INTERNET-DRAFT

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~~February 17, 1998~~May 10, 1999

Internet Printing Protocol/1.1: Encoding and Transport

Status of this Memo

Abstract

This document is one of a set of documents, which together describe all aspects of a new Internet Printing Protocol (IPP). IPP is an application level protocol that can be used for distributed printing using Internet tools and technologies. This document defines the rules for encoding IPP operations and IPP attributes into a new Internet mime media type called ~~“application/ipp”.~~"application/ipp". This document also defines the rules for transporting over HTTP a message body whose Content-Type is ~~“application/ipp”.~~"application/ipp". This document defines a new scheme named ~~‘ipp’~~'ipp' for identifying IPP printers and jobs. Finally, this document defines rules for supporting IPP/1.0 ~~clients~~Clients and Printers.

The full set of IPP documents includes:

Design Goals for an Internet Printing Protocol ~~[ipp-req]~~[rfc2567]
Rationale for the Structure and Model and Protocol for the Internet Printing Protocol ~~[ipp-rat]~~[rfc2568]
Internet Printing Protocol/1.1: Model and Semantics [ipp-mod]
Internet Printing Protocol/1.1: Encoding and Transport (this document)
Internet Printing Protocol/1.1: ~~Implementer’s~~Implementer's Guide [ipp-iig]
Mapping between LPD and IPP Protocols ~~[ipp-lpd]~~[rfc2069]

The document, ~~“Design~~"Design Goals for an Internet Printing ~~Protocol”,~~Protocol", 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/1.1. Operator and administrator requirements are out of scope for version 1.1.

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

The document, ~~“Internet~~"Internet Printing Protocol/1.1: Model and ~~Semantics”,~~Semantics", describes a simplified model with abstract objects, their attributes, and their operations that are independent of encoding and transport. It introduces a Printer and a Job object. The Job object optionally supports multiple documents per Job. It also addresses security, internationalization, and directory issues.

The document ~~“Internet~~"Internet Printing Protocol/1.1: ~~Implementer’s Guide”,~~Implementer's Guide", gives advice to implementers of IPP clients and IPP objects.

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

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1. Introduction

This document contains the rules for encoding IPP operations and describes two layers: the transport layer and the operation layer.

The transport layer consists of an HTTP/1.1 request or response. RFC 2068 [rfc2068] describes HTTP/1.1. This document specifies the HTTP headers that an IPP implementation supports.

The operation layer consists of a message body in an HTTP request or response. The document "Internet Printing Protocol/1.1: Model and Semantics" [ipp-mod] defines the semantics of such a message body and the supported values. This document specifies the encoding of an IPP operation. The aforementioned document [ipp-mod] is henceforth referred to as the ~~“IPP model document”~~"IPP model document"

2. Conformance Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [rfc2119].

3. Encoding of the Operation Layer

The operation layer MUST contain a single operation request or operation response. Each request or response consists of a sequence of values and attribute groups. Attribute groups consist of a sequence of attributes each of which is a name and value. Names and values are ultimately sequences of octets

The encoding consists of octets as the most primitive type. There are several types built from octets, but three important types are integers, character strings and octet strings, on which most other data types are built. Every character string in this encoding MUST be a sequence of characters where the characters are associated with some charset and some natural language. A character string MUST be in ~~“reading order”~~"reading order" with the first character in the value (according to reading order) being the first character in the encoding. A character string whose associated charset is US-ASCII whose associated natural language is US English is henceforth called a US-ASCII-STRING. A character string whose associated charset and natural language are specified in a request or response as described in the model document is henceforth called a LOCALIZED-STRING. An octet string MUST be in ~~“IPP~~"IPP model document ~~order”~~order" with the first octet in the value (according to the IPP model document order) being the first octet in the encoding Every integer in this encoding MUST be encoded as a signed integer using ~~two’s-complement~~two's-complement binary encoding with big-endian format (also known as ~~“network order” and “most~~"network order" and "most significant byte ~~first”).~~first"). The number of octets for an integer MUST be 1, 2 or 4, depending on usage in the protocol. Such one-octet integers, henceforth called SIGNED-BYTE, are used for the version-number and tag fields. Such two-byte integers, henceforth called SIGNED-SHORT are used for the operation-id, status-code and length fields. Four byte integers, henceforth called SIGNED-INTEGER, are used for values fields and the sequence number.

The following two sections present the operation layer in two ways

- informally through pictures and description
- formally through Augmented Backus-Naur Form (ABNF), as specified by RFC 2234 [rfc2234]

3.1 Picture of the Encoding

The encoding for an operation request or response consists of:

```
    -----------------------------------------------
    |             version-number                  |   2 bytes  - required
    -----------------------------------------------
    |          operation-id (request)             |
    |                  or                         |   2 bytes  - required
    |          status-code (response)             |
    -----------------------------------------------
    |               request-id                    |   4 bytes  - required
    -----------------------------------------------------------
    |          xxx-attributes-tag                 |   1 byte  |
    -----------------------------------------------           |-0 or more
    |        xxx-attribute-sequence               |   n bytes |
    -----------------------------------------------------------
    |         end-of-attributes-tag               |   1 byte   - required
    -----------------------------------------------
    |                  data                       |   q bytes  - optional
    -----------------------------------------------
```

The xxx-attributes-tag and xxx-attribute-sequence represents four different values of ~~“xxx”,~~"xxx", namely, operation, job, printer and unsupported. The xxx-attributes-tag and an xxx-attribute-sequence represent attribute groups in the model document. The xxx-attributes-tag identifies the attribute group and the xxx-attribute-sequence contains the attributes.

The expected sequence of xxx-attributes-tag and xxx-attribute-sequence is specified in the IPP model document for each operation request and operation response.

A request or response SHOULD contain each xxx-attributes-tag defined for that request or response even if there are no attributes except for the unsupported-attributes-tag which SHOULD be present only if the unsupported-attribute-sequence is non-empty. A receiver of a request MUST be able to process as equivalent empty attribute groups:

a) an xxx-attributes-tag with an empty xxx-attribute-sequence,

b) an expected but missing xxx-attributes-tag.

The data is omitted from some operations, but the end-of-attributes-tag is present even when the data is omitted. Note, the xxx-attributes-tags and end-of-attributes-tag are called ~~‘delimiter-tags’.~~'delimiter-tags'. Note: the xxx-attribute-sequence, shown above may consist of 0 bytes, according to the rule below.

An xxx-attributes-sequence consists of zero or more compound-attributes.

```
    -----------------------------------------------
    |            compound-attribute               |   s bytes - 0 or more
    -----------------------------------------------
```

A compound-attribute consists of an attribute with a single value followed by zero or more additional values.

Note: a ~~‘compound-attribute’~~'compound-attribute' represents a single attribute in the model document. The ~~‘additional value’~~'additional value' syntax is for attributes with 2 or more values.

Each attribute consists of:

```
-----------------------------------------------
|                  value-tag                  |   1 byte
-----------------------------------------------
|               name-length  (value is u)     |   2 bytes
-----------------------------------------------
|                     name                    |   u bytes
-----------------------------------------------
|              value-length  (value is v)     |   2 bytes
-----------------------------------------------
|                     value                   |   v bytes
-----------------------------------------------
```

An additional value consists of:

```
-----------------------------------------------------------
|                  value-tag                  |   1 byte  |
-----------------------------------------------           |
|            name-length  (value is 0x0000)   |   2 bytes |
-----------------------------------------------           |-0 or more
|              value-length (value is w)      |   2 bytes |
-----------------------------------------------           |
|                     value                   |   w bytes |
-----------------------------------------------------------
```

Note: an additional value is like an attribute whose name-length is 0.

