14 February 2011
Candidate Standard 5106.4-2011

The Printer Working Group

PWG Power Management Model

for Imaging Systems 1.0

Status: Approved

Abstract: This document defines an abstract PWG Power Management Model for Imaging Systems (Printers, Copiers, Multifunction Devices, etc.) that extends the abstract System and Subunit objects in the PWG Semantic Model.

This document is a PWG Candidate Standard. For a definition of a "PWG Candidate Standard", see:

ftp://ftp.pwg.org/pub/pwg/general/pwg-process-30.pdf

This document is available at:

ftp://ftp.pwg.org/pub/pwg/candidates/cs-wimspower10-20110214-5106.4.pdf

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The Printer Working Group (or PWG) is a Program of the IEEE Industry Standards and Technology Organization (ISTO) with member organizations including printer manufacturers, print server developers, operating system providers, network operating systems providers, network connectivity vendors, and print management application developers. The group is chartered to make printers and the applications and operating systems supporting them work together better. All references to the PWG in this document implicitly mean "The Printer Working Group, a Program of the IEEE ISTO." In order to meet this objective, the PWG will document the results of their work as open standards that define print related protocols, interfaces, procedures and conventions. Printer manufacturers and vendors of printer related software will benefit from the interoperability provided by voluntary conformance to these standards.

In general, a PWG standard is a specification that is stable, well understood, and is technically competent, has multiple, independent and interoperable implementations with substantial operational experience, and enjoys significant public support.

For additional information regarding the Printer Working Group visit: http://www.pwg.org

Contact information:

The Printer Working Group
c/o The IEEE Industry Standards and Technology Organization
445 Hoes Lane
Piscataway, NJ 08854
USA

WIMS Web Page:

http://www.pwg.org/wims/

WIMS Mailing List:

wims@pwg.org

Instructions for subscribing to the WIMS mailing list can be found at the following link:

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Implementers of this specification are encouraged to join the WIMS Mailing List in order to participate in any discussions of the specification. Suggested additions, changes, or clarification to this specification, should be sent to the WIMS Mailing list for consideration.

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1 Introduction (Informative)

The original IETF Printer MIB v1 [RFC1759] was published in March 1995, with major dependencies on the IETF Host Resources MIB v1 [RFC 1514] (for indices, devices, interfaces, storage, and Printer state). The subsequent IETF Printer MIB v2 [RFC3805] was published in June 2004, with major dependencies on the IETF Host Resources MIB v2 [RFC2790]. The IETF Finisher MIB [RFC3806] was also published in June 2004, with major dependencies on the IETF Printer MIB v2 [RFC3805] (for common subunits, datatypes, and alerts).
The original PWG Semantic Model/1.0 [PWG5105.1] was published in January 2004, with an abstract model and XML Schema for all the elements in IETF IPP/1.1 [RFC2911] and subsequent IETF and PWG IPP specifications. The PWG Semantic Model/2.0 [PWGSM20] is currently under development in the PWG Multifunction Device WG. However, no public standard currently addresses power management for Printers and other Imaging Systems.

1.1 Power Management Model Scope

This document defines an abstract PWG Power Management Model for Imaging Systems (Printers, Copiers, Multifunction Devices, etc.) that extends the abstract PWG Semantic Model (see section 4). This PWG Power Management Model applies to System and Subunit objects. This PWG Power Management Model does not apply to Service objects.

1.2 Power Management Element Classes

Sections 5, 6, and 7 of this document define all of the PWG Power Management Model elements. Below is a brief informal description of these element classes:

Power Status – This class of read-only power management elements consists of power general, power monitor, power log, power counter, and power meter elements that are only set by the Imaging System itself.

Power Capabilities – This class of read-only power management elements consists of supported stable power states and supported transitions between stable power states that are only set by the manufacturer of the Imaging System (i.e., they are intrinsic to the hardware configuration of the Imaging System).

Power Settings – This class of read-only and read-write power management elements consists of power management policies that are set by the manufacturer (factory defaults) and/or Administrator (site policies) and also power state change requests (i.e., operations) that are set by the Imaging System itself and/or the Administrator.

1.3 Consistency of Power Terminology

This document uses power terminology (see section 2.4 and section 9.1) that is technically aligned and consistent with the DMTF CIM Power State Management Profile [DSP1027], IEEE Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments [IEEE1621], and Advanced Configuration and Power Interface Specification v4.0 [ACPI].

WARNING: Some government and consortium documents that address power management do NOT use important power state terms consistently with existing usage in the computer industry and international standards. For example, for apparently historical reasons the US EPA Energy Star Program Requirements for Imaging Equipment v1.1 [ESPRINTER] differs in several serious ways:

(a) It confuses the term “power mode” (used to mean a *set* of power states in [DSP1027] and [IEEE1621]) with “power state” (used to mean a single ordinal power state in [DSP1027] and [IEEE1621]).
(b) It ambiguously defines Active Mode, Ready Mode (replacing former Idle Mode), Sleep Mode, Standby Mode, and Off Mode.
(c) It ambiguously defines Sleep Mode such that it is equivalent to the Standby (Light-Sleep) state in [DSP1027] and [IEEE1621] and modern operating systems.
(d) It ambiguously defines Standby Mode such that it is equivalent to either the Suspend (Deep-Sleep) state or the Hibernate (Off-Soft) state in [DSP1027] and [IEEE1621] and modern operating systems.

Imaging System manufacturers and software developers will discover that there are many such inconsistencies in government and consortium documents that address power management.

1.4 Power State Transition Notifications

This document specifies the recommended power state transition notification methods in section 5.7.

1.5 Vendor Extension Stable Power States

This specification supports the definition of vendor extension stable power states for any of the base standard DMTF CIM stable power states (see section 2.4.2). Details are specified in sections 2.4.5 and 9.1.1. This specification prohibits the definition of vendor extension power states for special power states (i.e., orderly shutdowns and resets), in order to avoid ambiguity.

2 Terminology

2.1 Conformance Terminology

The uppercase conformance keywords "MUST", "MUST NOT", "REQUIRED", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document shall be interpreted as defined in [RFC2119].

2.2 Printing Terminology

Normative definitions and semantics of printing terms are imported from IETF Printer MIB v2 [RFC3805], IETF Finisher MIB [RFC3806], and IETF IPP/1.1 [RFC2911].

This document also defines the following protocol roles in order to specify unambiguous conformance requirements:

Power Management Client – Initiator of power management session requests and sender of outgoing power management operation requests (e.g., an SNMP Manager).

Power Management Server - Listener for incoming power management session requests and receiver of incoming power management operation requests (e.g., an SNMP Agent).

2.3 Datatype Terminology

Normative definitions and semantics of the following standard abstract datatypes are imported from W3C XML Schema Part 2: Datatypes Second Edition [XMLTYPES]. These XML datatypes in turn are normatively mapped by this specification to their corresponding SNMP MIB datatypes.

Table 1 – Standard Abstract Datatypes (XML, SNMP)

XML Datatype	XML Reference	SNMP Datatype	SNMP Reference	Description
boolean	Section 3.3.2	TruthValue	[RFC2579]	binary true/false
Counter → int	Section 3.4.17	Counter32	[RFC2578]	non-negative 32-bit integer (MUST NOT decrease in value)
dateTime	Section 3.3.8	DateAndTime	[RFC2579]	date/time in ISO 8601 format
Enum → string	Section 3.3.1	INTEGER	[RFC2578]	enumerated positive 32-bit integer
Gauge → int	Section 3.4.17	Gauge32	[RFC2578]	non-negative 32-bit integer (MAY decrease in value)
int	Section 3.4.17	Integer32	[RFC2578]	signed 32-bit integer
string	Section 3.3.1	SnmpAdminString or DisplayString	[RFC3411] [RFC2579]	UTF-8 [RFC3629] - messages US-ASCII [ISO646] - keywords

2.4 Power Terminology

Normative definitions and semantics of the following standard power terms are technically aligned and consistent with DMTF CIM Power State Management Profile [DSP1027], IEEE Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments [IEEE1621], and Advanced Configuration and Power Interface Specification v4.0 [ACPI]. These power terms are also used in properties defined in the DMTF CIM power classes.

2.4.1 IEEE 1621 Power Modes

[IEEE 1621] (which is primarily concerned with a simple user interface) defines 3 basic "power modes": Off Mode, Sleep Mode, and On Mode. These "power modes" in turn can be qualified with "soft / hard", "light / deep", and "graceful" to describe specific power states (see the following sections and Table 2 in section 9.1 of this specification).

Off Mode – the set of power states where incoming jobs cannot be accepted immediately and existing jobs cannot be processed immediately (i.e., without a long delay for a power state transition to On Mode).

On Mode – the set of power states where incoming jobs can be accepted immediately and existing jobs can be processed immediately (i.e., with no delay for a power state transition).

Sleep Mode – the set of power states where incoming jobs MAY be accepted immediately, but existing jobs cannot be processed immediately (i.e., without a short delay for a power state transition to On Mode).

2.4.2 DMTF CIM Stable Power States

This specification imports (and renames for clarity and common usage) the normative definitions and semantics of the following DMTF CIM [DSP1027] stable power states. All other DMTF CIM power states are special (orderly shutdowns and power resets) and will eventually result in one of the stable power states defined below.

Note: This specification also supports the definition of vendor extension stable power states (see sections 2.4.5 and 9.1.1).

Hibernate – DMTF "Hibernate (Off-Soft)" (7) – ACPI S4 – the stable "Off Mode" power state where all kernel and application programs and data have been saved (e.g., to a hard disk) such that a transition to On allows recovery and continued processing without any loss of jobs or data – limited auxiliary power is consumed, e.g., console lights – no network interfaces are operational and human intervention is required to power up the system – compare with OffHard and OffSoft.

OffHard – DMTF "Off-Hard" (6) – ACPI G3 – the stable "Off Mode" power state where system power is mechanically or electrically turned off – no power is consumed – no network interfaces are operational and human intervention is required to power up the system – compare with Hibernate and OffSoft.

OffSoft – DMTF "Off-Soft" (8) – ACPI G2 or S5 – the stable "Off Mode" power state where only limited auxiliary power is consumed, e.g., console lights – no network interfaces are operational and human intervention is required to power up the system – compare with Hibernate and OffHard.

On – DMTF "On" (2) – ACPI G0 or S0 – the stable "On Mode" power state where the system is in Idle, Processing, Stopped, or Testing operational states (see section 2.5.1 below), with no delay required for a power state transition before processing incoming jobs.

