green
Internet-Draft
Intended status: Standards Track
Expires: 3 September 2025

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2 March 2025

A Network Topology Data Model for Energy Efficiency Management
draft-cwbgp-green-topology-energy-management-00

Abstract

This document defines a YANG Network Topology Data Model that can be used for Energy Efficiency Management within a network. The model provides both network-centric view of energy consumption of network devices and device view of energy consumption of individual components within network devices.

Discussion Venues

This note is to be removed before publishing as an RFC.

Discussion of this document takes place on the Network Inventory YANG Working Group mailing list (inventory-yang@ietf.org), which is archived at https://mailarchive.ietf.org/arch/browse/inventory-yang/.

Source for this draft and an issue tracker can be found at https://github.com/boucadair/draft-cwbgp-energy-saving-management.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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This Internet-Draft will expire on 3 September 2025.

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1. Introduction

With the growth of networks and the increase of awareness about the environmental impact, it is important to ensure energy efficiency in the operation of network infrastructures. Operators are thus seeking for more information to reflect the power consumption of a network and the contribution of involved nodes.

However, there are no standard mechanisms to report and control dynamic power usage or energy consumption of different networking equipment under different network configuration and conditions. For example, in a 'Tidal network' in which traffic volume undergoes significant fluctuations at different times, various energy management methods might be envisaged to optimize the energy efficiency at the network scale, e.g., by selectively disabling ports or cards on specific network nodes based on (forecast) traffic patterns.

This document defines YANG modules for use in energy management within a network. The modules cover both network and device levels (Section 3.5.1 of [I-D.ietf-netmod-rfc8407bis]). The modules can be used, e.g., for monitoring the energy consumption of network devices, such as (but are not limited to) routers, switches, security gateways, hosts, or servers. Where applicable, device monitoring extends to the individual components of the device.

The network model augments the "ietf-network" module [RFC8345], with the following rationale:

* Required parameters to monitor, control, and adjust nodes and components behaviors are added to the network topology as this allows operator to better assess the implications on node-specific action on the overall network.

The document leverages types defined in [RFC3418] and [RFC6933].

1.1. Notes to the RFC Editor

Note to the RFC Editor: This section is to be removed prior to publication.

This document contains placeholder values that need to be replaced with finalized values at the time of publication. This note summarizes all the substitutions that are needed.

Please apply the following replacements:

* XXXX --> the RFC number assigned to this I-D

* 2024-01-23 --> the actual date of the publication of this document

2. Conventions and Definitions

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 meanings of the symbols in the YANG tree diagrams are defined in [RFC8340].

The document uses the terms defined in [I-D.bclp-green-terminology] and [I-D.ietf-ivy-network-inventory-yang].

3. YANG Prefixes

Names of data nodes and other data model objects are prefixed using the standard prefix associated with the corresponding YANG imported modules, as shown in Table 1.

Prefix	YANG Module	Reference
ianahw	iana-hardware	[IANA_YANG]
ni	ietf-network-inventory	[I-D.ietf-ivy-network-inventory-yang]
yang	ietf-yang-types	[RFC6991]

Table 1: Prefixes and Corresponding YANG modules

4. Energy Saving Management Data Model Overview

4.1. Overview

"ietf-ntw-energy-saving" augments the node of abstract network model defined in [RFC8345] with energy consumption and power usage related attributes. At the network element level, the data model covers configuration of the energy saving mode and a set of related parameters to manage (e.g., retrieve or adjust) the status of power units, fans, boards, cards, ports, processors, and links. For example, the adjustment methods include frequency tuning, shutdown, or sleep mode. In addition, the methods also support the energy saving configuration for the ’tidal’ traffic flow, where related components can be turned off, e.g., during "idle" hours to optimize the energy consumption and then woken up based on some triggered (e.g., busy hours or other scheduled events).

The data model defines energy saving modes representing some energy consumption levels, which are basic, standard, or deep. For each consumption level, there is a combination of methods to reach the energy saving target level.

At the component level, the data model includes a set of monitoring statistics for energy consumption and energy saving operational state

of each component within the network device.

4.2. Energy Saving Management Network Model

The structure of the ESM Network Model is depicted in Figure 1.

```
module: ietf-ntw-energy-saving
  augment /nw:networks/nw:network/nw:node:
    +--ro energy-power-consumption {esm-common:energy-saving}?
    |  +--ro total-energy-consumption?   yang:gauge64
    |  +--ro saved-energy?               yang:gauge64
    |  +--ro eer?                        decimal64
    +--rw energy-saving-modes {esm-common:energy-saving}?
    |  +--rw energy-saving-mode* [mode]
    |     +--rw mode                    identityref
    |     +--rw energy-saving-method*   identityref
    +--ro component* [name] {esm-common:energy-saving}?
       +--ro name                 string
       +--ro class                identityref
       +--ro energy-monitoring
          +--ro energy-consumption
          |  +--ro average-power?    yang:gauge64
          |  +--ro saved-power?      yang:gauge64
          |  +--ro real-power?       yang:gauge64
          |  +--ro actual-volts?     int32
          |  +--ro actual-amperes?   int32
          |  +--ro actual-celsius?   int32
          +--ro energy-saving
             +--ro enabled?       boolean
             +--ro power-state?   identityref
```