From the standpoint of a parsing loop, the encoding consists of:

```
-----------------------------------------------
|                 version-number              |   2 bytes  - required
-----------------------------------------------
|               operation-id (request)        |
|                      or                     |   2 bytes  - required
|               status-code (response)        |
-----------------------------------------------
|                   request-id                |   4 bytes  - required
-----------------------------------------------------------
|        tag (delimiter-tag or value-tag)     |   1 byte  |
-----------------------------------------------           |-0 or more
|           empty or rest of attribute        |   x bytes |
-----------------------------------------------------------
|              end-of-attributes-tag          |   2 bytes  - required
-----------------------------------------------
|                     data                    |   y bytes  - optional
-----------------------------------------------
```

The value of the tag determines whether the bytes following the tag are:

- attributes
- data
- the remainder of a single attribute where the tag specifies the type of the value.

3.2 Syntax of Encoding

The syntax below is ABNF [rfc2234] except ~~‘strings of literals’~~'strings of literals' MUST be case sensitive. For example ~~‘a’~~'a' means lower case ~~‘a’~~'a' and not upper case ~~‘A’.~~'A'. In addition, SIGNED-BYTE and SIGNED-SHORT fields are represented as ~~‘%x’~~'%x' values which show their range of values.

```
ipp-message = ipp-request / ipp-response
ipp-request = version-number operation-id request-id
        *(xxx-attributes-tag  xxx-attribute-sequence) end-of-attributes-tag data
ipp-response = version-number status-code request-id
        *(xxx-attributes-tag xxx-attribute-sequence)  end-of-attributes-tag  data
xxx-attribute-sequence = *compound-attribute

xxx-attributes-tag = operation-attributes-tag / job-attributes-tag /
     printer-attributes-tag / unsupported-attributes-tag

version-number = major-version-number minor-version-number
major-version-number = SIGNED-BYTE  ; initially %d1
minor-version-number = SIGNED-BYTE  ; initially %d0

operation-id = SIGNED-SHORT    ; mapping from model defined below
status-code = SIGNED-SHORT  ; mapping from model defined below
request-id = SIGNED-INTEGER ; whose value is > 0

compound-attribute = attribute *additional-values

attribute = value-tag name-length name value-length value
additional-values = value-tag zero-name-length value-length value

name-length = SIGNED-SHORT    ; number of octets of ~~‘name’~~'name'
name = LALPHA *( LALPHA / DIGIT / ~~“-” / “_” / “.”~~"-" / "_" / "." )
value-length = SIGNED-SHORT  ; number of octets of ~~‘value’~~'value'
value = OCTET-STRING

data = OCTET-STRING

zero-name-length = %x00.00                      ; name-length of 0
operation-attributes-tag =  %x01                ; tag of 1
job-attributes-tag          =  %x02             ; tag of 2
printer-attributes-tag =  %x04                  ; tag of 4
unsupported- attributes-tag =  %x05    ; tag of 5
end-of-attributes-tag = %x03                    ; tag of 3
value-tag = %x10-FF

SIGNED-BYTE = BYTE
SIGNED-SHORT = 2BYTE
SIGNED-INTEGER = 4BYTE
DIGIT = %x30-39    ;  "0" to "9"
LALPHA = %x61-7A   ;  "a" to "z"
BYTE = %x00-FF
OCTET-STRING = *BYTE
```

The syntax allows an xxx-attributes-tag to be present when the xxx-attribute-sequence that follows is empty. The syntax is defined this way to allow for the response of Get-Jobs where no attributes are returned for some job-objects. Although it is

RECOMMENDED that the sender not send an xxx-attributes-tag if there are no attributes (except in the Get-Jobs response just mentioned), the receiver MUST be able to decode such syntax.

3.3 Version-number

The version-number MUST consist of a major and minor version-number, each of which MUST be represented by a SIGNED-BYTE. The protocol described in this document MUST have a major version-number of 1 (0x01) and a minor version-number of 1 (0x01). The ABNF for these two bytes MUST be %x01.01.

3.4 Operation-id

Operation-ids are defined as enums in the model document. An operation-ids enum value MUST be encoded as a SIGNED-SHORT.

Note: the values 0x4000 to 0xFFFF are reserved for private extensions.

3.5 Status-code

Status-codes are defined as enums in the model document. A status-code enum value MUST be encoded as a SIGNED-SHORT.

The status-code is an operation attribute in the model document. In the protocol, the status-code is in a special position, outside of the operation attributes.

If an IPP status-code is returned, then the HTTP Status-Code MUST be 200 (successful-ok). With any other HTTP Status-Code value, the HTTP response MUST NOT contain an IPP message-body, and thus no IPP status-code is returned.

3.6 Request-id

The request-id allows a client to match a response with a request. This mechanism is unnecessary in HTTP, but may be useful when application/ipp entity bodies are used in another context.

The request-id in a response MUST be the value of the request-id received in the corresponding request. A client can set the request-id in each request to a unique value or a constant value, such as 1, depending on what the client does with the request-id returned in the response. The value of the request-id MUST be greater than zero.

3.7 Tags

There are two kinds of tags:

- delimiter tags: delimit major sections of the protocol, namely attributes and data
- value tags: specify the type of each attribute value

3.7.1 Delimiter Tags

The following table specifies the values for the delimiter tags:

Tag Value (Hex)	**Delimiter**
0x00	reserved
0x01	operation-attributes-tag
0x02	job-attributes-tag
0x03	end-of-attributes-tag
0x04	printer-attributes-tag
0x05	unsupported-attributes-tag
0x06-0x0e	reserved for future delimiters
0x0F	reserved for future chunking-end-of-attributes-tag

When an xxx-attributes-tag occurs in the protocol, it MUST mean that zero or more following attributes up to the next delimiter tag are attributes belonging to group xxx as defined in the model document, where xxx is operation, job, printer, unsupported.

Doing substitution for xxx in the above paragraph, this means the following. When an operation-attributes-tag occurs in the protocol, it MUST mean that the zero or more following attributes up to the next delimiter tag are operation attributes as defined in the model document. When an job-attributes-tag occurs in the protocol, it MUST mean that the zero or more following attributes up to the next delimiter tag are job attributes or job template attributes as defined in the model document. When a printer-attributes-tag occurs in the protocol, it MUST mean that the zero or more following attributes up to the next delimiter tag are printer attributes as defined in the model document. When an unsupported-attributes-tag occurs in the protocol, it MUST mean that the zero or more following attributes up to the next delimiter tag are unsupported attributes as defined in the model document.

The operation-attributes-tag and end-of-attributes-tag MUST each occur exactly once in an operation. The operation-attributes-tag MUST be the first tag delimiter, and the end-of-attributes-tag MUST be the last tag delimiter. If the operation has a document-content group, the document data in that group MUST follow the end-of-attributes-tag.

Each of the other three xxx-attributes-tags defined above is OPTIONAL in an operation and each MUST occur at most once in an operation, except for job-attributes-tag in a Get-Jobs response which may occur zero or more times.

The order and presence of delimiter tags for each operation request and each operation response MUST be that defined in the model document. For further details, see section 3.9 ~~“~~"(Attribute) Name~~”~~" and section 11 ~~“~~"Appendix A: Protocol Examples~~”.~~".

A Printer MUST treat the reserved delimiter tags differently from reserved value tags so that the Printer knows that there is an entire attribute group that it ~~doesn’t~~doesn't understand as opposed to a single value that it ~~doesn’t~~doesn't understand.

3.7.2 Value Tags

The remaining tables show values for the value-tag, which is the first octet of an attribute. The value-tag specifies the type of the value of the attribute. The following table specifies the ~~“out-of-band”~~"out-of-band" values for the value-tag.

Tag Value (Hex)	**Meaning**
0x10	unsupported
~~0x11~~	~~reserved for future ‘default’~~
0x11	reserved for future 'default'
0x12	unknown
0x13	no-value
~~0x14-0x1F~~	~~reserved for future “out-of-band” values.~~
0x14-0x1F	reserved for future "out-of-band" values.