Standby – DMTF "Sleep-Light" (3) – ACPI S1 or S2 – the stable "Sleep Mode" power state with the shortest wake-up transition to On power state – typically, mechanical elements (motors, lamps, heaters, etc.) are turned off or turned down, but processors and network interfaces are fully active (e.g., normal clock rate) – some or all network interfaces are operational – compare with Suspend.

Suspend – DMTF "Sleep-Deep" (4) – ACPI S3 – the stable "Sleep Mode" power state with the lowest power consumption of any "Sleep Mode" power state – typically, mechanical elements (motors, lamps, heaters, etc.) are turned off, but processors and network interfaces are partially active (e.g., lower clock rate) – kernel and application programs and data are preserved (i.e., periodically refreshed) in main memory – at least one network interface is operational – compare with Standby.

2.4.3 DMTF CIM Special Power States

This specification imports (and renames for clarity and common usage) the normative definitions and semantics of the following DMTF CIM [DSP1027] special power states that represent orderly shutdowns (e.g., OffSoftGraceful) and power resets (e.g., ResetHard). All DMTF CIM special power states will eventually result in one of the stable power states defined in section 2.4.2 above.

OffHardGraceful – DMTF "Off-Hard Graceful" (13) – ACPI G3 – the special power state that performs a graceful hard power off – an orderly shutdown, followed by a hard power off cycle – and completes in the OffHard power state.

OffSoftGraceful – DMTF "Off-Soft Graceful" (12) – ACPI G2 or S5 – the special power state that performs a graceful soft power off – an orderly shutdown, followed by a soft power off cycle – and completes in the OffSoft power state.

ResetHard – DMTF "Power Cycle (Off-Hard)" (9) – ACPI G0 to G3, then S0 – the special power state that performs a hard power reset – hard power off cycle, followed by normal power on cycle – and completes in the On power state.

ResetHardGraceful – DMTF "Power Cycle Off-Soft Graceful" (16) – ACPI G3, then S0 – the special power state that performs a graceful hard power reset – an orderly shutdown, followed by a hard power reset – and completes in the On power state.

ResetINIT – DMTF "Diagnostic Interrupt (INIT)" (17) – ACPI S5, then S0 – the special power state (based on a diagnostic interrupt) that performs a hard power reset – hard power off cycle, followed by normal power on cycle – and completes in the On power state.

ResetMBR – DMTF "Master Bus Reset" (10) – ACPI S5, then S0 – the special power state (based on a master bus reset) that performs a hard power reset – hard power off cycle, followed by normal power on cycle – and completes in the On power state.

ResetMBRGraceful – DMTF "Master Bus Reset Graceful" (14) – ACPI S5, then S0 – the special power state that performs an orderly shutdown, followed by an MBR reset – and completes in the On power state.

ResetNMI – DMTF "Diagnostic Interrupt (NMI)" (11) – ACPI S5, then S0 – the special power state (based on a non-maskable interrupt) that performs a hard power reset – hard power off cycle, followed by normal power on cycle – and completes in the On power state.

ResetSoft – DMTF "Power Cycle (Off-Soft)" (5) – ACPI G2 or S5, then S0 w/ lost context – the special power state that performs a soft power reset – soft power off, followed by normal power on cycle – and completes in the On power state.

ResetSoftGraceful – DMTF "Power Cycle Off-Soft Graceful" (16) – ACPI G2 or S5, then S0 w/ lost context – the special power state that performs a graceful soft power reset – an orderly shutdown, followed by a soft power reset – and completes in the On power state.

2.4.4 DMTF CIM Out-of-band Power States

This specification imports and renames (for clarity and common usage) the normative definitions and semantics of the following DMTF CIM [DSP1027] out-of-band power states. None of these out-of-band power states has a mapping to ACPI [ACPI]. None of these out-of-band power states represents a meaningful requested power state in power policies or operations.

NotApplicable – DMTF "Not Applicable" (18) – not applicable power state – do not use for transitions.

NoChange – DMTF "No Change" (19) – no change power state – do not use for transitions.

Other – DMTF "Other" (1) – undefined other power state – DO NOT USE.

Unknown – DMTF "Unknown" (0) – unknown power state – use only for initial default.

2.4.5 Vendor Extension Stable Power States

This specification supports the definition of vendor extension stable power states for any of the base standard DMTF CIM stable power states (see sections 2.4.2 and 9.1). Vendor extension stable power states MUST have names of the form 'BaseVendor[1-5]', e.g., 'StandbyVendor1' (see section 9.1.1).

Usage: Implementations MUST support the corresponding base stable power state, e.g., 'Standby', whenever they support any vendor extension stable power state, e.g., 'StandbyVendor1'.

Usage: Vendor extension stable power states MUST be strictly ordered by their nominal inactive power consumption (see section 6.1.2), e.g., 'StandbyVendor2' MUST consume equal or higher power than 'StandbyVendor1' and 'StandbyVendor1' MUST consume equal or higher power than 'StandbyVendor' (the base state).

Usage: Vendor extensions MUST NOT be defined for DMTF CIM special power states or DMTF CIM out-of-band power states, in order to avoid ambiguity.

2.5 Operational State Terminology

The operational state of Imaging System components SHOULD be displayed to End Users and Operators whenever the power state of those components is displayed.

See: Section 4.6 of this specification.

2.5.1 Operational State of System

This specification imports the following standard System operational states defined in the IcServiceStateTC textual convention in the PWG Imaging System State and Counter MIB v2 [PWG5106.3], where they are derived from IETF Host Resources MIB v2 [RFC2790] and IETF IPP/1.1 [RFC2911].

Conformance: To claim conformance to this specification, a Power Management Server SHOULD conform to the corresponding set of valid power states as specified below in each operational state definition.

Down – The System is in OffHard, OffSoft, or Hibernate power state and is not available for either testing or normal Job processing.

Idle – The System is in On, Standby, or Suspend power state and is not currently processing any Jobs.

Other – For CIM compatibility – do NOT use.

Processing – The System is in On power state and is currently processing one or more normal Jobs.

Stopped – The System is in On, Standby, or Suspend power state and is currently stopped.

Testing – The System is in On power state and is currently testing and is NOT available for processing normal Jobs.

Unknown – For CIM compatibility and default values – do NOT use otherwise.

2.5.2 Operational State of Subunit

This specification imports all of the standard Subunit operational states defined in section 2.2.13.2.2 and the PrtSubUnitStatusTC textual convention of the IETF Printer MIB v2 [RFC3805].

3 Requirements

Per the PWG Process, this section specifies the formal rationale for developing a PWG Power Management Model, based on existing printing industry standards. This section also describes simple use models for the PWG Power Management Model.

3.1 Rationale for Power Management Model

The IETF Printer MIB v2 [RFC3805] and IETF Finisher MIB [RFC3806] define:

(a) Model of Print Devices
(b) Operations for Print Devices
- prtGeneralReset
- prtConsoleDisable

(c) Groups of simple attributes for Print Devices
- prtInputTable --> prtInputName
- finDeviceTable --> finDeviceType

(d) Conformance requirements for implementations of IETF Printer MIB v2 and IETF Finisher MIB

The IETF IPP/1.1 Model and Semantics [RFC2911] defines:

(a) Model of Print Services, Print Devices, and Print Jobs
(b) Operations for Print Services and Print Jobs
- Pause-Printer
- Print-Job

(c) Attributes for Print Services and Print Jobs
- printer-location
- job-id

(d) Conformance requirements for implementations of IETF IPP/1.1

But no public standard specification defines a power management model for Printers, Multifunction Devices, and other Imaging Systems, which causes increased operating costs for customers and issues of conformance to national, regional, and international standards.

Therefore a PWG Power Management Model should:

(a) Standardize a small set of power management elements for interoperability
(b) Encourage adoption of open standard printing and imaging infrastructures
(c) Discourage the further proliferation of vendor proprietary power management operations and elements that damage interoperability by duplicating PWG power management operations and elements

3.2 Use Cases for Power Management Model

See the informal description of power management element classes in section 1.2.

3.2.1 Local Printer Use Case

Alice, Bob, and Charlie are graphic artists who share a printer down the hall. They all work on a fairly regular schedule. Alice and Bob have convinced Charlie that he should remember to manually put the printer into the Hibernate power state before going home every Friday afternoon. But they all sometimes stay late on Friday and they often forget to put the printer into Hibernate power state before leaving - they need a PWG Power Management Model implemented in their printer.

3.2.2 Remote Printer Use Case

Joe and his colleagues send large documents to a printer in a building across the street in a 'glasshouse' with some corporate network servers.

Both Joe and the operator Sue in the glasshouse manage lots of print jobs - they need to hold and release jobs when printers are entering and exiting power saving states due to corporate site policies. Joe wants to keep track of printer power states (i.e., relative availability) - he needs to subscribe for power management events.

Sue is expected to manage several printers - she needs to be able to set and query site policies for power management of those printers.

3.2.3 Fleet Management Use Case

Acme Corporation has an office building with 15 floors and different departments on different floors. Acme has their main lobby on the ground floor. Acme has over 50 imaging devices (printers, copiers, MFDs, etc.) from multiple vendors spread throughout their building. Acme engineering staff works 5 days a week, but AP department works 6 days a week, and the main lobby is open 24/7.

The power consumption by these imaging devices is quite significant and Jim (system administrator) has been tasked to look for an approach for possible reduction in this power consumption.

Jim finds this nice tool in his fleet management software that allows him to set power management schedules and monitor power consumption for the imaging devices. So Jim does the following:

- Since the Acme engineering team [floors 10-15] only works 5 days a week 7am-7pm, Jim sets the Monday through Friday schedule for the engineering imaging devices so that the machines enter the Hibernate power state after 7pm and so that the first user can manually wake them up to the On power state each morning at 7am. On weekends, the machines remain in the Hibernate power state.

- Since there are few stand-alone printers, Jim ties computers to network printers in their vicinity such that when the computers go into Suspend or Hibernate state, the printers in their vicinity go into the Suspend or Hibernate power state as well.

- Other departments have different work schedules, so Jim schedules the imaging device sleep/wake cycles accordingly.

- Main lobby imaging devices are left in the On power state much longer.

- Certain specialized imaging devices (e.g., large format plotters) are only used periodically, so Jim changes the default power state on these machines to be Hibernate.

- Jim monitors job processing loads in the various imaging devices and finds that some machines are used very rarely, so he schedules different power state transitions for them.

Acme Corporation also has a print server on each floor that allows for load balancing, so:

- Jim adds power state as one of the load balancing options, such that if imaging devices A and B meet the requirements for the next job and device A is in On state, but device B is in Standby or Suspend state, then the job will be sent to device A, instead of waking up device B.

