A Project of the PWG IPPFAX Working Group

The IPPFAX/1.0 Protocol

IEEE-ISTO Printer Working Group

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Abstract

This document specifies the IPPFAX/1.0 protocol. The IPPFAX requirements [ifx-req] are derived from the requirements for Internet Fax [internet-fax-goals].

In summary, IPPFAX is used to provide a synchronous, reliable exchange of image Documents between clients and servers. The primary use envisaged of this protocol is to provide a synchronous image transmission service for the Internet. Contrast this with the Internet FAX protocol specified in [RFC2305] and [RFC2532] that uses the SMTP mail protocol as a transport.

The IPPFAX/1.0 protocol is a specialization of the IPP/1.1 [RFC2911], [RFC2910] protocol supporting a subset of the IPP operations with increased conformance requirements in some cases, some restrictions in other cases, and some additional REQUIRED attributes. The IPPFAX Protocol uses the 'ippfax' URL scheme (instead of the 'ipp' URL scheme) in all its operations. Most of the new attributes defined in this document MAY be supported by IPP Printers as OPTIONAL extensions to IPP as well. In addition, IPPFAX/1.0 REQUIRES the support of the IPP Event Notification mechanism [ipp-ntfy] using the 'ippget' Pull Delivery Method [~~ipp-~~get-method].

An IPPFAX Printer object is called a Receiver. A Receiver MUST support at least the ~~UIF~~PDFax ~~S~~F Profile as specified in [~~ifx-uif~~pdfax] which is defined for the '~~image/tiff~~application/pdf' document format MIME type [~~image-tiff~~pdf] and MAY support additional ~~UIF~~PDFax Profiles ~~for the 'image/tiff' and 'image/tiff-fx' [image-tiff-fx] document format MIME types~~. A Print System MAY be configured to support both the IPPFAX and IPP protocols concurrently, but each protocol requires separate Printer objects with distinct URLs.

ISSUE 01: Need to add IPPFAX Printer Description attributes for Amount of Receiver memory for JBIG2; REQUIRE Sender to query Receiver if going to exceed the maximum specified in [pdfax], say around 2M.

ISSUE 02: Add: Senders MUST NOT use OPTIONAL features, unless they have queried the Receiver using Get-Printer-Attributes and verified that the Receiver supports the OPTIONAL feature. Need to add Printer Description attributes to describe these OPTIONAL features.

ISSUE 03: Add: Receivers MUST NOT support any OPTIONAL features, unless the protocol has a way to indicate that support to the Sender.

ISSUE 04: Clarify that support of the 'pdfax-c' requires color, while the 'pdfax-cg' is just gray scale. Same for 'pdfax-d'. What about 'pdfax-m? A Sender MUST NOT send a color document to a 'pdfax-cg' Receiver, unless the Sending User has been explicitly notified.

This document is a draft of an IEEE-ISTO PWG Proposed Standard and is in full conformance with all provisions of the PWG Process (see: ftp://ftp.pwg.org/pub/pwg/general/pwg-process.pdf). PWG Proposed Standards are working documents of the IEEE-ISTO PWG and its working groups. The list of current PWG projects and drafts can be obtained at http://www.pwg.org.

When approved as a PWG standard, this document will be available from:
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1 Introduction

This document specifies the IPPFAX/1.0 protocol. The IPPFAX requirements [ifx-req] are derived from the requirements for Internet Fax [internet-fax-goals].

In summary IPPFAX is used to provide a synchronous, reliable exchange of image documents between clients and servers. The primary use envisaged of this protocol is to provide a synchronous image transmission service for the Internet. Contrast this with the Internet FAX protocol specified in [RFC2305] and [RFC2532] that uses the SMTP mail protocol as a transport.

IPPFAX is primarily intended as a method of supporting a synchronous, secure, high quality document distribution protocol over the Internet. It therefore discusses paper, pages, scanning and printing, etc. There is, however, no requirement that the input documents comes from actual paper nor is there a requirement that the output of the process be printed paper. The only conformance requirements are those associated with the exchange of data over the network.

The IPPFAX/1.0 protocol is a specialization of the IPP/1.1 [RFC2911], [RFC2910] protocol supporting a subset of the IPP operations with increased conformance requirements in some cases, some restrictions in other cases, and some additional REQUIRED attributes. The IPPFAX Protocol uses the 'ippfax' URL scheme (instead of the 'ipp' URL scheme) for all operations. Most of the new attributes defined in this document MAY be supported by IPP Printers as OPTIONAL extensions to IPP as well. Only the attributes defined in this document that start with the "ippfax-" prefix MUST NOT be used in the IPP Protocol (see section 1.3). In addition, IPPFAX/1.0 REQUIRES the support of the IPP Event Notification mechanism [ipp-ntfy] using the 'ippget' Pull Delivery Method [~~ipp-~~get-method]. See section 20 for a comparison of IPP and IPPFAX.

An IPPFAX Printer object is called a Receiver. A Receiver MUST support at least the ~~UIF~~PDFax ~~(Universal Image Format) S~~F Profile [~~ifx-uif~~pdfax] ~~which is defined for the 'image/tiff' document format MIME type [image-tiff]~~ and MAY support additional ~~UIF~~PDFax Profiles ~~for the 'image/tiff' and 'image/tiff-fx' [image-tiff-fx] document format MIME types~~. A Print System MAY be configured to support both the IPPFAX and IPP protocols concurrently for a single output device (or multiple output devices), but each protocol requires separate Printer objects with distinct URLs. Note - It is assumed that the reader is familiar with IPP/1.1 [RFC2911], [RFC2910], [RFC3196], and [ipp-iig-bis]. See section 23.

An IPPFAX client is called a Sender. The user of the Sender is called the Sending User. The Sending User either (1a) loads the Document into the Sender or (1b) causes the Sender to generate the Document data by means outside the scope of this standard, (2) indicates the Receiver's network location, and (3) starts the exchange.

1.1 Operations used

For each IPPFAX Job, the Sender sends at least the following operations to the Receiver in the following order:

1. Get-Printer-Attributes - Sender MUST verify that the Printer object is an (IPPFAX) Receiver and SHOULD determine some of the Receiver's basic capabilities, such as ~~UIF~~PDFax profiles supported.

2. Validate-Job - Sender MUST verify that the Receiver can support the Job attributes that the Sender will send in the IPPFAX Job.

3. Print-Job - Sender MUST submit the IPPFAX job with a single document (or MAY send Create-Job & one or more Send-Document operations if the Receiver also supports these operations)

4. Get-Notifications - The Sender MUST support and MUST use this operation to check for successful job completion unless the Sending User wishes otherwise.

1.2 Typical exchange

This section lists a typical exchange of information between a Sender and a Receiver using the four operations listed in section 1.1.

1. The Sending User determines the network location of the Receiver (value of the "printer-uri" operation attribute) – see section 4.1. This document does not specify how the Sending User does this. Possible methods include directory lookup, search engines, business cards, network enumeration protocols such as SLP, etc. See section 22 for the Generic Directory Schema for IPPFAX.

2. The Sending User either (1) loads the Document into the Sender or (2) causes the Sender to generate the Document data by means outside the scope of this document, indicates the Receiver's network location and starts the exchange.

3. The Sender MUST validate whether or not the Receiver is an IPPFAX-capable Printer and SHOULD determine the basic capabilities of the Receiver, including document format, profiles, and profile extensions – see section 7.1.

4. The Sender decides on the most appropriate data format depending on the Receiver's basic capabilities. The ~~UIF~~PDFax data formats and profiles are described in detail in ~~the~~ "~~Universal Image Format~~The Printer Working Group Standard for PDF FAX Format (~~UIF~~PDFax)" specification [~~ifx-uif~~pdfax].

5. The Sender MUST validate whether or not the Receiver will accept all of the attributes of the IPPFAX Job from this Sending User using the Validate-Job operation. See section 7.2. If the Receiver rejects the Validate-Job operation, the Sender can avoid sending the data.

6. The Sender either (1) scans the Document and converts it into an acceptable data format or (2) generates or forwards the Document representation in an acceptable data format – see section 6.6.

7. As part of the Validation and Job Creation, the following identities are determined and exchanged: Sender, Sending User, Receiver, and Receiving User – see section 8.

8. The Sender transmits the Document data to the Receiver – see section 9.

9. The Sending User receives a confirmation that the Receiver received the Document data – see section 9.4.

10. In addition the Sender MUST support and the Sending User MAY choose to receive an Event Notification that the Document has been successfully Delivered – see sections 9.3 and 9.6

If the Sender is unable to initiate or complete the exchange then it is assumed that the Sender will perform some form of retry. The mechanisms used and the user-visible behavior in this case is an implementer's choice and beyond the scope of this document.

1.3 Namespace used for attributes

Most of the new attributes defined in this document are intended to be used by both the IPP and IPPFAX protocols. As such, these attributes have neither the "ipp-" nor the "ippfax-" prefix in their names. The few attributes that are intended only for use in the IPPFAX protocol start with the "ippfax-" prefix in order to indicate their limited scope of usage. Such attributes (e.g., "ippfax-versions-supported") MUST NOT be supported by the IPP Protocol, i.e., MUST NOT be supported by IPP Printer objects.

On the other hand, unless explicitly specified otherwise, all existing IPP attributes, including future IPP extensions, apply to the IPPFAX Protocol as well, including attributes which have an "ipp-" prefix. For example, the IPP/1.1 "ipp-attribute-fidelity" operation attribute (see [RFC2911] section 3.2.1.1 and 3.2.1.2) and the IPP/1.1 "ipp-versions-supported" Printer Description attribute (see [RFC2911] section 4.4.14) are also used in the IPPFAX protocol, even though they have the "ipp-" prefix.

2 Terminology

This section defines the following additional terms that are used throughout this standard.

2.1 Conformance Terminology

Capitalized terms, such as **MUST, MUST NOT, REQUIRED, SHOULD, SHOULD NOT, MAY, NEED NOT,** and **OPTIONAL**, have special meaning relating to conformance to this specification. These terms are defined in [RFC2911] section 13.1 on conformance terminology, most of which is taken from RFC 2119 [RFC2119]. In order to help the reader compare and contrast the IPP and IPPFAX protocols, this document uses lower case "must", "may" etc., to reproduce IPP Protocol conformance requirements for

IPP clients and IPP Printer objects as stated in other documents. If such reproduction in this document contradicts an IPP document, it is a mistake, and that IPP document prevails.

2.2 Other Terminology

This standard defines a logical model of an IPPFAX interchange. The following terms are introduced and capitalized in order to indicate their specific meaning:

IPP Protocol The protocol defined in [RFC2911] and [RFC2910] and any IPP Protocol Extension document (see section 18). For the IPP/1.1 Protocol each operation request must use the 'ipp' URL scheme.

IPPFAX Protocol The protocol defined in this or a future revision document and any future extension document. For the IPPFAX Protocol each operation request MUST use the 'ippfax' URL scheme (see section 4.1 and 16). Unless a specific version number is appended to "IPPFAX", such as "IPPFAX/1.0", the term IPPFAX applies to all versions.

Printer object (or Printer) A hardware or software entity that accepts protocol operation requests and returns protocol responses. A Printer object MAY be: (1) an IPP Printer object or (2) an IPPFAX Printer object, DEPENDING ON IMPLEMENTATION (see section 3.3), but MUST NOT be both (since they support some different operations and attributes and are really two different kinds of Print Services). A Printer object MAY support multiple URLs with different security, authentication, and/or access control (see [RFC2911] sections 4.4.1, 4.4.2, 4.4.3, and 8). However, each URL for a Printer object MUST support the same operations and attributes with the same values, except as restricted depending on the security, authentication, and/or access control implied by the URL. In other words, each URL for a given Printer object is offering the same Print Service.

> Note: For brevity, this document uses the term "Receiver" instead of "IPPFAX Printer object". This document uses the term "Printer object" (and "Printer") when the statement is intended to apply to a Printer object that MAY support the IPP Protocol or the IPPFAX protocol (but not both).

Print Service The print functionality offered by a Printer object. Several different Printer objects MAY offer the same Print Service.

IPP Printer object A Printer object that supports the IPP Protocol and offers the IPP Print Service (by definition).

Receiver The Printer object that accepts IPPFAX protocol operations and receives the Document sent by the Sender. A Receiver offers the IPPFAX Print Service (by definition).

Print System All of the Printer objects on a single managed host network node. A Print System MAY support IPP and IPPFAX protocols concurrently (see section 3.3) for a single output device (or multiple output devices), but each protocol requires separate Printer objects with distinct URLs.

client A hardware and/or software entity that initiates protocol operation requests and accepts responses. A client MAY be: (1) an IPP client, (2) an IPPFAX client, or (3) both. However, this document uses the

term “Sender”, instead of “IPPFAX client”. This document uses the term “client” when the statement is intended to apply to a client that MAY support the IPP Protocol, the IPPFAX protocol, or both protocols.

IPP client A client that uses the IPP Protocol to interact with an IPP Printer object.

Sender A client that uses the IPPFAX Protocol to query a Receiver and transmit a Document to that Receiver.

Document The electronic representation of a set of one or more pages that the Sender sends to the Receiver.

Sending User The person interacting with the Sender.

Receiving User The intended human recipient of the Document being sent by the Sender to the Receiver.

Attribute Coloring The changing of attributes and/or values returned by a single Printer object in a Get-Printer-Attributes response depending on operation attributes supplied in the request, specifically the “document-format” (see section 5.1 and [RFC2911] section 3.2.5.1) and “~~uif~~pdfax-profile-requested” operation attributes.

Job Creation Operation The IPP or IPPFAX operations that creates IPP or IPPFAX Jobs, respectively, i.e., the Print-Job, Print-URI, and Create-Job operations (see [RFC2911]).

IPP Job A job submitted by an IPP client to an IPP Printer object using the IPP Protocol.

IPPFAX Job A job submitted by a Sender to a Receiver using the IPPFAX Protocol.

~~**TIFF** The Tag Image File Format defined by [TIFF] and identified by the ‘image/tiff’ MIME Media type (see [image-tiff]).~~

~~**TIFF-FX** The file format defined in [RFC2301], [tiff-fx], and [tiff-fx-ext1] as extensions to [TIFF] commonly known as TIFF-FX and identified by the ‘image/tiff-fx’ MIME Media type (see [image-tiff-fx]). [RFC2301] formally defines minimal, extended and lossless JBIG modes (Profiles S, F, J) for black-and-white fax, and base JPEG, lossless JBIG and Mixed Raster Content modes (Profiles C, L, M) for color and grayscale fax. These modes or profiles correspond to the content of the applicable ITU-T Recommendations (see the References section in [ifx-uif]).~~

Portable Document Format (PDF) The file format defined in [pdf].

~~**UIF**~~**PDFax** ~~**Profile (Universal Image Format Profile)**~~ A subset of PDF [pdf] and a ~~The~~ set of ~~TIFF-FX~~ PDF profiles that permit serialized generation of the PDF document. This subset of PDF is defined in “The Printer Working Group Standard for PDF FAX Format (PDFax)” ~~with higher conformance requirements and relaxed constraints for improved quality~~ (see [~~ifx-uif~~pdfax]).

Delivered The Receiver has either printed the Document and delivered the last sheet to the output bin or has forwarded the Document to some other system.

The terminology defined in [RFC2911], such as **attribute**, **operation**, **request**, **response**, **operation attribute**, **Printer Description attribute**, **Job Description attribute, integrity, and privacy** is also used in this document with the same capitalization conventions and semantics.

