The Printer Working Group

The Printer Working Group (PWG)

Internet Printing Protocol Version 2.0
(IPP/2.0)

Status: Stable Draft

Abstract: Since the release of IPP/1.1 (RFC 2910 and RFC 2911), numerous extensions to the IPP protocol have been published as IETF RFCs or PWG Candidate Standards. Many IPP developers are not aware of the existence of the many of these extensions, and there is no published document that references all of the extension specifications. As a consequence, only some of the extensions have been implemented.

This specification combines most of the previous IPP IETF or PWG IPP extensions into either a new base IPP/2.0 conformance level or a new extended IPP/2.1 conformance level. No new IPP functionality, beyond that defined in the previous IPP extensions, is specified in this document.

Implementation of this specification will allow printing applications to easily determine the capabilities of an IPP Printer without the need for extensive queries to the IPP Printer.

ftp://ftp.pwg.org/pub/pwg/ipp/ippv2-wd/wd-ipp20-20090602.pdf

About the IEEE-ISTO

The IEEE-ISTO is a not-for-profit corporation offering industry groups an innovative and flexible operational forum and support services. The IEEE-ISTO provides a forum not only to develop standards, but also to facilitate activities that support the implementation and acceptance of standards in the marketplace. The organization is affiliated with the IEEE (http://www.ieee.org/) and the IEEE Standards Association (http://standards.ieee.org/).

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About the IEEE-ISTO PWG

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

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

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

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Instructions for subscribing to the IPP mailing list can be found at the following link:
> http://www.pwg.org/mailhelp.html

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

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1 Introduction (Informative)

The original IPP/1.0 protocol specifications, [RFC2565] and [RFC 2566], were published by the IETF in April 1999.The subsequent IPP/1.1 protocol specifications, [RFC2910] and [RFC2911], were published by the IETF in September 2000.Since the publication of IPP/1.1, numerous IETF or PWG IPP extension specifications have been approved and published.

1.1 New IPP Versions

The purpose of this document is to provide a single reference to most of the existing IETF or PWG IPP extension specifications and to define new IPP versions that provide simple statements of the capabilities of an IPP Printer.

In sections 5 and 6, this document defines the new IPP/2.0 and IPP/2.1 conformance levels. Below is a brief informal description of the targeted printing environments:

IPP/2.0 – This IPP conformance level is targeted to an environment where a small number of users are typically physically located close to the device and the device is typically managed by the local users. The device is typically a low speed IPP/2.0 Printer with a limited feature set tailored to the requirements of a small group of users. Routine maintenance, such as loading paper and clearing paper jams, is usually performed by the current user. The configuration of the IPP/2.0 Printer for special jobs, such as the need for a unique paper size or color, is also handled by the user requiring the changed configuration.

IPP/2.1 – This IPP conformance level is targeted to an environment with more users and devices with higher speed and duty cycle ratings than IPP/2.0 Printers, but the primary difference is in the supported features, physical location, and maintenance of the device. A IPP/2.1 Printer is typically located in a central location with most users not very close physically. An End User's access to the IPP/2.1 Printer may be limited and maintenance is typically performed by assigned, trained personnel. Features such as paper size and type are typically fixed by site policies and are not easily modified for special use.IPP/2.1 Printers often have more post-processing features (such as punching, folding, stapling, etc.) than IPP/2.0 Printers.

2 Terminology 2.1 Conformance Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as defined in [RFC2119].

2.2 Printing Terminology

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

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

IPP Client - Initiator of outgoing IPP session requests and sender of outgoing IPP operation requests (HTTP/1.0 Client [RFC1957] / HTTP/1.1 Client [RFC2616]).

IPP Printer - Listener for incoming IPP session requests and receiver of incoming IPP operation requests (HTTP/1.0 Server [RFC1957] / HTTP/1.1 Server [RFC2616]).

3 Requirements

Per the PWG Process, this section specifies the formal rationale for developing an IPP/2.0 specification, based on existing printing industry standards. This section also describes simple use models for IPP/2.0 and IPP/2.1 environments.

3.1 Rationale for IPP/2.0

The Printer MIB v2 [RFC3805] and Port Monitor MIB [PWG5107.1] define:
- (a) Model of Print Devices
- (b) Operations for Print Devices
  - prtGeneralReset
  - prtConsoleDisable
- (c) Groups of simple attributes for Print Devices
  - prtInputTable --> prtInputName
  - ppmPortTable --> ppmPortServiceNameOrURI
- (d) Conformance requirements for implementations of Printer MIB v2 and Port Monitor MIB

The IPP/1.1 Model and Semantics [RFC2911] defines:
- (a) Model of Print Services, Print Devices, and Print Jobs
- (b) Operations for Print Services and Print Jobs
  - Pause-Printer
  - Print-Job
- (c) Attributes for Print Services and Print Jobs
  - printer-location
  - job-id
- (d) Conformance requirements for implementations of IPP/1.1

The IPP/1.1 Encoding and Transport [RFC2910] defines:
- (a) Protocol Bindings for IPP/1.1
  - HTTP with optional upgrade to TLS
- (b) Mappings of operations for Print Services and Print Jobs.
- (c) Conformance requirements for implementations of IPP/1.1

Later IETF and PWG standards-track specifications defined numerous IPP/1.1 extensions including:
- (a) New operations
  - Set-Printer-Attributes [RFC3380]
  Resume-Job [RFC3998]
- (b) New attribute syntaxes
  - collection [RFC3382]
- (c) New objects
  - Subscription [RFC3995]

Therefore an IPP/2.0 specification should:

- (a) Standardize profiles of the IPP/1.1 extensions for advanced printing functionality and reliable interoperability
- (b) Encourage adoption of modern IPP-based printing infrastructures
- (c) Discourage the further proliferation of vendor proprietary IPP operations and attributes that damage IPP interoperability by duplicating IETF or PWG IPP standard operations and attributes

3.2 Use Models

See the informal description of IPP/2.0 and IPP/2.1 printing environments in section 1.1.