The ~~“unsupported”~~"unsupported" value MUST be used in the attribute-sequence of an error response for those attributes which the printer does not support. The ~~“default”~~"default" value is reserved for future use of setting value back to their default value.

The ~~“unknown”~~"unknown" value is used for the value of a supported attribute when its value is temporarily unknown. The ~~“no-value”~~"no-value" value is used for a supported attribute to which no value has been assigned, e.g. ~~“job-k-octets-supported”~~"job-k-octets-supported" has no value if an implementation supports this attribute, but an administrator has not configured the printer to have a limit.

The following table specifies the integer values for the value-tag:

Tag Value (Hex)	**Meaning**
0x20	reserved
0x21	integer
0x22	boolean
0x23	enum
0x24-0x2F	reserved for future integer types

NOTE: 0x20 is reserved for ~~“generic integer”~~"generic integer" if it should ever be needed.

The following table specifies the octetString values for the value-tag:

Tag Value (Hex)	**Meaning**
0x30	octetString with an unspecified format
0x31	dateTime
0x32	resolution
0x33	rangeOfInteger
0x34	reserved for collection (in the future)
0x35	textWithLanguage
0x36	nameWithLanguage
0x37-0x3F	reserved for future octetString types

The following table specifies the character-string values for the value-tag:

Tag Value (Hex)	**Meaning**
0x40	reserved
0x41	textWithoutLanguage
0x42	nameWithoutLanguage
0x43	reserved
0x44	keyword
0x45	uri
0x46	uriScheme
0x47	charset
0x48	naturalLanguage
0x49	mimeMediaType
0x4A-0x5F	reserved for future character string types

NOTE: 0x40 is reserved for ~~“generic character-string”~~"generic character-string" if it should ever be needed.

NOTE: an attribute value always has a type, which is explicitly specified by its tag; one such tag value is "nameWithoutLanguage". An attribute's name has an implicit type, which is keyword.

The values 0x60-0xFF are reserved for future types. There are no values allocated for private extensions. A new type MUST be registered via the type 2 registration process [ipp-mod].

The tag 0x7F is reserved for extending types beyond the 255 values available with a single byte. A tag value of 0x7F MUST signify that the first 4 bytes of the value field are interpreted as the tag value. Note, this future extension doesn't affect parsers that are unaware of this special tag. The tag is like any other unknown tag, and the value length specifies the length of a value which contains a value that the parser treats atomically. All these 4 byte tag values are currently unallocated except that the values 0x40000000-0x7FFFFFFF are reserved for experimental use.

3.8 Name-Length

The name-length field MUST consist of a SIGNED-SHORT. This field MUST specify the number of octets in the name field which follows the name-length field, excluding the two bytes of the name-length field.

If a name-length field has a value of zero, the following name field MUST be empty, and the following value MUST be treated as an additional value for the preceding attribute. Within an attribute-sequence, if two attributes have the same name, the first occurrence MUST be ignored. The zero-length name is the only mechanism for multi-valued attributes.

3.9 (Attribute) Name

Some operation elements are called parameters in the model document [ipp-mod]. They MUST be encoded in a special position and they MUST NOT appear as an operation attributes. These parameters are:

- ~~“version-number”:~~"version-number": The parameter named ~~“version-number”~~"version-number" in the IPP model document MUST become the ~~“version-number”~~"version-number" field in the operation layer request or response.

- ~~“operation-id”:~~"operation-id": The parameter named ~~“operation-id”~~"operation-id" in the IPP model document MUST become the ~~“operation-id”~~"operation-id" field in the operation layer request.

- ~~“status-code”:~~"status-code": The parameter named ~~“status-code”~~"status-code" in the IPP model document MUST become the ~~“status-code”~~"status-code" field in the operation layer response.

- ~~“request-id”:~~"request-id": The parameter named ~~“request-id”~~"request-id" in the IPP model document MUST become the ~~“request-id”~~"request-id" field in the operation layer request or response.

All Printer and Job objects are identified by a Uniform Resource Identifier (URI) [rfc2396] so that they can be persistently and unambiguously referenced. The notion of a URI is a useful concept, however, until the notion of URI is more stable (i.e., defined more completely and deployed more widely), it is expected that the URIs used for IPP objects will actually be URLs [rfc1738] [rfc1808]. Since every URL is a specialized form of a URI, even though the more generic term URI is used throughout the rest of this document, its usage is intended to cover the more specific notion of URL as well.

Some operation elements are encoded twice, once as the request-URI on the HTTP Request-Line and a second time as a REQUIRED operation attribute in the application/ipp entity. These attributes are the target URI for the operation and are called printer-uri and job-uri. Note: The target URI is included twice in an operation referencing the same IPP object, but the two URIs NEED NOT be literally identical. One can be a relative URI and the other can be an absolute URI. HTTP/1.1 allows clients to generate and send a relative URI rather than an absolute URI. A relative URI identifies a resource with the scope of the HTTP server, but does not include scheme, host or port. The following statements characterize how URLs should be used in the mapping of IPP onto HTTP/1.1:

1. Although potentially redundant, a client MUST supply the target of the operation both as an operation attribute and as a URI at the HTTP layer. The rationale for this decision is to maintain a consistent set of rules for mapping application/ipp to possibly many communication layers, even where URLs are not used as the addressing mechanism in the transport layer.

2. Even though these two URLs might not be literally identical (one being relative and the other being absolute), they MUST both reference the same IPP object.
3. The URI in the HTTP layer is either relative or absolute and is used by the HTTP server to route the HTTP request to the correct resource relative to that HTTP server. The HTTP server need not be aware of the URI within the operation request.
4. Once the HTTP server resource begins to process the HTTP request, it might get the reference to the appropriate IPP Printer object from either the HTTP URI (using to the context of the HTTP server for relative URLs) or from the URI within the operation request; the choice is up to the implementation.
5. HTTP URIs can be relative or absolute, but the target URI in the operation MUST be an absolute URI.

The model document arranges the remaining attributes into groups for each operation request and response. Each such group MUST be represented in the protocol by an xxx-attribute-sequence preceded by the appropriate xxx-attributes-tag (See the table below and section 11 ~~“~~"Appendix A: Protocol Examples~~”).~~"). In addition, the order of these xxx-attributes-tags and xxx-attribute-sequences in the protocol MUST be the same as in the model document, but the order of attributes within each xxx-attribute-sequence MUST be unspecified. The table below maps the model document group name to xxx-attributes-sequence:

Model Document Group	***xxx*-attributes-sequence**
Operation Attributes	operations-attributes-sequence
Job Template Attributes	job-attributes-sequence
Job Object Attributes	job-attributes-sequence
Unsupported Attributes	unsupported- attributes-sequence
Requested Attributes (Get-Job-Attributes)	job-attributes-sequence
Requested Attributes (Get-Printer-Attributes)	printer-attributes-sequence
Document Content	in a special position as described above

If an operation contains attributes from more than one job object (e.g. Get-Jobs response), the attributes from each job object MUST be in a separate job-attribute-sequence, such that the attributes from the ith job object are in the ith job-attribute-sequence. See Section 11 ~~“~~"Appendix A: Protocol Examples~~”~~" for table showing the application of the rules above.

3.10 Value Length

Each attribute value MUST be preceded by a SIGNED-SHORT, which MUST specify the number of octets in the value which follows this length, exclusive of the two bytes specifying the length.

For any of the types represented by binary signed integers, the sender MUST encode the value in exactly four octets.

For any of the types represented by character-strings, the sender MUST encode the value with all the characters of the string and without any padding characters.

