The Ubiquity of Print

Enabling Printing within the Ubiquitous Web

Don Wright, Director of Standards, Lexmark International

Background

Few can argue the need for printing in today's world. Long after the pundits began to predict the paperless office of the future, the actual number of printed pages has continued to increase most notably due to the rapid increase in available information – information made available largely by the World Wide Web. While the web provides easy access to a treasure trove of information, printing that information is not nearly as easy as seeing and reading it in a browser.

> "There will be a paperless office when there is a paperless bathroom."
>
> --Wall Street Journal, 1985

Over the last 15 years, printing devices have become one of the most usable and manageable devices on the network, second only to the personal computer. The printing industry, including both printer manufacturers as well as software and operating system developers, have created an organization called the Printer Working Group (PWG)[1] where issues and problems related to the use and manageability of printing devices can be solved. While the PWG is not always the venue where these problems are solved, it has consistently served as the nexus for the companies and people to see that the problems are addressed. All of the companies and many of the same people who have been a part of the PWG have also been a part of the groups that have addressed printing in other organizations including groups like the UPnP™ Forum[2] and the Bluetooth® SIG[3]. Making ubiquitous printing a part of the ubiquitous web should be no different.

(Note: An overview of the evolution of network printing and network printing management can be found as an annex starting on page 4 of this paper.)

The PWG, the UPNP forum and others have often worked in relative isolation. In contrast, a group like the W3C consisting of experts in all aspects of the web from hundreds of member companies can examine and propose a more holistic solution.

Print and the Ubiquitous Web

Today, most printers are designed to be shared – many directly on a network. For printing on the ubiquitous web we should rely heavily on the work previously done such as the ***Devices Profile for Web Services***[4] and the printing model created by the ***PWG Semantic Model***[5].

While it is apparent that much of the groundwork has been laid and much of the foundation is in place, problems and issues remain to be solved.

ISSUES

There are a variety of issues that need to be addressed to enable the ubiquitous usage of

devices on the ubiquitous web. Some of them are very general issues such as:

1. Does a ubiquitous web mean that the full function of the device is available everywhere or that some "sufficient" subset of a device's full function is available everywhere?
2. Is a device a "service" as considered in typical "web services" based architectures?
3. Is a device an amalgamation of "services" as considered in typical "web services" based architectures?
4. Are devices "peers of" or "slaves to" the typical computers and servers which dominate the web today?

In addition, there are many, many questions which apply more specifically to printing devices. The following are some of the more obvious ones:

DISCOVERY:

1. How are printers discovered? Broadcasts? Directories?
2. Which printers are "in range" in a ubiquitous web?
3. Is selection by sub-net appropriate or sufficient?
4. Is geographic positioning information needed?

DELIVERY:

1. How is the print job delivered to the device? Is it negotiated or mandated? If it is mandated, should it be IPP or SOAP or HTTP PUT or something new?
2. Must the sender fully understand the capabilities of the device or are other solutions (e.g., XHTML-Print) sufficient?
3. Are intermediate services needed (or supported) to transform content into a form usable by a specific printing device?
4. If intermediate services are supported how do they bind to devices? How do clients bind to the intermediate services?

CAPABILITIES:

1. Are the attributes & value of the PWG Semantic Model sufficient or is a more complete negotiated capabilities model needed?
2. How are those device capabilities delivered to the client seeking to use that device? Protocol? Format?
3. Is the management of the capabilities and configuration of these devices appropriate for consideration as a part of this project?

SECURITY:

1. Is the content being printed secured? If so, how?
2. Does the client or the printer determine if and when security is needed?
3. What security is needed for the printing device itself to protect it from "print spam" and other attacks?
4. How is trust established between the client and the printer? How does the user know that the printer seen on the ubiquitous web is the printer it claims to be?

The work on ***Devices Profile for Web Services*** brings us closer to the concept of ubiquitous printing within the ubiquitous web but significant efforts to consider the unique requirements of printing and to

create the necessary profiles and other specifications are still needed.

PATH FORWARD

In order to move the concept of the ubiquitous web for non-computing devices forward, a number of foundational steps must be taken:

1. Specific use cases and needs for each of the various types of non-computer device classes (e.g., printers, cameras, scanners, and refrigerators) must be developed. A broad range of stakeholders from the affected industries must be engaged in the creation of these use cases. The development of these use cases should span a wide range of activities including typical consumer activities extending upward to complex business and industrial activities.

