The Printer Working Group

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IPP System Service v1.1 (SYSTEM)

Status: Approved

Abstract: This specification defines an IPP binding of the System object, System Control Service, Resource Service, and registration operation as defined in various Semantic Model specifications (PWG 5108.06, PWG 5108.03, and PWG 5109.1).

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

https://ftp.pwg.org/pub/pwg/general/process/pwg-process-4.pdf

This specification is available electronically at:

https://ftp.pwg.org/pub/pwg/candidates/cs-ippsystem11-20250328-5100.22.pdf
https://ftp.pwg.org/pub/pwg/candidates/cs-ippsystem11-20250328-5100.22.docx

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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.

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1. Introduction

This specification defines an IPP System Service binding of the PWG Semantic Model root System object and associated System Control Service that are defined in [PWG5108.06] and the PWG Resource Service that is defined in [PWG5108.03]. This specification defines IPP objects, operations, and attributes to support management and status monitoring of all configured Services, Subunits, and Resources on an Imaging System. This specification also defines IPP operations and attributes to support registration of an IPP System, through its IPP Proxy, with one or more Cloud Imaging Systems. This specification is technically aligned with the abstract Cloud Imaging Requirements and Model [PWG5109.1] and concrete IPP Shared Infrastructure Extensions [PWG5100.18].

2. Terminology

2.1 Conformance Terminology

Capitalized terms, such as MUST, MUST NOT, RECOMMENDED, REQUIRED, SHOULD, SHOULD NOT, MAY, and OPTIONAL, have special meaning relating to conformance as defined in Key words for use in RFCs to Indicate Requirement Levels [BCP14]. This specification defines the following additional capitalized conformance terms:

CONDITIONALLY REQUIRED: A MUST conformance requirement that applies only when a specified condition is true.

DEPRECATED: A SHOULD NOT conformance requirement for previously defined and approved protocol elements that are planned to be removed from use.

OBSOLETE: A MUST NOT conformance requirement for previously defined and approved protocol elements that have been removed from use.

2.2 Protocol Role Terminology

The following protocol roles are defined in order to specify unambiguous conformance requirements:

Client: Initiator of outgoing IPP session requests and sender of outgoing IPP operation requests (Hypertext Transfer Protocol -- HTTP/1.1 [STD99] User Agent).

Endpoint: Any computing device that can be connected to a network. Such devices normally are associated with a particular link layer address before joining the network and potentially an IP address once on the network. This includes: laptops, desktops, servers, cell phones, or any device that may have an IP address (or any other network layer address) [RFC5209].

Infrastructure Printer: A Printer that represents a Logical Device associated with both a Client and Proxy [PWG5100.18]. For Cloud-based implementations, the Infrastructure Printer corresponds to a Cloud Imaging Service [PWG5019.1].

Infrastructure System: A System that represents an entire Imaging System and accepts incoming requests and connections from both Clients and Proxies and contains zero or more Infrastructure Printers [PWG5100.18]. For Cloud-based implementations, the Infrastructure System corresponds to a Cloud Imaging System [PWG5019.1].

Printer: Listener for incoming IPP session requests and receiver of incoming IPP operation requests (Hypertext Transfer Protocol -- HTTP/1.1 [STD99] Server) that exposes an IPP Printer object and implements an Imaging Service.

Protocol Endpoint: An application interface, typically at the transport layer or session layer, that supports: a) initiating outgoing connection requests and operation requests; b) listening for incoming connection requests and operation requests; or c) both initiating and listening. Every Client, Printer, Proxy, and System supports at least one Protocol Endpoint. Printer and Server Protocol Endpoints are represented by distinct "ipp" or "ipps" URIs.

Proxy: A Client that sends configuration and status information to and retrieves and manages Jobs and Documents from an Infrastructure Printer [PWG5100.18] on behalf of one or more Output Devices and also communicates internally with an Infrastructure System to register the local System and get back Infrastructure Printer URIs.

System: Listener for incoming IPP session requests and receiver of incoming IPP operation requests (Hypertext Transfer Protocol -- HTTP/1.1 [STD99] Server) that exposes an IPP System object and implements a System Service.

2.3 Printing Terminology

Normative definitions and semantics of printing terms are imported from the Internet Printing Protocol/1.1 [STD92]. This specification defines the following additional printing terms:

AAA Framework: A common method for performing authentication, authorization, and accounting between multiple entities. See the Generic AAA Architecture [RFC2903] and AAA Authorization Framework [RFC2904] for background.

Administrator: An End User who is also authorized to manage all aspects of an Output Device or Printer, including creating the printer instances and controlling the authorization of other End Users and Operators [RFC2567].

Authenticated User: The same as "authenticated user" defined in [STD92] RFC 8011 Section 9.3.

Delivery Method: The mechanism by which a System or Printer delivers an Event Notification [RFC3995].

Document: An object created and managed by an Imaging Service that contains the description, processing, and status information. A Document object may have attached data and is bound to a single Job object [STD92].

End User: A person or software process that is authorized to perform basic printing functions, including finding/locating a printer, creating a local instance of a printer, viewing printer status, viewing printer capabilities, submitting a print job, viewing print job status, and altering the attributes of a print job [RFC2567].

Event: An occurrence (either expected or unexpected) within a System of a change of state, condition, or configuration of a System, Printer, or Job. An Event occurs only at one instant in time and does not span the time the physical Event takes place [RFC3995].

Event Notification: The information about an Event that the Printer delivers when an Event occurs [RFC3995].

Firmware: Persistent computer instructions and data embedded in the HCD that provides the basic functions of that device. Firmware is only replaced during a specialized update process. [PWG5110.1]

*Hardcopy Device (HCD)***:** A system producing or utilizing a physical embodiment of an electronic document or image. These systems include printers, scanners, fax machines, digital copiers, multifunction peripherals (MFPs), multifunction devices (MFDs), all-in-ones, and other similar products. [PWG5110.1]

IPP Binding: The Internet Printing Protocol implementation of an abstract information model and associated set of abstract operations and data elements [STD92].

Imaging Device: A physical hardware entity (stand-alone) or logical software entity (hosted on a network server) that supports one or more Imaging Services (e.g., Print, Scan, FaxOut, etc.) [PWG5108.01].

Imaging Service: A software entity that supports document or image processing (e.g., Print, Scan, FaxOut, 3D Print, etc.) [PWG5108.01]. An Imaging Service is represented by the IPP Printer object.

Imaging System: A logical or physical system that supports a System object and a System Service for monitoring and management of zero or more Imaging Services (e.g., Print, Scan, FaxOut, 3D Print, etc.) [PWG5108.01]. An Imaging System is represented by the IPP System object.

i^{th}: Referring to a specific IPP '1setOf' value - the first value, the second value, and so forth.

Job: An object created and managed by an Imaging Service that contains the description, processing, and status information. A Job object also contains zero or more Document objects [STD92].

Logical Device: A print server, software service, or gateway that processes jobs and either forwards or stores the processed job or uses one or more Physical Devices to render output [STD92].

Notification: Synonym for Event Notification [RFC3995].

Operator: An End User that also has special rights on the Output Device or Printer. The Operator typically monitors the status of the Printer and manages and controls the Jobs at the Output Device [RFC2567]. The Operator is allowed to query and control the Printer, Jobs, and Documents based on site policy.

Output Device: A single Logical or Physical Device [STD92].

Owner: The End User or Administrator who owns and manages (and typically created) a Job, Printer, Resource, Subscription, or System [PWG5108.06].

Physical Device: A hardware implementation of an endpoint device, e.g., a marking engine, a fax modem, etc [STD92].

Resident Application: Resident applications are those applications that are downloaded via an offline administrative or maintenance update procedure and persist after a power cycle of the HCD. These types of applications augment the normal operation of the HCD and provide additional functions that are available to all users of the HCD [PWG5110.1].

Resource: A data object (e.g., Firmware, font, logo, etc.) that can be configured on an Imaging System for use by one or more Imaging Services and has a System, Printer, or Job scope [PWG5108.01].

Spooling Service: An Imaging Service that stores all of a Job's document data so that it can be reprocessed as needed [PWG5100.18].

Streaming Service: An Imaging Service that stores some of a Job's document data as it is processed, output, and/or delivered [PWG5100.18].

Subscription: An object containing a set of attributes that indicate: the Notification Recipient (for Push Delivery Method only), the Delivery Method, the Subscribed Events that cause the Printer to deliver an Event Notification, and the information to include in an Event Notification [RFC3995].

Subunit: A hardware component (e.g., input tray or marker) or software component (e.g., input channel or interpreter) of an Imaging System [RFC3995] [PWG5108.01].

System Service: A software entity that supports management of all hardware and software components of an Imaging System and the System object defined in this specification [PWG5108.06].

User Application: User applications are applications that are downloaded and executed as part of normal operation of the HCD and may be dynamically installed and executed by

users. These applications do not include applications that are added via an offline administrative or maintenance update procedure. Examples of these types of applications include Java or Flash applications. User applications may or may not persist after a power cycle of the HCD [PWG5110.1].

2.4 Abbreviations

DPA: ISO Document Printing Application, https://www.iso.org/standard/18191.html

HCD: Hardcopy Device [PWG5110.1]

IANA: Internet Assigned Numbers Authority, https://www.iana.org/

IETF: Internet Engineering Task Force, https://www.ietf.org/

ISO: International Organization for Standardization, https://www.iso.org/

PWG: Printer Working Group, https://www.pwg.org/

3. Requirements for the IPP System Service

3.1 Rationale

Existing IPP specifications define the following features and functionality:

1. Internet Printing Protocol/2.x Fourth Edition (BASE) [PWG5100.12] defines:
    a. Three profiles that cover all previous IETF and PWG IPP specifications;
    b. Existing Printer and Job operations and attributes required for each profile;
    c. Standard IPP version numbers for each profile (2.0, 2.1, and 2.2); and
    d. Specific interoperability requirements, such as HTTP/1.1 support with chunking and IPP collection attribute support;
2. IPP Driver Replacement Extensions v2.0 (NODRIVER) [PWG5100.13] defines operations and attributes required for mobile printing and printing with generic drivers;
3. IPP Everywhere v1.1 [PWG5100.14] defines an IPP extension to support network printing without vendor-specific driver software, including transport protocols, various discovery protocols, and standard document formats;
4. IPP FaxOut Service [PWG5100.15] defines an IPP extension to support the PWG Semantic Model FaxOut Service [PWG5108.05] over IPP;
5. IPP Scan Service [PWG5100.17] defines an IPP extension to support the PWG Semantic Model Scan Service [PWG5108.02] over IPP;
6. IPP Shared Infrastructure Extensions v1.0 (INFRA) [PWG5100.18] defines operations and attributes required to allow IPP Printers to interface with shared services based in the network infrastructure, i.e., software-defined networks, and/or through Cloud-based solutions to remotely obtain and process Jobs and Documents, and provide state and configuration changes to those services;
7. Multicast DNS [RFC6762] defines how to perform ad-hoc DNS queries over a link-local network; and
8. DNS-Based Service Discovery [RFC6763] defines how to discover services using DNS.

Existing PWG Semantic Model specifications define the following features and functionality:

1. PWG MFD Model and Common Semantics [PWG5801.01] defines:
    a. A PWG System object as the root of the PWG Semantic Model (including the associated XML Schema); and
    b. An extension of the original PWG Semantic Model [PWG5105.1] (abstract print service) to support all of the typical multifunction services (Print, Scan, FaxOut, etc.);
2. PWG System object and System Control Service [PWG5108.05] defines the elements of the PWG System object and system operations of the PWG System Control Service;
3. PWG Resource Service [PWG5108.3] defines the elements of the PWG Resource object and resource operations of the PWG Resource Service; and
4. Cloud Imaging Requirements and Model [PWG5109.1] defines an abstract model to support Imaging Services using the Cloud, based on the PWG Semantic Model. The IPP Binding for this abstract model is described in IPP Shared Infrastructure Extensions v1.0 (INFRA) [PWG5100.18].

Therefore, this IPP System Service specification should define:

1. An IPP binding of the PWG System object;
2. An IPP binding of the PWG System Control Service to support management and monitoring of Imaging Systems and their configured Imaging Services; and
3. An IPP binding of the PWG Resource object and the PWG Resource Service.

3.2 Use Cases

3.2.1 Imaging System Service Enumeration

Jane wants to determine what services are available on an Imaging System and their capabilities. Jane initiates service enumeration by using the IPP Client on her laptop to send a query to the Imaging System for the list of available services. After receiving the response from the Imaging System, the IPP Client sends further queries to each Imaging Service for its capabilities and configuration. Finally, the IPP Client displays the list of available Imaging Services and their capabilities.

3.2.2 Imaging System Monitoring

Jane wants to monitor the usage and supply levels of an Imaging System. She uses the IPP Client on her laptop to periodically query the input trays and the supply levels of relevant components on the Imaging System and the usage counters for each Imaging Service supported by the Imaging System.

3.2.3 Imaging System Management

Jane needs to periodically pause and resume all of the services supported by an Imaging System in order to perform maintenance. She uses an Imaging System Management application on her laptop to send pause and resume requests to the Imaging System as needed.

3.2.4 Resource Management

Jane wants to install a resource (firmware, font, logo, etc.) on an Imaging System in order to extend the functionality of the Imaging System or an Imaging Service. She uses the IPP Client on her laptop to create and upload the desired resource to the Imaging System.

3.2.5 Bootstrap Client Access to Default Print Service

John sees that there's a new network printer installed in the hall near his office that has an IPv4 address written on the top (e.g., "10.1.2.3"). He wants to use that network printer but doesn't know how to find the specific URI of a running print service on that machine. He uses the IPP Client on his laptop to query the IPP System Service that listens on the standard IPP port (e.g., "ipp://10.1.2.3:631") on that machine to find the default print service URI on that machine (e.g., "ipp://printer12.example.com/ipp/print").

3.2.6 Discover an IPP System Service

Jane is managing the printing services on an enterprise network. She uses a management application on her Client device to find an IPP System Service on her network and configure and monitor the various imaging services they provide.

3.3 Exceptions

The standard Internet Printing Protocol/1.1 [STD92] access control, authorization, and role exceptions apply to the use cases defined in section 3.2.

3.4 Out of Scope

The out-of-scope requirements for this IPP System Service specification are:

1. Configuration of Imaging Services directly through the System Service (e.g., defaults or assigned Subunits).
2. Pause/Resume or Enable/Disable of a sparse list of specific Imaging Services on an Imaging System (because the resulting operation status would be complicated and/or ambiguous).
3. Migration of Imaging Services and/or Jobs to another Imaging System.
4. Support for any non-IPP Cloud Imaging System.
5. Definition of new discovery protocols.

3.5 Design Requirements

The design requirements for this IPP System Service specification are:

1. Follow the naming conventions defined in IPP/1.1: Model and Semantics [STD92], including keyword value case (lower) and hyphenation requirements;
2. Define objects, attribute groups, attributes, and values to support the System object, Resource object, and System Service;
3. Define operations to support the System Service and the use cases defined in section 3.2;
4. Define a DNS-SD service type for the IPP System Service;
5. Register all new IPP attributes, attribute groups, objects, operations, status codes, and values with IANA; and
6. Register the DNS-SD service type with IANA.

4. IPP Object Model

This specification extends the original IPP Model defined in section 2 of IETF IPP/1.1 Model and Semantics [STD92] from the original Print Service scope to include all Imaging Services on an Imaging System.

4.1 System Object

This specification defines a root object called a “System” object that represents an Imaging System and is an IPP binding of the System object defined in PWG System Object and System Control Service [PWG5108.06].

This object contains description values including name, manufacturer, and summaries of configured services, subunits, and resources, and overall status values including state and counters. Clients can query these values using the Get-System-Attributes operation (section 6.3.8) which, like the Get-Printer-Attributes operation [STD92], does not require authentication in order to facilitate discovery. Unlike Get-Printer-Attributes, the IPP System Service requires support for confidentiality and integrity (section 14.2) to mitigate the risk of a malicious implementation redirecting Clients to malicious IPP Printers.

Because the IPP operations on this System object and the IPP attributes defined for this System object are disjoint from those defined for the Printer object in [STD92], an IPP Imaging System that conforms to this specification supports both an IPP System object and (via a System response to the Get-Printers operation) zero or more IPP Printer objects, each of which has a separate IPP Protocol Endpoint, i.e., separate values of "ipp:" [RFC3510] and/or "ipps:" [RFC7472] URIs.

For the convenience of existing IPP Clients, this specification also includes the original Get-Printer-Attributes operation defined in the Internet Printing Protocol/1.1 [STD92] with an extension to automatically select the implementation-defined or site-defined “default” IPP Printer object, unless the IPP Client explicitly specifies a given target Printer object in the Get-Printer-Attributes request. Thus, Clients that target the System object's IPP Protocol Endpoint can still get useful information about a Printer object that can be used for printing.

4.2 Subunit Object

This specification identifies a component object called a “Subunit” object that is an IPP binding of the Subunit object defined in PWG MFD Model and Common Semantics [PWG5801.01] and is based on the Subunit (hardware or software component) defined in IETF Printer MIB v2 [RFC3805]. This specification does not define any explicit System object attributes to refer to Subunit objects. Instead, existing IPP Printer object attributes (e.g., “printer-input-tray” defined in [PWG5100.13]) can be used to convey information about Subunit objects.

4.3 Printer Object

This specification extends the original IPP Printer object defined in the Internet Printing Protocol/1.1 [STD92] to represent any Imaging Service (print, scan, etc.). The following specifications define the various Imaging Services as IPP Printers:

- IPP FaxOut Service [PWG5100.15]
- IPP Scan Service [PWG5100.17]
- IPP 3D Printing Extensions v1.1 [PWG5100.21]

This specification also defines a new “printer-id” Printer Status attribute for a unique identifier for each Printer object within the IPP System object. This extension simplifies references to Printer objects, each of which can potentially support multiple Protocol Endpoints in "printer-uri-supported" and “printer-xri-supported” with different Client authentication and Printer security policies. Clients use the "printer-id" attribute when sending requests to the System object and the "printer-uri" attribute when sending requests to a Printer object.

4.4 Job Object

This specification extends the original IPP Job object defined in IETF IPP/1.1 Model and Semantics [STD92] to represent a Job on any Imaging Service (Print, Scan, etc.), in order to reuse existing IPP Job operations and attributes in the individual Imaging Services, but NOT directly in this specification.

4.5 Document Object

This specification extends the original IPP Document object defined in IETF IPP/1.1 Model and Semantics [STD92] to represent a Document contained in a Job on any Imaging Service (Print, Scan, etc.), in order to reuse existing IPP Document operations and attributes in the individual Imaging Services, but NOT directly in this specification.

4.6 Resource Object

This specification extends the original Resource object defined in PWG Network Resource Service [PWG5108.03], in order to incorporate Resource operations directly into the IPP System Service. Resources are managed by the System and can only be created by an Administrator. Each Resource has a system-wide unique “resource-id” attribute (section 7.9.6). Resources are persistent until they are explicitly canceled by an Administrator or aborted by the System.

Like Jobs, Resources have an enumerated state value ("resource-state", section 7.9.11), a human-readable state message ("resource-state-message", section 7.9.12), and one or more state keywords ("resource-state-reasons", section 7.9.13).

Resources have an allocation scope of System, Printer, or Job. Throughout this specification, the phrases “[System|Printer|Job]-scope Resource” and “per-[System|Printer|Job] Resource” are used to specify the usage of Resources. The number of System|Printer|Job objects using (allocating) a resource is reported using the "resource-use-count" attribute (section 7.9.16).

Resources are created using the Create-Resource (section 6.3.2) and Send-Resource-Data (section 6.2.5) operations, installed (for subsequent use) using the Install-Resource (section 6.2.4) operation, and removed using the Cancel-Resource (section 6.2.1) operation. For a System-scope Resource, installing the Resource allocates it to the System object and increments the “resource-use-count”. Printer-scope Resources are allocated to a Printer object using the Allocate-Printer-Resources (section 6.1.1) operation. Job-scope Resources are allocated to a Job object in a Job Creation operation that includes a “resource-ids” (section 7.1.15) operation attribute.

When an allocated Resource is busy at the time of a Cancel-Resource request, ‘cancel-requested’ is added to the “resource-state-reasons” attribute and the Resource does not transition to a “resource-state” of ‘canceled’ until the allocated Resource is no longer busy, as indicated by a “resource-use-count” value of '0'.

See Figure 2 in section 7.9.11 for a diagram of normal Resource state transitions. Resources in this specification do not have leases and expiration times, as they formerly did in the original Resource object defined in [PWG5108.03].

IPP System Service implementations SHOULD support System-scope executable resources (e.g., for Firmware update). System Service implementations MAY support Printer-scope and/or Job-scope executable resources in an implementation-defined manner.

4.6.1 Resource History

The System MUST support an implementation-defined Resource History phase of at least 300 seconds to preserve the integrity of system log files. The System SHOULD delete Resource objects with “resource-state” of ‘canceled’ or ‘aborted’ from the Resource History when they have exceeded the implementation-defined Resource History period. This is analogous to the handling of Job objects in a terminal state as discussed in the section “Partitioning of Job States” in [STD92]. However, unlike Job objects, the Resource object associated data referenced by “resource-data-uri” SHOULD be discarded as soon as the Resource transitions to the ‘canceled’ or ‘aborted’ terminal state instead of at the end of the Resource History phase.

4.6.2 Resource Types

Resources generally fall into three categories: executable code such as Firmware and Resident/User Software applications, static content such as images, strings, and ICC profiles, and template content such as Document Tickets, Job Tickets, and Printer

configuration values. Each category has its own unique security considerations and not all categories will be supported by all System implementations.

Updates to executable code often requires a restart of the System to take effect, and this requirement is reflected in the state of the Resource after installation. Other types of resources can typically be used immediately after installation without a restart, but if a restart is required the same state information is reported for consistency.

4.7 Subscription Object

This specification extends the original IPP Subscription object defined in IPP Event Notifications and Subscriptions [RFC3995] to allow subscriptions to the IPP System object and its Resource objects for event notifications.

5. IPP Objects and Operations Summary

This specification combines and maps the PWG SM System and PWG System Control Service objects [PWG5801.01] into the IPP System object, which is the target of all IPP system-level and resource-level operations. This is consistent with Print Service operations targeted at original IPP Printer object.

This specification maps the PWG SM Resource object [PWG5108.03] into the IPP Resource object and defines a set of resource-level operations.

This specification defines additional attributes for the Printer and Job objects [STD92].

Note: All tables in this section list only top-level attributes. Collection member attributes are not listed here and are described in detail in section 7 IPP Attributes below their enclosing collection attributes.

5.1 System Attribute Group

This specification defines the system-attributes-tag (0x0A) for a System attribute group.

5.2 System Description Attributes

The potentially READ-WRITE attributes in the IPP System Description group are listed in Table 1.

Note: The SM/IPP Equivalent column specifies the Semantic Model element or IPP Printer Description attribute for the corresponding IPP System Description attribute. An SM/IPP Equivalent entry of “<none>” indicates that there is no previously defined equivalent attribute and the attribute is defined for the first time in this specification.

Table 1 - IPP System Description Attributes

Conformance	IPP Attribute Name	SM/IPP Equivalent	Reference
REQUIRED	charset-configured	charset-configured	[STD92]
REQUIRED	charset-supported	charset-supported	[STD92]
REQUIRED	document-format-supported	document-format-supported	[STD92]
REQUIRED	generated-natural-language-supported	generated-natural-language-supported	[STD92]
REQUIRED	ipp-features-supported	ipp-features-supported	[PWG5100.13]
REQUIRED	ipp-versions-supported	ipp-versions-supported	[STD92]
REQUIRED	multiple-document-printers-supported	multiple-document-jobs-supported	[STD92]
REQUIRED	natural-language-configured	natural-language-configured	[STD92]
REQUIRED	operations-supported	operations-supported	[STD92]
C. REQUIRED	output-device-x509-type-supported	<none>	<none>
OPTIONAL	power-calendar-policy-col	PowerCalendar	[PWG5108.06]
OPTIONAL	power-event-policy-col	PowerEvent	[PWG5108.06]
RECOMMENDED	power-timeout-policy-col	PowerTimeout	[PWG5108.06]

Conformance	IPP Attribute Name	SM/IPP Equivalent	Reference
REQUIRED	printer-creation-attributes-supported	job-creation-attributes-supported	[PWG5100.7]
REQUIRED	printer-service-type-supported	ServiceType	[PWG5108.06]
REQUIRED	resource-format-supported	document-format-supported	[STD92]
REQUIRED	resource-type-supported	document-format-supported	[STD92]
REQUIRED	resource-settable-attributes-supported	job-settable-attributes-supported	[RFC3380]
REQUIRED	system-contact-col	OwnerUri, OwnerVCard	[PWG5108.06]
REQUIRED	system-current-time	printer-current-time	[STD92]
REQUIRED	system-default-printer-id	<none>	<none>
REQUIRED	system-geo-location	printer-geo-location	[STD92]
REQUIRED	system-info	printer-info	[STD92]
REQUIRED	system-location	printer-location	[STD92]
REQUIRED	system-make-and-model	printer-make-and-model	[STD92]
REQUIRED	system-mandatory-printer-attributes	printer-mandatory-job-attributes	[PWG5100.13]
C. REQUIRED	system-mandatory-registration-attributes	printer-mandatory-job-attributes	[PWG5100.13]
OPTIONAL	system-message-from-operator	MessageFromOperator	[PWG5108.06]
REQUIRED	system-name	printer-name	[STD92]
REQUIRED	system-settable-attributes-supported	printer-settable-attributes-supported	[RFC3380]
REQUIRED	system-xri-supported	printer-xri-supported	[STD92]

5.3 System Status Attributes

The READ-ONLY attributes in the IPP System Status group are listed in Table 2. These attributes are inherently READ-ONLY and can only be modified indirectly as a side effect of one or more IPP System Service operations, but NOT by a Set-System-Attributes operation.

Note: The SM/IPP Equivalent column specifies the Semantic Model element or IPP Printer Status attribute for the corresponding IPP System Status attribute. An SM/IPP Equivalent entry of “<none>” indicates that there is no previously defined equivalent element or attribute and the attribute is defined for the first time in this specification.

Table 2 - IPP System Status Attributes

Conformance	IPP Attribute Name	SM/IPP Equivalent	Reference
RECOMMENDED	power-log-col	PowerLog	[PWG5108.06]
OPTIONAL	power-state-capabilities-col	PowerSupport	[PWG5108.06]
OPTIONAL	power-state-counters-col	PowerCounters	[PWG5108.06]
RECOMMENDED	power-state-monitor-col	PowerMonitor	[PWG5108.06]
OPTIONAL	power-state-transitions-col	PowerTransition	[PWG5108.06]
REQUIRED	system-config-change-date-time	printer-config-change-date-time	[PWG5100.13]
REQUIRED	system-config-change-time	printer-config-change-time	[PWG5100.13]
REQUIRED	system-config-changes	SystemConfigChangeNumber	[PWG5108.06]
REQUIRED	system-configured-printers	ConfiguredServices	[PWG5108.06]
REQUIRED	system-configured-resources	ConfiguredResources	[PWG5108.06]
RECOMMENDED	system-impressions-completed	SystemTotals	[PWG5108.06]

Conformance	IPP Attribute Name	SM/IPP Equivalent	Reference
RECOMMENDED	system-impressions-completed-col	SystemTotals	[PWG5108.06]
RECOMMENDED	system-media-sheets-completed	SystemTotals	[PWG5108.06]
RECOMMENDED	system-media-sheets-completed-col	SystemTotals	[PWG5108.06]
RECOMMENDED	system-pages-completed	SystemTotals	[PWG5108.06]
RECOMMENDED	system-pages-completed-col	SystemTotals	[PWG5108.06]
OPTIONAL	system-serial-number	SerialNumber	[PWG5108.06]
REQUIRED	system-state	printer-state	[STD92]
REQUIRED	system-state-change-date-time	printer-state-change-date-time	[RFC3995]
REQUIRED	system-state-change-time	printer-state-change-time	[RFC3995]
OPTIONAL	system-state-message	printer-state-message	[STD92]
REQUIRED	system-state-reasons	printer-state-reasons	[STD92]
RECOMMENDED	system-strings-languages-supported	printer-strings-languages-supported	[PWG5100.13]
RECOMMENDED	system-strings-uri	printer-strings-uri	[PWG5100.13]
REQUIRED	system-up-time	printer-up-time	[STD92]
REQUIRED	system-uuid	printer-uuid	[PWG5100.13]

5.4 System Operations

The operations for an IPP System Service conforming to this specification are listed in Table 3. All of these operations are REQUIRED except for Register-Output-Device which is CONDITIONALLY REQUIRED for Systems that implement IPP Shared Infrastructure Extensions [PWG5100.18]

Note: The SM/IPP/DPA Equivalent column specifies the Semantic Model, IPP, or DPA [ISO10175-3] operation. An SM/IPP/DPA Equivalent entry of “<none>” indicates that there is no previously defined equivalent operation and the operation is defined for the first time in this specification.

Table 3 - IPP System Service Operations

Code	IPP Operation Name	SM/IPP/DPA Equivalent	Reference
0x004B	Allocate-Printer-Resources	<none>	<none>
0x0052	Cancel-Resource	DeleteResource	[PWG5108.03]
0x001B	Cancel-Subscription	Cancel-Subscription	[RFC3995]
0x004C	Create-Printer	Create	[ISO10175-3]
0x0053	Create-Resource	StoreResource	[PWG5108.03]
0x0057	Create-Resource-Subscriptions	Create-Printer-Subscriptions	[RFC3995]
0x0058	Create-System-Subscriptions	Create-Printer-Subscriptions	[RFC3995]
0x004D	Deallocate-Printer-Resources	<none>	<none>
0x004E	Delete-Printer	DeleteService	[PWG5108.06]
0x0059	Disable-All-Printers	DisableAllServices	[PWG5108.06]
0x005A	Enable-All-Printers	EnableAllServices	[PWG5108.06]
0x001C	Get-Notifications	Get-Notifications	[RFC3996]

Code	IPP Operation Name	SM/IPP/DPA Equivalent	Reference
0x004F	Get-Printers	ListAllServices	[PWG5108.06]
0x000B	Get-Printer-Attributes	Get-Printer-Attributes	[STD92]
0x0065	Get-Printer-Resources	<none>	<none>
0x0020	Get-Resources	ListResources	[PWG5108.03]
0x001E	Get-Resource-Attributes	GetResourceElements	[PWG5108.03]
0x0019	Get-Subscriptions	Get-Subscriptions	[RFC3995]
0x0018	Get-Subscription-Attributes	Get-Subscription-Attributes	[RFC3995]
0x005B	Get-System-Attributes	GetSystemElements	[PWG5108.06]
0x005C	Get-System-Supported-Values	Get-Printer-Supported-Values	[RFC3380]
0x0054	Install-Resource	StoreResource	[PWG5108.03]
0x005D	Pause-All-Printers	PauseAllServices	[PWG5108.06]
0x005E	Pause-All-Printers-After-Current-Job	PauseAllServicesAfterCurrent Job	[PWG5108.06]
0x005F	Register-Output-Device	RegisterSystem [6]	[PWG5109.1]
0x001A	Renew-Subscription	Renew-Subscription	[RFC3995]
0x0060	Restart-System	Restart-Printer	[RFC3998]
0x0061	Resume-All-Printers	ResumeAllServices	[PWG5108.06]
0x0055	Send-Resource-Data	StoreResource	[PWG5108.03]
0x0056	Set-Resource-Attributes	SetResourceElements	[PWG5108.03]
0x0062	Set-System-Attributes	SetSystemElements	[PWG5108.06]
0x0063	Shutdown-All-Printers	ShutdownAllServices	[PWG5108.06]
0x0050	Shutdown-One-Printer	ShutdownService	[PWG5108.06]
0x0064	Startup-All-Printers	StartupAllServices	[PWG5108.06]
0x0051	Startup-One-Printer	StartupService	[PWG5108.06]

5.5 Resource Attribute Group

This specification defines the resource-attributes-tag (0x08) for a Resource attribute group.

