUsage</name>
      <valueType>cumulative</valueType>
      <displayName>Modulation Opsk link usage</displayName>
      <unit></unit>
      <description>Cumulative link usage of modulation Opsk</description>
      <lowerBound>0</lowerBound>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>rfFsk2C150WFecLU</name>
      <valueType>cumulative</valueType>
      <displayName>Modulation Classic 2FSK 150 with FEC link usage</displayName>
      <unit></unit>
     <description>Cumulative link usage of modulation Classic 2FSK 150 with FEC</description>

      <lowerBound>0</lowerBound>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>rfFsk2C150WtFecLU</name>
      <valueType>cumulative</valueType>
      <displayName>Modulation Classic 2FSK 150 without FEC link usage</displayName>
      <unit></unit>
      <description>Cumulative link usage of modulation Classic 2FSK 150 without
FEC</description>
      <lowerBound>0</lowerBound>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>rfFsk2Dr50WtFecLU</name>
      <valueType>cumulative</valueType>
      <displayName>Modulation 2FSK 50 without FEC link usage</displayName>
      <unit></unit>
      <description>Cumulative link usage of modulation 2FSK 50 without FEC</description>
      <lowerBound>0</lowerBound>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
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```
      <name>rfFsk2Dr150WtFecLU</name>
      <valueType>cumulative</valueType>
      <displayName>Modulation 2FSK 150 without FEC link usage</displayName>
      <unit></unit>
      <description>Cumulative link usage of modulation 2FSK 150 without FEC</description>
      <lowerBound>0</lowerBound>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>rfFsk2Dr150WFecLU</name>
      <valueType>cumulative</valueType>
      <displayName>Modulation 2FSK 150 with FEC link usage</displayName>
      <unit></unit>
      <description>Cumulative link usage of modulation 2FSK 150 with FEC</description>
      <lowerBound>0</lowerBound>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>phyTxSpeed</name>
      <valueType>counter</valueType>
      <displayName>Transmit Speed on PHY layer(PLC and RF combined)</displayName>
      <unit>bits/sec</unit>
     <description>The rate of data that has been transmitted by the network interface over
 physical layer, measured in bits per second, averaged over a short element-specific time
period (e.g. an hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
    </metricType>
    <metricType>
      <deviceType>wpan</deviceType>
      <name>phyRxSpeed</name>
      <valueType>counter</valueType>
      <displayName>Receive Speed on PHY layer(PLC and RF combined)</displayName>
      <unit>bits/sec</unit>
      <description>The rate of data that has been received by the network interface over
physical layer, measured in bits per second, averaged over a short element-specific time
period (e.g. an hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
    </metricType>
    <metricType>
      <deviceType>ppp</deviceType>
      <name>txSpeed</name>
      <valueType>counter</valueType>
      <displayName>Transmit Speed</displayName>
      <unit>bits/sec</unit>
      <description>The current speed of data transmission over the interface, measured in
bits per second, averaged over a short element-specific time period (e.g. an
hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
    </metricType>
    <metricType>
      <deviceType>ppp</deviceType>
      <name>txDrops</name>
      <valueType>counter</valueType>
      <displayName>Transmit Packet Drops</displayName>
      <unit>drops/sec</unit>
      <description>The rate of packets that were dropped while trying to transmit on the
interface because the outbound queue was full</description>
      <lowerBound>0</lowerBound>
      <upperBound>1</upperBound>
    </metricType>
    <metricType>
```

```
      <deviceType>ppp</deviceType>
      <name>rxSpeed</name>
      <valueType>counter</valueType>
      <displayName>Receive Speed</displayName>
      <unit>bits/sec</unit>
     <description>The rate of data that has been received by the network interface, measured
 in bits per second, averaged over a short element-specific time period (e.g. an
hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
    </metricType>
    <metricType>
      <deviceType>ppp</deviceType>
      <name>txUnicastPackets</name>
      <valueType>counter</valueType>
      <displayName>Transmit Unicast Packets</displayName>
      <unit>packets/sec</unit>
     <description>The current packet send rate over the interface, measured in packets per
 second, averaged over a short element-specific time period (e.g. an hour)</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
    </metricType>
    <metricType>
      <deviceType>ppp</deviceType>
      <name>rxUnicastPackets</name>
      <valueType>counter</valueType>
      <displayName>Receive Unicast Packets</displayName>
      <unit>packets/sec</unit>
      <description>The current packet receive rate over the interface, measured in packets
 per second, averaged over a short element-specific time period (e.g. an hour)</description>

      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
    </metricType>
    <metricType>
      <deviceType>RPL</deviceType>
      <name>hops</name>
      <valueType>gauge</valueType>
      <displayName>Hops</displayName>
      <unit>hops</unit>
      <description>The number of hops that the element is from the root of its RPL routing
 tree</description>
      <lowerBound>1</lowerBound>
      <upperBound>8</upperBound>
      <displayFormat>###</displayFormat>
    </metricType>
    <metricType>
      <deviceType>RPL</deviceType>
      <name>linkCost</name>
      <valueType>gauge</valueType>
      <displayName>Link Cost</displayName>
      <unit></unit>
      <description>The RPL cost value for the link between the element and its uplink
neighbor</description>
      <lowerBound>1</lowerBound>
      <upperBound>3</upperBound>
      <invalidValue>65535</invalidValue>
      <displayFormat>###</displayFormat>
    </metricType>
    <metricType>
      <deviceType>RPL</deviceType>
      <name>pathCost</name>
      <valueType>gauge</valueType>
      <displayName>Path Cost</displayName>
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```
      <unit></unit>
      <description>The RPL path cost value between the element and the root of the routing
tree</description>
      <lowerBound>1</lowerBound>
      <upperBound>24</upperBound>
      <invalidValue>65535</invalidValue>
    </metricType>
    <metricType>
      <deviceType>RPL</deviceType>
      <name>rssi</name>
      <valueType>gauge</valueType>
      <displayName>RSSI</displayName>
      <unit>dBm</unit>
      <description>The measured RSSI value of the primary mesh RF uplink</description>
      <lowerBound>-80</lowerBound>
      <upperBound>20</upperBound>
      <invalidValue>-128</invalidValue>
    </metricType>
    <metricType>
      <deviceType>RPL</deviceType>
      <name>reverseRssi</name>
      <valueType>gauge</valueType>
      <displayName>Reverse RSSI</displayName>
      <unit>dBm</unit>
     <description>The RSSI value measured by the element's mesh uplink neighbor</description>