The terminology defined in the IPP "Event Notifications and Subscriptions" specification [ipp-ntfy] and "The 'ippget' Delivery Method for Event Notifications" specification [~~ipp-~~get-method], such as **Event Notification**, **Event**, **Subscription Object**, **Per-Job Subscription**, **Per-Printer Subscription**, **Push Delivery Method**, and **Pull Delivery Method** is also used in this document with the same capitalization conventions and semantics.

3 IPPFAX Model

This sub-section defines the IPPFAX Model and its relationship to the IPP Protocol and Model.

3.1 Printer Object Relationships

A Print System MAY support one or more Printer objects on a single network host. RFC 2911 [RFC2911] defines the relationship between Printer objects and output devices to be many to many (see [RFC2911] section 2.1). So one Printer object can represent one or more output devices and an output device can be represented by one or more Printer objects. The same relationships hold for the IPPFAX Protocol so that the relationship between Receivers and output devices is many to many.

3.2 A Printer object with multiple URLs

For a Printer object that has multiple URLs, the multiple URLs MUST only be aliases for the Printer object, not connections to different Print Services. In other words, the semantics of operations and attributes accessed by the different URLs for a given Printer object MUST differ only in the security, authentication, and/or access control depending on the URL used.

The three parallel "printer-uri-supported" (1setOf uri), "uri-authentication-supported" (1setOf type2 keyword), and "uri-security-supported" (1setOf type2 keyword) Printer Description attributes (see [RFC2911] sections 4.4.1, 4.4.2, and 4.4.3, respectively) MUST contain the URLs, authentication, and security, respectively, supported by the Printer object. See also the OPTIONAL "printer-xri-supported" (collection) Printer Description attribute [RFC3380], which, if supported, MUST be used to set these three parallel attributes using the protocol.

Note: For a Printer object that supports multiple URLs, neither the IPP/1.1 protocol nor the IPPFAX/1.0 protocol provides a way for the administrator to Set or Get the values of Printer attributes whose values MAY depend on the URL used and/or MAY depend on the authenticated role of the requesting user. So, for example, there is no way to set the differing values of the "operations-supported" Printer attribute (see section 6.5) that depend on the URL using the IPP or IPPFAX protocol. Providing such means is left for future work as a single specification for use by both IPP and IPPFAX.

3.3 A Print System supporting both IPP and IPPFAX protocols

From section 3.2, if a Print System supports both IPP and IPPFAX, it MUST do so with separate Printer objects, not with a single Printer object with IPP and IPPFAX URLs. Each such Printer object MUST support either IPP or IPPFAX, but not both. In other words, each URL for a Printer object MUST have the same scheme, namely, 'ipp' or 'ippfax', i.e., MUST NOT have some URLs with the 'ipp' scheme and other URLs with the 'ippfax' scheme. The reason for this requirement for separate Printer objects for IPP and IPPFAX is because a URL and its Printer object is intended to represent a network resource offering a particular type of service, not several different types of services.

Note: it is possible to support IPP and IPPFAX Printer objects with a single piece of code in a Print System with conditional branching to handle the differences in conformance requirements between IPP and IPPFAX. For example, such conditional branching could depend on the "printer-uri" operation attribute supplied by the client in each request to the Print System. See section 20 for a comparison of IPP/1.1 and IPPFAX/1.0.

4 Common IPPFAX Operation Attribute Semantics

This section describes the IPPFAX/1.0 operation attribute semantics that are common to all operations. IPPFAX/1.0 does not define any new operations. Instead, IPPFAX/1.0 semantics are provided using existing IPP operations [RFC2911], [ipp-ntfy], [~~ipp-~~get-method], [RFC3380], etc. with increased conformance requirements as specified in this document.

4.1 printer-uri (uri) operation attribute ([RFC2911] section 3.1.5)

This operation attribute specifies the transfer path to the Receiver for the operation. As in IPP/1.1, the client MUST supply the "printer-uri" operation attribute in every IPPFAX request (see [RFC2911] section 3.1.5). For IPPFAX, the attribute value MUST be a URL using the 'ippfax' scheme (see section 16) specifying the Receiver's network location.

The following is an example value of the target "printer-uri" operation attribute and "printer-uri-supported" Printer Description attribute:

ippfax://www.acme.com/ippfax-printers/printer5

As in all URLs, the scheme identifies the protocol. For example, if a client supports both the IPP and IPPFAX protocols, then the URL scheme in the "printer-uri" operation attribute that the client supplies indicates the protocol and determines whether the client intends the Print System to use IPP or IPPFAX semantics. Similarly, if a Print System supports both the IPP and IPPFAX protocols, then the URL scheme in the target "printer-uri" operation attribute that the client supplies MUST determine the protocol, the Printer object, and the semantics that the Print System performs.

As in IPP/1.1 [RFC2911] for each operation, the Receiver NEED NOT validate that the "printer-uri" operation attribute is present and that the value supplied by the Sender matches one of the Receiver's "printer-uri-supported" Printer Description attribute (see section 6.1). For URI matching rules see section

16.7. If the Receiver does validate the “printer-uri” operation attribute and the URI value supplied does not match any value of the Receiver’s “printer-uri-supported” Printer Description attribute, the Receiver MUST reject the request, return the ‘client-error-attributes-or-values-not-supported’ status code, and return the attribute and value in the Unsupported Attributes Group.

4.2 version-number parameter ([RFC2911] section 3.1.8)

This IPP/1.1 operation parameter ([RFC2911] section 3.1.8) specifies the major and minor version number of the IPP Protocol being used *as part of the IPPFAX Protocol*. As in IPP/1.1, the Sender MUST supply this parameter in every request and the Receiver MUST return this parameter in every response.

For IPPFAX version 1.0 as specified in this document, the value of the IPP “version-number” parameter MUST be ‘1.1’ or a higher minor version number. The value is represented as 0x0101 (see [RFC2910]) where the major version number comes first (so-called “network byte order”).

If the Receiver does not support the supplied IPP major version *as part of the IPPFAX protocol*, the Receiver MUST respond as specified in [RFC2911] section 3.1.8 with the ‘server-error-version-not-supported’ status code. As in IPP/1.1, if the major version number is supported, but the minor version number is not, the Receiver SHOULD accept and attempt to perform the request (or reject the request if the operation is not supported), else the Receiver MUST reject the request and returns the ‘server-error-version-not-supported’ status code. In all cases as in IPP/1.1, the Receiver MUST return the “version-number” parameter with the value that it supports that is closest to the version number supplied by the client in the “version-number” parameter in the request.

4.3 ippfax-version-number (type2 keyword) operation attribute

The value of this operation attribute indicates the version of the IPPFAX Protocol and encoding that the Sender is requesting and the Receiver is returning. The Sender MUST supply this operation attribute in every request and the Receiver MUST return this operation attribute in every response. This operation attribute MUST be placed in the Operation Attributes Group *immediately* after the operation attributes whose order is specified in IPP/1.1 [RFC2911]. The semantics of the “ippfax-version-number” operation attribute serves the same purpose for the IPPFAX Protocol as the IPP/1.1 “version-number” parameter serves for the IPP Protocol (see [RFC2911] section 3.1.8).

If the Sender does not supply this attribute, the Receiver MUST reject the operation, MUST return the ‘client-error-bad-request’ status code, and SHOULD return the ‘ippfax-version-number’ attribute name keyword in the Unsupported Attributes Group (see section 14.1).

For IPPFAX version 1.0 as specified in this document, the value of the “ippfax-version-number” operation attribute MUST be ‘1.0’ keyword value. By including an IPPFAX version number in the client request, it allows the Sender to identify which version of IPPFAX the Sender is requesting to be used, i.e., the version whose conformance requirements the Sender may be depending upon the Receiver to meet.

The Receiver MUST indicate the IPPFAX versions supported using the “ippfax-versions-supported” (1setOf type2 keyword) Printer Description attribute (see section 6.3).

As in IPP/1.1, if the Receiver does not support the major version number supplied by the Sender, i.e., the major version field of the "ippfax-version-number" operation attribute does not match any of the values of the Printer's "ippfax-versions-supported" (see section 6.3), the Receiver MUST respond with a status code of 'server-error-version-not-supported' along with the closest version number that is supported (see [RFC2911] section 13.1.5.4). If the major version number is supported, but the minor version number is not, the Receiver SHOULD accept and attempt to perform the request (or reject the request if the operation is not supported), else it rejects the request and returns the 'server-error-version-not-supported' status code. In all cases, the Receiver MUST return the "ippfax-version-number" operation attribute in the response with the value that it supports that is closest to the version number supplied by the Sender in the request.

There is no version negotiation per se. However, if after receiving a 'server-error-version-not-supported' status code from a Receiver, a Sender SHOULD try again with a different version number. A Sender MAY also determine the versions supported either from a directory (see section 22) or by querying the Printer object's "ipp-versions-supported" (see section 6.2) and "ippfax-versions-supported" attributes (see section 6.3) to determine which IPP and IPPFAX versions are supported, respectively, as part of IPPFAX.

The Sender MUST send and the Receiver MUST check both the IPP (see section 4.2) and IPPFAX version numbers supplied by the Sender in each request, not just the IPPFAX version number.

5 Get-Printer-Attributes operation semantics

The Receiver MUST support the Get-Printer-Attributes operation as defined in [RFC2911] as extended by the semantics defined in this section.

5.1 document-format (mimeMediaType) operation attribute ([RFC2911] section 3.2.5.1)

This operation attribute identifies the document-format for which the Receiver MUST return the supported values of the requested attributes. The semantics of this Get-Printer-Attributes operation attribute is the same as for IPP ([RFC2911] section 3.2.5), with the following conformance requirement changes:

1. The Sender SHOULD supply the "document-format" operation attribute (IPP client may).
2. The Receiver MUST perform Attribute Coloring for the requested (or defaulted) document format (IPP Printer may).
3. Standard mimeMediaType values are defined in section 6.6.

5.2 ~~uif~~pdfax-profile-requested (type2 keyword) operation attribute

This operation attribute specifies one ~~UIF~~PDFax Profile (see [~~ifx-uif~~pdfax]). The Sender SHOULD supply the "~~uif~~pdfax-profile-requested" operation attribute in the Get-Printer-Attributes request if the document-format supplied is ~~either~~ '~~image/tiff~~application/pdf' [~~image-tiff~~pdf] ~~or 'image/tiff-fx' [image-tiff-fx]~~. The Receiver MUST support this operation attribute in a Get-Printer-Attributes operation.

If the ~~UIF~~PDFax Profile supplied by the Sender is not supported (value not contained in the Receiver's "~~uif~~pdfax-profiles-supported" Printer Description attribute - see section 6.7), the Receiver MUST reject the operation and return the 'client-error-document-format-not-supported' status code.

The Receiver MUST perform Attribute Coloring for the attributes returned as indicated in Table 1 and Table 2 depending on the value of the "document-format" and "~~uif~~pdfax-profile-requested" operation attributes supplied by the Sender in the Get-Printer-Attributes request.

If the Sender omits this attribute, the Receiver responds as if the Sender had supplied the ~~UIF~~PDFax ~~S~~F Profile (keyword value '~~uif~~pdfax-f~~s~~') that is REQUIRED for all Receivers to support and performs Attribute Coloring for that profile. Note: There is no "~~uif~~pdfax-profile-default" attribute defined for Get-Printer-Attributes (or for Job Creation operations).

Standard keyword values are defined in section 6.7.

6 IPPFAX Printer Description Attributes

This section defines the IPPFAX Printer Description attributes and the IPP Printer Description attributes whose semantics are augmented for IPPFAX.

Table 1 lists all the IPPFAX conformance requirements for IPP and IPPFAX Printer Description attributes whose semantics are defined in this document. The Receiver conformance requirements for Attribute Coloring in the Get-Printer-Attributes response that depends on the "document-format" and "~~uif~~pdfax-profile-requested" operation attribute values supplied by the client is indicated in the column labeled "Attribute Coloring".

Table 2 lists the other Printer Description attributes defined in IPP/1.1 [RFC2911] or IPP Notifications [ipp-ntfy] that are not in Table 1. The Printer Description attributes in Table 2 have the same conformance requirements as in [RFC2911] and [ipp-ntfy], as shown in Table 2. Any other Printer Description attributes defined in other documents are OPTIONAL for IPPFAX.

See section 9.2 for the Receiver conformance requirements for the "xxx-supported", "xxx-default", and "xxx-ready" Job Template Printer attributes.

Table 1 - Printer Description attributes conformance requirements

Attribute Name (attribute syntax)	IPP Printer support	Receiver support	Receiver Attribute Coloring	Section
printer-uri-supported (1setOf uri) *	must	MUST	MUST NOT	6.1, 8.4
ipp-versions-supported (1setOf type2 keyword) *	must	MUST**	MUST NOT	6.2
ippfax-versions-supported (1setOf type2 keyword)	MUST NOT	MUST**	MUST NOT	6.3
printer-is-accepting-jobs (boolean) *	must	MUST	MUST NOT	6.4
operations-supported (1setOf type2 enum) *	must	MUST	MUST NOT	6.5
document-format-supported (1setOf mimeMediaType) *	must	MUST	MUST NOT	6.6
~~uif~~pdfax-profiles-supported (1setOf type2 keyword)	may	MUST	MUST	6.7
~~uif~~pdfax-profile-capabilities (1setOf text(MAX))	may	MUST	MUST	6.8

* These IPP/1.1 attributes are defined in [RFC2911], but have enhanced semantics defined in this document.

** A Printer object that supports IPPFAX MUST NOT support IPP as well, but MUST support the "ipp-versions-supported" attribute to indicate the version(s) of IPP that are supported *as part of IPPFAX operations*. A Print System that supports both IPP and IPPFAX MUST support them as separate Printer objects (see section 3.3).

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523 **Table 2 - Additional Printer Description attributes conformance requirements**

Attribute Name (attribute syntax)	IPP Printer support	Receiver support	Receiver Attribute Coloring	Spec
uri-authentication-supported (1setOf type2 keyword)	must	MUST	MUST NOT	[RFC2911]
uri-security-supported (1setOf type2 keyword)	must	MUST	MUST NOT	[RFC2911]
printer-name (name(127))	must	MUST	MUST NOT	[RFC2911]
printer-location (text(127))	may	MAY	MUST NOT	[RFC2911]
printer-info (text(127))	may	MAY	MUST NOT	[RFC2911]
printer-more-info (uri)	may	MAY	MUST NOT	[RFC2911]
printer-driver-installer (uri)	may	MAY	MAY	[RFC2911]
printer-make-and-model (text(127))	may	MAY	MUST NOT	[RFC2911]
printer-more-info-manufacturer (uri)	may	MAY	MUST NOT	[RFC2911]
printer-state (type1 enum)	must	MUST	MUST NOT	[RFC2911]
printer-state-reasons (1setOf type2 keyword)	must	MUST	MUST NOT	[RFC2911]
printer-state-message (text(MAX))	may	MAY	MUST NOT	[RFC2911]
multiple-document-jobs-supported (boolean)	may	MAY	MUST NOT	[RFC2911]
charset-configured (charset)	must	MUST	MUST NOT	[RFC2911]
charset-supported (1setOf charset)	must	MUST	MUST NOT	[RFC2911]
natural-language-configured (naturalLanguage)	must	MUST	MUST NOT	[RFC2911]
generated-natural-language-supported (1setOf naturalLanguage)	must	MUST	MUST NOT	[RFC2911]
document-format-default (mimeMediaType)	must	MUST	MUST NOT	[RFC2911]
queued-job-count (integer(0:MAX))	must	MUST	MUST NOT	[RFC2911]
printer-message-from-operator (text(127))	may	MAY	MUST NOT	[RFC2911]
color-supported (boolean)	may	MAY	MAY	[RFC2911]
reference-uri-schemes-supported (1setOf uriScheme)	may	MAY	MAY	[RFC2911]
pdl-override-supported (type2 keyword)	must	MUST	MAY	[RFC2911]
printer-up-time (integer(1:MAX))	must	MUST	MUST NOT	[RFC2911]
printer-current-time (dateTime)	may	MAY	MUST NOT	[RFC2911]
multiple-operation-time-out (integer(1:MAX))	may	MAY	MUST NOT	[RFC2911]
compression-supported (1setOf type3 keyword)	must	MUST	MAY	[RFC2911]
job-k-octets-supported (rangeOfInteger(0:MAX))	may	MAY	MAY	[RFC2911]
job-impressions-supported (rangeOfInteger(0:MAX))	may	MAY	MAY	[RFC2911]
job-media-sheets-supported (rangeOfInteger(0:MAX))	may	MAY	MAY	[RFC2911]
pages-per-minute (integer(0:MAX))	may	MAY	MUST NOT	[RFC2911]
pages-per-minute-color (integer(0:MAX))	may	MAY	MUST NOT	[RFC2911]
printer-state-change-time (integer(1:MAX))	may	MAY	MUST NOT	[ipp-ntfy]
printer-state-change-date-time (dateTime)	may	MAY	MUST NOT	[ipp-ntfy]

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6.1 printer-uri-supported (1setOf uri) ([RFC 2911] section 4.4.1)

This attribute contains the set of target URIs that the Receiver supports, i.e., the URI values that a client can supply as values of the "printer-uri" target operation attribute in requests. As in IPP/1.1, the Receiver MUST support this Printer Description attribute (see [RFC2911] section 4.4.1). However, a single Printer object MUST NOT support both 'ipp' and 'ippfax' schemed URIs. Therefore, the schemes MUST all be 'ipp' or all 'ippfax'. In order for a Print System to support both IPP and IPPFAX, it MUST use separate Printer objects (see section 3.3).