If a value-tag contains an ~~“out-of-band”~~"out-of-band" value, such as ~~“unsupported”,~~"unsupported", the value-length MUST be 0 and the value empty — the value has no meaning when the value-tag has an~~“out-of-band” value. If a client receives a response with a nonzero value-length in this case, it MUST ignore the value field. If a printer receives a request with a nonzero value-length in this case, it MUST reject the request.~~"out-of-band" value.

3.11 (Attribute) Value

The syntax types and most of the details of their representation are defined in the IPP model document. The table below augments the information in the model document, and defines the syntax types from the model document in terms of the 5 basic types defined in section 3 ~~“~~"Encoding of the Operation Layer~~”.~~". The 5 types are US-ASCII-STRING, LOCALIZED-STRING, SIGNED-INTEGER, SIGNED-SHORT, SIGNED-BYTE, and OCTET-STRING.

Syntax of Attribute Value	**Encoding**
textWithoutLanguage, nameWithoutLanguage	LOCALIZED-STRING.
textWithLanguage	OCTET_STRING consisting of 4 fields: a) a SIGNED-SHORT which is the number of octets in the following field b) a value of type natural-language, c) a SIGNED-SHORT which is the number of octets in the following field, d) a value of type textWithoutLanguage. The length of a textWithLanguage value MUST be 4 + the value of field a + the value of field c.
nameWithLanguage	OCTET_STRING consisting of 4 fields: a) a SIGNED-SHORT which is the number of octets in the following field b) a value of type natural-language, c) a SIGNED-SHORT which is the number of octets in the following field d) a value of type nameWithoutLanguage. The length of a nameWithLanguage value MUST be 4 + the value of field a + the value of field c.
charset, naturalLanguage, mimeMediaType, keyword, uri, and uriScheme	US-ASCII-STRING.
~~boolean~~	~~SIGNED-BYTE where 0x00 is ‘false’ and 0x01 is ‘true’.~~
boolean	SIGNED-BYTE where 0x00 is 'false' and 0x01 is 'true'.
integer and enum	a SIGNED-INTEGER.
~~dateTime~~	~~OCTET-STRING consisting of eleven octets whose contents are defined by “DateAndTime” in RFC 1903 [rfc1903].~~
dateTime	OCTET-STRING consisting of eleven octets whose contents are defined by "DateAndTime" in RFC 1903 [rfc1903].
resolution	OCTET_STRING consisting of nine octets of 2 SIGNED-INTEGERs followed by a SIGNED-BYTE. The first SIGNED-INTEGER contains the value of cross feed direction resolution. The second SIGNED-INTEGER contains the value of feed direction resolution. The SIGNED-BYTE contains the units value.
rangeOfInteger	Eight octets consisting of 2 SIGNED-INTEGERs. The first SIGNED-INTEGER contains the lower bound and the second SIGNED-INTEGER contains the upper bound.
1setOf X	Encoding according to the rules for an attribute with more than 1 value. Each value X is encoded according to the rules for encoding its type.
octetString	OCTET-STRING

The type of the value in the model document determines the encoding in the value and the value of the value-tag.

3.12 Data

The data part MUST include any data required by the operation

4. Encoding of Transport Layer

HTTP/1.1 [rfc2068] is the transport layer for this protocol.

The operation layer has been designed with the assumption that the transport layer contains the following information:

- the URI of the target job or printer operation
- the total length of the data in the operation layer, either as a single length or as a sequence of chunks each with a length.

It is REQUIRED that a printer implementation support HTTP over the IANA assigned Well Known Port 631 (the IPP default port), though a printer implementation may support HTTP over some other port as well.

Each HTTP operation MUST use the POST method where the request-URI is the object target of the operation, and where the ~~“Content-Type”~~"Content-Type" of the message-body in each request and response MUST be ~~“application/ipp”.~~"application/ipp". The message-body MUST contain the operation layer and MUST have the syntax described in section 3.2 ~~“~~"Syntax of Encoding~~”.~~". A client implementation MUST adhere to the rules for a client described for HTTP1.1 [rfc2068] . A printer (server) implementation MUST adhere the rules for an origin server described for HTTP1.1 [rfc2068].

An IPP server sends a response for each request that it receives. If an IPP server detects an error, it MAY send a response before it has read the entire request. If the HTTP layer of the IPP server completes processing the HTTP headers successfully, it MAY send an intermediate response, such as ~~“100 Continue”,~~"100 Continue", with no IPP data before sending the IPP response. A client MUST expect such a variety of responses from an IPP server. For further information on HTTP/1.1, consult the HTTP documents [rfc2068].

An HTTP server MUST support chunking for IPP requests, and an IPP client MUST support chunking for IPP responses according to HTTP/1.1[rfc2068]. Note: this rule causes a conflict with non-compliant implementations of HTTP/1.1 that ~~don’t~~don't support chunking for POST methods, and this rule may cause a conflict with non-compliant implementations of HTTP/1.1 that ~~don’t~~don't support chunking for CGI scripts

5. IPP URL Scheme

The IPP/1.1 specification defines a new scheme 'ipp' as the value of a URL that identifies either an IPP printer object or an IPP job object. The IPP attributes using the ~~‘ipp’~~'ipp' scheme are specified below. Because the HTTP layer does not support the ~~‘ipp’~~'ipp' scheme, a client MUST map 'ipp' URLs to 'http' URLs, and then follows the HTTP [RFC2068][RFC2069] rules for constructing a Request-Line ~~Line~~ and HTTP headers. The mapping is simple because the ~~‘ipp’~~'ipp' scheme implies all of the same protocol semantics as that of the ~~‘http’~~'http' scheme [RFC2068], except that it represents a print service and the implicit (default) port number that clients use to connect to a server is port 631.

In the remainder of this section the term ~~‘ipp-URL’~~'ipp-URL' means a URL whose scheme is ~~‘ipp’~~'ipp' and whose implicit (default) port is 631. The term ~~‘http-URL’ means a URL whose scheme is ‘http’, and the term ‘https-URL’ means a URL whose scheme is ‘https’,~~'http-URL' means a URL whose scheme is 'http', and the term 'https-URL' means a URL whose scheme is 'https',

A client and an IPP object (i.e. the server) MUST support the ipp-URL value in the following IPP attributes.

job attributes:
    job-uri
    job-printer-uri
printer attributes:
    printer-uri-supported
operation attributes:
    job-uri
    printer-uri

Each of the above attributes identifies a printer or job object. The ipp-URL is intended as the value of the attributes in this list, and for no other attributes. All of these attributes have a syntax type of ~~'uri',~~'uri', but there are attributes with a syntax type of ~~'uri'~~'uri' that do not use the ~~'ipp'~~'ipp' scheme, e.g. ~~'job-more-info'.~~'job-more-info'.

If a printer registers its URL with a directory service, the printer MUST register an ipp-URL.

User interfaces are beyond the scope of this document. But if software exposes the ipp-URL values of any of the above five attributes to a human user, it is REQUIRED that the human see the ipp-URL as is.

When a client sends a request, it MUST convert a target ipp-URL to a target http-URL for the HTTP layer according to the following rules:

1. change the 'ipp' scheme to 'http'
2. add an explicit port 631 if the URL does not contain an explicit port. Note: port 631 is the IANA assigned Well Known Port for the ~~'ipp'~~'ipp' scheme.

The client MUST use the target http-URL in both the HTTP Request-Line and HTTP headers, as specified by HTTP[RFC2068][RFC2069] . However, the client MUST use the target ipp-URL for the value of the "printer-uri" or "job-uri" operation attribute within the application/ipp body of the request. The server MUST use the ipp-URL for the value of the ~~"printer-uri", "job-uri" or "printer-~~"printer-uri", "job-uri" or "printer-~~uri-supported"~~uri-supported" attributes within the application/ipp body of the response.

