                    Internet Printing Protocol/1.1:
                            IPP URL Scheme

Status of this Memo

   This document specifies an Internet standards track protocol for the
   Internet community, and requests discussion and suggestions for
   improvements. Please refer to the current edition of the "Internet
   Official Protocol Standards" (STD 1) for the standardization state
   and status of this protocol. Distribution of this memo is unlimited.

Abstract

   This memo defines the "ipp" URL (Uniform Resource Locator) scheme.
   This memo updates IPP/1.1: Encoding and Transport (RFC 2910), by
   expanding and clarifying Section 5, "IPP URL Scheme", of RFC 2910.
   An "ipp" URL is used to specify the network location of a print
   service that supports the IPP Protocol (RFC 2910), or of a network
   resource (for example, a print job) managed by such a print service.

Table of Contents

1. Introduction

   This memo conforms to all of the requirements in Registration
   Procedures for URL Scheme Names [RFC2717]. This memo also follows
   all of the recommendations in Guidelines for new URL Schemes
   [RFC2718].

   See section 1, "Introduction", of [RFC2911] and section 1,
   "Introduction", of [RFC3196] for overview information about IPP. See
   section 10, "Description of the Base IPP Documents", of [RFC3196] for
   a full description of the IPP document set.

   This memo updates IPP/1.1: Encoding and Transport (RFC 2910), by
   expanding and clarifying Section 5, "IPP URL Scheme", of RFC 2910,
   but does not define any new parameters or other new extensions to the
   syntax of IPP URLs.

   The IPP URL scheme defined in this document is based on the ABNF for
   the HTTP URL scheme defined in HTTP [RFC2616], which in turn is
   derived from the URI Generic Syntax [RFC2396] and further updated for
   IPv6 by [RFC2732]. An IPP URL is transformed into an HTTP URL
   according to the rules specified in section 5 of IPP Protocol
   [RFC2910].

   This document defines IPP URL scheme applicability, associated port
   (631), associated MIME type ("application/ipp"), character encoding,
   and syntax.

   This document is laid out as follows:

   - Section 2 defines the terminology used throughout the document.

   - Section 3 supplies references to the IPP Printer and IPP Job
      object model defined in IPP Model [RFC2911].

   - Section 4 specifies the IPP URL scheme.

   - Section 5 specifies the conformance requirements for IPP Clients
      and IPP Printers that claim conformance to this document.

   - Sections 6, 7, and 8 specify IANA, internationalization, and
      security considerations.

   - Sections 9, 10, 11, 12, and 13 specify normative references,
      informative references, acknowledgements, authors' addresses, and
      full IETF copyright statement.

   - Section 14 (Appendix A) is a completed registration template for
      the IPP URL Scheme (see section 6.0 of [RFC2717]).

2. Terminology

      This specification document uses the terminology defined in this
      section.

2.1. Conformance Terminology

      The uppercase terms "MUST", "MUST NOT", "REQUIRED", "SHALL",
      "SHALL NOT" "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and
      "OPTIONAL" in this document are to be interpreted as described in
      [RFC2119]. These terms are used to specify conformance
      requirements for all implementations (both print clients and print
      services) of this specification.

2.2. Model Terminology

      See section 12.2, "Model Terminology", in IPP Model [RFC2911].

3. IPP Model for Printers and Jobs

      See section 2, "IPP Objects", section 2.1, "Printer Object", and
      section 2.2, "Job Object", in [RFC2911] for a full description of
      the IPP object model and terminology.

      In this document, "IPP Client" means the software (on some
      hardware platform) that submits, monitors, and/or manages print
      jobs via the IPP Protocol [RFC2910] to a print spooler, print
      gateway, or physical printing device.

In this document, "IPP Printer object" means the software (on some
hardware platform) that receives print jobs and/or printer/job
operations via the IPP Protocol [RFC2910] from an "IPP Client".

In this document, "IPP Printer" is a synonym for "IPP Printer
object".

