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A YANG Data Model for Hardware Management

Abstract

This document defines a YANG data model for the management of hardware on a single server.

Status of This Memo

This is an Internet Standards Track document.

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1. Introduction

This document defines a YANG data model [RFC7950] for the management of hardware on a single server.

The data model includes configuration and system state (status information and counters for the collection of statistics).

The data model in this document is designed to be compliant with the Network Management Datastore Architecture (NMDA) [RFC8342]. For implementations that do not yet support NMDA, a temporary module with system state data only is defined in Appendix A.

1.1. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

The following terms are defined in [RFC8342] and are not redefined here:

- o client
- o server
- o configuration
- o system state
- o operational state
- o intended configuration

1.2. Tree Diagrams

Tree diagrams used in this document follow the notation defined in [RFC8340].

2. Objectives

This section describes some of the design objectives for the hardware data model.

- o The hardware data model needs to support many common properties used to identify hardware components.
- o Important information and states about hardware components need to be collected from devices that support the hardware data model.
- o The hardware data model should be suitable for new implementations to use as is.
- o The hardware data model defined in this document can be implemented on a system that also implements ENTITY-MIB; thus, the mapping between the hardware data model and ENTITY-MIB should be clear.
- o The data model should support pre-provisioning of hardware components.

3. Hardware Data Model

This document defines the YANG module "ietf-hardware", which has the following structure:

```

module: ietf-hardware
  +--rw hardware
    +--ro last-change?   yang:date-and-time
    +--rw component* [name]
      +--rw name          string
      +--rw class         identityref
      +--ro physical-index? int32 {entity-mib}?
      +--ro description?  string
      +--rw parent?       -> ../../component/name
      +--rw parent-rel-pos? int32
      +--ro contains-child* -> ../../component/name
      +--ro hardware-rev?  string
      +--ro firmware-rev? string
      +--ro software-rev? string
      +--ro serial-num?   string
      +--ro mfg-name?     string
      +--ro model-name?   string
      +--rw alias?        string
      +--rw asset-id?     string
      +--ro is-fru?       boolean
      +--ro mfg-date?     yang:date-and-time

```

```

+--rw uri*                inet:uri
+--ro uuid?               yang:uuid
+--rw state {hardware-state}?
|   +--ro state-last-changed? yang:date-and-time
|   +--rw admin-state?        admin-state
|   +--ro oper-state?        oper-state
|   +--ro usage-state?       usage-state
|   +--ro alarm-state?       alarm-state
|   +--ro standby-state?     standby-state
+--ro sensor-data {hardware-sensor}?
|   +--ro value?              sensor-value
|   +--ro value-type?        sensor-value-type
|   +--ro value-scale?       sensor-value-scale
|   +--ro value-precision?   sensor-value-precision
|   +--ro oper-status?       sensor-status
|   +--ro units-display?     string
|   +--ro value-timestamp?   yang:date-and-time
|   +--ro value-update-rate? uint32

```

notifications:

```

+---n hardware-state-change
+---n hardware-state-oper-enabled {hardware-state}?
|   +--ro name?              -> /hardware/component/name
|   +--ro admin-state?      -> /hardware/component/state/admin-state
|   +--ro alarm-state?      -> /hardware/component/state/alarm-state
+---n hardware-state-oper-disabled {hardware-state}?
|   +--ro name?              -> /hardware/component/name
|   +--ro admin-state?      -> /hardware/component/state/admin-state
|   +--ro alarm-state?      -> /hardware/component/state/alarm-state

```

3.1. The Components Lists

The data model for hardware presented in this document uses a flat list of components. Each component in the list is identified by its name. Furthermore, each component has a mandatory "class" leaf.

The "iana-hardware" module defines YANG identities for the hardware types in the IANA-maintained "IANA-ENTITY-MIB" registry.

The "class" leaf is a YANG identity that describes the type of the hardware. Vendors are encouraged to either directly use one of the common IANA-defined identities or derive a more specific identity from one of them.

4. Relationship to ENTITY-MIB

If the device implements the ENTITY-MIB [RFC6933], each entry in the `"/hardware/component"` list in the operational state is mapped to one `EntPhysicalEntry`. Objects that are writable in the MIB are mapped to `"config true"` nodes in the `"/hardware/component"` list, except `entPhysicalSerialNum`, which is writable in the MIB but `"config false"` in the YANG module.

The `"physical-index"` leaf MUST contain the value of the corresponding `entPhysicalEntry`'s `entPhysicalIndex`.

The `"class"` leaf is mapped to both `entPhysicalClass` and `entPhysicalVendorType`. If the value of the `"class"` leaf is an identity that either is derived from or is one of the identities in the `"iana-hardware"` module, then `entPhysicalClass` contains the corresponding `IANAPhysicalClass` enumeration value. Otherwise, `entPhysicalClass` contains the `IANAPhysicalClass` value `"other(1)"`. Vendors are encouraged to define an identity (derived from an identity in `"iana-hardware"` if possible) for each enterprise-specific registration identifier used for `entPhysicalVendorType` and use that identity for the `"class"` leaf.

The following table lists the YANG data nodes with corresponding objects in the ENTITY-MIB.

YANG data node in /hardware/component	ENTITY-MIB object
name	entPhysicalName
class	entPhysicalClass
physical-index	entPhysicalVendorType
description	entPhysicalIndex
parent	entPhysicalDescr
parent-rel-pos	entPhysicalContainedIn
contains-child	entPhysicalParentRelPos
hardware-rev	entPhysicalChildIndex
firmware-rev	entPhysicalHardwareRev
software-rev	entPhysicalFirmwareRev
serial-num	entPhysicalSoftwareRev
mfg-name	entPhysicalSerialNum
model-name	entPhysicalMfgName
alias	entPhysicalModelName
asset-id	entPhysicalAlias
is-fru	entPhysicalAssetID
mfg-date	entPhysicalIsFRU
uri	entPhysicalMfgDate
uuid	entPhysicalUris
	entPhysicalUUID

YANG Data Nodes and Related ENTITY-MIB Objects

5. Relationship to ENTITY-SENSOR-MIB

If the device implements the ENTITY-SENSOR-MIB [RFC3433], each entry in the "/hardware/component" list where the container "sensor-data" exists is mapped to one EntPhySensorEntry.

The following table lists the YANG data nodes with corresponding objects in the ENTITY-SENSOR-MIB.

YANG data node in /hardware/component/sensor-data	ENTITY-SENSOR-MIB object
value	entPhySensorValue
value-type	entPhySensorType
value-scale	entPhySensorScale
value-precision	entPhySensorPrecision
oper-status	entPhySensorOperStatus
units-display	entPhySensorUnitsDisplay
value-timestamp	entPhySensorValueTimeStamp
value-update-rate	entPhySensorValueUpdateRate

YANG Data Nodes and Related ENTITY-SENSOR-MIB Objects

6. Relationship to ENTITY-STATE-MIB

If the device implements the ENTITY-STATE-MIB [RFC4268], each entry in the "/hardware/component" list where the container "state" exists is mapped to one EntStateEntry.

The following table lists the YANG data nodes with corresponding objects in the ENTITY-STATE-MIB.