If a Print System supports both the IPP and IPPFAX protocols, it is RECOMMENDED that the Print System support Printer objects whose target URIs differ only in the scheme. Then a client that queries the "printer-uri-supported" attribute of one of the Printer objects with one of these two protocols, can query the same Print System with the other protocol just by changing the scheme to see if the other protocol is supported (as a separate Printer object).

The Receiver MUST support the 'ippfax' URL scheme (see section 16) and only the 'ippfax' URL scheme for this attribute (see section 3.3).

6.2 ipp-versions-supported (1setOf type2 keyword) ([RFC2911] section 4.4.14)

This attribute identifies the version or versions of the IPP Protocol that this Receiver supports as part of the IPPFAX Protocol (rather than indicating that the Receiver supports the IPP Protocol), including major and minor versions, i.e., the version numbers for which this Receiver meets the conformance requirements. The Receiver MUST support this Printer Description attribute. The Receiver MUST compare the "version-number" parameter (see section 4.2), with the values of this attribute in order to determine whether the Printer supports the IPP version requested by the Sender *as part of the IPPFAX Protocol*.

Standard keyword values are (from [RFC2911]:

'1.1': The "IPP part" of the IPPFAX operations meets the protocol and encoding conformance requirements of IPP version 1.1 as specified in [RFC2911], [RFC2910], and IPP extensions.

Note: As in [RFC2911] section 4.4.14, these version keyword values violate the syntax for keywords, by starting with an ASCII digit, instead of an ASCII lower case letter.

6.3 ippfax-versions-supported (1setOf type2 keyword)

This attribute identifies the version or versions of the IPPFAX Protocol that this Receiver supports, including major and minor versions, i.e., the version numbers for which this Receiver meets the conformance requirements. The support of this attribute indicates that this Printer object is a Receiver as opposed to an IPP Printer object. The Receiver MUST support this Printer Description attribute. An IPP Printer object MUST NOT support this attribute, since a Printer object MUST NOT support both IPP and IPPFAX (see section 3.3).

The Receiver MUST compare the “ippfax-version-number” operation attribute (see section 4.3) supplied by the Sender in each request, with the values of this attribute in order to determine whether the Receiver supports the IPPFAX version requested by the Sender.

Since a Printer object MUST NOT support both the IPP and IPPFAX protocols, there is no ambiguity with requiring a Receiver to support both the “ipp-versions-supported” and “ippfax-versions-supported” Printer Description attributes (see sections 6.2 and 6.3). If a Printer object supports the “ipp-versions-supported” attribute, but not the “ippfax-versions-supported” attribute, then by definition that Printer object supports the IPP Protocol. If a Printer object supports the “ippfax-versions-supported” Printer Description attribute, then by definition that Printer object is a Receiver and supports the IPPFAX Protocol and not the IPP Protocol. For such a Printer object, the “ipp-versions-supported” attribute indicates the versions of IPP that it supports *as part of IPPFAX operations*, rather than indicating that it supports the IPP Protocol (by itself).

Standard keyword values are:

‘1.0’: Meets the conformance requirements of IPPFAX version 1.0 as specified in this document.

Note: As in [RFC2911] section 4.4.14, these version keyword values violate the syntax for keywords, by starting with an ASCII digit, instead of an ASCII lower case letter. However, for consistency with IPP, these IPPFAX version keyword values are defined compatibly with the IPP version keyword values.

6.4 printer-is-accepting-jobs (boolean) ([RFC 2911] section 4.4.23)

This attribute indicates whether or not the Receiver is currently accepting (IPPFAX) Job Creation requests. As in IPP/1.1, the Receiver MUST support this Printer Description attribute (see [RFC2911] section 4.4.23).

See section 10.4 for a discussion of how the Enable-Printer and Disable-Printer administrative operations, if implemented, affect the value of this attribute.

6.5 operations-supported (1setOf type2 enum) ([RFC 2911] section 4.4.15)

This attribute identifies the set of supported operations for this Receiver and contained Job objects. As in IPP/1.1, the Receiver MUST support this Printer Description attribute (see [RFC2911] section 4.4.15).

The values of this attribute MAY depend on the URL supplied in the “printer-uri” operation attribute and/or MAY depend on the authority of the authenticated requesting user. For example, a Receiver the supports administrative operations MUST NOT support administrative operations for use by end users, but such a Receiver MAY return the administrative operation enums to end users. For example, if an end user queries a Printer that supports the Disable-Printer administrative operation, it MAY either (1) return the Disable-Printer enum or (2) use Attribute Coloring and not return the Disable-Printer enum to the end user. In either case, if an administrator queries the same Printer, it MUST return the Disable-Printer enum.

6.6 document-format-supported (1setOf mimeMediaType) ([RFC 2911] section 4.4.22)

This attribute identifies which document formats the Receiver supports. As in IPP/1.1, the Receiver MUST support this Printer Description attribute (see [RFC2911] section 4.4.22).

Since most document formats don't give the "blind interchange" guarantee of document presentation fidelity for all implementations and configurations, the IPPFAX document formats supported MUST be a subset of the IPP document formats supported.

Standard mimeMediaType values for IPPFAX jobs include:

Table 3 - Document Format MIME Media Types

mimeMediaType	Description	Sender support	Receiver support
~~image/tiff~~application/pdf [~~image-tiff~~pdf]	~~TIFF format [TIFF]~~Portable Document Format, PDFax subset	MUST	MUST
~~image/tiff-fx [image-tiff-fx]~~	~~TIFF-FX format [tiff-fx], [tiff-fx-ext1]~~	~~MAY~~	~~MAY~~
application/octet-stream	auto-sensing ([RFC2911] section 4.1.9.1)	MUST NOT	MUST NOT
any other MIME types	such as 'application/pdf'** (see [IANA-MT])	MUST NOT	MUST NOT

** Note: The recent ANSI and ISO PDF/X-1:1999, PDF/X:2001, and PDF/X-1a formats and under development PDF/X-2 and PDF/X-3 formats which are specializations of 'application/pdf' MIME type do not have registered MIME types, though some of these have the same "blind interchange" guarantee of document presentation fidelity as '~~image/tiff~~application/pdf' ~~and 'image/tiff-fx'~~ MIME type~~s~~.

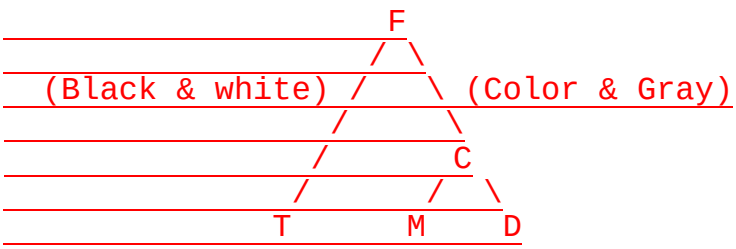
6.7 ~~uif~~pdfax-profiles-supported (1setOf type2 keyword)

This attribute identifies which black/white, grayscale, and color ~~UIF~~PDFax Profiles the Receiver supports. A Receiver MUST support this Printer Description attribute.

This attribute does not apply to additional document formats and profiles besides the ~~UIF~~PDFax Profiles [pdfax] of the '~~image/tiff~~application/pdf' [~~image-tiff~~pdf] ~~and 'image/tiff-fx' [image-tiff-fx]~~ document format~~s~~. Therefore, this attribute MUST NOT be returned if the "document-format" operation attribute supplied by the Sender in the Get-Printer-Attributes request does not support ~~UIF~~PDFax Profiles.

See [~~ifx-uif~~pdfax] Appendix A for the definition of each of these ~~UIF~~PDFax Profiles and the inter-dependency requirements for ~~UIF~~PDFax Profile support. The values of this attribute MUST conform to the inter-dependency requirements in [~~ifx-uif~~pdfax] for ~~UIF~~PDFax Profile support (for example, ~~UIF~~PDFax Profile ~~S~~F MUST be supported and ~~UIF~~PDFax Profile C MUST be supported if ~~UIF~~PDFax Profile L is supported, so the '~~uif~~pdfax-f~~s~~' keyword MUST always be present and the '~~uif~~pdfax-c' keyword MUST be present if the '~~uif~~pdfax-l' keyword is present).

The following tree diagram shows the relationship among PDFax Imaging Profiles:



Standard keyword values are shown in Table 4 along with the IANA registered MIME Media Type and File Name Extension Suffix:

Table 4 - ~~UIF~~PDFax Profile keywords

Keyword	MIME Type	File name suffix	Description (see [~~ifx-uif~~pdfax])	Sender support	Receiver support
~~uif~~pdfax-~~f~~s	~~image/tiff~~application/pdf	.~~tif~~pdf	~~UIF~~PDFax Profile ~~S~~F	MUST	MUST
~~uif-f~~	~~image/tiff~~	~~.tif~~	~~UIF Profile F~~	~~MAY~~	~~MAY, MUST if uif-j supported~~
~~uif~~pdfax-t~~j~~	~~image/tiff-fx~~application/pdf~~-*~~	.~~tfx~~pdf~~*~~	~~UIF~~PDFax Profile T~~J~~	MAY	MAY
~~uif~~pdfax-c	~~image/tiff-fx~~application/pdf~~-*~~	.~~tfx~~pdf~~*~~	~~UIF~~PDFax Profile C	MAY, MUST if pdfax-d or pdfax-m supported	MAY, MUST if ~~uif~~pdfax-d~~l~~ or ~~uif~~pdfax-m supported
~~uif~~pdfax-cg	~~image/tiff-fx~~application/pdf~~-*~~	.~~tfx~~pdf~~*~~	~~UIF~~PDFax Profile C with gray-scale subset	MAY, MUST if pdfax-dg or pdfax-m supported	MAY, MUST if ~~uif~~pdfax-d~~l~~g or ~~uif~~pdfax-m supported
~~uif~~pdfax-d~~l~~	~~image/tiff-fx~~application/pdf~~-*~~	.~~tfx~~pdf~~*~~	~~UIF~~PDFax Profile D~~L~~	MAY	MAY~~, MUST if uif-m supported~~
~~uif~~pdfax-~~l~~dg	~~image/tiff-fx~~application/pdf~~-*~~	.~~tfx~~pdf~~*~~	~~UIF~~PDFax Profile ~~L~~D with gray-scale subset	MAY	MAY~~, MUST if uif-m supported~~
~~uif~~pdfax-m	~~image/tiff-x~~application/pdf~~-*~~	.~~tfx~~pdf~~*~~	~~UIF~~PDFax Profile M	MAY	MAY

~~* See [image-tiff-fx]~~

6.8 ~~uif~~pdfax-profile-capabilities (1setOf text(MAX))

This attribute contains a CONNEG capability string expression as defined in [~~ifx-uif~~pdfax] Appendix A for ~~UIF~~PDFax Profiles. A Receiver MAY support this Printer Description attribute. This attribute is intended

to convey the capabilities of the Receiver that exceed the minimum requirements, if any, for each supported ~~UIF~~PDFax Profile.

This attribute does not apply to additional document formats and profiles besides the ~~UIF~~PDFax Profiles of the '~~image/tiff~~application/pdf' ~~[image-tiff] and 'image/tiff-fx' [image-tiff-fx]~~ document formats. Therefore, this attribute MUST NOT be returned if the "document-format" operation attribute supplied by the Sender in the Get-Printer-Attributes request does not support ~~UIF~~PDFax Profiles.

Each value MUST end with explicit White Space where CONNEG allows White Space to occur. However, there is no need to break a CONNEG expression into more than one value if it all fits into 1023 octets of a single text value (MAX = 1023).

The values taken together MUST conform to the minimum value in [~~ifx-uif~~pdfax], plus any additional capabilities that the Receiver supports. Thus a Sender can determine additional capabilities above the minimum for the ~~UIF~~PDFax Profiles that the Receiver supports (see section 6.7).

7 Sender Validation of the Receiver's Capabilities

This section describes how a Sender MUST first validate the target Printer as a Receiver and determines its basic capabilities (section 7.1) and then validate the IPPFAX Job (section 7.2).

7.1 Sender Validates the target Printer as a Receiver and determines its basic capabilities

The Sender MUST validate that the target Printer is a valid Receiver using the Get-Printer-Attributes operation as indicated in Table 5. The Sender SHOULD determine the Receiver's basic capabilities before generating the document data in order to ensure the best rendering the document as intended by the Sender before submitting an IPPFAX job as indicated in Table 5. The Sender MUST NOT rely solely on the IPPFAX Validate-Job operation followed by the IPPFAX Job Creation operation, since an IPP/1.1 (or IPP/1.0) Printer MAY accept both IPPFAX operations (but not perform IPPFAX semantics).

If the Sender requests these attributes using Get-Printer-Attributes and some of them are not returned, then the Sender MUST query the Sending User to inform that person that the Printer does not accept IPPFAX Jobs, so that the Sender has the opportunity to choose to abandon the exchange or to try an IPP URL (see section 6.1) and then query the Sending User if it OK to use the IPP Protocol.

The order of presentation in Table 5 is the likely order that a Sender would check the values, though the Sender can request all of the attributes in a single Get-Printer-Attributes operation (and the Receiver MAY return them in any order as specified in [RFC2911]).