In this document, "IPP Job object" means the set of attributes and
documents for one print job instantiated on an "IPP Printer".

In this document, "IPP Job" is a synonym for "IPP Job object".

In this document, "IPP URL" means a URL with the "ipp" scheme.

Note: In this document, "IPP URL" is a synonym for "ipp-URL" (in
section 4, "IPP URL Scheme", of this document) and "ipp-URL" (in
section 5, "IPP URL Scheme", of [RFC2910]).

4. IPP URL Scheme

4.1. IPP URL Scheme Applicability

The "ipp" URL scheme MUST only be used to specify absolute URLs
(relative IPP URLs are not allowed) for IPP print services and
their associated network resources. The "ipp" URL scheme MUST
only be used to specify the use of the abstract protocol defined
in IPP Model [RFC2911] over an HTTP [RFC2616] transport, as
defined in IPP Protocol [RFC2910]. Any other transport binding
for the abstract protocol defined in IPP Model [RFC2911] would
require a different URL scheme.

The "ipp" URL scheme allows an IPP client to choose an appropriate
IPP print service (for example, from a directory). The IPP client
can establish an HTTP connection to the specified IPP print
service. The IPP client can send IPP protocol requests (for
example, a "Print-Job" request) and receive IPP protocol responses
over that HTTP connection.

4.2. IPP URL Scheme Associated Port

All IPP URLs which do NOT explicitly specify a port MUST be
resolved to IANA-assigned well-known port 631, as registered in
[IANA-PORTREG].

See: IANA Port Numbers Registry [IANA-PORTREG].
See: IPP Protocol [RFC2910].

4.3. IPP URL Scheme Associated MIME Type

    All IPP URLs MUST be used to specify network print services which
    support the "application/ipp" MIME media type as registered in
    [IANA-MIMEREG] for IPP protocol requests and responses.

    See: IANA MIME Media Types Registry [IANA-MIMEREG].
    See: IPP Protocol [RFC2910].

4.4. IPP URL Scheme Character Encoding

    IPP URLs MUST use [RFC2396] encoding, as do their equivalent HTTP
    URLs. Characters other than those in the "reserved" and "unsafe"
    sets [RFC2396] are equivalent to their ""%" HEX HEX" encoding.

4.5. IPP URL Scheme Syntax

    The abstract protocol defined in IPP Model [RFC2911] places a
    limit of 1023 octets (NOT characters) on the length of a URI (see
    section 4.1.5, "uri", in [RFC2911]).

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

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

  The IPP URL scheme syntax in ABNF is as follows:

  ipp-URL = "ipp:" "//" host [":" port] [abs_path ["?" query]]

  If the port is empty or not given, port 631 is assumed. The
  semantics are that the identified resource (see section 5.1.2 of
  [RFC2616]) is located at the IPP print service listening for HTTP
  connections on that port of that host, and the Request-URI for the
  identified resource is 'abs_path'.

  If the 'abs_path' is not present in the URL, it MUST be given as "/"
  when used as a Request-URI for a resource (see section 5.1.2 of
  [RFC2616]).

4.6. IPP URL Examples

   Note: Literal IPv4 or IPv6 addresses SHOULD NOT be used in IPP URLs.

4.6.1. IPP Printer URL Examples

   The following are examples of well-formed IPP URLs for IPP Printers
   (for example, to be used as protocol elements in 'printer-uri'
   operation attributes of 'Print-Job' request messages):

      ipp://example.com
      ipp://example.com/printer
      ipp://example.com/printer/tiger
      ipp://example.com/printer/fox
      ipp://example.com/printer/tiger/bob
      ipp://example.com/printer/tiger/ira

   Each of the above URLs are well-formed URLs for IPP Printers and each
   would reference a logically different IPP Printer, even though some
   of those IPP Printers might share the same host system. The 'bob' or
   'ira' last path components might represent two different physical
   printer devices, while 'tiger' might represent some grouping of IPP
   Printers (for example, a load-balancing spooler). Or the 'bob' and
   'ira' last path components might represent separate human recipients
   on the same physical printer device (for example, a physical printer
   supporting two job queues). In either case, both 'bob' and 'ira'
   would behave as different and independent IPP Printers.