5.6 Resource Description Attributes

The potentially READ-WRITE attributes in the IPP Resource Description group are listed in Table 4.

Note: The SM Equivalent column specifies the Semantic Model element for the corresponding IPP Resource Description attribute.

Note: Printer-scope Resource objects MAY be:

1. Created **before** the related Create-Printer operation and then associated with a given Printer using a Create-Printer operation via the “resource-ids” operation attribute to update the “printer-resource-ids” Printer Status attribute;
2. Created **after** the related Create-Printer operation and then associated with a given Printer using an Allocate-Printer-Resources operation via the “resource-ids” operation attribute to update the “printer-resource-ids” Printer Status attribute; or

3. Created **after** the related Create-Printer operation and then associated with a given Printer using an HTTP PUT request [RFC7230] as defined in section 4.1.9 Resources of IPP Shared Infrastructure Extensions [PWG5100.18] to update the “printer-resource-ids” Printer Status attribute.

Note: Job-scope Resource objects MUST be created **before** the Job creation operation and then associated with a given Job via the “resource-ids” Job creation operation attribute to update the “job-resource-ids” Job Status attribute.

Table 4 - IPP Resource Description Attributes

Conformance	IPP Attribute Name	SM Equivalent	Reference
REQUIRED	resource-info	ResourceInfo	[PWG5108.03]
REQUIRED	resource-name	ResourceName	[PWG5108.03]

5.7 Resource Status Attributes

The READ-ONLY attributes in the IPP Resource Status group are listed in Table 5. These attributes are inherently READ-ONLY and can only be modified indirectly as a side effect of one or more IPP System Service operations, but NOT by a Set-Resource-Attributes operation. See Figure 2 in section 7.9.11 resource-state for a diagram of normal Resource state transitions.

Note: The SM/IPP Equivalent column specifies the Semantic Model element or IPP Job Status attribute for the corresponding IPP Resource Status attribute. An SM/IPP Equivalent entry of “<none>” indicates that there is no previously defined equivalent attribute and the attribute is defined for the first time in this specification.

Table 5 - IPP Resource Status Attributes

Conformance	IPP Attribute Name	SM/IPP Equivalent	Reference
REQUIRED	date-time-at-canceled	date-time-at-completed	[STD92]
REQUIRED	date-time-at-creation	date-time-at-creation	[STD92]
REQUIRED	date-time-at-installed	date-time-at-processing	[STD92]
REQUIRED	resource-data-uri	<none>	<none>
REQUIRED	resource-format	ResourceFormat	[PWG5108.03]
REQUIRED	resource-id	ResourceId	[PWG5108.03]
REQUIRED	resource-k-octets	job-k-octets	[STD92]
REQUIRED	resource-state	job-state	[STD92[
REQUIRED	resource-state-reasons	job-state-reasons	[STD92]
REQUIRED	resource-string-version	XxxStringVersion	[PWG5110.1]
REQUIRED	resource-type	ResourceType	[PWG5108.03]
REQUIRED	resource-use-count	<none>	<none>
REQUIRED	resource-uuid	job-uuid	[PWG5100.13]
REQUIRED	resource-version	XxxVersion	[PWG5110.1]
REQUIRED	time-at-canceled	time-at-completed	[STD92]
REQUIRED	time-at-creation	time-at-creation	[STD92]

Conformance	IPP Attribute Name	SM/IPP Equivalent	Reference
REQUIRED	time-at-installed	time-at-processing	[STD92]

5.8 Printer Description Attributes

Additional potentially READ-WRITE attributes in the IPP Printer Description group are listed in Table 6.

Table 6 - IPP Printer Description Attributes

Conformance	IPP Attribute Name	SM Equivalent	Reference
REQUIRED	printer-contact-col	OwnerUri, OwnerVCard	[PWG5108.06]

5.9 Printer Status Attributes

Additional READ-ONLY attributes in the IPP Printer Status group are listed in Table 7.

Note: The SM Equivalent column specifies the Semantic Model element for the corresponding IPP Printer Status attribute. An SM Equivalent entry of “<none>” indicates that there is no previously defined equivalent element and the attribute is defined for the first time in this specification.

Table 7 - IPP Printer Status Attributes

Conformance	IPP Attribute Name	SM Equivalent	Reference
REQUIRED	printer-config-changes	ConfigChanges	[PWG5106.1]
REQUIRED	printer-id	ID	[PWG5108.06]
RECOMMENDED	printer-impressions-completed	PrintServiceCounters	[PWG5108.01]
RECOMMENDED	printer-impressions-completed-col	PrintServiceCounters	[PWG5108.01]
RECOMMENDED	printer-media-sheets-completed	PrintServiceCounters	[PWG5108.01]
RECOMMENDED	printer-media-sheets-completed-col	PrintServiceCounters	[PWG5108.01]
RECOMMENDED	printer-pages-completed	PrintServiceCounters	[PWG5108.01]
RECOMMENDED	printer-pages-completed-col	PrintServiceCounters	[PWG5108.01]
REQUIRED	printer-resource-ids	<none>	<none>
REQUIRED	printer-service-type	ServiceType	[PWG5108.06]

5.10 Job Status Attributes

Additional READ--ONLY attributes in the IPP Job Status group are listed in Table 8.

Table 8 - IPP Job Status Attributes

Conformance	IPP Attribute Name
REQUIRED	job-resource-ids

6. IPP Operations

IPP System Service implementations MUST support Client authentication and Client authorization based on System policy. Except for Get-Printer-Attributes, all System Service operations MAY require Client authentication based on System policy. All IPP Clients MUST support HTTP Basic authentication and SHOULD support HTTP Digest authentication per [STD92].

Note: Get-Printer-Attributes does not require Client authentication for backwards compatibility with existing Clients.

Note: All IPP System Service operation requests and responses use standard operation parameters as defined in [STD92].

6.1 Printer Operations

IPP System Service operations on single Printer objects (except for Get-Printers) are defined in this section.

Note: The System MUST copy the value of any supplied “printer-message-from-operator” operation attribute to any affected Printer objects (for Create-Printer, Shutdown-One-Printer, and Startup-One-Printer).

6.1.1 Allocate-Printer-Resources

This REQUIRED operation allows an authorized Operator or Administrator to allocate Resources to an existing Printer object on the target System object and update “resource-use-count” in each Resource. If the Printer object is already shutdown, with ‘shutdown’ in the “printer-state-reasons”, then the System MUST return a “status-code” of ‘client-error-forbidden’.

Note: Clients MUST NOT supply and Systems MUST NOT accept resources whose "resource-type" is 'template-printer', as Printer template resources can only be used in a Create-Printer request (section 6.3.1).

6.1.1.1 Allocate-Printer-Resources Request

The following groups of attributes are part of an Allocate-Printer-Resources request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

“printer-id” (integer(1:65535)):

The Client MUST supply and the System MUST support this operation attribute which is the target Printer for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“resource-ids” (1setOf integer(1:MAX)):

The Client MUST supply and the System MUST support this attribute.

6.1.1.2 Allocate-Printer-Resources Response

The following groups of attributes are part of an Allocate-Printer-Resources response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Group 3: Printer Attributes

See [STD92] for details on returning Printer Attributes.

“printer-resource-ids” (1setOf integer(1:MAX)):

The System MUST return this attribute, which contains the complete list of Resources currently allocated to this Printer (including all of the valid ones listed in the request attribute “resource-ids”).

6.1.2 Deallocate-Printer-Resources

This REQUIRED operation allows an authorized Operator or Administrator to deallocate Resources from an existing Printer object on the target System object and update “resource-use-count” in each Resource. If the Printer object is already shutdown, with ‘shutdown’ in the “printer-state-reasons”, then the System MUST return a “status-code” of ‘client-error-forbidden’.

6.1.2.1 Deallocate-Printer-Resources Request

The following groups of attributes are part of a Deallocate-Printer-Resources request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

“printer-id” (integer(1:65535)):

The Client MUST supply and the System MUST support this operation attribute which is the target Printer for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“resource-ids” (1setOf integer(1:MAX)):

The Client MUST supply and the System MUST support this attribute.

6.1.2.2 Deallocate-Printer-Resources Response

The following groups of attributes are part of a Deallocate-Printer-Resources response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Groups 3: Printer Attributes

See [STD92] for details on returning Printer Attributes.

“printer-resource-ids” (1setOf integer(1:MAX)):

The System MUST return this attribute, which contains the complete list of remaining Resources currently allocated to this Printer (after removing all of the valid ones listed in the request attribute “resource-ids”).

6.1.3 Delete-Printer

This REQUIRED operation allows an authorized Operator or Administrator to delete entirely one configured Printer object (i.e., Job processing service) on the target System object. If the Printer object is not already shutdown, with ‘shutdown’ in the “printer-state-reasons”, then the System MUST return a “status-code” of ‘client-error-forbidden’.

This operation is semantically equivalent to the DeleteService operation defined in [PWG5108.06]. The Printer object and all associated Jobs will be removed entirely. The Printer object cannot be subsequently started up with a Startup-One-Printer operation.

If accepted, the System MUST shutdown the specified Printer with the “printer-state” set to ‘stopped’ (i.e., no Jobs can be processed and intervention is required) and the ‘shutdown’ value added to “printer-state-reasons”. This operation MAY change the state of the System itself to ‘stopped’ (if there are no other configured Printers or all other Printers already had a “printer-state” of ‘stopped’).

6.1.3.1 Delete-Printer Request

The following groups of attributes are part of a Delete-Printer request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

“printer-id” (integer(1:65535)):

The Client MUST supply and the System MUST support this operation attribute which is the target Printer for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

6.1.3.2 Delete-Printer Response

The following groups of attributes are part of a Delete-Printer response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Groups 3: Printer Attributes

See [STD92] for details on returning Printer Attributes.

“printer-state” (type1 enum) and
“printer-state-reasons” (1setOf type2 keyword) and
“printer-is-accepting-jobs” (boolean):

The System MUST return all three of these attributes.

Group 4: System Attributes

See [STD92] and [RFC3380] for details on returning analogous Printer Attributes.

“system-state” (type1 enum) and
“system-state-reasons” (1setOf type2 keyword):

The System MUST return both of these attributes.

6.1.4 Get-Printers

This REQUIRED operation allows an Authenticated User to retrieve a filtered list of some or all of the Printer objects (i.e., Job processing services) available to the End User. If no Printers match the specified filter criteria, then the System MUST return a “status-code” of 'successful-ok'.

This operation is semantically equivalent to the ListAllServices operation defined in [PWG5108.06]. This operation is also semantically equivalent to a sequence of Get-Printer-Attributes [STD92] operations to each Printer object.

If accepted, the System MUST return “printer-id” and “printer-xri-supported” for each matching Printer object. The returned Printers and Printer attributes from the System MAY also be filtered based on Client access rights (i.e., the value of “requesting-user-name”) or the specified “document-format”. This operation does not change the state of any Printer or the System itself.

Note: The list of Printers returned by the Get-Printers operation is distinct from the list of Printers in the "system-configured-printers" attribute (section 7.3.9). The "system-configured-printers" attribute only lists Printers that are directly managed by the System, while the Get-Printers operation can filter the list to those Printers that are available to a given End User and/or include Printers from other Systems that available within the same AAA Framework.

6.1.4.1 Get-Printers Request

The following groups of attributes are part of a Get-Printers request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

“printer-ids” (1setOf (integer(1:65535))):

The Client MAY supply and the System MUST support the “printer-ids” operation attribute which is the list of target Printers for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“first-index” (integer(1:MAX)):

The Client MAY supply and the System MUST support this attribute. If supplied, the System's response will start with the Nth configured Printer.

"limit" (integer(1:MAX)):

The Client MAY supply and the System MUST support this attribute. If supplied, the System's response will contain at most "limit" configured Printers.

“printer-geo-location” (uri):

The Client MAY supply and the System MUST support this attribute. If supplied, the System's response will be limited to configured Printers near the specified geolocation.

“printer-location” (text(127)):

The Client MAY supply and the System MUST support this attribute. If supplied, the System's response will be limited to configured Printers with a matching "printer-location" value.

“printer-service-type” (1setOf (type2 keyword)):

The Client MAY supply and the System MUST support this attribute. If supplied, the System's response will be limited to configured Printers with a

matching "printer-service-type", e.g., Printers offering ‘scan’ service. See “printer-service-type” in section 7.5 Printer Status Attributes.

“requested-attributes” (1setOf type2 keyword):

The Client MAY supply and the System MUST support this attribute. If this operation attribute is NOT supplied, then the System MUST only return the value of the “system-configured-printers” entry for each selected Printer. See section “system-configured-printers” in section 7.3 System Status Attributes.

The Client SHOULD supply only and the System MUST support requests for Printer attributes that are listed as IPP Printer source attributes in the table in section 4 Definition of Attribute Types in the IETF LDAP Schema for Printer Services [RFC7612].

"document-format" (mimeMediaType):

The Client MAY supply and the System MUST support this attribute. If this operation attribute is supplied, then the System MUST return the attributes and values that it uses to validate a job on a create or Validate-Job operation in which this document format is supplied. The System SHOULD return only (1) those attributes that are supported for the specified format and (2) the attribute values that are supported for the specified document format.

“which-printers” (type2 keyword):

The Client MAY supply and the System MUST support this attribute. If this operation attribute is supplied, then the System MUST return the attributes and values for the selected printers (e.g., Printers in ‘idle’ state). See “which-printers” in section 7.1 Operation Attributes.

6.1.4.2 Get-Printers Response

The following groups of attributes are part of a Get-Printers response. The System returns a Get-Printers operation response to the Client up to the number specified by the “limit” operation attribute that match the filter criteria as supplied by the Client in the request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes, unless no Printers match the filter criteria specified by the Client.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Groups 3 to N: Printer Attributes

See [STD92] for details on returning Printer Attributes.

“printer-id” (integer(1:65535)):

The System MUST return this attribute for each Printer.

“printer-uuid” (uri(45)):

The System MUST return this attribute for each Printer.

“printer-xri-supported” (1setOf collection):

The System MUST return this attribute for each Printer.

“printer-state” (type1 enum) and
“printer-state-reasons” (1setOf type2 keyword) and
“printer-is-accepting-jobs” (boolean):

The System MUST return all three of these attributes for each Printer.

6.1.5 Get-Printer-Resources

This REQUIRED operation allows an authorized End User to retrieve a filtered list of some or all of the Resource objects allocated on the target Printer object. If no Resources match the specified filter criteria, then the Printer MUST return a “status-code” of 'successful-ok'.

This operation is semantically analogous to the SM ListResources operation defined in [PWG5108.03]. This operation is also semantically analogous the Get-Jobs operation defined in [STD92].

If accepted, the Printer MUST return the “resource-id” for each matching Resource object. This operation does not change the state of any Resource or the Printer itself.

6.1.5.1 Get-Printer-Resources Request

The following groups of attributes are part of a Get-Printer-Resources request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the Printer MUST support both of these attributes.

“printer-uri” (uri):

The Client MUST supply and the Printer MUST support the “printer-uri” operation attribute which is the target Printer for the operation.

“resource-ids (1setOf (integer(1:MAX))):

The Client MAY supply and the Printer MUST support the “resource-ids” operation attribute which is the list of target Resources for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the Printer MUST support these attributes.

“first-index” (integer(1:MAX)):

The Client MAY supply and the Printer MUST support this attribute.

"limit" (integer(1:MAX)):

The Client MAY supply and the Printer MUST support this attribute.

“requested-attributes” (1setOf type2 keyword):

The Client MAY supply and the Printer MUST support this attribute. If this operation attribute is NOT supplied, then the System MUST only return the value of the equivalent “system-configured-resources” entry for each selected Resource. See section “system-configured-resources” in section 7.3 System Status Attributes.

"resource-formats" (1setOf (mimeMediaType)):

The Client MAY supply and the Printer MUST support this attribute. If this operation attribute is supplied, then the Printer MUST return the attributes

and values for the selected Resources. See “resource-format” in section 7.7 Resource Status Attributes.

“resource-states” (1setOf (type1 enum)):

The Client MAY supply and the Printer MUST support this attribute. If this operation attribute is supplied, then the Printer MUST return the attributes and values for the selected Resources. See “resource-state” in section 7.7 Resource Status Attributes.

“resource-types” (1setOf (type2 keyword)):

The Client MAY supply and the Printer MUST support this attribute. If this operation attribute is supplied, then the Printer MUST return the attributes and values for the selected Resources. See “resource-type” in section 7.7 Resource Status Attributes.

6.1.5.2 Get-Printer-Resources Response

The following groups of attributes are part of a Get-Printer-Resources response. The Printer returns a Get-Printer-Resources operation response to the Client up to the number specified by the “limit” operation attribute that match the filter criteria as supplied by the Client in the request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes, unless no Resources match the filter criteria specified by the Client.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The Printer MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Groups 3 to N: Resource Attributes

See [STD92] for details on returning analogous Printer Attributes.

“resource-id” (integer(1:MAX)):

The Printer MUST return this attribute.

“resource-uuid” (uri(45)):

The Printer MUST return this attribute.

“resource-state” (type1 enum) and
“resource-state-reasons” (1setOf type2 keyword):

The Printer MUST return both of these attributes.

6.1.6 Restart-One-Printer

This REQUIRED operation allows an authorized Operator or Administrator to restart one configured Printer object (i.e., Job processing service) on the target System object.

This operation is semantically equivalent to the Restart-Printer operation defined in [RFC3998].

6.1.6.1 Restart-One-Printer Request

The following groups of attributes are part of a Restart-One-Printer request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

“printer-id” (integer(1:65535)):

The Client MUST supply and the System MUST support the “printer-id” operation attribute which is the target Printer for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“printer-message-from-operator” (text(127)):

The Client MAY supply and the System MUST support this attribute.

6.1.6.2 Restart-One-Printer Response

The following groups of attributes are part of a Restart-One-Printer response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Group 3: Printer Attributes

See [STD92] for details on returning Printer Attributes.

“printer-xri-supported” (1setOf collection):

The System MUST return this attribute for the target Printer.

“printer-state” (type1 enum) and
“printer-state-reasons” (1setOf type2 keyword) and
“printer-is-accepting-jobs” (boolean):

The System MUST return all three of these attributes for the target Printer.

6.1.7 Shutdown-One-Printer

This REQUIRED operation allows an authorized Operator or Administrator to shutdown one configured Printer object (i.e., Job processing service) on the target System object.

This operation is semantically equivalent to the ShutdownService operation defined in [PWG5108.06]. This operation is also semantically equivalent to a Shutdown-Printer operation [RFC3998] to the configured Printer object (except for the resulting “printer-state” of ‘stopped’ rather than ‘idle’).

If accepted, the System MUST shutdown the specified Printer with the “printer-state” set to ‘stopped’ (i.e., no Jobs can be processed and intervention is required) and the ‘shutdown’ value added to “printer-state-reasons”. This operation MAY cause the System to pause with “system-state” set to ‘stopped’ (if all other Printers already had a “printer-state” of ‘stopped’).

The Client can later send a Startup-One-Printer operation to the System (preferred) or a Startup-Printer operation [RFC3998] to the Printer to start up the specified Printer.

6.1.7.1 Shutdown-One-Printer Request

The following groups of attributes are part of a Shutdown-One-Printer request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

“printer-id” (integer(1:65535)):

The Client MUST supply and the System MUST support the “printer-id” operation attribute which is the target Printer for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“printer-message-from-operator” (text(127)):

The Client MAY supply and the System MUST support this attribute.

6.1.7.2 Shutdown-One-Printer Response

The following groups of attributes are part of a Shutdown-One-Printer response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Group 3: Printer Attributes

See [STD92] for details on returning Printer Attributes.

“printer-xri-supported” (1setOf collection):

The System MUST return this attribute for the target Printer.

“printer-state” (type1 enum) and
“printer-state-reasons” (1setOf type2 keyword) and
“printer-is-accepting-jobs” (boolean):

The System MUST return all three of these attributes for the target Printer.

6.1.8 Startup-One-Printer

This REQUIRED operation allows an authorized Operator or Administrator to startup one configured Printer object (i.e., Job processing service) on the target System object.

This operation is semantically equivalent to the StartupService operation defined in [PWG5108.06].

If accepted, the System MUST start the specified Printer with the “printer-state” set to ‘stopped’ (i.e., no Jobs can be processed and intervention is required), “printer-is-accepting-jobs” set to ‘false’ (i.e., no incoming Jobs accepted), and the ‘paused’ value added to “printer-state-reasons” (i.e., no Job processing output allowed). This operation MAY cause the System to resume with “system-state” set to ‘idle’ (if all other Printers already had a “printer-state” of ‘stopped’).

The Client can later send one or more Set-Printer-Attributes operations to modify the configuration of the Printer, followed by Resume-Printer (i.e., remove ‘paused’ from “printer-state-reasons”) and Enable-Printer (i.e., change “printer-is-accepting-jobs” to ‘true’) to change the “printer-state” to ‘idle’ (unless there is another reason for the Printer to stay in the ‘stopped’ state).

6.1.8.1 Startup-One-Printer Request

The following groups of attributes are part of a Startup-One-Printer request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

“printer-id” (integer(1:65535)):

The Client MUST supply and the System MUST support the “printer-id” operation attribute which is the target Printer for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“printer-message-from-operator” (text(127)):

The Client MAY supply and the System MUST support this attribute.

6.1.8.2 Startup-One-Printer Response

The following groups of attributes are part of a Startup-One-Printer response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Group 3: Printer Attributes

See [STD92] for details on returning Printer Attributes.

“printer-xri-supported” (1setOf collection):

The System MUST return this attribute for the target Printer.

“printer-state” (type1 enum) and
“printer-state-reasons” (1setOf type2 keyword) and
“printer-is-accepting-jobs” (boolean):

The System MUST return all three of these attributes for the target Printer.

6.2 Resource Operations

IPP System Service operations on single Resource objects (except for Get-Resources) are defined in this section.

6.2.1 Cancel-Resource

This REQUIRED operation allows an authorized Operator or Administrator to cancel an existing Resource object on the target System object. If the Resource object’s “resource-state” is ‘canceled’ or ‘aborted’ or “resource-state-reasons” includes ‘cancel-requested’, then the System MUST return a “status-code” of ‘client-error-not-possible’.

This operation is semantically analogous to the SM DeleteResource operation defined in [PWG5108.03] (except that the Resource is not removed, in order to preserve the integrity of system log files). See section 4.6. Resource Object and section 4.6.1 Resource History for more details.

If accepted, the System MUST set the “resource-state” to ‘canceled’ or leave “resource-state” unchanged and add ‘cancel-requested’ to “resource-state-reasons” (e.g., if the Resource is currently in use by a Job). In either case, the System MUST make the Resource permanently unavailable for future use. The System MUST preserve all Resource object attributes for an implementation-defined Resource History period.

When “resource-state” eventually transitions to ‘canceled’, the System SHOULD delete any local copy of Resource data. This operation does not change the “system-state” of the System itself.

6.2.1.1 Cancel-Resource Request

The following groups of attributes are part of a Cancel-Resource request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

“resource-id” (integer(1:MAX)):

The Client MUST supply and the System MUST support this attribute which is the target Resource for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

"message" (text(127)):

The Client MAY supply and the System MUST support this attribute which provides a message to the Operator.

6.2.1.2 Cancel-Resource Response

The following groups of attributes are part of a Cancel-Resource response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

6.2.2 Create-Resource-Subscriptions

This REQUIRED operation allows an authorized Operator or Administrator to create one or more System Subscription objects on Resources.

This operation is semantically analogous to the Create-Job-Subscriptions operation defined in [RFC3995].

The Client supplies one or more Subscription Attributes groups, each containing one or more of the Subscription Template Attributes defined in section 5.3 Table 1 of [RFC3995]. The System MUST support all of the Subscription Template Attributes defined in section 5.3 Table 1 of [RFC3995]. If the Resource object's "resource-state" is 'canceled' or 'aborted' or "resource-state-reasons" includes 'cancel-requested', then the System MUST return a "status-code" of 'client-error-not-possible'.

If accepted, the System MUST create the requested Subscription objects. This operation does not change the state of the System itself.

6.2.2.1 Create-Resource-Subscriptions Request

The following groups of attributes are part of a Create-Resource-Subscriptions request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

"system-uri" (uri):

The Client MUST supply and the System MUST support the "system-uri" operation attribute which is the target System for the operation.

"notify-resource-id" (integer(1:MAX)):

The Client MUST supply and the System MUST support this attribute which is the target Resource for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

Groups 2-N: Subscription Template Attributes

For each occurrence of this group, the Client MUST supply and the System MUST support one or more Subscription Template attributes in any order.

6.2.2.2 Create-Resource-Subscriptions Response

The following groups of attributes are part of a Create-Resource-Subscriptions response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Groups 3-N: Subscription Attributes

See [RFC3995] for details on returning Subscription Attributes.

6.2.3 Get-Resource-Attributes

This REQUIRED operation allows an authorized Operator or Administrator to retrieve some or all of the attributes the target Resource object. For Resources, the possible names of attribute groups for the "requested-attributes" operation attribute are:

'resource-description': The subset of Resource Description attributes.

'resource-status': The subset of Resource Status attributes.

'all': All Resource attributes.

This operation is semantically equivalent to the GetResourceElements operation defined in [PWG5108.03]. This operation is also semantically analogous the Get-Job-Attributes and Get-Printer-Attributes operations defined in [STD92].

If accepted, the System MUST return the requested attributes for the selected Resource object. This operation does not change the state of any Resource or the System itself.

6.2.3.1 Get-Resource-Attributes Request

The following groups of attributes are part of a Get-Resource-Attributes request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

“resource-id (integer(1:MAX)):

The Client MUST supply and the System MUST support the “resource-id” operation attribute which is the target Resource for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“requested-attributes” (1setOf type2 keyword):

The Client MAY supply and the System MUST support this attribute. If this operation attribute is NOT supplied, then the System MUST only return the value of the “system-configured-resources” entry for each selected Resource. See section “system-configured-resources” in section 7.3 System Status Attributes.

6.2.3.2 Get-Resource-Attributes Response

The following groups of attributes are part of a Get-Resource-Attributes response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Group 3: Resource Attributes

See [STD92] for details on returning analogous Printer Attributes.

“resource-id” (integer(1:MAX)):

The System MUST return this attribute.

“resource-uuid” (uri(45)):

The System MUST return this attribute.

“resource-state” (type1 enum) and
“resource-state-reasons” (1setOf type2 keyword):

The System MUST return both of these attributes.

6.2.4 Install-Resource

This REQUIRED operation allows an authorized Operator or Administrator to install an existing Resource object for use on the target System object.

This operation is semantically analogous to the SM StoreResource operation defined in [PWG5108.03] (except that the Resource object is separately created with a previous Create-Resource operation and Resource data is separately uploaded with a previous Send-Resource-Data operation).

If the Resource object’s “resource-state” is not ‘available’ or “resource-state-reasons” includes ‘install-requested’, then the System MUST return a “status-code” of ‘client-error-not-possible’. The System MUST validate any Resource signature supplied in a previous Send-Resource-Data operation or embedded in the Resource data, for example as described in US NIST Digital Signature Standard [FIPS186-4], ENISA Algorithms, Key Size and Parameters Report [ENISAALG], ETSI Electronic Signatures and Infrastructures (ESI) Signature validation procedures and policies [TS102853], and IETF XML-Signature Syntax and Processing [RFC3275]. The System MUST validate the Resource format and type. The System SHOULD validate the

If accepted, the System MUST set the “resource-state” to ‘installed’ or leave “resource-state” unchanged and add ‘install-requested’ to “resource-state-reasons” (e.g., if this is an

executable Resource and requires a System reboot to complete the installation). This operation does not change the “system-state” of the System itself.

See section 4.6 Resource Object and section 4.6.1 Resource History for more details.

6.2.4.1 Install-Resource Request

The following groups of attributes are part of an Install-Resource request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

“resource-id” (integer(1:MAX)):

The Client MUST supply and the System MUST support this attribute which is the target Resource for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

6.2.4.2 Install-Resource Response

The following groups of attributes are part of an Install-Resource response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Group 3: Resource Object Attributes

This is the same set of attributes described in the Create-Resource response in section 6.2.2.1.

6.2.5 Send-Resource-Data

This REQUIRED operation allows an authorized Operator or Administrator to upload Resource data for an existing Resource object on the target System object.

This operation is semantically analogous to the SM StoreResource operation defined in [PWG5108.03] (except that the Resource object is separately created with a previous Create-Resource operation and Resource is separately installed with a subsequent Install-Resource-Data operation).

If the Resource object's "resource-state" is not 'pending', then the System MUST return a "status-code" of 'client-error-not-possible'. The System SHOULD validate any Resource signature supplied or embedded in the Resource data - see section 14.5 for recommendations. The System SHOULD validate the Resource format and type. The System SHOULD validate the Resource data contents.

If accepted, the System MUST set the "resource-state" to 'available'. This operation does not change the "system-state" of the System itself.

This operation is semantically analogous to the Send-Document operation defined in [STD92] and the SM StoreResource operation defined in [PWG5108.03] (except that the Resource object is separately created with a previous Create-Resource operation and installed for use with a subsequent Install-Resource operation). See section 4.6 Resource Object and section 4.6.1 Resource History for more details.

6.2.5.1 Send-Resource-Data Request

The following groups of attributes are part of a Send-Resource-Data request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

“resource-id” (integer(1:MAX)):

The Client MUST supply and the System MUST support this attribute which is the target Resource for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“resource-format” (mimeMediaType):

The Client MUST supply and the System MUST support this attribute.

“resource-signature” (1setOf octetString):

The Client MAY supply and the System MUST support this attribute which is the out-of-band digital signature for the Resource data.

Group 2: Resource Content

The Client MUST supply the Resource data.

6.2.5.2 Send-Resource-Data Response

The following groups of attributes are part of a Send-Resource-Data response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Group 3: Resource Object Attributes

This is the same set of attributes described in the Create-Resource response in section 6.2.2.1.

6.2.6 Set-Resource-Attributes

This REQUIRED operation allows an authorized Operator or Administrator to set the values of Resource Description attributes listed in “resource-settable-attributes-supported” (see section 7.2). For Client support for localization see “system-strings-languages-supported” and “system-strings-uri” in section 7.2. If one or more of the supplied Resource Description attributes and/or values are not actually settable, then the System MUST reject the entire request, indicating which attributes and/or values cannot be set, and return a “status-code” of 'client-error-not-possible'. If the Resource object’s “resource-state” is either ‘canceled’ or ‘aborted’ or “resource-state-reasons” contains ‘cancel-requested’, then the System MUST reject the entire request and return a “status-code” of 'client-error-not-possible'. See additional validation rules in section 4.1 Set-Printer-Attributes of [RFC3380].

This operation is semantically equivalent to the SetResourceElements operation defined in [PWG5108.03] and semantically analogous to the Set-Printer-Attributes operation defined in [RFC3380].

If accepted, the System MUST set every supplied Resource Description attribute to exactly the supplied value. The System MUST NOT partially set a subset of the supplied attributes. The System MUST accept this operation when the supplied attributes are valid and the value of “resource-state” (see section 7.7) is ‘installed’. The System SHOULD accept this operation when the supplied attributes are valid and the value of “resource-state” (see section 7.3) is either ‘pending’ or ‘available’. This operation does not change the “system-state” of the System itself.