664 **Table 5 - Receiver Attributes that the Sender validates with Get-Printer-Attributes**

Attribute	Ref.	Sender action
operation attributes:		
printer-uri	4.1	Sender MUST validate whether or not the Get-Printer-Attributes operation with a "printer-uri" target URL using the 'ippfax' scheme locates a valid Receiver destination.
Printer Description attributes:		
ippfax-versions-supported	6.3	Sender MUST check whether the Printer supports the IPPFAX Protocol on the target URL by checking whether or not the Printer supports this attribute, i.e., validate that the Printer is a Receiver.
operations-supported	6.5	If the Sender is going to use any operations that are OPTIONAL for a Receiver to support (such as Create-Job, Send-Document), the Sender SHOULD validate that the Receiver supports such operations (though the Printer MUST return an error if the client attempts to use an operation that the Printer doesn't support).
document-format-supported	6.6	Sender SHOULD** check which document formats the Receiver supports.
~~uif~~pdfax-profiles-supported	6.7	Sender SHOULD** check which ~~UIF~~PDFax Profiles of the 'image/tiff' and 'image/tiff-fx' document formats the Receiver supports, if the Sender uses any ~~UIF~~PDFax profiles other than '~~uif~~pdfax-f~~s~~'.
~~uif~~pdfax-profile-capabilities	6.8	Sender MUST check which OPTIONAL capabilities of each ~~UIF~~PDFax Profile the Receiver supports if the Sender uses any feature that is OPTIONAL for a ~~UIF~~PDFax Profile. The Sender MUST make this check, since profile capabilities are represented as CONNEG expressions (see [ifs-~~uif~~pdfax]) which the Validate-Job operation cannot check.
Job Template Printer attributes:		
media-supported	9.2.1.1	Sender SHOULD** check which media is supported, if the Sender specifies a particular media.
media-ready	9.2.1.1	Sender SHOULD check which media is ready (loaded, i.e., needs no human intervention to use).
printer-resolutions-supported	9.2.2.1	Sender SHOULD** check which resolutions are supported, so that it can use the highest resolution supported by the Receiver.

665 ** SHOULD** indicates that the Sender SHOULD check, but that if the Sender doesn't, then the Validate-
666 Job operation will catch any unsupported attributes or values and reject the operation.

667 ## 7.2 Validating the Printer's IPPFAX capabilities using the Validate-Job operation

668 After validating that the Printer is a Receiver (section 7.1), the Sender MUST validate the job attributes
669 using the Validate-Job operation (that doesn't include any Document data) before sending the IPPFAX Job

with the same attributes using an IPPFAX Job Creation operation that includes the Document data. The Sender MUST supply all the same operation and Job Template attributes in the Validate-Job request as it will supply in the subsequent Job Creation request (see section 9).

The Sender MUST supply the "ipp-attribute-fidelity" operation attribute with a 'true' value (see [RFC2911] section 3.2.1.1 and 15.1) in both the Validate-Job and the Job Creation operations. Then the Receiver will reject the request if any of the Job Template attributes and values are not supported, thereby ensuring that the document is printed as intended. If the Validate-Job is rejected because of the lack of support of one or more Job Template attributes, the Sender MUST query the user in order to proceed without these attributes. If the Validate-Job fails for more serious reasons, such as 'server-error-not-accepting-jobs ([RFC2911] section 13.1.5.7), the Sender MUST inform the Sending User so that person has the opportunity to choose to abandon the exchange or to try an IPP URL (see section 6.1) and then query the Sending User if it is OK to use the IPP Protocol. The main IPPFAX features that MAY be missing in the IPP Protocol are:

- Guaranteed exchange: Since IPP does not mandate any data formats it is possible that the Sender MAY not be able to discover a common data format that both it and the printer support.

- Identity exchange (section 8): IPP need not provide the definitive identity exchange that IPPFAX does. In many cases this is acceptable.

8 Identity exchange

This section defines the attributes that the Sender and the Receiver use to identify each to the other and to identify the Sending User and the Receiver User. Table 6 lists these attributes and shows the Sender and Receiver conformance requirements.

Table 6 - Summary of Identify Exchange attributes

Attribute	Sender supplies	Receiver supports
sending-user-vcard (text(MAX))	MAY *	MUST
receiving-user-vcard (text(MAX))	SHOULD *	MUST
sender-uri (uri)	MUST *	MUST
printer-uri-supported	MUST **	MUST

* Sender supplies in a Validate-Job and Job Creation operations.

** Sender supplies in a Get-Printer-Attributes request.

8.1 sending-user-vcard (text(MAX)) operation/Job Description attribute

This operation attribute identifies the Sending User in MIME vCard v3.0 [RFC2426, RFC2425] format. The Sender MAY send this operation attribute in an IPPFAX Job Creation operation. The Receiver MUST support this Job Creation and Validate-Job operation attribute according to the vCard v3.0 specification and MUST populate the job's corresponding Job Description attribute. The Receiver MUST support MAX (1023) octets of text. However, the Receiver MAY ignore any image, logo, and sound parts, in which case it MUST still accept the Job Creation request and return the 'successful-ok-ignored-or-substituted-

attributes' status code (see [RFC2911] section 13.1.2.2), but NEED NOT return the attribute and its ignored values in the Unsupported Attributes Group.

For a sample vCard see section 20. If the Sender supplies the attribute, then the Receiver MUST use its value to populate the Job object's corresponding Job Description attribute of the same name.

The Receiver MAY choose to use this information on a job start and end sheet (banner page) for the job. As in IPP/1.1, whether or not the Receiver prints a separate job start sheet depends on the "job-sheets" Job Template attribute, if supported. The Sender can request the Receiver to print a separate start sheet if the Receiver's "job-sheets-supported" Printer attribute (see [RFC2911] section 4.2.3) contains a value other than 'none'. The Sender can suppress the Receiver's separate start sheet if the Receiver's "job-sheets-supported" Printer attribute contains the 'none' value. If the Sender omits the "job-sheets" Job Template attribute, the Receiver's "job-sheets-default" value will be used.

8.2 receiving-user-vcard (text(MAX)) operation/Job Description attribute

This operation attribute identifies the intended Receiving User in MIME vCard format[RFC2426, RFC2425]. The Sender SHOULD send this operation attribute in an IPPFAX Job Creation or Validate-Job operation. The Receiver MUST support this Job Creation operation attribute and MUST populate the job's corresponding Job Description attribute. The Receiver MUST support MAX (1023) octets of text. However, the Receiver MAY ignore any image, logo, and sound parts, in which case it MUST still accept the Job Creation request and return the 'successful-ok-ignored-or-substituted-attributes' status code (see [RFC2911] section 13.1.2.2), but NEED NOT return the attribute and its ignored values in the Unsupported Attributes Group.

For a sample vCard see section 20. If the Sender supplies the attribute, then the Receiver MUST use its value to populate the Job object's corresponding Job Description attribute of the same name.

The Receiver MAY choose to use this information on a job start and end sheet (banner page) for the job. See discussion under section 8.1.

8.3 sender-uri (uri) operation/Job Description attribute

This operation attribute identifies the Sender in a similar manner to the way a Sending Station ID is used in a GSTN fax device. The value of this identity is not specified in this document but MUST uniquely identify the Sender device and be traceable to the Sender. The manufacturer of the Sender MUST ensure that the customer configures the Sender with a value for this attribute that is a syntactically valid URI before first attempt to send an IPPFAX Job.

The Sender MUST send this operation attribute with the configured value in an IPPFAX Job Creation operation. The Receiver MUST support this Job Creation operation attribute and MUST populate the job's corresponding Job Description attribute.

The Receiver MUST use its value to populate the Job object's corresponding Job Description attribute of the same name. This value is only a comment (since it can be spoofed) and is used for logging purposes

and has nothing to do with authentication (for which see section 11). This attribute is more akin to an email 'Reply-To' field.

8.4 printer-uri-supported (1setOf uri) Printer Description attribute ([RFC2911] section 4.4.1)

This IPP/1.1 Printer Description attribute (see [RFC2911] section 4.4.1) identifies the Receiving device, so that no new IPPFAX Printer Description attribute is needed. See section 6.1 for additional IPPFAX semantics for this attribute. The Sender MUST query this attribute using the Get-Printer-Attributes operation as specified in section 7.1 while supplying a target "printer-uri" operation attribute with the 'ippfax' scheme.

9 Transmission using the Print-Job or Create-Job/Send-Document operations

The Sender and Receiver MUST support creating IPPFAX Jobs using the Print-Job operation and MAY support creating IPPFAX Jobs using Create-Job and Send-Document, as well. The Sender and Receiver MUST NOT support print by reference, i.e., MUST NOT support the Print-URI and Send-URI operations, since they do not provide the same security and assurance of accessibility as pushing the document data does.

9.1 IPP/1.1 Validate-Job and Job Creation operation attributes

Table 7 lists the operation attributes for Validate-Job and Job Creation operations for Senders, IPP/1.1 Printers, and Receivers. Differences in Sender conformance from IPP/1.1 clients are indicated with footnotes. Any other IPP operation attributes defined in other documents are OPTIONAL for IPPFAX.

753 **Table 7 - IPP/1.1 Validate-Job and Job Creation operation attributes**

Operation attribute	Section	Sender supplies	IPP/1.1 Printer supports	Receiver supports
attributes-charset (charset)		MUST	must	MUST
attributes-natural-language (naturalLanguage)		MUST	must	MUST
printer-uri (uri) *	4.1	MUST	must	MUST
requesting-user-name (name(MAX)) *		SHOULD	must	MUST
job-name (name(MAX))		MAY	must	MUST
ipp-attribute-fidelity (boolean) *	9.1.1	MUST with 'true' value[1]	must	MUST
document-name (name(MAX)) *		MAY	must	MUST
compression (type3 keyword) *		MAY	must	MUST
document-format (mimeMediaType) *	9.1.2	MUST[2]	must	MUST
document-natural-language (naturalLanguage) *		MAY	may	MAY
job-k-octets (integer(0:MAX))		MAY	may	MAY
job-impressions (integer(0:MAX))		MAY	may	MAY
job-media-sheets (integer(0:MAX))		MAY	may	MAY
sending-user-vcard (1setOf text(MAX))	8.1	MAY	may	MUST
receiving-user-vcard (text(MAX))	8.2	SHOULD	may	MUST
sender-uri (name(MAX))	8.3	MUST	may	MUST
~~uif~~pdfax-profiles (1setOf type2 keyword) *	9.1.3	MUST	may	MUST

754 * As in IPP/1.1, these attributes are NOT Job Description attributes, only Operation attributes for Job
755 Creation and Validate-Job operations.
756

757 ### 9.1.1 ipp-attribute-fidelity operation attribute ([RFC2911] section 3.2.1.1)

758 In IPP/1.1, this operation attribute indicates whether or not the client requires the Printer to support all Job
759 Template attributes and values supplied. The Sender MUST supply this operation attribute in the Validate-
760 Job and Job Creation operations and the value MUST be 'true'. A Receiver MUST validate and support
761 this operation attribute. Note: [RFC2911] does not REQUIRE the IPP Client to supply this operation
762 attribute and allows the client to supply the 'false' value.

763 If the Sender does not supply this attribute or supplies the 'false' value, the Receiver MUST reject the
764 operation, MUST return the 'client-error-bad-request' status code, and SHOULD return the 'ipp-attribute-
765 fidelity' attribute name keyword in the Unsupported Attributes Group (see section 14.1).

[1] [RFC2911] does not require the client to supply the "ipp-attribute-fidelity" and allows the client to supply either the 'true' or 'false' value.

[2] The [RFC2911] does not require the IPP client to supply the "document-format" operation attribute.

9.1.2 document-format (mimeMediaType) operation attribute ([RFC2911] section 3.2.1.1)

This operation attribute identifies the MIME Media Type of the document that the Sender is sending. The Sender MUST supply this operation attribute in the Validate-Job and Job Creation operations. A Receiver MUST validate and support this operation attribute. Note: [RFC2911] does not REQUIRE the IPP Client to supply this operation attribute.

If the Sender does not supply this attribute, the Receiver MUST reject the operation, MUST return the 'client-error-bad-request' status code, and SHOULD return the 'document-format' attribute name keyword in the Unsupported Attributes Group (see section 14.1).

If the Sender supplies a value that the Receive does not support, i.e., not a value of the Receiver's "document-format-supported" Printer Description attribute, the Receiver MUST reject the operation and return the 'client-error-document-format-not-supported' status code (IPP conformance).

Standard mimeMediaType values are defined in section 6.6.

9.1.3 ~~uif~~pdfax-profiles (1setOf type2 keyword) Job Creation operation attribute

This attribute identifies the ~~UIF~~PDFax Profiles of the document that the Sender is sending. The Sender SHOULD supply this operation attribute in the Validate-Job and Job Creation operations as a hint to the Receiver as to what the ~~UIF~~PDFax Profiles [pdfax] are when the document format is '~~image/tiff~~application/pdf' [~~image-tiff~~pdf] ~~or 'image/tiff-fx' [image-tiff-fx]~~. A Receiver MUST validate and support this operation attribute.

If the Sender supplies a value that the Receive does not support, i.e., not a value of the Receiver's "~~uif~~pdfax-profiles-supported" Printer Description attribute, the Receiver MUST reject the operation and return the 'client-error-document-format-not-supported' status code (IPP conformance extended to ~~UIF~~PDFax profiles - see section 14.2).

If the Sender does not supply this attribute, the Receiver MUST accept the job anyway and validate as soon as possible that the Receiver can successfully render the document data. If possible, it is RECOMMENDED that such validation happen by examining the first part of the data before returning the Job Creation response. Note: there is no "~~uif~~pdfax-profiles-default" attribute defined.

If the Sender supplies a value that the Receiver determines later is incorrect when processing the document data, the document data takes precedence. Only if the Receiver does not support the discovered profile, MUST the Receiver abort the job.

Standard keyword values are defined in section 6.7.

9.2 Job Template Attributes (for Validate-Job and Job Creation operations)

Table 8 lists all of the Job Template attributes defined in other IPP documents for use in Validate-Job and Job Creation operations and shows their conformance for IPPFAX Jobs. As in [RFC2911], the term "Job

Template attribute" is actually up to four attributes: the "xxx" Job attribute, and the "xxx-default", "xxx-supported", and possibly the "xxx-ready" Printer attributes. Any other IPP Job Template attributes defined in other documents are OPTIONAL for IPPFAX.

As in IPP/1.1, if a Receiver supports the "xxx" Job Template attribute, then it MUST support the corresponding "xxx-default" (if defined) and "xxx-supported" Printer attributes as well, and MAY support the "xxx-ready" attribute (if defined).

In Table 8, if the "Sender supply" and "Receiver support" columns contain an explicit single value, the Sender MAY send and the Receiver MAY support the Job Template attribute for an IPPFAX Job, but MUST support only the indicated value. Note: Each such single value has been selected as the value for the attribute that would correspond to the *expected behavior* if the attribute were not supported at all. If these attributes are supplied in an IPPFAX Job with any other value, the Receiver MUST reject the Job Creation operation (since the value isn't supported and "ipp-attribute-fidelity" MUST be 'true'). If the Receiver supports this attribute, the Receiver MUST return only the indicated value in the Get-Printer-Attributes response for the corresponding "xxx-supported", "xxx-default" Printer attributes. Note: These are attributes which might degrade the appearance of the document or provide a significantly non-FAX feature if the non-default value were supplied and supported, such as "number-up" = 2 or "job-priority" = 100, respectively.

In Table 8, if the "Sender supply" and "Receiver support" columns contain "MUST NOT", the Sender MUST NOT supply and the Receiver MUST NOT support the Job Template attribute for an IPPFAX Job. If these attributes are supplied in an IPPFAX Job, the Receiver MUST reject the Job Creation operation (since the attribute isn't supported and "ipp-attribute-fidelity" MUST be 'true'). When querying the Receiver with the Get-Printer-Attributes operation, the corresponding "xxx-default" and "xxx-supported" MUST NOT be returned. Note: These are attributes which might degrade the appearance of the document or provide a significantly non-FAX feature and do not have an obvious value which corresponds to the behavior when the attribute is not supported at all, such as media-input-tray-check (type3 keyword | name(MAX)) or output-bin (type2 keyword | name(MAX)).