YANG data node in /hardware/component/state	ENTITY-STATE-MIB object
state-last-changed	entStateLastChanged
admin-state	entStateAdmin
oper-state	entStateOper
usage-state	entStateUsage
alarm-state	entStateAlarm
standby-state	entStateStandby

YANG Data Nodes and Related ENTITY-SENSOR-MIB Objects

7. Hardware YANG Modules

7.1. "ietf-hardware" Module

This YANG module imports typedefs from [RFC6991].

```
<CODE BEGINS> file "ietf-hardware@2018-03-13.yang"
```

```
module ietf-hardware {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-hardware";
  prefix hw;

  import ietf-inet-types {
    prefix inet;
  }
  import ietf-yang-types {
    prefix yang;
  }
  import iana-hardware {
    prefix ianahw;
  }

  organization
    "IETF NETMOD (Network Modeling) Working Group";

  contact
    "WG Web: <https://datatracker.ietf.org/wg/netmod/>
    WG List: <mailto:netmod@ietf.org>

    Editor: Andy Bierman
            <mailto:andy@yumaworks.com>

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            <mailto:mbj@tail-f.com>

    Editor: Jie Dong
            <mailto:jie.dong@huawei.com>

    Editor: Dan Romascanu
            <mailto:dromasca@gmail.com>";

  description
    "This module contains a collection of YANG definitions for
    managing hardware.

    This data model is designed for the Network Management Datastore
    Architecture (NMDA) defined in RFC 8342.
```

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This version of this YANG module is part of RFC 8348; see the RFC itself for full legal notices."

```
revision 2018-03-13 {
  description
    "Initial revision.";
  reference
    "RFC 8348: A YANG Data Model for Hardware Management";
}

/*
 * Features
 */

feature entity-mib {
  description
    "This feature indicates that the device implements
    the ENTITY-MIB.";
  reference
    "RFC 6933: Entity MIB (Version 4)";
}

feature hardware-state {
  description
    "Indicates that ENTITY-STATE-MIB objects are supported";
  reference
    "RFC 4268: Entity State MIB";
}

feature hardware-sensor {
  description
    "Indicates that ENTITY-SENSOR-MIB objects are supported";
  reference
    "RFC 3433: Entity Sensor Management Information Base";
}

/*
 * Typedefs
```

```
*/

typedef admin-state {
  type enumeration {
    enum unknown {
      value 1;
      description
        "The resource is unable to report administrative state.";
    }
    enum locked {
      value 2;
      description
        "The resource is administratively prohibited from use.";
    }
    enum shutting-down {
      value 3;
      description
        "The resource usage is administratively limited to current
        instances of use.";
    }
    enum unlocked {
      value 4;
      description
        "The resource is not administratively prohibited from
        use.";
    }
  }
  description
    "Represents the various possible administrative states.";
  reference
    "RFC 4268: Entity State MIB - EntityAdminState";
}

typedef oper-state {
  type enumeration {
    enum unknown {
      value 1;
      description
        "The resource is unable to report its operational state.";
    }
    enum disabled {
      value 2;
      description
        "The resource is totally inoperable.";
    }
    enum enabled {
      value 3;
    }
  }
}
```

```

        description
            "The resource is partially or fully operable.";
    }
    enum testing {
        value 4;
        description
            "The resource is currently being tested and cannot
            therefore report whether or not it is operational.";
    }
}
description
    "Represents the possible values of operational states.";
reference
    "RFC 4268: Entity State MIB - EntityOperState";
}

typedef usage-state {
    type enumeration {
        enum unknown {
            value 1;
            description
                "The resource is unable to report usage state.";
        }
        enum idle {
            value 2;
            description
                "The resource is servicing no users.";
        }
        enum active {
            value 3;
            description
                "The resource is currently in use, and it has sufficient
                spare capacity to provide for additional users.";
        }
        enum busy {
            value 4;
            description
                "The resource is currently in use, but it currently has no
                spare capacity to provide for additional users.";
        }
    }
}
description
    "Represents the possible values of usage states.";
reference
    "RFC 4268: Entity State MIB - EntityUsageState";
}

typedef alarm-state {

```

```
type bits {
  bit unknown {
    position 0;
    description
      "The resource is unable to report alarm state.";
  }
  bit under-repair {
    position 1;
    description
      "The resource is currently being repaired, which, depending
       on the implementation, may make the other values in this
       bit string not meaningful.";
  }
  bit critical {
    position 2;
    description
      "One or more critical alarms are active against the
       resource.";
  }
  bit major {
    position 3;
    description
      "One or more major alarms are active against the
       resource.";
  }
  bit minor {
    position 4;
    description
      "One or more minor alarms are active against the
       resource.";
  }
  bit warning {
    position 5;
    description
      "One or more warning alarms are active against the
       resource.";
  }
  bit indeterminate {
    position 6;
    description
      "One or more alarms of whose perceived severity cannot be
       determined are active against this resource.";
  }
}
description
  "Represents the possible values of alarm states. An alarm is a
   persistent indication of an error or warning condition."
```

```
    When no bits of this attribute are set, then no active alarms
    are known against this component and it is not under repair.";
reference
  "RFC 4268: Entity State MIB - EntityAlarmStatus";
}

typedef standby-state {
  type enumeration {
    enum unknown {
      value 1;
      description
        "The resource is unable to report standby state.";
    }
    enum hot-standby {
      value 2;
      description
        "The resource is not providing service, but it will be
        immediately able to take over the role of the resource to
        be backed up, without the need for initialization
        activity, and will contain the same information as the
        resource to be backed up.";
    }
    enum cold-standby {
      value 3;
      description
        "The resource is to back up another resource, but it will
        not be immediately able to take over the role of a
        resource to be backed up and will require some
        initialization activity.";
    }
    enum providing-service {
      value 4;
      description
        "The resource is providing service.";
    }
  }
  description
    "Represents the possible values of standby states.";
reference
  "RFC 4268: Entity State MIB - EntityStandbyStatus";
}

typedef sensor-value-type {
  type enumeration {
    enum other {
      value 1;
      description
        "A measure other than those listed below.";
    }
  }
}
```

```
    }
    enum unknown {
      value 2;
      description
        "An unknown measurement or arbitrary, relative numbers";
    }
    enum volts-AC {
      value 3;
      description
        "A measure of electric potential (alternating current).";
    }
    enum volts-DC {
      value 4;
      description
        "A measure of electric potential (direct current).";
    }
    enum amperes {
      value 5;
      description
        "A measure of electric current.";
    }
    enum watts {
      value 6;
      description
        "A measure of power.";
    }
    enum hertz {
      value 7;
      description
        "A measure of frequency.";
    }
    enum celsius {
      value 8;
      description
        "A measure of temperature.";
    }
    enum percent-RH {
      value 9;
      description
        "A measure of percent relative humidity.";
    }
    enum rpm {
      value 10;
      description
        "A measure of shaft revolutions per minute.";
    }
    enum cmm {
      value 11;
```

```

    description
      "A measure of cubic meters per minute (airflow).";
  }
  enum truth-value {
    value 12;
    description
      "Value is one of 1 (true) or 2 (false)";
  }
}
description
  "A node using this data type represents the sensor measurement
  data type associated with a physical sensor value. The actual
  data units are determined by examining a node of this type
  together with the associated sensor-value-scale node.

  A node of this type SHOULD be defined together with nodes of
  type sensor-value-scale and type sensor-value-precision.
  These three types are used to identify the semantics of a node
  of type sensor-value.";
reference
  "RFC 3433: Entity Sensor Management Information Base -
  EntitySensorDataType";
}

typedef sensor-value-scale {
  type enumeration {
    enum yocto {
      value 1;
      description
        "Data scaling factor of 10^-24.";
    }
    enum zepto {
      value 2;
      description
        "Data scaling factor of 10^-21.";
    }
    enum atto {
      value 3;
      description
        "Data scaling factor of 10^-18.";
    }
    enum femto {
      value 4;
      description
        "Data scaling factor of 10^-15.";
    }
    enum pico {
      value 5;

```



```
    description
      "Data scaling factor of 10^-12.";
  }
  enum nano {
    value 6;
    description
      "Data scaling factor of 10^-9.";
  }
  enum micro {
    value 7;
    description
      "Data scaling factor of 10^-6.";
  }
  enum milli {
    value 8;
    description
      "Data scaling factor of 10^-3.";
  }
  enum units {
    value 9;
    description
      "Data scaling factor of 10^0.";
  }
  enum kilo {
    value 10;
    description
      "Data scaling factor of 10^3.";
  }
  enum mega {
    value 11;
    description
      "Data scaling factor of 10^6.";
  }
  enum giga {
    value 12;
    description
      "Data scaling factor of 10^9.";
  }
  enum tera {
    value 13;
    description
      "Data scaling factor of 10^12.";
  }
  enum peta {
    value 14;
    description
      "Data scaling factor of 10^15.";
  }
}
```

```

enum exa {
  value 15;
  description
    "Data scaling factor of 10^18.";
}
enum zetta {
  value 16;
  description
    "Data scaling factor of 10^21.";
}
enum yotta {
  value 17;
  description
    "Data scaling factor of 10^24.";
}
}
description
  "A node using this data type represents a data scaling factor,
  represented with an International System of Units (SI) prefix.
  The actual data units are determined by examining a node of
  this type together with the associated sensor-value-type.

  A node of this type SHOULD be defined together with nodes of
  type sensor-value-type and type sensor-value-precision.
  Together, associated nodes of these three types are used to
  identify the semantics of a node of type sensor-value.";
reference
  "RFC 3433: Entity Sensor Management Information Base -
  EntitySensorDataScale";
}

typedef sensor-value-precision {
  type int8 {
    range "-8 .. 9";
  }
}
description
  "A node using this data type represents a sensor value
  precision range.

  A node of this type SHOULD be defined together with nodes of
  type sensor-value-type and type sensor-value-scale. Together,
  associated nodes of these three types are used to identify the
  semantics of a node of type sensor-value.

  If a node of this type contains a value in the range 1 to 9,
  it represents the number of decimal places in the fractional
  part of an associated sensor-value fixed-point number."