3.2.1. IPP/2.0 Printer

Alice, Bob, and Charlie are graphic artists who share a printer down the hall. They all load paper when needed. Alice and Bob have convinced Charlie that he should load the toner cartridges. But they do use many paper sizes - they need PWG Media Standardized Names [PWG5101.1] used in the IPP 'media' attribute.

3.2.2. IPP/2.1 Printer

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

Both Joe and the operator Sue in the glasshouse manage lots of jobs - they need to hold and release jobs. Joe wants to keep track of his jobs - he needs to subscribe for job events.

Sue is expected to manage several printers - she needs to enable and disable printers (i.e., enable/disable accepting new jobs over input channels).

4 Required IPP Standards

This section specifies the IPP standards required at each IPP version level. Each IPP version level requires support for the complete required functionality of all lower versions (by intentional design).

4.1 Version 1.0

An IPP/1.0 Printer must support the following specifications.

[RFC2565] Internet Printing Protocol/1.0: Encoding and Transport

[RFC2566] Internet Printing Protocol/1.0: Model and Semantics

4.2 Version 1.1

The IPP/1.1 protocol specifications supersede and obsolete the IPP/1.0 protocol specifications. An IPP/1.1 Printer must support the following specifications.

[RFC2910] Internet Printing Protocol/1.1: Encoding and Transport

[RFC2911] Internet Printing Protocol/1.1: Model and Semantics

[RFC3510] Internet Printing Protocol: IPP URL Scheme

4.3 Version 2.0

An IPP/2.0 Printer MUST support the IPP specifications required for IPP/1.1 plus the following.

[PWG5100.1] Internet Printing Protocol: "finishings" attribute values extension

[PWG5100.2] Internet Printing Protocol: "output-bin" attribute extension

[PWG5101.1] PWG Standard for Media Size Names (for "media" attribute)

4.4 Version 2.1

An IPP/2.1 Printer MUST support the IPP specifications required for IPP/2.0 plus the following.

[RFC3380] Internet Printing Protocol: Job and Printer Set Operations

[RFC3381] Internet Printing Protocol: Job Progress Attributes

[RFC3382] The 'collection' Attribute Syntax (for "media-col" and other attributes)

[RFC3995] Internet Printing Protocol: Event Notifications and Subscriptions

[RFC3996] Internet Printing Protocol: The 'ippget' Delivery Method for Event Notifications

[RFC3998] Internet Printing Protocol: Job and Printer Administrative Operations

[PWG5100.3] Internet Printing Protocol: Production Printing Attributes – Set 1 (for "media-col" attributes only)

[PWG5100.7] Internet Printing Protocol: Job Extensions

[PWG5100.yy] Internet Printing Protocol: Printer State Extensions

[[PWG Secretary – replace with assigned number after IPP PSX is approved]]]

5 Required IPP Operations

IPP/2.0 and IPP/2.1 specify higher conformance requirements for some IPP Operations in comparison to previous IPP specifications. Many IPP Operations were defined in their source specifications as optional. If they remained optional in this specification, the desired interoperability objective would not be achieved.

5.1 Original Required IPP Version 1.1 Operations

The following IPP Operations were originally specified as required in their respective source documents. For IPP/2.0 and higher implementations, all of these operations (except Validate-Job) MUST also be implemented if the source specification is included in the particular IPP version implemented.

Table 1 - Required Operations in IPP 1.1

Code	Operation Name	Source	IPP Version
0x0002	Print-Job	[RFC2911]	IPP/2.0
0x0004	Validate-Job	[RFC2911]	IPP/2.0
0x0008	Cancel-Job	[RFC2911]	IPP/2.0
0x0009	Get-Job-Attributes	[RFC2911]	IPP/2.0
0x000A	Get-Jobs	[RFC2911]	IPP/2.0
0x000B	Get-Printer-Attributes	[RFC2911]	IPP/2.0
0x0016	Create-Printer-Subscriptions	[RFC3995]	IPP/2.1
0x0018	Get-Subscription-Attributes	[RFC3995]	IPP/2.1
0x0019	Get-Subscriptions	[RFC3995]	IPP/2.1
0x001A	Renew-Subscription	[RFC3995]	IPP/2.1
0x001B	Cancel-Subscription	[RFC3995]	IPP/2.1
0x001C	Get-Notifications	[RFC3996]	IPP/2.1

5.2 Required and Optional IPP Version 2.0 Operations The following IPP Operations are included in their respective source documents. The conformance requirements for each IPP Operation in an IPP/2.0 implementation are defined below. Note that an IPP/2.0 implementation MAY also include support for additional IPP operations other than those specified in this list.

Note: Validate-Job can only validate the Job attributes included in a Print-Job or Create-Job operation, but not the Job document data (for interpreter errors). Therefore, Validate-Job is reduced to OPTIONAL in IPP/2.0, because it is not widely supported in existing IPP/1.1 implementations and it is not useful in an IPP/2.0 printing environment.

Table 2 - Required and Optional Operations in IPP/2.0

Code	Operation Name	Source	Support
0x0002	Print-Job	[RFC2911]	REQUIRED
0x0003	Print-URI	[RFC2911]	OPTIONAL
0x0004	Validate-Job (see note above)	[RFC2911]	OPTIONAL
0x0005	Create-Job	[RFC2911]	OPTIONAL
0x0006	Send-Document	[RFC2911]	OPTIONAL
0x0007	Send-URI	[RFC2911]	OPTIONAL
0x0008	Cancel-Job	[RFC2911]	REQUIRED
0x0009	Get-Job-Attributes	[RFC2911]	REQUIRED
0x000A	Get-Jobs	[RFC2911]	REQUIRED
0x000B	Get-Printer-Attributes	[RFC2911]	REQUIRED
0x000C	Hold-Job	[RFC2911]	OPTIONAL
0x000D	Release-Job	[RFC2911]	OPTIONAL
0x000E	Restart-Job	[RFC2911]	OPTIONAL
0x0010	Pause-Printer	[RFC2911]	OPTIONAL
0x0011	Resume-Printer	[RFC2911]	OPTIONAL
0x0012	Purge-Jobs	[RFC2911]	OPTIONAL

5.3 Required and Optional IPP Version 2.1 Operations The following IPP Operations are included in their respective source documents. The conformance requirements (some higher than in IPP/2.0) for each IPP Operation in an IPP/2.1 implementation are defined below. Note that an IPP/2.1 implementation MAY also include support for additional IPP operations other than those specified in this list.