Acme Corporation is expanding and they need to add new imaging devices to their fleet. Since Jim has done such a good job of saving power, Acme management asks for Jim's recommendations. Based on the power consumption data that Jim has gathered in recent months:

- Jim provides recommendations on which machines consume least power when in different power states.

- Jim has noticed that some devices consume a lot less power when in idle condition since they go into the Standby or Suspend power state based on a factory device policy.

3.2.4 Tech Support Use Case

Big Network Corporation has over 5,000 network printers and multifunction devices installed on their enterprise network. The operating, maintenance, and support costs for these network imaging devices are a significant budget item for Big Network Corporation.

Gracie is a senior engineer in a centralized Tech Support group at Big Network Corporation, specializing in network peripherals (storage devices, imaging devices, file servers, etc). Both end users and Facilities people regularly send in trouble tickets via email or Web forms to Tech Support. Trouble tickets for network peripherals (including imaging devices) are regularly escalated to Gracie.
Gracie uses a custom-built system management tool to periodically gather both system and subunit operating and power states as well as current and monthly power consumption of these network imaging devices. This information is acquired from vendor-specific: (a) private SNMP MIBs; (b) machine-readable Web Services interfaces; and/or (c) diagnostic protocols.

Gracie receives a trouble ticket from Facilities about operating costs for network peripherals at one of the branch offices. She uses her custom-built system management tool to view power consumption trends and anomalies at that branch office. She discovers that one imaging device has had very high power consumption in Standby and Suspend power states when compared with other similar models of imaging devices at that branch office. She tracks the problem down to a bad firmware update that has been leaving heaters and lamps turned on when in Standby and Suspend power states.

Gracie receives a trouble ticket from an end user who has been experiencing very long delays before first-page-out on a particular network printer. She uses her custom-built system management tool to examine the power state transition counters in that network printer. She tracks the problem down to a device configuration error that is sending the network printer into Suspend after 15 seconds of device inactivity.

3.2.5 Automatic Policy Use Case

Hot Sauce Corporation has over 1,000 network printers and multifunction devices installed on their enterprise network. The optimization of power management costs for these network imaging devices is a significant technical problem for Hot Sauce Corporation.

Howard is a system administrator at Hot Sauce Corporation, specializing in power management issues. He uses the built-in feature in some of their newest printers and multifunction devices to automatically create appropriate power management policies based on internal operational usage histories in the managed devices. After invoking this feature, Howard remembers to read and log the newly created power management policies for review and approval (or modification) by affected department managers.

3.3 Design Requirements for Power Management Model

The PWG Power Management Model design should:

(1) Be based on power management use cases that include workgroup, enterprise, and fleet management environments.

(2) Conform to existing naming conventions used in the PWG Semantic Model/2.0 [PWGSM20], including element name case (title) and keyword value case (title) requirements.

(3) Define a set of abstract power management elements for monitoring, history, capabilities (supported power states and transitions), policies (schedules and timeouts), counters (for power state transitions), meters (for power consumption), and operations (power state change requests).

(4) Define the correspondence between PWG standard power states and existing values of DMTF CIM_AssociatedPowerManagementService.PowerState in DMTF CIM v2.22 (or later version).

(5) Define the correspondence between PWG standard power states and existing values of ACPI [ACPI] power states per Table 3 in DMTF Power State Management Profile [DSP1027].

(6) Define terminology for PWG standard power states and their semantics in strict conformance with IEEE Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments [IEEE1621].

(7) Define explicit mapping details for concrete bindings to the PWG Semantic Model (XML Schema) and a future PWG Power Management MIB (SNMP MIB).

(8) Design for extensibility in a future version of this specification to support the automatic device-written policy use case specified in section 3.2.5 above (as this use case was deemed too complex to address in this first version).

4 Relationship to Other Public Standards

This section describes the extensions of the PWG Semantic Model/2.0 [PWGSM20], the IETF Printer MIB v2 [RFC3805], and the DMTF CIM Printing classes to incorporate the PWG Power Management Model for Imaging Systems (Printers, Copiers, Multifunction Devices, etc.).

The original PWG Semantic Model/1.0 [PWG5105.1] and accompanying XML Schema were based on the abstract model defined in section 2 of IETF IPP/1.1 [RFC2911].

The updated PWG Semantic Model/2.0 [PWGSM20] and accompanying XML Schema currently under development in the PWG Multifunction Device WG extends the IPP objects, operations, elements, and semantics to Multifunction Devices.

4.1 PWG Semantic Model – System

The PWG Semantic Model/2.0 [PWGSM20] defines a root object called System, which is equivalent to the System object in the DMTF Common Information Model (CIM) [DMTF-CIM] and is consistent with the System terminology in the IETF MIB-II [RFC1213], IETF Host Resources MIB v2 [RFC2790], IETF Printer MIB v2 [RFC3805], and IETF Finisher MIB [RFC3806].

The PWG Semantic Model/2.0 [PWGSM20] will include all of the abstract element classes of the PWG Power Management Model in the System object:

- Power Status Class – see section 5 of this specification
- Power Capabilities Class – see section 6 of this specification
- Power Settings Class – see section 7 of this specification

4.2 PWG Semantic Model – Subunits

The PWG Semantic Model/2.0 [PWGSM20] (work-in-progress) defines subordinate objects called Subunits, which are equivalent to the Component object in the DMTF Common Information Model (CIM) [DMTF-CIM] and are consistent with the Subunit tables defined in the IETF Printer MIB v2 [RFC3805] and IETF Finisher MIB [RFC3806].

The PWG Semantic Model/2.0 [PWGSM20] will include all of the abstract element classes of the PWG Power Management Model in the Subunits:

- Power Status Class – see section 5 of this specification (Power Monitor group ONLY)
- Power Capabilities Class – see section 6 of this specification
- Power Settings Class – see section 7 of this specification

WARNING: Implementation of the PWG Power Management Model on an Interpreter (unless it is running on a dedicated coprocessor) would be ambiguous (because an Interpreter is a software component of an Imaging System, similar to a Service - see below).

4.3 PWG Semantic Model – Services (out-of-scope)

The PWG Semantic Model/2.0 [PWGSM20] (work-in-progress) defines subordinate objects called Services, which are equivalent to the Service object in the DMTF Common Information Model (CIM) [DMTF-CIM] and the icServiceTable defined in the PWG Imaging System State and Counter MIB [PWG5106.3].

The PWG Semantic Model/2.0 [PWGSM20] will not support the PWG Power Management Model in any Service object (because each Service object represents a software component of an Imaging System).

4.4 IETF Printer MIB – Alerts and Notifications

The IETF Printer MIB v2 [RFC3805] defines the prtAlertTable, an ordered list of the warning and critical alerts on a Printer (or an MFD), which MUST be implemented as persistent across power cycles for conforming implementations of the PWG Power Management Model. The PrtAlertCodeTC textual convention defined in the IANA Printer MIB [IANA-PRT] defines both 'powerUp' (On) and 'powerDown' (OffSoft or OffHard).

The additional values 'standby', 'suspend', and 'hibernate' for PrtAlertCodeTC in the IANA Printer MIB are defined in section 9.7.

The IETF Printer MIB v2 also defines the printerV2Alert SNMP trap. Clients (SNMP Managers) may register for SNMP notifications.

4.5 DMTF CIM – Alerts

The DMTF CIM Printing Classes include CIM_PrintAlertRecord which contains the properties RecordData (every integer object in a prtAlertTable entry in the IETF Printer MIB v2 [RFC3805]) and LocalizedDescription (human-readable string object prtAlertDescription in a prtAlertTable entry).

4.6 PWG Imaging System State and Counter MIB v2 -– Operational States

The PWG Imaging System State and Counter (ISC) MIB v2 [PWG5106.3] defines the icKeyTable, icServiceTable, and icSubunitTable. The PWG ISC MIB also defines the IcServiceTypeTC, IcServiceStateTC, IcSubunitTypeTC, and IcSubunitStatusTC (bit-mask identical to PrtSubUnitStatusTC defined in IETF Printer MIB v2) textual conventions.

Conformance: Conforming implementations of this PWG Power Management Model that also implement the PWG ISC MIB v2 [PWG5106.3] and the icKeyTable, icServiceTable, or icSubunitTable MUST implement those tables as persistent across power cycles.

If the PowerLog.ComponentType element takes a value of 'System', then the corresponding icServiceState object (with icServiceType of 'sytemTotals') SHOULD be implemented to report the System operational state (e.g., 'idle' or 'processing'), which directly impacts power consumption.

If the PowerLog.ComponentType element takes a value of any Subunit defined in the IcSubunitType textual convention in the PWG ISC MIB, then the corresponding icSubunitStatus object SHOULD be implemented to report the Subunit operational state (e.g., 'Available and Idle' or 'Available and Active'), which directly impacts power consumption.

5 Power Status Element Definitions

The following elements are defined in the Power Status class of the PWG Power Management Model and MUST only be set by the Imaging System itself.

5.1 Power General Group (REQUIRED)

The Power General group describes the basic power management capabilities of this Imaging System and MUST only be instantiated on the System object. The following REQUIRED read-only elements are defined in the Power General group.

Notes:

(1) The natural language tag for human-readable strings in the PWG Power Management Model (currently only PowerStateMessage) is not included in this Power General group, because it is already present in the corresponding parent objects (System, Marker, etc.) in the PWG Semantic Model/2.0 [PWGSM20] XML Schema. This natural language tag MUST be defined in a MIB mapping of the PWG Power Management Model.

(2) The implementation supported access (i.e., read-only, read-write, or read-create) for power policies in the PWG Power Management Model is NOT included in this Power General group, because it is already present in the corresponding parent objects (System, Marker, etc.) in the PWG Semantic Model/2.0 [PWGSM20] XML Schema. This implementation supported access MUST be defined in a MIB mapping of the PWG Power Management Model.

5.1.1 PowerUsageIsRMSWatts (boolean)

The read-only element specifies whether or not the power consumption properties for this Imaging System use units of Root Mean Square (RMS) watts (true) or unnormalized so-called peak watts (false) in a binary encoding ('boolean' in an XML Schema or 'TruthValue' in an SNMP MIB).

Default Value: "false"

5.1.2 CanRequestPowerStates (string)

This read-only element specifies all of the stable and special power states (see sections 2.4.2 and 2.4.3) that can be requested (in policies or operations) on this Imaging System listed in a string (XML Schema/SNMP MIB).

Usage: This element MUST be of the format “<STATE1>,…,<STATEn>” and MUST contain a comma-delimited list of power state keywords (XML Schema) or corresponding positive integer values (SNMP MIB).

