

INTERNET DRAFT
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Rationale for the Structure of the Model and Protocol
for the Internet Printing Protocol

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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 on the Internet. There are multiple parts to IPP, but the primary architectural components are the Model, the Protocol and an interface to Directory Services. This document provides a high level overview of the architecture and provides the rationale for the decisions made in structuring the architecture.

The full set of IPP documents include:

Internet Printing Protocol/1.0: Requirements for an Internet
Printing Protocol
Internet Printing Protocol/1.0: Model and Semantics
Internet Printing Protocol/1.0: Security
Internet Printing Protocol/1.0: Protocol Specification
Internet Printing Protocol/1.0: Directory Schema

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1. ARCHITECTURAL OVERVIEW

The Internet Printing Protocol (IPP) is an application level protocol that can be used for distributed printing on the Internet. This protocol defines interactions between a client and a server. The client is provided the capability to inquire about capabilities of a printer, to submit print jobs and to inquire about and cancel print jobs. The server for these requests is the Printer; the Printer is an abstraction a generic document output device and/or a print service provider. Thus, the Printer could be a real printing device, such as a computer printer or fax output device, or it could be a service that interfaced with output devices.

The architecture for IPP defines (in the Model document) an abstract Model for the data which is used to control the printing process and to provide information about the process and the capabilities of the Printer. This abstract Model is hierarchical in nature and reflects the structure of the Printer and the Jobs that may be being processed by the Printer.

The Internet provides a channel between the client and the server/Printer. Use of this channel requires flattening and sequencing the hierarchical Model data. Therefore, the IPP also defines (in the Protocol document) an encoding of the data in the model for transfer between the client and server. This transfer of data may be either a request or the response to a request.

Finally, the IPP defines (in the Protocol document) a protocol for transferring the encoded request and response data between the client and the server/Printer.

An example of a typical interaction would be a request from

the client to create a print job. The client would assemble the Model data to be associated with that job, such as the name of the job, the media to use, the number of pages to place on each media instance, etc. This data would then be encoded according to the Protocol and would be transmitted according to the Protocol. The server/Printer would receive the encoded Model data, decode it into a form understood by the server/Printer and, based on that data, do one of two things: (1) accept the job or (2) reject the job. In either case, the server must construct a response in terms of the Model data, encode that response according to the Protocol and transmit that encoded Model data as the response to the request using the Protocol.

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Another part of the IPP architecture is the Directory Schema. The role of the Directory Schema is to provide a standard set of attributes which might be used to query a directory service for the URI of a Printer that is likely to meet the needs of the client.

The IPP architecture also addresses security issues such as control of access to server/Printers and secure transmissions of requests, response and the data to be printed.

2. THE PRINTER

Because the (abstract) server/Printer encompasses a wide range of implementations, it is necessary to make some assumptions about a minimal implementation. The most likely minimal implementation is one that is embedded in an output device running a specialized real time operating system and with limited processing, memory and storage capabilities. This Printer will be connected to the Internet and will have at least a TCP/IP capability with (likely) SNMP support for the Internet connection. In addition, it is likely the the Printer will be an HTML/HTTP server to allow direct user access to information about the printer.

3. RATIONALE FOR THE MODEL

The Model is defined independently of any encoding of the Model data both to support the likely uses of IPP and to be robust with respect to the possibility of alternate encodings.

It is expected that a client or server/Printer would represent the Model data in some data structure within the applications/servers that support IPP. Therefore, the Model was designed to make that representation straightforward. Typically, a parser or formatter would be used to convert from or to the encoded data format. Once in an internal form suitable to a product, the data can be manipulated by the product. For example, the data sent with a Print Job can be used to control the processing of that Print Job.

The semantics of IPP are attached to the (abstract) Model. Therefore, the application/server is not dependent on the encoding of the Model data, and it is possible to consider alternative mechanisms and formats by which the data could be transmitted from a client to a server; for example, a server

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could have a direct, client-less GUI interface that might be used to accept some kinds of Print Jobs. This independence would also allow a different encoding and/or transmission mechanism to be used if the ones adopted here were shown to be overly limiting in the future. Such a change could be migrated into new products as an alternate protocol stack/parser for the Model data.

