INTERNET-DRAFT

<draft-ietf-ipp-protocol-06.txt>

Robert Herriot (editor)
Sun Microsystems
Sylvan Butler
Hewlett-Packard
Paul Moore
Microsoft
Randy Turner
Sharp Labs
June 30, 1998

# Internet Printing Protocol/1.0: Encoding and Transport

## Status of this Memo

This document is an Internet-Draft. Internet-Drafts are working documents of the Internet Engineering Task Force (IETF), its areas, and its working groups. Note that other groups may also distribute working documents as Internet-Drafts.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress".

To learn the current status of any Internet-Draft, please check the "1id-abstracts.txt" listing contained in the Internet-Drafts Shadow Directories on ftp.is.co.za (Africa), nic.nordu.net (Europe), munnari.oz.au (Pacific Rim), ds.internic.net (US East Coast), or ftp.isi.edu (US West Coast).

## Copyright Notice



## 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. The protocol is heavily influenced by the printing model introduced in the Document Printing Application (DPA) [ISO10175] standard. Although DPA specifies both end user and administrative features, IPP version 1.0 (IPP/1.0) focuses only on end user functionality.

The full set of IPP documents includes:

Design Goals for an Internet Printing Protocol [ipp-req] (informational)
Rationale for the Structure and Model and Protocol for the Internet Printing Protocol [ipp-rat] (informational)
Internet Printing Protocol/1.0: Model and Semantics [ipp mod]
Internet Printing Protocol/1.0: Encoding and Transport (this document)

attributes, and their operations. The model introduces a Printer and a Job. The Job supports multiple documents per Job. The model document also addresses how security, internationalization, and directory issues are addressed. The protocol specification, “Internet Printing Protocol/1.0: Encoding and Transport”, is a formal mapping of the abstract operations and attributes defined in the model document onto HTTP/1.1. The protocol specification defines the encoding rules for a new Internet media type called “application/ipp”. The “Mapping between LPD and IPP Protocols” gives some advice to implementors of gateways between IPP and LPD (Line Printer Daemon) implementations.
This document is the "Internet Printing Protocol/1.0: Encoding and Transport" document.