6.2.6.1 Set-Resource-Attributes Request

The following groups of attributes are part of a Set-Resource-Attributes request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

“resource-id (integer(1:MAX)):

The Client MUST supply and the System MUST support the “resource-id” operation attribute which is the target Resource for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

Group 2: Resource Attributes

The IPP Client MUST supply a set of Resource attributes with one or more values (including explicitly allowed out-of-band values) as defined in [STD92] and section 7.2 of this specification.

See [RFC3380] for details on setting analogous Printer Attributes.

6.2.6.2 Set-Resource-Attributes Response

The following groups of attributes are part of a Set-Resource-Attributes response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Group 3: Resource Attributes

See [STD92] and [RFC3380] for details on returning analogous Printer Attributes.

“resource-id” (integer(1:MAX)):

The System MUST return this attribute.

“resource-uuid” (uri(45)):

The System MUST return this attribute.

“resource-state” (type1 enum) and
“resource-state-reasons” (1setOf type2 keyword):

The System MUST return both of these attributes.

6.3 System Operations

IPP System Service operations on single System objects or multiple Printer objects are defined in this section.

Note: The System MUST copy the value of any supplied “system-message-from-operator” operation attribute to “printer-message-from-operator” for any affected Printer objects (for [Disable, Enable, Pause, Resume, Shutdown, Startup]All-Printers, Pause-All-Printers-After-Current-Job, and Restart-System.

6.3.1 Create-Printer

This REQUIRED operation allows an authorized Operator or Administrator to create a new Printer object (i.e., Job processing service) on the target System object and optionally also create one or more new per-Printer Subscription objects.

This operation is semantically equivalent to the Create operation for a Printer object defined in ISO “Document Printing Application (DPA) Part 3: Management Abstract Service Definition and Procedures” [ISO10175-3] (where a newly created Printer object had the special initial state of ‘unknown’, which is NOT defined or used in this specification). This operation is semantically analogous to the Create-Job operation defined in [STD92].

If accepted, the System MUST create and initialize a new Printer object with the “printer-state” set to ‘stopped’ (i.e., no Jobs can be processed and intervention is required), “printer-is-accepting-jobs” set to ‘false’ (i.e., no incoming Jobs accepted), and the ‘paused’ value added to “printer-state-reasons” (i.e., no Job processing output allowed). This operation does not change the “system-state” of the System itself.

Resources can be allocated to the new Printer using the "resource-ids" operation attribute. A single Resource whose "resource-type" is 'template-printer' MAY be specified in the request. Any Printer attributes in the 'template-printer' Resource that are not present in the Create-Printer request are copied from the Resource into the newly created Printer - the template Resource is NOT allocated to the Printer. If the Client specifies more than one 'template-printer' Resource in the request, the System MUST reject the request with the 'client-error-conflicting-attributes' status code.

One or more per-Printer Subscription objects can also be created. The Client can then send one or more Set-Printer-Attributes operations to modify the configuration of the Printer, followed by Resume-Printer (to remove ‘paused’ from “printer-state-reasons”) and Enable-Printer (to change “printer-is-accepting-jobs” to ‘true’) to change “printer-state” to ‘idle’ (unless there is another reason for the Printer to stay in the ‘stopped’ state).

Note: When the first Print Service is created on a System, the System MUST set the value of “system-default-printer-id” to reference that Print Service.

Note: Printer-scope Resource objects MAY be:

1. Created **before** the related Create-Printer operation and then associated with a given Printer using a Create-Printer operation via the “resource-ids” operation attribute to update the “printer-resource-ids” Printer Status attribute;
2. Created **after** the related Create-Printer operation and then associated with a given Printer using an Allocate-Printer-Resources operation via the “resource-ids” operation attribute to update the “printer-resource-ids” Printer Status attribute; or
3. Created **after** the related Create-Printer operation and then associated with a given Printer using an HTTP PUT request [RFC7230] as defined in section 4.1.9 Resources of IPP Shared Infrastructure Extensions [PWG5100.18] to update the “printer-resource-ids” Printer Status attribute.

Note: Printer-scope Subscription objects MUST be created after the related Create-Printer operation, so that “notify-printer-id” can be correctly specified.

Note: Appropriate Subunits are automatically associated with a new Printer object based on “printer-service-type”, inherent System capabilities, and/or (out-of-band) System policies. Subunits are also associated by configured service capabilities, e.g., “sides-supported” and duplexer, “finishings-supported” and finishers, “print-color-mode-supported” and colorants, etc.

6.3.1.1 Create-Printer Request

The following groups of attributes are part of a Create-Printer request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“printer-service-type” (type2 keyword):

The Client MUST supply and the System MUST support this attribute.

“printer-message-from-operator” (text(127)):

The Client MAY supply and the System MUST support this attribute.

"printer-xri-requested" (1setOf collection):

The Client MAY supply and the System MUST support this attribute.

“resource-ids” (1setOf integer(1:MAX)):

The Client MAY supply and the System MUST support this attribute.

Group 2: Printer Description Attributes

<all mandatory Printer Description attributes>

The Client MUST supply and the System MUST support all of the attributes listed in “system-mandatory-printer-attributes”

<any other Printer Description attribute>

The Client MAY supply and the System MUST support all of the attributes listed in “printer-creation-attributes-supported”

Groups 3-N: Subscription Attributes

See [RFC3995] for details on supplying Subscription Attributes.

6.3.1.2 Create-Printer Response

The following groups of attributes are part of a Create-Printer response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Groups 3: Printer Attributes

See [STD92] for details on returning Printer Attributes.

“printer-id” (integer(1:65535)):

The System MUST return this attribute.

“printer-uuid” (uri(45)):

The System MUST return this attribute.

“printer-xri-supported” (1setOf collection)

The System MUST return this attribute.

“printer-state” (type1 enum) and
“printer-state-reasons” (1setOf type2 keyword) and
“printer-is-accepting-jobs” (boolean):

The System MUST return all three of these attributes.

Groups 4-N: Subscription Attributes

See [RFC3995] for details on returning Subscription Attributes.

6.3.2 Create-Resource

This REQUIRED operation allows an authorized Operator or Administrator to create a new Resource object on the target System object and optionally also create one or more new per-Resource Subscription objects.

This operation is semantically analogous to the SM StoreResource operation defined in [PWG5108.03] except that the Resource data is separately transferred with a subsequent Send-Resource-Data operation and installed for use with a subsequent Install-Resource operation.

If accepted, the System MUST create and initialize a new Resource object with the “resource-state” set to ‘pending’ (i.e., no Resource data has been associated yet). This operation does not change the “system-state” of the System itself. One or more per-Resource Subscription objects can also be created. The Client can then use one or more Set-Resource-Attributes operations to modify the Resource object, followed by a Send-Resource-Data operation (i.e., upload the associated Resource data) to change the “resource-state” to ‘available’. During processing of the Send-Resource-Data operation, the System can keep the “resource-state” of ‘pending’ and also add ‘resource-incoming’ to

“resource-state-reasons” if the upload completion is delayed. The Client can then use an Install-Resource operation to install the Resource, which will either change “resource-state” to ‘installed’ or add ‘install-requested’ to “resource-state-reasons”. See section 7.7.12 resource-state for a discussion of Resource object states and lifecycle phases.

Note: The Client MUST use both the Send-Resource-Data and Install-Resource operations for all “resource-type” values, which simplifies the Resource state machine.

Note: Printer-scope Resource objects MAY be:

1. Created **before** the related Create-Printer operation and then associated with a given Printer using a Create-Printer operation via the “resource-ids” operation attribute to update the “printer-resource-ids” Printer Status attribute;
2. Created **after** the related Create-Printer operation and then associated with a given Printer using an Allocate-Printer-Resources operation via the “resource-ids” operation attribute to update the “printer-resource-ids” Printer Status attribute; or
3. Created **after** the related Create-Printer operation and then associated with a given Printer using an HTTP PUT request [RFC7230] as defined in section 4.1.9 Resources of IPP Shared Infrastructure Extensions [PWG5100.18] to update the “printer-resource-ids” Printer Status attribute.

Note: Job-scope Resource objects MUST be created **before** the Job creation operation and then associated with a given Job via the “resource-ids” Job creation operation attribute to update the “job-resource-ids” Job Status attribute.

Note: Resource-scope Subscription objects MUST be created **after** the related Create-Resource operation, so that “notify-resource-id” can be correctly specified.

6.3.2.1 Create-Resource Request

The following groups of attributes are part of a Create-Resource request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“resource-type” (type2 keyword):

The Client MUST supply and the System MUST support this attribute.

"resource-patches" (text(MAX)):

The Client MAY supply and the System MUST support this attribute.

"resource-string-version" (text(MAX)):

The Client MAY supply and the System MUST support this attribute.

"resource-version" (octetString(64)):

The Client MAY supply and the System MUST support this attribute.

"resource-natural-language" (naturalLanguage):

The Client MAY supply and the System MUST support this attribute. Clients MUST supply it for resources of type 'static-strings'.

Group 2: Resource Description Attributes

<any Resource Description attribute>

The Client MAY supply and the System MAY support these attributes.

Groups 3-N: Subscription Attributes

See [RFC3995] for details on supplying Subscription Attributes.

6.3.2.2 Create-Resource Response

The following groups of attributes are part of a Create-Resource response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

“resource-format-accepted” (1setOf mimeMediaType)

This System MUST return this list of accepted Resource formats (for use in Send-Resource-Data) based on the “resource-type” specified in the Create-Response request.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Groups 3: Resource Attributes

See [STD92] for details on returning analogous Printer Attributes.

“resource-id” (integer(1:MAX)):

The System MUST return this attribute.

“resource-uuid” (uri(45)):

The System MUST return this attribute.

“resource-state” (type1 enum) and
“resource-state-reasons” (1setOf type2 keyword):

The System MUST return both of these attributes.

Groups 4-N: Subscription Attributes

See [RFC3995] for details on returning Subscription Attributes.

6.3.3 Create-System-Subscriptions

This REQUIRED operation allows an authorized Operator or Administrator to create one or more System Subscription objects.

This operation is semantically analogous to the Create-Printer-Subscriptions operation defined in [RFC3995].

The Client supplies one or more Subscription Attributes groups, each containing one or more of the Subscription Template Attributes defined in section 5.3 Table 1 of [RFC3995]. The System MUST support all of the Subscription Template Attributes defined in section 5.3 Table 1 of [RFC3995].

If accepted, the System MUST create the requested Subscription objects. This operation does not change the state of the System itself.

6.3.3.1 Create-System-Subscriptions Request

The following groups of attributes are part of a Create-System-Subscriptions request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

"notify-printer-ids" (1setOf integer(1:65535)):

The Client MAY supply and the System MUST support this attribute.

Groups 2-N: Subscription Template Attributes

For each occurrence of this group, the Client MUST supply and the System MUST support one or more Subscription Template attributes in any order.

6.3.3.2 Create-System-Subscriptions Response

The following groups of attributes are part of a Create-System-Subscriptions response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Groups 3-N: Subscription Attributes

See [RFC3995] for details on returning Subscription Attributes.

6.3.4 Delete-Printer

This REQUIRED operation allows an authorized Operator or Administrator to delete a Printer object, i.e., Job processing service, on the target System object.

This operation is semantically equivalent to the Delete operation for a Printer object defined in ISO “Document Printing Application (DPA) Part 3: Management Abstract Service Definition and Procedures” [ISO10175-3].

If accepted, the System MUST shutdown the Printer and delete the Printer object from the System.

Because the Printer may require time to cancel a currently printing Job, the Printer MAY not be deleted immediately. The System indicates this is the case by adding the 'moving-to-paused' keyword to the "printer-state-reasons" attribute returned in the response. If the Printer is deleted immediately, the System returns a value of 'stopped' in the "printer-state" attribute and 'deleted' in the "printer-state-reasons" attribute in the response.

This operation can change the “system-state” of the System itself depending on the state of any other Printer objects.

6.3.4.1 Delete-Printer Request

The following groups of attributes are part of a Delete-Printer request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri) and "printer-id" (integer(1:65535)):

The Client MUST supply and the System MUST support the “system-uri” and "printer-id" operation attributes which specify the target Printer for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

6.3.4.2 Delete-Printer Response

The following groups of attributes are part of a Delete-Printer response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Printer Attributes

"printer-state" (type1 enum):

The current state of the Printer. A Printer that has been deleted will have the state 'stopped'.

"printer-state-reasons" (1setOf type2 keyword):

The current state reasons of the Printer. A Printer that has been deleted will have a single keyword value of 'deleted' in this attribute. A Printer that is in the process of being deleted will have a keyword value of 'moving-to-paused' in this attribute.

Group 3: System Attributes

See [STD92] and [RFC3380] for details on returning analogous Printer Attributes.

“system-state” (type1 enum) and
“system-state-reasons” (1setOf type2 keyword):

The System MUST return both of these attributes.

6.3.5 Disable-All-Printers

This REQUIRED operation allows an authorized Operator or Administrator to pause all configured Printer objects (i.e., Job processing services) on the target System object. If no

Printers are configured on the System, then the System MUST return a “status-code” of 'successful-ok'.

This operation is semantically equivalent to the DisableAllServices operation defined in [PWG5108.06]. This operation is also semantically equivalent to a sequence of Disable-Printer operations [RFC3398] to each configured Printer object.

If accepted, the System MUST disable each configured Printer with “printer-is-accepting-jobs” set to ‘false’ but the value of “printer-state” or “printer-state-reasons” is not affected by the Disable-All-Printers operation. This operation does not change the System state.

6.3.5.1 Disable-All-Printers Request

The following groups of attributes are part of a Disable-All-Printers request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“system-message-from-operator” (text(127)):

The Client MAY supply and the System MUST support this attribute.

6.3.5.2 Disable-All-Printers Response

The following groups of attributes are part of a Disable-All-Printers response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Groups 3-N: Printer Attributes

See [STD92] for details on returning Printer Attributes.

“printer-id” (integer(1:65535)):

The System MUST return this attribute.

“printer-uuid” (uri(45)):

The System MUST return this attribute.

“printer-xri-supported” (1setOf collection)

The System MUST return this attribute.

“printer-state” (type1 enum) and
“printer-state-reasons” (1setOf type2 keyword) and
“printer-is-accepting-jobs” (boolean):

The System MUST return all three of these attributes.

6.3.6 Enable-All-Printers

This REQUIRED operation allows an authorized Operator or Administrator to enable all configured Printer objects (i.e., Job processing services) on the target System object. If no Printers are configured on the System, then the System MUST return a “status-code” of 'successful-ok'.

This operation is semantically equivalent to the EnableAllServices operation defined in [PWG5108.06]. This operation is also semantically equivalent to a sequence of Enable-Printer operations [RFC3398] to each configured Printer object.

If accepted, the System MUST enable each configured Printer with “printer-is-accepting-jobs” set to ‘true’ but the value of “printer-state” or “printer-state-reasons” is not affected by the Enable-All-Printers operation. This operation does not change the System state.

6.3.6.1 Enable-All-Printers Request

The following groups of attributes are part of a Enable-All-Printers request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“system-message-from-operator” (text(127)):

The Client MAY supply and the System MUST support this attribute.

6.3.6.2 Enable-All-Printers Response

The following groups of attributes are part of a Enable-All-Printers response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Groups 3-N: Printer Attributes

See [STD92] for details on returning Printer Attributes.

“printer-id” (integer(1:65535)):

The System MUST return this attribute.

“printer-uuid” (uri(45)):

The System MUST return this attribute.

“printer-xri-supported” (1setOf collection)

The System MUST return this attribute.

“printer-state” (type1 enum) and
“printer-state-reasons” (1setOf type2 keyword) and
“printer-is-accepting-jobs” (boolean):

The System MUST return all three of these attributes.

6.3.7 Get-Resources

This REQUIRED operation allows an authorized Operator or Administrator to retrieve a filtered list of some or all of the Resource objects on the target System object. If no Resources match the specified filter criteria, then the System MUST return a “status-code” of 'successful-ok'. For Resources, the possible names of attribute groups for the "requested-attributes" operation attribute are:

'resource-description': The subset of Resource Description attributes.

'resource-status': The subset of Resource Status attributes.

'all': All Resource attributes.

This operation is semantically equivalent to the ListResources operation defined in [PWG5108.03]. This operation is also semantically analogous the Get-Jobs operation defined in [STD92].

If accepted, the System MUST return the “resource-id” for each matching Resource object. This operation does not change the state of any Resource or the System itself.

6.3.7.1 Get-Resources Request

The following groups of attributes are part of a Get-Resources request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

“resource-ids (1setOf (integer(1:MAX))):

The Client MAY supply and the System MUST support the “resource-ids” operation attribute which is the list of target Resources for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“first-index” (integer(1:MAX)):

The Client MAY supply and the System MUST support this attribute.

"limit" (integer(1:MAX)):

The Client MAY supply and the System MUST support this attribute.

“requested-attributes” (1setOf type2 keyword):

The Client MAY supply and the System MUST support this attribute. If this operation attribute is NOT supplied, then the System MUST only return the value of the “system-configured-resources” entry for each selected Resource. See section “system-configured-resources” in section 7.3 System Status Attributes.

"resource-formats" (1setOf (mimeMediaType)):

The Client MAY supply and the System MUST support this attribute. If this operation attribute is supplied, then the System MUST return the attributes

and values for the selected Resources. See “resource-format” in section 7.7 Resource Status Attributes.

“resource-states” (1setOf (type1 enum)):

The Client MAY supply and the System MUST support this attribute. If this operation attribute is supplied, then the System MUST return the attributes and values for the selected Resources. See “resource-state” in section 7.7 Resource Status Attributes.

“resource-types” (1setOf (type2 keyword)):

The Client MAY supply and the System MUST support this attribute. If this operation attribute is supplied, then the System MUST return the attributes and values for the selected Resources. See “resource-type” in section 7.7 Resource Status Attributes.

6.3.7.2 Get-Resources Response

The following groups of attributes are part of a Get-Resources response. The System returns a Get-Resources operation response to the Client up to the number specified by the “limit” operation attribute that match the filter criteria as supplied by the Client in the request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes, unless no Printers match the filter criteria specified by the Client.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Groups 3 to N: Resource Attributes

See [STD92] for details on returning analogous Printer Attributes.

“resource-id” (integer(1:MAX)):

The System MUST return this attribute.

“resource-uuid” (uri(45)):

The System MUST return this attribute.

“resource-state” (type1 enum) and
“resource-state-reasons” (1setOf type2 keyword):

The System MUST return both of these attributes.

6.3.8 Get-System-Attributes

This REQUIRED operation retrieves some or all of the attributes the target System object. For the System, the possible names of attribute groups for the "requested-attributes" operation attribute are:

'resource-template': The subset of Resource Template attributes.

'system-description': The subset of System Description attributes.

'system-status': The subset of System Status attributes.

'all': All System attributes.

This operation is semantically equivalent to the GetSystemElements operation defined in [PWG5108.06]. This operation is also semantically analogous the Get-Job-Attributes and Get-Printer-Attributes operations defined in [STD92].

If accepted, the System MUST return the requested attributes for the target System object. This operation does not change the state of the System itself.

Access Rights: The Get-System-Attributes operation is not limited to particular class or role and, like the Get-Printer-Attributes operation [STD92], is intended as an open means of discovering System capabilities and status, and such requests are not authenticated to or filtered for particular End Users.

6.3.8.1 Get-System-Attributes Request

The following groups of attributes are part of a Get-System-Attributes request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“requested-attributes” (1setOf type2 keyword):

The Client MAY supply and the System MUST support this attribute. If this operation attribute is NOT supplied, then the System MUST return all of the System attributes except for “power-[xxx]’” (System power details), “system-configured-printers” and “system-configured-resources”. See sections “power-[xxx]” in section 7.2 System Description Attributes. See also sections “power-[xxx]”, “system-configured-printers” and “system-configured-resources” in section 7.3 System Status Attributes.

6.3.8.2 Get-System-Attributes Response

The following groups of attributes are part of a Get-System-Attributes response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Group 3: System Attributes

See [STD92] for details on returning analogous Printer Attributes.

6.3.9 Get-System-Supported-Values

This REQUIRED operation allows an authorized Operator or Administrator to request the values that the System allows in the Set-System-Attributes operation for "xxx-supported" attributes. For the System, the possible names of attribute groups for the "requested-attributes" operation attribute are:

'resource-template': The subset of Resource Template attributes.

'system-description': The subset of System Description attributes.

'all': All System attributes.

This operation is semantically analogous to the Get-Printer-Supported-Values operation defined in [RFC3380].

If accepted, the System MUST return the requested attributes for the target System object. This operation does not change the state of the System itself.

6.3.9.1 Get-System-Supported-Values Request

The following groups of attributes are part of a Get-System-Supported-Values request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“requested-attributes” (1setOf type2 keyword):

The Client MAY supply and the System MUST support this attribute. If this operation attribute is NOT supplied, then the System MUST return all of the System “xxx-supported” attributes.

6.3.9.2 Get-System-Supported-Values Response

The following groups of attributes are part of a Get-System-Supported-Values response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Group 3: System Attributes

See [STD92] for details on returning analogous Printer Attributes.

6.3.10 Pause-All-Printers

This REQUIRED operation allows an authorized Operator or Administrator to pause all configured Printer objects (i.e., Job processing services) on the target System object. If no Printers are configured on the System, then the System MUST return a “status-code” of 'successful-ok'.

This operation is semantically equivalent to the PauseAllServices operation defined in [PWG5108.06]. This operation is also semantically equivalent to a sequence of Pause-Printer operations [STD92] to each configured Printer object.

If accepted, the System MUST pause each configured Printer with the “printer-state” set to ‘stopped’ and the ‘paused’ value added to “printer-state-reasons” (unless there is another reason for the Printer to stay in the ‘idle’ or ‘processing’ state, in which case the ‘moving-to-paused’ value is added to “printer-state-reasons”). This operation will change the state of the System itself to ‘stopped’ when all configured Printers have completed pause and moved to the 'stopped' state (with the ‘moving-to-paused’ value removed from their “printer-state-reasons”).

6.3.10.1 Pause-All-Printers Request

The following groups of attributes are part of a Pause-All-Printers request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“system-message-from-operator” (text(127)):

The Client MAY supply and the System MUST support this attribute.

6.3.10.2 Pause-All-Printers Response

The following groups of attributes are part of a Pause-All-Printers response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Groups 3-N: Printer Attributes

See [STD92] for details on returning Printer Attributes.

“printer-id” (integer(1:65535)):

The System MUST return this attribute.

“printer-uuid” (uri(45)):

The System MUST return this attribute.

“printer-xri-supported” (1setOf collection)

The System MUST return this attribute.

“printer-state” (type1 enum) and
“printer-state-reasons” (1setOf type2 keyword) and
“printer-is-accepting-jobs” (boolean):

The System MUST return all three of these attributes.

Group N+1: System Attributes

See [STD92] and [RFC3380] for details on returning analogous Printer Attributes.

“system-state” (type1 enum) and
“system-state-reasons” (1setOf type2 keyword):

The System MUST return both of these attributes.

6.3.11 Pause-All-Printers-After-Current-Job

This REQUIRED operation allows an authorized Operator or Administrator to pause all configured Printer objects (i.e., Job processing services) on the target System object after all currently processing Jobs have completed (but prevent new Jobs from starting). If no Printers are configured on the System, then the System MUST return a “status-code” of 'successful-ok'.

This operation is semantically equivalent to the PauseAllServicesAfterCurrentJob operation defined in [PWG5108.06]. This operation is also semantically equivalent to a sequence of Pause-Printer operations [STD92] to each configured Printer object.

If accepted, the System MUST pause each configured Printer with the “printer-state” set to ‘stopped’ and the ‘paused’ value added to “printer-state-reasons” (unless there is another reason for the Printer to stay in the ‘idle’ or ‘processing’ state, in which case the ‘moving-to-paused’ value is added to “printer-state-reasons”) after all currently Processing Jobs have completed. This operation will change the state of the System itself to ‘stopped’ when all configured Printers have completed pause and moved to the 'stopped' state (with the ‘moving-to-paused’ value removed from their “printer-state-reasons”).

6.3.11.1 Pause-All-Printers-After-Current-Job Request

The following groups of attributes are part of a Pause-All-Printers-After-Current-Job request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“system-message-from-operator” (text(127)):

The Client MAY supply and the System MUST support this attribute.

6.3.11.2 Pause-All-Printers-After-Current-Job Response

The following groups of attributes are part of a Pause-All-Printers-After-Current-Job response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Groups 3-N: Printer Attributes

See [STD92] for details on returning Printer Attributes.

“printer-id” (integer(1:65535)):

The System MUST return this attribute.

“printer-uuid” (uri(45)):

The System MUST return this attribute.

“printer-xri-supported” (1setOf collection)

The System MUST return this attribute.

“printer-state” (type1 enum) and
“printer-state-reasons” (1setOf type2 keyword) and
“printer-is-accepting-jobs” (boolean):

The System MUST return all three of these attributes.

Group N+1: System Attributes

See [STD92] and [RFC3380] for details on returning analogous Printer Attributes.

“system-state” (type1 enum) and
“system-state-reasons” (1setOf type2 keyword):

The System MUST return both of these attributes.

6.3.12 Register-Output-Device

This CONDITIONALLY REQUIRED operation allows an authorized Proxy to register an Output Device with the target System object. Systems that conform to the IPP Shared Infrastructure Extensions [PWG5100.18] MUST support this operation.

The Register-Output-Device operation returns a Printer object of the specified type that accepts Jobs on behalf of the Output Device. How these Printer objects are created or provisioned is implementation specific. This operation does not change the “system-state” of the System itself.

A System that supports the "output-device-x509-certificate" (section 7.1.3) operation attribute will associate the X.509 certificate and public key with the Proxy's Output Device, allowing TLS certificate authentication to be used for subsequent Proxy requests to the returned Printer.

Similarly, a System that supports the "output-device-x509-request" (section 7.1.4) operation attribute will generate an X.509 certificate and public key for the Proxy's Output Device. This certificate is returned to the Proxy and associated with the Proxy's Output Device for subsequent Proxy requests to the returned Printer. When the generated certificate expires, the Proxy sends a new Register-Output-Device request to obtain a fresh certificate and public key.

If a Client supplies both the "output-device-x509-certificate" and "output-device-x509-request" attributes in the same request, the System MUST reject the request and return the 'client-error-conflicting-attributes' status code with the two attributes in the unsupported attributes group.

The supported X.509 certificate/request types are listed in the "output-device-x509-type-supported" (section 7.2.19) System Description attribute. If a Proxy supplies an unsupported X.509 certificate/request value, the System MUST reject the operation and return the 'client-error-attributes-or-values-not-supported' status code with the corresponding operation attribute in the unsupported attributes group.

Access Rights: The Authenticated User performing this operation MUST be a Proxy of the System object. Otherwise, the System MUST reject the operation and return 'client-error-forbidden', 'client-error-not-authenticated', or 'client-error-not-authorized' as appropriate.

6.3.12.1 Register-Output-Device Request

The following groups of attributes are part of a Register-Output-Device request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Proxy MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Proxy MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

"output-device-uuid" (uri(45)):

The Proxy MUST supply this attribute and the Infrastructure Printer MUST support this attribute. It provides the identity of the Output Device for the request.

"output-device-x509-certificate" (1setOf text(MAX)):

The Proxy MAY supply and the System MAY support this attribute which supplies an X.509 certificate and public key to be associated with the Proxy's Output Device.

"output-device-x509-request" (1setOf text(MAX)):

The Proxy MAY supply and the System MAY support this attribute which supplies an X.509 certificate signing request for the Proxy's Output Device.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Proxy SHOULD supply and the System MUST support these attributes.

“printer-service-type” (type2 keyword):

The Proxy MUST supply and the System MUST support this attribute.

"printer-xri-requested" (1setOf collection):

The Proxy MAY supply and the System MUST support this attribute.

6.3.12.2 Register-Output-Device Response

The following groups of attributes are part of a Register-Output-Device response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

"output-device-x509-certificate" (1setOf text(MAX)):

When the Client supplies the "output-device-x509-request" operation attribute in the Register-Output-Device request, the System returns this attribute containing an X.509 certificate and public key to be used by the Proxy's Output Device.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Group 3: Printer Attributes

See [STD92] for details on returning Printer Attributes.

“printer-id” (integer(1:65535)):

The System MUST return this attribute.

“printer-uuid” (uri(45)):

The System MUST return this attribute.

“printer-xri-supported” (1setOf collection)

The System MUST return this attribute.

“printer-state” (type1 enum) and
“printer-state-reasons” (1setOf type2 keyword) and
“printer-is-accepting-jobs” (boolean):

The System MUST return all three of these attributes.

6.3.13 Restart-System

This REQUIRED operation allows an authorized Operator or Administrator to restart an entire System with existing Firmware or different Firmware (from Install-Resource after Create-Resource and Send-Resource-Data). Figure 1 shows how this operation is processed.

This operation can be used to restore the System to a known state when one or more configured Printers have become non-responsive or corrupted. This operation can also be used periodically to accomplish “software rejuvenation", a proactive technique that was identified as a cost-effective solution during research at the AT&T Bell Laboratories on fault-tolerant software in the 1990s [REJUVENATION].

This operation is semantically analogous to the Startup-Printer operation defined in [RFC3998].

If accepted, the System MUST:

1. Send a response to the Client (to confirm acceptance of the operation) that includes the “restart-get-interval (integer(0:MAX))” (section 7.1.25) operation attribute;
2. Shutdown each configured Printer;
3. Install pending Resources;
4. Restart the entire System; and
5. Startup each configured Printer with the “printer-state” set to ‘stopped’ (unless there is another reason for the Printer to stay in the ‘idle’ or ‘processing’ state, in which case the ‘starting’ value is added to “printer-state-reasons”), “printer-is-accepting-jobs” set to ‘false’ (i.e., no incoming Jobs accepted), and the ‘paused’ value added to “printer-state-reasons” (i.e., no Job processing output allowed).

This operation will change the “system-state” of the System itself to ‘stopped’ when all Printers have completed shutdown and later started and moved to the ‘stopped’ state with the ‘starting’ value removed from “printer-state-reasons”.

The Client can later send one or more Set-System-Attributes operations to modify the configuration of the System.

Note 1: After a restart, all Printers must be enabled and resumed to continue processing Jobs. This is typically done using the Enable-All-Printers and Resume-All-Printers operations.