For example, when an IPP client sends a request directly (i.e. no proxy) to an ipp-URL ~~"ipp://myhost.com/myprinter/myqueue",~~"ipp://myhost.com/myprinter/myqueue", it opens a TCP connection to port 631 (the ipp implicit port) on the host ~~"myhost.com"~~"myhost.com" and sends the following data:

```
POST /myprinter/myqueue HTTP/1.1
Host: myhost.com:631
Content-type: application/ipp
Transfer-Encoding: chunked
...
"printer-uri" "ipp://myhost.com/myprinter/myqueue"
              (encoded in application/ipp message body)
...
```

As another example, when an IPP client sends the same request as above via a proxy ~~"myproxy.com",~~"myproxy.com", it opens a TCP connection to the proxy port 8080 on the proxy host ~~"myproxy.com"~~"myproxy.com" and sends the following data:

```
POST http://myhost.com:631/myprinter/myqueue   HTTP/1.1
Host: myhost.com:631
Content-type: application/ipp
Transfer-Encoding: chunked
...
"printer-uri" "ipp://myhost.com/myprinter/myqueue"
              (encoded in application/ipp message body)
...
```

The proxy then connects to the IPP origin server with headers that are the same as the "no-proxy" example above.

6. Compatibility with IPP/1.0 Implementations

IPP/1.1 server implementations ~~must be compatible with IPP 1.0~~SHOULD interoperate with IPP/1.0 client implementations, as defined in ~~[ipp-mod-10] and [ipp-pro-10] documents. For compatibility with IPP/1.0 implementations, IPP objects (i.e. a server) MUST support additional schemes when communicating with IPP/1.0 clients as described in this section:~~

[rfc 2565] and [rfc 2566] documents. If an IPP/1.1 server implementation does not support an IPP/1.0 client, it MUST return the error 'server-error-version-not-supported' and the version in the response MUST be a version that the server supports and SHOULD be a version that is closest to the clients version in the request.

The following are specific rules of interoperability for an IPP/1.1 server that supports IPP/1.0 clients.

- If a server receives an IPP/1.0 request, it MUST return an IPP/1.0 response. That is, it MUST support both an http-URL and an https-URL in the target ~~“printer-uri” and “job-uri”~~"printer-uri" and "job-uri" operation attributes in a request. The rules for attributes in a response is covered in the next two bullet items.

- When a server returns the printer attribute ~~“printer-uri-supported”,~~"printer-uri-supported", it MUST return all values of the attribute for an IPP/1.1 request. For an IPP/1.0 request, a server MUST return a subset of the attribute values, excluding those that are ipp-URLs, and including those that are http-URLs and https-URLs..

- The table below shows the type of URL that a server returns for the ~~“job-uri” and “job-printer-uri”~~"job-uri" and "job-printer-uri" job attributes for all operations based on how the job was created.

Operation attributes for a request	Job created via			
	ipp	secure ipp	http	https
ipp	ipp	*No URL returned*	ipp	*No URL returned*
secure ipp	ipp	ipp	ipp	ipp
http	http	*No URL returned*	http	*No URL returned*
https	http	https	http	https

- If a server registers a nonsecure ipp-URL with a name service, then it MUST also register an http-URL. If a printer supports a secure connection using SSL3, then it MUST register an https-URL.

IPP/1.1 client implementations SHOULD interoperate with IPP/1.0 server implementations. If an IPP/1.1 client receives an error 'server-error-version-not-supported' and the version in the response is 1.0 and the client supports IPP/1.0, the IPP/1.1 client MUST convert the target URI (as defined in Section 4 of this document) and act as an IPP/1.0 client [rfc 2565 and rfc 2566]. If the IPP/1.1 operation was intended to be secure, the target conversion MUST result in an 'https' scheme; otherwise it is an 'http' scheme.

7. Security Considerations

The IPP Model and Semantics document [ipp-mod] discusses high level security requirements (Client Authentication, Server Authentication and Operation Privacy). Client Authentication is the mechanism by which the client proves its identity to the server in a secure manner. Server Authentication is the mechanism by which the server proves its identity to the client in a secure manner. Operation Privacy is defined as a mechanism for protecting operations from eavesdropping.

7.1 Security Conformance

IPP clients MUST/SHOULD [which is to be determined in consultation with the Area Director] support:

- Digest Authentication [rfc2069].
    - MD5 and MD5-sess MUST be implemented and supported.
    - The Message Integrity feature NEED NOT be used.

IPP Printers MUST/SHOULD [which is to be determined in consultation with the Area Director] support:

- Digest Authentication [rfc2069].
    - MD5 and MD5-sess MUST be implemented and supported.
    - The Message Integrity feature NEED NOT be used.

~~document defines an IPP implementation with "privacy" as one that implements Transport Layer Security (TLS) [rfc2246]. TLS meets the requirements for IPP security with regards to features such as mutual~~IPP Printers SHOULD support TLS for client ~~authentication, server~~ authentication and operation privacy. If an IPP Printer supports TLS, it MUST support the TLS_DHE_DSS_WITH_3DES_EDE_CBC_SHA cipher suite as mandated by RFC 2246 [rfc2246]. All other cipher suites are OPTIONAL. An IPP Printer MAY support Basic Authentication (described in HTTP/1.1 [rfc 2068]) for ~~privacy (via encryption).~~ client authentication if the channel is secure. TLS with the above mandated cipher suite can provide such a secure channel.

The IPP Model and Semantics document defines two printer attributes ("uri-authentication-supported" and "uri-security-supported") that the client can use to discover the security policy of a printer. That document also outlines IPP-specific security considerations and should be the primary reference for security implications with ~~regards to the IPP protocol itself.~~

regard to the IPP protocol itselfFor backward compatibility with ~~The IPP Model document defines an IPP implementation with "authentication" as one that implements the standard way for transporting IPP messages within HTTP 1.1. These include the security considerations outlined in the HTTP 1.1 standard document [rfc2068] and Digest Access Authentication extension [rfc2069].~~

~~The current HTTP infrastructure supports HTTP over TCP port 80. IPP server implementations MUST offer IPP services using HTTP over the IANA assigned Well Known Port 631 (the IPP default port). IPP server implementations may support other ports, in addition to this port.~~

~~See further discussion of IPP security concepts in the model document [ipp-mod].~~IPP version 1.0, IPP clients and printers MAY also support SSL3. This is in addition to the security required in this document.

7.2 Using IPP with TLS

An initial IPP request never uses TLS. The switch to TLS occurs either because the server grants the ~~client's~~client's request to upgrade to TLS, or a server asks to switch to TLS in its response. Secure communication begins with a ~~server's~~server's response to switch to TLS. The initial connection is not secure. Any client expecting a secure connection should first use a non-sensitive operation (e.g. an HTTP POST with an empty message body) to establish a secure connection before sending any sensitive data. During the TLS handshake, the original session is preserved.

An IPP client that wants a secure connection MUST send "TLS/1.0" as one of the field-values of the HTTP/1.1 Upgrade request header, e.g. "Upgrade: TLS/1.0" (see rfc2068 section 14.42). If the origin-server grants the upgrade request, it MUST respond with "101 Switching Protocols", and it MUST include the header "Upgrade: TLS/1.0" to indicate what it is switching to. An IPP client MUST be ready to react appropriately if the server does not grant the upgrade request. Note: the ~~'Upgrade header'~~'Upgrade header' mechanism allows unsecured and secured traffic to share the same port (in this case, 631).

With current technology, an IPP server can indicate that it wants an upgrade only by returning ~~"401 unauthorized" or "403 forbidden".~~"401 unauthorized" or "403 forbidden". A server MAY give the client an additional hint by including an ~~"Upgrade: TLS"~~"Upgrade: TLS" header in the response. When an IPP client receives such a response, it can perform the request again with an Upgrade header with the ~~"TLS/1.0"~~"TLS/1.0" value.

If a server supports TLS, it SHOULD include the ~~"Upgrade"~~"Upgrade" header with the value ~~"TLS/1.0"~~"TLS/1.0" in response to any OPTIONS request.