```

If a node of this type contains a value in the range -8 to -1, it represents the number of accurate digits in the associated sensor-value fixed-point number.

The value zero indicates the associated sensor-value node is not a fixed-point number.

Server implementers must choose a value for the associated sensor-value-precision node so that the precision and accuracy of the associated sensor-value node is correctly indicated.

For example, a component representing a temperature sensor that can measure 0 to 100 degrees C in 0.1 degree increments, +/- 0.05 degrees, would have a sensor-value-precision value of '1', a sensor-value-scale value of 'units', and a sensor-value ranging from '0' to '1000'. The sensor-value would be interpreted as 'degrees C * 10'."

reference

"RFC 3433: Entity Sensor Management Information Base - EntitySensorPrecision";

}

```
typedef sensor-value {
  type int32 {
    range "-1000000000 .. 1000000000";
  }
}
```

description

"A node using this data type represents a sensor value.

A node of this type SHOULD be defined together with nodes of type sensor-value-type, type sensor-value-scale, and type sensor-value-precision. Together, associated nodes of those three types are used to identify the semantics of a node of this data type.

The semantics of a node using this data type are determined by the value of the associated sensor-value-type node.

If the associated sensor-value-type node is equal to 'voltsAC', 'voltsDC', 'amperes', 'watts', 'hertz', 'celsius', or 'cmm', then a node of this type MUST contain a fixed-point number ranging from -999,999,999 to +999,999,999. The value -1000000000 indicates an underflow error. The value +1000000000 indicates an overflow error. The sensor-value-precision indicates how many fractional digits are represented in the associated sensor-value node.

If the associated sensor-value-type node is equal to 'percentRH', then a node of this type MUST contain a number ranging from 0 to 100.

If the associated sensor-value-type node is equal to 'rpm', then a node of this type MUST contain a number ranging from -999,999,999 to +999,999,999.

If the associated sensor-value-type node is equal to 'truth-value', then a node of this type MUST contain either the value 1 (true) or the value 2 (false).

If the associated sensor-value-type node is equal to 'other' or 'unknown', then a node of this type MUST contain a number ranging from -1000000000 to 1000000000.";

reference

"RFC 3433: Entity Sensor Management Information Base - EntitySensorValue";

}

```
typedef sensor-status {
  type enumeration {
    enum ok {
      value 1;
      description
        "Indicates that the server can obtain the sensor value.";
    }
    enum unavailable {
      value 2;
      description
        "Indicates that the server presently cannot obtain the
        sensor value.";
    }
    enum nonoperational {
      value 3;
      description
        "Indicates that the server believes the sensor is broken.
        The sensor could have a hard failure (disconnected wire)
        or a soft failure such as out-of-range, jittery, or wildly
        fluctuating readings.";
    }
  }
  description
    "A node using this data type represents the operational status
    of a physical sensor.";
  reference
    "RFC 3433: Entity Sensor Management Information Base -
    EntitySensorStatus";
}
```

```
}

/*
 * Data nodes
 */

container hardware {
  description
    "Data nodes representing components.

    If the server supports configuration of hardware components,
    then this data model is instantiated in the configuration
    datastores supported by the server. The leaf-list 'datastore'
    for the module 'ietf-hardware' in the YANG library provides
    this information.";

  leaf last-change {
    type yang:date-and-time;
    config false;
    description
      "The time the '/hardware/component' list changed in the
      operational state.";
  }

  list component {
    key name;
    description
      "List of components.

      When the server detects a new hardware component, it
      initializes a list entry in the operational state.

      If the server does not support configuration of hardware
      components, list entries in the operational state are
      initialized with values for all nodes as detected by the
      implementation.

      Otherwise, this procedure is followed:

      1. If there is an entry in the '/hardware/component' list
      in the intended configuration with values for the nodes
      'class', 'parent', and 'parent-rel-pos' that are equal
      to the detected values, then the list entry in the
      operational state is initialized with the configured
      values, including the 'name'.
```

2. Otherwise (i.e., there is no matching configuration entry), the list entry in the operational state is initialized with values for all nodes as detected by the implementation.

If the '/hardware/component' list in the intended configuration is modified, then the system MUST behave as if it re-initializes itself and follow the procedure in (1).";
reference