      <lowerBound>-80</lowerBound>
      <upperBound>20</upperBound>
      <invalidValue>-128</invalidValue>
    </metricType>
    <metricType>
      <deviceType>RPL</deviceType>
      <name>tmFwdTxResRaw</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Tone Map Forward Tx Res Raw</displayName>
      <unit></unit>
      <description>The txres field integer value in tone map forward message</description>
      <lowerBound>-1000</lowerBound>
      <upperBound>1000</upperBound>
    </metricType>
    <metricType>
      <deviceType>RPL</deviceType>
      <name>tmFwdTxGainRaw</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Tone Map Forward Tx Gain Raw</displayName>
      <unit></unit>
      <description>The txres gain integer value in tone map forward message</description>
      <lowerBound>-1000</lowerBound>
      <upperBound>1000</upperBound>
    </metricType>
    <metricType>
      <deviceType>RPL</deviceType>
      <name>tmFwdTxGain</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Tone Map Forward Tx Gain</displayName>
      <unit></unit>
      <description>Equals to txResRaw * txResGain</description>
      <lowerBound>-1000000</lowerBound>
      <upperBound>1000000</upperBound>
    </metricType>
    <metricType>
      <deviceType>RPL</deviceType>
      <name>tmFwdToneQuality</name>
      <valueType>gauge</valueType>
```

```
      <displayName>Mesh Tone Map Forward Tone Quality</displayName>
      <unit></unit>
      <description>The number of bits set in the tone map vector</description>
      <lowerBound>0</lowerBound>
      <upperBound>24</upperBound>
    </metricType>
    <metricType>
      <deviceType>RPL</deviceType>
      <name>tmRevTxResRaw</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Tone Map Reverse Tx Res Raw</displayName>
      <unit></unit>
      <description>The txres field integer value in tone map reverse message</description>
      <lowerBound>-1000</lowerBound>
      <upperBound>1000</upperBound>
    </metricType>
    <metricType>
      <deviceType>RPL</deviceType>
      <name>tmRevTxGainRaw</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Tone Map Reverse Tx Gain Raw</displayName>
      <unit></unit>
      <description>The txres gain integer value in tone map reverse message</description>
      <lowerBound>-1000</lowerBound>
      <upperBound>1000</upperBound>
    </metricType>
    <metricType>
      <deviceType>RPL</deviceType>
      <name>tmRevTxGain</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Tone Map Reverse Tx Gain</displayName>
      <unit></unit>
      <description>Equals to txResRaw * txResGain</description>
      <lowerBound>-1000000</lowerBound>
      <upperBound>1000000</upperBound>
    </metricType>
    <metricType>
      <deviceType>RPL</deviceType>
      <name>tmRevToneQuality</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Tone Map Reverse Tone Quality</displayName>
      <unit></unit>
      <description>The number of bits set in the tone map reverse vector</description>
      <lowerBound>0</lowerBound>
      <upperBound>24</upperBound>
    </metricType>
    <metricType>
      <deviceType>RPL</deviceType>
      <name>absolutePhase</name>
      <valueType>gauge</valueType>
      <displayName>Mesh absolute phase of power</displayName>
      <unit></unit>
      <description>Relative position of current and voltage waveforms for a PLC
Node</description>
      <lowerBound>0</lowerBound>
      <upperBound>76800</upperBound>
    </metricType>
    <metricType>
      <deviceType>RPL</deviceType>
      <name>rank</name>
      <valueType>gauge</valueType>
      <displayName>Mesh Route RPL Rank</displayName>
      <unit></unit>
      <description>Rank is a representation of the location of the node within the RPL
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tree</description>
      <lowerBound>0</lowerBound>
      <upperBound>100</upperBound>
    </metricType>
    <metricType>
      <name>nodeLocalTime</name>
      <valueType>gauge</valueType>
      <displayName>NodeTime</displayName>
      <unit>sec</unit>
      <description>UTC time as reported by the device</description>
      <lowerBound>0</lowerBound>
      <upperBound>4294967296</upperBound>
    </metricType>
    <metricType>
      <name>batteryLevel</name>
      <valueType>gauge</valueType>
      <displayName>Battery Level</displayName>
      <unit>percent</unit>
      <description>The percentage of charge remaining in battery</description>
      <lowerBound>0</lowerBound>
      <upperBound>101</upperBound>
    </metricType>
    <metricType>
      <name>batteryRuntime</name>
      <valueType>gauge</valueType>
      <displayName>Battery Remaining Time</displayName>
      <unit>minutes</unit>
      <description>The runtime remaining on battery</description>
      <lowerBound>0</lowerBound>
      <upperBound>65535</upperBound>
    </metricType>
    <metricType>
      <name>batteryChargeTime</name>
      <valueType>gauge</valueType>
      <displayName>Battery Charging Time</displayName>
      <unit>minutes</unit>
      <description>The time required to charge battery</description>
      <lowerBound>0</lowerBound>
      <upperBound>65535</upperBound>
    </metricType>
    <metricType>
        <name>totalQueueJumpCnt</name>
        <valueType>gauge</valueType>
        <displayName>Mesh Link Queue Jump Count</displayName>
        <unit>packets</unit>
       <description>Total count of jump packets or number of dequeue packets</description>