In Table 8, the "Receiver Attribute Coloring" column indicates the Receiver conformance requirements for Attribute Coloring in the Get-Printer-Attributes response that depends on the "document-format" and "~~uif~~pdfax-profile-requested" operation attribute values supplied by the Sender. The 'n/a' value indicates not applicable, since the attribute either MUST NOT be supported or MUST have only the indicated single value.

Table 8 - IPPFAX Semantics for Job Template Attributes

Job Template attribute	Sender supply *	Receiver support *	Receiver Attribute Coloring	Reference
copies (integer(1:MAX))	MAY	MAY	MAY	[RFC2911]
cover-back (collection)	MAY	MAY	MAY	[ipp-prod-print]
cover-front (collection)	MAY	MAY	MAY	[ipp-prod-print]
document-overrides (collection)	MAY	MAY	MAY	[~~ipp-coll~~RFC3382]
finishings (1setOf type2 enum)	MAY	MAY	MAY	[RFC2911]
finishings-col (collection)	MAY	MAY	MAY	[ipp-prod-print]
force-front-side (1setOf integer(1:MAX))	MAY	MAY	MAY	[ipp-prod-print]
imposition-template (type2 keyword | name(MAX))	'none'	'none'	n/a	[ipp-prod-print]
insert-sheet (1setOf collection)	'insert-count' = 0	'insert-count' = 0	n/a	[ipp-prod-print]
job-account-id (name(MAX))	MAY	MAY	MAY	[ipp-prod-print]
job-accounting-sheets (collection)	MAY	MAY	MAY	[ipp-prod-print]
job-accounting-user-id (name(MAX))	MAY	MAY	MAY	[ipp-prod-print]
job-error-sheet (collection)	MAY	MAY	MAY	[ipp-prod-print]
job-hold-until (type3 keyword | name(MAX))	'no-hold'	'no-hold'	n/a	[RFC2911]
job-message-to-operator (text(MAX))	MAY	MAY	MAY	[ipp-prod-print]
job-priority (integer(1:100)	50	50	n/a	[RFC2911]
job-sheet-message (text(MAX))	MAY	MAY	MAY	[ipp-prod-print]
job-sheets (type3 keyword | name(MAX))	MAY	MAY	MAY	[RFC2911]
job-sheets-col (collection)	MAY	MAY	MAY	[ipp-prod-print]
media (type3 keyword | name(MAX))	MUST (see section 9.2.1)	MUST (see section 9.2.1)	MAY	[RFC2911]
media-col (collection)	MAY	MAY	MAY	[ipp-prod-print]
media-input-tray-check (type3 keyword | name(MAX))	MUST NOT	MUST NOT	n/a	[ipp-prod-print]
multiple-document-handling (type2 keyword)	MAY	MAY	MAY	[RFC2911]
number-up (integer(1:MAX)	1	1	n/a	[RFC2911]
orientation-requested (type2 enum)	'portrait'	'portrait'	n/a	[RFC2911]
output-bin (type2 keyword | name(MAX))	MUST NOT	MUST NOT	n/a	[ipp-output-bin]
page-delivery (type2 keyword)	'system-specified'	'system-specified'	n/a	[ipp-prod-print]
page-order-received (type2 keyword)	'1-to-n-order'	'1-to-n-order'	n/a	[ipp-prod-print]
page-overrides (1setOf collection)	MAY	MAY	MAY	[~~ipp-coll~~RFC3382]
page-ranges (1setOf rangeOfInteger(1:MAX))	1:MAX	1:MAX	n/a	[RFC2911]
pages-per-subset (1setOf integer(1:MAX))	MUST NOT	MUST NOT	n/a	[ipp-prod-print]
presentation-direction-number-up (type2 keyword)	'toright-tobottom'	'toright-tobottom'	n/a	[ipp-prod-print]

Job Template attribute	Sender supply *	Receiver support *	Receiver Attribute Coloring	Reference
print-quality (type2 enum)	'high'	'high'	n/a	[RFC2911]
printer-resolution (resolution)	MAY (see section 9.2.2)	MUST (see section 9.2.2)	MUST	[RFC2911]
separator-sheets (collection)	MAY	MAY	MAY	[ipp-prod-print]
sheet-collate (type2 keyword)	'collated'	'collated'	n/a	[~~ipp-job-prog~~RFC3381]
sides (type2 keyword)	MAY	MAY	MAY	[RFC2911]
x-image-position (type2 keyword)	'none'	'none'	n/a	[ipp-prod-print]
x-image-shift (integer(MIN:MAX))	0	0	n/a	[ipp-prod-print]
x-side1-image-shift (integer(MIN:MAX))	0	0	n/a	[ipp-prod-print]
x-side2-image-shift (integer(MIN:MAX))	0	0	n/a	[ipp-prod-print]
y-image-position (type2 keyword)	'none'	'none'	n/a	[ipp-prod-print]
y-image-shift (integer(MIN:MAX))	0	0	n/a	[ipp-prod-print]
y-side1-image-shift (integer(MIN:MAX))	0	0	n/a	[ipp-prod-print]
y-side2-image-shift (integer(MIN:MAX))	0	0	n/a	[ipp-prod-print]

* If a single value is indicated, then a Receiver MAY support the indicated Job Template attribute, but MUST support only the indicated value. Note: Each such single value has been selected as the value for the attribute that would correspond to the *expected behavior* if the attribute were not supported at all.

9.2.1 media (type2 keyword | name(MAX)) Job Template attribute ([RFC2911] section 4.2.11)

This Job Template attribute ([RFC2911] section 4.2.11) identifies the medium to be used for all sheets of the job. The Sender MUST supply the "media" Job Template attribute in the Validate-Job and Job Creation requests and the Receiver MUST support it, along with the "media-default", "media-ready", and "media-supported" Printer attributes.

The ~~UIF~~PDFax Profiles standard [~~ifx-uif~~pdfax] REQUIRES that both the Sender and the Receiver be able to determine the dimensions from the keyword value. Therefore, the keyword values MUST be Media Size Self Describing names defined in the PWG Standardized Name standard [pwg-media].

Standard keyword values (see [pwg-media]) include:

'na_letter_8.5x11in'
'iso_a4_210x297mm'

9.2.1.1 media-supported and media-ready Job Template Printer attributes

The Sender MUST query the values of the "media-supported" and "media-ready" attributes ([RFC2911] section 4.2.11), since the Sender MUST supply the "media" Job Template attribute in the Job Creation

operation. The “media-ready” attribute indicates which media are currently loaded and will not require human intervention in order to be used.

Standard keyword values are defined in section 9.2.1.

9.2.2 printer-resolution (resolution) Job Template attribute ([RFC2911] section 4.2.12)

This Job Template attribute ([RFC2911] section 4.2.12) identifies the cross-feed and feed direction resolutions that Printer uses for the Job. The Sender MAY supply the “printer-resolution” Job Template attribute in the Validate-Job and Job Creation requests and the Receiver MUST support it, along with the “printer-resolution-default”, and “printer-resolution-supported” Printer attributes.

For ~~UIF~~PDFax Documents, tf the Sender supplies the “printer-resolution” (resolution) Job Template attribute, the value MUST agree with the resolution of each of the pages of the ~~UIF~~PDFax Document. If the supplied value disagrees with the resolution of any of the pages of the ~~UIF~~PDFax Document, the Receiver MUST obey the resolution in the ~~UIF~~PDFax document, on a page by page basis.

Note: The main purpose of requiring the Receiver to support the “printer-resolution” Job Template attribute is so that the Sender can query the corresponding “printer-resolution-supported” (1setOf resolution) Printer attribute to see what resolutions are supported in addition to the ones REQUIRED for the ~~UIF~~PDFax Profiles supported. See section 9.2.2.1.

9.2.2.1 printer-resolution-supported Job Template Printer attribute

If the Sender is using a resolution for a ~~UIF~~PDFax Profile that is not one of the REQUIRED resolutions for the ~~UIF~~PDFax Profile being used, then the Sender SHOULD query the “printer-resolution-supported” Printer attribute. The Receiver MUST support Attribute Coloring (by document format and by ~~UIF~~PDFax profile) for the ‘~~image/tiff~~application/pdf’ [~~image-tiff~~pdf] ~~and ‘image/tiff-fx’ [image-tiff-fx]~~ document-formats. Thus this attribute allows the Sender to determine the additional resolutions supported in addition to the resolutions required for support of each of the ~~UIF~~PDFax Profiles without having to interpret the CONNEG expression values of the “~~uif~~pdfax-profile-capabilities” Printer Description attribute (see section 6.8).

9.3 Subscription Template Attributes Conformance Requirements

Table 9 lists the conformance requirements for Subscription attributes on the Job Creation and Validate-Job requests. The attributes in Subscription Objects are shown immediately followed (indented) by their corresponding Default and Supported Printer Attributes.

878 **Table 9 - Subscription Template attributes conformance requirements**

Attribute Name (attribute syntax) Attribute in Subscription Object Default and Supported Printer Attributes	Sender Conformance in Job Creation operations	Receiver Conformance	Reference
notify-recipient-uri (uri)	MAY *	MAY	[ipp-ntfy]
notify-schemes-supported (1setOf uriScheme)	n/a	MAY	[ipp-ntfy]
notify-pull-method (type2 keyword)	MUST **	MUST	section 9.3.1
notify-pull-method-supported (1setOf type2 keyword)	n/a	MUST	[ipp-ntfy]
notify-events (1setOf type2 keyword)	MAY	MUST	section 9.3.2
notify-events-default (1setOf type2 keyword) notify-events-supported (1setOf type2 keyword) notify-max-events-supported (integer(2:MAX))	n/a	MUST	[ipp-ntfy]
notify-attributes (1setOf type2 keyword)	MAY	MAY	[ipp-ntfy]
notify-attributes-supported (1setOf type2 keyword)	n/a	MAY	[ipp-ntfy]
notify-user-data (octetString(63))	MAY	MUST	[ipp-ntfy]
notify-charset (charset)	MAY	MUST	[ipp-ntfy]
charset-supported (1setOf charset)	n/a	MUST	[RFC2911]
notify-natural-language (naturalLanguage)	MAY	MUST	[ipp-ntfy]
generated-natural-language-supported (1setOf naturalLanguage)	n/a	MUST	[RFC2911]
notify-lease-duration (integer(0:67108863))	MAY	MUST	[ipp-ntfy]
notify-lease-duration-default (integer(0:67108863)) notify-lease-duration-supported (1setOf (integer(0:67108863) | rangeOfInteger(0:67108863)))	n/a	MUST	[ipp-ntfy]
notify-time-interval (integer(0:MAX))	MAY	MUST	[ipp-ntfy]

879 * The Sender MUST supply at least the “notify-recipient-uri” attribute for any Push Delivery Method.
880 ** The Sender MUST supply at least the “notify-pull-method” attribute for any Pull Delivery Method,
881 such as the REQUIRED ‘ippget’ Delivery Method.
882

883 ### 9.3.1 notify-pull-method (type2 keyword) Subscription Template attribute [ipp-ntfy]

884 This Subscription Template attribute defined in [ipp-ntfy] indicates the Pull Delivery Method. A Sender
885 MUST supply this attribute with the ‘ippget’ Delivery Method keyword value [~~ipp-~~get-method] in order to
886 determine when the Document has been Delivered so that the Sender can give a positive acknowledgement
887 to the Sending User. A Receiver MUST support the subset of the IPP Notification specification [ipp-ntfy]
888 indicated in this document and the ‘ippget’ Notification Delivery Method [~~ipp-~~get-method].

889 ### 9.3.2 Notification Event Conformance Requirements

890 Table 10 lists the conformance requirements for notification events.

The Receiver MUST support the 'job-progress' event (which is OPTIONAL in [ipp-ntfy]), as well as all of the REQUIRED events in [ipp-ntfy] ('none', 'printer-state-change', 'printer-stopped', 'job-state-change', 'job-created', and 'job-completed'). However, the Receiver MUST NOT support any Printer Events in Per-Job Subscriptions, since that would give an IPPFAX Sender information about the Printer while the Printer was printing other IPPFAX Jobs. If the Sender subscribes to the 'job-progress' event, the Receiver MUST generate an event for every sheet, as moderated by the Printer's "notify-time-interval" attribute [ipp-ntfy], which the Sender can obtain using the Get-Notifications request.

For the purposes of IPPFAX, the 'job-completed' event notifications means that the Receiver has delivered the IPPFAX Job somewhere; either actually delivered printed sheets to the output bin or forwarded the job and document to some other system.

Table 10 - Notification Events conformance requirements

Event	IPP/1.1 Printer Conformance	Sender Conformance for Job Creation support	Sender Use	Receiver Conformance per-Job	Receiver Conformance Per-Printer	Section
none	must	MAY	MAY	MUST	MUST	9.3.2
Job Events:						
job-state-changed	must	MAY	MAY	MAY	MUST	9.3.2
job-created	must	MAY	MAY	MAY	MUST	9.3.2
job-completed	must	MUST	MAY	MUST	MUST	9.3.2
job-stopped	may	MAY	MAY	MAY	MAY	
job-config-changed	may	MUST NOT	MUST NOT	MUST NOT	MUST NOT	
job-progress	may	MAY	MAY	MUST	MAY	9.3.2
Printer Events:						
printer-state-changed	must	MUST NOT	MUST NOT	MUST NOT	MUST	9.3.2
printer-restarted	may	MUST NOT	MUST NOT	MUST NOT	MAY	
printer-shutdown	may	MUST NOT	MUST NOT	MUST NOT	MAY	
printer-stopped	must	MUST NOT	MUST NOT	MUST NOT	MUST	9.3.2
printer-config-changed	may	MUST NOT	MUST NOT	MUST NOT	MAY	
printer-media-changed	may	MUST NOT	MUST NOT	MUST NOT	MAY	
printer-finishings-changed	may	MUST NOT	MUST NOT	MUST NOT	MAY	
printer-queue-order-changed	may	MUST NOT	MUST NOT	MUST NOT	MAY	

9.4 Confirmation using the Document Creation response

The Sender knows when the Receiver has successfully received the entire Document when the Receiver returns the 'successful-ok' status code in the Print-Job, or Send-Document. The Sender MUST then inform

the Sending User by means outside the scope of this standard that the document has successfully been received. See section 9.3.2 for informing the Sending User when the document has been successfully printed.

9.5 Sender URI Stamping

The Sender MUST place the Sender's URI, i.e., the value of the "sender-uri" attribute (see section 8.3), along with the date and time, in one of the following places, DEPENDING ON IMPLEMENTATION:

1. On a cover page automatically generated by the Sender that is sent before the rest of the document.
2. Merged with the first page of the document.
3. At the top of every page of the sent Document.

The Sender MAY include additional data (Sending User, Receiver identity, etc.). As for regular FAX, it is RECOMMENDED that this information be represented as bit map data, so that it is more difficult for it to be modified before it gets to the Receiver.

9.6 Get-Notifications operation to get Event Notifications

The Sender MUST support the Get-Notifications operation with at least the 'job-completed' event (see section 9.3.2). Furthermore, the Sender MUST use the Get-Notifications operations to get at least the 'job-completed' event for any IPPFAX job it submits, unless the Sending User has explicitly indicated otherwise to the Sender (by means outside the scope of this document). The Receiver MUST support the Get-Notifications operation as defined in [~~ipp-~~get-method]. See section 9.3.2 for the events that MUST be supported, since the IPPFAX conformance requirements differ from those of [ipp-ntfy].

10 IPPFAX Implementation of other IPP operations

Section 5 defined the semantic requirements for the Get-Printer-Attributes operation, section 7 defined the semantic requirements for Validate-Job, and section 9 defined the semantic requirements for Job Creation operations for IPPFAX. This section defines the IPPFAX semantics and conformance requirements for the other IPP operations.