"RFC 6933: Entity MIB (Version 4) - entPhysicalEntry";

```
leaf name {
  type string;
  description
    "The name assigned to this component.

    This name is not required to be the same as
    entPhysicalName.";
}
```

```
leaf class {
  type identityref {
    base ianahw:hardware-class;
  }
  mandatory true;
  description
    "An indication of the general hardware type of the
    component.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalClass";
}
```

```
leaf physical-index {
  if-feature entity-mib;
  type int32 {
    range "1..2147483647";
  }
  config false;
  description
    "The entPhysicalIndex for the entPhysicalEntry represented
    by this list entry.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalIndex";
}
```

```
leaf description {
  type string;
  config false;
}
```

```
description
  "A textual description of the component. This node should
  contain a string that identifies the manufacturer's name
  for the component and should be set to a distinct value
  for each version or model of the component.";
reference
  "RFC 6933: Entity MIB (Version 4) - entPhysicalDescr";
}

leaf parent {
  type leafref {
    path "../..../component/name";
    require-instance false;
  }
  description
    "The name of the component that physically contains this
    component.

    If this leaf is not instantiated, it indicates that this
    component is not contained in any other component.

    In the event that a physical component is contained by
    more than one physical component (e.g., double-wide
    modules), this node contains the name of one of these
    components. An implementation MUST use the same name
    every time this node is instantiated.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalContainedIn";
}

leaf parent-rel-pos {
  type int32 {
    range "0 .. 2147483647";
  }
  description
    "An indication of the relative position of this child
    component among all its sibling components. Sibling
    components are defined as components that:

    o share the same value of the 'parent' node and

    o share a common base identity for the 'class' node.

    Note that the last rule gives implementations flexibility
    in how components are numbered. For example, some
    implementations might have a single number series for all
    components derived from 'ianahw:port', while some others
    might have different number series for different
```

```
components with identities derived from 'ianahw:port' (for
example, one for registered jack 45 (RJ45) and one for
small form-factor pluggable (SFP)).";

reference
  "RFC 6933: Entity MIB (Version 4) -
  entPhysicalParentRelPos";
}

leaf-list contains-child {
  type leafref {
    path "../..../component/name";
  }
  config false;
  description
    "The name of the contained component.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalChildIndex";
}

leaf hardware-rev {
  type string;
  config false;
  description
    "The vendor-specific hardware revision string for the
    component. The preferred value is the hardware revision
    identifier actually printed on the component itself (if
    present).";
  reference
    "RFC 6933: Entity MIB (Version 4) -
    entPhysicalHardwareRev";
}

leaf firmware-rev {
  type string;
  config false;
  description
    "The vendor-specific firmware revision string for the
    component.";
  reference
    "RFC 6933: Entity MIB (Version 4) -
    entPhysicalFirmwareRev";
}

leaf software-rev {
  type string;
  config false;
```



```
description
  "The vendor-specific software revision string for the
  component.";
reference
  "RFC 6933: Entity MIB (Version 4) -
  entPhysicalSoftwareRev";
}

leaf serial-num {
  type string;
  config false;
  description
    "The vendor-specific serial number string for the
    component. The preferred value is the serial number
    string actually printed on the component itself (if
    present).";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalSerialNum";
}

leaf mfg-name {
  type string;
  config false;
  description
    "The name of the manufacturer of this physical component.
    The preferred value is the manufacturer name string
    actually printed on the component itself (if present).

    Note that comparisons between instances of the
    'model-name', 'firmware-rev', 'software-rev', and
    'serial-num' nodes are only meaningful amongst components
    with the same value of 'mfg-name'.

    If the manufacturer name string associated with the
    physical component is unknown to the server, then this
    node is not instantiated.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalMfgName";
}

leaf model-name {
  type string;
  config false;
  description
    "The vendor-specific model name identifier string
    associated with this physical component. The preferred
    value is the customer-visible part number, which may be
    printed on the component itself.
```

```
    If the model name string associated with the physical
    component is unknown to the server, then this node is not
    instantiated.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalModelName";
}

leaf alias {
  type string;
  description
    "An 'alias' name for the component, as specified by a
    network manager, that provides a non-volatile 'handle' for
    the component.

    If no configured value exists, the server MAY set the
    value of this node to a locally unique value in the
    operational state.

    A server implementation MAY map this leaf to the
    entPhysicalAlias MIB object. Such an implementation needs
    to use some mechanism to handle the differences in size
    and characters allowed between this leaf and
    entPhysicalAlias. The definition of such a mechanism is
    outside the scope of this document.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalAlias";
}

leaf asset-id {
  type string;
  description
    "This node is a user-assigned asset tracking identifier for
    the component.

    A server implementation MAY map this leaf to the
    entPhysicalAssetID MIB object. Such an implementation
    needs to use some mechanism to handle the differences in
    size and characters allowed between this leaf and
    entPhysicalAssetID. The definition of such a mechanism is
    outside the scope of this document.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalAssetID";
}

leaf is-fru {
  type boolean;
  config false;
}
```

```
description
  "This node indicates whether or not this component is
  considered a 'field-replaceable unit' by the vendor.  If
  this node contains the value 'true', then this component
  identifies a field-replaceable unit.  For all components
  that are permanently contained within a field-replaceable
  unit, the value 'false' should be returned for this
  node.";
reference
  "RFC 6933: Entity MIB (Version 4) - entPhysicalIsFRU";
}

leaf mfg-date {
  type yang:date-and-time;
  config false;
  description
    "The date of manufacturing of the managed component.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalMfgDate";
}

leaf-list uri {
  type inet:uri;
  description
    "This node contains identification information about the
    component.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalUris";
}

leaf uuid {
  type yang:uuid;
  config false;
  description
    "A Universally Unique Identifier of the component.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalUUID";
}

container state {
  if-feature hardware-state;
  description
    "State-related nodes";
  reference
    "RFC 4268: Entity State MIB";

  leaf state-last-changed {
    type yang:date-and-time;
```

```
config false;
description
  "The date and time when the value of any of the
  admin-state, oper-state, usage-state, alarm-state, or
  standby-state changed for this component.

  If there has been no change since the last
  re-initialization of the local system, this node
  contains the date and time of local system
  initialization.  If there has been no change since the
  component was added to the local system, this node
  contains the date and time of the insertion.";
reference
  "RFC 4268: Entity State MIB - entStateLastChanged";
}

leaf admin-state {
  type admin-state;
  description
    "The administrative state for this component.

    This node refers to a component's administrative
    permission to service both other components within its
    containment hierarchy as well other users of its
    services defined by means outside the scope of this
    module.

    Some components exhibit only a subset of the remaining
    administrative state values.  Some components cannot be
    locked; hence, this node exhibits only the 'unlocked'
    state.  Other components cannot be shut down gracefully;
    hence, this node does not exhibit the 'shutting-down'
    state.";
  reference
    "RFC 4268: Entity State MIB - entStateAdmin";
}

leaf oper-state {
  type oper-state;
  config false;
  description
    "The operational state for this component.

    Note that this node does not follow the administrative
    state.  An administrative state of 'down' does not
    predict an operational state of 'disabled'.
```

Note that some implementations may not be able to accurately report oper-state while the admin-state node has a value other than 'unlocked'. In these cases, this node MUST have a value of 'unknown'.
";

```
reference
  "RFC 4268: Entity State MIB - entStateOper";
}

leaf usage-state {
  type usage-state;
  config false;
  description
    "The usage state for this component.

    This node refers to a component's ability to service
    more components in a containment hierarchy.

    Some components will exhibit only a subset of the usage
    state values. Components that are unable to ever
    service any components within a containment hierarchy
    will always have a usage state of 'busy'. In some
    cases, a component will be able to support only one
    other component within its containment hierarchy and
    will therefore only exhibit values of 'idle' and
    'busy'.  
";
  reference
    "RFC 4268: Entity State MIB - entStateUsage";
}

leaf alarm-state {
  type alarm-state;
  config false;
  description
    "The alarm state for this component. It does not
    include the alarms raised on child components within its
    containment hierarchy.  
";
  reference
    "RFC 4268: Entity State MIB - entStateAlarm";
}

leaf standby-state {
  type standby-state;
  config false;
  description
    "The standby state for this component.
```

```

        Some components will exhibit only a subset of the
        remaining standby state values.  If this component
        cannot operate in a standby role, the value of this node
        will always be 'providing-service'.";
    reference
        "RFC 4268: Entity State MIB - entStateStandby";
}
}

container sensor-data {
    when 'derived-from-or-self(..../class,
        "ianahw:sensor")' {
        description
            "Sensor data nodes present for any component of type
            'sensor'";
    }
    if-feature hardware-sensor;
    config false;

    description
        "Sensor-related nodes.";
    reference
        "RFC 3433: Entity Sensor Management Information Base";

    leaf value {
        type sensor-value;
        description
            "The most recent measurement obtained by the server
            for this sensor.

            A client that periodically fetches this node should also
            fetch the nodes 'value-type', 'value-scale', and
            'value-precision', since they may change when the value
            is changed.";
        reference
            "RFC 3433: Entity Sensor Management Information Base -
            entPhySensorValue";
    }

    leaf value-type {
        type sensor-value-type;
        description
            "The type of data units associated with the
            sensor value";
        reference
            "RFC 3433: Entity Sensor Management Information Base -
            entPhySensorType";
    }
}

```

```
leaf value-scale {
  type sensor-value-scale;
  description
    "The (power of 10) scaling factor associated
    with the sensor value";
  reference
    "RFC 3433: Entity Sensor Management Information Base -
    entPhySensorScale";
}

leaf value-precision {
  type sensor-value-precision;
  description
    "The number of decimal places of precision
    associated with the sensor value";
  reference
    "RFC 3433: Entity Sensor Management Information Base -
    entPhySensorPrecision";
}

leaf oper-status {
  type sensor-status;
  description
    "The operational status of the sensor.";
  reference
    "RFC 3433: Entity Sensor Management Information Base -
    entPhySensorOperStatus";
}

leaf units-display {
  type string;
  description
    "A textual description of the data units that should be
    used in the display of the sensor value.";
  reference
    "RFC 3433: Entity Sensor Management Information Base -
    entPhySensorUnitsDisplay";
}

leaf value-timestamp {
  type yang:date-and-time;
  description
    "The time the status and/or value of this sensor was last
    obtained by the server.";
  reference
    "RFC 3433: Entity Sensor Management Information Base -
    entPhySensorValueTimeStamp";
}
```

```

leaf value-update-rate {
  type uint32;
  units "milliseconds";
  description
    "An indication of the frequency that the server updates
    the associated 'value' node, represented in
    milliseconds. The value zero indicates:

    - the sensor value is updated on demand (e.g.,
      when polled by the server for a get-request),

    - the sensor value is updated when the sensor
      value changes (event-driven), or

    - the server does not know the update rate.";
  reference
    "RFC 3433: Entity Sensor Management Information Base -
    entPhySensorValueUpdateRate";
}
}
}
}
}
/*
 * Notifications
 */

notification hardware-state-change {
  description
    "A hardware-state-change notification is generated when the
    value of /hardware/last-change changes in the operational
    state.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entConfigChange";
}

notification hardware-state-oper-enabled {
  if-feature hardware-state;
  description
    "A hardware-state-oper-enabled notification signifies that a
    component has transitioned into the 'enabled' state.";

  leaf name {
    type leafref {
      path "/hardware/component/name";
    }
  }
}