Default Value: “” (empty string)

5.2 Power Monitor Group (REQUIRED)

The Power Monitor group lists the current power state for each System or Subunit. The following REQUIRED read-only elements are defined in the Power Monitor group .

5.2.1 PowerState (PowerStateWKV)

This read-only element specifies the current enumerated power state as a keyword (XML Schema) or a positive 32-bit integer (SNMP MIB) of this System or Subunit. Conforming implementations MUST support standard power states (e.g., Standby) whenever they support vendor extensions (e.g., StandbyVendor1).

Implementor's Note: Implementors of this PWG Power Management Model SHOULD consider the impact on system logging and network management applications before reporting intermediate power states, e.g., OffSoft or Standby before On during a ResetSoft power operation.

Default Value: "Unknown"

5.2.2 PowerStateMessage (string)

This read-only element specifies a human-readable string in UTF-8 [RFC3629] that describes, explains, or qualifies the current power state of this System or Subunit.

Usage: This element: (a) MUST identify the power state; (b) SHOULD identify the method of entry to the power state, e.g., "from timeout trigger" or "from user request"; (c) SHOULD identify the nominal power consumption, e.g., "(34 watts)"; and (d) MAY include any other power-related information, e.g., "can accept jobs" or "can process jobs".

Default Value: "" (empty string)

5.3 Power Log Group (REQUIRED)

The Power Log group lists the power log records for this Imaging System and MUST only be instantiated on the System object. The following REQUIRED read-only elements are defined in the Power Log group.

Usage: All Imaging Systems MUST implement this Power Log group as persistent across power cycles and hardware reconfigurations. Imaging Systems SHOULD only add records to the Power Log group when a power state transition occurs (i.e., successive Power Log records for the same component SHOULD NOT have the same power state). Imaging Systems SHOULD support at least 10 records in the Power Log (for reliable fleet management).

5.3.1 LogID (int (1..MAX)) – KEY

This read-only KEY element specifies the instance in a positive 32-bit integer (XML Schema and SNMP MIB) of this Power Log group of elements (e.g., for queries).

Default Value: <not specified for key>

5.3.2 PowerState (PowerStateWKV)

This read-only element specifies the logged enumerated power state as a keyword (XML Schema) or a positive 32-bit integer (SNMP MIB) of the source System or Subunit.

Usage: Imaging Systems SHOULD only add records to the Power Log group when a power state transition occurs (i.e., successive Power Log records for the same component SHOULD NOT have the same power state). Recording a system heartbeat event (without a power state transition) in the Power Log MAY be useful (especially if power state notifications are also sent to system management tools – see section 5.7), but implementers SHOULD consider the loss of functionality caused by a Power Log flooded with heartbeat events.

Implementor's Note: Implementors of this PWG Power Management Model SHOULD consider the impact on system logging and network management applications before reporting intermediate power states, e.g., OffSoft or Standby before On during a ResetSoft power operation.

Default Value: "Unknown"

5.3.3 PowerStateMessage (string)

This read-only element specifies a human-readable string in UTF-8 [RFC3629] that describes, explains, or qualifies the logged power state of the source System or Subunit.

Usage: This element: (a) MUST identify the power state; (b) SHOULD identify the method of entry to the power state, e.g., "from timeout trigger" or "from user request"; (c) SHOULD identify the nominal power consumption, e.g., "(34 watts)"; and (d) MAY include any other power-related information, e.g., "can accept jobs" or "can process jobs".

Default Value: "" (empty string)

5.3.4 PowerStateDateAndTime (dateTime)

This read-only element specifies the date/time of transition into the logged power state in an ISO 8601 conformant encoding ('dateTime' in an XML Schema or 'DateAndTime' in an SNMP MIB) of the source System or Subunit.

Default Value: "" (empty string) or <omitted> (SNMP MIB)

5.3.5 PowerComponentType (PowerComponentTypeWKV)

This read-only element specifies the enumerated type (System or specific Subunit type, e.g., InputTray) as a keyword (XML Schema) or a positive 32-bit integer (SNMP MIB) of the source System or Subunit.

Default Value: "System"

5.3.6 PowerComponentReferenceId (int (0..MAX))

This read-only element specifies the identifier in a positive 32-bit integer or zero (if not available, because there is no corresponding component in another XML schema or SNMP MIB) (XML Schema/SNMP MIB) of the source component instance (System or Subunit) of the above PowerComponentType element.

Usage: For a System object, the value of this element MUST be the corresponding identifier (e.g., value of hrDeviceIndex (for hrDevicePrinter) in SNMP MIB). For a Subunit object, the value of this element MUST be the corresponding identifier (e.g., value of InputTrayId in XML Schema or prtInputIndex in SNMP MIB).

Default Value: "0"

5.4 Power Counter Group (OPTIONAL)

The Power Counter group of Power Status elements contains the lifetime power counters for each System or Subunit. The following OPTIONAL read-only elements are defined in the Power Counter group.

Usage: All Imaging Systems that implement this Power Counter group MUST implement all properties as persistent across power cycles and hardware reconfigurations.

5.4.1 HibernateTransitions (Counter (0..MAX))

This read-only element specifies the lifetime number of transitions into the Hibernate power state in a positive 32-bit integer or zero (XML Schema/SNMP MIB) of this System or Subunit.

5.4.2 OnTransitions (Counter (0..MAX))

This read-only element specifies the lifetime number of transitions into the On power state in a positive 32-bit integer or zero (XML Schema/SNMP MIB) of this System or Subunit.

5.4.3 StandbyTransitions (Counter (0..MAX))

This read-only element specifies the lifetime number of transitions into the Standby power state in a positive 32-bit integer or zero (XML Schema/SNMP MIB) of this System or Subunit.

5.4.4 SuspendTransitions (Counter (0..MAX))

This read-only element specifies the lifetime number of transitions into the Suspend power state in a positive 32-bit integer or zero (XML Schema/SNMP MIB) of this System or Subunit.

5.5 Power Meter Group (OPTIONAL)

The Power Meter group of Power Status elements contains the current, monthly, and lifetime power meters for each System or Subunit. The following OPTIONAL read-only elements are defined in the Power Meter group.

Usage: All Imaging Systems that implement this Power Meter group MUST implement all properties as persistent across power cycles and hardware reconfigurations.

5.5.1 PowerMetersAreActual (boolean)

The read-only element specifies whether or not Power Meter properties for this System or Subunit are based on actual measurement (true) or software estimation (false) in a binary encoding ('boolean' in an XML Schema or 'TruthValue' in an SNMP MIB).

Default Value: "false"

5.5.2 PowerCurrentWatts (Gauge (0..MAX))

This read-only element specifies the current power consumption in watts in a positive 32-bit integer or zero (for less than one watt, i.e., nominal none) of this Imaging System.

5.5.3 PowerPeakWatts (Gauge (0..MAX))

This read-only element specifies the peak power consumption in watts in a positive 32-bit integer or zero (for less than one watt, i.e., nominal none) since last reboot of this System or Subunit.

5.5.4 PowerCurrentMonthKWH (Gauge (0..MAX))

This read-only element specifies the current month's power consumption in kilowatt hours in a positive 32-bit integer or zero (for less than one kilowatt hour, i.e., nominal none) of this System or Subunit.

Usage: Because it specifies the *current* month's power consumption, the value of this property will change rapidly.

5.5.5 PowerPreviousMonthKWH (Gauge (0..MAX))

This read-only element specifies the previous month's power consumption in kilowatt hours in a positive 32-bit integer or zero (for less than one kilowatt hour, i.e., nominal none) of this System or Subunit.

Usage: Because it specifies the *previous* month's power consumption, the value of this property will be stable and may be read on any day of the current month (for reliable accounting).

5.5.6 PowerLifetimeKWH (Counter (0..MAX))

This read-only element specifies the lifetime power consumption in kilowatt hours in a positive 32-bit integer or zero (for less than one kilowatt hour, i.e., nominal none) of this System or Subunit.

5.6 Examples of Power Status Elements (Informative)

Below are concrete usage examples of Power Status elements.

5.6.1 Examples of Power General Group

Example of a System object with Power General Group:

System.SystemStatus.PowerGeneral.PowerUsageIsRMSWatts = “true”
System.SystemStatus.PowerGeneral.CanRequestPowerStates =
“On,Standby,Suspend,ResetSoft,OffHard,OffSoft,ResetHard”

5.6.2 Examples of Power Monitor Group

Example of a System object that is powered on and ready for Jobs:

System.SystemStatus.PowerMonitor.PowerState = “On”
System.SystemStatus.PowerMonitor.PowerStateMessage = “On from calendar trigger (34 watts)”

Example of a Subunit object (Marker) that is in standby and must warm up before printing Jobs:

Marker.MarkerStatus.PowerMonitor.PowerState = “Standby”
Marker.MarkerStatus.PowerMonitor.PowerStateMessage = “Standby from timeout trigger (18 watts)”

5.6.3 Examples of Power Log Group

Excerpt from a System object power log:

System.SystemStatus.PowerLog[1].LogID = “1” (KEY)
System.SystemStatus.PowerLog[1].PowerState = “On”
System.SystemStatus.PowerLog[1].PowerStateMessage = “On from calendar trigger (34 watts)”
System.SystemStatus.PowerLog[1].PowerStateTimestamp = “2000-01-12T12:13:14Z”
System.SystemStatus.PowerLog[1].PowerComponentType = “System”
System.SystemStatus.PowerLog[1].PowerComponentReferenceId = “1”

System.SystemStatus.PowerLog[2].LogID = “2” (KEY)
System.SystemStatus.PowerLog[2].PowerState = “Suspend”
System.SystemStatus.PowerLog[2].PowerStateMessage = “Suspend from timeout trigger (7 watts)”
System.SystemStatus.PowerLog[2].PowerStateTimestamp = “2000-01-12T19:00:13Z”
System.SystemStatus.PowerLog[2].PowerComponentType = “System”
System.SystemStatus.PowerLog[2].PowerComponentReferenceId = “1”

5.6.4 Example of Power Counter Group

Excerpt from a System object:

System.SystemStatus.PowerCounter.HibernateTransitions = “25”
System.SystemStatus.PowerCounter.OnTransitions = “212”
System.SystemStatus.PowerCounter.StandbyTransitions = “74”
System.SystemStatus.PowerCounter.SuspendTransitions = “122”

5.6.5 Example of Power Meter Group

Excerpt from a System object:

System.SystemStatus.PowerGeneral.PowerUsageIsRMSWatts = “true”

System.SystemStatus.PowerMeter.PowerMetersAreActual = “true” (actual measurement)
System.SystemStatus.PowerMeter.PowerCurrentWatts = “22”
System.SystemStatus.PowerMeter.PowerPeakWatts = “54”
System.SystemStatus.PowerMeter.PowerCurrentMonthKWH = “2048”
System.SystemStatus.PowerMeter.PowerPreviousMonthKWH = “3244”
System.SystemStatus.PowerMeter.PowerLifetimeKWH = “31344”

5.7 Power State Transition Notifications (RECOMMENDED)

Imaging Systems and Imaging Clients that support this Power Management Model SHOULD support power state transition notifications for System and Subunit components via the printerV2Alert SNMP trap defined in IETF Printer MIB v2 [RFC3805], the PWG Imaging System Power MIB [PWG5106.5], IPP Event Notifications [RFC 3995], Web Services interfaces, and any other supported system management protocols.