        <lowerBound>0</lowerBound>
        <upperBound>1000000000</upperBound>
        <displayFormat>###,###</displayFormat>
    </metricType>
    <metricType>
        <name>totalQueueEvictionCnt</name>
        <valueType>gauge</valueType>
        <displayName>Mesh Link Queue Eviction Count</displayName>
        <unit>packets</unit>
        <description>Total count of eviction packets or number of enqueue
packets</description>
        <lowerBound>0</lowerBound>
        <upperBound>1000000000</upperBound>
        <displayFormat>###,###</displayFormat>
    </metricType>
    <metricType>
        <name>meshQueueJumpRate</name>
```

```
        <valueType>gauge</valueType>
        <displayName>Mesh Link Queue Jump Rate</displayName>
        <unit>packets/sec</unit>
        <description>Rate at which the packets were dropped from the queue due to higher
priority network traffic</description>
        <lowerBound>0</lowerBound>
        <upperBound>1000000000</upperBound>
        <displayFormat>###,###</displayFormat>
    </metricType>
    <metricType>
        <name>meshQueueEvictionRate</name>
        <valueType>gauge</valueType>
        <displayName>Mesh Link Queue Eviction Rate</displayName>
        <unit>packets/sec</unit>
        <description>Rate at which the packets were enqueued due to lower priority network
 traffic</description>
        <lowerBound>0</lowerBound>
        <upperBound>1000000000</upperBound>
        <displayFormat>###,###</displayFormat>
    </metricType>
    <metricType>
        <name>interPanMigration</name>
        <valueType>gauge</valueType>
        <displayName>Inter Pan Migrations</displayName>
        <unit>count</unit>
        <description>Count of inter pan migrations</description>
        <lowerBound>0</lowerBound>
        <upperBound>1000000000</upperBound>
        <displayFormat>###,###</displayFormat>
    </metricType>
    <metricType>
        <name>intraPanMigration</name>
        <valueType>gauge</valueType>
        <displayName>Intra Pan Migrations</displayName>
        <unit>count</unit>
        <description>Count of intra pan migrations</description>
        <lowerBound>0</lowerBound>
        <upperBound>1000000000</upperBound>
        <displayFormat>###,###</displayFormat>
    </metricType>
    <metricType>
        <name>missedPeriodicInventory</name>
        <valueType>gauge</valueType>
        <displayName>Missed Periodic Inventory Collections</displayName>
        <unit>count</unit>
        <description>Count of Missed Periodic Inventory Collections</description>
        <lowerBound>0</lowerBound>
        <upperBound>1000000000</upperBound>
        <displayFormat>###,###</displayFormat>
    </metricType>
  </metricTypes>
</cgms>
```

Event Types

The following is a sample list of event types for the end point device.

```
<?xml version="1.0" encoding="UTF-8" ?>
<event xmlns="http://www.w3schools.com" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.w3schools.com cmEvent.xsd">
<eventTypes kind="cgmesh">
<eventType>
<eventTypeName>UNKNOWN</eventTypeName>
```

```
<eventCategory>unknown</eventCategory>
<eventSearchName>unknown</eventSearchName>
<eventTypeDisplayString>Unknown Event</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Unknown event.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>restoration</eventTypeName>
<eventCategory>restoration</eventCategory>
<eventSearchName>restoration</eventSearchName>
<eventTypeDisplayString>Restoration</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Device restored from outage.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>up</eventTypeName>
<eventCategory>up</eventCategory>
<eventSearchName>up</eventSearchName>
<eventTypeDisplayString>Up</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Device is up.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>down</eventTypeName>
<eventCategory>down</eventCategory>
<eventSearchName>down</eventSearchName>
<eventTypeDisplayString>Down</eventTypeDisplayString>
<eventSeverity>MAJOR</eventSeverity>
<eventTypeDefaultMessage>Device is down.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>outage</eventTypeName>
<eventCategory>outage</eventCategory>
<eventSearchName>outage</eventSearchName>
<eventTypeDisplayString>Outage</eventTypeDisplayString>
<eventSeverity>CRITICAL</eventSeverity>
<eventTypeDefaultMessage>Outage detected on device.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>UserEventType</eventTypeName>
<eventCategory>rule</eventCategory>
<eventSearchName>ruleEvent</eventSearchName>
<eventTypeDisplayString>Rule Event</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Event generated by rule.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>timeMismatch</eventTypeName>
<eventCategory>timeMismatch</eventCategory>
<eventSearchName>timeMismatch</eventSearchName>
<eventTypeDisplayString>Time Mismatch</eventTypeDisplayString>
<eventSeverity>MAJOR</eventSeverity>
<eventTypeDefaultMessage>NMS server time mismatches with the device local
time.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>timeMismatchResolved</eventTypeName>
<eventCategory>timeMismatchResolved</eventCategory>
<eventSearchName>timeMismatchResolved</eventSearchName>
<eventTypeDisplayString>Time Mismatch Resolved</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>NMS server time matches with the device local
time.</eventTypeDefaultMessage>
</eventType>
```