```



```
    description
      "The name of the component that has transitioned into the
       'enabled' state.";
  }
  leaf admin-state {
    type leafref {
      path "/hardware/component/state/admin-state";
    }
    description
      "The administrative state for the component.";
  }
  leaf alarm-state {
    type leafref {
      path "/hardware/component/state/alarm-state";
    }
    description
      "The alarm state for the component.";
  }
  reference
    "RFC 4268: Entity State MIB - entStateOperEnabled";
}

notification hardware-state-oper-disabled {
  if-feature hardware-state;
  description
    "A hardware-state-oper-disabled notification signifies that a
     component has transitioned into the 'disabled' state.";

  leaf name {
    type leafref {
      path "/hardware/component/name";
    }
    description
      "The name of the component that has transitioned into the
       'disabled' state.";
  }
  leaf admin-state {
    type leafref {
      path "/hardware/component/state/admin-state";
    }
    description
      "The administrative state for the component.";
  }
  leaf alarm-state {
    type leafref {
      path "/hardware/component/state/alarm-state";
    }
  }
}
```

```

    description
      "The alarm state for the component.";
  }
  reference
    "RFC 4268: Entity State MIB - entStateOperDisabled";
}
}
<CODE ENDS>

```

7.2. "iana-hardware" Module

```
<CODE BEGINS> file "iana-hardware@2018-03-13.yang"
```

```

module iana-hardware {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:iana-hardware";
  prefix ianahw;

```

```

  organization "IANA";
  contact
    "      Internet Assigned Numbers Authority

    Postal: ICANN
           12025 Waterfront Drive, Suite 300
           Los Angeles, CA 90094-2536
           United States of America

    Tel:    +1 310 301 5800
    E-Mail: iana@iana.org>";

```

```

description
  "IANA-defined identities for hardware class.

```

The latest revision of this YANG module can be obtained from the IANA website.

Requests for new values should be made to IANA via email (iana@iana.org).

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set forth in Section 4.c of the IETF Trust's Legal Provisions
Relating to IETF Documents
(<https://trustee.ietf.org/license-info>).

The initial version of this YANG module is part of RFC 8348;
see the RFC itself for full legal notices.";

reference

"<https://www.iana.org/assignments/yang-parameters>";

revision 2018-03-13 {

description

"Initial revision.";

reference

"RFC 8348: A YANG Data Model for Hardware Management";

}

/*

* Identities

*/

identity hardware-class {

description

"This identity is the base for all hardware class
identifiers.";

}

identity unknown {

base ianahw:hardware-class;

description

"This identity is applicable if the hardware class is unknown
to the server.";

}

identity chassis {

base ianahw:hardware-class;

description

"This identity is applicable if the hardware class is an
overall container for networking equipment. Any class of
physical component, except a stack, may be contained within a
chassis; a chassis may only be contained within a stack.";

}

identity backplane {

base ianahw:hardware-class;

description

"This identity is applicable if the hardware class is some sort
of device for aggregating and forwarding networking traffic,
such as a shared backplane in a modular ethernet switch. Note

```
        that an implementation may model a backplane as a single
        physical component, which is actually implemented as multiple
        discrete physical components (within a chassis or stack).";
    }

identity container {
    base ianahw:hardware-class;
    description
        "This identity is applicable if the hardware class is capable
        of containing one or more removable physical entities,
        possibly of different types.  For example, each (empty or
        full) slot in a chassis will be modeled as a container.  Note
        that all removable physical components should be modeled
        within a container component, such as field-replaceable
        modules, fans, or power supplies.  Note that all known
        containers should be modeled by the agent, including empty
        containers.";
}

identity power-supply {
    base ianahw:hardware-class;
    description
        "This identity is applicable if the hardware class is a
        power-supplying component.";
}

identity fan {
    base ianahw:hardware-class;
    description
        "This identity is applicable if the hardware class is a fan or
        other heat-reduction component.";
}

identity sensor {
    base ianahw:hardware-class;
    description
        "This identity is applicable if the hardware class is some sort
        of sensor, such as a temperature sensor within a router
        chassis.";
}

identity module {
    base ianahw:hardware-class;
    description
        "This identity is applicable if the hardware class is some sort
        of self-contained sub-system.  If a module component is
        removable, then it should be modeled within a container
```

```
    component; otherwise, it should be modeled directly within
    another physical component (e.g., a chassis or another
    module).";
}

identity port {
  base ianahw:hardware-class;
  description
    "This identity is applicable if the hardware class is some sort
    of networking port capable of receiving and/or transmitting
    networking traffic.";
}

identity stack {
  base ianahw:hardware-class;
  description
    "This identity is applicable if the hardware class is some sort
    of super-container (possibly virtual) intended to group
    together multiple chassis entities. A stack may be realized
    by a virtual cable, a real interconnect cable attached to
    multiple chassis, or multiple interconnect cables. A stack
    should not be modeled within any other physical components,
    but a stack may be contained within another stack. Only
    chassis components should be contained within a stack.";
}

identity cpu {
  base ianahw:hardware-class;
  description
    "This identity is applicable if the hardware class is some sort
    of central processing unit.";
}

identity energy-object {
  base ianahw:hardware-class;
  description
    "This identity is applicable if the hardware class is some sort
    of energy object, i.e., it is a piece of equipment that is
    part of or attached to a communications network that is
    monitored, it is controlled, or it aids in the management of
    another device for Energy Management.";
}

identity battery {
  base ianahw:hardware-class;
  description
    "This identity is applicable if the hardware class is some sort
    of battery.";
```

```

}

identity storage-drive {
  base ianahw:hardware-class;
  description
    "This identity is applicable if the hardware class is some sort
    of component with data storage capability as its main
    functionality, e.g., hard disk drive (HDD), solid-state device
    (SSD), solid-state hybrid drive (SSHHD), object storage device
    (OSD), or other.";
}
}

<CODE ENDS>

```

8. IANA Considerations

This document defines the initial version of the IANA-maintained "iana-hardware" YANG module.

The "iana-hardware" YANG module is intended to reflect the "IANA-ENTITY-MIB" MIB module so that if a new enumeration is added to the "IANAPhysicalClass" textual convention, the same class is added as an identity derived from "ianahw:hardware-class".

When the "iana-hardware" YANG module is updated, a new "revision" statement must be added in front of the existing revision statements.

8.1. URI Registrations

This document registers three URIs in the "IETF XML Registry" [RFC3688]. Per the format in RFC 3688, the following registrations have been made.

```

URI: urn:ietf:params:xml:ns:yang:iana-hardware
Registrant Contact: The IESG.
XML: N/A, the requested URI is an XML namespace.

```

```

URI: urn:ietf:params:xml:ns:yang:ietf-hardware
Registrant Contact: The IESG.
XML: N/A, the requested URI is an XML namespace.

```

```

URI: urn:ietf:params:xml:ns:yang:ietf-hardware-state
Registrant Contact: The IESG.
XML: N/A, the requested URI is an XML namespace.

```

8.2. YANG Module Registrations

This document registers three YANG modules in the "YANG Module Names" registry [RFC6020].

```
name:          iana-hardware
namespace:    urn:ietf:params:xml:ns:yang:iana-hardware
prefix:       ianahw
reference:    RFC 8348
```

```
name:          ietf-hardware
namespace:    urn:ietf:params:xml:ns:yang:ietf-hardware
prefix:       hw
reference:    RFC 8348
```

```
name:          ietf-hardware-state
namespace:    urn:ietf:params:xml:ns:yang:ietf-hardware-state
prefix:       hw-state
reference:    RFC 8348
```

9. Security Considerations

The YANG modules specified in this document define a schema for data that is designed to be accessed via network management protocols such as NETCONF [RFC6241] or RESTCONF [RFC8040]. The lowest NETCONF layer is the secure transport layer, and the mandatory-to-implement secure transport is Secure Shell (SSH) [RFC6242]. The lowest RESTCONF layer is HTTPS, and the mandatory-to-implement secure transport is TLS [RFC5246].

The NETCONF access control model [RFC8341] provides the means to restrict access for particular NETCONF or RESTCONF users to a preconfigured subset of all available NETCONF or RESTCONF protocol operations and content.