Notice

Table of Contents

# 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/1.0: 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"

# 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" 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 model document 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 binary encoding with big-endian format (also known as "network order" and "most significant byte 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.

```
    ---------------------------------------------
    |                 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”, 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.

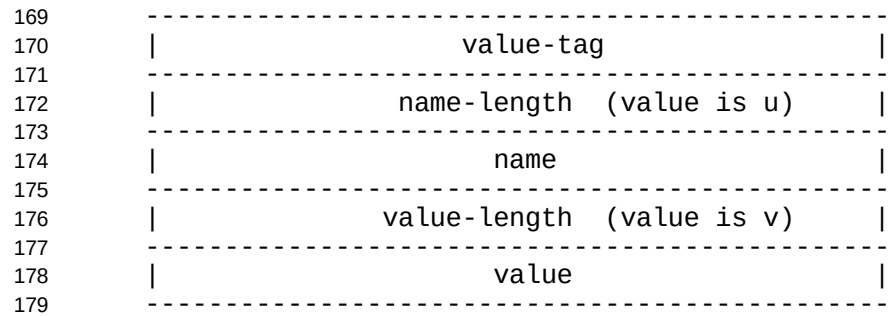
The data is omitted from some operations, but the end-of-attributes-tag is present even when the data is omitted. Note, the xxx-attributes-tags and end-of-attributes-tag are called ‘delimiter-tags’. Note: the xxx-attribute-sequence, shown above may consist of 0 bytes, according to the rule below.

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

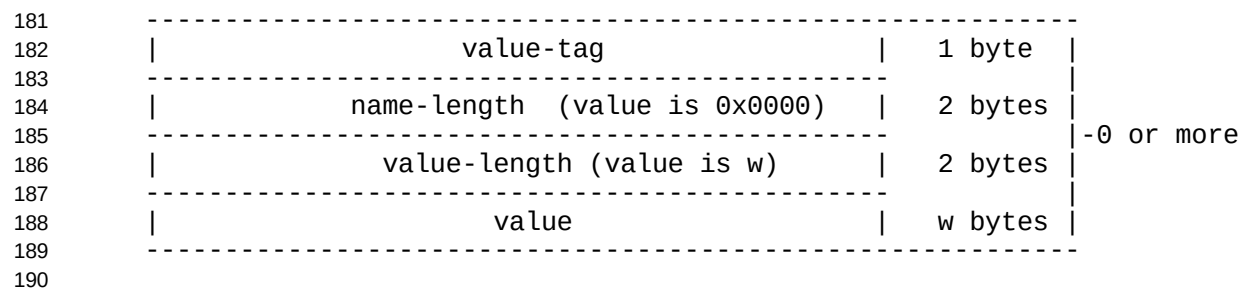
```
    ---------------------------------------------
    |             compound-attribute            |   s bytes - 0 or more
    ---------------------------------------------
```

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

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

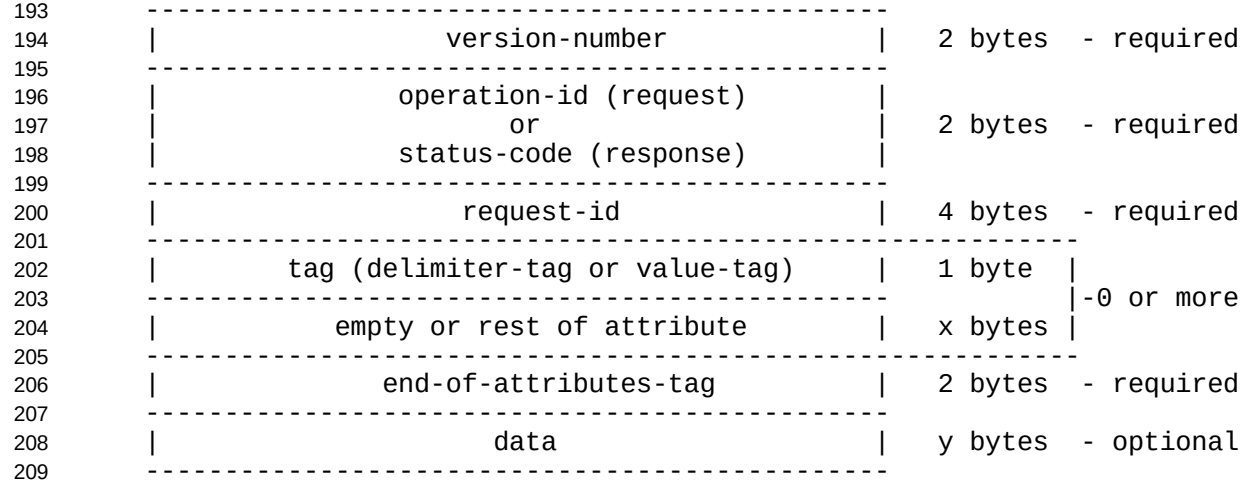



An additional value consists of:




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

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



## 3.2 Syntax of Encoding

The syntax below is ABNF [rfc2234] except 'strings of literals' MUST be case sensitive. For example 'a' means lower case 'a' and not upper case 'A'. In addition, SIGNED-BYTE and SIGNED-SHORT fields are represented as '%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 = LALPHA *( LALPHA / DIGIT / "-" / "_" / "." )
value-length = SIGNED-SHORT  ; number of octets of '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
```

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 0 (0x00). The ABNF for these two bytes MUST be %x01.00.

## 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 (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:

| 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 as defined in the model document. When an 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 9 “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 understand as opposed to a single value that it 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” values for the value-tag.

| Tag Value (Hex) | Meaning |
|---|---|

supported attribute to which no value has been assigned, e.g. “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” if 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 |

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": The parameter named "version-number" in the IPP model document MUST become the "version-number" field in the operation layer request or response.
- "operation-id": The parameter named "operation-id" in the IPP model document MUST become the "operation-id" field in the operation layer request.
- "status-code": The parameter named "status-code" in the IPP model document MUST become the "status-code" field in the operation layer response.
- "request-id": The parameter named "request-id" in the IPP model document MUST become the "request-id" field in the operation layer request or response.