IPPFAX restricts the use of IPP in certain cases in order to make attaching a Receiver to the Internet a safe option – see section 11.

The Receiver MUST fully support the Print-Job, Validate-Job, Get-Printer-Attributes and Get-Notifications operations, as defined by this document. The following subsections define restrictions and conformance requirements placed on the Cancel-Job, Get-Job-Attributes, Get-Jobs, Enable-Printer, Disable-Printer, Set-Printer-Attributes, and Get-Printer-Attributes operations. For a conforming IPPFAX Receiver implementation, the support for each of the IPP operations is indicated in Table 11and Table 12.

There is no requirement for the Receiver to implement any of the OPTIONAL features of IPP unless explicitly stated elsewhere in this document. If a Receiver implementation supports administrative operations, such as Create-Printer-Subscriptions, Disable-Printer, etc., then it MUST provide a method of restricting available operations for non-authorized clients to the operations specified herein.

10.1 Operation Conformance Requirements

Table 11 lists the conformance requirements for Printer operations for (1) an IPP/1.1 Printer ('ipp' URL), (2) the non-privileged IPPFAX Sender, (3) an IPPFAX Receiver receiving a request from a non-privileged User, and (4) an IPPFAX Receiver receiving a request from an authenticated and authorized operator or administrator, if the Receiver supports operator/administrator authentication and authorization.

Table 12 lists the conformance requirements for Job and Subscription operations for (1) an IPP/1.1 Printer ('ipp') URL, (2) the non-privileged IPPFAX Sender which MUST be on the same URL as the job was created (the target "printer-uri" MUST match the Job's "job-printer-uri" Job Description attribute), (3) an IPPFAX Receiver receiving a request from the Job or Subscription Object Owner, (4) from some other non-privileged user, and (5) if the operation is supported at all - from an authenticated and authorized operator or administrator.

The Receiver MUST support Subscription Creation for the Job-Creations operations that it supports, but NEED NOT support any other notification operations, such as Create-Job-Subscriptions, Create-Printer-Subscriptions, Get-Subscription-Attributes, Get-Subscription-Attributes, Renew-Subscription, or Cancel-Subscription, even though [ipp-ntfy] requires all but the Create-Job-Subscriptions operation.

If a Receiver chooses to allow other IPP notification operations then it SHOULD provide a method of restricting all other notification operations to authenticated administrators.

Table 11 - Conformance for Printer Operations

Operation Name	IPP/1.1 Printer support	IPPFAX Sender support for a User	IPPFAX Receiver from a User	IPPFAX Receiver from an Operator, if supported	Reference
Print-Job	must	MUST	MUST	MUST	section 9
Print-URI	may	MUST NOT	MUST NOT	MUST NOT	[RFC2911]
Validate-Job	must	MUST	MUST	MUST	section 7.2
Create-Job	may	MAY	MAY	MAY	[RFC2911]
Get-Jobs	must	MAY	MAY*	MAY	section 10.3
Get-Printer-Attributes	must	MUST	MUST	MUST	sections 5, 6
Pause-Printer	may	MUST NOT	MUST NOT	MAY	[RFC2911]
Resume-Printer	may	MUST NOT	MUST NOT	MAY	[RFC2911]
Purge-Jobs	may	MUST NOT	MUST NOT	MUST NOT	[RFC2911]
Set-Printer-Attributes	may	MUST NOT	MUST NOT	MAY	section 10.5
Get-Printer-Supported-Values	may	MUST NOT	MUST NOT	MAY	section 10.5
Create-Printer-Subscription	may	MUST NOT	MUST NOT	MAY	[ipp-ntfy]
Get-Subscriptions	may	MAY	MAY	MAY	[ipp-ntfy]
Send-Notifications	may	MUST NOT	MAY **	MAY	[ipp-indp-method]
Get-Print-Support-Files	may	MAY	MAY	MAY	[ipp-install]
Enable-Printer	may	MUST NOT	MUST NOT	MAY	section 10.4
Disable-Printer	may	MUST NOT	MUST NOT	MAY	section 10.4
Pause-Printer-After-Current-Job	may	MUST NOT	MUST NOT	MAY	[ipp-adm-ops]
Hold-New-Jobs	may	MUST NOT	MUST NOT	MAY	[ipp-adm-ops]
Release-Held-New-Jobs	may	MUST NOT	MUST NOT	MAY	[ipp-adm-ops]
Deactivate-Printer	may	MUST NOT	MUST NOT	MAY	[ipp-adm-ops]
Activate-Printer	may	MUST NOT	MUST NOT	MAY	[ipp-adm-ops]
Restart-Printer	may	MUST NOT	MUST NOT	MAY	[ipp-adm-ops]
Shutdown-Printer	may	MUST NOT	MUST NOT	MAY	[ipp-adm-ops]
Startup-Printer	may	MUST NOT	MUST NOT	MAY	[ipp-adm-ops]
Cancel-Current-Job	may	MUST NOT	MUST NOT	MUST NOT	[ipp-adm-ops]
Suspend-Current-Job	may	MUST NOT	MUST NOT	MAY	[ipp-adm-ops]

Legend:

MAY* - If supported, Get-Job-Attributes and Get-Jobs MUST restrict certain attributes, such as “job-name”, and “job-originating-user-name”. See section 10.3.

MAY** - For Send-Notifications, the Receiver *sends to* a User or Operator (rather than *receives from*).

965 **Table 12 - Conformance for Job and Subscription Operations**

Operation Name	IPP/1.1 Printer support	IPPFAX Sender support for a User	IPPFAX Receiver from Owner***	IPPFAX Receiver from Other User	IPPFAX Receiver from Operator, if supported	Reference
Send-Document	may	MAY	MAY	MUST NOT	MUST NOT	[RFC2911]
Send-URI	may	MUST NOT	MUST NOT	MUST NOT	MUST NOT	[RFC2911]
Cancel-Job	must	MUST NOT	MUST NOT	MUST NOT	MUST NOT	section 10.2
Get-Job-Attributes	must	MAY	MAY	MAY*	MAY	section 10.3
Set-Job-Attributes	must	MAY	MUST NOT	MUST NOT	MAY	[RFC3380]
Hold-Job	may	MUST NOT	MUST NOT	MUST NOT	MAY	[RFC2911]
Release-Job	may	MUST NOT	MUST NOT	MUST NOT	MAY	[RFC2911]
Restart-Job	may	MUST NOT	MUST NOT	MUST NOT	MAY**	[RFC2911]
Create-Job-Subscription	may	MAY	MAY	MUST NOT	MAY	[ipp-ntfy]
Get-Subscription-Attributes	may	MAY	MAY	MUST NOT	MAY	[ipp-ntfy]
Get-Subscriptions	may	MAY	MAY	MUST NOT	MAY	[ipp-ntfy]
Renew-Subscription	may	MUST NOT	MUST NOT	MUST NOT	MAY	[ipp-ntfy]
Cancel-Subscription	may	MAY	MAY	MUST NOT	MAY***	[ipp-ntfy]
Get-Notifications	may	MUST	MUST	MUST NOT	MAY	section 9.6
Reprocess-Job	may	MUST NOT	MUST NOT	MUST NOT	MAY**	[ipp-adm-ops]
Resume-Job	may	MUST NOT	MUST NOT	MUST NOT	MAY	[ipp-adm-ops]
Promote-Job	may	MUST NOT	MUST NOT	MUST NOT	MAY	[ipp-adm-ops]
Schedule-Job-After	may	MUST NOT	MUST NOT	MUST NOT	MUST NOT	[ipp-adm-ops]

966 Legend:
967 **MAY*** - If supported, Get-Job-Attributes and Get-Jobs MUST restrict certain attributes, such as “job-name”, and “job-
968 originating-user-name”. See section 10.3.
969 **MAY**** - Restart-Job and Reprocess-Job are for the operator to recover from a problem with the job, not to make
970 additional copies.
971 **MAY***** - Operators MAY cancel their own subscriptions, but MUST NOT cancel subscriptions belonging to others.
972 **Owner** refers to the owner of the Job or Subscription object.

973 ## 10.2 Cancel-Job operation ([RFC2911] section 3.3.3)

974 It is inappropriate for a Sender or an operator to Cancel an IPPFAX Job, i.e., to transmit a Document as an
975 IPPFAX Job, receive confirmation of its arrival and then cancel it. Therefore:

976 The Sender MUST NOT attempt to cancel the print job once it has been sent to the Receiver.

977 The Receiver MUST reject Cancel-Job operations whether issued by a user or an administrator targeted at
978 IPPFAX Jobs. The Cancel-Job operation therefore MUST be an unsupported operation for a Receiver and
979 MUST be reflected in the value of the “operations-supported” Printer attribute (see section 6.5). Note:
980 Non-support of the Cancel-Job operation is a change from the IPP behavior where Cancel-Job is required.

10.3 Get-Job-Attributes and Get-Jobs operations ([RFC2911] sections 3.3.4 and 3.2.6)

The public nature of IPPFAX interactions make it inappropriate for a client to be able to query a Receiver for certain information about jobs that it did not send.

The Receiver SHOULD restrict the job attributes that any Sender can request for any IPPFAX Job in a Get-Jobs or a Get-Job-Attributes operation to appropriate ones for a public service. For example, a Receiver MAY return only the following Job attributes:

job-id, job-uri
job-k-octets, job-k-octets-completed
job-media-sheets, job-media-sheets-completed,
time-at-creation, time-at-processing
job-state, job-state-reasons
number-of-intervening-jobs

The exact choice of Job attributes that a client can query for IPPFAX Jobs, including not returning any, DEPENDS ON IMPLEMENTATION and the security policy in force and is outside the scope of this standard (as in IPP/1.1).

This attribute set allows a client to determine the load on a Receiver (and perhaps choose an alternative destination or warn the Sending User).

See the discussion in [RFC2911] section 8.4 for a description of how a Receiver MUST behave if it receives a request for an attribute outside this set.

An IPP administrator MAY read all attributes.

10.4 Enable-Printer and Disable-Printer operations [ipp-adm-ops]

The Enable-Printer and Disable-Printer operations [ipp-adm-ops] allow a remote operator to change the value of the Receiver's "printer-is-accepting-jobs" (boolean) Printer Description attribute (see section 6.4) to 'true' or 'false', respectively. These operations are OPTIONAL for a Receiver to support.

These operations affect all jobs that can be submitted to the Printer object. If a Print System supports both IPP and IPPFAX, then it MUST support them with separate Printer objects (see section 3.3). Therefore, a client MUST issue separate operations to each Printer object in order to affect both IPP and IPPFAX jobs on the same Print System, the 'ipp' URL scheme or the 'ippfax' URL scheme in the "printer-uri" target operation attribute for the IPP Printer object or the Receiver (IPPFAX Printer object), respectively.

10.5 Set-Printer-Attributes and Get-Printer-Supported-Values operations [RFC3380]

The Set-Printer-Attributes and Get-Printer-Supported-Values operations [RFC3380] are OPTIONAL administrative operation for IPPFAX, as for IPP. If a Receiver supports these operations, then the "document-format" and "~~uif~~pdfax-profile-requested" operation attributes MUST be supported for these

operations as well so that the administrator can set values that require Attribute Coloring (by document format and ~~UIF~~PDFax profile). See the description of the Get-Printer-Attributes operation in section 5 which also REQUIRES these operation attributes to be supported.

11 Security considerations

IPPFAX presents an interesting challenge of balancing security and openness. Many of the envisaged uses of IPPFAX require confidentiality of the data – at the same time the Receiver typically has no prior knowledge of the Sender or the Sending User. This last point will normally rule out all user-based authentication and access control. This is the reason for the restriction placed on querying and canceling IPPFAX Jobs.

11.1 Privacy

Any exchange between a Sender and a Receiver MUST be carried using the privacy mechanism specified in IPP/1.1 namely TLS [RFC2246]. In some cases this will also result in mutual authentication of the Sender and Receiver (in the case where both sides have certificates).

The Receiver MUST have a TLS certificate.

The Sender MAY have a certificate. A Receiver MAY decide to reject requests that come from Senders that do not have a certificate and return the 'client-error-not-authenticated' status code.

A Sender can either use its own certificate or it can use one associated with the Sending User.

Senders and Receivers SHOULD do what current browsers do, namely, be deployed with the public keys of a number of the top Certificate Authorities. If a Sender gets a public key from a Receiver that it doesn't recognize, the Sender MUST query the Sending User to see if the Sending User trusts the Receiver before sending the IPPFAX job to the Receiver.

The distribution of private keys to Senders or Receivers is outside the scope of this document, but it is done over the network, it MUST be over a secure channel. See Internet Key Exchange (IKE) [RFC2409].

11.2 uri-authentication-supported (1setOf type2 keyword) ([RFC2911] section 4.4.2)

This attribute (see [RFC2911] section 4.4.2) identifies the Client Authentication mechanism associated with each URI listed in the "printer-uri-supported" attribute (see section 6.1).

Table 13 - Authentication Requirements

"uri-authentication-supported" keyword	Sender support and usage	Receiver support and usage
none	MAY support and MAY use	MAY support and MAY use. If the 'none' value is supported by an implementation, then the administrator MUST be able to configure the Printer to not support the 'none' value (by means outsides the scope of this document)
requesting-user-name	MUST NOT	MUST NOT
basic	MAY support and MAY use when the TLS channel is secured with Data Privacy using the cipher suites indicated below* or stronger.	MAY support and MAY use when the TLS channel is secured with Data Privacy using the cipher suites indicated below* or stronger
digest	MUST support and MUST use, including the MD5 and MD5-sess algorithms and Message Integrity, unless using 'certificate' or 'negotiate'	MUST support and MAY use, including the MD5 and MD5-sess algorithms and Message Integrity
certificate	SHOULD support and MAY use when not using any of the above	MUST support and MAY use. For this value, the Receiver MUST validate the certificate for all client requests.

* TLS_DHE_DSS_WITH_3DES_EDE_CBC_SHA mandated by [RFC2246].

Table 14 compares the Digest Authentication requirements for IPP/1.1 clients, IPP/1.1 Printers, IPPFAX Senders, and IPPFAX Receivers.

Table 14 - Digest Authentication Conformance Requirements

Feature	IPP/1.1 Client	IPP/1.1 Printer	IPPFAX Sender	IPPFAX Receiver
MD5 and MD5-sess	must support must use	should support should use	MUST support MUST use	MUST support MUST use
The Message Integrity feature	must support may use	should support may use	MUST support MUST use	MUST support MUST use

11.3 uri-security-supported (1setOf type2 keyword) ([RFC2911] section 4.4.3)

This attribute (see [RFC2911] section 4.4.3) identifies the security (Integrity and Privacy) mechanisms used for each URI listed in the "printer-uri-supported" attribute (see section 6.1).

Table 15 - Security (Integrity and Privacy) Requirements

uri-security-supported	Sender support and usage	Receiver support and usage
none	MUST NOT	MUST NOT
ssl2	MUST NOT	MUST NOT
ssl3	MUST NOT	MUST NOT
tls	TLS Data Integrity - MUST support and MUST use	MUST support and MUST use
	TLS Data Privacy - MUST support and MAY use. The Sender (device) MUST query the Sending User (human) before omitting Privacy (encryption).	MUST support and MAY use

Table 16 compares the TLS conformance requirements for IPP/1.1 clients, IPP/1.1 Printers, IPPFAX Senders, and IPPFAX Receivers.