Note: Validate-Job is restored as REQUIRED in IPP/2.1 (as in IPP/1.1), for strict IPP/1.1 compatibility and because REQUIRED Create-Job/Print-Job in IPP/2.1 make Validate-Job trivial to implement.

Table 3 - Required and Optional Operations in IPP/2.1

Code	Operation Name	Source	Support
0x0002	Print-Job	[RFC2911]	REQUIRED
0x0003	Print-URI	[RFC2911]	OPTIONAL
0x0004	Validate-Job	[RFC2911]	REQUIRED
0x0005	Create-Job	[RFC2911]	REQUIRED
0x0006	Send-Document	[RFC2911]	REQUIRED
0x0007	Send-URI	[RFC2911]	OPTIONAL
0x0008	Cancel-Job	[RFC2911]	REQUIRED
0x0009	Get-Job-Attributes	[RFC2911]	REQUIRED
0x000A	Get-Jobs	[RFC2911]	REQUIRED
0x000B	Get-Printer-Attributes	[RFC2911]	REQUIRED
0x000C	Hold-Job	[RFC2911]	REQUIRED
0x000D	Release-Job	[RFC2911]	REQUIRED
0x000E	Restart-Job	[RFC2911]	REQUIRED
0x0010	Pause-Printer	[RFC2911]	REQUIRED
0x0011	Resume-Printer	[RFC2911]	REQUIRED
0x0012	Purge-Jobs	[RFC2911]	REQUIRED
0x0013	Set-Printer-Attributes	[RFC3380]	REQUIRED
0x0014	Set-Job-Attributes	[RFC3380]	REQUIRED
0x0015	Get-Printer-Supported-Values	[RFC3380]	REQUIRED
0x0016	Create-Printer-Subscriptions	[RFC3995]	REQUIRED
0x0017	Create-Job-Subscriptions	[RFC3995]	OPTIONAL
0x0018	Get-Subscription-Attributes	[RFC3995]	REQUIRED
0x0019	Get-Subscriptions	[RFC3995]	REQUIRED
0x001A	Renew-Subscription	[RFC3995]	REQUIRED
0x001B	Cancel-Subscription	[RFC3995]	REQUIRED
0x001C	Get-Notifications	[RFC3995]	REQUIRED
0x0022	Enable-Printer	[RFC3998]	REQUIRED
0x0023	Disable-Printer	[RFC3998]	REQUIRED
0x0024	Pause-Printer-After-Current-Job	[RFC3998]	OPTIONAL
0x0025	Hold-New-Jobs	[RFC3998]	OPTIONAL
0x0026	Release-Held-New-Jobs	[RFC3998]	OPTIONAL
0x0027	Deactivate-Printer	[RFC3998]	OPTIONAL
0x0028	Activate-Printer	[RFC3998]	OPTIONAL
0x0029	Restart-Printer	[RFC3998]	OPTIONAL
0x002A	Shutdown-Printer	[RFC3998]	OPTIONAL
0x002B	Startup-Printer	[RFC3998]	OPTIONAL
0x002C	Reprocess-Job	[RFC3998]	OPTIONAL
0x002D	Cancel-Current-Job	[RFC3998]	OPTIONAL
0x002E	Suspend-Current-Job	[RFC3998]	OPTIONAL
0x002F	Resume-Job	[RFC3998]	OPTIONAL
0x0030	Promote-Job	[RFC3998]	OPTIONAL
0x0031	Schedule-Job-After	[RFC3998]	OPTIONAL

6 Required IPP Attributes

This section specifies the IPP Attributes that MUST be implemented for conformance to IPP/2.0 and IPP/2.1 and also provides a summary of the original required IPP/1.1 Attributes.

6.1 Required IPP Version 1.1 Attributes

The following IPP Attributes were originally specified as required in IPP/1.1 [RFC2911].

Table 4 - Required Attributes in IPP1.1

Attribute Name	Object	Source
attributes-charset	operation/all	[RFC2911]
attributes-natural-language	operation/all	[RFC2911]
charset-configured	Printer	[RFC2911]
charset-supported	Printer	[RFC2911]
compression	Job	[RFC2911]
compression-supported	Printer	[RFC2911]
document-format	Job	[RFC2911]
document-format-default	Printer	[RFC2911]
document-format-supported	Printer	[RFC2911]
document-name	Job	[RFC2911]
generated-natural-language-supported	Printer	[RFC2911]
ipp-attribute-fidelity	Job	[RFC2911]
ipp-versions-supported	Printer	[RFC2911]
job-id	Job	[RFC2911]
job-name	Job	[RFC2911]
job-originating-user-name	Job	[RFC2911]
job-printer-up-time	Job	[RFC2911]
job-printer-uri	Job	[RFC2911]
job-state	Job	[RFC2911]
job-state-reasons	Job	[RFC2911]
job-uri	Job	[RFC2911]
limit	operation	[RFC2911]
my-jobs	operation	[RFC2911]
natural-language-configured	Printer	[RFC2911]
operations-supported	Printer	[RFC2911]
pdl-override-supported	Printer	[RFC2911]
printer-is-accepting-jobs	Printer	[RFC2911]
printer-name	Printer	[RFC2911]
printer-state	Printer	[RFC2911]
printer-state-reasons	Printer	[RFC2911]
printer-up-time	Printer	[RFC2911]
printer-uri	operation	[RFC2911]
printer-uri-supported	Printer	[RFC2911]
queued-job-count	Printer	[RFC2911]
requested-attributes	operation	[RFC2911]
requesting-user-name	operation	[RFC2911]
time-at-completed	Job	[RFC2911]
time-at-creation	Job	[RFC2911]
time-at-processing	Job	[RFC2911]
uri-authentication-supported	Printer	[RFC2911]
uri-security-supported	Printer	[RFC2911]
which-jobs	operation	[RFC2911]