Upgrade is a hop-by-hop header (rfc2068, section 13.5.1), so each intervening proxy which supports TLS MUST also request the same version of TLS/1.0 on its subsequent request. Furthermore, any caching proxy which supports TLS MUST NOT reply from its cache when TLS/1.0 has been requested (although clients are still recommended to explicitly include "Cache-control: no-cache").

Note: proxy servers may be able to request or initiate a TLS-secured connection, e.g. the outgoing or incoming firewall of a trusted subnetwork.

~~Note: the initial connection (containing the Upgrade header) is not secure. Any client expecting a secure connection should first use a non-sensitive operation (e.g. an HTTP POST with an empty message body) to establish a secure connection before sending any sensitive data.~~

8. References

[char] N. Freed, J. Postel: IANA Charset Registration Procedures, Work in Progress (draft-freed-charset-reg-02.txt).

[dpa] ISO/IEC 10175 Document Printing Application (DPA), June 1996.

[iana] IANA Registry of Coded Character Sets: ftp://ftp.isi.edu/in-notes/iana/assignments/character-sets.

[ipp-iig] Hastings, Tom, et al., "Internet Printing Protocol/1.1: ~~Implementer's Guide", draft-ietf-ipp-implementers-guide-00.txt, November 1998,~~Implementer's Guide", draft-ietf-ipp-implementers-guide-01.txt, February 1999, work in progress.

~~[ipp-lpd] Herriot, R., Hastings, T., Jacobs, N., Martin, J., "Mapping between LPD and IPP Protocols", draft-ietf-ipp-lpd-ipp-map-05.txt, November 1998.~~

~~[ipp-mod-10] R. deBry, T. Hastings, R. Herriot, S. Isaacson, P. Powell, "Internet Printing Protocol/1.0: Model and Semantics", <draft-ietf-ipp-model-11.txt>, November, 1998.~~

[ipp-mod] R. deBry, T. Hastings, R. Herriot, S. Isaacson, P. Powell, "Internet Printing Protocol/1.0: Model and Semantics", ~~<draft-ietf-ipp-model-v11-00.txt>, February,~~<draft-ietf-ipp-model-v11-02.txt>, May, 1999.

~~[ipp-pro-10] Herriot, R., Butler, S., Moore, P., Turner, R., “Internet Printing Protocol/1.0: Encoding and Transport”, draft-ietf-ipp-protocol-07.txt, November 1998.~~

[ipp-pro] Herriot, R., Butler, S., Moore, P., Turner, R., ~~“Internet~~"Internet Printing Protocol/1.1: Encoding and ~~Transport”,~~Transport", draft-ietf-ipp-protocol-v11-00-.txt, February 1999.

~~[ipp-rat] Zilles, S., “Rationale for the Structure and Model and Protocol for the Internet Printing Protocol”, draft-ietf-ipp-rat-04.txt, November 1998.~~

~~[ipp-req] Wright, D., "Design Goals for an Internet Printing Protocol", draft-ietf-ipp-req-03.txt, November, 1998.~~

[rfc822] Crocker, D., "Standard for the Format of ARPA Internet Text Messages", RFC 822, August 1982.

[rfc1123] Braden, S., "Requirements for Internet Hosts - Application and Support", RFC 1123, October, 1989.

[rfc1179] McLaughlin, L. III, (editor), "Line Printer Daemon Protocol" RFC 1179, August 1990.

[rfc1543] Postel, J., "Instructions to RFC Authors", RFC 1543, October 1993.

[rfc1738] Berners-Lee, T., Masinter, L., McCahill, M. , "Uniform Resource Locators (URL)", RFC 1738, December, 1994.

[rfc1759] Smith, R., Wright, F., Hastings, T., Zilles, S., and Gyllenskog, J., "Printer MIB", RFC 1759, March 1995.

[rfc1766] H. Alvestrand, " Tags for the Identification of Languages", RFC 1766, March 1995.

[rfc1808] R. Fielding, ~~“Relative~~"Relative Uniform Resource ~~Locators”,~~Locators", RFC1808, June 1995.

[rfc1903] J. Case, et al. ~~“Textual~~"Textual Conventions for Version 2 of the Simple Network Management Protocol ~~(SNMPv2)”,~~(SNMPv2)", RFC 1903, January 1996.

[rfc2046] N. Freed & N. Borenstein, Multipurpose Internet Mail Extensions (MIME) Part Two: Media Types. November 1996, RFC 2046.

[rfc2048] N. Freed, J. Klensin & J. Postel. Multipurpose Internet Mail Extension (MIME) Part Four: Registration Procedures. November 1996 (Also BCP0013), RFC 2048.

[rfc2068] R Fielding, et al, ~~“Hypertext~~"Hypertext Transfer Protocol – ~~HTTP/1.1”~~HTTP/1.1" RFC 2068, January 1997.

[rfc2069] J. Franks, et al, ~~“An~~"An Extension to HTTP: Digest Access ~~Authentication”~~Authentication" RFC 2069, January 1997.

[rfc2119] S. Bradner, "Key words for use in RFCs to Indicate Requirement Levels", RFC 2119 , March 1997.

[rfc2184] N. Freed, K. Moore, ~~“MIME~~"MIME Parameter Value and Encoded Word Extensions: Character Sets, Languages, and ~~Continuations”,~~Continuations", RFC 2184, August 1997.

[rfc2234] D. Crocker et al., ~~“Augmented~~"Augmented BNF for Syntax Specifications: ~~ABNF”,~~ABNF", RFC 2234. November 1997.

[rfc2246] T. Dierks et al., ~~“The TLS Protocol”,~~"The TLS Protocol", RFC 2246. January 1999.

[rfc2396] Berners-Lee, T., Fielding, R., Masinter, L., "Uniform Resource Identifiers (URI): Generic Syntax", RFC 2396, August 1998.

[rfc2565] Herriot, R., Butler, S., Moore, P., Turner, R., "Internet Printing Protocol/1.0: Encoding and Transport", rfc 2565, April 1999.

[rfc 2566] R. deBry, T. Hastings, R. Herriot, S. Isaacson, P. Powell, "Internet Printing Protocol/1.0: Model and Semantics", rfc 2566, April, 1999.

[rfc2567] Wright, D., "Design Goals for an Internet Printing Protocol", RFC2567,April 1999.

[rfc2568] Zilles, S., "Rationale for the Structure and Model and Protocol for the Internet Printing Protocol", RC 2568,April 1999.

[rfc2569] Herriot, R., Hastings, T., Jacobs, N., Martin, J., "Mapping between LPD and IPP Protocols RFC 2569, April 1999.

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11. Appendix A: Protocol Examples

11.1 Print-Job Request

The following is an example of a Print-Job request with job-name, copies, and sides specified. The ~~“ipp-attribute-fidelity”~~"ipp-attribute-fidelity" attribute is set to 'true' so that the print request will fail if the "copies" or the "sides" attribute are not supported or their values are not supported.