Note: The power state extensions for the PrtAlertCodeTC textual convention defined in the IANA Printer MIB [IANAPRT] are specified in section 9.7 of this document. The power state extensions for the printer-state-reasons attribute defined in IPP/1.1 [RFC2911] are specified in section 9.8 of this document.

6 Power Capabilities Element Definitions

The following elements are defined in the PowerCapabilities class of the PWG Power Management Model and MUST only be set by the Imaging System itself.

6.1 Power Support Group (OPTIONAL)

The Power Support group lists the supported DMTF CIM stable power states (see section 2.4.2) and vendor extension stable power states (see section 2.4.5) for each System or Subunit. The following OPTIONAL read-only elements are defined in the Power Support group.

6.1.1 PowerState (PowerStateWKV) – KEY

This read-only KEY element specifies the instance as a keyword (XML Schema) or a positive 32-bit integer (SNMP MIB) of this Power Support group of elements – a supported stable enumerated power state of the System or Subunit.

Default Value: <not specified for key>

6.1.2 PowerInactiveWatts (int (0..MAX))

This read-only element specifies the nominal power consumption in watts in a positive 32-bit integer or zero (for less than one watt, i.e., nominal none) of this stable power state for the System or Subunit (as determined by the manufacturer, NOT by actual power usage measurement), when the System or Subunit is in a inactive operational state (e.g., Idle or Stopped).

Default Value: “0”

6.1.3 PowerActiveWatts (int (0..MAX))

This read-only element specifies the nominal power consumption in watts in a positive 32-bit integer or zero (for less than one watt, i.e., nominal none) of this stable power state for the System or Subunit (as determined by the manufacturer, NOT by actual power usage measurement), when the System or Subunit is in an active operational state (e.g., Processing or Testing).

Default Value: “0”

6.1.4 PowerPeakWatts (int (0..MAX))

This read-only element specifies the peak power consumption in watts in a positive 32-bit integer or zero (for less than one watt) of this stable power state for the System or Subunit (as determined by the manufacturer, NOT by actual power usage measurement), when the System or Subunit is in an active operational state (e.g., Processing or Testing).

Default Value: “0”

6.1.5 CanAcceptJobs (boolean)

This read-only element specifies whether the System or Subunit will accept new incoming Jobs in this stable power state in a binary encoding ('boolean' in an XML Schema or 'TruthValue' in an SNMP MIB), unless the System or Subunit has been disabled by an Administrator. This element does NOT report the disabled condition.

Default Value: "false"

6.1.6 CanProcessJobs (boolean)

This read-only element specifies whether the System or Subunit will process new incoming Jobs or existing queued Jobs in this stable power state in a binary encoding ('boolean' in an XML Schema or 'TruthValue' in an SNMP MIB), unless the System or Subunit has been paused by an Administrator. This element does NOT report the paused condition.

Default Value: "false"

6.1.7 CanRequestPowerState (boolean)

This read-only element specifies whether this power state is valid for use in the Power Policy (Timeout, Calendar, and Event) and Power Request groups in a binary encoding ('boolean' in an XML Schema or 'TruthValue' in an SNMP MIB).

Default Value: "false"

6.1.8 CanUseInterfaces (string)

This read-only element specifies whether the System will use the Interfaces listed in a string (XML Schema/SNMP MIB) or the empty string (none) in this stable power state, unless one or more of these Interfaces has been disabled or powered down by an Administrator. This element does NOT report the disabled or down conditions of the Interfaces.

Usage: This element MUST be of the format "<ID1>,…,<IDn>" (e.g., 1,3,4) and MUST contain a comma-delimited list of InterfaceID values (XML Schema) or corresponding ifIndex values (SNMP MIB). If this element is instantiated on a Subunit (e.g., in an SNMP MIB), then this element MUST have the same value as corresponding element in the parent System object.

Default Value: "" (empty string)

6.2 Power Transition Group (OPTIONAL)

The Power Transition group lists the supported transitions between DMTF CIM stable power states (see section 2.4.2) or vendor extension stable power states (see section 2.4.5) for each System or Subunit. The following OPTIONAL read-only elements are defined in the Power Transition group.

6.2.1 StartPowerState (PowerStateWKV) – KEY

This read-only KEY element specifies the starting stable enumerated power state (see section 2.4.2) as a keyword (XML Schema) or a positive 32-bit integer (SNMP MIB) of this power state transition for the System or Subunit.

Default Value: <not specified for key>

6.2.2 EndPowerState (PowerStateWKV) – KEY

This read-only KEY element specifies the ending stable enumerated power state (see section 2.4.2) as a keyword (XML Schema) or a positive 32-bit integer (SNMP MIB) of this power state transition for the System or Subunit.

Default Value: <not specified for key>

6.2.3 StateChangeSeconds (int (0..MAX))

This read-only element specifies the nominal duration in seconds in a positive 32-bit integer or zero (for less than one second, i.e., nominal immediate) of this power state transition of the System or Subunit (as determined by the manufacturer, NOT the actual power transition duration measurement).

Default Value: “0” (nominal immediate)

6.3 Examples of Power Capabilities Elements (Informative)

Below are concrete usage examples of Power Capabilities elements.

6.3.1 Examples of Power Support Group

Example of a System object that supports standby and administrative request for standby:

System.SystemStatus.PowerGeneral.PowerUsageIsRMSWatts = “true”
System.SystemStatus.PowerSupport[Standby].PowerState = “Standby” (KEY)
System.SystemStatus.PowerSupport[Standby].PowerInactiveWatts = “14”
System.SystemStatus.PowerSupport[Standby].PowerActiveWatts = “20”
System.SystemStatus.PowerSupport[Standby].PowerPeakWatts = “24”
System.SystemStatus.PowerSupport[Standby].CanAcceptJobs = “true”
System.SystemStatus.PowerSupport[Standby].CanProcessJobs = “false”
System.SystemStatus.PowerSupport[Standby].CanRequestPowerState = “true”
System.SystemStatus.PowerSupport[Standby].CanUseInterfaces = “1,2,3”

Example of a System object that supports hibernate but NOT administrative request for hibernate:

System.SystemStatus.PowerGeneral.PowerUsageIsRMSWatts = “true”

System.SystemStatus.PowerSupport[Hibernate].PowerState = “Hibernate” (KEY)

System.SystemStatus.PowerSupport[Hibernate].PowerInactiveWatts = “2”
System.SystemStatus.PowerSupport[Hibernate].PowerActiveWatts = “2”
System.SystemStatus.PowerSupport[Hibernate].PowerPeakWatts = “2”
System.SystemStatus.PowerSupport[Hibernate].CanAcceptJobs = “false”
System.SystemStatus.PowerSupport[Hibernate].CanProcessJobs = “false”
System.SystemStatus.PowerSupport[Hibernate].CanRequestPowerState = “false”
System.SystemStatus.PowerSupport[Hibernate].CanUseInterfaces = “” (none)

6.3.2 Examples of Power Transition Group

Example of a System object that supports a transition from standby to on:

System.SystemStatus.PowerTransition[Standby,On].StartPowerState = “Standby” (KEY)
System.SystemStatus.PowerTransition[Standby,On].EndPowerState = “On” (KEY)
System.SystemStatus.PowerTransition[Standby,On].StateChangeSeconds = “22”

Example of a System object that supports a transition from standby to suspend:

System.SystemStatus.PowerTransition[Standby,Suspend].StartPowerState = “Standby” (KEY)
System.SystemStatus.PowerTransition[Standby,Suspend].EndPowerState = “Suspend” (KEY)
System.SystemStatus.PowerTransition[Standby,Suspend].StateChangeSeconds = “15”

7 Power Settings Element Definitions

The following elements are defined in the Power Settings class of the PWG Power Management Model and MAY be set by the Imaging System itself and/or Administrator.

7.1 Power Request Group (OPTIONAL)

The Power Request group supports user requests for power state transitions for each System or Subunit. The following OPTIONAL read-write and read-only elements are defined in the Power Request group.

7.1.1 RequestPowerState (PowerStateWKV)

This read-write element specifies the requested stable or special enumerated power state as a keyword (XML Schema) or a positive 32-bit integer (SNMP MIB) and MAY be set by either the Imaging System or the Administrator.

Default Value: “Unknown”

7.1.2 RequestStatus (PowerRequestStatusWKV)

This read-only element specifies the current enumerated request processing status as a keyword (XML Schema) or a positive 32-bit integer (SNMP MIB) of this power request for the System or Subunit and MUST only be set by the Imaging System itself.

Default Value: “None”

7.2 Power Timeout Group (RECOMMENDED)

The Power Timeout Group lists configured timeout-based power state change policies for each System or Subunit. The following RECOMMENDED read-write and read-only elements are defined in the Power Timeout group. These Power Timeout elements are technically aligned with the IETF Schedule MIB [RFC3231], for compatibility and extensibility.

Usage: All Imaging Systems that support this Power Timeout group MUST implement this Power Timeout group as persistent across power cycles and hardware reconfigurations.

7.2.1 TimeoutID (int (1..MAX)) – KEY

This read-only KEY element specifies the instance in a positive 32-bit integer of this timeout policy for the System or Subunit (e.g., for queries).

Default Value: <not specified for key>

7.2.2 RequestPowerState (PowerStateWKV)

This read-write element specifies the requested stable or special enumerated power state as a keyword (XML Schema) or a positive 32-bit integer (SNMP MIB) of this timeout policy for the System or Subunit.

Default Value: “Unknown”

7.2.3 StartPowerState (PowerStateWKV)

This read-write element specifies the timeout starting stable enumerated power state as a keyword (XML Schema) or a positive 32-bit integer (SNMP MIB) of this power policy for the System or Subunit.

Default Value: “NotApplicable”

7.2.4 TimeoutPredicate (PowerTimeoutPredicateWKV)

This read-write element specifies the timeout predicate condition as a keyword (XML Schema) or a positive 32-bit integer (SNMP MIB) of this power policy for the System or Subunit.