6.2 Required IPP Version 2.0 Attributes

The following IPP Attributes MUST be supported by an IPP/2.0 implementation, in addition to all the IPP Attributes listed in section 6.1 above. Note that an IPP/2.0 implementation MAY also include support for additional IPP Attributes other than those specified in this list.

Table 5 - Required Attributes in IPP/2.0

Attribute Name	Object	Source
color-supported	Printer	[RFC2911]
copies	Job	[RFC2911]
copies-default	Printer	[RFC2911]
copies-supported	Printer	[RFC2911]
finishings	Job	[RFC2911]
finishings-default	Printer	[RFC2911]
finishings-supported	Printer	[RFC2911]
media (note 1)	Job	[RFC2911]
media-default (note 1)	Printer	[RFC2911]
media-supported (note 1)	Printer	[RFC2911]
orientation-requested	Job	[RFC2911]
orientation-requested-default	Printer	[RFC2911]
orientation-requested-supported	Printer	[RFC2911]
output-bin	Job	[PWG5100.2]
pages-per-minute	Printer	[RFC2911]
pages-per-minute-color (note 2)	Printer	[RFC2911]
print-quality	Job	[RFC2911]
print-quality-default	Printer	[RFC2911]
print-quality-supported	Printer	[RFC2911]
printer-info	Printer	[RFC2911]
printer-location	Printer	[RFC2911]
printer-make-and-model	Printer	[RFC2911]
printer-more-info	Printer	[RFC2911]
printer-resolution	Job	[RFC2911]
printer-resolution-default	Printer	[RFC2911]
printer-resolution-supported	Printer	[RFC2911]
sides	Job	[RFC2911]
sides-default	Printer	[RFC2911]
sides-supported	Printer	[RFC2911]

Notes:

1. Values of the media attribute that contain media size names and media type names MUST conform to [PWG5101.1] for IPP/2.0 and higher implementations.

2. The pages-per-minute-color attribute is only required for IPP/2.0 and higher implementations if the printer supports more than 1 color (i.e., the value of color-supported is 'true').

3. The media-ready attribute is NOT required for IPP/2.0 implementations, because it cannot be supported by remote IPP spoolers.

6.3 Required IPP Version 2.1 Attributes

The following IPP Attributes MUST be supported by an IPP/2.1 implementation, in addition to all the IPP Attributes listed in sections 6.1 and 6.2 above. Note that an IPP/2.1 implementation MAY also include support for additional IPP Attributes other than those specified in this list.

Table 6 - Required Attributes in IPP/2.1

Attribute Name	Object	Source
compression-supplied	Job	[PWG5100.7]
ippget-event-life	Printer	[RFC3996]
job-hold-until	Job	[RFC2911]
job-hold-until-default	Printer	[RFC2911]
job-hold-until-supported	Printer	[RFC2911]
job-priority	Job	[RFC2911]
job-priority-default	Printer	[RFC2911]
job-priority-supported	Printer	[RFC2911]
job-settable-attributes-supported	Printer	[RFC3380]
job-sheets	Job	[RFC2911]
job-sheets-default	Printer	[RFC2911]
job-sheets-supported	Printer	[RFC2911]
last-document	operation	[RFC2911]
media-col (note 1)	Job	[RFC3382] & [PWG5100.3]
media-col-default (note 1)	Printer	[RFC3382] & [PWG5100.3]
media-col-supported (note 1)	Printer	[RFC3382] & [PWG5100.3]
media-col.media-color (note 2)	Job	[PWG5100.3]
media-col.media-key (note 2)	Job	[PWG5100.3]
media-col.media-size (note 2)	Job	[PWG5100.3]
media-col.media-type (note 2)	Job	[PWG5100.3]
multiple-operation-time-out	Printer	[RFC2911]
notify-charset	Subscription	[RFC3995]
notify-events	Subscription	[RFC3995]
notify-events-default	Printer	[RFC3995]
notify-events-supported	Printer	[RFC3995]
notify-get-interval	response	[RFC3996]
notify-job-id	Subscription	[RFC3995]
notify-lease-duration	Subscription	[RFC3995]
notify-lease-duration-default	Printer	[RFC3995]
notify-lease-duration-supported	Printer	[RFC3995]
notify-lease-expiration-time	Subscription	[RFC3995]
notify-max-events-supported	Printer	[RFC3995]
notify-natural-language	Subscription	[RFC3995]
notify-printer-up-time	Subscription	[RFC3995]
notify-printer-uri	Subscription	[RFC3995]
notify-pull-method	Subscription	[RFC3995]
notify-pull-method-supported	Printer	[RFC3995]
notify-sequence-number	Subscription	[RFC3995]
notify-sequence-numbers	operation	[RFC3996]
notify-subscribed-event	Subscription	[RFC3995]
notify-subscriber-user-name	Subscription	[RFC3995]

Attribute Name	Object	Source
notify-subscription-id	Subscription	[RFC3995]
notify-subscription-ids	operation	[RFC3996]
notify-text	Subscription	[RFC3995]
notify-time-interval	Subscription	[RFC3995]
notify-user-data	Subscription	[RFC3995]
notify-wait	operation	[RFC3996]
output-device-assigned	Job	[RFC3998]
printer-alert	Printer	[PWG5100.yy]
printer-alert-description	Printer	[PWG5100.yy]
printer-settable-attributes-supported	Printer	[RFC3380]
printer-state-change-time	Printer	[RFC3995]
printer-state-reasons	Printer	[RFC2911] & [PWG5100.yy]

Notes:

1. The media-col collection attribute is REQUIRED in IPP/2.1 implementations and is normatively defined in [PWG5100.3] and only briefly described in an *example* in [RFC3382].