Octets	Symbolic Value	Protocol field
0x0101	1.1	version-number
0x0002	Print-Job	operation-id
0x00000001	1	request-id
0x01	start operation-attributes	operation-attributes-tag
0x47	charset type	value-tag
0x0012		name-length
attributes-charset	attributes-charset	name
0x0008		value-length
us-ascii	US-ASCII	value
0x48	natural-language type	value-tag
0x001B		name-length
attributes-natural-language	attributes-natural-language	name

Octets	Symbolic Value	Protocol field
0x0005		value-length
en-us	en-US	value
0x45	uri type	value-tag
0x000B		name-length
printer-uri	printer-uri	name
0x0015		value-length
ipp://forest/pinetree	printer pinetree	value
0x42	nameWithoutLanguage type	value-tag
0x0008		name-length
job-name	job-name	name
0x0006		value-length
foobar	foobar	value
0x22	boolean type	value-tag
0x0016		name-length
ipp-attribute-fidelity	ipp-attribute-fidelity	name
0x0001		value-length
0x01	true	value
0x02	start job-attributes	job-attributes-tag
0x21	integer type	value-tag
0x0006		name-length
copies	copies	name
0x0004		value-length
0x00000014	20	value
0x44	keyword type	value-tag
0x0005		name-length
sides	sides	name
0x0013		value-length
two-sided-long-edge	two-sided-long-edge	value
0x03	end-of-attributes	end-of-attributes-tag
%!PS...	<PostScript>	data

11.2 Print-Job Response (successful)

Here is an example of a successful Print-Job response to the previous Print-Job request. The printer supported the "copies" and "sides" attributes and their supplied values. The status code returned is 'successful-ok'.

Octets	Symbolic Value	Protocol field
0x0101	1.1	version-number
0x0000	successful-ok	status-code
0x00000001	1	request-id
0x01	start operation-attributes	operation-attributes-tag
0x47	charset type	value-tag
0x0012		name-length
attributes-charset	attributes-charset	name
0x0008		value-length
us-ascii	US-ASCII	value
0x48	natural-language type	value-tag
0x001B		name-length
attributes-natural-language	attributes-natural-language	name
0x0005		value-length

Octets	Symbolic Value	Protocol field
en-us	en-US	value
0x41	textWithoutLanguage type	value-tag
0x000E		name-length
status-message	status-message	name
0x000D		value-length
successful-ok	successful-ok	value
0x02	start job-attributes	job-attributes-tag
0x21	integer	value-tag
0x0006		name-length
job-id	job-id	name
0x0004		value-length
147	147	value
0x45	uri type	value-tag
0x0007		name-length
job-uri	job-uri	name
0x0019		value-length
ipp://forest/pinetree/123	job 123 on pinetree	value
~~0x23~~	~~nameWithoutLanguage type~~	~~value-tag~~
0x23	enum type	value-tag
0x0009		name-length
job-state	job-state	name
0x0004		value-length
0x0003	pending	value
0x03	end-of-attributes	end-of-attributes-tag

11.3 Print-Job Response (failure)

Here is an example of an unsuccessful Print-Job response to the previous Print-Job request. It fails because, in this case, the printer does not support the "sides" attribute and because the value '20' for the "copies" attribute is not supported. Therefore, no job is created, and neither a "job-id" nor a "job-uri" operation attribute is returned. The error code returned is 'client-error-attributes-or-values-not-supported' (0x040B).

Octets	Symbolic Value	Protocol field
0x0101	1.1	version-number
0x040B	client-error-attributes-or-values-not-supported	status-code
0x00000001	1	request-id
0x01	start operation-attributes	operation-attribute tag
0x47	charset type	value-tag
0x0012		name-length
attributes-charset	attributes-charset	name
0x0008		value-length
us-ascii	US-ASCII	value
0x48	natural-language type	value-tag
0x001B		name-length
attributes-natural-language	attributes-natural-language	name
0x0005		value-length
en-us	en-US	value
0x41	textWithoutLanguage type	value-tag
0x000E		name-length

Octets	**Symbolic Value**	**Protocol field**
status-message	status-message	name
0x002F		value-length
client-error-attributes-or-values-not-supported	client-error-attributes-or-values-not-supported	value
0x05	start unsupported-attributes	unsupported-attributes tag
0x21	integer type	value-tag
0x0006		name-length
copies	copies	name
0x0004		value-length
0x00000014	20	value
0x10	unsupported (type)	value-tag
0x0005		name-length
sides	sides	name
0x0000		value-length
0x03	end-of-attributes	end-of-attributes-tag

11.4 Print-Job Response (success with attributes ignored)

Here is an example of a successful Print-Job response to a Print-Job request like the previous Print-Job request, except that the value of ~~'ipp-attribute-fidelity'~~'ipp-attribute-fidelity' is false. The print request succeeds, even though, in this case, the printer supports neither the "sides" attribute nor the value '20' for the "copies" attribute. Therefore, a job is created, and both a "job-id" and a "job-uri" operation attribute are returned. The unsupported attributes are also returned in an Unsupported Attributes Group. The error code returned is ~~'successful-ok-ignored-or-substituted-attributes~~'successful-ok-ignored-or-substituted-attributes' (0x0001).

Octets	**Symbolic Value**	**Protocol field**
0x0101	1.1	version-number
0x0001	successful-ok-ignored-or-substituted-attributes	status-code
0x00000001	1	request-id
0x01	start operation-attributes	operation-attributes-tag
0x47	charset type	value-tag
0x0012		name-length
attributes-charset	attributes-charset	name
0x0008		value-length
us-ascii	US-ASCII	value
0x48	natural-language type	value-tag
0x001B		name-length
attributes-natural-language	attributes-natural-language	name
0x0005		value-length
en-us	en-US	value
0x41	textWithoutLanguage type	value-tag
0x000E		name-length
status-message	status-message	name
0x002F		value-length
successful-ok-ignored-or-substituted-attributes	successful-ok-ignored-or-substituted-attributes	value
0x05	start unsupported-attributes	unsupported-attributes tag
0x21	integer type	value-tag
0x0006		name-length
copies	copies	name

Octets	Symbolic Value	Protocol field
0x0004		value-length
0x00000014	20	value
0x10	unsupported (type)	value-tag
0x0005		name-length
sides	sides	name
0x0000		value-length
0x02	start job-attributes	job-attributes-tag
0x21	integer	value-tag
0x0006		name-length
job-id	job-id	name
0x0004		value-length
147	147	value
0x45	uri type	value-tag
0x0007		name-length
job-uri	job-uri	name
0x0019		value-length
ipp://forest/pinetree/123	job 123 on pinetree	value
~~0x23~~	~~nameWithoutLanguage type~~	~~value-tag~~
0x23	enum type	value-tag
0x0009		name-length
job-state	job-state	name
0x0004		value-length
0x0003	pending	value
0x03	end-of-attributes	end-of-attributes-tag

11.5 Print-URI Request

The following is an example of Print-URI request with copies and job-name parameters:

Octets	Symbolic Value	Protocol field
0x0101	1.1	version-number
0x0003	Print-URI	operation-id
0x00000001	1	request-id
0x01	start operation-attributes	operation-attributes-tag
0x47	charset type	value-tag
0x0012		name-length
attributes-charset	attributes-charset	name
0x0008		value-length
us-ascii	US-ASCII	value
0x48	natural-language type	value-tag
0x001B		name-length
attributes-natural-language	attributes-natural-language	name
0x0005		value-length
en-us	en-US	value
0x45	uri type	value-tag
0x000B		name-length
printer-uri	printer-uri	name
0x0015		value-length

Octets	Symbolic Value	Protocol field
ipp://forest/pinetree	printer pinetree	value
0x45	uri type	value-tag
0x000C		name-length
document-uri	document-uri	name
0x0011		value-length
ftp://foo.com/foo	ftp://foo.com/foo	value
0x42	nameWithoutLanguage type	value-tag
0x0008		name-length
job-name	job-name	name
0x0006		value-length
foobar	foobar	value
0x02	start job-attributes	job-attributes-tag
0x21	integer type	value-tag
0x0006		name-length
copies	copies	name
0x0004		value-length
0x00000001	1	value
0x03	end-of-attributes	end-of-attributes-tag