2. Examine in detail the architectures and models of similar or related efforts (e.g., UPnP) that have already been created. Identify the strengths and weaknesses of each of those designs.

3. Develop the overarching model or architecture for non-computer devices for all classes for the ubiquitous web. This architecture should consider what was learned in #2 above and reuse what is appropriate. This architecture should strongly consider utilizing and building upon existing standard technologies whenever possible. If pre-existing standards cannot be adopted unchanged, work with the developers of those standards and make minimal modification to them to align them with the ubiquitous web architecture.

4. Based on the architecture developed above, specific standards (or recommendations) must be developed to address the specific issues and needs of the use cases for each of the device classes. These may be in the form of completely new standards or simply be profiles which specify how a multiplicity of standards should be used to connect a specific device class to the ubiquitous web. Some of this work may be done within the W3C or done through partnerships with other groups.

The printing community remains an active and effective one. Organizations like the Printer Working Group continue to provide forums to discuss emerging issues and a venue to solve them. We recommend the engagement of the printing community, both directly with developers and manufacturers and through groups like the PWG, to work toward enabling the use of printing devices on the ubiquitous web.

Annex: Historical Overview

In the Beginning: IPP

In the mid 1990's, a group of companies recognized a need to create a standard for printing across the network. At that time, a variety of largely proprietary protocols supplemented by an anemic LPR protocol[6] dominated print submission across the network.

IBM, Lexmark, Novell and Xerox recognized the need for a standard and began an effort within the nascent PWG that eventually became the Internet Printing Protocol (IPP).[7] Other companies, including Canon, Dataproducts, Epson, Hewlett-Packard, Microsoft, QMS, Ricoh, Sharp Labs and Sun Microsystems, quickly joined the effort.

Early in the development process, the team realized it had to answer several basic questions before it could proceed:

1. What information is needed about a printer's capabilities and state are necessary in order to print?

2. What commands to the printer are necessary to adequately control and submit print jobs?

3. How should the print job formatting commands passed within the print job interact with formatting commands contained within the job description language (late binding versus early binding)?

4. How should the print job be transported to the printer?

The answers to the first three questions above are found in ***Internet Printing Protocol/1.1: Model and Semantics***, now RFC2911.

Information about the printer and its capabilities can potentially be enormous. As such, the IPP group settled on a relatively small number of attributes which included specific information about the manufacturer, make and model of the device. The assumption was that if the information defined by IPP was insufficient for an application, it would need to obtain the additional information knowing the manufacturer, make and model. A generic device capabilities syntax or protocol, such as **conneg,**[8] was not included. See Figure 1 for sample attributes discoverable and in some cases settable within IPP.

To address question 2, the IPP group decided on a small number of basic operations. While many more can be imagined, this core group of operations is sufficient for most applications and even includes the concept of printing a URI. (Note: Not all operations are required for compliance with IPP.) See Figure 2 for the complete list of operations defined by IPP.

Printer-name
Printer-location
Printer-make-and-model
Printer-state
Charset-supported
Document-format-supported
Color-supported
PDL-override-supported
compression-supported
Pages-per-minute
Job-priority
Copies
Finishing
Sides
Number-up
Orientation
Media
Printer-Resolution
Print-quality

Figure 1 – Sample of IPP Printer Description & Job Attributes

In the end, the IPP group determined it was unable to mandate a single solution to the question of late binding versus early binding. As such, by using a pair of attribute (pdl-override and ipp-attribute-fidelity), the client is able to determine the capabilities of the device and structure print jobs accordingly.

The last question is addressed in a separate document, ***Internet Printing Protocol/1.1: Encoding and Transport***, now RFC2910.

Print-Job
Print-URI
Validate-Job
Create-Job
Send-Document
Send-URI
Cancel-Job
Get-Job-Attributes
Get-Jobs
Get-Printer-Attributes
Hold-Job
Release-Job
Restart-Job
Pause-Printer
Resume-Printer
Purge-Jobs

Figure 2 - IPP Operations

At the time, the computing power of most printers was severely limited. A design decision was made to encode the IPP protocol over the wire in a binary format. Very late in the process, an effort was made to convert the IPP binary encoding to an XML-based one. In the end, this effort was defeated due to the delay that such a change would cause and due to the continued perception that XML would be too verbose for a printer's processor to handle. In retrospect, while is seemed right at the time, it was probably the wrong decision for the long term.