2. These media-col member attributes are REQUIRED in IPP/2.1 implementations – all other media-col member attributes not listed in the table above are OPTIONAL in IPP/2.1. Values of media-col.media-color, media-col.media-size, and media-col.media-type attributes MUST conform to [PWG5101.1] for IPP/2.1 implementations.3. The media-col-ready attribute is NOT required for IPP/2.1 implementations, because it cannot be supported by remote IPP spoolers.

[[[PWG Secretary – resolve the document number for PSX "PWG5100.yy"]]]

7 Conformance Requirements

7.1 IPP Printer Conformance Requirements

To claim conformance to this specification, an IPP Printer implementation MUST:
  (a) support all REQUIRED IPP Operations defined in section 5 of this specification;
  (b) support all REQUIRED IPP Attributes defined in section 6 of this specification;.
  (c) conform to the requirements for an IPP Object specified in section 5.2 of [RFC2911];
  (d) conform to the IPP Job and Printer Administrative operation requirements specified in section 11 of [RFC3998];
  (e) conform to the Internationalization Considerations defined in section 9 of this specification; and
  (f) conform to the Security Considerations defined in section 10 of this specification.

7.2 IPP Client Conformance Requirements

To claim conformance to this specification, an IPP Client MUST:
  (a) explicitly identify the implemented set of IPP Operations defined in section 5 of this specification;
  (b) explicitly identify the implemented set of IPP Attributes defined in section 6 of this specification;
  (c) conform to the requirements for an IPP Client specified in section 5.1 of [RFC2911];
  (d) conform to the Internationalization Considerations defined in section 9 of this specification; and
  (e) conform to the Security Considerations defined in section 10 of this specification.

7.3 IPP over HTTP Conformance Requirements

The IPP/1.1 specification [RFC2911] requires implementation of IPP/1.1 transport over HTTP/1.1 as defined in [RFC2616]. Historically, some IPP implementations have not implemented an HTTP/1.1 transport (i.e., have only supported HTTP/1.0) or else have not implemented complete HTTP/1.1 support.

To claim conformance to this specification, an IPP Printer or IPP Client implementation MUST:
  (a) support the complete HTTP/1.1 protocol as defined in [RFC2616];
  (b) support chunking as defined in section 3.6.1 of [RFC2616];
  (c) support the Expect header as defined in section 5.3 of [RFC2616].

7.4 IPP over TLS Conformance Requirements

To claim conformance to this specification, an IPP Printer or IPP Client that supports TLS/1.0 [RFC2246] or later TLS specification MUST:
  (a) support the HTTP Upgrade protocol as defined in [RFC2817]; and
  (b) support the required minimum cipher suite for interoperability defined in the claimed TLS specification.

7.5 IPP Unsupported Attributes Conformance Requirements

The IPP/1.1 specification [RFC2911] requires that IPP Attributes received, that are not supported or not understood, must be processed according to the defined procedures, and that an appropriate status code must be returned. Historically, some IPP implementations have not conformed to this requirement, causing communication problems and failed IPP printing operations.

To claim conformance to this specification, an IPP Printer or IPP Client implementation MUST:
  (a) correctly process unsupported attributes, values, or groups as defined in sections 3.1.7, 3.1.8, 3.2.1.2, 3.3.5.1, 3.3.7.1, 4.1.2.3, and 13.1.2.2 in [RFC2911];
  (b) correctly process unsupported collection attributes as defined in section 7 in [RFC3382].(c) correctly support reading the IPP noValue tag as a valid value for an attribute that normally would be encoded as an enum, integer, name, or keyword value tag;(d) correctly process (or ignore) collection values as defined by [RFC3382], even if the IPP implementation does not support the collection attribute itself.

8 IANA and PWG Considerations

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

The following new keyword values are defined for the ipp-versions-supported attribute [RFC2911]:

'2.0': Meets all the conformance requirements of IPP version 2.0, as specified in PWG 5100.xx, in addition to the requirements for IPP/1.1 as specified in [RFC2911] and [RFC2910].

'2.1': Meets all the conformance requirements of IPP version 2.1, as specified in PWG 5100.xx, in addition to the requirements for IPP 2.0 as specified above.

[[[PWG Secretary: When this document is published, replace 5100.xx above with the PWG document number assigned to this specification.]]]

9 Internationalization Considerations

IPP/1.1 [RFC2911] requires conforming IPP Printer implementations to support the UTF-8 [RFC3629] encoding of Unicode [UNICODE] [ISO10646].

To claim conformance to this specification, IPP Printer or IPP Client implementation:
(a) MUST support UTF-8 as defined in [RFC3629]; and
(b) SHOULD support Network Unicode as defined in [RFC5198], which requires transmission of well-formed UTF-8 strings and recommends transmission of normalized UTF-8 strings in Normalization Form C (NFC) [UAX15].

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

WARNING – Performing normalization on UTF-8 strings received from IPP Clients and subsequently storing the results (e.g., in IPP Job objects) could cause false negatives in IPP Client searches and failed access (e.g., to IPP Printers with percent-encoded UTF-8 URIs now 'hidden').

10 Security Considerations

To claim conformance to this specification, an IPP Printer or IPP Client implementation that supports Transport Layer Security (TLS) MUST support the mandatory cipher suite required in the claimed TLS specification (summarized in the table below).