All Printer and Job objects are identified by a Uniform Resource Identifier (URI) [rfc1630] 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:

- "printer-uri": When the target is a printer and the transport is HTTP or HTTPS (for TLS), the target printer-uri defined in each operation in the IPP model document MUST be an operation attribute called "printer-uri" and it MUST also be specified outside of the operation layer as the request-URI on the Request-Line at the HTTP level.
- "job-uri": When the target is a job and the transport is HTTP or HTTPS (for TLS), the target job-uri of each operation in the IPP model document MUST be an operation attribute called "job-uri" and it MUST also be specified outside of

1. Although potentially redundant, a client MUST supply the target of the operation both as an Operation and as a URI at the HTTP layer. The rationale for this decision is to maintain a consistent set of rules for mapping IPP to possibly many communication layers, even where URLs are not used as the addressing mechanism.
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 9 “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 9 “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.

## 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:<br>a) a SIGNED-SHORT which is the number of octets in the following field<br>b) a value of type natural-language,<br>c) a SIGNED-SHORT which is the number of octets in the following field,<br>d) a value of type textWithoutLanguage.<br><br>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:<br>a) a SIGNED-SHORT which is the number of octets in the following field<br>b) a value of type natural-language,<br>c) a SIGNED-SHORT which is the number of octets in the following field<br>d) a value of type nameWithoutLanguage.<br><br>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' |
| integer and enum | a SIGNED-INTEGER |
| 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 |

| Syntax of Attribute Value | Encoding |
|---|---|
| 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 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 port some other port as well. In addition, a printer may have to support another port for privacy (See Section 5 “Security Considerations”.

Note: even though port 631 is the IPP default, port 80 remains the default for an HTTP URI. Thus a URI for a printer using port 631 MUST contain an explicit port, e.g. "http://forest:631/pinetree".

Note: Consistent with RFC 2068 (HTTP/1.1), HTTP URI’s for IPP implicitly reference port 80. If a URI references some other port, the port number MUST be explicitly specified in the URI.

Each HTTP operation MUST use the POST method where the request-URI is the object target of the operation, and where the “Content-Type” of the message-body in each request and response MUST be “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 in RFC 2068 [rfc2068]. A printer (server) implementation MUST adhere the rules for an origin server described in RFC 2068.

The IPP layer doesn’t have to deal with chunking. In the context of CGI scripts, the HTTP layer removes any chunking information in the received data.

A client MUST NOT expect a response from an IPP server until after the client has sent the entire response. But a client MAY

- the “response/ server” column indicates whether a server sends the header.
- the “response /client” column indicates whether a client supports the header when received.
- the “values and conditions” column specifies the allowed header values and the conditions for the header to be present in a request/response.

The table for “request headers” does not have columns for responses, and the table for “response headers” does not have columns for requests.

The following is an explanation of the values in the “request/client” and “response/ server” columns.

- **must:** the client or server MUST send the header,
- **must-if:** the client or server MUST send the header when the condition described in the “values and conditions” column is met,
- **may:** the client or server MAY send the header
- **not:** the client or server SHOULD NOT send the header. It is not relevant to an IPP implementation.

The following is an explanation of the values in the “response/client” and “request/ server” columns.

- **must:** the client or server MUST support the header,
- **may:** the client or server MAY support the header
- **not:** the client or server SHOULD NOT support the header. It is not relevant to an IPP implementation.

## 4.1 General Headers

The following is a table for the general headers.

| **General-Header** | **Request** | | **Response** | | **Values and Conditions** |
|---|---|---|---|---|---|
| | **Client** | **Server** | **Server** | **Client** | |
| Cache-Control | must | not | must | not | “no-cache” only |
| Connection | must-if | must | must-if | must | “close” only. Both client and server SHOULD keep a connection for the duration of a sequence of operations. The client and server MUST include this header for the last operation in such a sequence. |
| Date | may | may | must | may | per RFC 1123 [rfc1123] from RFC 2068 |
| Pragma | must | not | must | not | “no-cache” only |

## 4.2 Request Headers

The following is a table for the request headers.