The "Sons" of IPP

The development of IPP was a massive effort starting in 1996 and was still developing additional RFCs as late as 2005. In the mean time, a number of other projects re-used the model and concepts of IPP.

UPnP™ Forum

In 1999, the Universal Plug and Play forum began developing the ***PrintBasic Service Template***[9] for UPNP Device Architecture[10] version 1.0.

The UPnP printing working group chose to recast the IPP model and semantics into the architecture of UPnP which used XML for encoding and SOAP for the protocol and HTTP PUT for print data transfers. Given that UPnP was designed to be usable by devices such as cell-phones and PDAs, the large computing overhead necessary to create the largely *defacto* standard printer page description languages, PCL and PostScript, was a problem. The UPnP group looked at a number of solutions and, in the end, decided to base printing on a derivative of XHTML. The group decided that when printing from these low-end devices, "content was king" rather than the typical printing perspective that absolute formatting consistency and fidelity was required.

Early versions of XHTML-Print[11] were developed for simultaneous use by the UPnP group and the Bluetooth group (see below). Fortunately, there was a core group of companies that could work in both spaces while living within the confidentiality restrictions of both groups. Eventually, after both the UPnP and Bluetooth work went public, this specification was handed off to the PWG which drove the work to become two separate PWG candidate standards[12]. In 2003, an agreement was reached with the W3C to give this work to the W3C's HTML and STYLE working groups with the intent for them to become W3C recommendations. **XHTML-Print**[13] is now a W3C Proposed Recommendation and the ***CSS Print***

Profile[14] is now a W3C Candidate Recommendation.

The UPnP group settled on a reduced set of operations derived from IPP as well as a slightly different set of printer and job elements.

Subsequently, a ***PrintEnhanced Service Template***[15] was developed which better addressed the needs of photo printing. The ***XHTML-Print*** and ***CSS Print Profile*** specifications are still core to this new UPnP specification. Additional operations and attributes were added over what was specific in ***PrintBasic*** to achieve the functionality desired.

Bluetooth® SIG

In 2000, shortly after the start of the UPnP effort, another effort was begin. This time it was within the Bluetooth Special Interest Group and its goal was to develop a ***Basic Print Profile***[16] to enable printing in the Bluetooth environment. Many of the same companies and people were simultaneously participating in both the UPnP and Bluetooth efforts.

The Bluetooth group picked up the XHTML-Print work first proposed with the UPnP group. Like UPnP, the processing power of the expected devices using Bluetooth radios, e.g., cell-phone and PDAs, made the selection of a simple, mandatory printer page description language like XHTML-Print attractive. Like UPnP, the Bluetooth group also selected a slightly different set of operations and printer and job elements from those described by IPP.

The Semantic Model

Seeing the rapid adoption of XML in the IT community, the PWG revisited at least part of its IPP decision about the encoding of the printing model. It also revisited the limited set of operations and attributes used by IPP as well as the enhancements made by UPnP, Bluetooth and others. The result was the ***PWG Semantic Model*** document and the ***Semantic Model XML Schema***[17] describing it.

The PWG's Semantic Model has incorporated the original conceptual IPP work as well as the enhancements developed subsequently for efforts such as UPnP and Bluetooth. As such, additional operations, printer description elements, job description elements and document description elements are defined. Even those elements not included in IPP for implementation simplification reasons have been fully described within the PWG Semantic Model. The model is robust and complete.

In addition to the Semantic Model, the PWG has also created standards for the names for the various types and sizes of media, e.g. paper, transparencies, as well as names for the character repertoires (aka Character Sets) supported by a printing device. These documents, ***Standard for Media Standardized Names***[18] and ***Repertoires-Support Element***[19] are necessary for internationization and full function operation of many printing devices.

Print Service Interface

During the development of the Bluetooth ***Basic Printing Profile***, a new need became apparent. With the increase in personal mobility coinciding with the creation of the Bluetooth environment, the nearest printer was often one the user had never seen before and for which the user's computing device lacked appropriate printer drivers. With the wide variety of document formats available on the Web, it was and is often impossible to load the desired document into a cell phone or PDA for either viewing or printing.

Therefore, to address the broadest set of mobile and Internet printing situations, a service needed to be available on the network to take a document in one format, convert it to another format suitable for

printing, and then deliver it to the desired printer. This delivery could be either directly from the printing service or through some proxy, including the originating client itself. The content could originate on the Web or could have been created by the client.