Default Value: “None”

7.2.5 TimeoutSeconds (int (0..MAX))

This read-write element specifies the timeout interval in seconds as a positive 32-bit integer (XML Schema and SNMP MIB) or zero (for none) of this power policy for the System or Subunit.

Default Value: “0” (none)

7.3 Power Calendar Group (OPTIONAL)

The Power Calendar Group lists configured calendar-based power state change policies for each System or Subunit. The following OPTIONAL read-write and read-only elements are defined in the Power Calendar group. These Power Calendar elements are technically aligned with the IETF Schedule MIB [RFC3231], for compatibility and extensibility.

Usage: All Imaging Systems that support this Power Calendar group MUST implement this Power Calendar group as persistent across power cycles and hardware reconfigurations.

7.3.1 CalendarID (int (1..MAX)) – KEY

This read-only KEY element specifies the instance in a positive 32-bit integer of this calendar policy for the System or Subunit (e.g., for queries).

Default Value: <not specified for key>

7.3.2 RequestPowerState (PowerStateWKV)

This read-write element specifies the requested stable or special enumerated power state as a keyword (XML Schema) or a positive 32-bit integer (SNMP MIB) of this calendar policy for the System or Subunit.

Default Value: “Unknown”

7.3.3 CalendarRunOnce (boolean)

This read-write element specifies whether this calendar policy should be run once (single execution) or repeatedly (multiple executions) in a binary encoding (‘boolean’ in an XML Schema or ‘TruthValue’ in an SNMP MIB).

Default Value: “false”

7.3.4 CalendarDayOfWeek (PowerCalendarDayOfWeekWKV)

This read-write element specifies the trigger enumerated day of the week (Sunday through Saturday or any) as a keyword (XML Schema)or a positive 32-bit integer (SNMP MIB) of this calendar policy for the System or Subunit.

Default Value: “Any”

7.3.5 CalendarMonth (PowerCalendarMonthWKV)

This read-write element specifies the trigger enumerated month (January through December or any) as a keyword (XML Schema)or a positive 32-bit integer (SNMP MIB) of this calendar policy for the System or Subunit.

Default Value: “Any”

7.3.6 CalendarDay (int (0..31)

This read-write element specifies the trigger day of the month as a positive 32-bit integer (XML Schema and SNMP MIB) or zero (for any) of this calendar policy for the System or Subunit.

Usage: ‘1’ is the first day of the month, ‘2’ is the second day of the month, etc.

Default Value: “0” (any day of the month)

7.3.7 CalendarHour (int (0..23)

This read-write element specifies the trigger hour as a non-negative 32-bit integer (XML Schema and SNMP MIB) of this calendar policy for the System or Subunit.

Usage: ‘0’ is the first hour of the day (12:00-12:59 am), ‘1’ is the second hour of the day (1:00-1:59 am), etc. Exactly midnight (i.e., 12:00 am) is specified by a value of zero for CalendarHour and a value of zero for CalendarMinute.

Default Value: “0” (first hour of the day)

7.3.8 CalendarMinute (int (0..59))

This read-write element specifies the trigger minute as a non-negative 32-bit integer (XML Schema and SNMP MIB) of this calendar policy for the System or Subunit.

Usage: ‘0’ is the first minute of the hour (e.g., 7:00pm), ‘1’ is the second minute of the hour (e.g., 7:01pm), etc. Exactly at the hour (e.g., 7:00pm) is specified by a value of zero for CalendarMinute.

Default Value: “0” (first minute of the hour)

7.4 Power Event Group (OPTIONAL)

The Power Event Group lists configured event-based power state change policies for each System or Subunit. The following OPTIONAL read-write and read-only elements are defined in the Power Event group.

Usage: All Imaging Systems that support this Power Event group MUST implement this Power Event group as persistent across power cycles and hardware reconfigurations.

7.4.1 EventID (int (1..MAX)) – KEY

This read-only KEY element specifies the instance in a positive 32-bit integer of this event policy for the System or Subunit (e.g., for queries).

Default Value: <not specified for key>

7.4.2 RequestPowerState (PowerStateWKV)

This read-write element specifies the requested stable or special enumerated power state as a keyword (XML Schema) or a positive 32-bit integer (SNMP MIB) of this event policy for the System or Subunit.

Default Value: “Unknown”

7.4.3 EventName (string)

This read-write element specifies the trigger event name as a keyword (XML Schema or SNMP MIB) of this event policy for the System or Subunit.

Usage: Event names MUST be either: (a) the exact case-sensitive label (starting with a lowercase character) of an enumerated value in the PrtAlertCodeTC textual convention in the IANA Printer MIB [IANAPRT] (e.g., ‘jam’); or (b) a case-sensitive keyword (starting with an Uppercase character) vendor event name (e.g., ‘AcmeCrackedCrock’). Event name keywords MUST be specified in US-ASCII [ISO646] (for interoperability).

Default Value: “” (empty string)

7.5 Examples of Power Settings Elements (Informative)

Below are concrete usage examples of Power Settings elements.

7.5.1 Examples of Power Request Group

Example of a System object that is processing a request for suspend:

System.SystemDescription.PowerRequest.RequestPowerState = “Suspend”
System.SystemDescription.PowerRequest.RequestStatus = “InProgress”

Example of a System object that has completed a request for power on:

System.SystemDescription.PowerRequest.RequestPowerState = “On”
System.SystemDescription.PowerRequest.RequestStatus = “Success”

7.5.2 Examples of Power Timeout Group

Example of a System object with a configured site policy for standby on inactivity:

System.SystemDescription.PowerTimeout[5].TimeoutID = “5”
System.SystemDescription.PowerTimeout[5].RequestPowerState = “Standby”
System.SystemDescription.PowerTimeout[5].StartPowerState = “On”
System.SystemDescription.PowerTimeout[5].TimeoutPredicate = “Inactivity”
System.SystemDescription.PowerTimeout[5].TimeoutSeconds = “120”

Example of a System object with a configured site policy for wakeup on activitiy:

System.SystemDescription.PowerTimeout[6].TimeoutID = “6”
System.SystemDescription.PowerTimeout[6].RequestPowerState = “On”
System.SystemDescription.PowerTimeout[6].StartPowerState = “NotApplicable”
System.SystemDescription.PowerTimeout[6].TimeoutPredicate = “Activity”
System.SystemDescription.PowerTimeout[6].TimeoutSeconds = “3

7.5.3 Examples of Power Calendar Group

Example of a System object that supports a site policy for hibernate every Friday at 7pm:

System.SystemDescription.PowerCalendar[23].CalendarID = “23” (KEY)
System.SystemDescription.PowerCalendar[23].RequestPowerState = “Hibernate”
System.SystemDescription.PowerCalendar[23].CalendarDayOfWeek = “Friday”
System.SystemDescription.PowerCalendar[23].CalendarMonth = “Any”
System.SystemDescription.PowerCalendar[23].CalendarDay = “0” (Any)
System.SystemDescription.PowerCalendar[23].CalendarHour = “19”
System.SystemDescription.PowerCalendar[23].CalendarMinute = “0”

Example of a System object that supports a site policy for wakeup every Monday at 8pm:

System.SystemDescription.PowerCalendar[24].CalendarID = “24” (KEY)
System.SystemDescription.PowerCalendar[24].RequestPowerState = “On”
System.SystemDescription.PowerCalendar[24].CalendarDayOfWeek = “Monday”
System.SystemDescription.PowerCalendar[24].CalendarMonth = “Any”
System.SystemDescription.PowerCalendar[24].CalendarDay = “0” (Any)
System.SystemDescription.PowerCalendar[24].CalendarCalendarHour = “8”
System.SystemDescription.PowerCalendar[24].CalendarMinute = “0”

7.5.4 Examples of Power Event Group

Example of a System object that supports a site policy for standby because of paper jam:

System.SystemDescription.PowerEvent[10].EventID = “10” (KEY)
System.SystemDescription.PowerEvent[10].RequestPowerState = “Standby”
System.SystemDescription.PowerEvent[10].EventName = “jam”

Example of a System object that supports a factory default policy for wakeup because of power on:

System.SystemDescription.PowerEvent[1].EventID = “1” (KEY)
System.SystemDescription.PowerEvent[1].RequestPowerState = “On”
System.SystemDescription.PowerEvent[1].EventName = “powerUp”

8 Conformance Requirements

Below are the summary conformance requirements for this specification.

8.1 Power Management Server Conformance Requirements

To claim conformance to this specification, a Power Management Server implementation for a Printer, Multifunction Device, or other Imaging System:

(a) MUST support the REQUIRED Power General, Power Monitor, and Power Log groups defined in section 5 of this specification;
(b) MUST only implement the Power General and Power Log groups on the System object per section 5 of this specification;
(c) MUST implement the Power Log group as persistent across power cycles and hardware reconfigurations and SHOULD support at least 10 records in the Power Log (for reliable fleet management);
(d) MUST implement all supported power policies (Power Timeout, Power Calendar, and/or Power Event) as persistent across power cycles and hardware reconfigurations;
(e) SHOULD support the RECOMMENDED Power Timeout group defined in section 7 of this specification;
(f) MUST conform to the Internationalization Considerations defined in section 10 of this specification;
(g) MUST conform to the Security Considerations defined in section 11 of this specification;
(h) MUST support the PWG Power Management Model for the System object;
(i) SHOULD implement the PWG Imaging System State and Counter MIB v2 [PWG5106.3] (operational states), the IETF Printer MIB v2 [RFC3805] (alerts), and the PWG Imaging System Power MIB [PWG5106.5] (power states) in order to report comprehensive System and Subunit states;
(j) SHOULD conform to the mapping of valid power states to each operational state defined in section 2.5.1 of this specification;
(k) Only if the icKeyTable, icServiceTable, or icSubunitTable in the PWG Imaging System State and Counter MIB v2 [PWG5106.3] are implemented, MUST also implement those tables as persistent across power cycles as required in section 4.6 of this specification;
(l) Only if the Scanner and/or Marker components are supported, SHOULD also support the PWG Power Management Model for the Scanner and Marker objects; and
(m) Only if notifications are supported, SHOULD also support the Power State Transition Notifications defined in sections 5.7, 9.7, and 9.8.

