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A YANG Model for SmartPDU Monitoring and Control  
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## Abstract

This document defines a YANG data model for Smart Power Distribution Units (SmartPDUs). SmartPDUs extend traditional PDUs by incorporating telemetry and remote control functions that enable detailed monitoring and management of energy consumption. Current SmartPDU solutions are largely proprietary, exposing heterogeneous APIs and data formats that complicate integration and automation. The proposed YANG model provides a vendor-neutral framework for configuration, monitoring, and control of intelligent power distribution systems.

An initial version of the proposed YANG data model has been developed during the GREEN Framework and Use Cases project at the Hackathon performed during IETF 123 (July 2025).

## Status of This Memo

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## 1. Introduction

Power Distribution Units (PDUs) are a basic component of both data center and network infrastructures, providing power delivery, protection, and monitoring capabilities to connected equipment (e.g., routers, servers, etc). With the evolution towards the notion of SmartPDUs, which integrate advanced telemetry and remote control functions, operators can achieve finer-grained visibility and management of energy consumption across their technical facilities.

However, current SmartPDU implementations are largely proprietary. Different vendors expose distinct APIs and data formats for monitoring and control, leading to significant challenges in integration and automation. The lack of a common data framework hinders interoperability and makes it difficult to achieve consistent energy management across heterogeneous devices.

Furthermore, without a standardized architecture, real-time aggregation of energy usage data across multiple PDUs and vendors is cumbersome and often requires custom software adaptation. This fragmentation limits the ability of infrastructure operators to automate energy-saving policies, perform coordinated power control, and support sustainability objectives.

To address these challenges, this document proposes a YANG data model for SmartPDUs. The model intends to provide a vendor-neutral, structured framework for configuration, monitoring, and control of intelligent power distribution systems. It aims to enable interoperable management of SmartPDUs, support real-time energy telemetry collection, and facilitate integration with higher-level management and analytics systems.

The proposed YANG model aligns with ongoing efforts in the IETF to promote standardized network and infrastructure management through YANG-based interfaces. It is intended to serve as a foundation for consistent, automated, and energy-efficient power management across diverse networked environments.

## 2. Use Cases

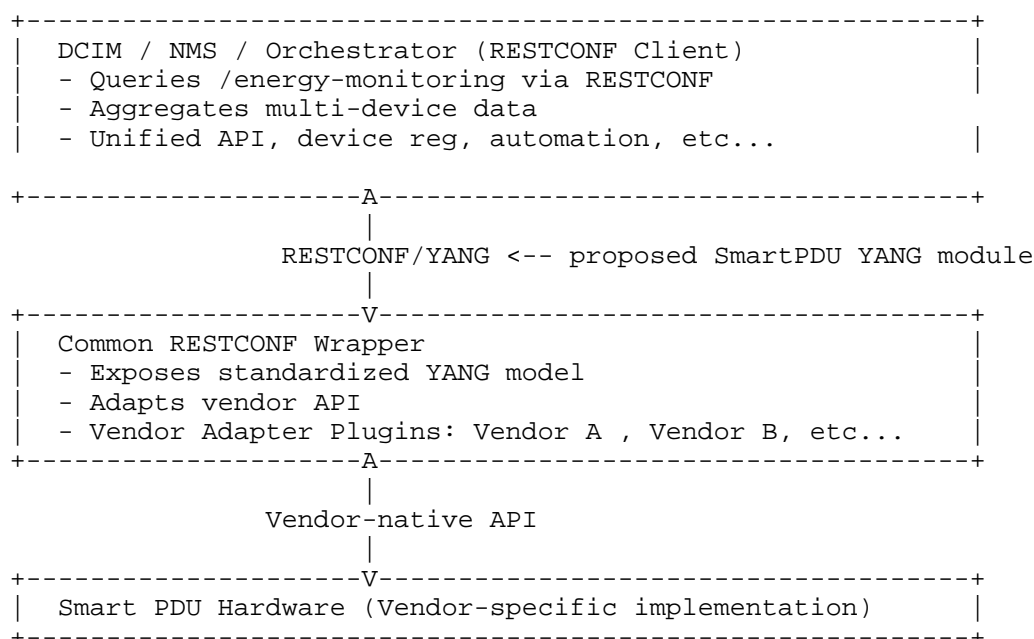
A number of use cases justify the convenience of defining a YANG data model for facilitating the operation of SmartPDUs. The following are some exemplary use cases which can be benefited of the availability of an SmartPDU YANG model:

- \* Data centers with a focus on green computing and energy efficiency. Modern data centers aim to minimize power consumption and carbon footprint. A standardized SmartPDU YANG model enables consistent configuration and telemetry interfaces for energy-aware infrastructure components, supporting sustainable operations and regulatory compliance.
- \* Real-time monitoring of energy consumption (EC) across different network equipment. Operators require fine-grained and real-time visibility into the energy consumption of servers, switches, routers, and other devices. A common YANG model allows uniform data collection and reporting of EC metrics across heterogeneous PDUs, facilitating proactive energy management and fault detection.
- \* Ability to control and remotely shut down certain PDU ports, even across devices from different vendors. In multi-vendor environments, proprietary interfaces hinder remote control and automation. A standardized YANG model provides vendor-independent mechanisms to enable, disable, or schedule PDU outlets, improving operational efficiency and safety during maintenance or energy-saving actions.