Table 7 - TLS Cipher Suite Requirements in IPP Versions

Version	TLS Version	TLS Requirement	Mandatory TLS Cipher Suite
IPP/1.1	1.0 [RFC2246]	should per [RFC2911]	TLS_DHE_DSS_WITH_3DES_EDE_CBC_SHA
IPP/2.0	1.1 [RFC4346]	SHOULD	TLS_RSA_WITH_3DES_EDE_CBC_SHA
IPP/2.1	1.2 [RFC5246]	SHOULD	TLS_RSA_WITH_AES_128_CBC_SHA

11 References

11.1 Normative References

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2001.
ftp://ftp.pwg.org/pub/pwg/candidates/cs-ippoutputbin10-20010207-5100.2.pdf, .doc

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PWG Candidate Standard 5100.7, IPP Job Extensions, PWG 5100.7, October 2003.
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[PWG5100.yy]
PWG Candidate Standard 5100.yy-2009, IPP Printer State Extensions, PWG 5100.yy TBD 2009.
ftp://ftp.pwg.org/pub/pwg/candidates/cs-ippstate10-2009mmdd-5100.yy.pdf, .doc
[[[PWG Secretary – change '5100.yy' after approval of IPP PSX and add month of approval]]]

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Hypertext Transfer Protocol -- HTTP/1.1. R. Fielding, J. Gettys, J. Mogul, H. Frystyk, L. Masinter, P.
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[RFC2817]
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        Event Notifications", RFC 3996, March, 2005.
        http://www.ietf.org/rfc/rfc3996.txt

[RFC3998]
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[RFC4346] T.Dierks, E. Rescorla, "Transport Layer Security 1.1", RFC 4346, April 2006,
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[RFC5246] T.Dierks, E. Rescorla, "Transport Layer Security 1.2", RFC 5246, August 2008,
        http://www.ietf.org/rfc/rfc5246.txt

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        http://www.unicode.org/versions/Unicode5.1.0/

11.2 Informative References

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        R. Herriot, S. Butler, P. Moore, R. Turner, "Internet Printing Protocol/1.0: Encoding and Transport",
        RFC 2565, April, 1999.
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        R. deBry, T. Hastings, R. Herriot, S. Isaacson, P. Powell, "Internet Printing Protocol/1.0: Model and
        Semantics", RFC 2566, April, 1999.
        http://www.ietf.org/rfc/rfc2566.txt

[RFC2567]
        D. Wright, IETF IPP Design Goals, RFC 2567, April 1999.
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[RFC3196]
        T. Hastings, C. Manros, K. Kugler, H. Holst, P. Zehler, "Internet Printing Protocol/1.1:
        Implementor's Guide", RFC 3196, November, 2001.
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13 Appendix X Document Revisions (Informative)
[PWG Secretary: This section must be removed when this document is approved!]

A. Changes made to create 2 June 2009 version (after PWG Last Call)
LCRC – Replaced "IPP/2.x" with "IPP/2.0 and IPP/2.1" or "IPP/2.0 or higher" as appropriate for clarity
LCRC – Added table numbers and captions and corrected formatting (double lines, etc.)
LCRC – Highlighted in yellow all notes to the PWG Secretary about things to be removed or modified before publication as a Candidate Standard (to ensure that they are not missed)
LCRC – Moved useful but non-normative information about IPP/2.0 and IPP/2.1 printing environments from Section 2 Terminology added to Section1 Introduction
LCRC – Completely rewrote Section 2 Terminology by direct cut-and-paste from IPP PSX spec
LCRC – Removed "Informative" from title of Section 3 Requirements
LCRC – Changed Section 5.2 IPP/2.0 to reduce Validate-Job to OPTIONAL – added note with rationale
LCRC – Changed Section 5.3 IPP/2.1 to restore Validate-Job to REQUIRED– added note with rationale
LCRC – Restored orientation-requested and orientation-requested-default to table in Section 6.2 IPP/2.0
LCRC – Deleted blank rows in table in Section 6.2 IPP/2.0
LCRC – Added notes to Sections 6.2 and 6.3 to explain why media-ready and media-col-ready are not required (cannot be supported in remote spoolers)
LCRC – Corrected text color from grey to black in Sections 7.3 and 7.4
LCRC – Moved TLS portion of Section 7.3 to new Section 7.4 IPP over TLS
LCRC – Removed "For example…" in normative Section 7.5 and renumbered (a) to (d) requirements
LCRC – Changed email address for Harry Lewis is updated and added email address for Ron Bergman in Section 12

B. Changes made to create 22 March 2009 version
Global – Deleted "(Normative)" from chapter headings (but kept the few "(Informative") suffixes) per Glen Petrie and IETF best practice (RFC 4181)
Global – Replaced the (rare) "IPP function set" with "IPP conformance level" to avoid redundant terminology
Changed Abstract and Section 1 Introduction – edits for readability per Glen Petrie
Changed Section 2 Terminology – clarified definitions of IPP/2.0 and IPP/2.1 to note typical local versus central device management per Glen Petrie
Changed Section 3 Requirements – clarified context from PWG Process and added text to Section 3.1 Rationale
Changed Section 4 Required IPP Standards – minor editorial fixups
Changed Section 5 Required IPP Operations and Section 6 Required IPP Attributes – minor editorial fixups, alphabetize or downcase some attributes, and clarify text per Glen Petrie
Changed Section 7 Conformance Requirements – rewrote all requirements as numbered lists for clarity per Glen Petrie and IPP WG discussion
Changed Section 9 Internationalization Considerations – replaced ambiguous "NOTE WELL" with "WARNING" per Glen Petrie and IPP WG discussion
Changed Section 10 Security Considerations – spelled out TLS and rewrote first paragraph per Glen Petrie and IPP WG discussion

C. Changes made to create 24 January 2009 version
Changed document status from Prototype to Stable per IPP WG discussion
Moved Section 11 Required IPP Attributes to follow Section 5 Required IPP Operations per IPP WG discussion
Added media-color, media-key, media-size, and media-type to table in section 6.3 for IPP/2.1 per IPP WG discussion
Added notes about normative source of media-col [PWG5100.3] and selected REQUIRED attributes after table in Section 6.3 per IPP WG discussion