8.2 Power Management Client Conformance Requirements

To claim conformance to this specification, a Power Management Client implementation for a Printer, Multifunction Device, or other Imaging System:

(a) MUST support the REQUIRED Power General, Power Monitor, and Power Log groups defined in section 5 of this specification;
(b) SHOULD support the RECOMMENDED Power Timeout group defined in section 7 of this specification;
(c) MUST explicitly identify the implemented set of PWG Power Management Model elements defined in sections 5, 6, and 7 of this specification;

(d) MUST conform to the Internationalization Considerations defined in section 10 of this specification;
(e) MUST conform to the Security Considerations defined in section 11 of this specification;
(f) MUST support the PWG Power Management Model for the System object; and
(g) SHOULD implement the PWG Imaging System State and Counter MIB v2 [PWG5106.3] (operational states), the IETF Printer MIB v2 [RFC3805] (alerts), and the PWG Imaging System Power MIB [PWG5106.5] (power states) in order to query comprehensive System and Subunit states;
(h) Only if the Scanner and/or Marker components are supported, SHOULD also support the PWG Power Management Model for the Scanner and Marker objects; and
(i) Only if notifications are supported, SHOULD also support the Power State Transition Notifications defined in section 5.7, 9.7, and 9.8.

9 IANA and PWG Considerations

The IANA registration considerations for this document for the PrtAlertCodeTC textual convention defined in the IANA Printer MIB [IANAPRT] are specified in section 9.7 below. The IANA registration considerations for this document for the printer-state-reason attribute defined in IPP/1.1 [RFC2911] are specified in section 9.8 below.

The XML Schema for the PWG Semantic Model/2.0 [PWGSM20] will include all of the Power Management Model element groups defined in sections 5,6, and 7 of this specification (see detailed requirements in section 4).

The XML Schema for the PWG Semantic Model/2.0 [PWGSM20] will include the standard values of the PowerStateWKV, PowerCalendarMonthWKV, PowerCalendarDayOfWeekWKV, PowerComponentTypeWKV, PowerRequestStatusWKV, and PowerTimeoutPredicateWKV enumerations defined below.

9.1 PowerStateWKV (Enum)

The table below lists all of the enumerated power state keyword values for XML Schema in the PWG Semantic Model/2.0 [PWGSM20] and their normative mapping to corresponding SNMP MIB enumerated names/values, DMTF CIM [DSP1027] power state names/values, and ACPI [ACPI] power state names.

See: Table 3 on page 12 in section 7.3 of DMTF Power State Management Profile [DSP1027].

See: PowerState, RequestedPowerState, AvailableRequestedPowerStates, and TransitioningToPowerState in CIM AssociatedPowerManagementService class.

Table 2 – Standard Power State Values (XML, SNMP, DMTF, ACPI)

XML Power State Keyword	SNMP Power State Name/Value [4]	DMTF CIM Power State Name/Value [4]	ACPI Power State Name	Description and Required Imaging System Behavior
Other [1]	other(1)	Other(1)	(none)	Other – DO NOT USE
Unknown [2]	unknown(2)	Unknown(0)	(none)	Unknown – Initial Default ONLY
On	on(20)	On (2)	G0 or S0 Working	On – new jobs MUST be accepted/processed immediately
Standby	standby(30)	Sleep-Light (3)	S1 or S2	Standby – highest power usage in Sleep Mode – shortest warm-up to On – new jobs MAY be accepted
Suspend	suspend(40)	Sleep-Deep (4)	S3	Suspend – lowest power usage in Sleep Mode – new jobs MAY be accepted
ResetSoft	resetSoft(50)	Power Cycle (Off-Soft) (5)	G2 or S5, then S0 (w/	Soft power reset – soft power off, then

			lost context)	power on
OffHard	offHard(60)	Off-Hard (6)	G3	Hard power off – mechanical unplug – no power consumed – Off Mode
Hibernate	hibernate(70)	Hibernate (Off-Soft) (7)	S4	Hibernate – save context and OS, then soft power off – limited auxiliary power – Off Mode – NOT Sleep mode
OffSoft	offSoft(80)	Off-Soft (8)	G2 or S5	Soft power off – switch w/ flea or auxiliary power – Off Mode
ResetHard	resetHard(90)	Power Cycle (Off-Hard) (9)	G0 to G3, then S0	Hardware power reset – hard power off, then power on
ResetMBR [3]	resetMBR(100)	Master Bus Reset (10)	S5, then S0	Hardware power reset (MBR)
ResetNMI [3]	resetNMI(110)	Diagnostic Interrupt (NMI) (11)	S5, then S0	Hardware power reset (NMI)
OffSoftGraceful	offSoftGraceful(120)	Off-Soft Graceful (12)	G2 or S5	Orderly shutdown, then soft power off to OffSoft
OffHardGraceful	offHardGraceful(130)	Off-Hard Graceful (13)	G3	Orderly shutdown, then hard power off to OffHard
ResetMBRGraceful [3]	resetMBRGraceful(140)	Master Bus Reset Graceful (14)	S5, then S0	Orderly shutdown, then MBR power reset
ResetSoftGraceful	resetSoftGraceful(150)	Power Cycle Off-Soft Graceful (15)	G2 or S5, then S0 (w/ lost context)	Orderly shutdown, then soft power reset
ResetHardGraceful	resetHardGraceful(160)	Power Cycle Off-Hard Graceful (16)	G3, then S0	OrderlyShutdown, then hard power off, then power on
ResetINIT[3]	resetINIT(170)	Diagnostic Interrupt (INIT) (17)	S5, then S0	Hardware power reset (INIT)
NotApplicable	notApplicable(180)	Not Applicable (18)	(none)	Not applicable (for power transitions)
NoChange	noChange(190)	No Change (19)	(none)	No change (for power transitions)

Notes:

(1) 'Other' MUST only be used for DMTF CIM compatibility.

(2) 'Unknown' MUST only be used for initial default values.

(3) 'resetMBR', 'resetNMI', 'resetINIT' MUST NOT be used in the Power Request or power policy groups, because they represent hardware interrupts (see section 6.1.5 CanRequestPowerState).

(4) SNMP MIB values are DMTF CIM values multiplied by 10 (see section 9.1.1 below).

9.1.1 Vendor Extension Stable Power States

Vendor extensions (see section 2.4.5) to base standard DMTF CIM stable power states (see section 2.4.2) MUST be defined as follows:

(1) In XML Schema elements, the base standard stable power state keyword (e.g., Standby) MUST be suffixed with 'Vendor' followed by a single digit between '1' and '5' (e.g., StandbyVendor1).

(2) In SNMP MIB objects, the base standard stable power state name (e.g., standby) MUST be suffixed with 'Vendor' followed by a single digit between '1' and '5' (e.g., standbyVendor1) and the corresponding base standard power state value (e.g., 30) MUST be added to a single digit between '1' and '5' (e.g., 31).

Usage: Implementations MUST support the corresponding base stable power state, e.g., 'Standby', whenever they support any vendor extension stable power state, e.g., 'StandbyVendor1'.

Usage: Vendor extension stable power states MUST be strictly ordered by their nominal inactive power consumption (see section 6.1.2), e.g., 'StandbyVendor2' MUST consume equal or higher power than 'StandbyVendor1' and 'StandbyVendor1' MUST consume equal or higher power than 'StandbyVendor' (the base standard stable power state).

Usage: Vendor extensions MUST NOT be defined for DMTF CIM special power states or DMTF CIM out-of-band power states, to avoid ambiguity.

9.2 PowerCalendarMonthWKV (Enum)

The table below lists all of the enumerated calendar month keyword values for XML Schema in the PWG Semantic Model/2.0 [PWGSM20] and their normative mapping to corresponding SNMP MIB enumerated names/values.

Table 3 – Standard Power Calendar Month Values (XML, SNMP)

XML Power Calendar Month Keyword	SNMP Power Calendar Month Name/Value	Description
January	january(1)	January
February	february(2)	February
March	march(3)	March
April	april(4)	April
May	may(5)	May
June	june(6)	June
July	july(7)	July
August	august(8)	August
September	september(9)	September
October	october(10)	October
November	november(11)	November
December	december(12)	December
None	none(13)	None – no calendar month

9.3 PowerCalendarDayOfWeekWKV (Enum)

The table below lists all of the enumerated calendar day of the week keyword values for XML Schema in the PWG Semantic Model/2.0 [PWGSM20] and their normative mapping to corresponding SNMP MIB enumerated names/values.

Table 4 – Standard Power Calendar Day of Week Values (XML, SNMP)

XML Power Calendar Month Keyword	SNMP Power Calendar Month Name/Value	Description
Sunday	sunday(1)	Sunday

Monday	monday(2)	Monday
Tuesday	tuesday(3)	Tuesday
Wednesday	wednesday(4)	Wednesday
Thursday	thursday(5)	Thursday
Friday	friday(6)	Friday
Saturday	saturday(7)	Saturday
Any	any(8)	any calendar day of the week

9.4 PowerComponentTypeWKV (Enum)

The table below lists all of the enumerated power component type (System or specific Subunit, e.g., InputTray) keyword values for XML Schema in the PWG Semantic Model/2.0 [PWGSM20] and their normative mapping to corresponding SNMP MIB enumerated names/values.

Note: This enumeration is technically aligned with PrtAlertGroupTC and prtAlertGroup in the IETF Printer MIB v2 [RFC3805] and the superset IcSubunitTypeTC and icSubunitType in the PWG Imaging System State and Counter MIB [PWG5106.3].

Table 5 – Standard Power Component Type Values (XML, SNMP)

XML Power Component Type Keyword	SNMP Power Component Type Name/Value	Description and PrtAlertGroupTC or IcSubunitTypeTC* Name/Value
Other	other(1)	Other – Vendor component
Unknown	unknown(2)	Unknown – Initial Default ONLY
Console	console(4)	Console – console(4)
System	system(5)	System – generalPrinter(5)
Cover	cover(6)	Cover or Interlock – cover(6)
		N/A – localization(7) – part of System or Subunit [1]
InputTray	inputTray(8)	Input Tray – input(8)
OutputTray	outputTray(9)	Output Tray – output(9)
Marker	marker(10)	Marker – marker(10)
		N/A – markerSupplies(11) – part of Marker [1]
		N/A – markerColorant(12) – part of Marker [1]
MediaPath	mediaPath(13)	Media Path – mediaPath(13)
InputChannel	inputChannel(14)	Input Channel – channel(14)
Interpreter	interpreter(15)	Interpreter – interpreter(15)
		N/A – consoleDisplayBuffer(16) – part of Console [1]
		N/A – consoleLights(17) – part of Console [1]
		N/A – alert(18) – part of System or Subunit [1]
Finisher	finisher(30)	Finisher – finDevice(30) [3]
Interface	interface(40)	Interface - interface(40) [2]
Scanner	scanner(50)	Scanner – scanner(50) [2]
ScanMediaPath	scanMediaPath(51)	Scan Media Path – <none> [4]
FaxModem	faxModem(60)	Fax Modem – <none> [4]
OutputChannel	outputChannel(70)	Output Channel – <none> [4]
Storage	storage(80)	Storage – <none> [4]
Processor	processor(90)	Processor – <none> [4]

Notes:

(1) Component settings (e.g., localization(7) in PrtAlertGroupTC) and subcomponents (e.g., consoleLights(17) in PrtAlertGroupTC) are intentionally omitted from the PWG Power Management Model.