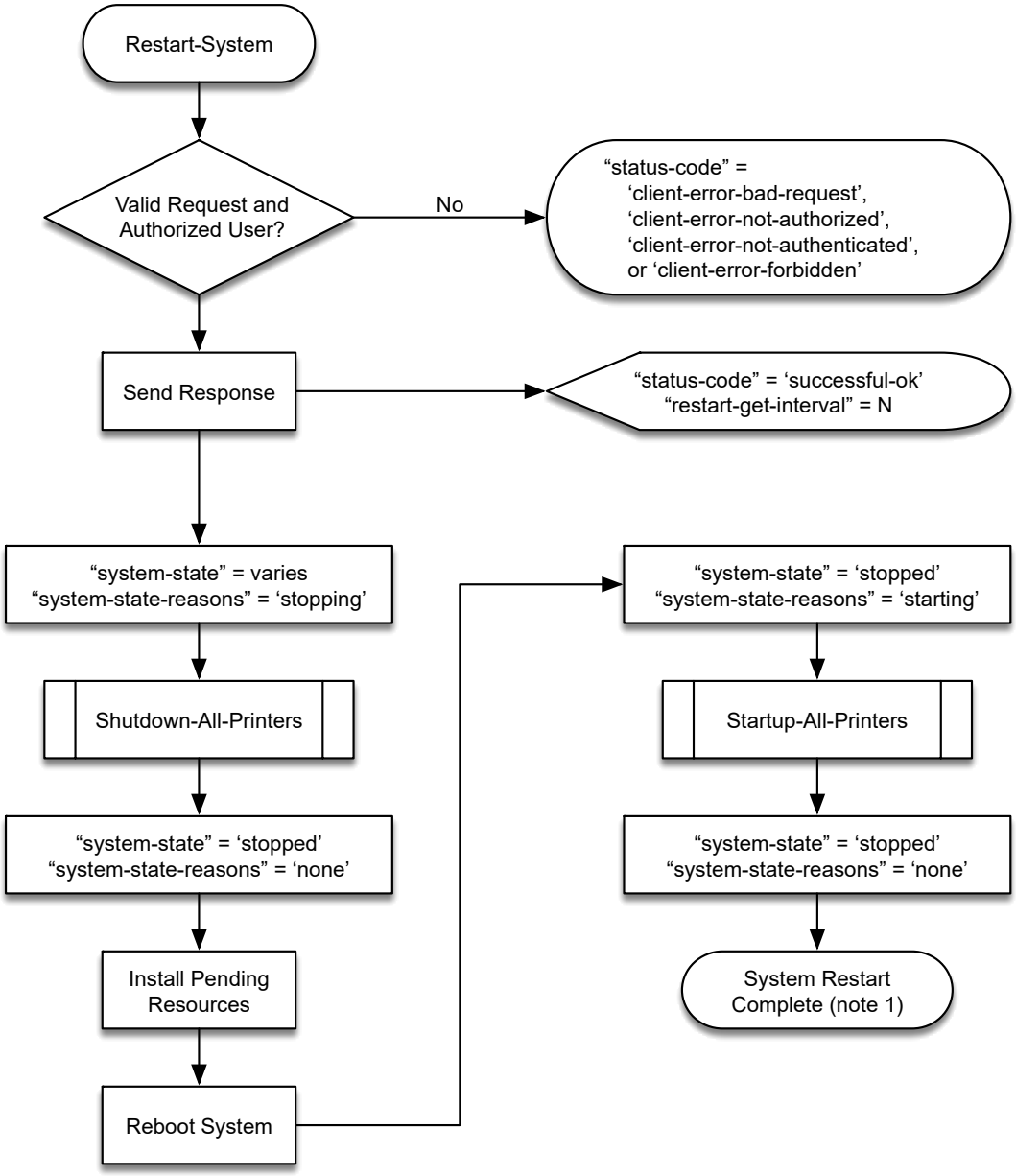

Figure 1 - Restart-System Flow Chart

6.3.13.1 Restart-System Request

The following groups of attributes are part of a Restart-System request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“system-message-from-operator” (text(127)):

The Client MAY supply and the System MUST support this attribute.

6.3.13.2 Restart-System Response

The following groups of attributes are part of a Restart-System response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

“restart-get-interval” (integer(0:MAX)):

If successful, the System MUST return this attribute which contains the number of seconds that the Client SHOULD wait before trying a Get-System-Attributes operation to confirm the completion of the System restart.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Group 3: System Attributes

See [STD92] and [RFC3380] for details on returning analogous Printer Attributes.

“system-state” (type1 enum) and
“system-state-reasons” (1setOf type2 keyword):

The System MUST return both of these attributes.

6.3.14 Resume-All-Printers

This REQUIRED operation allows an authorized Operator or Administrator to resume all configured Printer objects (i.e., Job processing services) on the target System object. If no Printers are configured on the System, then the System MUST return a “status-code” of 'successful-ok'.

This operation is semantically equivalent to the ResumeAllServices operation defined in [PWG5108.06]. This operation is also semantically equivalent to a sequence of Resume-Printer operations [STD92] to each configured Printer object.

If accepted, the System MUST resume each configured Printer with the “printer-state” set to ‘idle’ and the ‘paused’ value removed from “printer-state-reasons” (unless there is another reason for the Printer to stay in the ‘stopped’ state, in which case the ‘resuming’ value is added to “printer-state-reasons”). This operation will change the “system-state” of the System itself to ‘idle’ when all configured Printers have completed resume and moved to the ‘idle’ state (with the ‘resuming’ value removed from “printer-state-reasons”).

6.3.14.1 Resume-All-Printers Request

The following groups of attributes are part of a Resume-All-Printers request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“system-message-from-operator” (text(127)):

The Client MAY supply and the System MUST support this attribute.

6.3.14.2 Resume-All-Printers Response

The following groups of attributes are part of a Resume-All-Printers response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Groups 3-N: Printer Attributes

See [STD92] for details on returning Printer Attributes.

“printer-id” (integer(1:65535)):

The System MUST return this attribute.

“printer-uuid” (uri(45)):

The System MUST return this attribute.

“printer-xri-supported” (1setOf collection)

The System MUST return this attribute.

“printer-state” (type1 enum) and
“printer-state-reasons” (1setOf type2 keyword) and
“printer-is-accepting-jobs” (boolean):

The System MUST return all three of these attributes.

Group N+1: System Attributes

See [STD92] and [RFC3380] for details on returning analogous Printer Attributes.

“system-state” (type1 enum) and
“system-state-reasons” (1setOf type2 keyword):

The System MUST return both of these attributes.

6.3.15 Set-System-Attributes

This REQUIRED operation allows an authorized Operator or Administrator to set the values of System Description attributes listed in “system-settable-attributes-supported” (see section 7.2). For Client support for localization see “system-strings-languages-supported” and “system-strings-uri” in section 7.2. If one or more of the supplied System Description attributes and/or values are not actually settable, then the System MUST reject the entire request, indicating which attributes and/or values cannot be set, and return a “status-code” of 'client-error-not-possible'. See additional validation rules in section 4.1 Set-Printer-Attributes of [RFC3380].

This operation is semantically equivalent to the SetSystemElements operation defined in [PWG5108.06] and semantically analogous to the Set-Printer-Attributes operation defined in [RFC3380].

If accepted, the System MUST set every supplied System Description attribute to exactly the supplied value. The System MUST NOT partially set a subset of the supplied attributes. The System MUST accept this operation when the supplied attributes are valid and the value of “system-state” (see section 7.3) is either ‘idle’ or ‘stopped’. The System SHOULD accept this operation when the supplied attributes are valid and the value of “system-state” (see section 7.3) is ‘processing’. This operation does not change the “system-state” of the System itself.

6.3.15.1 Set-System-Attributes Request

The following groups of attributes are part of a Set-System-Attributes request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

Group 2: System Attributes

The IPP Client MUST supply a set of System attributes with one or more values (including explicitly allowed out-of-band values) as defined in [STD92] and section 7.2 of this specification.

See [RFC3380] for details on setting analogous Printer Attributes.

6.3.15.2 Set-System-Attributes Response

The following groups of attributes are part of a Set-System-Attributes response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

6.3.16 Shutdown-All-Printers

This REQUIRED operation allows an authorized Operator or Administrator to shutdown all configured Printer objects (i.e., Job processing services) on the target System object. If no Printers are configured on the System, then the System MUST return a “status-code” of 'successful-ok'.

This operation is semantically equivalent to the ShutdownAllServices operation defined in [PWG5108.06]. This operation is also semantically equivalent to a sequence of Shutdown-Printer operations [RFC3998] to each configured Printer object (except for the resulting “printer-state” of ‘stopped’ rather than ‘idle’).

If accepted, the System MUST shutdown each configured Printer that has not already been shut down with the “printer-state” set to ‘stopped’ (unless there is another reason for the Printer to stay in the ‘idle’ or ‘processing’ state, in which case the ‘stopping’ value is added to “printer-state-reasons”) and the ‘shutdown’ value added to “printer-state-reasons”. This operation will change the “system-state” of the System itself to ‘stopped’ when configured Printers have completed shutdown and moved to the ‘stopped’ state with the ‘stopping’ value removed from “printer-state-reasons”.

The Client can later send a Startup-All-Printers operation (preferred) or a sequence of Startup-One-Printer operations (preferred) or Startup-Printer operations [RFC3998] to each Printer to start up all of the configured Printers.

6.3.16.1 Shutdown-All-Printers Request

The following groups of attributes are part of a Shutdown-All-Printers request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“system-message-from-operator” (text(127)):

The Client MAY supply and the System MUST support this attribute.

6.3.16.2 Shutdown-All-Printers Response

The following groups of attributes are part of a Shutdown-All-Printers response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Groups 3-N: Printer Attributes

See [STD92] for details on returning Printer Attributes.

“printer-id” (integer(1:65535)):

The System MUST return this attribute.

“printer-uuid” (uri(45)):

The System MUST return this attribute.

“printer-xri-supported” (1setOf collection)

The System MUST return this attribute.

“printer-state” (type1 enum) and
“printer-state-reasons” (1setOf type2 keyword) and
“printer-is-accepting-jobs” (boolean):

The System MUST return all three of these attributes.

Group N+1: System Attributes

See [STD92] and [RFC3380] for details on returning analogous Printer Attributes.

“system-state” (type1 enum) and
“system-state-reasons” (1setOf type2 keyword):

The System MUST return both of these attributes.

6.3.17 Startup-All-Printers

This REQUIRED operation allows an authorized Operator or Administrator to startup or restart all configured Printer objects (i.e., Job processing services) on the target System object. If no Printers are configured on the System, then the System MUST return a “status-code” of 'successful-ok'.

This operation is semantically equivalent to the StartupAllServices operation defined in [PWG5108.06]. This operation is also semantically equivalent to a sequence of Startup-One-Printer operations for each configured Printer object.

If accepted, the System MUST startup or restart each configured Printer with the “printer-state” set to ‘stopped’ (unless there is another reason for the Printer to stay in the ‘idle’ or ‘processing’ state, in which case the ‘starting’ value is added to “printer-state-reasons”), “printer-is-accepting-jobs” set to ‘false’ (i.e., no incoming Jobs accepted), and the ‘paused’ value added to “printer-state-reasons” (i.e., no Job processing output allowed). This operation will change the “system-state” of the System itself to ‘stopped’ when all Printers have completed startup and moved to the ‘stopped’ state with the ‘starting’ value removed from “printer-state-reasons”.

The Client can later send one or more Set-Printer-Attributes operations to modify the configuration of each Printer, followed by Resume-Printer (i.e., remove ‘paused’ from “printer-state-reasons”) and Enable-Printer (i.e., change “printer-is-accepting-jobs” to ‘true’).

6.3.17.1 Startup-All-Printers Request

The following groups of attributes are part of a Startup-All-Printers request.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The Client MUST supply and the System MUST support both of these attributes.

“system-uri” (uri):

The Client MUST supply and the System MUST support the “system-uri” operation attribute which is the target System for the operation.

"requesting-user-name" (name(MAX)) and
"requesting-user-uri" (uri):

The Client SHOULD supply and the System MUST support these attributes.

“system-message-from-operator” (text(127)):

The Client MAY supply and the System MUST support this attribute.

6.3.17.2 Startup-All-Printers Response

The following groups of attributes are part of a Startup-All-Printers response.

Group 1: Operation Attributes

"attributes-charset" (charset) and
"attributes-natural-language" (naturalLanguage):

The System MUST return both of these attributes.

"status-message" (text(255)) and/or
"detailed-status-message" (text(MAX)):

The System MAY return one or both of these attributes.

Group 2: Unsupported Attributes

See [STD92] for details on returning Unsupported Attributes.

Groups 3-N: Printer Attributes

See [STD92] for details on returning Printer Attributes.

“printer-id” (integer(1:65535)):

The System MUST return this attribute.

“printer-uuid” (uri(45)):

The System MUST return this attribute.

“printer-xri-supported” (1setOf collection)

The System MUST return this attribute.

“printer-state” (type1 enum) and
“printer-state-reasons” (1setOf type2 keyword) and
“printer-is-accepting-jobs” (boolean):

The System MUST return all three of these attributes.

Group N+1: System Attributes

See [STD92] and [RFC3380] for details on returning analogous Printer Attributes.

“system-state” (type1 enum) and
“system-state-reasons” (1setOf type2 keyword):

The System MUST return both of these attributes.

7. IPP Attributes

7.1 Operation Attributes

The following operation attributes can be applicable to one or more System, Printer, Resource, Job, or Subscription operations.

7.1.1 notify-printer-ids (1setOf (integer(1:65535)))

This operation attribute specifies the list of “printer-id” values for target Printer objects as used in the Create-System-Subscriptions operation (section 6.3.3). See “printer-id” in section 7.5 Printer Status Attributes.

7.1.2 notify-resource-id (integer(1:MAX))

This operation attribute specifies the target Resource object as used in the Create-Resource-Subscriptions operation (section 6.2.2). The value is the same as the "resource-id" Resource Status attribute (section 7.9.6).

7.1.3 output-device-x509-certificate (1setOf text(MAX))

This operation attribute provides the PEM-encoded [RFC7468] X.509 certificate and public key for the Proxy's Output Device. Because an X.509 certificate and public key can exceed the allowed length of a text value (1023 octets), this attribute uses the 1setOf syntax to allow the value to be split over multiple text values. Each text value is concatenated by the System to form the complete PEM-encoded sequence, for example:

```
output-device-x509-certificate='-----BEGIN CERTIFICATE-----\n',
'MIIFADCCA2igAwIBAgIEYzmoCDANBgkqhkiG9w0BAQsFADBrMQswCQYDVQQGEwJD\n',
'QTESMBAGA1UEAwwJbG9jYWxob3N0MRIwEAYDVQQKDAlsb2NhbGhvc3QxEDAOBgNV\n',
'BAsMB1Vua25vd24xEDAOBgNVBAgMB1Vua25vd24xEDAOBgNVBAcMB1Vua25vd24w\n',
'...\n',
'CZkbz0PWK1huKDfepsd8Y8vimJlx5XdjFgF5DbAO7oKLR3Yv\n',
'-----END CERTIFICATE-----\n'
```

7.1.4 output-device-x509-request (1setOf text(MAX))

This operation attribute provides the PEM-encoded [RFC7468] X.509 certificate signing request for the Proxy's Output Device. Because an X.509 certificate signing request can exceed the allowed length of a text value (1023 octets), this attribute uses the 1setOf syntax to allow the value to be split over multiple text values. Each text value is concatenated by the System to form the complete PEM-encoded sequence, for example:

```
output-device-x509-request='-----BEGIN CERTIFICATE REQUEST-----\n',
'MIID/zCCAmcCAQAwXTELMAkGA1UEBhMCQ0ExFDASBgNVBAMMC2V4YW1wbGUuY29t\n',
'MRQwEgYDVQQKDAtleGFtcGxlLmNvbTEQMA4GA1UECAwHVW5rbm93bjEQMA4GA1UE\n',
'BwwHVW5rbm93bjCCAaIwDQYJKoZIhvcNAQEBBQADggGPADCCAYoCggGBAOs8sEBQ\n',
'...\n',
'kJ4hqhYLM2D6KT55sLZxjXiRqw==\n',
```



```
'-----END CERTIFICATE REQUEST-----\n'
```

7.1.5 printer-id (integer(1:65535))

This operation attribute specifies the target Printer object as used in Get-Printer-Attributes and some other Printer operations defined in section 6 and is semantically equivalent to the ServiceSummary element ID defined in [PWG5108.06] and semantically analogous to the “job-id” attribute defined in [STD92]. See “printer-id” in section 7.5 Printer Status Attributes.

7.1.6 printer-ids (1setOf (integer(1:65535)))

This operation attribute specifies the list of “printer-id” values for target Printer objects as used in Get-Printers and some other Printer operations defined in section 6 and is semantically equivalent to a list of the SM ServiceSummary ID element defined in [PWG5108.06] and semantically analogous a list of the “job-id” attribute defined in [STD92]. See “printer-id” in section 7.5 Printer Status Attributes.

7.1.7 printer-geo-location (uri)

This operation attribute specifies a filter for the applicable Printers as used in Get-Printers defined in section 6 and is semantically analogous to the “printer-geo-location” attribute defined in [PWG5100.13].

7.1.8 printer-location (text(127))

This operation attribute specifies a filter for the applicable Printers as used in Get-Printers defined in section 6 and is semantically analogous to the “printer-location” attribute defined in [STD92].

7.1.9 printer-service-type (1setOf (type2 keyword))

This operation attribute specifies the service type for a Printer as used in Create-Printer or a filter for the applicable Printers as used in Get-Printers defined in section 6 and is semantically equivalent to the ServiceSummary element ServiceType defined in [PWG5108.06]. See “printer-service-type” in section 7.5 Printer Status Attributes.

7.1.10 printer-xri-requested (1setOf collection)

This operation attribute specifies the type of authentication ("xri-authentication (type2 keyword)" member attribute) and security ("xri-security (type2 keyword)" member attribute) that is wanted for newly created Printers using the Create-Printer operation (section 6.3.1) or Register-Output-Device operation (section 6.3.12). The "xri-uri (uri)" member attribute MUST NOT be included in the collection since the System assigns that value.

7.1.11 resource-format (mimeMediaType)

This operation attribute specifies the format for a Resource as used in Send-Resource-Data request or a filter for the applicable Resources as used in Get-Resources defined in section

6 and is semantically equivalent to the ResourceFormat element defined in [PWG5108.03] and semantically analogous to the “document-format” attribute defined in [STD92]. See “resource-format” in section 7.7 Resource Status Attributes.

7.1.12 resource-format-accepted (1setOf mimeMediaType)

This operation attribute specifies the accepted formats for a Resource as used in Create-Resource response and is semantically analogous to the SM ResourceFormat element defined in [PWG5108.03] and the “document-format” attribute defined in [STD92]. See “resource-format” in section 7.7 Resource Status Attributes.

7.1.13 resource-formats (1setOf (mimeMediaType))

This operation attribute specifies a filter for the applicable Resources as used in Get-Resources defined in section 6 and is semantically analogous to the SM ResourceFormat element defined in [PWG5108.03] and the “document-format” attribute defined in [STD92]. See “resource-format” in section 7.7 Resource Status Attributes.

7.1.14 resource-id (integer(1:MAX))

This operation attribute specifies the target Resource object as used in Get-Resource-Attributes and other Resource operations defined in section 6 and is semantically equivalent to the SM ResourceId element defined in [PWG5108.03] and semantically analogous to the “job-id” attribute defined in [STD92]. See “resource-id” in section 7.7 Resource Status Attributes.

7.1.15 resource-ids (1setOf integer(1:MAX))

This operation attribute specifies the list of “resource-id” values for associated Resource objects as used in the Create-Printer and Allocate-Printer-Resources operations defined in section 6 or in a Job Creation operation (Create-Job, Print-Job, or Print-URI) defined in [STD92] and is semantically analogous to the “job-printer-uri” attribute defined in [STD92]. See “resource-id” in section 7.7 Resource Status Attributes.

7.1.16 resource-k-octets (integer(0:MAX))

This operation attribute specifies the size of the data for a Resource as used in Create-Resource/Send-Resource-Data defined in section 6 and is semantically analogous to the “job-k-octets” attribute defined in [STD92]. See “resource-k-octets” in section 7.7 Resource Status Attributes.

7.1.17 resource-natural-language (naturalLanguage)

This operation attribute specifies the natural language associated with a Resource.

7.1.18 resource-patches (text(MAX) | no-value)

This operation attribute contains the list of patches applied to the Resource delimited by a Carriage Return/Line Feed pair (0x0d0a). This attribute is semantically analogous to the FirmwarePatches attribute defined in [PWG5110.4].

7.1.19 resource-signature (1setOf octetString(MAX))

This operation attribute specifies an out-of-band digital signature for Resource data as used in Send-Resource-Data defined in section 6.2.5, when the particular Resource data format does not include an embedded digital signature.

A Client MAY also supply this operation attribute with an out-of-band digital signature to request override of an embedded digital signature in the Resource data (e.g., when the embedded signature has been invalidated due to compromised keys, compromised algorithms, compromised CAs, etc.). An IPP System SHOULD support this method of signature override for long-term stability.

See section 12 Security Considerations for details of digital signature handling in IPP System Service.

7.1.20 resource-states (1setOf (type1 enum))

This operation attribute specifies a filter for the applicable Resources as used in Get-Resources defined in section 6 and is semantically analogous to the “job-state” attribute defined in [STD92] and replaces the semantically analogous SM DateTimeAtExpiration (Resource lease time) and ResourceIsExpired elements defined in [PWG5108.03]. See “resource-state” in section 7.7 Resource Status Attributes.

7.1.21 resource-string-version (text(MAX) | no-value)

This operation attribute contains the string version of the Resource, which SHOULD conform to section 4.2.4 “String Version” of IETF PA-TNC [RFC5792] which defines the internal string fields Product Version Number, Internal Build Number, and Configuration Version Number. This attribute is semantically analogous to the FirmwareStringVersion attribute defined in [PWG5110.4] and is typically used to provide a human-readable software version number.

7.1.22 resource-type (type2 keyword)

This operation attribute specifies a type for the new Resource as used in Create-Resource defined in section 6 and replaces the semantically analogous SM DateTimeAtExpiration (Resource lease time) element defined in [PWG5108.03]. See “resource-type” in section 7.7 Resource Status Attributes.

7.1.23 resource-types (1setOf (type2 keyword))

This operation attribute specifies a filter for the applicable Resources as used in Get-Resources defined in section 6 and replaces the semantically analogous SM

DateTimeAtExpiration (Resource lease time) element defined in [PWG5108.03]. See “resource-type” in section 7.7 Resource Status Attributes.

7.1.24 resource-version (octetString(64) | no-value)

This operation attribute contains the numeric version of the Resource, which SHOULD conform to section 4.2.3 “Numeric Version” of IETF PA-TNC [RFC5792] which defines the internal integer fields Major Version Number, Minor Version Number, Build Number, Service Pack Major, and Service Pack Minor. This attribute is semantically analogous to the FirmwareVersion attribute defined in [PWG5110.4] and is typically used to provide a machine-readable software version number, often using a cryptographic hash.

7.1.25 restart-get-interval (integer(0:MAX)

This operation attribute specifies an interval in seconds that the Client SHOULD wait before querying the System with a Get-System-Attributes operation to confirm completion of the restart requested by a Restart-System operation and is semantically analogous to the “notify-get-interval” attribute defined in [RFC3996].

7.1.26 system-uri (uri)

This operation attribute specifies the target System object as used in Get-Printers and all other operations defined in section 6 and is semantically analogous to the “printer-uri” attribute defined in [STD92] and semantically equivalent to the SM SystemURI element defined in [PWG5108.06].

7.1.27 which-printers (type2 keyword):

This operation attribute specifies a filter for the applicable Printers as used in Get-Printers defined in section 6 and is semantically analogous to the “which-jobs” attribute defined in [STD92].

Standard keyword values for this attribute include:

‘accepting’: All Printers with “printer-state” of ‘idle’ or ‘processing’ and “printer-is-accepting-jobs” of ‘true’.

‘all’: All Printers configured on this System object, regardless of their state.

‘idle’: All Printers with “printer-state” of ‘idle’.

‘not-accepting: All Printers with “printer-is-accepting-jobs” of ‘false’.

‘processing’: All Printers with “printer-state” of ‘processing’.

‘shutdown’: All Printers with “printer-state” of ‘stopped’ and “printer-state-reasons” of ‘shutdown’.

‘stopped’: All Printers with “printer-state” of ‘stopped’, but do not have “printer-state-reasons” of ‘shutdown’ or ‘testing’.

‘testing’: All Printers with “printer-state” of ‘stopped’ and “printer-state-reasons” of 'testing’.

7.2 System Description Attributes

System Description attributes are typically READ-WRITE and can potentially be set by an Operator or Administrator using the Set-System-Attributes operation (see section 6). Writable System Description attributes are listed in the value of “system-settable-attributes-supported” (see section 7.2.42).

7.2.1 charset-configured (charset)

This REQUIRED System attribute identifies the charset that is used to represent attributes with 'text' and 'name' attribute syntaxes and is semantically analogous to the "charset-configured" Printer attribute defined in [STD92]. The value of the "charset-configured" attribute MUST be one of the values of the "charset-supported" attribute defined in section 7.2.2.

7.2.2 charset-supported (1setOf charset)

This REQUIRED System attribute lists the charsets that are supported for values of attributes with 'text' and 'name' attribute syntaxes and is semantically analogous to the "charset-supported" Printer attribute defined in [STD92]. The value 'utf-8' MUST be present, since IPP objects MUST support the UTF-8 [RFC3629] charset.

7.2.3 document-format-supported (1setOf mimeMediaType)

This REQUIRED System attribute lists the Document formats that are supported by Printers managed by the System.

7.2.4 ippget-event-life (integer(15:MAX))

This REQUIRED System attribute specifies the Event Life value that the System assigns to each Event and is semantically equivalent to the "ippget-event-life" Printer attribute defined in [RFC3996].

7.2.5 ipp-features-supported (1setOf type2 keyword)

This REQUIRED System attribute lists the IPP extension features that are supported by the System and is semantically equivalent to the “ipp-features-supported” Printer attribute defined in [PWG5100.13]. Systems MUST include the 'resource-object' and 'system-object' values (section 9.1).

7.2.6 ipp-versions-supported (1setOf type2 keyword)

This REQUIRED System attribute identifies the supported IPP protocol version(s) and is semantically equivalent to the "ipp-versions-supported" Printer attribute defined in [STD92].

7.2.7 multiple-document-printers-supported (boolean)

This REQUIRED System attribute specifies whether Printers managed by the System are capable of supporting multiple Document Jobs and is semantically analogous to the "multiple-document-jobs-supported" Printer Description attribute [STD92].

7.2.8 natural-language-configured (naturalLanguage)

This REQUIRED System attribute identifies the natural language that is used for System-generated attribute values with 'text' and 'name' attribute syntaxes and is semantically equivalent to the "natural-language-configured" Printer attribute defined in [STD92].

7.2.9 generated-natural-language-supported (1setOf naturalLanguage)

This REQUIRED System attribute lists the natural language(s) that are supported for System-generated attribute values with 'text' and 'name' attribute syntaxes and is semantically equivalent to the "generated-natural-language-supported" Printer attribute defined in [STD92].

Note: The natural language(s) supported for System-generated values depends on implementation and/or configuration. However, unlike charsets, System objects MUST accept requests with any natural language or any Natural Language Override whether or not the natural language is supported for System-generated attribute values.

Note: A System that supports multiple natural languages, often has separate catalogs of messages, one for each natural language supported.

7.2.10 notify-attributes-supported (1setOf keyword)

This REQUIRED System attribute lists additional attributes that can be included in an event notification and is semantically equivalent to the Printer attribute of the same name defined in [RFC3995].

7.2.11 notify-events-default (1setOf type2 keyword)

This REQUIRED System attribute lists the default events for new Subscriptions and is semantically equivalent to the Printer attribute of the same name defined in [RFC3995].

7.2.12 notify-events-supported (1setOf type2 keyword)

This REQUIRED System attribute lists the supported "notify-events" values and is semantically equivalent to the Printer attribute of the same name defined in [RFC3995].

Systems MUST support the 'printer-config-changed', 'printer-created', 'printer-deleted', 'printer-state-changed', 'printer-stopped', 'resource-canceled', 'resource-config-changed', 'resource-created', 'resource-installed', 'resource-state-changed', 'system-config-changed', 'system-restarted', 'system-shutdown', 'system-state-changed', and 'system-stopped' values.

7.2.13 notify-lease-duration-default (integer(0:67108863))

This REQUIRED System attribute specifies the default lease duration for a new Subscription object and is semantically equivalent to the Printer attribute of the same name defined in [RFC3995].

7.2.14 notify-lease-duration-supported (1setOf (integer(0:67108863) | rangeOfInteger(0: 67108863)))

This REQUIRED System attribute lists the supported lease duration values and is semantically equivalent to the Printer attribute of the same name defined in [RFC3995].

7.2.15 notify-max-events-supported (integer(2:MAX))

This REQUIRED System attribute specifies the maximum number of events that can be specified in the "notify-events" Subscription Template attribute and is semantically equivalent to the Printer attribute of the same name defined in [RFC3995].

7.2.16 notify-pull-method-supported (1setOf type2 keyword)

This REQUIRED System attribute lists the supported pull notification methods and is semantically equivalent to the Printer attribute of the same name defined in [RFC3995]. Systems MUST support the 'ippget' pull notification method.

7.2.17 notify-schemes-supported (1setOf uriScheme)

This CONDITIONALLY REQUIRED System attribute lists push notification schemes that are supported by the System and is semantically equivalent to the Printer attribute of the same name defined in [RFC3995]. This attribute MUST be supported if the System supports push notifications.

7.2.18 operations-supported (1setOf type2 enum)

This REQUIRED System attribute lists the supported System operations and is semantically equivalent to the “operations-supported" Printer attribute defined in [STD92].

7.2.19 output-device-x509-type-supported (1setOf type2 keyword)

This CONDITIONALLY REQUIRED attribute lists the supported X.509 certificate/signing request types for the "output-device-x509-certificate" (section 7.1.3) and "output-device-x509-request" (section 7.1.4) operation attributes. A System that supports either the "output-

device-x509-certificate" or "output-device-x509-request" operation attributes in a Register-Output-Device request (section 6.3.12) MUST support this attribute.

The following values are defined by this specification:

'ecdsa-p256_sha256': ECDSA certificate signing request with P-256 curve/key and SHA-256 hash

'ecdsa-p384_sha256': ECDSA certificate signing request with P-384 curve/key and SHA-256 hash

'ecdsa-p521_sha256': ECDSA certificate signing request with P-521 curve/key and SHA-256 hash

'rsa-2048_sha256': RSA certificate signing request with 2048 bit key and SHA-256 hash

'rsa-3072_sha256': RSA certificate signing request with 3072 bit key and SHA-256 hash

'rsa-4096_sha256': RSA certificate signing request with 4096 bit key and SHA-256 hash

7.2.20 power-calendar-policy-col (1setOf collection)

This OPTIONAL System attribute lists the configured System calendar-based power state change policies and is semantically equivalent to the Power Calendar group defined in [PWG5106.4]. If “power-calendar-policy-col” is supported, then all member attributes in this collection are REQUIRED for the System but are OPTIONAL for the Client to supply.

For example, an automated System power state transition to ‘hibernate’ at 6pm every Friday evening could be scheduled in “power-calendar-policy-col” as follows:

```
calendar-id=32     # arbitrary unique value for calendar policy
day-of-week=6      # Friday is 6th day counting from Sunday
hour=18            # 6pm is 18:00 on a 24-hour clock
request-power-state='hibernate'
                   # target power state
```

In the above example, the irrelevant “day-of-month”, “minute”, “month”, and “run-once” member attributes have been omitted.

7.2.20.1 calendar-id (integer(1:MAX))

This REQUIRED member attribute contains the unique key of this calendar policy and is semantically equivalent to the CalendarID element in the Power Calendar group defined in [PWG5106.4].

7.2.20.2 day-of-month (integer(1:31))

This REQUIRED member attribute specifies the trigger day of the month for this calendar policy and is semantically equivalent to the CalendarDay element in the Power Calendar group defined in [PWG5106.4]. The value ‘1’ represents the first day of the month.

See “system-current-time” defined above for the relevant System date, time, and time zone values.

7.2.20.3 day-of-week (integer(1:7))

This REQUIRED member attribute specifies the trigger day of the week for this calendar policy and is semantically equivalent to the CalendarDayOfWeek element in the Power Calendar group defined in [PWG5106.4]. The value ‘1’ represents Sunday.

See “system-current-time” defined above for the relevant System date, time, and time zone values.