There are a number of data nodes defined in the YANG module "ietf-hardware" that are writable/creatable/deletable (i.e., config true, which is the default). These data nodes may be considered sensitive or vulnerable in some network environments. Write operations (e.g., edit-config) to these data nodes without proper protection can have a negative effect on network operations. These are the subtrees and data nodes and their sensitivity/vulnerability:

```
/hardware/component/admin-state: Setting this node to 'locked' or
'shutting-down' can cause disruption of services ranging from
those running on a port to those on an entire device, depending on
the type of component.
```

Some of the readable data nodes in these YANG modules may be considered sensitive or vulnerable in some network environments. It is thus important to control read access (e.g., via `get`, `get-config`, or `notification`) to these data nodes. These are the subtrees and data nodes and their sensitivity/vulnerability:

`/hardware/component`: The leafs in this list expose information about the physical components in a device, which may be used to identify the vendor, model, version, and specific device-identification information of each system component.

`/hardware/component/sensor-data/value`: This node may expose the values of particular physical sensors in a device.

`/hardware/component/state`: Access to this node allows one to figure out what the active and standby resources in a device are.

10. References

10.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <<https://www.rfc-editor.org/info/rfc2119>>.
- [RFC3433] Bierman, A., Romascanu, D., and K. Norseth, "Entity Sensor Management Information Base", RFC 3433, DOI 10.17487/RFC3433, December 2002, <<https://www.rfc-editor.org/info/rfc3433>>.
- [RFC3688] Mealling, M., "The IETF XML Registry", BCP 81, RFC 3688, DOI 10.17487/RFC3688, January 2004, <<https://www.rfc-editor.org/info/rfc3688>>.
- [RFC4268] Chisholm, S. and D. Perkins, "Entity State MIB", RFC 4268, DOI 10.17487/RFC4268, November 2005, <<https://www.rfc-editor.org/info/rfc4268>>.
- [RFC5246] Dierks, T. and E. Rescorla, "The Transport Layer Security (TLS) Protocol Version 1.2", RFC 5246, DOI 10.17487/RFC5246, August 2008, <<https://www.rfc-editor.org/info/rfc5246>>.
- [RFC6020] Bjorklund, M., Ed., "YANG - A Data Modeling Language for the Network Configuration Protocol (NETCONF)", RFC 6020, DOI 10.17487/RFC6020, October 2010, <<https://www.rfc-editor.org/info/rfc6020>>.

- [RFC6241] Enns, R., Ed., Bjorklund, M., Ed., Schoenwaelder, J., Ed., and A. Bierman, Ed., "Network Configuration Protocol (NETCONF)", RFC 6241, DOI 10.17487/RFC6241, June 2011, <<https://www.rfc-editor.org/info/rfc6241>>.
- [RFC6242] Wasserman, M., "Using the NETCONF Protocol over Secure Shell (SSH)", RFC 6242, DOI 10.17487/RFC6242, June 2011, <<https://www.rfc-editor.org/info/rfc6242>>.
- [RFC6933] Bierman, A., Romascanu, D., Quittek, J., and M. Chandramouli, "Entity MIB (Version 4)", RFC 6933, DOI 10.17487/RFC6933, May 2013, <<https://www.rfc-editor.org/info/rfc6933>>.
- [RFC6991] Schoenwaelder, J., Ed., "Common YANG Data Types", RFC 6991, DOI 10.17487/RFC6991, July 2013, <<https://www.rfc-editor.org/info/rfc6991>>.
- [RFC7950] Bjorklund, M., Ed., "The YANG 1.1 Data Modeling Language", RFC 7950, DOI 10.17487/RFC7950, August 2016, <<https://www.rfc-editor.org/info/rfc7950>>.
- [RFC8040] Bierman, A., Bjorklund, M., and K. Watsen, "RESTCONF Protocol", RFC 8040, DOI 10.17487/RFC8040, January 2017, <<https://www.rfc-editor.org/info/rfc8040>>.
- [RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <<https://www.rfc-editor.org/info/rfc8174>>.
- [RFC8341] Bierman, A. and M. Bjorklund, "Network Configuration Access Control Model", STD 91, RFC 8341, DOI 10.17487/RFC8341, March 2018, <<https://www.rfc-editor.org/info/rfc8341>>.
- [RFC8342] Bjorklund, M., Schoenwaelder, J., Shafer, P., Watsen, K., and R. Wilton, "Network Management Datastore Architecture (NMDA)", RFC 8342, DOI 10.17487/RFC8342, March 2018, <<https://www.rfc-editor.org/info/rfc8342>>.

10.2. Informative References

- [RFC8340] Bjorklund, M. and L. Berger, Ed., "YANG Tree Diagrams", BCP 215, RFC 8340, DOI 10.17487/RFC8340, March 2018, <<https://www.rfc-editor.org/info/rfc8340>>.

Appendix A. Hardware State Data Model

This non-normative appendix contains a data model designed as a temporary solution for implementations that do not yet support the Network Management Datastore Architecture (NMDA) defined in [RFC8342]. It has the following structure:

```

module: ietf-hardware-state
  x--ro hardware
    x--ro last-change?    yang:date-and-time
    x--ro component* [name]
      x--ro name          string
      x--ro class         identityref
      x--ro physical-index? int32 {entity-mib}?
      x--ro description?  string
      x--ro parent?       -> ../../component/name
      x--ro parent-rel-pos? int32
      x--ro contains-child* -> ../../component/name
      x--ro hardware-rev? string
      x--ro firmware-rev? string
      x--ro software-rev? string
      x--ro serial-num?   string
      x--ro mfg-name?     string
      x--ro model-name?   string
      x--ro alias?        string
      x--ro asset-id?     string
      x--ro is-fru?       boolean
      x--ro mfg-date?     yang:date-and-time
      x--ro uri*          inet:uri
      x--ro uuid?         yang:uuid
      x--ro state {hardware-state}?
        | x--ro state-last-changed? yang:date-and-time
        | x--ro admin-state?        hw:admin-state
        | x--ro oper-state?         hw:oper-state
        | x--ro usage-state?        hw:usage-state
        | x--ro alarm-state?        hw:alarm-state
        | x--ro standby-state?      hw:standby-state
      x--ro sensor-data {hardware-sensor}?
        x--ro value?                hw:sensor-value
        x--ro value-type?           hw:sensor-value-type
        x--ro value-scale?          hw:sensor-value-scale
        x--ro value-precision?      hw:sensor-value-precision
        x--ro oper-status?          hw:sensor-status
        x--ro units-display?        string
        x--ro value-timestamp?      yang:date-and-time
        x--ro value-update-rate?    uint32

```

```

notifications:
  x---n hardware-state-change
  x---n hardware-state-oper-enabled {hardware-state}?
  | x--ro name?          -> /hardware/component/name
  | x--ro admin-state?   -> /hardware/component/state/admin-state
  | x--ro alarm-state?   -> /hardware/component/state/alarm-state
  x---n hardware-state-oper-disabled {hardware-state}?
  x--ro name?           -> /hardware/component/name
  x--ro admin-state?    -> /hardware/component/state/admin-state
  x--ro alarm-state?    -> /hardware/component/state/alarm-state

```

A.1. Hardware State YANG Module

```
<CODE BEGINS> file "ietf-hardware-state@2018-03-13.yang"
```

```

module ietf-hardware-state {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-hardware-state";
  prefix hw-state;

  import ietf-inet-types {
    prefix inet;
  }
  import ietf-yang-types {
    prefix yang;
  }
  import iana-hardware {
    prefix ianahw;
  }
  import ietf-hardware {
    prefix hw;
  }

  organization
    "IETF NETMOD (Network Modeling) Working Group";

  contact
    "WG Web:   <https://datatracker.ietf.org/wg/netmod/>
    WG List:   <mailto:netmod@ietf.org>

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```

Editor: Dan Romascanu
<mailto:dromasca@gmail.com>;

description

"This module contains a collection of YANG definitions for monitoring hardware.

This data model is designed as a temporary solution for implementations that do not yet support the Network Management Datastore Architecture (NMDA) defined in RFC 8342. Such an implementation cannot implement the module 'ietf-hardware' properly, since without NMDA support, it is not possible to distinguish between instances of nodes in the running configuration and operational states.

The data model in this module is the same as the data model in 'ietf-hardware', except all nodes are marked as 'config false'.

If a server that implements this module but doesn't support NMDA also supports configuration of hardware components, it SHOULD also implement the module 'ietf-hardware' in the configuration datastores. The corresponding state data is found in the '/hw-state:hardware' subtree.

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This version of this YANG module is part of RFC 8348; see the RFC itself for full legal notices."