```
<eventType>
<eventTypeName>manualCloseEvent</eventTypeName>
<eventCategory>Operation</eventCategory>
<eventSearchName>manualCloseEvent</eventSearchName>
<eventTypeDisplayString>Manual Close(Issue)</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Admin changed issue state to closed.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>unknownRegReason</eventTypeName>
<eventCategory>Registration</eventCategory>
<eventSearchName>unknownRegReason</eventSearchName>
<eventTypeDisplayString>Unknown Registration Reason</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Mesh node registered for unknown reason.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>coldBoot</eventTypeName>
<eventCategory>Registration</eventCategory>
<eventSearchName>coldBoot</eventSearchName>
<eventTypeDisplayString>Cold Boot</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Mesh node registered due to cold boot.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>manualReRegistration</eventTypeName>
<eventCategory>Registration</eventCategory>
<eventSearchName>manualReRegistration</eventSearchName>
<eventTypeDisplayString>Manual Re-Registration</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Mesh node registered due to manual
registration.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>rejoinedWithNewIP</eventTypeName>
<eventCategory>Registration</eventCategory>
<eventSearchName>rejoinedWithNewIP</eventSearchName>
<eventTypeDisplayString>Rejoined with New IP Address</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Mesh node registered with new IP address.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>nmsAddrChange</eventTypeName>
<eventCategory>Registration</eventCategory>
<eventSearchName>nmsAddrChange</eventSearchName>
<eventTypeDisplayString>NMS Address Change</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Mesh node registered due to NMS address
change.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>manualNMSAddrChange</eventTypeName>
<eventCategory>Registration</eventCategory>
<eventSearchName>manualNMSAddrChange</eventSearchName>
<eventTypeDisplayString>Manual NMS Address Change</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Mesh node registered due to manual NMS address
change.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>nmsError</eventTypeName>
<eventCategory>Registration</eventCategory>
<eventSearchName>nmsError</eventSearchName>
<eventTypeDisplayString>NMS Returned Error</eventTypeDisplayString>
```

```
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Mesh node registered due to NMS error.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>meterCertChange</eventTypeName>
<eventCategory>Registration</eventCategory>
<eventSearchName>meterCertChange</eventSearchName>
<eventTypeDisplayString>Mesh Certificate Change</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Mesh node registered due to certificate
change.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>unknownWPANChange</eventTypeName>
<eventCategory>WPAN Change</eventCategory>
<eventSearchName>unknownWPANChange</eventSearchName>
<eventTypeDisplayString>Unknown WPAN Change</eventTypeDisplayString>
<eventSeverity>MAJOR</eventSeverity>
<eventTypeDefaultMessage>Mesh node changed PAN for unknown reason.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>meshConnectivityLost</eventTypeName>
<eventCategory>WPAN Change</eventCategory>
<eventSearchName>meshConnectivityLost</eventSearchName>
<eventTypeDisplayString>Mesh Connectivity Lost</eventTypeDisplayString>
<eventSeverity>MAJOR</eventSeverity>
<eventTypeDefaultMessage>Mesh node lost all connectivity.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>meshLinkKeyTimeout</eventTypeName>
<eventCategory>WPAN Change</eventCategory>
<eventSearchName>meshLinkKeyTimeout</eventSearchName>
<eventTypeDisplayString>Mesh Link Key Timeout</eventTypeDisplayString>
<eventSeverity>MAJOR</eventSeverity>
<eventTypeDefaultMessage>Mesh node link key timed out.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>defaultRouteLost</eventTypeName>
<eventCategory>WPAN Change</eventCategory>
<eventSearchName>defaultRouteLost</eventSearchName>
<eventTypeDisplayString>Default Route Lost</eventTypeDisplayString>
<eventSeverity>MAJOR</eventSeverity>
<eventTypeDefaultMessage>Mesh node lost default route.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>migratedToBetterPAN</eventTypeName>
<eventCategory>WPAN Change</eventCategory>
<eventSearchName>migratedToBetterPAN</eventSearchName>
<eventTypeDisplayString>Migrated to Better PAN</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Mesh node migrated to better PAN.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>METER_REAUTHENTICATION</eventTypeName>
<eventCategory>Authentication</eventCategory>
<eventSearchName>dot1xReauth</eventSearchName>
<eventTypeDisplayString>Dot1x Reauthentication</eventTypeDisplayString>
<eventSeverity>MINOR</eventSeverity>
<eventTypeDefaultMessage>Multiple attempts to send the mesh-key to the meter failed.
Reauthenticating.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>AUTHENTICATION_FAILED</eventTypeName>
<eventCategory>Authentication</eventCategory>
```

```
<eventSearchName>dot1xAuthFailure</eventSearchName>
<eventTypeDisplayString>Dot1x Authentication Failure</eventTypeDisplayString>
<eventSeverity>MAJOR</eventSeverity>
<eventTypeDefaultMessage>Dot1x authentication failed for meter.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>restorationRegistration</eventTypeName>
<eventCategory>Registration</eventCategory>
<eventSearchName>restorationRegistration</eventSearchName>
<eventTypeDisplayString>Restoration Registration</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Mesh node registered after an outage.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>signatureFailure</eventTypeName>
<eventCategory>Security</eventCategory>
<eventSearchName>signatureFailure</eventSearchName>
<eventTypeDisplayString>Invalid CSMP Signature</eventTypeDisplayString>
<eventSeverity>CRITICAL</eventSeverity>
<eventTypeDefaultMessage>Invalid signature reported by mesh node</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>deviceAdded</eventTypeName>
<eventCategory>DeviceLifecycle</eventCategory>
<eventSearchName>deviceAdded</eventSearchName>
<eventTypeDisplayString>Device Added</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>New device is added</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>deviceRemoved</eventTypeName>
<eventCategory>DeviceLifecycle</eventCategory>
<eventSearchName>deviceRemoved</eventSearchName>
<eventTypeDisplayString>Device Removed</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Device is removed</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>registrationFailed</eventTypeName>
<eventCategory>Registration</eventCategory>
<eventSearchName>registrationFailed</eventSearchName>
<eventTypeDisplayString>Device Registration Failed</eventTypeDisplayString>
<eventSeverity>MAJOR</eventSeverity>
<eventTypeDefaultMessage>FND receive CGMSNotification with code = 3 during device
registration</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>registering</eventTypeName>
<eventCategory>registering</eventCategory>
<eventSearchName>registering</eventSearchName>
<eventTypeDisplayString>Registering</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Device is registering</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>blocked</eventTypeName>
<eventCategory>blocked</eventCategory>
<eventSearchName>blocked</eventSearchName>
<eventTypeDisplayString>Blocked</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Device is blocked</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>blockMeshDeviceFailed</eventTypeName>
```