Improved all section titles (for conformance) in section 5 and section 6 for clarity

Deleted all references to Document Object [PWG5100.5] per Mike Sweet

Inserted page breaks at all major sections per Bill Wagner

D. Changes made to create 11 January 2009 version

Global – Corrected English usage and sentence structure throughout this specification

Global – Added "(Normative)" or "(Informative)" to each major section title for clarity

Global – Deleted all content for IPP/2.2 in all sections (to be added to a second edition of this specification) per discussion at PWG F2F in December 2008

Global – Corrected all normative keywords to uppercase (shall or must to MUST, should to SHOULD, may to MAY, required to REQUIRED, optional to OPTIONAL, etc.) per discussion at PWG F2F in December 2008

Global – Changed all "RFC 2911" to "[RFC2911]", etc., per comments from Bill Wagner

Global – Changed all "IPP printer" (lowercase) to "IPP Printer" (capitalized) per IPP standard naming conventions

Global – Changed all "current IPP specifications" to "[previous/original] IPP specifications" as appropriate (because, when approved, *this* document will be a current IPP spec)

Global – Deleted all references to PWG 5100.6 and PWG 5100.8 (only applicable to IPP/2.2, to be added to a second edition of this specification) per discussion at PWG F2F in December 2008

Global – Added requirements and references for [PWG5100.yy] (IPP PSX), per discussion at PWG F2F in December 2008

Cover Page – Changed document status from "Interim" to "Prototype" per PWG Process

Abstract – Clarified several sentences for accuracy

Section 1 – Clarified several sentences for accuracy

Section 6 – Added explicit normative conformance references to sections 5, 8, 9, and 11 per discussion at PWG F2F in December 2008

Section 11.3 – Added "printer-state-reasons" (new values), "printer-alert", and "printer-alert-description" to IPP/2.1 Required Attributes per discussion at PWG F2F in December 2008

E. Changes made to create 18 November 2008 version

Changed document filename per PWG naming conventions

Global - Changed "IPPv2.0" to "IPP/2.0", etc., per IPP standard naming conventions

Global - Many small editorial changes for readability and English usage

F. Changes made to create October 22, 2008 version

Section 6.1: Changed "1.2" to "2.1".

Section 11: Added "… and also provides a reference to the currently required version 1.1 attributes." Added an "Object" column to all tables in this section.

Section 11.2: Added "output-bin" entry.

Section 11.3: Added "output-device-assigned" and "printer-state-change-time"

Section 11.4: Added "copies-actual", "document-format-detected", "document-format-supplied", "document-message", "document-message-supplied", "document-name", "document-name-supplied", "finishings-actual", "job-hold-until-actual", "job-priority-actual", "job-sheets-actual", "media-actual", "media-col-actual", "multiple-document-handling-actual", "number-up-actual", "output-bin-actual", "orientation-requested-actual", "overrides-actual", "overrides-supported", "page-ranges-actual", "print-quality-actual", "printer-resolution-actual", and "sides-actual".

Section 11.4: Changed "2.1" to "2.2". Changed "document-job-url" to "document-job-uri".

G. Changes made to create October 10, 2008 version

Section 6.1: Added " Also, IPPv1.2 and IPP/2.2 must conform to the Job and Printer Administrative operations requirements, as specified in [RFC3998] section 11."

Section 7: Changed " ipp_versions_supported" to " ipp-versions-supported"
                        Changed "RFC EDITOR" to PWG Secretary"

Section 9: Revised to show requirements as a table. Restored requirements for IPP/1.1 removed in last update (9/29/2008)..

Section 11: Major changes

Section 11.1 changed to apply to IPP/1.1, text modified, no changes to table.

Section 11.2 New section for IPP/2.0.

Section 11.3 was 11.2, text modified and new entries added to table.

Section 11.4 was 11.3, text modified and new entries added to table.

H. Changes made to create September 29, 2008 version

Section 6: Moved 6.1 to 6.4, moved 6.2 to 6.3, added new sections 6.1 and 6.2

In 6.3 and 6.4, changed "current IPP" to "IPP/1.1".

Section 7: Replaced "this document" with "PWG 51XX.X" in three places. Added: " NOTE TO RFC EDITOR: When this document is published, replace 51XX.X with the PWG ISTO document number assigned to this specification."

Section 8: Replaced "For interoperability and basic support for multiple languages, IPP/1.1 conforming Printer implementations MUST support…"

With " IPP/1.1 [RFC2911] requires conforming Printer implementations to support…"

Section 9: Deleted " For interoperability and basic support for security, IPP/1.1 conforming Printer implementations SHOULD support TLS/1.0 [RFC2246] with a mandatory cipher suite of TLS_DHE_DSS_WITH_3DES_EDE_CBC_SHA."

Section 10.1: Reordered entries to maintain alphabetical/numeric order.

Section 11 Required Attributes: New section. Renumbered remaining sections

I. Changes made to create September 19, 2008 version

Section 7 Added:

The following new keyword values are defined for the ipp_versions_supported attribute [RFC2911]:

'2.0': Meets all the conformance requirements of IPP version 2.0, as specified in this document, in addition to the requirements for IPP/1.1 as specified in [RFC2911] [RFC2911] and RFC 2910 [RFC2910].

'2.1': Meets all the conformance requirements of IPP version 2.1, as specified in this document, in addition to the requirements for IPP 2.0 as specified above.

'2.2': Meets all the conformance requirements of IPP version 2.2, as specified in this document, in addition to the requirements for IPP 2.1 as specified above.

Section 8 Added:

For interoperability and basic support for multiple languages, IPP/1.1 conforming Printer implementations MUST support the UTF-8 [RFC3629] encoding of Unicode [UNICODE] [ISO10646].