7.2.20.4 hour (integer(0:23))

This REQUIRED member attribute specifies the trigger hour for this calendar policy and is semantically equivalent to the CalendarHour element in the Power Calendar group defined in [PWG5106.4]. The value ‘0’ represents the first hour of the day (i.e., 12:00-12:59am). Midnight (i.e., 12:00am) is specified by a value of zero for “hour” and a value of zero for “minute”.

See “system-current-time” defined above for the relevant System date, time, and time zone values.

Note: Due to local time zone changes (summer time to standard time or vice versa), it’s possible that a given hour will not occur in a given month.

7.2.20.5 minute (integer(0:59))

This REQUIRED member attribute specifies the trigger minute for this calendar policy and is semantically equivalent to the CalendarMinute element in the Power Calendar group defined in [PWG5106.4]. The value ‘0’ represents the first minute of the hour (e.g., 7:00am).

See “system-current-time” defined above for the relevant System date, time, and time zone values.

7.2.20.6 month (integer(1:12))

This REQUIRED member attribute specifies the trigger month for this calendar policy and is semantically equivalent to the CalendarMonth element in the Power Calendar group defined in [PWG5106.4]. The value of ‘1’ represents January.

See “system-current-time” defined above for the relevant System date, time, and time zone values.

7.2.20.7 request-power-state (type1 enum)

This REQUIRED member attribute specifies the requested stable or ephemeral (transitional) power state for this calendar policy and is semantically equivalent to the RequestPowerState element in the Power Calendar group defined in [PWG5106.4].

Standard values and constraints on vendor extension values are defined in section 7.3.1.2.

7.2.20.8 run-once (boolean)

This REQUIRED member attribute specifies whether this calendar policy should be run once (single execution) or repeatedly (multiple executions) and is semantically equivalent to the CalendarRunOnce element in the Power Calendar group defined in [PWG5106.4].

7.2.21 power-event-policy-col (1setOf collection)

This OPTIONAL System attribute lists the configured System event-based power state change policies and is semantically equivalent to the Power Event group defined in [PWG5106.4].

For example, an automated System power state transition to ‘standby’ upon every ‘jam’ condition could be scheduled in “power-event-policy-col” as follows:

```
event-id=11         # arbitrary unique value for event policy
event-name='jam'    # name of event
request-power-state='standby'
                    # target power state
```

7.2.21.1 event-id (integer(1:MAX))

This REQUIRED member attribute contains the unique key of this event policy and is semantically equivalent to the EventID element in the Power Event group defined in [PWG5106.4].

7.2.21.2 event-name (name(127))

This REQUIRED member attribute specifies the trigger event name of this event policy and is semantically equivalent to the EventName element in the Power Event group defined in [PWG5106.4].

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 vendor event name (starting with an uppercase character, e.g., ‘ExamplePowerEvent’). Event names MUST be specified in US-ASCII [ISO646] (for interoperability).

7.2.21.3 request-power-state (type1 enum)

This REQUIRED member attribute specifies the requested stable or ephemeral (transitional) power state for this event policy and is semantically equivalent to the SM RequestPowerState element in the Power Event group defined in [PWG5106.4].

Standard values and constraints on vendor extension values are defined in section 7.3.1.2.

7.2.22 power-timeout-policy-col (1setOf collection)

This RECOMMENDED System attribute lists the configured System timeout-based power state change policies and is semantically equivalent to the SM Power Timeout group defined in [PWG5106.4].

For example, an automated System power state transition to ‘standby’ upon 5 minutes of inactivity in ‘on’ power state could be scheduled in “power-timeout-policy-col” as follows:

```
request-power-state='standby'
                        # target power state
start-power-state='on'  # starting power state
timeout-id=23           # arbitrary unique value for timeout policy
timeout-predicate='inactivity'
                        # predicate of system inactivity
timeout-seconds=300     # duration before transition to target power state
```

7.2.22.1 request-power-state (type1 enum)

This REQUIRED member attribute specifies the requested stable or ephemeral (transitional) power state for this timeout policy and is semantically equivalent to the SM RequestPowerState element in the Power Timeout group defined in [PWG5106.4].

Standard values and constraints on vendor extension values are defined in section 7.3.1.2.

7.2.22.2 start-power-state (type1 enum)

This REQUIRED member attribute specifies the trigger starting stable power state for this timeout policy and is semantically equivalent to the SM StartPowerState element in the Power Timeout group defined in [PWG5106.4]. Note: Ephemeral (transitional) power states cannot be specified as triggers for timeout policies.

Standard values and constraints on vendor extension values for stable power states are defined in section 7.3.1.2.

7.2.22.3 timeout-id (integer(1:MAX))

This REQUIRED member attribute contains the unique key of this timeout policy and is semantically equivalent to the SM TimeoutID element in the Power Timeout group defined in [PWG5106.4].

7.2.22.4 timeout-predicate (type2 keyword)

This REQUIRED member attribute specifies the trigger predicate (i.e., pre-condition) for this timeout policy and is semantically equivalent to the SM TimeoutPredicate element in the Power Timeout group defined in [PWG5106.4].

The standard keyword values for this attribute are:

‘activity’: Incoming Job, console input, etc.

‘inactivity’: No incoming, queued, or processing Jobs, console input, etc.

‘none’: No timeout predicate condition.

7.2.22.5 timeout-seconds (integer(0:MAX))

This REQUIRED member attribute specifies the trigger timeout interval in seconds (or zero for an immediate trigger controlled by the other trigger member attributes) for this timeout policy and is semantically equivalent to the SM TimeoutSeconds element in the Power Timeout group defined in [PWG5106.4].

7.2.23 printer-creation-attributes-supported (1setOf keyword)

This REQUIRED System attribute lists Printer Description attributes supported for the Create-Printer operation and is semantically analogous to the “job-creation-attributes-supported” Printer Description attribute defined in [PWG5100.7]. Table 9 lists the minimum Printer Description attributes that SHOULD be included in this attribute.

Table 9 - Common Printer Creation Attributes

IPP Attribute Name	Reference
document-format-default	[STD92]
document-format-supported	[STD92]
multiple-document-jobs-supported	[STD92]
natural-language-configured	[STD92]
printer-geo-location	[PWG5100.13]
printer-info	[STD92]
printer-location	[STD92]
printer-make-and-model	[STD92]
printer-name	[STD92]

7.2.24 printer-service-type-supported (1setOf type2 keyword)

This REQUIRED System attribute lists the supported "printer-service-type" values for the Create-Printer (section 6.3.1) operation.

7.2.25 resource-format-supported (1setOf mimeMediaType)

This REQUIRED System attribute lists Resource formats supported for Send-Resource-Data operations and is semantically analogous to the “document-format-supported” attribute defined in [STD92].

7.2.26 resource-type-supported (1setOf type2 keyword)

This REQUIRED System attribute lists Resource types supported for Create-Resource and Send-Resource-Data operations and is semantically analogous to the “document-format-supported” attribute defined in [STD92].

7.2.27 resource-settable-attributes-supported (1setOf keyword)

This REQUIRED System attribute lists Resource Description attributes supported for READ-WRITE access and can be configured by an Operator or Administrator. See “system-strings-languages-supported” and “system-strings-uri” below for Client localization support.

7.2.28 system-asset-tag (octetString(MAX))

This RECOMMENDED System attribute contains the site-specific asset tag or identifier value.

7.2.29 system-contact-col (collection | unknown)

This RECOMMENDED System attribute identifies the System contact, typically the Administrator or Operator. Table 10 lists the "system-contact-col" member attributes. When specified in a Set-System-Attributes operation, the collection value MUST contain all REQUIRED member attributes as the entire collection value is replaced.

Table 10 - "xxx-contact-col" Member Attributes

Conformance	Member Attribute
REQUIRED	contact-name (name(MAX))
RECOMMENDED	contact-uri (uri)
RECOMMENDED	contact-vcard (1setOf text(MAX))

7.2.29.1 contact-name (name(MAX))

This REQUIRED member attribute contains the contact name, e.g., "Bob Smith".

7.2.29.2 contact-uri (uri)

This RECOMMENDED member attribute contains the contact URI, e.g., “mailto:bob@example.com,” and is semantically analogous to the SM OwnerURI element defined in [PWG5108.01].

7.2.29.3 contact-vcard (1setOf text(MAX))

This RECOMMENDED member attribute contains the contact vCard [RFC6350] and is semantically analogous to the SM OwnerVCard element defined in [PWG5108.01].

7.2.30 system-current-time (dateTime)

This REQUIRED System attribute specifies the current date and time for the System and is semantically equivalent to the SM CurrentTime element defined in [PWG5108.06].

7.2.31 system-default-printer-id (integer(1:65535) | no-value)

This REQUIRED System attribute identifies the unique identifier of the default Print Service configured by the Operator, Administrator, or manufacturer (used by the End User operation Get-Printer-Attributes defined in this specification) and is semantically analogous to the “printer-uri-supported” and “job-printer-uri” attributes defined in [STD92]. When a System has no configured Print Services, that System MUST return the ‘no-value’ out-of-band value defined in [STD92] for “system-default-printer-id”. For a related use case, see section 3.2.5 Bootstrap Client Access to Default Print Service.

Note: When the first Print Service is created on a System, the System MUST set the value of “system-default-printer-id” to reference that Print Service.

7.2.32 system-dns-sd-name (name(63))

This REQUIRED attribute provides the current DNS-SD service name for the System. For example, if this attribute contains "Example System" the System will register “Example System._ipps-system._tcp.local.”. The default value is based on the "system-name" attribute (section 7.2.40).

Systems that support changing the value using the Set-System-Attributes operation MUST list 'system-dns-sd-name' in the "system-settable-attributes-supported" System Description attribute [PWG5100.22]. When a new name is set, the System MUST re-register all DNS-SD services associated with it. However, if the new name causes a collision with other network devices, the System MUST replace the value set with a non-conflicting name as required by multicast DNS, typically by appending a unique number to the provided name.

Note: Changing the DNS-SD service name can prevent Clients from resolving the System's services if those Clients use a statically configured name for the System.

7.2.33 system-geo-location (uri | unknown)

This REQUIRED System attribute specifies the System geographic location using the “geo:” URI scheme [RFC5870] and is semantically analogous to the "printer-geo-location" Printer attribute defined in [PWG5100.13]. When the location is unknown, Systems MUST return the ‘unknown’ out-of-band value defined in [STD92]. Systems MUST allow the Operator or Administrator to configure the geographic location manually.

7.2.34 system-info (text(127))

This REQUIRED System attribute specifies System descriptive information, e.g., "This System can be used for printing color transparencies for HR presentations," and is semantically analogous to the "printer-info" Printer attribute defined in [STD92].

7.2.35 system-location (text(127))

This REQUIRED System attribute identifies the System location, e.g., "This System is in Room 123A, second floor of building XYZ," and is semantically analogous to the "printer-location" Printer attribute defined in [STD92].

7.2.36 system-mandatory-printer-attributes (1setOf keyword)

This REQUIRED System attribute identifies the mandatory-to-supply Printer Description attributes for a Create-Printer operation on this System and is semantically analogous to the "printer-mandatory-job-attributes" Printer Description attribute defined in [PWG5100.13]. This REQUIRED System attribute lists the minimum Printer and operation attributes that are required for a successful Create-Printer operation. The System MUST include in this attribute the 'printer-name' value.

7.2.37 system-mandatory-registration-attributes (1setOf keyword)

This CONDITIONALLY REQUIRED attribute identified mandatory-to-supply operation attributes for a Register-Output-Device (section 6.3.12) operation on this System. A System that supports the "output-device-x509-certificate" (section 7.1.3) or "output-device-x509-request" (section 7.1.4) operation attributes and the Register-Output-Device operation MUST support this attribute.

The list of values MUST include 'output-device-uuid' and 'printer-service-type'.

7.2.38 system-make-and-model (text(127))

This REQUIRED System attribute identifies the System make and model and is semantically analogous to the "printer-make-and-model" Printer attribute defined in [STD92]. The manufacturer can initially populate this attribute.

7.2.39 system-message-from-operator (text(127))

This OPTIONAL System attribute provides a message from an Operator, Administrator, or "intelligent" process to indicate the reasons for modification or other System management action and is semantically analogous to the "printer-message-from-operator" Printer attribute defined in [STD92].

7.2.40 system-name (name(127))

This REQUIRED System attribute contains the System name and is semantically analogous to the "printer-name" Printer attribute defined in [STD92]. The default value incorporates the make, model, and serial number of the System, e.g., "Example Model (SN123456)".

7.2.41 system-service-contact-col (collection | unknown)

This RECOMMENDED System attribute contains contact information for the service agent responsible for maintaining the System, or the 'unknown' out-of-band value if no service agent contact information has been configured. Table 10 lists the member attributes. When specified in a Set-System-Attributes operation, the collection value MUST contain all REQUIRED member attributes as the entire collection value is replaced.

7.2.42 system-settable-attributes-supported (1setOf keyword)

This REQUIRED System attribute lists the System Description attributes that can be changed using the Set-System-Attributes operation (section 6.3.15) and is semantically equivalent to the "printer-settable-attributes-supported" Printer Description attribute [RFC3380]. The 'none' keyword value can be returned by itself to indicate that no System Description attributes can be changed.

7.2.43 system-strings-languages-supported (1setOf naturalLanguage)

This RECOMMENDED System attribute lists natural languages supported for the “system-strings-uri” System attribute and is semantically analogous to the “printer-strings-languages-supported” Printer attribute defined in [PWG5100.13].

This attribute MUST be supported if the "system-strings-uri" attribute is supported.

7.2.44 system-strings-uri (uri | no-value)

This RECOMMENDED System attribute provides a "text/strings" message catalog file using "http:" or "https:" URIs that SHOULD be System-resident so that Client interaction with the System does not require access to external networks and is semantically analogous to the “printer-strings-uri” Printer attribute defined in [PWG5100.13]. Systems SHOULD provide localizations for all supported System attributes, keywords, and enums, so that a Client may present a consistent user interface to the User.

This attribute MUST be supported if the "system-strings-uri" attribute is supported.

7.2.45 system-xri-supported (1setOf collection)

This REQUIRED System attribute lists supported XRI (URI, authentication, and security tuples) for the System and is semantically analogous to the "printer-xri-supported" Printer attribute defined in [RFC3380] and the SM XriSupported element defined in [PWG5108.01].

7.2.45.1 xri-uri (uri)

This REQUIRED member attribute specifies an “ipp:” [RFC3510] or “ipps:” [RFC7472] URI for the System and is semantically analogous to a value of the “xri-uri” member attribute defined in [RFC3380].

7.2.45.2 xri-authentication (type2 keyword)

This REQUIRED member attribute specifies the IPP Client authentication mechanism associated with the corresponding value of “xri-uri” and is semantically analogous to a value of the “xri-authentication” member attribute defined in [RFC3380]. The original standard values for this attribute are defined in [STD92] and extension values are registered in the IANA IPP Registry [IANAIPP].

7.2.45.3 xri-security (type2 keyword)

This REQUIRED member attribute specifies the IPP transport security mechanism associated with the corresponding value of “xri-uri” and is semantically analogous to a value of the “xri-security” member attribute defined in [RFC3380]. The original standard values for this attribute are defined in [STD92] and extension values are registered in the IANA IPP Registry [IANAIPP].

7.3 System Status Attributes

All of the System Status attributes are READ-ONLY and cannot be changed directly by the Set-System-Attributes operation.

7.3.1 power-log-col (1setOf collection)

This RECOMMENDED System attribute lists System power log entries (for events) and is semantically equivalent to the Power Log group defined in [PWG5106.4].

Systems SHOULD minimize the number of power log entries in this attribute for reliability. Systems MUST record all final stable power state transitions in this attribute for every sequence invoked by an ephemeral requested power state such as ‘reset-nmi’. Systems MAY omit intermediate state transitions invoked by such ephemeral requested states as ‘reset-nmi’.

7.3.1.1 log-id (integer(1:MAX))

This REQUIRED member attribute contains the unique key of this power log entry and is semantically equivalent to the SM LogID element in the Power Log group defined in [PWG5106.4].

7.3.1.2 power-state (type1 enum)

This REQUIRED member attribute identifies the recorded stable or ephemeral (transitional) power state for this power log entry and is semantically equivalent to the SM PowerState element in the Power Log group defined in [PWG5106.4]. The ‘hibernate’, ‘off-hard’, ‘off-soft’, ‘on’, ‘standby’, and ‘suspend’ values (and their vendor-specific variants) are considered stable power states while all others are ephemeral transition states that will eventually lead to a stable power state.

Standard enum values derived from Table 2 of [PWG5106.4] are:

'20' (on): On, new Jobs MUST be accepted/processed immediately.

'21' (on-vendor1): First vendor-specific 'on' state.

'22' (on-vendor2): Second vendor-specific 'on' state.

'23' (on-vendor3): Third vendor-specific 'on' state.

'24' (on-vendor4): Fourth vendor-specific 'on' state.

'25' (on-vendor5): Fifth vendor-specific 'on' state.

'30' (standby): Standby – highest power usage in Sleep Mode – shortest warm-up to On – new Jobs MAY be accepted.

'31' (standby-vendor1): First vendor-specific 'standby' state.

'32' (standby-vendor2): Second vendor-specific 'standby' state.

'33' (standby-vendor3): Third vendor-specific 'standby' state.

'34' (standby-vendor4): Fourth vendor-specific 'standby' state.

'35' (standby-vendor5): Fifth vendor-specific 'standby' state.

'40' (suspend): Suspend – lowest power usage in Sleep Mode – new Jobs MAY be accepted.

'41' (suspend-vendor1): First vendor-specific 'suspend' state.

'42' (suspend-vendor2): Second vendor-specific 'suspend' state.

'43' (suspend-vendor3): Third vendor-specific 'suspend' state.

'44' (suspend-vendor4): Fourth vendor-specific 'suspend' state.

'45' (suspend-vendor5): Fifth vendor-specific 'suspend' state.

'50' (reset-soft): Soft power reset – soft power off, then power on.

'60' (off-hard): Hard power off – mechanical unplug – no power consumed – Off Mode.

'70' (hibernate): Hibernate – save context and OS, then soft power off – limited auxiliary power – Off Mode – NOT Sleep mode.

'71' (hibernate-vendor1): First vendor-specific 'hibernate' state.

'72' (hibernate-vendor2): Second vendor-specific 'hibernate' state.

'73' (hibernate-vendor3): Third vendor-specific 'hibernate' state.

'74' (hibernate-vendor4): Fourth vendor-specific 'hibernate' state.

'75' (hibernate-vendor5): Fifth vendor-specific 'hibernate' state.

'80' (off-soft): Soft power off – switch w/flea or auxiliary power – Off Mode.

'81' (off-soft-vendor1): First vendor-specific 'off-soft' state.

'82' (off-soft-vendor2): Second vendor-specific 'off-soft' state.

'83' (off-soft-vendor3): Third vendor-specific 'off-soft' state.

'84' (off-soft-vendor4): Fourth vendor-specific 'off-soft' state.

'85' (off-soft-vendor5): Fifth vendor-specific 'off-soft' state.

'90' (reset-hard): Hardware power reset – hard power off, then power on.

'100' (reset-mbr): Hardware power reset (MBR).

'110' (reset-nmi): Hardware power reset (NMI).

'120' (off-soft-graceful): Orderly shutdown, then soft power off to off-soft.

'130' (off-hard-graceful): Orderly shutdown, then hard power off to off-hard.

'140' (reset-mbr-graceful): Orderly shutdown, then MBR power reset.

'150' (reset-soft-graceful): Orderly shutdown, then soft power reset.

'160' (reset-hard-graceful): Orderly shutdown, then hard power off, then power on.

'170' (reset-init): Hardware power reset (INIT).

'180' (not-applicable): Not applicable (for power transitions).

'190' (no-change): No change (for power transitions).

7.3.1.3 power-state-date-time (dateTime)

This REQUIRED member attribute identifies the date and time of transition into the recorded power state for this power log entry and is semantically equivalent to the SM PowerStateDateAndTime element in the Power Log group defined in [PWG5106.4].

7.3.1.4 power-state-message (text (255))

This OPTIONAL member attribute contains a human-readable string in UTF-8 [RFC3629] that describes, explains, or qualifies the logged power state and is semantically equivalent to the SM PowerStateMessage element in the Power Log group defined in [PWG5106.4]. For example, "standby - System is shutting down by user request (2W)" when transitioning to final 'off-soft' power state.

Usage: This attribute: (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”.

7.3.2 power-state-capabilities-col (1setOf collection)

This OPTIONAL System attribute lists System supported power capabilities for each stable power state and is semantically equivalent to the SM Power Support group defined in [PWG5106.4].

7.3.2.1 can-accept-jobs (boolean)

This REQUIRED member identifies whether the System can accept new incoming Jobs in this stable power state, unless the System or has been disabled by an Operator or Administrator, and is semantically equivalent to the SM CanAcceptJobs element in the Power Support group defined in [PWG5106.4].

7.3.2.2 can-process-jobs (boolean)

This REQUIRED member identifies whether the System can process new incoming Jobs or existing queued Jobs in this stable power state and is semantically equivalent to the SM CanProcessJobs element in the Power Support group defined in [PWG5106.4].

7.3.2.3 power-active-watts (integer(0:MAX))

This REQUIRED member attribute identifies the nominal power consumption in watts for this stable power state when the System is in an active operational state (i.e., ‘processing’) and is semantically equivalent to the SM PowerActiveWatts element in the Power Support group defined in [PWG5106.4].

7.3.2.4 power-inactive-watts (integer(0:MAX))

This REQUIRED member attribute identifies the nominal power consumption in watts for this stable power state when the System is in an inactive operational state (i.e., ‘idle’ or ‘stopped’) and is semantically equivalent to the SM PowerInactiveWatts element in the Power Support group defined in [PWG5106.4].

7.3.2.5 power-state (type1 enum)

This REQUIRED member attribute identifies a System supported stable power state that is the unique key of this power state capability entry and is semantically equivalent to the SM PowerState element in the Power Support group defined in [PWG5106.4].

Standard values and constraints on vendor extension values are defined in section 7.3.1.2.

7.3.3 power-state-counters-col (1setOf collection)

This OPTIONAL System attribute lists System power state transition counters and is semantically equivalent to the SM Power Counter group defined in [PWG5106.4].

7.3.3.1 hibernate-transitions (integer(0:MAX))

This REQUIRED member attribute contains the System lifetime number of transitions into the ‘hibernate’ power state and is semantically equivalent to the SM HibernateTransitions element in the Power Counter group defined in [PWG5106.4].

7.3.3.2 on-transitions (integer(0:MAX))

This REQUIRED member attribute contains the System lifetime number of transitions into the ‘on’ power state and is semantically equivalent to the SM OnTransitions element in the Power Counter group defined in [PWG5106.4].

7.3.3.3 standby-transitions (integer(0:MAX))

This REQUIRED member attribute contains the System lifetime number of transitions into the ‘standby’ power state and is semantically equivalent to the SM StandbyTransitions element in the Power Counter group defined in [PWG5106.4].

7.3.3.4 suspend-transitions (integer(0:MAX))

This REQUIRED member attribute contains the System lifetime number of transitions into the ‘suspend’ power state and is semantically equivalent to the SM SuspendTransitions element in the Power Counter group defined in [PWG5106.4].

7.3.4 power-state-monitor-col (collection)

This RECOMMENDED System attribute contains the System power state and is semantically equivalent to the SM Power General, Power Meters, and Power Monitor groups defined in [PWG5106.4].

Note: Power consumption attribute values are volatile and typically change regularly at implementation-defined intervals.

7.3.4.1 current-month-kwh (integer(0:MAX))

This REQUIRED member attribute contains the current month's System power consumption in kilowatt hours and is semantically equivalent to the SM PowerCurrentMonthKWH element in the Power Meter group defined in [PWG5106.4]. The System MUST reset the value of this attribute to zero at the beginning of every month.

7.3.4.2 current-watts (integer(0:MAX))

This REQUIRED member attribute contains the current System instantaneous power consumption in watts and is semantically equivalent to the SM PowerCurrentWatts element in the Power Meter group defined in [PWG5106.4].

Note: The value of this attribute is typically determined by software estimation instead of actual current measurement.

7.3.4.3 lifetime-kwh (integer(0:MAX))

This REQUIRED member attribute contains the lifetime System power consumption in kilowatt hours and is semantically equivalent to the SM PowerLifetimeKWH element in the Power Meter group defined in [PWG5106.4].

7.3.4.4 meters-are-actual (boolean)

This REQUIRED member attribute identifies whether or not System power meter attributes are based on actual measurement (true) or software estimation (false) and is semantically equivalent to the SM PowerMetersAreActual element in the Power Meter group defined in [PWG5106.4].

7.3.4.5 power-state (type1 enum)

This REQUIRED member attribute identifies the current stable or ephemeral (transitional) System power state and is semantically equivalent to the SM PowerState element in the Power Monitor group defined in [PWG5106.4].

Standard values and constraints on vendor extension values are defined in section 7.3.1.2.

7.3.4.6 power-state-message (text (255))

This OPTIONAL member attribute contains a human-readable string in UTF-8 [RFC3629] that describes, explains, or qualifies the current System power state (e.g.,) and is semantically equivalent to the SM PowerStateMessage element in the Power Monitor group defined in [PWG5106.4]. For example, "standby - System is shutting down by user request (2W)" when transitioning to final 'off-soft' power state.

Usage: This attribute: (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”.

7.3.4.7 power-usage-is-rms-watts (boolean)

This REQUIRED member attribute identifies whether or not the power consumption properties for this System use units of Root Mean Square (RMS) watts (true) or unnormalized so-called peak watts (false) and is semantically equivalent to the SM PowerUsageIsRMSWatts element in the Power General group defined in [PWG5106.4].valid-request-power-states (1setOf (type1 keyword))

This REQUIRED member attribute identifies all of the stable and ephemeral power states that can be requested (in policies) on this System and is semantically equivalent to the SM CanRequestPowerStates element in the Power General group defined in [PWG5106.4].

Standard values and constraints on vendor extension values are defined in section 7.2.1 Power States and Policies.

7.3.5 power-state-transitions-col (1setOf collection)

This OPTIONAL System attribute lists valid System power state transitions and is semantically equivalent to the SM Power Transition group defined in [PWG5106.4].

7.3.5.1 end-power-state (type1 enum)

This REQUIRED member attribute identifies the ending stable System power state for this valid power state transition and is semantically equivalent to the SM EndPowerState element in the Power Transition group defined in [PWG5106.4].

Standard values and constraints on vendor extension values are defined in section 7.3.1.2.

7.3.5.2 start-power-state (type1 enum)

This REQUIRED member attribute identifies the starting stable System power state for this valid power state transition and is semantically equivalent to the SM EndPowerState element in the Power Transition group defined in [PWG5106.4].

Standard values and constraints on vendor extension values are defined in section 7.3.1.2.

7.3.5.3 state-transition-seconds (integer(0:MAX))

This REQUIRED member attribute contains the nominal duration in seconds for this valid power state transition and is semantically equivalent to the SM StateChangeSeconds element in the Power Transition group defined in [PWG5106.4].

7.3.6 system-config-change-date-time (dateTime)

This REQUIRED System attribute contains the value of “system-current-time” (date and time) for the most recent System configuration change.

7.3.7 system-config-change-time (integer(0:MAX))

This REQUIRED System attribute contains the value of “system-up-time” (seconds since System startup) for the most recent System configuration change or zero if no System configuration change has occurred.

7.3.8 system-config-changes (integer(0:MAX))

This REQUIRED System attribute contains the count of configuration changes for the System and is semantically equivalent to the SM SystemConfigChangeNumber element defined in [PWG5108.06] and semantically analogous to the prtGeneralConfigChanges object defined in [RFC3805]. Each time a Set-System-Attributes operation is performed that changes the value of any attribute and each time the System changes the value of any attribute outside of an operation, the System MUST increment value of the “system-config-changes” attribute by exactly one. Each time that the System performs a power cycle (from ‘off’ to ‘on’), the System MUST reset the value of this attribute to zero.

7.3.9 system-configured-printers (1setOf collection | no-value)

This REQUIRED System attribute contains the summary of all configured Printers for the System and is semantically equivalent to the SM ConfiguredServices element defined in [PWG5108.06]. Table 11 lists the member attributes for collection values. If there are no configured Printers for the System, the 'no-value' out-of-band value is returned.

Note: The list of Printers in the "system-configured-printers" attribute is distinct from the list of Printers returned by the Get-Printers operation (section 6.1.4). The "system-configured-printers" attribute only lists Printers that are directly managed by the System, while the Get-Printers operation can filter the list to those Printers that are available to a given End User and/or include Printers from other Systems that available within the same AAA Framework.

Table 11 - "system-configured-printers" Member Attributes

Conformance	IPP Attribute Name	Reference
REQUIRED	printer-id	[PWG5100.22]
REQUIRED	printer-info	[STD92]
REQUIRED	printer-is-accepting-jobs	[STD92]
REQUIRED	printer-name	[STD92]
REQUIRED	printer-service-type	[PWG5100.22]
REQUIRED	printer-state	[STD92]
REQUIRED	printer-state-reasons	[STD92]
REQUIRED	printer-xri-supported	[RFC3380]

7.3.9.1 printer-id (integer(1:65535))

This REQUIRED member attribute uniquely identifies the Printer within the System and is semantically equivalent to the SM ServiceSummary element ID defined in [PWG5108.06] and semantically analogous to the “job-id” attribute defined in [STD92]. See “printer-id” in section 7.7.2.

7.3.9.2 printer-info (text(127))

This REQUIRED member attribute contains the description of the Printer and is semantically equivalent to the "printer-info" Printer attribute defined in [STD92] but is not included in the SM ServiceSummary element defined in [PWG5108.06].

7.3.9.3 printer-is-accepting-jobs (boolean)

This REQUIRED member attribute identifies whether the Printer is currently accepting incoming Jobs and is semantically equivalent to the "printer-is-accepting-jobs" Printer attribute defined in [STD92] and the SM ServiceSummary IsAcceptingJobs element defined in [PWG5108.06].

7.3.9.4 printer-name (name(127))

This REQUIRED member attribute identifies the name of the Printer and is semantically equivalent to the "printer-name" Printer attribute defined in [STD92] and the SM ServiceSummary ServiceName element defined in [PWG5108.06].

7.3.9.5 printer-service-type (type2 keyword)

This REQUIRED member attribute identifies the service type of the Printer and is semantically equivalent to the "printer-service-type" Printer attribute defined in section 7.7.9 and the SM ServiceSummary ServiceType element defined in [PWG5108.06].

7.3.9.6 printer-state (type1 enum)

This REQUIRED member attribute contains the current state of the Printer and is semantically equivalent to the "printer-state" Printer attribute defined in [STD92] and the SM ServiceSummary State element defined in [PWG5108.06].

7.3.9.7 printer-state-reasons (1setOf type2 keyword)

This REQUIRED member attribute contains additional detail about the current state of the Printer and is semantically equivalent to the "printer-state-reasons" Printer attribute defined in [STD92] and the SM ServiceSummary StateReasons element defined in [PWG5108.06].

7.3.9.8 printer-xri-supported (1setOf collection)

This REQUIRED member attribute lists the supported URI, authentication, and security tuples for the Printer and is semantically equivalent to the "printer-xri-supported" Printer attribute defined in [RFC3380] and the SM ServiceSummary ServiceXriSupported element defined in [PWG5108.06].

7.3.10 system-configured-resources (1setOf collection | no-value)

This REQUIRED System attribute contains the summary of all configured Resources for the System and is semantically equivalent to the SM ConfiguredResources element defined in [PWG5108.06]. Table 12 list the member attributes for collection values. If there are no configured Resources for the System, the 'no-value' out-of-band value is returned.