```
<eventCategory>Security</eventCategory>
<eventSearchName>blockMeshDeviceFailed</eventSearchName>
<eventTypeDisplayString>Block Mesh Device Failure</eventTypeDisplayString>
<eventSeverity>MAJOR</eventSeverity>
<eventTypeDefaultMessage>Block mesh device operation failed.</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>estError</eventTypeName>
<eventCategory>EST</eventCategory>
<eventSearchName>estError</eventSearchName>
<eventTypeDisplayString>EST Error</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Error occurred processing EST request from the
device</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>sslError</eventTypeName>
<eventCategory>EST</eventCategory>
<eventSearchName>sslError</eventSearchName>
<eventTypeDisplayString>SSL Error</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>SSL Error occurred processing EST request from the
device</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>cacertRequest</eventTypeName>
<eventCategory>EST</eventCategory>
<eventSearchName>cacertRequest</eventSearchName>
<eventTypeDisplayString>CACert Request</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Received EST CACert request from the device</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>cacertResponse</eventTypeName>
<eventCategory>EST</eventCategory>
<eventSearchName>cacertResponse</eventSearchName>
<eventTypeDisplayString>CACert Response</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Sent EST CACert response to the device</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>enrollRequest</eventTypeName>
<eventCategory>EST</eventCategory>
<eventSearchName>enrollRequest</eventSearchName>
<eventTypeDisplayString>Enroll Request</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Received EST Enroll request from the device</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>reenrollRequest</eventTypeName>
<eventCategory>EST</eventCategory>
<eventSearchName>reenrollRequest</eventSearchName>
<eventTypeDisplayString>Re-Enroll Request</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Received EST Re-Enroll request from the
device</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>enrollSuccess</eventTypeName>
<eventCategory>EST</eventCategory>
<eventSearchName>enrollSuccess</eventSearchName>
<eventTypeDisplayString>Enroll Success</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Device EST Enrollment succeeded</eventTypeDefaultMessage>
```

```
</eventType>
<eventType>
<eventTypeName>reenrollSuccess</eventTypeName>
<eventCategory>EST</eventCategory>
<eventSearchName>reenrollSuccess</eventSearchName>
<eventTypeDisplayString>Re-Enroll Success</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Device EST Re-Enrollment succeeded</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>enrollFailure</eventTypeName>
<eventCategory>EST</eventCategory>
<eventSearchName>enrollFailure</eventSearchName>
<eventTypeDisplayString>Enroll Failure</eventTypeDisplayString>
<eventSeverity>CRITICAL</eventSeverity>
<eventTypeDefaultMessage>Device EST Enrollment failed</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>reenrollFailure</eventTypeName>
<eventCategory>EST</eventCategory>
<eventSearchName>reenrollFailure</eventSearchName>
<eventTypeDisplayString>Re-Enroll Failure</eventTypeDisplayString>
<eventSeverity>CRITICAL</eventSeverity>
<eventTypeDefaultMessage>Device EST Re-Enrollment failed</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>authenticationSuccess</eventTypeName>
<eventCategory>EST</eventCategory>
<eventSearchName>authenticationSuccess</eventSearchName>
<eventTypeDisplayString>Authentication Success</eventTypeDisplayString>
<eventSeverity>INFO</eventSeverity>
<eventTypeDefaultMessage>Device EST authentication succeeded</eventTypeDefaultMessage>
</eventType>
<eventType>
<eventTypeName>authenticationFailure</eventTypeName>
<eventCategory>EST</eventCategory>
<eventSearchName>authenticationFailure</eventSearchName>
<eventTypeDisplayString>Authentication Failure</eventTypeDisplayString>
<eventSeverity>MAJOR</eventSeverity>
<eventTypeDefaultMessage>Device EST authentication failed</eventTypeDefaultMessage>
</eventType>
</eventTypes>
</event>
```

Issue Types

The following is a sample list of issue types for the end point device.

```
<?xml version="1.0" encoding="UTF-8" ?>
<issue xmlns="http://www.w3schools.com" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.w3schools.com cgrEvent.xsd">
<issueTypes kind="cgmesh">
<issueType>
<issueTypeName>UNKNOWN</issueTypeName>
<issueCategory>unknown</issueCategory>
<issueSearchName>unknown</issueSearchName>
<issueTypeDisplayString>Unknown Issue</issueTypeDisplayString>
<issueSeverity>INFO</issueSeverity>
<issueTypeDefaultMessage>The issue raised/closed does not have a defined issue
type.</issueTypeDefaultMessage>
</issueType>
<issueType>
<issueTypeName>deviceDown</issueTypeName>
```