(2) Some hardware components (e.g., scanner(50) in IcSubunitTypeTC) are not in PrtAlertCodeTC.

(3) Specific Finisher types (e.g., stapler(302) in IcSubunitTypeTC) are intentionally omitted from the PWG Power Management Model, as they are not first-class object types in the PWG Semantic Model/2.0 [PWGSM20].

(4) Some hardware components (e.g., ScanMediaPath) are not enumerated in either PrtAlertCodeTC or IcSubunitTypeTC.

9.5 PowerRequestStatusWKV (Enum)

The table below lists all of the enumerated power request status keyword values for XML Schema in the PWG Semantic Model/2.0 [PWGSM20] and their normative mapping to corresponding SNMP MIB enumerated names/values.

Table 6 – Standard Power Request Status Values (XML, SNMP)

XML Power Request Status Keyword	SNMP Power Request Status Name/Value	Description
Other	other(1)	Other – DO NOT USE – for CIM
Unknown	unknown(2)	Unknown – DO NOT USE – for CIM
None	none(3)	None – Initial default value ONLY
InProgress	inProgress(4)	InProgress – Currently active power request
Warning	warning(5)	Warning – Completed w/ warning(s)
Error	error(6)	Error – Completed w/ error(s)
Success	success(7)	Success – Completed successfully

9.6 PowerTimeoutPredicateWKV (Enum)

The table below lists all of the enumerated timeout predicate keyword values for XML Schema in the PWG Semantic Model/2.0 [PWGSM20] and their normative mapping to corresponding SNMP MIB enumerated names/values.

Table 7 – Standard Power Timeout Predicate Values (XML, SNMP)

XML Power Timeout Predicate Keyword	SNMP Power Timeout Predicate Name/Value	Description
Other	other(1)	Other – DO NOT USE – for CIM
Unknown	unknown(2)	Unknown – DO NOT USE – for CIM
None	none(3)	None – no timeout predicate condition
Activity	activity(4)	Activity – incoming job, console input, etc.
Inactivity	inactivity(5)	Inactivity – no incoming or queued jobs, console input, etc.

9.7 PrtAlertCodeTC in IANA Printer MIB

The following values should be added to the PrtAlertCodeTC textual convention in the IANA Printer MIB [IANAPRT] according to the procedures defined in section 2.4.1 of IETF Printer MIB v2 [RFC3805]:


```
                    standby(508),               -- Not in RFC 3805
                    suspend(509),               -- Not in RFC 3805
                    hibernate(510),             -- Not in RFC 3805
```


9.8 printer-state-reasons in IANA IPP Registry

This section contains the exact registration information for IANA to update the IANA IPP Registry based on the procedures defined in [RFC2911].

The registry entry will contain the following information:

```
Section 9 (References)

[PWG5106.4] PWG Power Management Model for Imaging Systems v1.0, PWG 5106.4,
February 2011.
             ftp://ftp.pwg.org/pub/pwg/candidates/
                 cs-wimspower10-<20110214>-5106.4.pdf

Section 2 (Keyword Attribute Values)

The following new keyword values are defined for the printer-state-reasons
attribute [RFC2911]:

Attribute (attribute syntax)
  Keyword Attribute Value                       Reference
  -----------------------                       ---------
printer-state-reasons                           [RFC2911]
  standby                                       [PWG5106.4]
  suspend                                       [PWG5106.4]
  hibernate                                     [PWG5106.4]
```


10 Internationalization Considerations

The IETF Policy on Policy on Character Sets and Languages [RFC2277] requires conforming network protocols to support the UTF-8 [RFC3629] encoding of Unicode [UNICODE] [ISO10646].

Conformance: To claim conformance to this specification, a Power Management Server or Power Management Client implementation:

(a) MUST support UTF-8 as defined in [RFC3629]; and
(b) SHOULD support Network Unicode as defined in [RFC5198], which requires transmission of well-formed UTF-8 strings and recommends transmission of normalized UTF-8 strings in Normalization Form C (NFC) [UAX15].

Unicode NFC is defined as the result of performing Canonical Decomposition (into base characters and combining marks) followed by Canonical Composition (into canonical composed characters wherever Unicode has assigned them).

WARNING – Performing normalization on UTF-8 strings received from Power Management Clients and subsequently storing the results (e.g., in System objects) could cause false negatives in Power Management Client searches and failed access.

11 Security Considerations

To claim conformance to this specification, a Power Management Server or Power Management Client that supports secure administrative operations that are privileged (i.e., Operator or Administrator ONLY) MUST implement any supported power state change and power policy create/delete/update protocol requests as secure and privileged administrative operations.

Conformance: To claim conformance to this specification, a Power Management Server or Power Management Client that supports Transport Layer Security (TLS) MUST support the mandatory cipher suite required in the claimed TLS specification (summarized in the table below).

Table 8 – TLS Support Requirements for Power Management

TLS Version	Mandatory TLS Cipher Suite
1.0 [RFC2246]	TLS_DHE_DSS_WITH_3DES_EDE_CBC_SHA
1.1 [RFC4346]	TLS_RSA_WITH_3DES_EDE_CBC_SHA
1.2 [RFC5246]	TLS_RSA_WITH_AES_128_CBC_SHA

12 References

12.1 Normative References

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[DSP0004]
DMTF Common Information Model (CIM) Infrastructure, DSP0004, May 2009.
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[DSP1027]
DMTF Power State Management Profile, DSP1027, December 2009.
http://www.dmtf.org/standards/published_documents/DSP1027_2.0.0.pdf

[IANAPRT]
IANA Printer MIB, originally published in RFC3805, June 2004.
ftp://ftp.iana.org/assignments/ianaprinter-mib

[IEEE1621]
Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments, IEEE 1621, December 2004.

[ISO10646]
Information Technology - Universal Multiple-octet Coded Character Set (UCS), ISO/IEC Standard 10646, 2006.

[PWG5105.1]
PWG Semantic Model/1.0, PWG Candidate Standard 5105.1-2004, January 2004.
ftp://ftp.pwg.org/pub/pwg/candidates/cs-sm10-20040120-5105.1.pdf

[PWG5106.5]
PWG Imaging System Power MIB v1.0, PWG Candidate Standard 5106.5-2011, February 2011.
ftp://ftp.pwg.org/pub/pwg/candidates/cs-wimspowermib10-20110214-5106.5.pdf

[RFC2119]
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[RFC2246]
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[RFC2277]
IETF Policy on Character Sets and Languages, RFC 2277, January 1998.
http://www.ietf.org/rfc/rfc2277.txt

[RFC2790]
IETF Host Resources MIB v2, RFC 2790, March 2000.
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IETF Internet Printing Protocol/1.1: Model and Semantics, RFC 2911, September 2000.
http://www.ietf.org/rfc/rfc2911.txt

[RFC3231]
IETF Schedule MIB, RFC 3231, January 2002.
http://www.ietf.org/rfc/rfc3629.txt

[RFC3629]
IETF UTF-8 Transformation of ISO 10646, RFC 3629, November 2003.
http://www.ietf.org/rfc/rfc3629.txt

[RFC3805]
IETF Printer MIB v2, RFC 3805, June 2004.
http://www.ietf.org/rfc/rfc3805.txt

[RFC3806]
IETF Finisher MIB, RFC 3806, June 2004.
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[RFC3995]
IPP Event Notifications and Subscriptions, RFC 3995, March 2005.
http://www.ietf.org/rfc/rfc3995.txt

[RFC4346]
IETF Transport Layer Security 1.1, RFC 4346, April 2006.
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Unicode Format for Network Interchange, RFC 5198, March, 2008.
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12.2 Informative References

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13 Editor's Address (Informative)

Ira McDonald
High North Inc
PO Box 221
Grand Marais, MI 49839
USA
Email: blueroofmusic@gmail.com
Phone: +1-906-494-2434

The editor would like to especially thank the following individuals who also contributed significantly to the development of this document:

Nehal Dantwala	Samsung
Mike Fenelon	Microsoft
Rick Landau	Dell
Joe Murdock	Sharp
Nancy Chen	Okidata
Glen Petrie	Epson
Jerry Thrasher	Lexmark
William Wagner	TIC
Peter Zehler	Xerox

14 Appendix A Design Alternatives (Informative)

This section provides durable documentation of the 'road not taken' on various design alternatives during the development of this document.

14.1 Require Power General and Power Log only on System Object

The Power General and Power Log groups in the Power Status class were allowed only on the System object, for consistency with IETF Printer MIB v2 and recent modeling experience in DMTF CIM.

14.2 Delete Power State Characteristics from Power Monitor

The Power State characteristics (PowerInactiveWatts and CanXxx) in Power Support group were deleted from the Power Monitor group, due to redundancy.

14.3 Retain PowerStateMessage in Power Log

The PowerStateMessage element was intentionally retained in the Power Log group, for diagnostic usage.

14.4 Decompose Power Policy

The Power Policy group was decomposed into Power Timeout, Power Calendar, and Power Event groups, for clarity and to reduce model complexity.

14.5 Reduce Conformance for Power Capabilities

The Power Support and Power Transition groups in the Power Capabilities class were reduced from RECOMMENDED to OPTIONAL, because they expose power usage claims, per PWG Last Call.

14.6 Delete Timestamps from Power Request

The StartRequestTimestamp and EndRequestTimestamp elements were deleted from the Power Request group, due to redundancy with the PowerStateTimestamp element in Power Log.

14.6 Delete MonitorID and RequestID keys

The MonitorID (in Power Monitor) and RequestID (in Power Request) were deleted, due to redundancy (because there can only be one instance of Power Monitor or Power Request groups in each object).

14.7 Reduce Conformance for Power Meter

The Power Meter group in the Power Status class was reduced from RECOMMENDED to OPTIONAL, because it exposes power usage claims, per PWG Last Call.

14.8 Delete MaxXxxRecords from Power General

The MaxXxxRecords elements in the Power General group were deleted, because they are of limited utility, per PWG Last Call.

14.9 Change transitional to special for power states

The term “transitional power states” (obscure and inaccurate) was changed to “special power states”, for clarity, per PWG Last Call.