Figure 1: ESM Network Model Tree Structure

5. Network Topology Energy Efficiency Management YANG Module

The module imports "ietf-network" [RFC8345] and "ietf-energy-saving-common".

```
<CODE BEGINS> file "ietf-ntw-energy-saving@2024-01-23.yang"
module ietf-ntw-energy-saving {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-ntw-energy-saving";
  prefix esm-ntw;

  import ietf-energy-efficiency-common {
    prefix esm-common;
    reference
      "RFC XXXX: YANG Data Models for Energy Saving Management";
  }
  import ietf-network {
    prefix nw;
    reference
      "RFC 8345: A YANG Data Model for Network Topologies";
  }
  import ietf-yang-types {
    prefix yang;
    reference
      "RFC 6991: Common YANG Types";
  }
  import iana-hardware {
   prefix ianahw;
   reference
     "https://www.iana.org/assignments/iana-hardware/iana-hardware.xhtml";
  }
  organization
    "IETF XXX Working Group.";
```

```
contact
  "WG Web:   <https://datatracker.ietf.org/wg/xxx/>;
   WG List:  <mailto:xxxx@ietf.org>

   Author:   Gen Chen
             <mailto:chengen@huawei.com>
   Editor:   Qin Wu
             <mailto:bill.wu@huawei.com>
   Editor:   XXX XXXX
             <mailto:xxx.xxx@orange.com>
   Author:   Carlos Pignataro
             <mailto:cpignata@gmail.com>";
description
  "This module contains a collection of YANG definitions for power
   and energy management of devices. It also augments both the
   network topology and inventory models.

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   identified as authors of the code.  All rights reserved.

   Redistribution and use in source and binary forms, with or
   without modification, is permitted pursuant to, and subject
   to the license terms contained in, the Revised BSD License
   set forth in Section 4.c of the IETF Trust's Legal Provisions
   Relating to IETF Documents
   (https://trustee.ietf.org/license-info).

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

revision 2024-01-23 {
  description
    "Initial revision.";
  reference
    "RFC XXXX: YANG Data Models for Energy Saving Management";
}

augment "/nw:networks/nw:network/nw:node" {
  if-feature "esm-common:energy-saving";
  description
    "Energy monitoring data for network elements.";
  container energy-power-consumption {
    config false;
    description
      "Statistics data about energy and power monitoring.";
    uses esm-common:energy-power-consumption-stats;
    leaf start-time {
      type yang:date-and-time;
      description
        "The time (in hundredths of a second) since the
        network management portion of the system was last
        re-initialized. It corresponds to the sysUpTime MIB object.
        It specifies the start time of the energy measurement
        results collection.";
    reference
      "RFC 3418:   Management Information Base (MIB) for the
                   Simple Network Management Protocol (SNMP)";
    }
  }
  container energy-saving-modes {
    description
      "List of the energy saving mode.";
    uses esm-common:energy-saving-modes;
  }
  list component {
    key name;
```

```
        config false;
        description
        "List of components.";
        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";
          }
        container energy-monitoring {
          description
            "Energy monitoring data for components.";
          container energy-consumption {
            description
            "Statistics of component about energy monitoring.";
            uses esm-common:energy-consumption-data;
          }
         container energy-saving {
          description
          "Controls energy saving parameters of a component.";
           leaf enabled {
            type boolean;
            default "true";
             description
               "Controls whether the energy-saving
               of the component is enabled (when set to true)
                or disabled (set to false).";
           }
           leaf power-state {
            type identityref {
              base esm-common:energy-saving-power-state;
            }
            description
              "The device energy saving operator state.";
           }
         }
       }
     }
   }
   <CODE ENDS>
```

6. Security Considerations

This section is modeled after the template described in Section 3.7 of [I-D.ietf-netmod-rfc8407bis].

The "ietf-ntw-energy-saving" YANG module defines a data model that is designed to be accessed via YANG-based management protocols, such as NETCONF [RFC6241] and RESTCONF [RFC8040]. These protocols have to use a secure transport layer (e.g., SSH [RFC4252], TLS [RFC8446], and QUIC [RFC9000]) and have to use mutual authentication.

The Network Configuration Access Control Model (NACM) [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 several data nodes defined in this YANG module 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. Specifically, the following subtrees and data nodes have particular sensitivities/vulnerabilities:

energy-saving-modes: This leaf specifies the energy saving mode set globally on a device.

esm-ntw:energy-saving/esm-ntw:enabled: This leaf enable/disables energy saving state of specific component.

Some of the readable data nodes in this YANG module 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. Specifically, the following subtrees and data nodes have particular sensitivities/ vulnerabilities:

'TBC': ....

7. IANA Considerations

7.1. The "IETF XML" Registry

This document requests IANA to register the following URIs in the "ns" sub-registry within the "IETF XML Registry" [RFC3688]:

URI: urn:ietf:params:xml:ns:yang:ietf-ntw-energy-saving
Registrant Contact: The IESG.
XML: N/A, the requested URIs are XML namespaces.

7.2. The "YANG Module Names" Registry

This document requests IANA to register the following YANG modules in the "YANG Module Names" registry [RFC6020] within the "YANG Parameters" registry group.

name: ietf-ntw-energy-saving
prefix: esm-ntw
namespace: urn:ietf:params:xml:ns:yang:ietf-ntw-energy-saving
Maintained by IANA? N
Reference: RFC XXXX

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8.1. Normative References

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8.2. Informative References

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Acknowledgments

This work has benefited from the discussions that occurred during the Sustainable Networking Side Meeting in IETF#117 and the "e-impact" IAB workshop. In particular, [I-D.cx-opsawg-green-metrics] assess several sustainability-related attributes such as power consumption, energy efficiency, and carbon footprint associated with a network, its equipment, and the services that are provided over it and suggest a set of metrics that provide network observability and can be used to optimize a network's "greenness". [I-D.manral-bmwg-power-usage] and [I-D.cprjgf-bmwg-powerbench] provide suggestions for measuring power usage of live networks under different traffic loads and various switch router configuration settings.

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