   The following are examples of well-formed IPP URLs for IPP Printers
   with (optional) ports and paths:

      ipp://example.com
      ipp://example.com/˜smith/printer
      ipp://example.com:631/˜smith/printer

   The first and second IPP URLs above MUST be resolved to port 631
   (IANA assigned well-known port for IPP). The second and third IPP
   URLs above are equivalent (see section 4.7 below).

4.6.2. IPP Job URL Examples

   The following are examples of well-formed IPP URLs for IPP Jobs (for
   example, to be used as protocol elements in 'job-uri' attributes of
   'Print-Job' response messages):

      ipp://example.com/printer/123
      ipp://example.com/printer/tiger/job123

IPP Job URLs are valid and meaningful only until Job completion and
possibly an implementation defined optional period of persistence
after Job completion (see IPP Model [RFC2911]).

Ambiguously, section 4.3.1 'job-uri' of IPP Model [RFC2911] states
that:

    "the precise format of a Job URI is implementation dependent."

Thus, the relationship between the value of the "printer-uri"
operation attribute used in a 'Print-Job' request and the value of
the "job-uri" attribute returned in the corresponding 'Print-Job'
response is implementation dependent. Also, section 4.3.3 'job-
printer-uri' of IPP Model [RFC2911] states that the 'job-printer-uri'
attribute of a Job object:

    "permits a client to identify the Printer object that created this
    Job object when only the Job object's URI is available to the
    client."

However, the above statement is false, because the transform from an
IPP Job URL to the corresponding IPP Printer URL is unspecified in
either IPP Model [RFC2911] or IPP Protocol [RFC2910].

IPP Printers that conform to this specification SHOULD only generate
IPP Job URLs (for example, in the "job-uri" attribute in a 'Print-
Job' response) by appending exactly one path component to the
corresponding IPP Printer URL (for interoperability).

4.7. IPP URL Comparisons

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

- A port that is empty or not given MUST be treated as equivalent to
   the well-known port for that IPP URL (port 631);

   See: Section 3.2.3, "URI Comparison", in [RFC2616].

5. Conformance Requirements

5.1. IPP Client Conformance Requirements

   IPP Clients that conform to this specification:

   a) MUST only send IPP protocol connections to the port specified in
      each given IPP URL (if present) or otherwise to IANA assigned
      well-known port 631;

   b) MUST only send IPP URLs used as protocol elements in outgoing IPP
      protocol request messages (for example, in the "printer-uri"
      operation attribute in a 'Print-Job' request) that conform to the
      ABNF specified in section 4.5, "IPP URL Scheme Syntax, of this
      document;

   c) MUST only convert IPP URLs to their corresponding HTTP URL forms
      according to the rules in section 5, "IPP URL Scheme", in
      [RFC2910].

5.2. IPP Printer Conformance Requirements

   IPP Printers that conform to this specification:

   a) MUST listen for incoming IPP protocol connections on IANA-assigned
      well-known port 631, unless explicitly configured by system
      administrators or site policies;

   b) SHOULD NOT listen for incoming IPP protocol connections on any
      other port, unless explicitly configured by system administrators
      or site policies;

   c) SHOULD only accept IPP URLs used as protocol elements in incoming
      IPP protocol request messages (for example, in the "printer-uri"
      operation attribute in a 'Print-Job' request) that conform to the
      ABNF specified in section 4.5, "IPP URL Scheme Syntax", of this
      document;

   d) SHOULD only send IPP URLs used as protocol elements in outgoing
      IPP protocol response messages (for example, in the "job-uri"
      attribute in a 'Print-Job' response) that conform to the ABNF
      specified in section 4.5, "IPP URL Scheme Syntax", of this
      document;

   e) SHOULD only generate IPP Job URLs (for example, in the "job-uri"
      attribute in a 'Print-Job' response) by appending exactly one path
      component to the corresponding IPP Printer URL (for
      interoperability);

   f) SHOULD NOT use literal IPv6 or IPv4 addresses in configured or
      locally generated IPP URLs.