Table 12 - "system-configured-resources" Member Attributes

Conformance	IPP Attribute Name	Reference
REQUIRED	resource-format	[PWG5100.22]
REQUIRED	resource-id	[PWG5100.22]
REQUIRED	resource-info	[PWG5100.22]
REQUIRED	resource-name	[PWG5100.22]
REQUIRED	resource-state	[PWG5100.22]
REQUIRED	resource-state-reasons	[PWG5100.22]
REQUIRED	resource-type	[PWG5100.22]

7.3.10.1 resource-format (mimeMediaType)

This REQUIRED member attribute identifies the format of the Resource and is semantically equivalent to the "resource-format" Resource attribute defined in section 7.9.5 and the SM ResourceSummary ResourceFormat element defined in [PWG5108.06].

7.3.10.2 resource-id (integer(1:MAX))

This REQUIRED member attribute contains the unique identifier of the Resource and is semantically equivalent to the "resource-id" Resource attribute defined in section 7.9.6 and the SM ResourceSummary ResourceId element defined in [PWG5108.06].

7.3.10.3 resource-info (text(127))

This REQUIRED member attribute contains the description of the Resource and is semantically equivalent to the "resource-info" Resource attribute defined in section 7.8.1 but is not included in the original SM ResourceSummary element defined in [PWG5108.06].

7.3.10.4 resource-name (name(127))

This REQUIRED member attribute identifies the name of the Resource and is semantically equivalent to the "resource-name" Resource attribute defined in section 7.8.2 and the SM ResourceSummary ResourceName element defined in [PWG5108.06].

7.3.10.5 resource-state (type1 enum)

This REQUIRED member attribute contains the current state of the Resource and is semantically equivalent to the "resource-state" Resource attribute defined in section 7.9.11 but is not included in the original SM ResourceSummary element defined in [PWG5108.06].

7.3.10.6 resource-state-reasons (1setOf type2 keyword)

This REQUIRED member attribute contains a list of state reasons for the Resource and is semantically equivalent to the "resource-state-reasons" Resource attribute defined in section 7.9.13 but is not included in the original SM Resource object defined in [PWG5108.03].

7.3.10.7 resource-type (type2 keyword)

This REQUIRED member attribute identifies the type of the Resource and is semantically equivalent to the "resource-type" Resource attribute defined in section 7.9.15 and the SM ResourceSummary ResourceType element defined in [PWG5108.06].

7.3.11 system-firmware-name (1setOf name(MAX))

This REQUIRED attribute lists the names of each Firmware component used by the System and conforms to the FirmwareName attribute in the PWG HCD Heath Assessment Attributes [PWG5110.1] specification. Each "system-firmware-xxx" attribute MUST have the same

cardinality (number of values). The i[th] value of this attribute corresponds to the i[th] value of the other "system-firmware-xxx" attributes.

7.3.12 system-firmware-patches (1setOf text(MAX))

This REQUIRED attribute lists the patches applied to each Firmware component used by the System and conforms to the FirmwarePatches attribute in the PWG HCD Heath Assessment Attributes [PWG5110.1] specification. Each "system-firmware-xxx" attribute MUST have the same cardinality (number of values). The i[th] value of this attribute corresponds to the i[th] value of the other "system-firmware-xxx" attributes.

7.3.13 system-firmware-string-version (1setOf text(MAX))

This REQUIRED attribute lists the string versions of each Firmware component used by the System and conforms to the FirmwareStringVersion attribute in the PWG HCD Heath Assessment Attributes [PWG5110.1] specification. Each "system-firmware-xxx" attribute MUST have the same cardinality (number of values). The i[th] value of this attribute corresponds to the i[th] value of the other "system-firmware-xxx" attributes.

7.3.14 system-firmware-version (1setOf octetString(64))

This REQUIRED attribute lists the version numbers of each Firmware component used by the System and conforms to the FirmwareVersion attribute in the PWG HCD Heath Assessment Attributes [PWG5110.1] specification. Each "system-firmware-xxx" attribute MUST have the same cardinality (number of values). The i[th] value of this attribute corresponds to the i[th] value of the other "system-firmware-xxx" attributes.

7.3.15 system-impressions-completed (integer(0:MAX))

This RECOMMENDED System attribute provides the total number of impressions processed by all configured Printers, corresponding to the icImpressionTotalImps property defined in the PWG Imaging System State and Counter MIB v2.0 [PWG5106.3].

7.3.16 system-impressions-completed-col (collection)

This RECOMMENDED System attribute provides a breakdown of the total number of impressions processed by all configured Printers. Table 13 lists the member attributes that correspond to the PWG Imaging System State and Counter MIB v2.0 [PWG5106.3] properties.

Table 13 - "xxx-impressions-completed-col" Member Attributes

IPP Member Attribute	Counter MIB Equivalent
blank (integer(0:MAX))	icImpressionBlankImps
blank-two-sided (integer(0:MAX))	icTwoSidedBlankImps
full-color (integer(0:MAX))	icImpressionFullColorImps
full-color-two-sided (integer(0:MAX))	icTwoSidedFullColorImps
highlight-color (integer(0:MAX))	icImpressionHighlightColorImps

highlight-color-two-sided (integer(0:MAX))	icTwoSidedHighlightColorImps
monochrome (integer(0:MAX))	icImpressionMonochromeImps
monochrome-two-sided (integer(0:MAX))	icTwoSidedMonochromeImps

7.3.17 system-media-sheets-completed (integer(0:MAX))

This RECOMMENDED System attribute provides the total number of media sheets processed by all configured Printers, corresponding to the icMediaUsedTotalSheets property defined in the PWG Imaging System State and Counter MIB v2.0 [PWG5106.3].

7.3.18 system-media-sheets-completed-col (collection)

This RECOMMENDED System attribute provides a breakdown of the total number of media sheets processed by all configured Printers. Table 14 lists the member attributes that correspond to the PWG Imaging System State and Counter MIB v2.0 [PWG5106.3] properties.

Table 14 - "xxx-media-sheets-completed-col" Member Attributes

IPP Member Attribute	Counter MIB Equivalent
blank (integer(0:MAX))	icMediaUsedBlankSheets
full-color (integer(0:MAX))	icMediaUsedFullColorSheets
highlight-color (integer(0:MAX))	icMediaUsedHighlightColorSheets
monochrome (integer(0:MAX))	icMediaUsedMonochromeSheets

7.3.19 system-pages-completed (integer(0:MAX))

This RECOMMENDED System attribute provides the total number of pages processed by all configured Printers, corresponding to the icImpressionTotalImps property defined in the PWG Imaging System State and Counter MIB v2.0 [PWG5106.3].

7.3.20 system-pages-completed-col (collection)

This RECOMMENDED System attribute provides a breakdown of the total number of pages processed by all configured Printers. Table 15 lists the member attributes that correspond to the PWG Imaging System State and Counter MIB v2.0 [PWG5106.3] properties.

Table 15 - "xxx-pages-completed-col" Member Attributes

IPP Member Attribute	Counter MIB Equivalent
full-color (integer(0:MAX))	icImageFullColorImages
monochrome (integer(0:MAX))	icImageMonochromeImages

7.3.21 system-resident-application-name (1setOf name(MAX))

This CONDITIONALLY REQUIRED attribute lists the names of each resident application used by the System and conforms to the ResidentApplicationName attribute in the PWG

HCD Heath Assessment Attributes [PWG5110.1] specification. Systems that support Resident Applications MUST support this attribute.

Each "system-resident-application-xxx" attribute MUST have the same cardinality (number of values). The i^{th} value of this attribute corresponds to the i^{th} value of the other "system-resident-application-xxx" attributes.

7.3.22 system-resident-application-patches (1setOf text(MAX))

This CONDITIONALLY REQUIRED attribute lists the patches applied to each Resident Application used by the System and conforms to the ResidentApplicationPatches attribute in the PWG HCD Heath Assessment Attributes [PWG5110.1] specification. Systems that support Resident Applications MUST support this attribute.

Each "system-resident-application-xxx" attribute MUST have the same cardinality (number of values). The i^{th} value of this attribute corresponds to the i^{th} value of the other "system-resident-application-xxx" attributes.

7.3.23 system-resident-application-string-version (1setOf text(MAX))

This CONDITIONALLY REQUIRED attribute lists the string versions of each Resident Application used by the System and conforms to the ResidentApplicationStringVersion attribute in the PWG HCD Heath Assessment Attributes [PWG5110.1] specification. Systems that support Resident Applications MUST support this attribute.

Each "system-resident-application-xxx" attribute MUST have the same cardinality (number of values). The i^{th} value of this attribute corresponds to the i^{th} value of the other "system-resident-application-xxx" attributes.

7.3.24 system-resident-application-version (1setOf octetString(64))

This CONDITIONALLY REQUIRED attribute lists the version numbers of each Resident Application used by the System and conforms to the ResidentApplicationVersion attribute in the PWG HCD Heath Assessment Attributes [PWG5110.1] specification. Systems that support Resident Applications MUST support this attribute.

Each "system-resident-application-xxx" attribute MUST have the same cardinality (number of values). The i^{th} value of this attribute corresponds to the i^{th} value of the other "system-resident-application-xxx" attributes.

7.3.25 system-serial-number (text(255))

This OPTIONAL System attribute identifies the serial number for the System and is semantically equivalent to the SM SerialNumber element defined in [PWG5108.06] and semantically analogous to the prtGeneralSerialNumber element defined in [RFC3805].

7.3.26 system-state (type1 enum)

This REQUIRED System attribute contains the current state for the System and is semantically equivalent to the SM State element defined in [PWG5108.06] and semantically analogous to the “printer-state” attribute defined in [STD92].

Standard values for this attribute are:

'3' (idle): Indicates that one or more Printers are in the ‘idle’ state and none are in the 'processing' state.

'4' (processing): Indicates that one or more Printers are in the 'processing' state.

'5' (stopped): Indicates that all Printers are in the ‘stopped’ state.

7.3.27 system-state-change-date-time (dateTime)

This REQUIRED System attribute contains the value of “system-current-time” (date and time) for the most recent System state change and is semantically analogous to the “printer-state-change-date-time” attribute defined in [RFC3995].

7.3.28 system-state-change-time (integer(0:MAX))

This REQUIRED System attribute contains the value of “system-up-time” (seconds since System startup) for the most recent System state change or zero if no System state change has occurred and is semantically analogous to the “printer-state-change-time” attribute defined in [RFC3995].

7.3.29 system-state-message (text(MAX))

This OPTIONAL System attribute contains a state message for the System and is semantically analogous to the SM StateMessages element defined in [PWG5108.06] and the “printer-state-message” attribute defined in [STD92]. If supported, the value reflects the state of the System as a whole and not the state of any one Printer.

7.3.30 system-state-reasons (1setOf type2 keyword)

This REQUIRED System attribute contains a list of state reasons for the System and is semantically equivalent to the SM StateReasons element defined in [PWG5108.06] and the “printer-state-reasons” attribute defined in [STD92]. In addition to the keywords defined here, any applicable “printer-state-reasons” keyword value, with severity suffix removed, can be used in “system-state-reasons”.

System objects that represent a single Multi-Function Device (MFD) SHOULD include the union of all "printer-state-reasons" values (with severity suffixes remove) from all Printers managed by the System.

The following System-specific values are defined:

'none': There are no additional reasons associated with the current System state.

'system-restarting': The System is processing a Restart-System (section 6.3.13) operation at this time.

7.3.31 system-time-source-configured (type2 keyword | name(MAX))

This REQUIRED attribute identifies the source for time values on the System and corresponds to the TimeSource attribute in the PWG HCD Heath Assessment Attributes [PWG5110.1] specification. Name values specify a Network Time Protocol (NTP) or Simple Network Time Protocol (SNTP) [RFC5905] server host name. The following keyword values are defined:

'dhcp': The System obtains the NTP or SNTP server address via DHCP option 42 [RFC2132].

'ntp': The System uses an NTP server that was configured out-of-band from IPP.

'onboard': The System uses an internal real time clock.

'sntp': The System uses a SNTP server that was configured out-of-band from IPP.

Note: The TimeSource [PWG5110.1] attribute is also defined to support a URI value, however no URI scheme has been defined for NTP or SNTP. Therefore, the IPP attribute syntax only supports the keyword and name values.

7.3.32 system-up-time (integer(1:MAX))

This REQUIRED System attribute contains the time in seconds since last boot for the System and is semantically equivalent to the SM UpTime element defined in [PWG5108.06].

7.3.33 system-user-application-name (1setOf name(MAX))

This CONDITIONALLY REQUIRED attribute lists the names of each User Application used by the System and conforms to the UserApplicationName attribute in the PWG HCD Heath Assessment Attributes [PWG5110.1] specification. Systems that support User Applications MUST support this attribute.

Each "system-user-application-xxx" attribute MUST have the same cardinality (number of values). The i^{th} value of this attribute corresponds to the i^{th} value of the other "system-user-application-xxx" attributes.

7.3.34 system-user-application-patches (1setOf text(MAX))

This CONDITIONALLY REQUIRED attribute lists the patches applied to each User Application used by the System and conforms to the UserApplicationPatches attribute in the PWG HCD Heath Assessment Attributes [PWG5110.1] specification. Systems that support User Applications MUST support this attribute.

Each "system-user-application-xxx" attribute MUST have the same cardinality (number of values). The i^{th} value of this attribute corresponds to the i^{th} value of the other "system-user-application-xxx" attributes.

7.3.35 system-user-application-string-version (1setOf text(MAX))

This CONDITIONALLY REQUIRED attribute lists the string versions of each User Application used by the System and conforms to the UserApplicationStringVersion attribute in the PWG HCD Heath Assessment Attributes [PWG5110.1] specification. Systems that support User Applications MUST support this attribute.

Each "system-user-application-xxx" attribute MUST have the same cardinality (number of values). The i^{th} value of this attribute corresponds to the i^{th} value of the other "system-user-application-xxx" attributes.

7.3.36 system-user-application-version (1setOf octetString(64))

This CONDITIONALLY REQUIRED attribute lists the version numbers of each User Application used by the System and conforms to the UserApplicationVersion attribute in the PWG HCD Heath Assessment Attributes [PWG5110.1] specification. Systems that support User Applications MUST support this attribute.

Each "system-user-application-xxx" attribute MUST have the same cardinality (number of values). The i^{th} value of this attribute corresponds to the i^{th} value of the other "system-user-application-xxx" attributes.

7.3.37 system-uuid (uri(45))

This REQUIRED System attribute contains the UUID as a URI [RFC4122] for the System and is semantically equivalent to the SM ServiceUuid element defined in [PWG5108.01].

7.3.38 xri-authentication-supported (1setOf type2 keyword)

This REQUIRED System attribute lists the supported "xri-authentication" member attribute values and is semantically equivalent to the Printer Status attribute of the same name.

7.3.39 xri-security-supported (1setOf type2 keyword)

This REQUIRED System attribute lists the supported "xri-security" member attribute values and is semantically equivalent to the Printer Status attribute of the same name.

7.3.40 xri-uri-scheme-supported (1setOf uriScheme)

This REQUIRED System attribute lists the supported "xri-uri" member attribute URI schemes and is semantically equivalent to the Printer Status attribute of the same name.

7.4 Document Status Attributes

All Document Status attributes are READ-ONLY and cannot be directly updated by the Set-Document-Attributes operation.

7.4.1 document-resource-ids (1setOf integer(1:MAX))

This REQUIRED Document attribute lists the Printer resource IDs allocated to the Document. The value(s) are the actual resource IDs copied from the "resource-ids" (section 7.1.15) operation attribute from the Document Creation request.

7.5 Job Status Attributes

All Job Status attributes are READ-ONLY and cannot be directly updated by the Set-Job-Attributes operation.

7.5.1 job-resource-ids (1setOf integer(1:MAX))

This REQUIRED Job attribute lists the Printer resource IDs allocated to the Job. The value(s) are the actual resource IDs copied from the "resource-ids" (section 7.1.15) operation attribute from the Job Creation request.

7.6 Printer Description Attributes

Printer Description attributes are typically READ-WRITE and can potentially be set by an Operator or Administrator using the Set-Printer-Attributes operation [RFC3380]. Writable Printer Description attributes are listed in the value of “printer-settable-attributes-supported” [RFC3380].

7.6.1 printer-contact-col (collection | unknown)

This RECOMMENDED Printer attribute identifies the Printer contact person, typically the Administrator or Operator. Table 10 lists the "printer-contact-col" member attributes, which are the same as the "system-contact-col" System Description attribute (section 7.2.29). The default "printer-contact-col" value is the value of the "system-contact-col" System Description attribute at the time of Printer Creation.

7.7 Printer Status Attributes

All of the Printer Status attributes are READ-ONLY and cannot be set directly by the Set-Printer-Attributes operation.

7.7.1 printer-config-changes (integer(0:MAX))

This REQUIRED Printer attribute identifies the number of configuration changes (in Printer Description attributes) for a Printer semantically equivalent to the SM Monitoring

ConfigChanges element defined in [PWG5106.1] and the prtGeneralConfigChanges property in IETF Printer MIB v2 [RFC3805]. The value of this attribute MUST be incremented by one for each operation that changes the Printer configuration (rather than incrementing by one for each configuration attribute that was changed by the single operation).

7.7.2 printer-id (integer(1:65535))

This REQUIRED Printer attribute uniquely identifies the Printer within the System and is semantically equivalent to the SM ServiceSummary ID element defined in [PWG5108.06] and semantically analogous to the “job-id” attribute defined in [STD92].

7.7.3 printer-impressions-completed (integer(0:MAX))

This RECOMMENDED Printer attribute provides the total number of impressions processed by the Printer, corresponding to the icImpressionTotalImps property defined in the PWG Imaging System State and Counter MIB v2.0 [PWG5106.3].

7.7.4 printer-impressions-completed-col (collection)

This RECOMMENDED Printer attribute provides a breakdown of the total number of impressions processed by the Printer. Table 13 lists the member attributes that correspond to the PWG Imaging System State and Counter MIB v2.0 [PWG5106.3] properties.

7.7.5 printer-media-sheets-completed (integer(0:MAX))

This RECOMMENDED Printer attribute provides the total number of media sheets processed by the Printer, corresponding to the icMediaUsedTotalSheets property defined in the PWG Imaging System State and Counter MIB v2.0 [PWG5106.3].

7.7.6 printer-media-sheets-completed-col (collection)

This RECOMMENDED Printer attribute provides a breakdown of the total number of media sheets processed by the Printer. Table 14 lists the member attributes that correspond to the PWG Imaging System State and Counter MIB v2.0 [PWG5106.3] properties.

7.7.7 printer-pages-completed (integer(0:MAX))

This RECOMMENDED Printer attribute provides the total number of pages processed by the Printer, corresponding to the icImpressionTotalImps property defined in the PWG Imaging System State and Counter MIB v2.0 [PWG5106.3].

7.7.8 printer-pages-completed-col (collection)

This RECOMMENDED Printer attribute provides a breakdown of the total number of pages processed by the Printer. Table 15 lists the member attributes that correspond to the PWG Imaging System State and Counter MIB v2.0 [PWG5106.3] properties.

7.7.9 printer-service-type (type2 keyword)

This REQUIRED Printer attribute identifies the service type for a Printer as used in Create-Printer defined in section 6 and is semantically equivalent to the SM Service Summary ServiceType element defined in [PWG5108.06]. Vendor-specific service types SHOULD be keywords constructed in the form “smiNNN-name”, where “NNN” is the vendor’s enterprise SMI number assigned by IANA. Vendor-specific service types SHOULD be registered with IANA.

Standard keyword values for this attribute include:

‘copy’: A Copy Service as defined in [PWG5108.04].

‘faxin’: A FaxIn Service as defined in [RFC2707] and [PWG5108.01].

‘faxout’: A FaxOut Service as defined in [PWG5100.15].

‘print’: A Print Service as defined in [STD92].

‘print3d’: A 3D Print Service as defined in [PWG5100.21]

‘scan’: A Scan Service as defined in [PWG5100.17].

‘transform’: A Transform Service as defined in [PWG5108.01].

7.8 Resource Description Attributes

Resource Description attributes are typically READ-WRITE and can potentially be set by an Operator or Administrator using the Set-Resource-Attributes operation (see section 6). Writable Resource Description attributes are listed in the value of “resource-settable-attributes-supported” System Description attribute defined above in section 7.2.

7.8.1 resource-info (text(MAX))

This REQUIRED Resource attribute contains the description of the Resource and is semantically equivalent to the SM ResourceInfo element defined in [PWG5108.03] and semantically analogous to the "printer-info" Printer attribute defined in [STD92].

7.8.2 resource-name (name(MAX))

This REQUIRED Resource attribute contains the name of the Resource and is semantically equivalent to the SM ResourceName element defined in [PWG5108.03] and semantically analogous to the "printer-name" Printer attribute defined in [STD92].

7.9 Resource Status Attributes

All of the Resource Status attributes are READ-ONLY and cannot be directly updated by the Set-Resource-Attributes operation.

7.9.1 date-time-at-canceled (dateTime | no-value)

This REQUIRED Resource attribute contains the date and time of Resource cancelation request (i.e., when Cancel-Resource operation is accepted) or Resource abortion by the System, which can be before the Resource transitions to the ‘canceled’ or ‘aborted’ state. It is semantically analogous to the SM DateTimeAtExpiration element defined in [PWG5108.03] and semantically analogous to the Job “date-time-at-completed” attribute defined in [STD92]. If the Resource has not been canceled or aborted, the 'no-value' out-of-band value is returned.

7.9.2 date-time-at-creation (dateTime)

This REQUIRED Resource attribute contains the date and time of Resource creation request (i.e., when Create-Resource operation is accepted) and is semantically equivalent to the SM DateTimeAtCreation element defined in [PWG5108.03] and semantically analogous to the “date-time-at-creation” Job attribute defined in [STD92].

7.9.3 date-time-at-installed (dateTime | no-value)

This REQUIRED Resource attribute contains the date and time of Resource installation request (i.e., when Install-Resource operation is accepted), which can be before the Resource transitions to the ‘installed’ state. It is semantically analogous to the “date-time-at-processing” Job attribute defined in [STD92]. If the Resource has not been installed, the 'no-value' out-of-band value is returned.

7.9.4 resource-data-uri (uri | no-value))

This REQUIRED Resource attribute identifies the URI of the Resource data, if any. When a Resource has no associated data, the System MUST return the ‘no-value’ out-of-band value defined in [STD92] for “resource-data-uri”.

7.9.5 resource-format (mimeMediaType)

This REQUIRED Resource attribute identifies the format of the Resource data and is semantically equivalent to the SM ResourceFormat element defined in [PWG5108.03] and semantically analogous to the “document-format” attribute defined in [STD92].

7.9.6 resource-id (integer(1:MAX))

This REQUIRED Resource attribute uniquely identifies the Resource within the System and is semantically equivalent to the SM ResourceId element defined in [PWG5108.03] and semantically analogous to the “job-id” attribute defined in [STD92].

7.9.7 resource-k-octets (integer(0:MAX))

This REQUIRED Resource attribute contains the size of the data associated with the Resource (if any) but is not included in the original Resource object defined in [PWG5108.03] and semantically analogous to the “job-k-octets” attribute defined in [STD92].

7.9.8 resource-natural-language (naturalLanguage)

This Resource attribute contains the natural language associated with the resource and is REQUIRED for 'static-strings' Resources.

7.9.9 resource-patches (text(MAX) | no-value)

This Resource attribute contains the list of patches applied to the Resource delimited by a Carriage Return/Line Feed pair (0x0d0a). This attribute is semantically analogous to the FirmwarePatches attribute defined in [PWG5110.4].

7.9.10 resource-signature (1setOf octetString)

This Resource attribute contains the out-of-band digital signature for Resource data as used in Send-Resource-Data defined in section 6.2.5, when the particular Resource data format does not include an embedded digital signature.

See section 12 Security Considerations for details of digital signature handling in IPP System Service.

7.9.11 resource-state (type1 enum)

This REQUIRED Resource attribute contains the current state of the Resource and is semantically analogous to the SM DateTimeOfExpiration and ResourceHasExpired elements defined in [PWG5108.03] and semantically analogous to the “job-state” attribute defined in [STD92].

Standard enum values for this attribute are:

‘3' (pending): The Resource has been created but is not yet available or installed.

‘4' (available): The Resource data has been uploaded and the Resource is available for installation.

‘5' (installed): The Resource has been installed and is ready for use.

‘6' (canceled): The Resource has been canceled and can no longer be used.

‘7' (aborted): The Resource has been aborted by the System and can no longer be used.

Normal Resource state transitions are shown in Figure 2 below. Resource states normally progress from top to bottom (‘created’ to ‘available’ to ‘installed’) until the Resource finally transitions to a terminal state of ‘canceled’ (by Administrator) or ‘aborted’ (by System). See note 2 below for one of the exceptions to normal Resource state transitions.

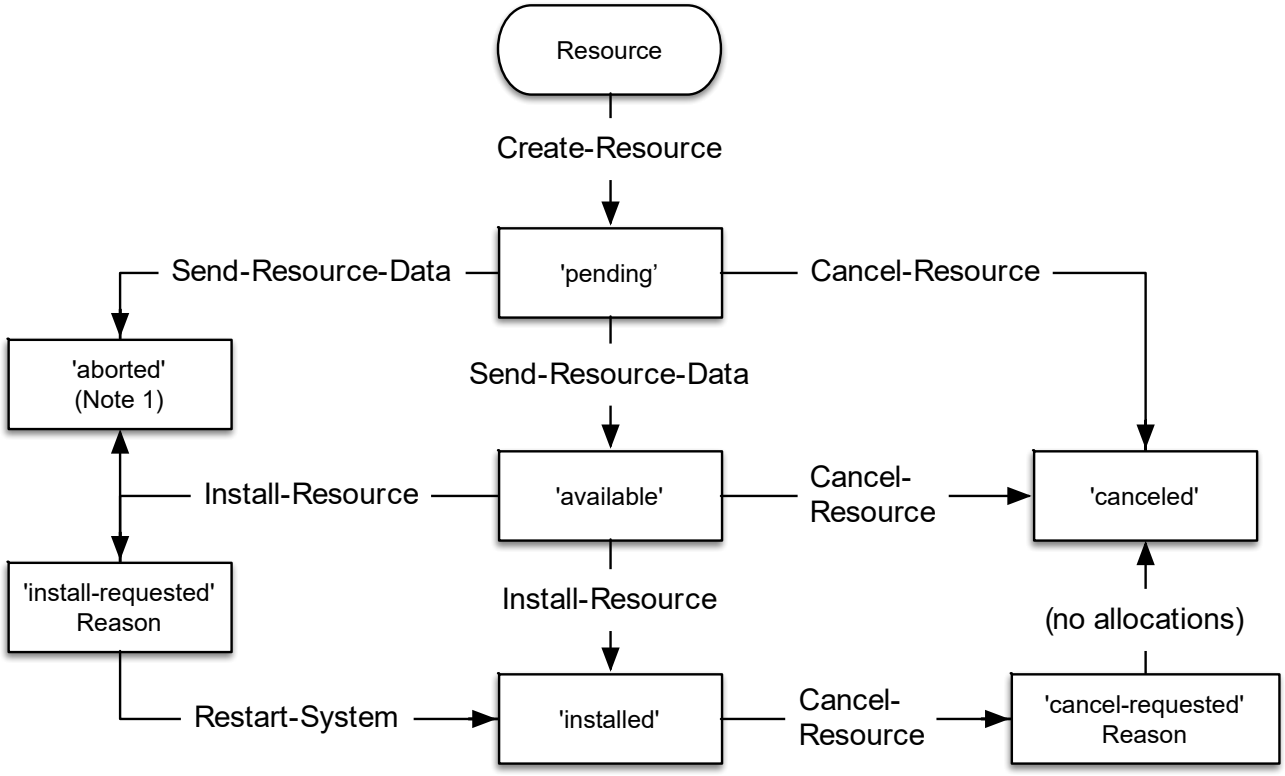

Figure 2 - IPP Resource Object Life Cycle

Notes:

1) A Resource object can transition to the ‘aborted’ state due to an interrupted Send-Resource-Data request, corrupted Resource data, an unsupported Resource data format, inability to store the Resource data, inability to install the Resource data, and/or other System internal fault conditions. The “resource-state-reasons” attribute will contain the reason for the Resource being aborted by the System.

2) When a new Resource version is installed that replaces a previous Resource version (e.g., Firmware), the old Resource “resource-state” MUST transition back to ‘available’ and the old Resource “resource-use-count” MUST be set to zero.

7.9.12 resource-state-message (text(MAX))

This REQUIRED Resource attribute contains a state message for the Resource but is not included in the original Resource object defined in [PWG5108.03] and semantically analogous to the “job-state-message” attribute defined in [STD92].

7.9.13 resource-state-reasons (1setOf type2 keyword)

This REQUIRED Resource attribute contains a list of state reasons for the Resource but is not included in the original Resource object defined in [PWG5108.03] and is semantically analogous to the “job-state-reasons” attribute defined in [STD92]. Any applicable “job-state-reasons” keyword value can be used in “resource-state-reasons”.

Standard values for this attribute are:

> **‘cancel-requested’**: A Cancel-Resource operation has been received and accepted and the Resource will become permanently unavailable when the cancellation is completed (e.g., after the current Job using the Resource is completed).
>
> **‘install-requested’**: An Install-Resource operation has been received and accepted and the Resource will become available for use when the installation is completed (e.g., potentially after the next System or Subunit reboot in the case of an executable Resource).
>
> **‘resource-incoming’**: A Send-Resource-Data operation has been received and accepted, Resource data upload is in progress, and “resource-state” will transition to ‘available’ after the upload is completed.

7.9.14 resource-string-version (text(MAX) | no-value)

This REQUIRED Resource attribute contains the string version of the Resource, which SHOULD conform to section 4.2.4 “String Version” of IETF PA-TNC [RFC5792] which defines the internal string fields Product Version Number, Internal Build Number, and Configuration Version Number. This attribute is semantically analogous to the FirmwareStringVersion attribute defined in [PWG5110.4] and is typically used to provide a human-readable software version number.

7.9.15 resource-type (type2 keyword)

This REQUIRED Resource attribute identifies the type of the Resource and is semantically equivalent to the SM ResourceType element defined in [PWG5108.03].

IPP System Service implementations SHOULD support System-scope executable resources (e.g., for Firmware update). System Service implementations MAY support Printer-scope and/or Job-scope executable resources in an implementation-defined manner.

Standard values for this attribute (with their resource category prefix) include:

> **‘executable-firmware’**: Executable Firmware.
>
> **‘executable-software’**: Executable (Resident/User Application) software.

‘static-font’: Static font.

‘static-form’: Static form.

‘static-icc-profile’: Static ICC profile.

‘static-image’: Static image such as a Printer icon.

‘static-logo’: Static logo such as an organizational logo used on letterhead.

'static-other': Static resource of some other kind.

'static-strings': Static localization (".strings") file.

‘template-document’: Template for creating Document object [PWG5100.5].

‘template-job’: Template for creating Job object [PWG5108.07].

‘template-printer’: Template for creating Printer object [STD92].

7.9.16 resource-use-count (integer(0:MAX))

This REQUIRED Resource attribute contains the use count (i.e., allocation count) for the Resource but is not included in the original Resource object defined in [PWG5108.03].

Note: If the System internal use count exceeds MAX, then the System MUST return “resource-use-count” with a value of MAX.

7.9.17 resource-uuid (uri(45))

This REQUIRED Resource attribute identifies the UUID as a URI [RFC4122] for the Resource but is not included in the original Resource object defined in [PWG5108.03] and is semantically analogous to the “system-uuid” attribute defined in section 7.3.