Table 16 - Transport Layer Security (TLS) Conformance Requirements

TLS Feature	IPP/1.1 Client	IPP/1.1 Printer	IPPFAX Sender	IPPFAX Receiver
Server Authentication	must support should use	should support may use	MUST use	MUST support
Client Authentication*	may support may use	may support may use	SHOULD support	MUST support MAY use
Data Integrity	may support may use	should support should use	MUST use	MUST support
Data Privacy	may support may use	should support may use	MUST support MAY** use.	MUST support

* The 'certificate' keyword value for the "uri-authentication-supported" attribute [RFC2911].

** The Sender MUST query the Sending User before omitting the Data Privacy encryption.

Senders and Receivers MUST support the TLS_DHE_DSS_WITH_3DES_EDE_CBC_SHA cipher suite as mandated by RFC 2246 [RFC2246]. All stronger cipher suites are OPTIONAL; weaker cipher suites MUST NOT be supported or used by Senders or Receivers.

A Receiver MAY support Basic Authentication (described in HTTP/1.1 [RFC2617]) for Client Authentication if the TLS channel is secured with Data Privacy. TLS with the above mandated cipher suite or stronger can provide such a secure channel.

11.4 Using IPPFAX with TLS

The Sender MUST use only TLS for all IPPFAX operations on the IPPFAX URL. The client MUST start the transaction in TLS, rather than using HTTP upgrade requests. The following paragraph of [RFC2818] further explains:

> The agent acting as the HTTP client should also act as the TLS client. It should initiate a connection to the server on the appropriate port and then send the TLS ClientHello to begin the TLS handshake. When the TLS handshake has finished. The client may then initiate the first HTTP request. All HTTP data MUST be sent as TLS "application data". Normal HTTP behavior, including retained connections should be followed.

Contrast this IPPFAX requirement with the IPP requirement in section 8.2 of [RFC2910]. The following client actions compare IPP with IPPFAX from a client's point of view:

IPP/1.1 sequence:

1. Start TCP connection
2. Zero or more HTTP/IPP requests
3. HTTP/IPP request with Upgrade to TLS header
4. TLS handshake
5. finish the HTTP/IPP request securely
6. Send more HTTP/IPP requests securely ...

IPPFAX sequence:

1. Start TCP connection
2. Send TLS ClientHello
3. rest of TLS handshake
4. Send HTTP/IPPFAX requests securely ... (which usually will be a Get-Printer-Attributes, followed by Validate-Job and Print-Job operations).

11.5 Access control

It is expected that the majority of IPPFAX Receivers will operate in a public mode when operating on the Internet, so that anonymous users can send documents without requiring client authentication (corresponding to the 'none' value for the "uri-authentication-supported" attribute - see section 11.2). However a Receiver MAY protect itself using any Client Authentication method specified in [RFC2911] (digest authentication [RFC2069] for example) to restrict access to any or all of its functionality.

However, the primary intent of IPPFAX is to create a controlled public access mode. It therefore does not really make much sense to combine IPPFAX and user authentication; they are achieving the same thing.

11.6 Reduced feature set

An administrator or device implementer MAY choose to setup up a Print Service so that it only works as a IPPFAX Receiver (i.e., offers no 'native' IPP operations and does not accept IPP Jobs). In this mode it offers a restricted set of features and MAY be more safely connected to the Internet.

A Receiver that is operating in this mode MUST do so by rejecting any non-IPPFAX request and return a 'client-error-attributes-or-values-not-supported' error status code as indicated in section 4.1 for an unsupported value of the "printer-uri" operation attribute. For job operations attempted on IPPFAX Jobs, the Receiver MUST return the 'client-error-not-authorized' error status code, unless the Sender is authenticated as the system administrator and the Receiver supports such access.

12 Gateways to other systems

A common scenario will be where IPPFAX acts as an on-ramp or off-ramp to other Document transmission systems.

12.1 Off-Ramps

In the IPPFAX 'Off-ramp' scenario the user with a Document to send uses an IPPFAX Sender to transmit a Document to an IPPFAX Receiver within a gateway that in turn transmits it to some other destination, i.e. GSTN FAX. Handling Off-ramps is beyond the scope of this document, but may be a future IPPFAX extensions building on the Off-ramp work of the Internet FAX WG.

12.2 On-Ramps

In the IPPFAX On-Ramp scenario the user originally sent the Document using some other mechanism to some intermediate agent. The intermediate agent, acting as an IPPFAX Sender, then uses the IPPFAX Protocol to transmit the Document to an Receiver which MAY be either a final destination or an Off-Ramp. IPPFAX has no specific support for on-ramps.

13 Attribute Syntaxes

No new attribute syntaxes are defined.

14 Status codes

In addition to the semantics of the status codes defined in [RFC2911] and [~~ipp-~~get-method], the following additional semantics are defined for [RFC2911] status codes:

14.1 client-error-bad-request (0x0400) [RFC2911 section 13.1.4.1]

The client has failed to supply one or more attributes in a request which are REQUIRED to be supplied. The requirement can be because of the Printer's current configuration or because of some other attributes that the client supplied. The Printer MUST reject the request, MUST return the 'client-error-bad-request' status code, and SHOULD return the keyword attribute name(s) (but not the values) of the missing attribute(s) in the Unsupported Attributes Group in the response.

14.2 document-format-not-supported (0x040A) [RFC2911 section 13.1.4.11]

The concept of a document format is extended to include the ~~UIF~~PDFax Profile. This status code is returned if the document format is not supported, including the indicated ~~UIF~~PDFax Profile.

15 Conformance Requirements

This section summarizes the conformance requirements for Senders and Receivers that are defined elsewhere in this document.

1. A Sender and Receiver MUST observe the attribute name space conventions specified in section 1.3.

2. The Sender MUST supply and the Receiver MUST support (1) the "printer-uri" operation attribute with the 'ippfax' scheme, (2) the "version-number" parameter with the IPP/1.1 '1.1' (or higher minor version) value, and (3) the "ippfax-version-number" operation attribute with the IPPFAX/1.0 '1.0' keyword value in all operations to get the IPPFAX semantics as described in section 4.

3. The Receiver MUST support the Get-Printer-Attributes operation as described in sections 5.

4. The Receiver MUST support the Printer Description attributes as specified in section 6.

5. The Sender MUST validate that the target Printer is IPPFAX-capable using the Get-Printer-Attributes operation and validate that the Receiver supports the job using the Validate-Job operation as specified in section 7.

6. The Sender MUST supply and the Receiver MUST support the operation/Job Description attributes for Identify Exchange as described in section 8.

7. The Sender MUST support submitting and the Receiver MUST accept IPPFAX Jobs as defined in section 9.

8. The Sender MUST place the Sender's identity in the document according to section 9.5.

9. The Sender and Receiver MUST support the IPP Notification for Job Creation operations, the 'ippget' Delivery Method, the Get-Notifications operation for the events indicated in sections 9.6, 9.3, and 9.3.2, respectively.

10. The Sender and Receiver MUST support the operations as indicated in section 10.

11. The Sender and Receiver MUST support the security mechanisms indicated in section 11, including TLS.

16 IPPFAX URL Scheme

This section is intended for use in registering the 'ippfax' URL scheme with IANA and fully conforms to the requirements in [RFC2717].

16.1 IPPFAX URL Scheme Applicability and Intended Usage

This document defines the 'ippfax' URL (Uniform Resource Locator) scheme for specifying the location of an IPPFAX Receiver which implements the IPPFAX Protocol specified in this document.

The 'ippfax' URL scheme defined in this document is based on the ABNF for the basic hierarchical URL syntax in [RFC2396]; however relative URL forms, parameters, and/or query parts are NOT allowed in an IPPFAX URL. The 'ippfax' URL scheme is case-insensitive in the host name or host address part; however the path part is case-sensitive, as in [RFC2396]. Codepoints outside [US-ASCII] MUST be hex escaped by the mechanism defined in [RFC2396].

The intended usage of the 'ippfax' URL scheme is COMMON.

16.2 IPPFAX URL Scheme Associated IPPFAX Port

All IPPFAX URLs which do NOT explicitly specify a port MUST be used over IANA-assigned well-known port xxx [TBA by IANA] for the IPPFAX Protocol.

See: IANA Port Numbers Registry [IANA-PORTREG].

16.3 IPPFAX URL Scheme Associated MIME Type

All IPPFAX protocol operations (requests and responses) MUST be conveyed in an 'application/ipp' MIME media type [RFC2910] as registered in [IANA-MT]. IPPFAX URLs MUST refer to IPPFAX Receivers which support this 'application/ipp' operation encoding.

See: IANA MIME Media Types Registry [IANA-MT].

16.4 IPPFAX URL Scheme Character Encoding

The IPPFAX URL scheme defined in this document is based on the ABNF for the HTTP URL scheme defined in HTTP/1.1 [RFC2616], which is derived from the URI Generic Syntax [RFC2396] and further updated by [RFC2732] and [RFC2373] (for IPv6 addresses in URLs). The IPPFAX URL scheme is case-

insensitive in the ‘scheme’ and ‘host’ (host name or host address) part; however, the ‘abs_path’ part is case-sensitive, as in [RFC2396]. Code points outside [US-ASCII] MUST be hex escaped by the mechanism specified in [RFC2396].

16.5 IPPFAX URL Scheme Syntax in ABNF

The IPP protocol places a limit of 1023 octets (NOT characters) on the length of a URI (see section 4.1.5 ‘uri’ in [RFC2911]). An IPPFAX Receiver MUST return ‘client-error-request-value-too-long’ (see section 13.1.4.10 in [RFC2911]) when a URI received in a request is too long.

Note: IPPFAX Receivers ought to be cautious about depending on URI lengths above 255 bytes, because some older client or proxy implementations might not properly support these lengths.

IPPFAX URLs MUST be represented in absolute form. Absolute URLs always begin with a scheme name followed by a colon. For definitive information on URL syntax and semantics, see “Uniform Resource Identifiers (URI): Generic Syntax and Semantics” [RFC2396]. This specification adopts the definitions of “port”, “host”, “abs_path”, and “query” from [RFC2396], as updated by [RFC2732] and [RFC2373] (for IPv6 addresses in URLs).

The IPPFAX URL scheme syntax in ABNF is as follows:

```
ippfax_URL = “ippfax:” “//” host [ “:” port ] [ abs_path [ “?” query ]]
```

If the port is empty or not given, the IANA-assigned port as defined in section 16.2 is assumed. The semantics are that the identified resource (see section 5.1.2 of [RFC2616]) is located at the IPPFAX Notification Recipient listening for HTTP connections on that port of that host, and the Request-URI for the identified resource is ‘abs_path’.

Note: The use of IP addresses in URLs SHOULD be avoided whenever possible (see [RFC1900]).

If the ‘abs_path’ is not present in the URL, it MUST be given as “/” when used as a Request-URI for a resource (see section 5.1.2 of [RFC2616]). If a proxy receives a host name which is not a fully qualified domain name, it MAY add its domain to the host name it received. If a proxy receives a fully qualified domain name, the proxy MUST NOT change the host name.

16.6 IPPFAX URL Examples

The following are examples of valid IPPFAX URLs for Notification Recipient objects (using DNS host names):

```
ippfax://abc.com
ippfax://abc.com/listener
```

Note: The use of IP addresses in URLs SHOULD be avoided whenever possible (see [RFC1900]).

The following literal IPv4 addresses:

```
     192.9.5.5                    ; IPv4 address in IPv4 style
     186.7.8.9                    ; IPv4 address in IPv4 style
```

are represented in the following example IPPFAX URLs:

```
     ippfax://192.9.5.5/listener
     ippfax://186.7.8.9/listeners/tom
```

The following literal IPv6 addresses (conformant to [RFC2373]):

```
     ::192.9.5.5                  ; IPv4 address in IPv6 style
     ::FFFF:129.144.52.38         ; IPv4 address in IPv6 style
     2010:836B:4179::836B:4179    ; IPv6 address per RFC 2373
```

are represented in the following example IPPFAX URLs:

```
     ippfax://[::192.9.5.5]/listener
     ippfax://[::FFFF:129.144.52.38]/listener
     ippfax://[2010:836B:4179::836B:4179]/listeners/tom
```

16.7 IPPFAX URL Comparisons

When comparing two IPPFAX URLs to decide if they match or not, the comparer MUST use the same rules as those defined for HTTP URI comparisons in [RFC2616], with the sole following exception:

- A port that is empty or not given MUST be treated as equivalent to the port as defined in section 16.2 for that IPPFAX URL;

17 IANA Considerations

IANA shall register the ippfax URL scheme as defined in section 16 according to the procedures of [RFC2717] and assign a well known port.

```
Operation Attributes:
ippfax-version-number (type2 keyword)            IEEE-ISTO 5102.1 4.3
~~uif~~pdfax-profile-requested (type2 keyword)          IEEE-ISTO 5102.1
5.2
~~uif~~pdfax-profiles (1setOf type2 keyword)            IEEE-ISTO 5102.1
9.1.3

Operation/Job Description attributes:
sending-user-vcard (text(MAX))                   IEEE-ISTO 5102.1 8.1
receiving-user-vcard (text(MAX                   IEEE-ISTO 5102.1 8.2
sender-uri (uri)                                 IEEE-ISTO 5102.1 8.3

Printer Description Attributes:
ippfax-versions-supported (1setOf type2 keyword) IEEE-ISTO 5102.1 6.3
```

```
pdfax-profiles-supported (1setOf type2 keyword)    IEEE-ISTO 5102.1 6.7
pdfax-profile-capabilities (1setOf text(MAX))      IEEE-ISTO 5102.1 6.8
```

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(c) 1986-1988, 1992 Adobe Systems Incorporated. All Rights Reserved.

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IPP Web Page: http://www.pwg.org/ipp/
IPP Mailing List: ipp@pwg.org

To subscribe to the ipp mailing list, send the following email:

1) send it to majordomo@pwg.org
2) leave the subject line blank
3) put the following two lines in the message body:

subscribe ipp
end

Implementers of this specification document are encouraged to join the IPP Mailing List in order to participate in any discussions of clarification issues and review of registration proposals for additional attributes and values. In order to reduce spam the mailing list rejects mail from non-subscribers, so you must subscribe to the mailing list in order to send a question or comment to the mailing list.

Other Participants:

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20 Appendix A: Comparison of IPP/1.1 and IPPFAX/1.0 (Informative)

This informative appendix compares IPP/1.1 and IPPFAX/1.0 with references to the appropriate sections for details. If this appendix contradicts or omits any differences, it is a mistake and the body of this document still prevails. Most of the differences are in conformance requirements only. Therefore, for most of the differences, it is possible to implement both with the same code (without conditional branches).

Legend:

** Where IPP/1.1 and IPPFAX/1.0 have a real difference, such as IPP/1.1 must and IPPFAX/1.0 MUST NOT, (indicated below by leading **), would a conditional branch be needed in the implementation code in order to support both IPP/1.1 and IPPFAX/1.0.

* Where IPP/1.1 is a may and IPPFAX/1.0 is a MUST NOT (indicated below by a leading *), would a conditional branch be needed in the implementation code in order to support both IPP/1.1 and IPPFAX/1.0, *but only if the IPP/1.1 part supports the feature*.

Differences between the IPP/1.1 protocol and the IPPFAX/1.0 protocol:

1. ** IPP uses the 'ipp' URL scheme with a default port of 631, while IPPFAX uses the 'ippfax' URL scheme with a default port of xxx [TBA by IANA] (section 4.1 and 16).

2. ** IPP has only one version number parameter, while IPPFAX has two version numbers: the "version-number" parameter for IPP (section 4.2) and the "ippfax-version-number" operation attribute for IPPFAX (section 4.3).