6.   IANA Considerations

   This IPP URL Scheme specification does not introduce any additional
   IANA considerations, beyond those described in [RFC2910] and
   [RFC2911].

   See: Section 6, "IANA Considerations" in [RFC2910]
   See: Section 6, "IANA Considerations" in [RFC2911].

7.   Internationalization Considerations

   This IPP URL Scheme specification does not introduce any additional
   internationalization considerations, beyond those described in
   [RFC2910] and [RFC2911].

   See: Section 7, "Internationalization Considerations", in [RFC2910].
   See: Section 7, "Internationalization Considerations", in [RFC2911].

8.   Security Considerations

   This IPP URL Scheme specification does not introduce any additional
   security considerations, beyond those described in [RFC2910] and
   [RFC2911], except the following:

   a) An IPP URL might be faked to point to a rogue IPP print service,
      thus collecting confidential document contents from IPP clients.
      Server authentication mechanisms and security mechanisms specified
      in the IPP Protocol [RFC2910] are sufficient to address this
      threat.

   b) An IPP URL might be used to access an IPP print service by an
      unauthorized IPP client. Client authentication mechanisms and
      security mechanisms specified in the IPP Protocol [RFC2910] are
      sufficient to address this threat.

   c) An IPP URL might be used to access an IPP print service at a print
      protocol application layer gateway (for example, an IPP to LPD
      gateway [RFC2569]) causing silent compromise of IPP security
      mechanisms. There is no practical defense against this threat by
      a client system. System administrators should avoid such
      compromising configurations.

   d) An IPP URL does not have parameters to specify the required client
      authentication mechanism (for example, 'certificate' as defined in
      section 4.4.2, "uri-authentication-supported", of IPP Model

[RFC2911]) and required security mechanism (for example, 'tls' as
defined in section 4.4.3, "uri-security-supported", of IPP Model
[RFC2911]). Service discovery or directory protocols might be
used to discover the required client authentication and security
mechanisms associated with given IPP URLs.

Historical Note: During the development of this document,
consideration was given to the addition of standard IPP URL
parameters for the client authentication and security mechanisms.
However, based on a strong IETF IPP Working Group consensus, no
parameters were added to the "ipp" URL scheme as originally defined
in IPP Protocol [RFC2910] in September 2000, for reasons of backwards
compatibility with the many currently shipping implementations of
IPP/1.1.

See: Section 8, "Security Considerations", in [RFC2910].
See: Section 8, "Security Considerations", in [RFC2911].

9. Intellectual Property Rights

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this standard. Please address the information to the IETF Executive
Director.

10. Normative References

   [RFC2234]   Crocker, D. and P. Overell, "Augmented BNF for Syntax
                  Specifications: ABNF", RFC 2234, November 1997.

   [RFC2396]   Berners-Lee, T., Fielding, R. and L. Masinter,
                  "Uniform Resource Identifiers (URI): Generic Syntax",
                  RFC 2396, August 1998.

   [RFC2616]   Fielding, R., Gettys, J., Mogul, J., Frystyk, H.,
                  Masinter, L., Leach, P. and T. Berners-Lee, "Hypertext
                  Transfer Protocol -- HTTP/1.1", RFC 2616, June 1999.

   [RFC2732]   Hinden, R., Carpenter, B. and L. Masinter, "Format for
                  Literal IPv6 Addresses in URL's", RFC 2732, December
                  1999.

   [RFC2910]   Herriot, R., Butler, S., Moore, P., Turner, R. and J.
                  Wenn, "IPP/1.1 Encoding and Transport [IPP Protocol]",
                  RFC 2910, September 2000.