Having an abstract Model also allows the Model data to be aligned with the (abstract) model used in the Printer, Job and Host Resources MIBs. This provides consistency in interpretation of the data obtained independently of how the data is accessed, whether via IPP or via SNMP and the

Printer/Job MIBs.

4. RATIONALE FOR THE PROTOCOL

There are two parts to the Protocol: (1) the encoding of the Model data and (2) the mechanism for transmitting the model data between client and server.

4.1 The Encoding

To make it simpler to develop embedded printers, a very simple binary encoding has been chosen. This encoding is adequate to represent the kinds of data that occur within the Model. It has a simple structure consisting of name value pairs in which the names are length specified strings constrained to characters from a subset of ASCII and the values are either scalars or a sequence of scalars. Each scalar value has a length specification and is represented either as an 4 byte integer or a string.

A fully encoded request/response has a version number, an operation (for a request) or a status and optionally a status message (for a response), associated parameters and attributes which are encoded Model data and, optionally (for a request), print data following the Model data.

4.2 The Transmission Mechanism

The chosen mechanism for transmitting the encoded Model data is HTTP 1.1 Post (and associated response). No modifications to HTTP 1.1 are proposed or required.

The sole role of the Transmission Mechanism is to provide a transfer of encoded Model data from/to the client to/from the server. This could be done using any data delivery mechanism. The key reasons why HTTP 1.1 Post is used are given below. The

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most important of these is the first. With perhaps this exception, these reasons could be satisfied by other

mechanisms. There is no claim that this list uniquely determines a choice of mechanism.

1. HTTP 1.0 is already widely deployed and, based on the recent evidence, HTTP 1.1 will be widely deployed as the manufacturers release new products. The performance benefits of HTTP 1.1 have been shown and manufactures are reacting postively.

Wide deployment has meant that many of the problems of making a protocol work in a wide range of environments from local net to intranet to internet have been solved and will stay solved with HTTP 1.1 deployment.

2. HTTP 1.1 solves most of the problems that might have required a new protocol to be developed. HTTP 1.1 allows persistent connections that make a multi-message protocol be more efficient; for example it is practical to have a separate CreatJob and SendJob messages. Chunking allows the transmission of large print files without having to prescan the file to determine the file length. The accept headers allow the client's protocol and localization desires to be transmitted with the IPP operations and data. If the Model were to provide for the redirection of Job requests, such as Cancel-Job, when a Job is moved, the HTTP redirect response allows a client to be informed when a Job he is interested in is moved to another server/Printer for any reason.
3. Most network Printers will be implementing HTTP servers for reasons other than IPP. These network attached Printers want to provide information on how to use the printer, its current state, etc. in HTML. This requires having an HTTP server which would be available to do IPP functions as well.
4. Most of the complexity of HTTP 1.1 is concerned with the implementation of proxies and not the implementation of clients and/or servers. Work is proceding in the HTTP Working Group to help identify what must be done by a server. As the Protocol document shows, that is not very much.
5. An HTTP based solution fits well with the Internet security mechanism that are currently deployed or being deployed. HTTP will run over SSL/TLS. The digest

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authentication mechanism of HTTP 1.1 provides an adequate level of access control (at least for intranet usage). These solutions are deployed and in practical use; a new solution would require extensive use to have the same degree of confidence in its security.

5. RATIONALE FOR THE DIRECTORY SCHEMA

Successful use of IPP depends on the client finding a suitable IPP enabled Printer to which to send a IPP requests, such as print a job. This task is simplified if there is a Directory Service which can be queried for a suitable Printer. The purpose of the Directory Schema is to have a standard description of Printer attributes that can be associated the the URI for the printer. These attributes are a subset of the Model attributes and can be encoded in the appropriate query syntax for the Directory Service being used by the client.

6. RATIONALE FOR SECURITY

Security is an areas of active work on the Internet. Complete solutions to a wide range of security concerns are not yet available. Therefore, in the design of IPP, the focus has been on identifying a set of security protocols/features that are implemented (or currently implementable) and solve real problems with distributed printing. The two areas that seem appropriate to support are: (1) authorization to use a Printer and (2) secure interaction with a printer. The chosen mechanisms are the digest authentication mechanism of HTTP 1.1 and the SSL/TLS secure communication mechanism, which also includes authorization.

7. REFERENCES

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