| Request-Header | Client | Server | Request Values and Conditions |
|---|---|---|---|
| Accept | may | must | "application/ipp" only. This value is the default if the client omits it |
| Accept-Charset | not | not | Charset information is within the application/ipp entity |
| Accept-Encoding | may | must | empty and per RFC 2068 [rfc2068] and IANA registry for content-codings |
| Accept-Language | not | not | language information is within the application/ipp entity |
| Authorization | must-if | must | per RFC 2068. A client MUST send this header when it receives a 401 "Unauthorized" response and does not receive a "Proxy-Authenticate" header. |
| From | not | not | per RFC 2068. Because RFC recommends sending this header only with the user's approval, it is not very useful |
| Host | must | must | per RFC 2068 |
| If-Match | not | not | |
| If-Modified-Since | not | not | |
| If-None-Match | not | not | |
| If-Range | not | not | |
| If-Unmodified-Since | not | not | |
| Max-Forwards | not | not | |
| Proxy-Authorization | must-if | not | per RFC 2068. A client MUST send this header when it receives a 401 "Unauthorized" response and a "Proxy-Authenticate" header. |
| Range | not | not | |

| Response-Header | Server | Client | Response Values and Conditions |
|---|---|---|---|
| Accept-Ranges | not | not | |
| Age | not | not | |
| Location | must-if | may | per RFC 2068. When URI needs redirection. |
| Proxy-Authenticate | not | must | per RFC 2068 |
| Public | may | may | per RFC 2068 |
| Retry-After | may | may | per RFC 2068 |
| Server | not | not | |
| Vary | not | not | |
| Warning | may | may | per RFC 2068 |
| WWW-Authenticate | must-if | must | per RFC 2068. When a server needs to authenticate a client. |

## 4.4 Entity Headers

The following is a table for the entity headers.

| Entity-Header | Request | | Response | | Values and Conditions |
|---|---|---|---|---|---|
| | Client | Server | Server | Client | |
| Allow | not | not | not | not | |
| Content-Base | not | not | not | not | |
| Content-Encoding | may | must | must | must | per RFC 2068 and IANA registry for content codings. |
| Content-Language | not | not | not | not | Application/ipp handles language |
| Content-Length | must-if | must | must-if | must | the length of the message-body per RFC 2068. Header MUST be present if Transfer-Encoding is absent.. |

| Entity-Header | Request | | Response | | Values and Conditions |
|---|---|---|---|---|---|
| | Client | Server | Server | Client | |
| ETag | not | not | not | not | |
| Expires | not | not | not | not | |
| Last-Modified | not | not | not | not | |

# 5. Security Considerations

The IPP Model document defines an IPP implementation with “privacy” as one that implements Transport Layer Security (TLS) Version 1.0. TLS meets the requirements for IPP security with regards to features such as mutual authentication and privacy (via encryption). The IPP Model document also outlines IPP-specific security considerations and should be the primary reference for security implications with regards to the IPP protocol itself.

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 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

# 6. References

[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.

[rfc1630] T. Berners-Lee, “Universal Resource Identifiers in WWW: A Unifying Syntax for the Expression of Names and Addresses of Objects on the Network as used in the Word-Wide Web”, RFC 1630, June 1994.

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

[rfc2046] N. Freed & N. Borenstein, Multipurpose Internet Mail Extensions (MIME) Part Two: Media Types. November 1996. (Obsoletes RFC1521, RFC1522, RFC1590), RFC 2046.

[rfc2048] N. Freed, J. Klensin & J. Postel. Multipurpose Internet Mail Extension (MIME) Part Four: Registration Procedures. November 1996. (Format: TXT=45033 bytes) (Obsoletes RFC1521, RFC1522, RFC1590) (Also BCP0013), RFC 2048.

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

[rfc2069] J. Franks, et al, " An Extension to HTTP: Digest Access 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 Parameter Value and Encoded Word Extensions: Character Sets, Languages, and Continuations", RFC 2184, August 1997,

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

[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-lpd] Herriot, R., Hastings, T., Jacobs, N., Martin, J., " Mapping between LPD and IPP Protocols", draft-ietf-ipp-lpd-ipp-map-04.txt, June 1998.