   [RFC2911]   Hastings, T., Herriot, R., deBry, R., Isaacson, S. and
                  P. Powell, "IPP/1.1 Model and Semantics [IPP Model]",
                  RFC 2911, September 2000.

   [US-ASCII]   Coded Character Set -- 7-bit American Standard Code
                  for Information Interchange, ANSI X3.4-1986.

11. Informative References

   [IANA-MIMEREG] IANA MIME Media Types Registry.
                  ftp://ftp.iana.org/in-notes/iana/assignments/media-
                  types/...

   [IANA-PORTREG] IANA Port Numbers Registry. ftp://ftp.iana.org/in-
                  notes/iana/assignments/port-numbers

   [RFC2569]   Herriot, R., Hastings, T., Jacobs, N. and J. Martin,
                  "Mapping between LPD and IPP Protocols", RFC 2569,
                  April 1999.

   [RFC2717]   Petke, R. and I. King, "Registration Procedures for
                  URL Scheme Names", RFC 2717, November 1999.

   [RFC2718]   Masinter, L., Alvestrand, H., Zigmond, D. and R.
                  Petke, "Guidelines for new URL Schemes", RFC 2718,
                  November 1999.

   [RFC3196]   Hastings, T., Manros, C., Zehler, P., Kugler, C. and
                     H. Holst, "Internet Printing Protocol/1.1:
                     Implementor's Guide", RFC 3196, November 2001.

12. Acknowledgments

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   IETF IPP WG.

   Section 5, "IPP URL Scheme", in IPP Protocol [RFC2910] was the
   primary input to this IPP URL Scheme specification.

Appendix A - Registration of "ipp" URL Scheme

   Note: The following registration obsoletes section 5, "IPP URL
   Scheme", of IPP Protocol [RFC2911].

   URL Scheme Name: ipp

   URL Scheme Syntax:

      ipp-URL = "ipp:" "//" host [":" port] [abs_path ["?" query]]

   Character Encoding Considerations:

      IPP URLs MUST use [RFC2396] encoding, as do their equivalent HTTP
      URLs. Characters other than those in the "reserved" and "unsafe"
      sets [RFC2396] are equivalent to their ""%" HEX HEX" encoding.

   Intended Usage:

      The intended usage of the "ipp" URL scheme is COMMON.

      An "ipp" URL is used to specify the network location of a print
      service that supports the IPP Protocol [RFC2910], or of a network
      resource (for example, a print job) managed by such a print
      service. An IPP client can choose to establish an HTTP connection
      to the specified print service for transmission of IPP protocol
      requests (for example, IPP print job submission requests).

   Applications or Protocols which use this URL scheme:

      See: Section 5, "IPP URL Scheme", in IPP Protocol [RFC2910].

   Interoperability Considerations:

      See: Section 9, "Interoperability with IPP/1.0 Implementations",
      in IPP Protocol [RFC2910].

   Security Considerations:

      See: Section 8, "Security Considerations", in IPP Protocol
      [RFC2910].

   Relevant Publications:

   [RFC2910] Herriot, R., Butler, S., Moore, P., Turner, R. and J. Wenn,
             "IPP/1.1 Encoding and Transport [IPP Protocol]", RFC 2910,
             September 2000.

   [RFC2616] Fielding, R., Gettys, J., Mogul, J., Frystyk, H., Masinter,
             L., Leach, P. and T. Berners-Lee, "Hypertext Transfer
             Protocol -- HTTP/1.1", RFC 2616, June 1999.

   [RFC3510] Herriot, R. and I. McDonald, "IPP/1.1: IPP URL Scheme", RFC
             3510, April 2003.

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   Usage questions and comments on this IPP URL Scheme should be sent
   directly to the editors at their above addresses (and to the IPP
   mailing list, if you are a subscriber - see below).

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

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

   1) send it to majordomo@pwg.org

   2) leave the subject line blank

   3) put the following two lines in the message body: subscribe ipp

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

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Acknowledgement