```
revision 2018-03-13 {
  description
    "Initial revision.";
  reference
    "RFC 8348: A YANG Data Model for Hardware Management";
}

/*
 * Features
 */
```

```
feature entity-mib {
  status deprecated;
  description
    "This feature indicates that the device implements
    the ENTITY-MIB.";
  reference
    "RFC 6933: Entity MIB (Version 4)";
}

feature hardware-state {
  status deprecated;
  description
    "Indicates that ENTITY-STATE-MIB objects are supported";
  reference
    "RFC 4268: Entity State MIB";
}

feature hardware-sensor {
  status deprecated;
  description
    "Indicates that ENTITY-SENSOR-MIB objects are supported";
  reference
    "RFC 3433: Entity Sensor Management Information Base";
}

/*
 * Data nodes
 */

container hardware {
  config false;
  status deprecated;
  description
    "Data nodes representing components.";

  leaf last-change {
    type yang:date-and-time;
    status deprecated;
    description
      "The time the '/hardware/component' list changed in the
      operational state.";
  }

  list component {
    key name;
    status deprecated;
    description
      "List of components."
  }
}
```

When the server detects a new hardware component, it initializes a list entry in the operational state.

If the server does not support configuration of hardware components, list entries in the operational state are initialized with values for all nodes as detected by the implementation.

Otherwise, this procedure is followed:

1. If there is an entry in the '/hardware/component' list in the intended configuration with values for the nodes 'class', 'parent', and 'parent-rel-pos' that are equal to the detected values, then:

- 1a. If the configured entry has a value for 'mfg-name' that is equal to the detected value or if the 'mfg-name' value cannot be detected, then the list entry in the operational state is initialized with the configured values for all configured nodes, including the 'name'.

Otherwise, the list entry in the operational state is initialized with values for all nodes as detected by the implementation. The implementation may raise an alarm that informs about the 'mfg-name' mismatch condition. How this is done is outside the scope of this document.

- 1b. Otherwise (i.e., there is no matching configuration entry), the list entry in the operational state is initialized with values for all nodes as detected by the implementation.

If the '/hardware/component' list in the intended configuration is modified, then the system MUST behave as if it re-initializes itself and follow the procedure in (1).";
reference

"RFC 6933: Entity MIB (Version 4) - entPhysicalEntry";

```
leaf name {
  type string;
  status deprecated;
  description
    "The name assigned to this component.
```

This name is not required to be the same as entPhysicalName.";

```
}

leaf class {
  type identityref {
    base ianahw:hardware-class;
  }
  mandatory true;
  status deprecated;
  description
    "An indication of the general hardware type of the
    component.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalClass";
}

leaf physical-index {
  if-feature entity-mib;
  type int32 {
    range "1..2147483647";
  }
  status deprecated;
  description
    "The entPhysicalIndex for the entPhysicalEntry represented
    by this list entry.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalIndex";
}

leaf description {
  type string;
  status deprecated;
  description
    "A textual description of the component. This node should
    contain a string that identifies the manufacturer's name
    for the component and should be set to a distinct value
    for each version or model of the component.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalDescr";
}

leaf parent {
  type leafref {
    path "../../component/name";
    require-instance false;
  }
  status deprecated;
}
```

```

description
  "The name of the component that physically contains this
  component.

  If this leaf is not instantiated, it indicates that this
  component is not contained in any other component.

  In the event that a physical component is contained by
  more than one physical component (e.g., double-wide
  modules), this node contains the name of one of these
  components. An implementation MUST use the same name
  every time this node is instantiated.";
reference
  "RFC 6933: Entity MIB (Version 4) -
  entPhysicalContainedIn";
}

leaf parent-rel-pos {
  type int32 {
    range "0 .. 2147483647";
  }
  status deprecated;
  description
    "An indication of the relative position of this child
    component among all its sibling components. Sibling
    components are defined as components that:

     o share the same value of the 'parent' node and

     o share a common base identity for the 'class' node.

    Note that the last rule gives implementations flexibility
    in how components are numbered. For example, some
    implementations might have a single number series for all
    components derived from 'ianahw:port', while some others
    might have different number series for different
    components with identities derived from 'ianahw:port' (for
    example, one for RJ45 and one for SFP).";

  reference
    "RFC 6933: Entity MIB (Version 4) -
    entPhysicalParentRelPos";
}

leaf-list contains-child {
  type leafref {
    path "../..../component/name";
  }
}

```



```
    status deprecated;
    description
      "The name of the contained component.";
    reference
      "RFC 6933: Entity MIB (Version 4) - entPhysicalChildIndex";
  }

leaf hardware-rev {
  type string;
  status deprecated;
  description
    "The vendor-specific hardware revision string for the
    component. The preferred value is the hardware revision
    identifier actually printed on the component itself (if
    present).";
  reference
    "RFC 6933: Entity MIB (Version 4) -
    entPhysicalHardwareRev";
}

leaf firmware-rev {
  type string;
  status deprecated;
  description
    "The vendor-specific firmware revision string for the
    component.";
  reference
    "RFC 6933: Entity MIB (Version 4) -
    entPhysicalFirmwareRev";
}

leaf software-rev {
  type string;
  status deprecated;
  description
    "The vendor-specific software revision string for the
    component.";
  reference
    "RFC 6933: Entity MIB (Version 4) -
    entPhysicalSoftwareRev";
}

leaf serial-num {
  type string;
  status deprecated;
}
```

```
description
  "The vendor-specific serial number string for the
  component. The preferred value is the serial number
  string actually printed on the component itself (if
  present).";
reference
  "RFC 6933: Entity MIB (Version 4) - entPhysicalSerialNum";
}

leaf mfg-name {
  type string;
  status deprecated;
  description
    "The name of the manufacturer of this physical component.
    The preferred value is the manufacturer name string
    actually printed on the component itself (if present).

    Note that comparisons between instances of the
    'model-name', 'firmware-rev', 'software-rev', and
    'serial-num' nodes are only meaningful amongst components
    with the same value of 'mfg-name'.

    If the manufacturer name string associated with the
    physical component is unknown to the server, then this
    node is not instantiated.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalMfgName";
}

leaf model-name {
  type string;
  status deprecated;
  description
    "The vendor-specific model name identifier string
    associated with this physical component. The preferred
    value is the customer-visible part number, which may be
    printed on the component itself.

    If the model name string associated with the physical
    component is unknown to the server, then this node is not
    instantiated.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalModelName";
}

leaf alias {
  type string;
  status deprecated;
```

```
description
  "An 'alias' name for the component, as specified by a
  network manager, that provides a non-volatile 'handle' for
  the component.

  If no configured value exists, the server MAY set the
  value of this node to a locally unique value in the
  operational state.

  A server implementation MAY map this leaf to the
  entPhysicalAlias MIB object. Such an implementation needs
  to use some mechanism to handle the differences in size
  and characters allowed between this leaf and
  entPhysicalAlias. The definition of such a mechanism is
  outside the scope of this document.";
reference
  "RFC 6933: Entity MIB (Version 4) - entPhysicalAlias";
}

leaf asset-id {
  type string;
  status deprecated;
  description
    "This node is a user-assigned asset tracking identifier for
    the component.