7.9.18 resource-version (octetString(64) | no-value)

This REQUIRED Resource attribute contains the numeric version of the Resource, which SHOULD conform to section 4.2.3 “Numeric Version” of IETF PA-TNC [RFC5792] which defines the internal integer fields Major Version Number, Minor Version Number, Build Number, Service Pack Major, and Service Pack Minor. This attribute is semantically analogous to the FirmwareVersion attribute defined in [PWG5110.4] and is typically used to provide a machine-readable software version number, often using a cryptographic hash.

7.9.19 time-at-canceled (integer(MIN:MAX) | no-value)

This REQUIRED Resource attribute contains the time of Resource cancelation request (i.e., when Cancel-Resource operation is accepted) or Resource abortion by the System, which can be before the Resource transitions to the ‘canceled’ or ‘aborted’ state. It is not included

in the original Resource object defined in [PWG5108.03] and is semantically analogous to the “time-at-completed” Job attribute defined in [STD92]. If the Resource has not been canceled or aborted, the 'no-value' out-of-band value is returned.

7.9.20 time-at-creation (integer(MIN:MAX))

This REQUIRED Resource attribute contains the time of Resource creation request (i.e., when Create-Resource operation is accepted) but is not included in the original Resource object defined in [PWG5108.03] and is semantically analogous to the “time-at-creation” Job attribute defined in [STD92].

7.9.21 time-at-installed (integer(MIN:MAX) | no-value)

This REQUIRED Resource attribute contains the time of Resource installation request (i.e., when Install-Resource operation is accepted), which can be before the Resource transitions to the ‘installed’ state. It is not included in the original Resource object defined in [PWG5108.03] and is semantically analogous to the “time-at-processing” Job attribute defined in [STD92]. If the Resource has not been installed, the 'no-value' out-of-band value is returned.

7.10 Subscription Status Attributes

All Subscription Status attributes are READ-ONLY.

7.10.1 notify-resource-id (integer(1:MAX))

This attribute provides the "resource-id" associated with a Subscription. Systems MUST support this attribute for Resource Subscriptions.

7.10.2 notify-system-uri (uri)

This attribute provides the "system-uri" associated with a Subscription. Systems MUST support this attribute for System and Resource Subscriptions.

7.11 Event Notifications Attributes

7.11.1 notify-resource-id (integer(1:MAX))

This attribute provides the "resource-id" value associated with the event. Systems MUST support this attribute for System and Resource Subscription event notifications.

7.11.2 notify-system-up-time (integer(0:MAX))

This attribute provides the "system-up-time" value when the event occurred. Systems MUST support this attribute for System and Resource Subscription event notifications.

7.11.3 notify-system-uri (uri)

This attribute provides the "system-uri" for the subscribed event. Systems MUST support this attribute for System and Resource Subscription event notifications.

8. Additional Semantics for Existing Operations

8.1 Cancel-Subscription, Get-Notifications, Get-Subscription-Attributes, Get-Subscriptions, Renew-Subscription: system-uri (uri)

This specification adds the "system-uri" (section 7.1.26) operation attribute to specify the target System object of the operation.

8.2 Create-Job, Print-Job, Print-URI: resource-ids (1setOf integer(1:MAX))

This specification adds the "resources-ids (1setOf integer(1:MAX))" (section 7.1.15) operation attribute to specify a list of Printer resources that are to be allocated to the created Job.

A single Resource whose "resource-type" is 'template-job' MAY be specified in the request. Any Job attributes in the 'template-job' Resource that are not present in the Job Creation request are copied from the Resource into the newly created Job - the template Resource is NOT allocated to the Job. If the Client specifies more than one 'template-job' Resource in the request, the Printer MUST reject the request with the 'client-error-conflicting-attributes' status code.

If any of the resource IDs are not allocated to the Printer, or if the "resource-type" is not 'template-job' or one of the 'static-xxx' values, the Printer returns the "resource-ids" attribute with the corresponding resource IDs in the Unsupported Attributes group of the response. The returned "status-code" value will be 'successful-ok-ignored-or-substituted-attributes' or 'client-error-attributes-or-values-not-supported' depending on the requested attribute fidelity.

The successfully allocated resource IDs are copied to the corresponding "job-resource-ids" Job Status attribute (section 7.5.1).

8.3 Get-Printer-Attributes: system-uri (uri) or printer-uri (uri)

This specification adds the "system-uri" (section 7.1.26) operation attribute to specify the target System object of the operation.

When this request is sent to the System object, the System responds as if the request was sent to the default Printer for the System (section 7.2.31). If no default Printer is configured, the System responds with the 'client-error-not-found' status code.

8.4 Send-Document and Send-URI: resource-ids (1setOf integer(1:MAX))

This specification adds the "resources-ids (1setOf integer(1:MAX))" (section 7.1.15) operation attribute to specify a list of Printer resources that are to be allocated to the created Document.

A single Resource whose "resource-type" is 'template-document' MAY be specified in the request. Any Document attributes in the 'template-document' Resource that are not present in the Document Creation request are copied from the Resource into the newly created Document - the template Resource is NOT allocated to the Document. If the Client specifies more than one 'template-document' Resource in the request, the Printer MUST reject the request with the 'client-error-conflicting-attributes' status code.

If any of the resource IDs are not allocated to the Printer, or if the "resource-type" is not 'template-document' or one of the 'static-xxx' values, the Printer returns the "resource-ids" attribute with the corresponding resource IDs in the Unsupported Attributes group of the response. The returned "status-code" value will be 'successful-ok-ignored-or-substituted-attributes' or 'client-error-attributes-or-values-not-supported' depending on the requested attribute fidelity.

The successfully allocated resource IDs are copied to the corresponding "document-resource-ids" Document Status attribute (section 7.4.1).

9. Additional Values for Existing Attributes

9.1 ipp-features-supported (1setOf type2 keyword)

This specification defines the following new "ipp-features-supported" values:

'resource-object': This value is reported by Printers and Systems that support the Resource object.

'system-object': This value is reported by Systems to indicate support for this specification.

9.2 notify-events (1setOf type2 keyword)

This specification defines the following new "notify-events" values:

'printer-created': REQUIRED - a Printer was created.

'printer-deleted': REQUIRED - a Printer was deleted.

'resource-canceled': REQUIRED - a Resource was canceled.

'resource-config-changed': REQUIRED - when the configuration of the Resource is changed, i.e., when any Resource Description attribute is changed.

'resource-created': REQUIRED - a Resource was created.

'resource-installed': REQUIRED - a Resource was installed.

'resource-state-changed': REQUIRED - the Resource changed state from any state to any other state. Specifically, the value of the Resource's "resource-state" or "resource-state-reasons" attributes change.

'system-config-changed': REQUIRED - when the configuration of the System is changed, i.e., when any System Description attribute is changed.

'system-restarted': OPTIONAL - when the System is booted/started up.

'system-shutdown': OPTIONAL - when the System is being shut/powered down. This event is delivered before the System is down.

'system-state-changed': REQUIRED - the System changed state from any state to any other state. Specifically, the value of the System's "system-state" or "system-state-reasons" attributes changed.

'system-stopped': REQUIRED - when the "system-state" is 'stopped'.

9.3 printer-state-reasons (1setOf type2 keyword)

This specification defines the following new "printer-state-reasons" values:

'deleted'; The Printer has been deleted.

'resuming'; The Printer is processing a Resume-Printer request.

'testing'; The Printer is being tested.

9.4 requested-attributes (1setOf type2 keyword)

This specification defines the following new "requested-attributes" values:

'resource-description': The subset of Resource Description attributes.

'resource-status': The subset of Resource Status attributes.

'resource-template': The subset of Resource Template attributes.

'system-description': The subset of System Description attributes.

'system-status': The subset of System Status attributes.

9.5 uri-authentication-supported (1setOf type2 keyword)

This specification defines the following new "uri-authentication-supported" [STD92] values:

'certificate+basic': The Printer or System requires both a TLS client certificate and HTTP Basic authentication [RFC7617] to authorize requests.

'certificate+digest': The Printer or System requires both a TLS client certificate and HTTP Digest authentication [RFC7616] to authorize requests.

'certificate+oauth': The Printer or System requires both a TLS client certificate and an OAuth Bearer token [RFC6750] to authorize requests.

10. Status Codes

10.1 server-error-too-many-printers (0x050D)

This status code is returned when a new Printer cannot be created, typically via the Create-Printer (section 6.3.1) or Register-Output-Device (section 6.3.12) operations.

11. Discovery

11.1 DNS-Based Service Discovery

DNS-Based Service Discovery (DNS-SD) [RFC6763] uses service (SRV) records and traditional unicast and multicast DNS (mDNS) [RFC6762] queries. Services are identified by a service instance name consisting of an instance name, a service type or subtype name, and a domain name. Discovery of Systems involves a single service type as described in the following sections.

Systems that support DNS-SD MUST support mDNS and MAY support dynamic DNS updates via Dynamic Updates in the Domain Name System (DNS UPDATE) [RFC2136] and other mechanisms.

11.1.1 IPP System Service Type

This specification defines the "_ipps-system._tcp" service type to allow Clients to discover Systems. Because the IPP System Service v1.0 [PWG5100.22] REQUIRES implementations to support IPPS [RFC7472], there is no non-IPPS service type.

11.1.2 Service (SRV) Instance Name

Systems MUST NOT use a service instance name containing a unique identifier by default. A unique identifier MAY be added to the instance if there is a name collision.

The domain portion of the service instance name MUST BE "local." for mDNS.

Systems that support DNS-SD MUST advertise the "_ipps-system._tcp" service over mDNS. For example, a System named "Example System" would advertise the service instance name "Example System._ipps-system._tcp.local.".

11.1.3 Geo-Location (LOC)

Systems MUST publish LOC records [RFC1876] over mDNS to provide the physical location of the System. Systems MUST allow the End User to configure the geo-location manually. If the accuracy of the geo-location is unknown, a value of $9x10^9$ meters (0x99) MUST be used.

11.1.4 Text (TXT)

Systems MUST publish a text (TXT) record that provides service information over mDNS. Systems that support dynamic DNS updates MUST publish separate TXT records for each domain that is updated. **Error! Reference source not found.** lists all the key/value pairs t hat are defined with the corresponding default values. Systems SHOULD omit key/value pairs when the value matches the default value for the corresponding key to limit the size of the TXT record.

The combined length of a TXT key/value pair ("key=value") cannot exceed 255 octets. This limit is sometimes smaller than the limit imposed by the corresponding IPP attribute.

The combined length of all TXT key/value pairs provided by the System SHOULD BE 400 octets or less for unicast DNS and MUST NOT exceed 1300 octets for multicast DNS.

Clients MUST ignore incomplete key/value pairs at the end of a truncated TXT record.

Table 16 - DNS TXT Record Keys

Key	Description	Default Value
air	The type of authentication information that is required for the System as reported by the "system-xri-supported.xri-authentication" attribute values.	'none'
note	The location of the System as reported by the "system-location" System Description attribute.	" (empty string)
UUID	The UUID of the System without the 'urn:uuid:' prefix as reported by the "system-uuid" System Status attribute.	" (empty string)

11.1.4.1 air

The "air" key defines the type of authentication information that is required for imaging. The value is derived from the "xri-authentication" member attribute in the "system-xri-supported" System Description attribute [PWG5100.22]. The following values are supported:

'certificate'; Authentication using X.509 certificates. This is equivalent to the 'certificate' value for the "xri-authentication" member attribute.

'certificate+oauth'; Authentication using X.509 certificates and OAuth 2.0 authentication is required using the Bearer method. This is equivalent to the 'certificate+oauth' value for the "xri-authentication " member attribute.

'certificate+username,password'; Authentication using X.509 certificates and HTTP Basic or Digest authentication. This is equivalent to the 'certificate+basic' and 'certificate+digest' values for the "xri-authentication" member attribute.

'negotiate'; Kerberized authentication is required. This DEPRECATED value is equivalent to the 'negotiate' value for the "xri-authentication" member attribute.

'none'; No authentication is required. This is equivalent to the 'none' value for the "xri-authentication " member attribute.

'oauth'; OAuth 2.0 authentication is required using the Bearer method. This is equivalent to the 'oauth' value for the "xri-authentication " member attribute.

'username,password'; Username + password authentication is required. This is equivalent to the 'basic' or 'digest' values for the "xri-authentication " member attribute.

The default value for the "air" key is 'none'.

11.1.4.2 UUID

The REQUIRED "UUID" key provides the value of the "system-uuid" System Status attribute [PWG 5100.22] without the leading "urn:uuid:". For example, if a System reports a "system-uuid" value of:

```
urn:uuid:12345678-9ABC-DEF0-1234-56789ABCDEF0
```

The "UUID" key will have a value of:

```
12345678-9ABC-DEF0-1234-56789ABCDEF0
```


12. Conformance Requirements

12.1 Conformance Requirements for Clients

In order for a Client to claim conformance to this specification, a Client MUST support:

1. The required IPP operations defined in section 6,
2. The required IPP attributes defined in section 0,
3. The internationalization considerations in section 0, and
4. The security and privacy considerations in section 0.

12.2 Conformance Requirements for Infrastructure Systems

In order for an Infrastructure System to claim conformance to this specification, an Infrastructure System MUST support:

1. The required IPP operations defined in section 6,
2. The required IPP attributes defined in section 0,
3. The additional IPP operation semantics defined in section 8,
4. The additional IPP attribute values defined in section 0,
5. The required discovery methods defined in section 11,
6. The internationalization considerations in section 0, and
7. The security and privacy considerations in section 0.

12.3 Conformance Requirements for Systems

In order for a System to claim conformance to this specification, a System MUST support:

1. The required IPP operations defined in section 6,
2. The required IPP attributes defined in section 0,
3. The additional IPP operation semantics defined in section 8,
4. The additional IPP attribute values defined in section 0,
5. The required discovery methods defined in section 11,
6. The internationalization considerations in section 0, and
7. The security and privacy considerations in section 0.

13. Internationalization Considerations

For interoperability and basic support for multiple languages, conforming implementations MUST support the Universal Character Set (UCS) Transformation Format -- 8 bit (UTF-8) [STD63] encoding of Unicode [UNICODE] [ISO10646] and the Unicode Format for Network Interchange [RFC5198].

Implementations of this specification SHOULD conform to the following standards on processing of human-readable Unicode text strings, see:

- Unicode Bidirectional Algorithm [UAX9] – left-to-right, right-to-left, and vertical
- Unicode Line Breaking Algorithm [UAX14] – character classes and wrapping
- Unicode Normalization Forms [UAX15] – especially NFC for [RFC 5198]
- Unicode Text Segmentation [UAX29] – grapheme clusters, words, sentences
- Unicode Identifier and Pattern Syntax [UAX31] – identifier use and normalization
- Unicode Collation Algorithm [UTS10] – sorting
- Unicode Locale Data Markup Language [UTS35] – locale databases

Implementations of this specification are advised to also review the following informational documents on processing of human-readable Unicode text strings:

- Unicode Character Encoding Model [UTR17] – multi-layer character model
- Unicode Character Property Model [UTR23] – character properties
- Unicode Conformance Model [UTR33] – Unicode conformance basis

14. Security and Privacy Considerations

The IPP extensions defined in this specification require the same security and privacy considerations as defined in the Internet Printing Protocol/1.1 [STD92] and PWG System Object and System Control Service Semantics [PWG5108.06], plus the additional security considerations below.

14.1 Human-readable Strings

Implementations of this specification SHOULD conform to the following standard on processing of human-readable Unicode text strings, see:

- Unicode Security Mechanisms [UTS39] – detecting and avoiding security attacks

Implementations of this specification are advised to also review the following informational document on processing of human-readable Unicode text strings:

- Unicode Security FAQ [UNISECFAQ] – common Unicode security issues

14.2 Confidentiality and Integrity

Clients and Systems MUST provide confidentiality and integrity of data in transit using either an interface providing physical security such as USB or using TLS encryption [RFC8446] over otherwise unsecured local or network connections,

14.3 Access Control

Because of the potential for abuse and misuse, Systems SHOULD provide access control mechanisms including lists of allowed Clients, authentication, and authorization for site defined policies since, except for Get-Printer-Attributes for legacy Clients, an IPP System Service consists of administrative operations for Authenticate Users.

14.4 Physical Safety

Systems MUST NOT allow Clients to disable physical safety features of the hardware, such as protective gates, covers, or interlocks.

14.5 Digital Signature Validation

When accepting new resource data using the Send-Resource-Data operation, the System SHOULD validate any Resource signature supplied or embedded in the Resource data, for example as described in US NIST Digital Signature Standard [FIPS186-4], ENISA Algorithms, Key Size and Parameters Report [ENISAALG], ETSI Electronic Signatures and

Infrastructures (ESI) Signature validation procedures and policies [TS102853], and IETF XML-Signature Syntax and Processing [RFC3275].

In the event that the "resource-signature (1setOf octetString)" operation attribute (section 7.1.18) is specified for Resource data with an embedded signature, both signatures MUST be validated. Resource signatures MAY be re-validated at other times by the System, however such validation is outside the scope of this specification.

14.6 Encrypted Resources

Resource data can be encrypted as part of the underlying resource format. Systems SHOULD NOT decrypt such resources until they are used in order to provide the best protection at rest for those resources. Key distribution and management for such resources is outside the scope of this specification.

14.7 Malicious Resources and File Sharing

Systems MUST limit access to the Create-Resource and Send-Resource-Data operations to authorized Administrators in order to prevent the System from being used as a file sharing repository or a source of malicious content. Systems SHOULD scan all Resource data for known malware, viruses, and other malicious content.

14.8 X.509 Certificates for Output Devices

Systems MAY support the "output-device-x509-certificate" (section 7.1.3) and "output-device-x509-request" (section 7.1.4) operation attributes which are used to associate and generate X.509 certificates with a particular Output Device for subsequent Proxy requests to an Infrastructure Printer. A System advertises the supported certificate types in the "output-device-x509-type-supported" (section 7.2.19) System Description attribute.

The X.509 commonName field in certificates and signing requests MUST be the "output-device-uuid" value for the Proxy's Output Device without the 'urn:uuid:' prefix. The maximum life and allowed certificate types are based on a combination of site policy and current TLS best practices [RFC9325].

14.9 X.509 Certificates for Systems

Systems MUST support the IPP over HTTPS Transport Binding and 'ipps' URI Scheme [RFC7472] and the Transport Layer Security (TLS) Protocol Version 1.2 or higher [RFC8446].

Systems SHOULD use X.509 certificates that have been signed by a local or public Certificate Authority to establish trust as documented in the Recommendations for Secure Use of Transport Layer Security (TLS) and Datagram Transport Layer Security (DTLS) [RFC9325].

Systems that are accessible on the public Internet SHOULD NOT use self-signed X.509 certificates.

14.9.1 Impersonation Attacks with mDNS and Self-Signed X.509 Certificates

A variety of well-known mDNS [RFC6762] impersonation attacks are possible when using self-signed certificates and a Trust On First Use (TOFU) policy. This attack is exacerbated by the need for the System to regenerate its self-signed X.509 certificate whenever the mDNS hostname changes.

Attackers typically assume control of an existing DNS-SD service instance name ("Example System._ipps-system._tcp") so the Clients direct their requests from the original hostname ("ex123456abcdef.local") to an alternate host masquerading as the real System with a different mDNS hostname ("mallory.local"). Since mDNS hostname conflicts are a part of the mDNS protocol, the Client cannot disallow such changes nor can it assume an attack is in progress.

If the Client pins the self-signed certificate to the mDNS hostname, a change in the hostname triggers a fresh TOFU evaluation for the System at the new address. Again, since mDNS hostname conflicts are a part of the mDNS protocol, the Client cannot assume this is an attack. Moreover, since conflict resolution and certificate generation are handled automatically by the System without notifications to the End User, the Client cannot reasonably ask the End User to evaluate any mDNS hostname or X.509 certificate changes.

If the Client pins the self-signed certificate to the DNS-SD service instance name or "system-uuid" (section 7.3.37) value, the Client's TOFU check will fail. However, there is no way for the Client to detect that the failure is due to an attack or a valid mDNS hostname change, and it is likewise unlikely the End User will possess the information necessary to evaluate the failure.

If the Client pins the self-signed certificate to both the mDNS hostname and DNS-SD service instance name or "system-uuid" value, the Client remains vulnerable to the same impersonation attack as pinning with only the mDNS hostname.

When sufficient local infrastructure exists, e.g., a local Certificate Authority service, Clients and Servers SHOULD use such infrastructure to acquire and evaluate the trust of X.509 certificates, SHOULD disable any TOFU evaluation policy, and SHOULD NOT use self-signed X.509 certificates.

Systems SHOULD use a default mDNS hostname consisting of a two or three letter vendor prefix followed by unique values such as the network interface MAC address in order to minimize the likelihood of a mDNS hostname conflict. For example, the default mDNS hostname for a System developed by a vendor named "Example" for an network interface with a MAC address of 12:34:56:AB:CD:EF would be "ex123456abcdef.local".

15. IANA Considerations

15.1 Object Registrations

The objects defined in this specification will be published by IANA according to the procedures in the Internet Printing Protocol/1.1 [STD92] in the following location:

https://www.iana.org/assignments/ipp-registrations

The registry entries will contain the following information:

Object Name	Reference
Resource	[PWG5100.22]
System	[PWG5100.22]

15.2 Attribute Registrations

The attributes defined in this specification will be published by IANA according to the procedures in Internet Printing Protocol/1.1 [STD92] in the following location:

https://www.iana.org/assignments/ipp-registrations

The registry entries will contain the following information:

Operation attributes:	Reference
notify-printer-ids (1setOf integer(1:65535))	[PWG5100.22]
notify-resource-id (integer(1:MAX))	[PWG5100.22]
output-device-x509-certificate (1setOf text(MAX))	[PWG5100.22]
output-device-x509-request (1setOf text(MAX))	[PWG5100.22]
printer-id (integer(1:65535))	[PWG5100.22]
printer-ids (1setOf integer(1:65535))	[PWG5100.22]


```
printer-geo-location (uri)
                                                                    [PWG5100.22
]
printer-location (text(127))
                                                                    [PWG5100.22
]
printer-service-type (1setOf type2 keyword)
                                                                    [PWG5100.22
]
printer-xri-requested (1setOf collection)
                                                                    [PWG5100.22
]
resource-format (mimeMediaType)
                                                                    [PWG5100.22
]
resource-format-accepted (1setOf mimeMediaType)
                                                                    [PWG5100.22
]
resource-formats (1setOf mimeMediaType)
                                                                    [PWG5100.22
]
resource-id (integer(1:MAX))
                                                                    [PWG5100.22
]
resource-ids (1setOf integer(1:MAX))
                                                                    [PWG5100.22
]
resource-k-octets (integer(0:MAX))
                                                                    [PWG5100.22
]
resource-natural-language (naturalLanguage)
                                                                    [PWG5100.22
]
resource-patches (text(MAX) | no-value)
                                                                    [PWG5100.22
]
resource-signature (1setOf octetString(MAX))
                                                                    [PWG5100.22
]
resource-states (1setOf type1 enum)
                                                                    [PWG5100.22
]
resource-string-version (text(MAX) | no-value)
                                                                    [PWG5100.22
]
resource-type (type2 keyword)
                                                                    [PWG5100.22
]
resource-types (1setOf type2 keyword)
                                                                    [PWG5100.22
]
resource-version (octetString(64) | no-value)
                                                                    [PWG5100.22
]
```



```
restart-get-interval (integer(0:MAX))
                                                                    [PWG5100.22
]
system-uri (uri)
                                                                    [PWG5100.22
]
which-printers (type2 keyword)
                                                                    [PWG5100.22
]

System Description attributes:                                      Reference
------------------------------                                      ---------
charset-configured (charset)
                                                                    [PWG5100.22
]
charset-supported (1setOf charset)
                                                                    [PWG5100.22
]
document-format-supported (1setOf mimeMediaType)
                                                                    [PWG5100.22
]
ippget-event-life (integer(15:MAX))
                                                                    [PWG5100.22
]
ipp-features-supported (1setOf type2 keyword)
                                                                    [PWG5100.22
]
ipp-versions-supported (1setOf type2 keyword)
                                                                    [PWG5100.22
]
multiple-document-printers-supported (boolean)
                                                                    [PWG5100.22
]
natural-language-configured (naturalLanguage)
                                                                    [PWG5100.22
]
generated-natural-language-supported (1setOf naturalLanguage)
                                                                    [PWG5100.22
]
notify-attributes-supported (1setOf keyword)
                                                                    [PWG5100.22
]
notify-events-default (1setOf type2 keyword)
                                                                    [PWG5100.22
]
notify-events-supported (1setOf type2 keyword)
                                                                    [PWG5100.22
]
notify-lease-duration-default (integer(0:67108863))
                                                                    [PWG5100.22
]
notify-lease-duration-supported (1setOf (integer(0:67108863) |
rangeOfInteger(0:67108863))
                                                                    [PWG5100.22
]
```



```
notify-max-events-supported (integer(2:MAX))
                                                                [PWG5100.22
]
notify-pull-method-supported (1setOf type2 keyword)
                                                                [PWG5100.22
]
notify-schemes-supported (1setOf uriScheme)
                                                                [PWG5100.22
]
operations-supported (1setOf type2 enum)
                                                                [PWG5100.22
]
output-device-x509-type-supported (1setOf type2 keyword)
                                                                [PWG5100.22
]
power-calendar-policy-col (1setOf collection)
                                                                [PWG5100.22
]
  calendar-id (integer(1:MAX))
                                                                [PWG5100.22
]
  day-of-month (integer(1:31))
                                                                [PWG5100.22
]
  day-of-week (integer(1:7))
                                                                [PWG5100.22
]
  hour (integer(0:23))
                                                                [PWG5100.22
]
  minute (integer(0:59))
                                                                [PWG5100.22
]
  month (integer(1:12))
                                                                [PWG5100.22
]
  request-power-state (type1 keyword)
                                                                [PWG5100.22
]
  run-once (boolean)
                                                                [PWG5100.22
]
power-event-policy-col (1setOf collection)
                                                                [PWG5100.22
]
  event-id (integer(1:MAX))
                                                                [PWG5100.22
]
  event-name (name(127))
                                                                [PWG5100.22
]
  request-power-state (type1 keyword)
                                                                [PWG5100.22
]
```



```
power-timeout-policy-col (1setOf collection)
                                                                    [PWG5100.22
]
  start-power-state (type1 keyword)
                                                                    [PWG5100.22
]
  timeout-id (integer(1:MAX))
                                                                    [PWG5100.22
]
  timeout-predicate (type2 keyword)
                                                                    [PWG5100.22
]
  timeout-seconds (integer(0:MAX))
                                                                    [PWG5100.22
]
printer-creation-attributes-supported (1setOf keyword)
                                                                    [PWG5100.22
]
resource-format-supported (1setOf mimeMediaType)
                                                                    [PWG5100.22
]
resource-type-supported (1setOf type2 keyword)
                                                                    [PWG5100.22
]
resource-settable-attributes-supported (1setOf keyword)
                                                                    [PWG5100.22
]
system-asset-tag (octetString(MAX))
                                                                    [PWG5100.22
]
system-current-time (dateTime)
                                                                    [PWG5100.22
]
system-default-printer-id (integer(1:65535) | no-value)
                                                                    [PWG5100.22
]
system-dns-sd-name (name(63))
                                                                    [PWG5100.22
]
system-geo-location (uri | unknown)
                                                                    [PWG5100.22
]
system-info (text(127))
                                                                    [PWG5100.22
]
system-location (text(127))
                                                                    [PWG5100.22
]
system-mandatory-printer-attributes (1setOf keyword)
                                                                    [PWG5100.22
]
system-mandatory-registration-attributes (1setOf keyword)
                                                                    [PWG5100.22
]
```



```
system-make-and-model (text(127))
                                                                    [PWG5100.22
]
system-message-from-operator (text(127))
                                                                    [PWG5100.22
]
system-name (name(127))
                                                                    [PWG5100.22
]
system-contact-col (collection | unknown)
                                                                    [PWG5100.22
]
  < member attributes are the same as "printer-contact-col" >
                                                                    [PWG5100.22
]
system-service-contact-col (collection | unknown)
                                                                    [PWG5100.22
]
system-settable-attributes-supported (1setOf keyword)
                                                                    [PWG5100.22
]
system-strings-languages-supported (1setOf naturalLanguage)
                                                                    [PWG5100.22
]
system-strings-uri (uri | no-value)
                                                                    [PWG5100.22
]
system-xri-supported (1setOf collection)
                                                                    [PWG5100.22
]
  < member attributes are the same as "printer-xri-supported" >
                                                                    [PWG5100.22
]

System Status attributes:                                           Reference
-------------------------                                           ---------
power-log-col (1setOf collection)
                                                                    [PWG5100.22
]
  log-id (integer(1:MAX))
                                                                    [PWG5100.22
]
  power-state (type1 keyword)
                                                                    [PWG5100.22
]
  power-state-date-time (dateTime)
                                                                    [PWG5100.22
]
  power-state-message (text(255))
                                                                    [PWG5100.22
]
power-state-capabilities-col (1setOf collection)
                                                                    [PWG5100.22
]
```



```
    can-accept-jobs (boolean)
                                                                    [PWG5100.22
  ]
    can-process-jobs (boolean)
                                                                    [PWG5100.22
  ]
    power-active-watts (integer(0:MAX))
                                                                    [PWG5100.22
  ]
    power-inactive-watts (integer(0:MAX))
                                                                    [PWG5100.22
  ]
    power-state (type1 keyword)
                                                                    [PWG5100.22
  ]
  power-state-counters-col (1setOf collection)
                                                                    [PWG5100.22
  ]
    hibernate-transitions (integer(0:MAX))
                                                                    [PWG5100.22
  ]
    on-transitions (integer(0:MAX))
                                                                    [PWG5100.22
  ]
    standby-transitions (integer(0:MAX))
                                                                    [PWG5100.22
  ]
    suspend-transitions (integer(0:MAX))
                                                                    [PWG5100.22
  ]
  power-state-monitor-col (collection)
                                                                    [PWG5100.22
  ]
    current-month-kwh (integer(0:MAX))
                                                                    [PWG5100.22
  ]
    current-watts (integer(0:MAX))
                                                                    [PWG5100.22
  ]
    lifetime-kwh (integer(0:MAX))
                                                                    [PWG5100.22
  ]
    meters-are-actual (boolean)
                                                                    [PWG5100.22
  ]
    power-state (type1 keyword)
                                                                    [PWG5100.22
  ]
    power-state-message (text(255))
                                                                    [PWG5100.22
  ]
    power-usage-is-rms-watts (boolean)
                                                                    [PWG5100.22
  ]
```



```
power-state-transitions-col (1setOf collection)
                                                                    [PWG5100.22
]
  end-power-state (type1 keyword)
                                                                    [PWG5100.22
]
  start-power-state (type1 keyword)
                                                                    [PWG5100.22
]
  state-transition-seconds (integer(0:MAX))
                                                                    [PWG5100.22
]
system-config-change-date-time (dateTime)
                                                                    [PWG5100.22
]
system-config-change-time (integer(0:MAX))
                                                                    [PWG5100.22
]
system-config-changes (integer:0:MAX))
                                                                    [PWG5100.22
]
system-configured-printers (1setOf collection)
                                                                    [PWG5100.22
]
  printer-id (integer(0:65535))
                                                                    [PWG5100.22
]
  printer-info (text(127))
                                                                    [PWG5100.22
]
  printer-is-accepting-jobs (boolean)
                                                                    [PWG5100.22
]
  printer-name (name(127))
                                                                    [PWG5100.22
]
  printer-service-type (type2 keyword)
                                                                    [PWG5100.22
]
  printer-state (type1 enum)
                                                                    [PWG5100.22
]
  printer-state-reasons (1setOf type2 keyword)
                                                                    [PWG5100.22
]
  printer-xri-supported (collection)
                                                                    [PWG5100.22
]
    < member attributes are the same as "printer-xri-supported" >
                                                                    [PWG5100.22
]
system-configured-resources (1setOf collection)
                                                                    [PWG5100.22
]
```



```
  resource-format (mimeMediaType)
                                                                    [PWG5100.22
]
  resource-id (integer(1:MAX))
                                                                    [PWG5100.22
]
  resource-info (text(127))
                                                                    [PWG5100.22
]
  resource-name (name(127))
                                                                    [PWG5100.22
]
  resource-state (type1 enum)
                                                                    [PWG5100.22
]
  resource-type (type2 keyword)
                                                                    [PWG5100.22
]
system-firmware-name (1setOf name(MAX))
                                                                    [PWG5100.22
]
system-firmware-patches (1setOf text(MAX))
                                                                    [PWG5100.22
]
system-firmware-string-version (1setOf text(MAX))
                                                                    [PWG5100.22
]
system-firmware-version (1setOf octetString(64))
                                                                    [PWG5100.22
]
system-impressions-completed (integer(0:MAX))
                                                                    [PWG5100.22
]
system-impressions-completed-col (collection)
                                                                    [PWG5100.22
]
  < member attributes are the same as "job-impressions-col" >
                                                                    [PWG5100.22
]
system-media-sheets-completed (integer(0:MAX))
                                                                    [PWG5100.22
]
system-media-sheets-completed-col (collection)
                                                                    [PWG5100.22
]
  < member attributes are the same as "job-media-sheets-col" >
                                                                    [PWG5100.22
]
system-pages-completed (integer(0:MAX))
                                                                    [PWG5100.22
]
system-pages-completed-col (collection)
                                                                    [PWG5100.22
]
```



```
  < member attributes are the same as "job-pages-col" >
                                                                    [PWG5100.22
]
system-resident-application-name (1setOf name(MAX))
                                                                    [PWG5100.22
]
system-resident-application-patches (1setOf text(MAX))
                                                                    [PWG5100.22
]
system-resident-application-string-version (1setOf text(MAX))
                                                                    [PWG5100.22
]
system-resident-application-version (1setOf octetString(64))
                                                                    [PWG5100.22
]
system-serial-number (text(255))
                                                                    [PWG5100.22
]
system-state (type1 enum)
                                                                    [PWG5100.22
]
system-state-change-date-time (dateTime)
                                                                    [PWG5100.22
]
system-state-change-time (integer(0:MAX))
                                                                    [PWG5100.22
]
system-state-message (text(MAX))
                                                                    [PWG5100.22
]
system-state-reasons (1setOf type2 keyword)
                                                                    [PWG5100.22
]
system-time-source (type2 keyword | name(MAX))
                                                                    [PWG5100.22
]
system-up-time (integer(1:MAX))
                                                                    [PWG5100.22
]
system-user-application-name (1setOf name(MAX))
                                                                    [PWG5100.22
]
system-user-application-patches (1setOf text(MAX))
                                                                    [PWG5100.22
]
system-user-application-string-version (1setOf text(MAX))
                                                                    [PWG5100.22
]
system-user-application-version (1setOf octetString(64))
                                                                    [PWG5100.22
]
system-uuid (uri(45))
                                                                    [PWG5100.22
]
```



```
xri-authentication-supported (1setOf type2 keyword)
                                                                    [PWG5100.22
]
xri-security-supported (1setOf type2 keyword)
                                                                    [PWG5100.22
]
xri-uri-scheme-supported (1setOf uriScheme)
                                                                    [PWG5100.22
]

Document Status attributes:                                         Reference
---------------------                                               ---------
document-resource-ids (1setOf integer(1:MAX))
                                                                    [PWG5100.22
]

Job Status attributes:                                              Reference
---------------------                                               ---------
job-resource-ids (1setOf integer(1:MAX))
                                                                    [PWG5100.22
]

Printer Description attributes:                                     Reference
------------------------------                                      ---------
printer-contact-col (collection | unknown)
                                                                    [PWG5100.22
]
  contact-name (name(MAX))
                                                                    [PWG5100.22
]
  contact-uri (uri)
                                                                    [PWG5100.22
]
  contact-vcard (1setOf text(MAX))
                                                                    [PWG5100.22
]

Printer Status attributes:                                          Reference
-------------------------                                           ---------
printer-config-changes (integer(0:MAX))
                                                                    [PWG5100.22
]
printer-id (integer(1:65535))
                                                                    [PWG5100.22
]
printer-impressions-completed (integer(0:MAX))
                                                                    [PWG5100.22
]
printer-impressions-completed-col (collection)
                                                                    [PWG5100.22
]
  < member attributes are the same as "job-impressions-col" >
                                                                    [PWG5100.22
]
```



```
printer-media-sheets-completed (integer(0:MAX))
                                                                    [PWG5100.22
]
printer-media-sheets-completed-col (collection)
                                                                    [PWG5100.22
]
  < member attributes are the same as "job-media-sheets-col" >
                                                                    [PWG5100.22
]
printer-pages-completed (integer(0:MAX))
                                                                    [PWG5100.22
]
printer-pages-completed-col (collection)
                                                                    [PWG5100.22
]
  < member attributes are the same as "job-pages-col" >
                                                                    [PWG5100.22
]
printer-service-type (type2 keyword)
                                                                    [PWG5100.22
]

Resource Description attributes:                                    Reference
--------------------------------                                    ---------
resource-info (text(MAX))
                                                                    [PWG5100.22
]
resource-name (name(MAX))
                                                                    [PWG5100.22
]

Resource Status attributes:                                         Reference
---------------------------                                         ---------
date-time-at-canceled (dateTime | no-value)
                                                                    [PWG5100.22
]
date-time-at-creation (dateTime)
                                                                    [PWG5100.22
]
date-time-at-installed (dateTime | no-value)
                                                                    [PWG5100.22
]
resource-data-uri (uri | no-value)
                                                                    [PWG5100.22
]
resource-format (mimeMediaType)
                                                                    [PWG5100.22
]
resource-id (integer(1:MAX))
                                                                    [PWG5100.22
]
resource-k-octets (integer(0:MAX))
                                                                    [PWG5100.22
]
```



```
resource-natural-language (naturalLanguage)
                                                                    [PWG5100.22
]
resource-patches (text(MAX) | no-value)
                                                                    [PWG5100.22
]
resource-signature (1setOf octetString(MAX))
                                                                    [PWG5100.22
]
resource-state (type1 enum)
                                                                    [PWG5100.22
]
resource-state-message (text(MAX))
                                                                    [PWG5100.22
]
resource-state-reasons (1setOf type2 keyword)
                                                                    [PWG5100.22
]
resource-string-version (text(MAX) | no-value)
                                                                    [PWG5100.22
]
resource-type (type2 keyword)
                                                                    [PWG5100.22
]
resource-use-count (integer(0:MAX))
                                                                    [PWG5100.22
]
resource-uuid (uri(45))
                                                                    [PWG5100.22
]
resource-version (octetString(64) | no-value)
                                                                    [PWG5100.22
]
time-at-canceled (integer(MIN:MAX) | no-value)
                                                                    [PWG5100.22
]
time-at-creation (integer(MIN:MAX))
                                                                    [PWG5100.22
]
time-at-installed (integer(MIN:MAX) | no-value)
                                                                    [PWG5100.22
]

Subscription Status attributes:                                     Reference
-------------------------------                                     ---------
notify-resource-id (integer(1:MAX))
                                                                    [PWG5100.22
]
notify-system-uri (uri)
                                                                    [PWG5100.22
]

Event Notifications attributes:                                     Reference
-------------------------------                                     ---------
```



```
notify-resource-id (integer(1:MAX))
                                                                    [PWG5100.22
]
notify-system-up-time (integer(0:MAX))
                                                                    [PWG5100.22
]
notify-system-uri (uri)
                                                                    [PWG5100.22
]
```