- \* Automatic load balancing or power capping to optimize energy use. Dynamic power distribution requires coordination between PDUs and higher-level orchestration systems. A SmartPDU YANG model offers standardized configuration and telemetry hooks to support automated load balancing, power capping, and policy-based optimization.
- \* Integration with higher-level management systems for reporting and analytics. Energy data from PDUs is increasingly valuable for analytics and sustainability dashboards. A consistent YANG interface simplifies integration with network management, telemetry collectors, and AI-driven analytics platforms, reducing integration costs and promoting interoperability.
- \* Tighter integration with software power management techniques. As servers and network elements implement software-based power management (e.g., CPU frequency scaling, sleep states), coordination with physical power infrastructure becomes critical. A SmartPDU YANG model bridges this gap, enabling end-to-end power control workflows through standardized APIs.

### 3. Functional Components and YANG module positioning

The proposed YANG data model assumes the existence of adaptors to vendor-specific APIs, according to the following scheme.



It is assumed these functional components being part of the framework defined in [I-D.belmq-green-framework].

#### 4. Design Principles

The definition of the SmartPDU YANG data model follows a set of key principles intended to ensure interoperability, extensibility, and operational efficiency across heterogeneous environments. These principles guide the model structure, data organization, and management interfaces to support a unified approach to energy monitoring and control.

- \* Unified and Vendor-Neutral Access Layer. The model defines a unified management layer that enables querying and control of any SmartPDU device, regardless of vendor implementation. This abstraction allows consistent access to monitoring and configuration data through standardized YANG-based interfaces.
- \* Capability Discovery. The model provides mechanisms to discover device capabilities related to power management and energy-saving functions. This includes identifying supported control features, outlet-level granularity, available telemetry, and automation support.
- \* Real-Time Energy Consumption Monitoring. Support is included for retrieving real-time energy consumption (EC) data both at the device level and for individual outlets. Such information enables operators to perform detailed energy analysis, trend tracking, and optimization of power usage.
- \* Outlet-Level Control. The model supports remote control of individual outlets, including the ability to trigger operations such as shutdown, power-cycle, or state toggling where supported by the underlying device.
- \* RESTCONF-Based Access and Extensibility. The model is designed to operate over RESTCONF, providing a standardized management interface. To accommodate heterogeneous environments, vendor-specific extensions can be integrated through adapter plugins, enabling multi-vendor interoperability while preserving standardized core functions.
- \* Fine-Grained Energy Management. Through outlet-level telemetry and control, the model facilitates fine-grained management of energy resources. This capability supports precise monitoring, fault isolation, and localized optimization actions.

- \* Cross-Vendor Interoperability. Interoperability across PDUs from different vendors is a core objective. The model defines common data structures and operational semantics to ensure consistent control and reporting, enabling unified management of mixed-device deployments.
- \* Support for Automated Energy Policies. The model enables automation frameworks to implement energy-saving policies such as power capping, load balancing, and scheduled shutdowns.
- \* Event Notifications and Alarms. To support real-time operational awareness, the model defines mechanisms for notifications and alarms. These events can be used to signal threshold violations, power faults, or changes in device state, facilitating responsive and automated management.

## 5. YANG data model for SmartPDUs

The following model is defined for the operation on SmartPDUs.

```

module: pdu-common
  +--rw pdu-system
  |   +--rw manufacturer?      string
  |   +--rw model?             string
  |   +--rw serial-number?     string
  |   +--rw firmware-version?  string
  |   +--rw ip-address?        inet:ip-address
  |   +--rw uptime?            yang:counter64
  |   +--rw temperature?       decimal64
  |   +--rw humidity?          decimal64
  +--rw network
  |   +--rw ip-address?        inet:ip-address
  |   +--rw subnet-mask?       inet:ip-address
  |   +--rw gateway?           inet:ip-address
  |   +--rw snmp-enabled?      boolean
  |   +--rw restconf-enabled?  boolean
  |   +--rw netconf-enabled?   boolean
  +--rw input-lines
  |   +--rw line* [id]
  |   |   +--rw id              string
  |   |   +--rw voltage?        decimal64
  |   |   +--rw current?        decimal64
  |   |   +--rw frequency?      decimal64
  |   |   +--rw power?          decimal64
  |   |   +--rw energy?         decimal64
  |   |   +--rw status?         enumeration { ok, warning, fault }

```

```

|
+--rw outlets
|   +--rw outlet* [id]
|       +--rw id?          string
|       +--rw label?       string
|       +--rw voltage?     decimal64
|       +--rw current?     decimal64
|       +--rw power?       decimal64
|       +--rw energy?      decimal64
|       +--rw power-factor? decimal64
|       +--rw status?      enumeration { on, off, error, unknown }
|       +--rw admin-state? enumeration { on, off, reboot }
|       +--rw last-change? yang:date-and-time
|       +--rw lock-state?  boolean
|
+--rw sensors
|   +--rw sensor* [id]
|       +--rw id?          string
|       +--rw type?        enumeration { temperature, humidity, airflow }
|       +--rw value?       decimal64
|       +--rw unit?        string
|       +--rw status?      enumeration { ok, warning, fault }
|
+--rw thresholds
|   +--rw threshold* [label]
|       +--rw label?       string
|       +--rw parameter?   string
|       +--rw low-limit?   decimal64
|       +--rw high-limit?  decimal64
|       +--rw action?      enumeration { alert, shutdown, ignore }

```

## 6. Security and operational considerations

To be provided.

## 7. Informative References

[I-D.belmq-green-framework]

Claise, B., Contreras, L. M., Lindblad, J., Palmero, M., Stephan, E., and Q. Wu, "Framework for Energy Efficiency Management", Work in Progress, Internet-Draft, draft-belmq-green-framework-06, 20 October 2025, <<https://datatracker.ietf.org/doc/html/draft-belmq-green-framework-06>>.

## Appendix A. Implementation status

An initial version of the proposed YANG data model has been developed during the GREEN Framework and Use Cases project at the Hackathon performed during IETF 123 (July 2025).

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