658 11.6 Create-Job Request

659 The following is an example of Create-Job request with no parameters and no attributes:

Octets	Symbolic Value	Protocol field
0x0101	1.1	version-number
0x0005	Create-Job	operation-id
0x00000001	1	request-id
0x01	start operation-attributes	operation-attributes-tag
0x47	charset type	value-tag
0x0012		name-length
attributes-charset	attributes-charset	name
0x0008		value-length
us-ascii	US-ASCII	value
0x48	natural-language type	value-tag
0x001B		name-length
attributes-natural-language	attributes-natural-language	name
0x0005		value-length
en-us	en-US	value
0x45	uri type	value-tag
0x000B		name-length
printer-uri	printer-uri	name
0x0015		value-length
ipp://forest/pinetree	printer pinetree	value
0x03	end-of-attributes	end-of-attributes-tag

660 11.7 Get-Jobs Request

661 The following is an example of Get-Jobs request with parameters but no attributes:

Octets	Symbolic Value	Protocol field
0x0101	1.1	version-number

Octets	Symbolic Value	Protocol field
0x000A	Get-Jobs	operation-id
0x00000123	0x123	request-id
0x01	start operation-attributes	operation-attributes-tag
0x47	charset type	value-tag
0x0012		name-length
attributes-charset	attributes-charset	name
0x0008		value-length
us-ascii	US-ASCII	value
0x48	natural-language type	value-tag
0x001B		name-length
attributes-natural-language	attributes-natural-language	name
0x0005		value-length
en-us	en-US	value
0x45	uri type	value-tag
0x000B		name-length
printer-uri	printer-uri	name
0x0015		value-length
ipp://forest/pinetree	printer pinetree	value
0x21	integer type	value-tag
0x0005		name-length
limit	limit	name
0x0004		value-length
0x00000032	50	value
0x44	keyword type	value-tag
0x0014		name-length
requested-attributes	requested-attributes	name
0x0006		value-length
job-id	job-id	value
0x44	keyword type	value-tag
0x0000	additional value	name-length
0x0008		value-length
job-name	job-name	value
0x44	keyword type	value-tag
0x0000	additional value	name-length
0x000F		value-length
document-format	document-format	value
0x03	end-of-attributes	end-of-attributes-tag

662 ## 11.8 Get-Jobs Response

663 The following is an of Get-Jobs response from previous request with 3 jobs. The Printer returns no information about the second
664 job (because of security reasons):

Octets	Symbolic Value	Protocol field
0x0101	1.1	version-number
0x0000	successful-ok	status-code
0x00000123	0x123	request-id (echoed back)
0x01	start operation-attributes	operation-attribute-tag
0x47	charset type	value-tag
0x0012		name-length
attributes-charset	attributes-charset	name
0x000A		value-length

Octets	Symbolic Value	Protocol field
ISO-8859-1	ISO-8859-1	value
0x48	natural-language type	value-tag
0x001B		name-length
attributes-natural-language	attributes-natural-language	name
0x0005		value-length
en-us	en-US	value
0x41	textWithoutLanguage type	value-tag
0x000E		name-length
status-message	status-message	name
0x000D		value-length
successful-ok	successful-ok	value
0x02	start job-attributes (1st object)	job-attributes-tag
0x21	integer type	value-tag
0x0006		name-length
job-id	job-id	name
0x0004		value-length
147	147	value
0x36	nameWithLanguage	value-tag
0x0008		name-length
job-name	job-name	name
0x000C		value-length
0x0005		sub-value-length
fr-ca	fr-CA	value
0x0003		sub-value-length
fou	fou	name
0x02	start job-attributes (2nd object)	job-attributes-tag
0x02	start job-attributes (3rd object)	job-attributes-tag
0x21	integer type	value-tag
0x0006		name-length
job-id	job-id	name
0x0004		value-length
148	149	value
0x36	nameWithLanguage	value-tag
0x0008		name-length
job-name	job-name	name
0x0012		value-length
0x0005		sub-value-length
de-CH	de-CH	value
0x0009		sub-value-length
isch guet	isch guet	name
0x03	end-of-attributes	end-of-attributes-tag

12. Appendix C: Registration of MIME Media Type Information for "application/ipp"

This appendix contains the information that IANA requires for registering a MIME media type. The information following this paragraph will be forwarded to IANA to register application/ipp whose contents are defined in Section 3 ~~“~~"Encoding of the Operation Layer~~”~~" in this document:

MIME type name: application

MIME subtype name: ipp

A Content-Type of "application/ipp" indicates an Internet Printing Protocol message body (request or response). Currently there ~~are two versions: IPP/1.0, and~~is one version: IPP/1.1, whose syntax is described in Section 3 ~~“~~"Encoding of the Operation Layer~~” of [ipp-pro-10] and~~" of [ipp-pro],~~respectively,~~ and whose semantics are described in ~~[ipp-mod-10] and [ipp-mod], respectively.~~[ipp-mod].

Required parameters: none

Optional parameters: none

Encoding considerations:

IPP/1.1 protocol requests/responses MAY contain long lines and ALWAYS contain binary data (for example attribute value lengths).

Security considerations:

IPP/1.1 protocol requests/responses do not introduce any security risks not already inherent in the underlying transport protocols. Protocol mixed-version interworking rules in [ipp-mod] as well as protocol encoding rules in [ipp-pro] are complete and unambiguous.

Interoperability considerations:

IPP/1.1 requests (generated by clients) and responses (generated by servers) MUST comply with all conformance requirements imposed by the normative specifications [ipp-mod] and [ipp-pro]. Protocol encoding rules specified in [ipp-pro] are comprehensive, so that interoperability between conforming implementations is guaranteed (although support for specific optional features is not ensured). Both the "charset" and "natural-language" of all IPP/1.1 attribute values which are a LOCALIZED-STRING are explicit within IPP protocol requests/responses (without recourse to any external information in HTTP, SMTP, or other message transport headers).

~~IPP/1.1 servers MUST support both IPP/1.0 and IPP/1.1. See the section in [ipp-pro] entitled "Compatibility with IPP/1.0 Implementations" for a discussion of compatibility with IPP/1.0.~~

Published specification:

~~[ipp-mod-10] Isaacson, S., deBry, R., Hastings, T., Herriot, R., Powell, P., “Internet Printing Protocol/1.0: Model and Semantics” draft-ietf-ipp-model-11.txt, November, 1998.~~

[ipp-mod] Isaacson, S., deBry, R., Hastings, T., Herriot, R., Powell, P., ~~“Internet~~"Internet Printing Protocol/1.1: Model and ~~Semantics”~~Semantics" draft-ietf-ipp-model-v11-00.txt, February, 1999.

[ipp-pro] Herriot, R., Butler, S., Moore, P., Turner, R., ~~“Internet~~"Internet Printing Protocol/1.1: Encoding and ~~Transport”,~~Transport", draft-ietf-ipp-protocol-v11-00.txt, February, 1999.

Applications which use this media type:

Internet Printing Protocol (IPP) print clients and print servers, communicating using HTTP/1.1 (see [IPP-PRO]), SMTP/ESMTP, FTP, or other transport protocol. Messages of type "application/ipp" are self-contained and transport-independent, including "charset" and "natural-language" context for any LOCALIZED-STRING value.

Person & email address to contact for further information:

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Intended usage:

COMMON

13. Appendix D: ~~Notices~~Changes from IPP /1.0

IPP/1.1 is identical to IPP/1.0 with the follow changes:

1. Attributes values that identify a printer or job object use a new 'ipp' scheme. The 'http' and 'https' schemes are supported only for backward compatibility. See section 5.

2. New requirement for support of Digest Authentication. See Section 7.1

3. TLS is recommended for channel security. In addition, SSL3 may be supported for backward compatibility. See Section 7.2

14. Full Copyright Statement

~~14.Appendix E: Changes from IPP /1.0~~

~~IPP/1.1 is identical to IPP/1.0 with the follow changes:~~

~~1.Attributes values that identify a printer or job object use a new ‘ipp’ scheme. The ‘http’ and ‘https’ schemes are supported only for backward compatibility.~~

~~TLS provides security. SSL3 is supported only for backward compatibility.~~