```
<issueCategory>Device</issueCategory>
<issueSearchName>down</issueSearchName>
<issueTypeDisplayString>Down</issueTypeDisplayString>
<issueSeverity>MAJOR</issueSeverity>
<issueTypeDefaultMessage>Device is down.</issueTypeDefaultMessage>
</issueType>
<issueType>
<issueTypeName>registrationFailed</issueTypeName>
<issueCategory>Device</issueCategory>
<issueSearchName>registrationFailed</issueSearchName>
<issueTypeDisplayString>Device Registration Failed</issueTypeDisplayString>
<issueSeverity>MAJOR</issueSeverity>
<issueTypeDefaultMessage>Device Registration failed due to configuration
error</issueTypeDefaultMessage>
</issueType>
<issueType>
<issueTypeName>deviceOutage</issueTypeName>
<issueCategory>Device</issueCategory>
<issueSearchName>Outage</issueSearchName>
<issueTypeDisplayString>Outage</issueTypeDisplayString>
<issueSeverity>CRITICAL</issueSeverity>
<issueTypeDefaultMessage>Device is in outage.</issueTypeDefaultMessage>
</issueType>
<issueType>
<issueTypeName>deviceTimeMismatch</issueTypeName>
<issueCategory>Device</issueCategory>
<issueSearchName>deviceTimeMismatch</issueSearchName>
<issueTypeDisplayString>Device-NMS Time Mismatch</issueTypeDisplayString>
<issueSeverity>MAJOR</issueSeverity>
<issueTypeDefaultMessage>Device time and NMS time are not in sync.</issueTypeDefaultMessage>
</issueType>
<issueType>
<issueTypeName>signatureFailure</issueTypeName>
<issueCategory>Security</issueCategory>
<issueSearchName>signatureFailure</issueSearchName>
<issueTypeDisplayString>Invalid CSMP Signature</issueTypeDisplayString>
<issueSeverity>CRITICAL</issueSeverity>
<issueTypeDefaultMessage>Verify certificate setup. Also verify that mesh node and IoT-FND
are time synchronized.</issueTypeDefaultMessage>
</issueType>
<issueType>
<issueTypeName>enrollFailure</issueTypeName>
<issueCategory>EST</issueCategory>
<issueSearchName>enrollFailure</issueSearchName>
<issueTypeDisplayString>Enroll Failure</issueTypeDisplayString>
<issueSeverity>CRITICAL</issueSeverity>
<issueTypeDefaultMessage>Device EST Enrollment failed.</issueTypeDefaultMessage>
</issueType>
<issueType>
<issueTypeName>reenrollFailure</issueTypeName>
<issueCategory>EST</issueCategory>
<issueSearchName>reenrollFailure</issueSearchName>
<issueTypeDisplayString>Re-Enroll Failure</issueTypeDisplayString>
<issueSeverity>CRITICAL</issueSeverity>
<issueTypeDefaultMessage>Device EST Re-Enrollment failed.</issueTypeDefaultMessage>
</issueType>
<issueType>
<issueTypeName>authenticationFailure</issueTypeName>
<issueCategory>EST</issueCategory>
<issueSearchName>authenticationFailure</issueSearchName>
<issueTypeDisplayString>Authentication Failure</issueTypeDisplayString>
<issueSeverity>CRITICAL</issueSeverity>
<issueTypeDefaultMessage>Device EST authentication failed.</issueTypeDefaultMessage>
</issueType>
```

```
</issueTypes>
</issue>
```

System Rules

The following is a sample list of system rules for the end point device.

```
<?xml version="1.0" encoding="UTF-8" ?>
<cgms xmlns="http://www.w3schools.com" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">

  <rules kind="">
    <rule>
      <name>Down Rule</name>
      <username>system</username>
      <query>deviceType:{0} eventName:down</query>
      <action type="manage_issue" parameter="issueTypeName:deviceDown issueStatus:OPEN" />
    </rule>
    <rule>
      <name>Up from Down Rule</name>
      <username>system</username>
      <query>deviceType:{0} eventName:up</query>
      <action type="manage_issue" parameter="issueTypeName:deviceDown issueStatus:CLOSED"
/>
    </rule>

    <rule>
      <name>Registration Failed Rule</name>
      <username>system</username>
      <query>deviceType:{0} eventName:registrationFailed</query>
      <action type="manage_issue" parameter="issueTypeName:registrationFailed
issueStatus:OPEN" />
    </rule>
    <rule>
      <name>Up from Registration Failed Rule</name>
      <username>system</username>
      <query>deviceType:{0} eventName:up</query>
      <action type="manage_issue" parameter="issueTypeName:registrationFailed
issueStatus:CLOSED" />
    </rule>

    <rule>
      <name>Outage Rule</name>
      <username>system</username>
      <query>deviceType:{0} eventName:outage</query>
      <action type="manage_issue" parameter="issueTypeName:deviceOutage issueStatus:OPEN"
/>
    </rule>
    <rule>
      <name>Up from Outage Rule</name>
      <username>system</username>
      <query>deviceType:{0} eventName:up</query>
     <action type="manage_issue" parameter="issueTypeName:deviceOutage issueStatus:CLOSED"
 />
    </rule>
    <rule>
      <name>Restored from Outage Rule</name>
      <username>system</username>
      <query>deviceType:{0} eventName:restoration</query>
     <action type="manage_issue" parameter="issueTypeName:deviceOutage issueStatus:CLOSED"
 />
    </rule>