Print Service Interface[20] (PSI) created a set of interfaces and methods that enable a client to create a Print Job on a Print Service. The Print Service can then transform the information to be printed on the printer to the proper format.

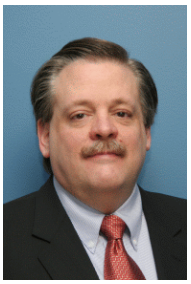
This effort was done before the creation and stabilization of Web Services standards like WS-Addressing, WS-Discovery, WS-Eventing and others. It therefore developed specialized solutions for these problems. Although the solution specified was eventually completed, it was soon obsoleted by the plethora of WS-* specifications.

Despite a lack of implementations, much can be learned from the use cases and other concepts developed within PSI to address the need for ubiquitous printing by an ever more mobile user community.

Web Services and Print

In May 2004, a group of companies announced ***Devices Profile for Web Services***. These companies included Intel, Lexmark, Microsoft and Ricoh.

This profile defines a minimal set of implementation constraints to enable secure Web service messaging, discovery, description, and eventing on resource-constrained printer endpoints. It depends heavily on XML, SOAP, WSDL, WS-Addressing, WS-Discovery, WS-Eventing, WS-Security, and other Web services specifications.



Don Wright is the Director of Standards for Lexmark International and the Past Chair of the IEEE Standards Association Standards Board. He currently also serves as Chair of the IEEE Standards Association Standards Board Patent Committee. He has over 26 years of IT product development experience with Lexmark and previously IBM. Mr. Wright is a member of the Board of Governors of the IEEE Standards Association and the Board of Directors of the IEEE Industry Standards and Technology Organization, a 501(c)6 non-profit organization devoted to the development and support of a number of IT industry consortia.

Mr. Wright is especially active in the development of standards relating to printing. In addition to his work with the IEEE, his involvement includes the World Wide Web Consortium where he is the Lexmark Advisory Committee representative and have served on the Patent Policy Working Group, the Printer Working Group (a program of the IEEE ISTO) where he is the past Chair., the Executive Board of the InterNational Committee for Information Technology Standards (INCITS), the Universal Plug and Play Forum, and the Bluetooth SIG, among others. Mr. Wright has chaired a number of standards committees and is the author of numerous papers, drafts and standards. He holds both Bachelor of Science and Master of Engineering Degrees in Electrical Engineering from the University of Louisville.

REFERENCES

[1] http://www.pwg.org

[2] http://www.upnp.org

[3] https://www.bluetooth.org

[4] http://msdn.microsoft.com/ws/2005/05/devprof

[5] ftp://ftp.pwg.org/pub/pwg/candidates/cs-sm10-20040120-5105.1.pdf

[6] http://www.ietf.org/rfc/rfc1179.txt

[7] See http://www.ietf.org/rfc/rfc2567.txt, http://www.ietf.org/rfc/rfc2910.txt and http://www.ietf.org/rfc/rfc2911.txt

[8] http://www.ietf.org/rfc/rfc2533 (and others)

[9] http://www.upnp.org/standardizeddcps/printer.asp

[10] http://www.upnp.org/standardizeddcps/upnpresources20051215.zip

[11] http://www.xhtml-print.org

[12] See ftp://ftp.pwg.org/pub/pwg/candidates/cs-xpxprt10-20030331-5102.1.html and ftp://ftp.pwg.org/pub/pwg/candidates/cs-xpcssprt10-20030331-5102.2.html

[13] http://www.w3.org/TR/2004/CR-xhtml-print-20040120/

[14] http://www.w3.org/TR/2004/CR-css-print-20040225/

[15] http://www.upnp.org/standardizeddcps/printenhanced.asp

[16] http://www.bluetooth.org/foundry/adopters/document/BPP_SPEC_V10/en/1/BPP_SPEC_V10.pdf

[17] http://www.pwg.org/schemas/sm/1.0/PwgSchema_1.00.zip

[18] ftp://ftp.pwg.org/pub/pwg/candidates/cs-pwgmsn10-20020226-5101.1.pdf

[19] ftp://ftp.pwg.org/pub/pwg/candidates/cs-crrepsup10-20040201-5101.2.pdf

[20] ftp://pwg.org/pub/pwg/candidates/cs-psi10-20050225-5104.2.pdf