Differences between an IPP client and a Sender:

1. An IPP Client may use any IPP operation, while a Sender MUST use at least Get-Printer-Attributes (sections 5 and 7.1), Validate-Job (section 7.2), and Print-Job operations (section 9). A Sender MUST use the Get-Notifications operation, unless the Sending User has explicitly indicated otherwise (section 9.6).

2. In the Get-Printer-Attributes request, an IPP Client may supply the "document-format" and "~~uif~~pdfax-profile-requested" operation attributes, while a Sender SHOULD (sections 5.1 and 5.2) in order to get Attribute Coloring.

3. ** In the Job Creation operations and the Validate-Job operation, an IPP Client may supply the "ipp-attribute-fidelity" operation attribute with either the 'true' or 'false' value or may omit the attribute entirely, while the Sender MUST always supply the attribute and with the 'true' value (sections 7.2 and 9.1.1).

4. In the Job Creation operations and the Validate-Job operation, an IPP Client may supply the "document-format" operation attribute, while the Sender MUST supply it (section 9.1.2).

5. * An IPP Client may support any MIME Media Type as the value of the "document-format" operation attribute, while the Sender MUST support at least the 'image/tiff' MIME Media Type, MAY support the 'image/tiff-fx' MIME Media Type, and MUST NOT support any MIME Media Type unless it has the same "blind interchange" guarantee of document presentation fidelity as TIFF-FX [tiff-fx] (section 6.6).

6. In the Job Creation operations and the Validate-Job operation, an IPP Client may supply the "media" Job Template attribute, while the Sender MUST supply it (section 9.2.1).

7. * An IPP Client may supply any keyword listed in [RFC2911] section 14 (Appendix C) for the "media" Job Template attribute or the Media Size Self Describing Name keyword values defined in

the IEEE-ISTO 5101.1 “Media Standardized Names” [pwg-media], while the Sender MUST use the keyword values from [pwg-media] (section 9.2.1).

8. There are no requirements for an IPP Client to indicate the client or the client user in the document, while the Sender MUST supply the “sender-uri” value along with a date and time, on at least the cover page (section 9.5).

9. An IPP Client need not support Event Notification, while the Sender MUST support at least the ‘ippget’ Pull Delivery Method (section 9.3), which REQUIRES using the Get-Notifications operation (section 9.6).

10. An IPP Client may support any events, while a Sender MUST NOT support the ‘job-config-changed’ event and MUST NOT support any Printer events (section 9.3.2).

11. An IPP Client may support Client Authentication, while a Sender MUST support at least ‘digest’ and ‘certificate’ (section 11.2).

12. An IPP Client may support Data Integrity and Data Privacy, while a Sender MUST support Data Integrity and may use Data Privacy with at least the TLS_DHE_DSS_WITH_3DES_EDE_CBC_SHA cipher suite (section 11.2).

Differences between an IPP Printer and a Receiver:

1. In the Get-Printer-Attributes response, an IPP Printer may color the attribute values returned according to the “document-format” supplied, while a Receiver MUST color the values returned according to both the “document-format” and “~~uif~~pdfax-profile-requested” operation attributes supplied (sections 5 and 6), including the “printer-resolutions-supported” attribute (section 9.2.2.1).

2. * An IPP Printer is not required to support any particular document formats, while a Receiver MUST support the ~~UIF~~PDFax ‘image/tiff’ format with profile ~~uif~~pdfax-~~f~~s, MAY support ‘image/tiff-fx’, and MUST NOT support any others, unless they have the same level of “blind interchange” guarantee for document presentation fidelity as TIFF-FX (section 6.6) .

3. * An IPP Printer may support ‘application/octet-stream’ (auto-sensing - [RFC2911] 4.1.9.1), while a Receiver MUST NOT (section 6.6).

4. An IPP Printer may support the IPPFAX attributes: “~~uif~~pdfax-profile-requested”, “~~uif~~pdfax-profiles-supported”, “sending-user-vcard”, “receiving-user-vcard”, “sender-uri”, and “~~uif~~pdfax-profiles”, while a Receiver MUST (sections 5.2, 6, 8, and 9.1.3).

5. ** An IPP Printer MUST NOT support the “ippfax-versions” and “ippfax-versions-supported” attributes, while a Receiver MUST (sections 4.3 and 6.3).

6. ** An IPP Printer must support both values of the “ipp-attribute-fidelity” operation attribute, while the Receiver MUST only support the ‘true’ value (section 9.1.1).

7. ** An IPP Printer must assume a value of ‘false’ if the IPP Client omits the “ipp-attribute-fidelity” operation attribute, while the Receiver MUST reject the request with the ‘client-error-bad-request’ status code (section 9.1.1).

8. An IPP Printer is not required to support any particular Job Template attributes, while a Receiver MUST support at least the “media” and “printer-resolution” Job Template attributes, including the “media-ready” Printer attribute (section 9.2).

9. * An IPP Printer may supply any keyword listed in [RFC2911] section 14 (Appendix C) for the “media” Job Template attribute or the Media Size Self Describing Name keyword values defined in the IEEE-ISTO 5101.1 “Media Standardized Names” [pwg-media], while the Receiver MUST support a subset of the keyword values from [pwg-media] (section 9.2.1).

10. * An IPP Printer may support any Job Template attribute values, while a Receiver is restricted to a single value for many Job Template attributes for which other values would alter the appearance of the document or provide a non-FAX-like feature (section 9.2).

11. * An IPP Printer may support Print-URI and Send-URI operations, while a Receiver MUST NOT (section 10.1).

12. An IPP Printer must support Get-Jobs and Get-Job-Attributes operations, while a Receiver NEED NOT (section 10.1).

13. ** An IPP Printer must support Cancel-Job operation, while a Receiver MUST NOT (section 10.2).

14. An IPP Printer may support administrative operations without authentication, while a Receiver MUST authenticate administrative operations, if administrative operations are supported (section 10.1).

15. * An IPP Printer may support the following operations from an authenticated operator or administrator: Purge-Jobs, Cancel-Current-Job, Cancel-Job, and Schedule-Job-After, while a Receiver MUST reject such operations from an authenticated operator or administrator.

16. An IPP Printer may support Event Notification, while a Receiver MUST support Event Notification (sections 9.3 and 10.1) and at least the ‘ippget’ Delivery Method (section 9.6), which REQUIRES support for the Get-Notifications operation.

17. If an IPP Printer supports Event Notification, it must support the ‘job-state-changed’ and ‘job-created’ events for Per-Job Subscriptions, while a Receiver NEED NOT (section 9.3.2).

18. ** If an IPP Printer supports Printer Events, then it MUST support them for both Per-Job and Per-Printer Subscriptions, while a Receiver MUST NOT support them for Per-Job Subscriptions (section 9.3.2).

19. If an IPP Printer supports Event Notification, it may support the ‘job-progress’ event, while a Receiver MUST for Per-Job Subscriptions (section 9.3.2).

20. * If an IPP Printer supports Event Notification, it may support the 'job-config-changed' event, while a Receiver MUST NOT (section 9.3.2).

21. If an IPP Printer supports the Set-Printer-Attributes operation, then it may support setting the Attribute Coloring values according to the "document-format" operation attribute, while the Receiver, if it supports the Set-Printer-Attributes operation, MUST support setting the Attribute Coloring values according to the "document-format" and "~~uif~~pdfax-profile-requested" operation attributes (section 10.5).

22. An IPP Printer should support and may use TLS, while a Receiver MUST support and MUST use TLS (section 11.3).

23. An IPP Printer may support Client Authentication, while a Receiver MUST support at least 'digest' and 'certificate' (section 11.2).

24. An IPP Printer may support Data Integrity and Data Privacy and support them with any cipher suite, while a Receiver MUST support both Data Integrity and Data Privacy with at least the TLS_DHE_DSS_WITH_3DES_EDE_CBC_SHA cipher suite (section 11.2).

21 Appendix B: vCard Example

The following ASCII text is a complete vCard v3.0 [RFC2426, RFC2425] example:

```
BEGIN:VCARD
VERSION:3.0
N:Moore;Paul
FN:Paul Moore
ORG:Netreon
TEL;CELL;VOICE:1+206-251-7008
ADR;WORK:;;10900 NE 8th St;Bellvue;WA;98004;United States of America
EMAIL;PREF;INTERNET:pmoore@netreon.com
REV:19991207T215341Z
END:VCARD
```

22 Appendix C: Generic Directory Schema for an IPPFAX Receiver

This section defines a generic schema for an entry in a directory service. A directory service is a means by which service users can locate service providers. In IPPFAX environments, this means that Receivers (IPPFAX Printers) can be registered (either automatically or with the help of an administrator) as entries of type PRINTER in the directory using an IMPLEMENTATION SPECIFIC mechanism such as entry attributes, entry type fields, specific branches, etc. Directory clients can search or browse for entries of type PRINTER. Clients use the directory service to find entries based on naming, organizational contexts, or filtered searches on attribute values of entries. For example, a client can find all printers in the "Local Department" context. Authentication and authorization are also often part of a directory service so that an

administrator can place limits on end users so that they are only allowed to find entries to which they have certain access rights. IPPFAX itself does not require any specific directory service protocol or provider.

Note: Some directory implementations allow for the notion of “aliasing”. That is, one directory entry object can appear as multiple directory entry objects with different names for each object. In each case, each alias refers to the same directory entry object which refers to a single IPPFAX Printer object.

The generic IPPFAX schema is a subset of IPPFAX Job Template and Printer Description attributes (Table 1, Table 2, and [RFC2911] sections 4.2 and 4.4). These attributes are identified as either RECOMMENDED or OPTIONAL for the directory entry itself. This conformance labeling is NOT the same conformance labeling applied to the attributes of IPPFAX Printers objects. The conformance labeling in this Appendix is intended to apply to directory templates and to Receivers that subscribe by adding one or more entries to a directory. RECOMMENDED attributes SHOULD be associated with each directory entry. OPTIONAL attributes MAY be associated with the directory entry (if known or supported). In addition, all directory entry attributes SHOULD reflect the current attribute values for the corresponding IPPFAX Printer object.

The names of attributes in directory schema and entries SHOULD be the same as the IPPFAX Printer attribute names as shown, as much as possible.

In order to bridge between the directory service and the IPPFAX Printer object, one of the RECOMMENDED directory entry attributes is the Printer object’s “printer-uri-supported” attribute. The directory client queries the “printer-uri-supported” attribute (or its equivalent) in the directory entry and then the IPPFAX client addresses the IPPFAX Printer object using one of its URIs. The “uri-security-supported” attribute identifies the protocol (if any) used to secure a channel. If a Printer object supports both IPP and IPPFAX, there should be two separate directory entries in order to represent these two services.

Table 17 defines the generic schema for directory entries of abstract type PRINTER. In the future this schema could also be directory entries of type FAX. In either case, the concrete type MUST be IPPFAX. If a Printer object supports both IPP and IPPFAX, there should be two separate directory entries in order to represent these two services, one with concrete type IPP and the other with concrete type IPPFAX, respectively.

Table 17 - Generic Schema Directory Entries

Attribute	Conformance	Reference
All of the attributes in [RFC2911] section 16 Appendix E Generic Directory Schema (including “ipp-versions-supported” - see section 6.2), plus:	As stated in [RFC2911] section 16	[RFC2911]
ippfax-versions-supported (1setOf type2 keyword)	RECOMMENDED	section 6.3
~~uif~~pdfax-profiles-supported (1setOf type2 keyword)	RECOMMENDED	section 6.7

23 Appendix D: Summary of other IPP documents

The full set of IPP documents includes:

1. Design Goals for an Internet Printing Protocol [RFC2567]
2. Rationale for the Structure and Model and Protocol for the Internet Printing Protocol [RFC2568]
3. Internet Printing Protocol/1.1: Model and Semantics (this document)
4. Internet Printing Protocol/1.1: Encoding and Transport [RFC2910]
5. Internet Printing Protocol/1.1: Implementer's Guide [RFC3196] and [ipp-iig-bis]
6. Mapping between LPD and IPP Protocols [RFC2569]

The "Design Goals for an Internet Printing Protocol" document takes a broad look at distributed printing functionality, and it enumerates real-life scenarios that help to clarify the features that need to be included in a printing protocol for the Internet. It identifies requirements for three types of users: end users, operators, and administrators. It calls out a subset of end user requirements that are satisfied in IPP/1.0. A few OPTIONAL operator operations have been added to IPP/1.1.

The "Rationale for the Structure and Model and Protocol for the Internet Printing Protocol" document describes IPP from a high level view, defines a roadmap for the various documents that form the suite of IPP specification documents, and gives background and rationale for the IETF working group's major decisions.

The "Internet Printing Protocol/1.1: Encoding and Transport" document is a formal mapping of the abstract operations and attributes defined in the model document onto HTTP/1.1 [RFC2616]. It defines the encoding rules for a new Internet MIME media type called "application/ipp". This document also defines the rules for transporting over HTTP a message body whose Content-Type is "application/ipp". This document defines a new scheme named 'ipp' for identifying IPP printers and jobs.

The "Internet Printing Protocol/1.1: Implementer's Guide" document gives insight and advice to implementers of IPP clients and IPP objects. It is intended to help them understand IPP/1.1 and some of the considerations that may assist them in the design of their client and/or IPP object implementations. For example, a typical order of processing requests is given, including error checking. Motivation for some of the specification decisions is also included.

The "Mapping between LPD and IPP Protocols" document gives some advice to implementers of gateways between IPP and LPD (Line Printer Daemon) implementations.

24 Appendix E: Description of the IEEE Industry Standards and Technology (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/).

For additional information regarding the IEEE-ISTO and its industry programs visit:

http://www.ieee-isto.org.

25 Appendix F: Description of the IEEE-ISTO PWG

The Printer Working Group (or PWG) is a Program of the IEEE Industry Standards and Technology Organization (ISTO) and is an alliance among printer manufacturers, print server developers, operating system providers, network operating systems providers, network connectivity vendors, and print management application developers 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

26 Revision History (to be removed when standard is approved)

Revision	Date	Author	Notes
1	1/16/01	Paul Moore, Netreon	Initial version
2	2/27/01	Paul Moore, Gail Songer, Netreon	Specify TLS as MUST Removed Cover page and combined device Added need for big text types
3	4/11/01	Gail Songer, Netreon	Move attribute definition to first reference
4	5/24/01	Tom Hastings	Editorially updated the document to follow the style of the IPP standard documents. Added 23 issues to be reviewed. Capitalized the special terms throughout without showing revisions in order to make the document with revisions more readable.
5	5/21/01	Tom Hastings, John Pulera, Ira McDonald	Updated from the 6/6/01 telecon agreements on most of the 23 issues. There are 20 issues remaining, mostly new.
6	7/27/01	Tom Hastings, Ira McDonald	Updated from the 6/29/01 telecon. There are 41 issues remaining, mostly new.
7	10/8/01	Tom Hastings, Ira McDonald	Updated with all the resolutions to the 41 ISSUES from the August 1, 2001 IPPFAX WG meeting in Toronto, and the subsequent telecons: August, 9, 14, and 17, 2001. There are 4 (new) issues remaining.
8	11/17/01	Tom Hastings	Updated with the agreements from the IPPFAX WG

			meeting, 10/24/01, Texas. See minutes. There are 5 issues remaining.
9	12/31/01	Tom Hastings	Updated with the agreements reached at the 12/14/01 telecon.
10	2/19/02	Tom Hastings	Updated with the agreements reached as the 2/5/02 IPPFAX WG meeting. There are no remaining issues.
11	9/20/02	Tom Hastings	Replaced all occurrences of UIF with PDFax and uif with pdfax. Replaced profile S with F, J with T, and L with D.

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