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

[ipp-pro] Herriot, R., Butler, S., Moore, P., Tuner, R., "Internet Printing Protocol/1.0: Encoding and Transport", draft-ietf-ipp-pro-06.txt, June, 1998.

[ipp-rat] Zilles, S., "Rationale for the Structure and Model and Protocol for the Internet Printing Protocol", draft-ietf-ipp-rat-03.txt, June, 1998.

[ipp-req] Wright, D., "Design Goals for an Internet Printing Protocol", draft-ietf-ipp-req-02.txt, June, 1998.

# 7. Author's Address

Robert Herriot (editor) Paul Moore

11311 Chinden Blvd.
Boise, ID 83714

Phone: 208-396-6000
Fax: 208-396-3457
Email: sbutler@boi.hp.com

5750 NW Pacific Rim Blvd
Camas, WA 98607

Phone: 360-817-8456
Fax: : 360-817-8436
Email: rturner@sharplabs.com

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

# 8. Other Participants:

Chuck Adams - Tektronix
Ron Bergman - Dataproducts
Keith Carter - IBM
Angelo Caruso - Xerox
Jeff Copeland - QMS
Roger Debry - IBM
Lee Farrell - Canon
Sue Gleeson - Digital
Charles Gordon - Osicom
Brian Grimshaw - Apple
Jerry Hadsell - IBM
Richard Hart - Digital
Tom Hastings - Xerox
Stephen Holmstead
Zhi-Hong Huang - Zenographics
Scott Isaacson - Novell
Rich Lomicka - Digital
David Kellerman - Northlake Software
Robert Kline - TrueSpectra
Dave Kuntz - Hewlett-Packard
Takami Kurono - Brother
Rich Landau - Digital
Greg LeClair - Epson
Harry Lewis - IBM
Tony Liao - Vivid Image
David Manchala - Xerox
Carl-Uno Manros - Xerox
Jay Martin - Underscore
Larry Masinter - Xerox
Ira McDonald, Xerox
Bob Pentecost - Hewlett-Packard
Patrick Powell - SDSU
Jeff Rackowitz - Intermec
Xavier Riley - Xerox
Gary Roberts - Ricoh
Stuart Rowley - Kyocera
Richard Schneider - Epson
Shigern Ueda - Canon
Bob Von Andel - Allegro Software
William Wagner - Digital Products
Jasper Wong - Xionics
Don Wright - Lexmark
Rick Yardumian - Xerox
Lloyd Young - Lexmark
Peter Zehler - Xerox
Frank Zhao - Panasonic
Steve Zilles - Adobe

# 9. Appendix A: Protocol Examples

| Octets | Symbolic Value | Protocol field |
|---|---|---|
| 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 |
| 0x001A | | value-length |
| http://forest:631/pinetree | printer pinetree | 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 |
| 0x0005 | | 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 |

## 9.2 Print-Job Response (successful)

Here is an example of a Print-Job response which is successful:

| Octets | Symbolic Value | Protocol field |
|---|---|---|

| Octets | Symbolic Value | Protocol field |
|---|---|---|
| 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 |
| 0x0002 | | value-length |
| OK | OK | value |
| 0x02 | start job-attributes | job-attributes-tag |
| 0x21 | integer | value-tag |
| 0x0007 | | name-length |
| job-id | job-id | name |
| 0x0004 | | value-length |
| 147 | 147 | value |
| 0x45 | uri type | value-tag |
| 0x0008 | | name-length |
| job-uri | job-uri | name |
| 0x001E | | value-length |
| http://forest:631/pinetree/123 | job 123 on pinetree | value |
| 0x25 | nameWithoutLanguage type | value-tag |
| 0x0008 | | name-length |
| job-state | job-state | name |
| 0x0001 | | value-length |
| 0x03 | pending | value |
| 0x03 | end-of-attributes | end-of-attributes-tag |