    <rule>
```

```
      <name>Time Mismatch Rule</name>
      <username>system</username>
      <query>deviceType:{0} eventName:timeMismatch</query>
      <action type="manage_issue" parameter="issueTypeName:deviceTimeMismatch
issueStatus:OPEN" />
    </rule>
    <rule>
      <name>Time Mismatch Resolved Rule</name>
      <username>system</username>
      <query>deviceType:{0} eventName:timeMismatchResolved</query>
      <action type="manage_issue" parameter="issueTypeName:deviceTimeMismatch
issueStatus:CLOSED" />
    </rule>
    <rule>
      <name>Signature Validation Failure</name>
      <username>system</username>
      <query>deviceType:{0} eventName:signatureFailure</query>
     <action type="manage_issue" parameter="issueTypeName:signatureFailure issueStatus:OPEN"
 />
    </rule>
  </rules>
</cgms>
```

License Support

The registered devices utilize the current endpoint license for lifecycle management in FND.

Viewing Endpoints on Dashboard

On the FND dashboard, the endpoints dashlets display the following properties for the registered devices:

- Endpoint States Over Time
- Endpoint Config Group Template Mismatch Over Time
- Endpoint Firmware Group Template Mismatch Over Time
- Endpoint Inventory
- Hop Count Distribution
- Config Group Template Mismatch
- Firmware Group Template Mismatch
- RF and PLC Media utilization over time

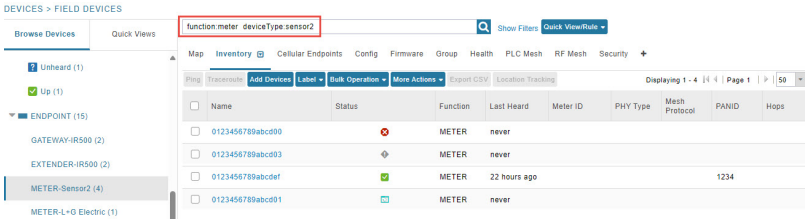
Viewing Endpoints on Field Devices Page

The registered endpoint devices appear on the Field Devices page, with the device type and function as defined in the meta data file; their function is similar to the existing endpoints in FND.

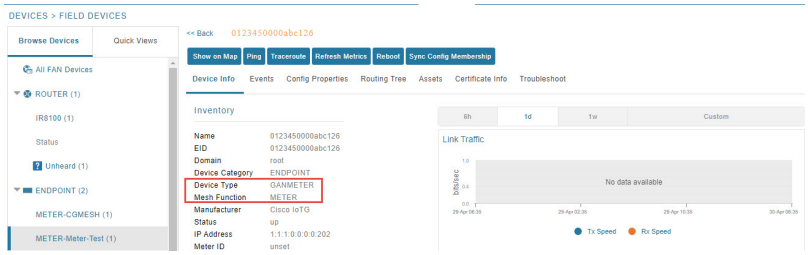
To view the registered devices:

Procedure

Step 1 Choose **DEVICES** > **Field Devices** > **ENDPOINTS** to view the inventory of the registered device.



Step 2 Click the registered endpoint device to view the device information.



Both the Device Inventory and the Device Details pages display the tabs, buttons, filter options similar to the existing endpoints in FND.

Viewing VendorTLV on Field Devices Page

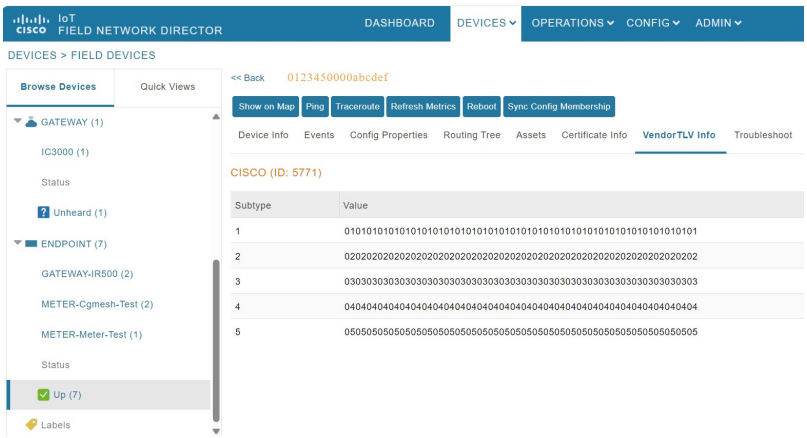
The vendor TLV details are added in the inventory page. It also displays vendor name in the following format as vendor name (vendor-id). For example, Cisco (ID: 5771) , where ID refers IANA PEN of the vendor received by FND during device registration.

To view the vendor details:

Procedure

Step 1 Choose **DEVICES** > **Field Devices** > **ENDPOINTS** to view the inventory of the registered device.

Step 2 In the Device Details page, navigate to **VendorTLV info** tab to view the vendor name, vendor ID and the list of **Subtype** and its **Value**.



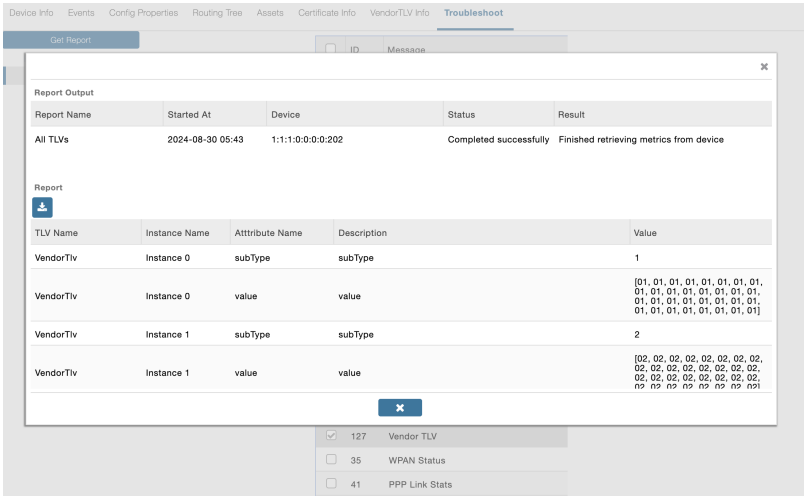
Viewing Response from the Endpoint for the VendorTLV

To view the response from the endpoint for the VendorTLV:

Procedure

Step 1 Choose **DEVICES** > **Field Devices** > **ENDPOINTS** to view the inventory of the registered device.

Step 2 In the Device Details page, navigate to **Troubleshoot** tab to view the response from the endpoint for the VendorTLV 127.



Configuring Markdown Timer

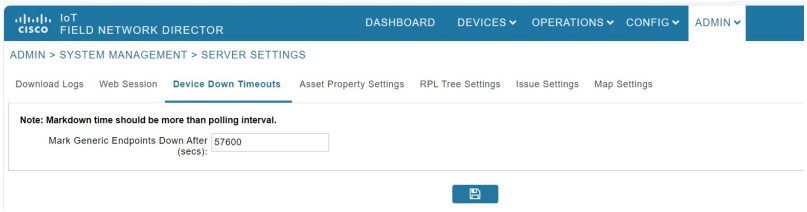
Once the endpoint is added with the generic device type, the **Mark Generic Endpoints Down After** option is enabled in **Device Down Timeouts** tab.

To configure the Markdown timer:

Procedure

Step 1 Choose **ADMIN** > **System Management** > **Server Settings**.

Step 2 Click the **Device Down Timeouts** tab.



Step 3 Enter the time in the **Mark Generic Endpoints Down After** field.

Step 4 Click the disk icon to save the configuration.

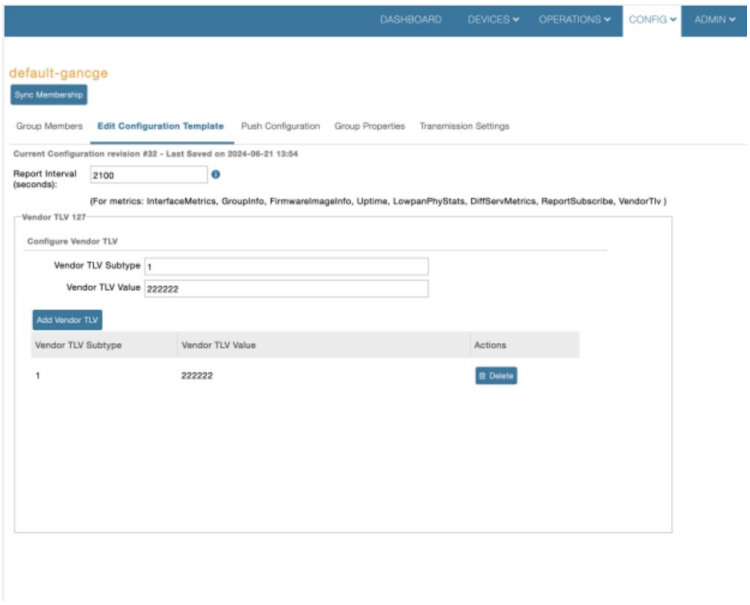
Supported Periodic Metric TLVs

FND supports the following TLVs for periodic metrics.

TLV ID	TLV Name
23	Interface Metrics
17	IP Route
25	IP Route RPL Metrics
58	Group Info
75	Firmware Image Info
22	Uptime
61	LoWPAN PHY Stats
88	DiffServ Metrics
13	Report Subscribe
127	Vendor TLV

Procedure

Step 1 Choose **CONFIG** > **Device Configuration** > **Edit Configuration Template** tab.



Step 2 Select the **Vendor TLV Subtype** from the drop-down list and click **Add Vendor TLV** to configure the Vendor TLV.

Pushing Configuration

The registered endpoint devices appear in the UI with the default configuration group name (default-deviceType). The configuration defined for the devices is read from the meta data file and is reflected in the default configuration group. The Cisco IoT FND release 4.12 allows you to configure and process only the report interval TLV metrics for the new endpoint devices.

Cisco IoT FND release 5.0 allows you to change and retrieve the Vendor TLV details and push the configuration to the new endpoint devices.

The default template configuration is:

```
[{
    "name": "ReportSubscribe",
    "value": {
        "interval": 28800,
        "tlvid": ["InterfaceMetrics", "IPRoute", "IPRouteRPLMetrics", "GroupInfo",
"FirmwareImageInfo", "Uptime", "LowpanPhyStats", "DiffServMetrics", "ReportSubscribe",
"VendorTlv"]
    } }]
```

When you select the **RPL Tree Settings** as **Mesh Nodes**, add the VendorTLV in the metadata file `default[devicetype]Template.json`.

When you select the **RPL Tree Settings** as **Router**, add the VendorTLV in the metadata file `default[devicetype]NoIPRouteTemplate.json file`.

The events defined in the `deviceTypeEventTypes.xml` are applicable for the new endpoint devices.

Procedure

Step 1 Choose **CONFIG** > **Device Configuration** > **Push Configuration** tab.

Step 2 Select Push ENDPOINT Configuration from the drop-down list and click **Submit** to push the configuration to the devices from FND.

Signing CSMP Message

To enable the CSMP signing in FND the following configuration is required:

- Ensure that the CSMP certificate, present in FND, is installed in the endpoint.
- Enable the CSMP signing setting in the endpoints.

Firmware Upgrade

Starting from Cisco IoT FND release 5.0 the following TLVs are supported as a part of Firmware upgrade and management.

TLV ID	TLV Name
65	Transfer Request
67	Image Block
68	Load Request
69	Cancel Load Request
70	Set Backup Request
71	Transfer Response
72	Load Response
73	Cancel Load Response
74	Set Backup Response
75	Firmware Image Info

Cisco IoT FND reads the following fields in the firmware image header:

```
hdrVersion - mandatory
hdrLen - mandatory
appRevMajor - mandatory
appRevMinor - mandatory
appBuild - mandatory
appLen - mandatory
appName - mandatory
appGitBranch - not mandatory
appGitCommit - not mandatory
appGitFlag - not mandatory
appBuildDate - mandatory
hw_info - mandatory
kernelVersion - not mandatory
```

Update the hw_info field in the `deviceTypeMeta.json` file with the same hw_info present in the firmware image header. FND maps the hw_info with the device type internally.

Navigate to **CONFIG** > **Firmware Update** > **Images** tab and select the endpoint **PLC-RF** to upload the firmware images.