For interoperability and best practice support for multiple languages, IPP/2.0 conforming Printer implementations SHOULD support Network Unicode [RFC5198] - which REQUIRES transmission of well-formed UTF-8 strings and RECOMMENDS transmission of normalized UTF-8 strings in Normalization Form C (NFC) [UAX15].

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

NOTE WELL - Performing normalization on UTF-8 strings received from IPP clients and subsequently storing the results (e.g., in IPP Job objects) could cause false negatives in IPP client searches and failed access (e.g., to IPP Printers with percent-encoded UTF-8 URIs now 'hidden').

Section 8 Removed:

In addition to the internationalization requirements in the referenced IPP specifications, it is strongly recommended the inclusion of Network Unicode [RFC5198] to provide support of multiple languages." Was " This document presents no internationalization considerations for IPP implementations beyond those covered in the referenced IPP Specifications."

Section 9 Added:

For interoperability and basic support for security, IPP/1.1 conforming Printer implementations SHOULD support TLS/1.0 [RFC2246] with a mandatory cipher suite of LS_DHE_DSS_WITH_3DES_EDE_CBC_SHA.

For interoperability and better support for security, IPP/2.0 conforming Printer implementations SHOULD support TLS/1.1 [RFC4346] with a mandatory cipher suite of TLS_RSA_WITH_3DES_EDE_CBC_SHA.

For interoperability and best practice for security, IPP/2.1 conforming Printer implementations SHOULD support TLS/1.2 [RFC5246] with a mandatory cipher suite of TLS_RSA_WITH_AES_128_CBC_SHA.

For interoperability and best practice for security, IPP/2.2 conforming Printer implementations MUST support TLS/1.2 [RFC5246] with a mandatory cipher suite of TLS_RSA_WITH_AES_128_CBC_SHA.

Section 10 Added:

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

[RFC2246] T.Dierks, C. Allen, "Transport Layer Security 1.0", RFC 2246, January 1999, http://www.ietf.org/rfc/rfc2246.txt

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

[RFC4346] T.Dierks, E. Rescorla, "Transport Layer Security 1.1", RFC 4346, April 2006, http://www.ietf.org/rfc/rfc4346.txt

[RFC5246] T.Dierks, E. Rescorla, "Transport Layer Security 1.2", RFC 5246, August 2008, http://www.ietf.org/rfc/rfc5246.txt

[UAX15] M. Davis, M. Duerst, "Unicode Normalization Forms", Unicode Standard Annex 15, March 2008, http://www.unicode.org/reports/tr15/

[UNICODE] M. Davis, et al, "Unicode Standard v5.1.0", Unicode Standard, April 2008, http://www.unicode.org/versions/Unicode5.1.0/

J. Changes made to create August 27, 2008 version.

Section 6.3: Removed entire section

Section 10: Removed references for [JFIF], [RFC2083], [PWG 5102.3], and [X-PRINT].

K. Changes made to create August 15, 2008 version.

Removed references to "Simple Workgroup Printer", "Enterprise Printer", and "Production Printer". Where appropriate these names were changed to "IPP/2.0", "IPP/2.1", and "IPP/2.2" respectively.

L. Changes made to create August 6, 2008 version.

Changed format of document location to conform to the PWG Process Specification.

Updated the Table Of Contents.

A global replacement of "Work Group" with "Workgroup".

Section 3 Added 3.1 Rational and 3.2 Use Models text.

Section 4.4 Added "[RFC3382] The 'collection' Attribute Syntax (September 2002)". Also, corrected publication dates for [RFC3380], [RFC3381], [RFC3996], and [RFC3998].

Section 5.2 Added " Note that a V2.0 implementation may also include support for additional IPP operations other than specified in this list."

Section 5.3 Added " Note that a V2.1 implementation may also include support for additional IPP operations other than specified in this list."

Section 6 Renamed "Conformance Requirements" was "IPPv2 Protocol Addenda"

Current text in section 6 added to Section 6.1

Section 6.1 " Many implementations historically have not conformed to this requirement, causing communication problems and failed printing." was " It has been reported that many implementations do not conform to this requirement, which can result in problems with the host side communication processes."

Section 6.1 Added to end of second paragraph "…, including collection attributes as defined in [RFC3382], section 7."

Section 6.1 Added third paragraph " For example, implementations MUST support reading the IPP noValue tag as a valid value for an attribute that normally would be encoded as an enum, integer, name, or keyword value tag. Similarly, implementations MUST correctly process (or ignore) collection values as defined by [RFC3382], even if the implementation does not support the media-col attribute itself."

Added Section 6.2 and 6.3.

Added Section 7 IANA and PWG Considerations (The remaining sections have been renumbered.)

Section 8 (was section 7): " In addition to the internationalization requirements in the referenced IPP specifications, it is strongly recommended the inclusion of Network Unicode [RFC5198] to provide support of multiple languages." Was " This document presents no internationalization considerations for IPP implementations beyond those covered in the referenced IPP Specifications."

Section 10: Added references for [JFIF], [RFC2083], [RFC2616], [RFC2817], [RFC5198], [PWG 5102.3], and [X-PRINT].

M. Changes made to create July 18, 2008 version.

Abstract: Added "queries to the IPP Printer." to complete the last sentence in the abstract.

Section 5.1: Removed "Create Job Subscriptions" (code = 0x0017) from table (an optional OP).

Section 5.2: Added all operations that are applicable to the specifications required for IPP/2.0.

Section 5.3: Added all operations that are applicable to the specifications required for IPP/2.1.

Section 5.4: Added all operations that are applicable to the specifications required for IPP/2.2.

Section 6: " are to be processed according to the defined procedures," was "are to be "gracefully" processed"

Section 6: " per [RFC2911], sections 3.1.7, 3.1.8, 3.2.1.2, 3.3.5.1, 3.3.7.1, 4.1.2.3, and 13.1.2.2." was "per (TBD add reference)."