## 9.3 Print-Job Response (failure)

Here is an example of a Print-Job response which fails because the printer does not support sides and because the value 20 for copies is not supported:

| Octets | Symbolic Value | Protocol field |
|---|---|---|
| 0x0100 | 1.0 | version-number |
| 0x0400 | client-error-bad-request | status-code |
| 0x00000001 | 1 | request-id |
| 0x01 | start operation-attributes | operation-attribute tag |
| 0x47 | charset type | value-tag |
| 0x0012 | | name-length |

| Octets | Symbolic Value | Protocol field |
|---|---|---|
| 0x000E | | name-length |
| status-message | status-message | name |
| 0x000D | | value-length |
| bad-request | bad-request | value |
| 0x04 | start unsupported-attributes | unsupported-attributes tag |
| 0x21 | integer type | value-tag |
| 0x000C | | name-length |
| job-k-octets | job-k-octets | name |
| 0x0004 | | value-length |
| 0x001000000 | 16777216 | value |
| 0x21 | integer type | value-tag |
| 0x0005 | | 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 |

## 9.4 Print-URI Request

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

| Octets | Symbolic Value | Protocol field |
|---|---|---|
| 0x0100 | 1.0 | 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 |

| Octets | Symbolic Value | Protocol field |
|---|---|---|
| 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 |
| 0x0005 | | name-length |
| copies | copies | name |
| 0x0004 | | value-length |
| 0x00000001 | 1 | value |
| 0x03 | end-of-attributes | end-of-attributes-tag |

522 ## 9.5 Create-Job Request

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

| Octets | Symbolic Value | Protocol field |
|---|---|---|
| 0x0100 | 1.0 | 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 |
| 0x001A | | value-length |
| http://forest:631/pinetree | printer pinetree | value |
| 0x03 | end-of-attributes | end-of-attributes-tag |

524 ## 9.6 Get-Jobs Request

| Octets | Symbolic Value | Protocol field |
|---|---|---|
| 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 |
| 0x001A | | value-length |
| http://forest:631/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 |

## 9.7 Get-Jobs Response

The following is an of Get-Jobs response from previous request with 3 jobs. The Printer returns no information about the second job.

| Octets | Symbolic Value | Protocol field |
|---|---|---|
| 0x0100 | 1.0 | version-number |
| 0x0000 | OK (successful) | status-code |
| 0x00000123 | 0x123 | request-id (echoed back) |

| Octets | Symbolic Value | Protocol field |
|---|---|---|
| en-us | en-US | value |
| 0x41 | textWithoutLanguage type | value-tag |
| 0x000E | | name-length |
| status-message | status-message | name |
| 0x0002 | | value-length |
| OK | OK | value |
| 0x02 | start job-attributes (1st object) | job-attributes-tag |
| 0x48 | natural-language type | value-tag |
| 0x001B | | name-length |
| attributes-natural-language | attributes-natural-language | name |
| 0x0005 | | value-length |
| fr-CA | fr-CA | value |
| 0x21 | integer type | value-tag |
| 0x0006 | | name-length |
| job-id | job-id | name |
| 0x0004 | | value-length |
| 147 | 147 | value |
| 0x42 | nameWithoutLanguage type | value-tag |
| 0x0008 | | name-length |
| job-name | job-name | name |
| 0x0003 | | name-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 | 148 | value |
| 0x35 | 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 |

# 10. Appendix B: Registration of MIME Media Type Information for "application/ipp"

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

**Required parameters:** none

**Optional parameters:** none

**Encoding considerations:**

IPP/1.0 protocol requests/responses MAY contain long lines and ALWAYS contain binary data (for example attribute value lengths).

**Security considerations:**

IPP/1.0 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/1.0 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/1.0 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).

**Published specification:**

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

[ipp-pro] Herriot, R., Butler, S., Moore, P., Tuner, R., “Internet Printing Protocol/1.0: Encoding and Transport”, draft-ietf-ipp-pro-06.txt, June, 1998.

**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:**

or

Robert Herriot
Sun Microsystems Inc.
901 San Antonio Road, MPK-17
Palo Alto, CA 94303

Phone: 650-786-8995
Fax: 650-786-7077
Email: robert.herriot@eng.sun.com

**Intended usage:**

COMMON

# 11. Appendix C: Full Copyright Statement