    A server implementation MAY map this leaf to the
    entPhysicalAssetID MIB object. Such an implementation
    needs to use some mechanism to handle the differences in
    size and characters allowed between this leaf and
    entPhysicalAssetID. The definition of such a mechanism is
    outside the scope of this document.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalAssetID";
}

leaf is-fru {
  type boolean;
  status deprecated;
  description
    "This node indicates whether or not this component is
    considered a 'field-replaceable unit' by the vendor. If
    this node contains the value 'true', then this component
    identifies a field-replaceable unit. For all components
    that are permanently contained within a field-replaceable
    unit, the value 'false' should be returned for this
    node.";
```

```
reference
  "RFC 6933: Entity MIB (Version 4) - entPhysicalIsFRU";
}

leaf mfg-date {
  type yang:date-and-time;
  status deprecated;
  description
    "The date of manufacturing of the managed component.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalMfgDate";
}

leaf-list uri {
  type inet:uri;
  status deprecated;
  description
    "This node contains identification information about the
    component.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalUris";
}

leaf uuid {
  type yang:uuid;
  status deprecated;
  description
    "A Universally Unique Identifier of the component.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entPhysicalUUID";
}

container state {
  if-feature hardware-state;
  status deprecated;
  description
    "State-related nodes";
  reference
    "RFC 4268: Entity State MIB";

  leaf state-last-changed {
    type yang:date-and-time;
    status deprecated;
    description
      "The date and time when the value of any of the
      admin-state, oper-state, usage-state, alarm-state, or
      standby-state changed for this component."
  }
}
```

```
    If there has been no change since the last
    re-initialization of the local system, this node
    contains the date and time of local system
    initialization.  If there has been no change since the
    component was added to the local system, this node
    contains the date and time of the insertion.";
  reference
    "RFC 4268: Entity State MIB - entStateLastChanged";
}

leaf admin-state {
  type hw:admin-state;
  status deprecated;
  description
    "The administrative state for this component.

    This node refers to a component's administrative
    permission to service both other components within its
    containment hierarchy as well as other users of its
    services defined by means outside the scope of this
    module.

    Some components exhibit only a subset of the remaining
    administrative state values.  Some components cannot be
    locked; hence, this node exhibits only the 'unlocked'
    state.  Other components cannot be shut down gracefully;
    hence, this node does not exhibit the 'shutting-down'
    state.";
  reference
    "RFC 4268: Entity State MIB - entStateAdmin";
}

leaf oper-state {
  type hw:oper-state;
  status deprecated;
  description
    "The operational state for this component.

    Note that this node does not follow the administrative
    state.  An administrative state of 'down' does not
    predict an operational state of 'disabled'.

    Note that some implementations may not be able to
    accurately report oper-state while the admin-state node
    has a value other than 'unlocked'.  In these cases, this
    node MUST have a value of 'unknown'.";
  reference
    "RFC 4268: Entity State MIB - entStateOper";
```

```
}  
  
leaf usage-state {  
  type hw:usage-state;  
  status deprecated;  
  description  
    "The usage state for this component.  
  
    This node refers to a component's ability to service  
    more components in a containment hierarchy.  
  
    Some components will exhibit only a subset of the usage  
    state values.  Components that are unable to ever  
    service any components within a containment hierarchy  
    will always have a usage state of 'busy'.  In some  
    cases, a component will be able to support only one  
    other component within its containment hierarchy and  
    will therefore only exhibit values of 'idle' and  
    'busy'.";  
  reference  
    "RFC 4268: Entity State MIB - entStateUsage";  
}  
  
leaf alarm-state {  
  type hw:alarm-state;  
  status deprecated;  
  description  
    "The alarm state for this component.  It does not  
    include the alarms raised on child components within its  
    containment hierarchy.";  
  reference  
    "RFC 4268: Entity State MIB - entStateAlarm";  
}  
  
leaf standby-state {  
  type hw:standby-state;  
  status deprecated;  
  description  
    "The standby state for this component.  
  
    Some components will exhibit only a subset of the  
    remaining standby state values.  If this component  
    cannot operate in a standby role, the value of this node  
    will always be 'providing-service'.";  
  reference  
    "RFC 4268: Entity State MIB - entStateStandby";  
}  
}
```

```

container sensor-data {
  when 'derived-from-or-self(..../class,
                                "ianahw:sensor")' {
    description
      "Sensor data nodes present for any component of type
       'sensor'";
  }
  if-feature hardware-sensor;
  status deprecated;

  description
    "Sensor-related nodes.";
  reference
    "RFC 3433: Entity Sensor Management Information Base";

  leaf value {
    type hw:sensor-value;
    status deprecated;
    description
      "The most recent measurement obtained by the server
       for this sensor.

       A client that periodically fetches this node should also
       fetch the nodes 'value-type', 'value-scale', and
       'value-precision', since they may change when the value
       is changed.";
    reference
      "RFC 3433: Entity Sensor Management Information Base -
       entPhySensorValue";
  }

  leaf value-type {
    type hw:sensor-value-type;
    status deprecated;
    description
      "The type of data units associated with the
       sensor value";
    reference
      "RFC 3433: Entity Sensor Management Information Base -
       entPhySensorType";
  }

  leaf value-scale {
    type hw:sensor-value-scale;
    status deprecated;
    description
      "The (power of 10) scaling factor associated
       with the sensor value";
  }

```

```
reference
  "RFC 3433: Entity Sensor Management Information Base -
    entPhySensorScale";
}

leaf value-precision {
  type hw:sensor-value-precision;
  status deprecated;
  description
    "The number of decimal places of precision
     associated with the sensor value";
  reference
    "RFC 3433: Entity Sensor Management Information Base -
      entPhySensorPrecision";
}

leaf oper-status {
  type hw:sensor-status;
  status deprecated;
  description
    "The operational status of the sensor.";
  reference
    "RFC 3433: Entity Sensor Management Information Base -
      entPhySensorOperStatus";
}

leaf units-display {
  type string;
  status deprecated;
  description
    "A textual description of the data units that should be
     used in the display of the sensor value.";
  reference
    "RFC 3433: Entity Sensor Management Information Base -
      entPhySensorUnitsDisplay";
}

leaf value-timestamp {
  type yang:date-and-time;
  status deprecated;
  description
    "The time the status and/or value of this sensor was last
     obtained by the server.";
  reference
    "RFC 3433: Entity Sensor Management Information Base -
      entPhySensorValueTimeStamp";
}
```



```

leaf value-update-rate {
  type uint32;
  units "milliseconds";
  status deprecated;
  description
    "An indication of the frequency that the server updates
    the associated 'value' node, represented in
    milliseconds.  The value zero indicates:

    - the sensor value is updated on demand (e.g.,
      when polled by the server for a get-request),

    - the sensor value is updated when the sensor
      value changes (event-driven), or

    - the server does not know the update rate.";
  reference
    "RFC 3433: Entity Sensor Management Information Base -
    entPhySensorValueUpdateRate";
}
}
}
}
}
/*
 * Notifications
 */

notification hardware-state-change {
  status deprecated;
  description
    "A hardware-state-change notification is generated when the
    value of /hardware/last-change changes in the operational
    state.";
  reference
    "RFC 6933: Entity MIB (Version 4) - entConfigChange";
}

notification hardware-state-oper-enabled {
  if-feature hardware-state;
  status deprecated;
  description
    "A hardware-state-oper-enabled notification signifies that a
    component has transitioned into the 'enabled' state.";

  leaf name {
    type leafref {
      path "/hardware/component/name";
    }
  }
}

```

```

    }
    status deprecated;
    description
      "The name of the component that has transitioned into the
       'enabled' state.";
  }
  leaf admin-state {
    type leafref {
      path "/hardware/component/state/admin-state";
    }
    status deprecated;
    description
      "The administrative state for the component.";
  }
  leaf alarm-state {
    type leafref {
      path "/hardware/component/state/alarm-state";
    }
    status deprecated;
    description
      "The alarm state for the component.";
  }
  reference
    "RFC 4268: Entity State MIB - entStateOperEnabled";
}

notification hardware-state-oper-disabled {
  if-feature hardware-state;
  status deprecated;
  description
    "A hardware-state-oper-disabled notification signifies that a
     component has transitioned into the 'disabled' state.";

  leaf name {
    type leafref {
      path "/hardware/component/name";
    }
    status deprecated;
    description
      "The name of the component that has transitioned into the
       'disabled' state.";
  }
  leaf admin-state {
    type leafref {
      path "/hardware/component/state/admin-state";
    }
    status deprecated;
  }

```

```
    description
      "The administrative state for the component.";
  }
  leaf alarm-state {
    type leafref {
      path "/hardware/component/state/alarm-state";
    }
    status deprecated;
    description
      "The alarm state for the component.";
  }
  reference
    "RFC 4268: Entity State MIB - entStateOperDisabled";
}

}

<CODE ENDS>
```

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