15.3 Keyword Attribute Value Registrations

The keyword attribute values defined in this specification will be published by IANA according to the procedures in the Internet Printing Protocol/1.1 [STD92] in the following location:

https://www.iana.org/assignments/ipp-registrations

The registry entries will contain the following information:

```
Attributes (attribute syntax)
  Keyword Attribute Value                                           Reference
-------------------------                                           ---------
ipp-features-supported (1setOf type2 keyword)
                                                                    [PWG5100.13
]
  resource-object
                                                                    [PWG5100.22
]
  system-object
                                                                    [PWG5100.22
]

notify-events (1setOf type2 keyword)                                [RFC3995]
  printer-created
                                                                    [PWG5100.22
]
  printer-deleted
                                                                    [PWG5100.22
]
  resource-canceled
                                                                    [PWG5100.22
]
  resource-config-changed
                                                                    [PWG5100.22
]
  resource-created
                                                                    [PWG5100.22
]
  resource-installed
                                                                    [PWG5100.22
]
```



```
    resource-state-changed
                                                                    [PWG5100.22
]
    system-config-changed
                                                                    [PWG5100.22
]
    system-restarted
                                                                    [PWG5100.22
]
    system-shutdown
                                                                    [PWG5100.22
]
    system-state-changed
                                                                    [PWG5100.22
]
    system-stopped
                                                                    [PWG5100.22
]

output-device-x509-type-supported (1setOf type2 keyword)
                                                                    [PWG5100.22
]
    ecdsa-p256_sha256
                                                                    [PWG5100.22
]
    ecdsa-p384_sha256
                                                                    [PWG5100.22
]
    ecdsa-p521_sha256
                                                                    [PWG5100.22
]
    rsa-2048_sha256
                                                                    [PWG5100.22
]
    rsa-3072_sha256
                                                                    [PWG5100.22
]
    rsa-4096_sha256
                                                                    [PWG5100.22
]

printer-service-type (type2 keyword)
                                                                    [PWG5100.22
]
    copy
                                                                    [PWG5100.22
]
    faxin
                                                                    [PWG5100.22
]
    faxout
                                                                    [PWG5100.22
]
    print
                                                                    [PWG5100.22
]
```



```
    print3d
                                                                [PWG5100.22
]
    scan
                                                                [PWG5100.22
]
    transform
                                                                [PWG5100.22
]

printer-state-reasons (1setOf type2 keyword)                    [STD92]
    deleted
                                                                [PWG5100.22
]
    resuming
                                                                [PWG5100.22
]
    testing
                                                                [PWG5100.22
]

requested-attributes (1setOf type2 keyword)                     [STD92]
    resource-description
                                                                [PWG5100.22
]
    resource-status
                                                                [PWG5100.22
]
    resource-template
                                                                [PWG5100.22
]
    system-description
                                                                [PWG5100.22
]
    system-status
                                                                [PWG5100.22
]

resource-state-reasons (1setOf type2 keyword)
                                                                [PWG5100.22
]
    < any "job-state-reasons" value >
                                                                [PWG5100.22
]
    cancel-requested
                                                                [PWG5100.22
]
    install-requested
                                                                [PWG5100.22
]
    resource-incoming
                                                                [PWG5100.22
]
```



```
resource-type (type2 keyword)
                                                                    [PWG5100.22
]
  executable-firmware
                                                                    [PWG5100.22
]
  executable-software
                                                                    [PWG5100.22
]
  static-font
                                                                    [PWG5100.22
]
  static-form
                                                                    [PWG5100.22
]
  static-icc-profile
                                                                    [PWG5100.22
]
  static-image
                                                                    [PWG5100.22
]
  static-logo
                                                                    [PWG5100.22
]
  static-other
                                                                    [PWG5100.22
]
  static-strings
                                                                    [PWG5100.22
]
  template-document
                                                                    [PWG5100.22
]
  template-job
                                                                    [PWG5100.22
]
  template-printer
                                                                    [PWG5100.22
]

system-state-reasons (1setOf type2 keyword)
                                                                    [PWG5100.22
]
  < any "printer-state-reasons" value >
                                                                    [PWG5100.22
]

system-time-source (type2 keyword | name(MAX))
                                                                    [PWG5100.22
]
  dhcp
                                                                    [PWG5100.22
]
  ntp
                                                                    [PWG5100.22
]
```



```
    onboard
                                                                    [PWG5100.22
  ]
    sntp
                                                                    [PWG5100.22
  ]

  timeout-predicate (type2 keyword)
                                                                    [PWG5100.22
  ]
    activity
                                                                    [PWG5100.22
  ]
    inactivity
                                                                    [PWG5100.22
  ]
    none
                                                                    [PWG5100.22
  ]

  uri-authentication-supported (1setOf type2 keyword)               [RFC8011]
    certificate+basic
                                                                    [PWG5100.22
  ]
    certificate+digest
                                                                    [PWG5100.22
  ]
    certificate+oauth
                                                                    [PWG5100.22
  ]

  which-printers (type2 keyword)
                                                                    [PWG5100.22
  ]
    all
                                                                    [PWG5100.22
  ]
    idle
                                                                    [PWG5100.22
  ]
    not-accepting
                                                                    [PWG5100.22
  ]
    processing
                                                                    [PWG5100.22
  ]
    shutdown
                                                                    [PWG5100.22
  ]
    stopped
                                                                    [PWG5100.22
  ]
    testing
                                                                    [PWG5100.22
  ]
```


15.4 Enum Attribute Value Registrations

The enumerations defined in this specification will be published by IANA according to the procedures in the Internet Printing Protocol/1.1 [STD92] in the following flocation:

https://www.iana.org/assignments/ipp-registrations

The registry entries will contain the following information:

```
Attributes (attribute syntax)
  Enum Value    Enum Symbolic Name                                  Reference
------------    ------------------                                  ---------
end-power-state (type1 enum)
                                                                    [PWG5100.22
]
  < any "power-state" value >
                                                                    [PWG5100.22
]

operations-supported (1setOf type2 enum)                            [STD92]
  0x001E        Get-Resource-Attributes
                                                                    [PWG5100.22
]
  0x0020        Get-Resources
                                                                    [PWG5100.22
]
  0x004B        Allocate-Printer-Resources
                                                                    [PWG5100.22
]
  0x004C        Create-Printer
                                                                    [PWG5100.22
]
  0x004D        Deallocate-Printer-Resources
                                                                    [PWG5100.22
]
  0x004E        Delete-Printer
                                                                    [PWG5100.22
]
  0x004F        Get-Printers
                                                                    [PWG5100.22
]
  0x0050        Shutdown-One-Printer
                                                                    [PWG5100.22
]
  0x0051        Startup-One-Printer
                                                                    [PWG5100.22
]
  0x0052        Cancel-Resource
                                                                    [PWG5100.22
]
  0x0053        Create-Resource
                                                                    [PWG5100.22
]
```



```
  0x0054        Install-Resource
                                                                [PWG5100.22
]
  0x0055        Send-Resource-Data
                                                                [PWG5100.22
]
  0x0056        Set-Resource-Attributes
                                                                [PWG5100.22
]
  0x0057        Create-Resource-Subscriptions
                                                                [PWG5100.22
]
  0x0058        Create-System-Subscriptions
                                                                [PWG5100.22
]
  0x0059        Disable-All-Printers
                                                                [PWG5100.22
]
  0x005A        Enable-All-Printers
                                                                [PWG5100.22
]
  0x005B        Get-System-Attributes
                                                                [PWG5100.22
]
  0x005C        Get-System-Supported-Values
                                                                [PWG5100.22
]
  0x005D        Pause-All-Printers
                                                                [PWG5100.22
]
  0x005E        Pause-All-Printers-After-Current-Job
                                                                [PWG5100.22
]
  0x005F        Register-Output-Device
                                                                [PWG5100.22
]
  0x0060        Restart-System
                                                                [PWG5100.22
]
  0x0061        Resume-All-Printers
                                                                [PWG5100.22
]
  0x0062        Set-System-Attributes
                                                                [PWG5100.22
]
  0x0063        Shutdown-All-Printers
                                                                [PWG5100.22
]
  0x0064        Startup-All-Printers
                                                                [PWG5100.22
]
  0x0065        Get-Printer-Resources
                                                                [PWG5100.22
]
```



```
  0x0067        Restart-One-Printer
                                                                  [PWG5100.22
]

power-state (type1 enum)
                                                                  [PWG5100.22
]
  20            on
                                                                  [PWG5100.22
]
  21            on-vendor1
                                                                  [PWG5100.22
]
  22            on-vendor2
                                                                  [PWG5100.22
]
  23            on-vendor3
                                                                  [PWG5100.22
]
  24            on-vendor4
                                                                  [PWG5100.22
]
  25            on-vendor5
                                                                  [PWG5100.22
]
  30            standby
                                                                  [PWG5100.22
]
  31            standby-vendor1
                                                                  [PWG5100.22
]
  32            standby-vendor2
                                                                  [PWG5100.22
]
  33            standby-vendor3
                                                                  [PWG5100.22
]
  34            standby-vendor4
                                                                  [PWG5100.22
]
  35            standby-vendor5
                                                                  [PWG5100.22
]
  40            suspend
                                                                  [PWG5100.22
]
  41            suspend-vendor1
                                                                  [PWG5100.22
]
  42            suspend-vendor2
                                                                  [PWG5100.22
]
  43            suspend-vendor3
                                                                  [PWG5100.22
]
```



```
  44            suspend-vendor4
                                                                [PWG5100.22
]
  45            suspend-vendor5
                                                                [PWG5100.22
]
  50            reset-soft
                                                                [PWG5100.22
]
  60            off-hard
                                                                [PWG5100.22
]
  70            hibernate
                                                                [PWG5100.22
]
  71            hibernate-vendor1
                                                                [PWG5100.22
]
  72            hibernate-vendor2
                                                                [PWG5100.22
]
  73            hibernate-vendor3
                                                                [PWG5100.22
]
  74            hibernate-vendor4
                                                                [PWG5100.22
]
  75            hibernate-vendor5
                                                                [PWG5100.22
]
  80            off-soft
                                                                [PWG5100.22
]
  81            off-soft-vendor1
                                                                [PWG5100.22
]
  82            off-soft-vendor2
                                                                [PWG5100.22
]
  83            off-soft-vendor3
                                                                [PWG5100.22
]
  84            off-soft-vendor4
                                                                [PWG5100.22
]
  85            off-soft-vendor5
                                                                [PWG5100.22
]
  90            reset-hard
                                                                [PWG5100.22
]
  100           reset-mbr
                                                                [PWG5100.22
]
```



```
  110           reset-nmi
                                                                [PWG5100.22
]
  120           off-soft-graceful
                                                                [PWG5100.22
]
  130           off-hard-graceful
                                                                [PWG5100.22
]
  140           reset-mbr-graceful
                                                                [PWG5100.22
]
  150           reset-soft-graceful
                                                                [PWG5100.22
]
  160           reset-hard-graceful
                                                                [PWG5100.22
]
  170           reset-init
                                                                [PWG5100.22
]
  180           not-applicable
                                                                [PWG5100.22
]
  190           no-change
                                                                [PWG5100.22
]

request-power-state (type1 enum)
                                                                [PWG5100.22
]
  < any "power-state" value >
                                                                [PWG5100.22
]

resource-state (type1 enum)
                                                                [PWG5100.22
]
  3             pending
                                                                [PWG5100.22
]
  4             available
                                                                [PWG5100.22
]
  5             installed
                                                                [PWG5100.22
]
  6             canceled
                                                                [PWG5100.22
]
  7             aborted
                                                                [PWG5100.22
]
```



```
start-power-state (type1 enum)
                                                                    [PWG5100.22
]
  < any "power-state" value >
                                                                    [PWG5100.22
]

system-state (type1 enum)
                                                                    [PWG5100.22
]
  3             idle
                                                                    [PWG5100.22
]
  4             processing
                                                                    [PWG5100.22
]
  5             stopped
                                                                    [PWG5100.22
]
```

15.5 Attribute Group Registrations

The attribute groups defined in this specification will be published by IANA according to the procedures in the Internet Printing Protocol/1.1 [STD92] in the following location:

https://www.iana.org/assignments/ipp-registrations

The registry entries will contain the following information:

```
Attribute Group Value   Symbolic Name                          Reference
---------------------   -------------                          ---------
0x08                    resource-attributes-tag
                                                               [PWG5100.22
]
0x0A                    system-attributes-tag
                                                               [PWG5100.22
]
```

15.6 Operation Registrations

The operations defined in this specification will be published by IANA according to the procedures in the Internet Printing Protocol/1.1 [STD92] in the following location:

https://www.iana.org/assignments/ipp-registrations

The registry entries will contain the following information:

```
Operation Name                                                 Reference
--------------                                                 ---------
Allocate-Printer-Resources
                                                               [PWG5100.22
]
```



```
Cancel-Resource
                                                                [PWG5100.22
]
Cancel-Subscription(extension)
                                                                [PWG5100.22
]
Create-Job(extension)
                                                                [PWG5100.22
]
Create-Printer
                                                                [PWG5100.22
]
Create-Resource
                                                                [PWG5100.22
]
Create-Resource-Subscriptions
                                                                [PWG5100.22
]
Create-System-Subscriptions
                                                                [PWG5100.22
]
Deallocate-Printer-Resources
                                                                [PWG5100.22
]
Delete-Printer
                                                                [PWG5100.22
]
Disable-All-Printers
                                                                [PWG5100.22
]
Enable-All-Printers
                                                                [PWG5100.22
]
Get-Notifications(extension)
                                                                [PWG5100.22
]
Get-Printer-Attributes(extension)
                                                                [PWG5100.22
]
Get-Printer-Resources
                                                                [PWG5100.22
]
Get-Printers
                                                                [PWG5100.22
]
Get-Resource-Attributes
                                                                [PWG5100.22
]
Get-Resources
                                                                [PWG5100.22
]
Get-Subscription-Attributes(extension)
                                                                [PWG5100.22
]
```



```
Get-Subscriptions(extension)
                                                                [PWG5100.22
]
Get-System-Attributes
                                                                [PWG5100.22
]
Get-System-Supported-Values
                                                                [PWG5100.22
]
Install-Resource
                                                                [PWG5100.22
]
Pause-All-Printers
                                                                [PWG5100.22
]
Pause-All-Printers-After-Current-Job
                                                                [PWG5100.22
]
Print-Job(extension)
                                                                [PWG5100.22
]
Print-URI(extension)
                                                                [PWG5100.22
]
Register-Output-Device
                                                                [PWG5100.22
]
Restart-One-Printer
                                                                [PWG5100.22
]
Restart-System
                                                                [PWG5100.22
]
Renew-Subscription(extension)
                                                                [PWG5100.22
]
Resume-All-Printers
                                                                [PWG5100.22
]
Send-Document(extension)
                                                                [PWG5100.22
]
Send-Resource-Data
                                                                [PWG5100.22
]
Send-URI(extension)
                                                                [PWG5100.22
]
Set-Resource-Attributes
                                                                [PWG5100.22
]
Set-System-Attributes
                                                                [PWG5100.22
]
```



```
Shutdown-All-Printers
                                                                  [PWG5100.22
]
Shutdown-One-Printer
                                                                  [PWG5100.22
]
Startup-All-Printers
                                                                  [PWG5100.22
]
Startup-One-Printer
                                                                  [PWG5100.22
]
```

15.7 Status Code Registrations

The status codes defined in this specification will be published by IANA according to the procedures in the Internet Printing Protocol/1.1 [STD92] in the following location:

https://www.iana.org/assignments/ipp-registrations

The registry entries will contain the following information:

```
Value    Status Code Name                                    Reference
------   ------------------------------------------------    ---------
0x0500:0x05FF - Server Error:
  0x050D server-error-too-many-printers
                                                                  [PWG5100.22
]
```


15.8 Service Type Registration

The DNS-SD service type defined in this specification will be published by IANA according to the procedures in Internet Assigned Numbers Authority (IANA) Procedures for the Management of the Service Name and Transport Protocol Port Number Registry [BCP165].

The registration template is as follows:

```
Service Name: ipps-system

Transport Protocol(s): tcp

Assignee/Contact: Michael Sweet, msweet@msweet.org

Description: Imaging System Services using the Internet Printing Protocol
over HTTPS.

Reference: https://ftp.pwg.org/pub/pwg/candidates/cs-ippsystem11-20250328-
5100.22.pdf

Port Number: 631

Service Code:

Known Unauthorized Uses:

Assignment Notes: Change controller is The Printer Working Group, c/o The
IEEE Industry Standards and Technology Organization, 445 Hoes Lane,
Piscataway, NJ 08854, USA
```


16. Overview of Changes

16.1 IPP System Service v1.1

The following changes were made to the previous version of this specification [PWG5100.22-2019]:

- Added content from the IPP System Service Discovery v1.0 registration document
- Added support for using X.509 certificates and certificate signing requests with the Register-Output-Device operation
- Added RECOMMENDED "system-asset-tag" and "system-service-contact-col" System Description attributes based on the corresponding Printer Description attributes from the IPP Enterprise Printing Extensions v2.0 (EPX) [PWG5100.11]
- Clarified access rights for Get-System-Attributes, which is a public query operation like Get-Printer-Attributes
- The "system-resident-application-xxx" and "system-user-application-xxx" System Status attributes are now CONDITIONALLY REQUIRED based on support for resident and user applications.
- The "notify-events-supported" System Description attribute no longer requires the 'none' keyword.

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19. Appendix A – Rationale for Design Choices

This section describes the rationale for important design choices made in the development of this IPP System Service specification.

19.1 Resource Object

19.1.1 Move Resource Service operations into System Service

The PWG Network Resource Service [PWG5108.03] was unique because it wasn't a Job service and was implicitly a capability of the overall System. Therefore, selected Resource operations have been incorporated into the System Service.

19.1.2 Remove some Resource operations

The PWG Network Resource Service [PWG5108.03] defined a DeleteResource operation that was incompatible with System log files and audit trail mechanisms. Instead a new Cancel-Resource operation has been added to the System Service that permanently removes the Resource from further use but preserves the Resource metadata in a Resource History phase for correlation with System log files.

The PWG Network Resource Service [PWG5108.03] defined a RetrieveResource operation for reading the contents of the Resource data that was inherently insecure. This operation has been removed from the System Service.

The PWG Network Resource Service [PWG5108.03] defined a ReplaceResource operation for replacing the contents of the Resource data that was inherently insecure. This operation has been removed from the System Service.

The PWG Network Resource Service [PWG5108.03] defined a RenewResource operation for renewing the lease on a Resource. This operation has been removed from the System Service.

The PWG Network Resource Service [PWG5108.03] defined a set of Administrative service-level operations (DisableResourceService, EnableResourceService, RestartResourceService, ShutdownResourceService, and StartupResourceService). These operations have been removed from the System Service.

19.1.3 Decompose some Resource operations

The PWG Network Resource Service [PWG5108.03] defined a single operation StoreResource that both created the Resource metadata object and uploaded the Resource data, by analogy to the Print-Job operation defined in [STD92]. Consistent with current PWG design philosophy, this StoreResource operation has been decomposed into Create-Resource (create Resource object), Send-Resource-Data (upload Resource data), and Install-Resource (install executable, static, or template Resource for use). Installation of an executable Resource (e.g., Firmware) can involve a System or Subunit reboot to complete.

19.1.4 Replace Resource lease with Resource state

The PWG Network Resource Service [PWG5108.03] used the lease concept from the Subscription object defined in [RFC3995]. There was a strong consensus to move away from leases and instead add a new “resource-state” Resource Status attribute for clarity and flexibility.

19.2 Printer Object

19.2.1 Restricted “printer-id” Range

For compatibility with IETF Printer MIB v2 [RFC3805] and existing discovery protocols the maximum value of “printer-id” and members of “printer-ids” is restricted to 65535 (16-bit unsigned maximum value). Although some IPP implementations might support more than 65535 print queues, this 16-bit restriction was deemed important for best compatibility with SNMP, Bluetooth, and other interfaces. Implementations needing more than 65535 print queues can use “printer-uuid” and/or partitioning of “printer-id” number spaces.

19.3 Power States and Policies

This specification imports (and renames for clarity and common usage) the normative definitions and semantics of System power states from the PWG Power Management Model for Imaging Systems 1.0 [PWG5106.4], which is aligned with DMTF CIM [DSP1027] and ACPI [ACPI] power state definitions and semantics.

19.3.1 Power States

Powers states are represented by the SNMP enumerated values. The associated IPP keyword value is the XML Power State keyword converted from TitleCase to hyphenated-lowercase.

19.3.2 Power Policies

Power state transition policies can be scheduled by an Operator or Administrator in “power-calendar-policy-col”, “power-event-policy-col”, and “power-timeout-policy-col” System attributes. These policies can use triggers based on calendar times (e.g., 1st day of month), named events (e.g., ‘jam’), or elapsed time (e.g., 5 minutes of inactivity after entering ‘standby’ power state resulting in a further transition to ‘suspend’ power state).

System administrative operations can also invoke System power state transitions (e.g., Restart-System can invoke a ‘reset-soft-graceful’ transition). Job creation operations can be delayed in some System power states (e.g., during the warm up transition from ‘suspend’ to ‘on’). Job creation operations can also be prohibited in some System power states (e.g., in ‘hibernate’ and ‘off-soft’).

Note: This specification intentionally does not define any explicit operations for changing System power states. System power policies can be used instead to schedule power state transitions.

An example of an automated System power state transition to ‘hibernate’ at 6pm every Friday evening could be scheduled in “power-calendar-policy-col” as follows:

```
calendar-id=32   # arbitrary unique value for calendar policy
day-of-week=6    # Friday is 6th day counting from Sunday
hour=18          # 6pm is 18:00 on a 24-hour clock
request-power-state=60
                 # target power state 'hibernate'
```

In the above example, the irrelevant “day-of-month”, “minute”, “month”, and “run-once” member attributes have been omitted.

An example of a Restart-System operation implementation could be as follows:

1. ‘stopping’ is added to “system-state-reasons” for the System.
2. ‘stopping’ is added to “printer-state-reasons” for each configured Printer.
3. ‘processing-to-stop-point’ is added to “job-state-reasons” for each active Job.
4. All active Jobs complete normally (because the stop point is a Job boundary) and ‘processing-to-stop-point’ is removed from “job-state-reasons” for each completed Job.
5. ‘stopping’ is removed from “printer-state-reasons” and “printer-state” is changed to ‘stopped’ for each configured Printer.
6. ‘stopping’ is removed from “system-state-reasons” and “system-state” is changed to ‘stopped’ for the System.
7. The System executes a ‘reset-soft-graceful’ transition, resulting in “power-state” in “power-state-monitor-col” values: on → standby → off-soft → standby → on.
8. “system-state” is changed to ‘idle’ for the System and “printer-state” is changed to ‘idle’ for each configured Printer.
9. Job processing resumes normally on all Printers.

19.4 Executable Resources

This specification defines two types of executable resources: Firmware ('executable-firmware') and Resident/User Application software ('executable-software'). While no specific file format has been mandated, an executable resource file:

- Provides a manifest providing descriptive text, version number(s), subunit or other associations, and a cryptographic hash of the executable content,
- Provides a cryptographic signature of the metadata, and
- Contains the executable content.

When subunit Firmware is installed (or queued for installation on the next restart of the System), it applies to all compatible subunits. For example, if a System contains multiple

fold finishers and an Administrator installs new fold Finisher firmware, all of the fold finishers are updated - there is no way to selectively upgrade a single subunit.

When Resident/User Application software is installed, it typically applies to the System and all of its Printers. However, this specification does not prohibit applications that need to be subsequently allocated to a Printer, for example a cloud-based PDF interpreter application could be installed and later allocated to a specific Printer.

