Introduction

The intent of this paper is to review and refresh the rationale for the MFD Modeling effort and the generation of PWG Semantic Model version 2. Specifically, this paper:

1) Reaffirms the value of PWG modeling work and its benefits to PWG members and the industry as a whole.
2) Outlines the next steps necessary to realize these benefits, building upon the foundation laid by the MFD modeling effort. As the Modeling work nears completion, a shared understanding of what comes next and why is important.
3) Examines the realization of the MFD model to various concrete mappings. The industry will benefit from this work only by the application of the model in various network environments.
4) Proposes a realization of the MFD model in a concrete mapping to Web Services. Examine how we can utilize the modeling work in real-world situations. The mapping can help in addressing existing problems as well as in allowing additional functionality through the application of existing Web Service Standards.
5) Considers how the MFD modeling work can be part of an evolutionary path to advance the Internet Printing Protocol to an Imaging Peripherals Protocol.

Evolution of Semantic Model

Semantic Model V1.0 was approved as PWG Candidate Standard 5105.1 in 2004. Establishing industry wide consensus on the semantics of printing has had many benefits. The semantics are applicable to a number of capabilities including Service Location, representation in Directory Services, Device Monitoring and Management, and Job Submission, monitoring and control. Industry wide consensus has allowed the alignment of print related semantics across many environments, promoting consistent behavior regardless of the specific mapping.

The consensus on a common model has benefited device and service vendors by permitting rapid development of new protocol bindings (e.g., WS-Print) and industry specific applications (e.g., JDF Digital Print). The common model has resulted in reduced product development cost, increased reliability, and quicker time to market for print service related product implementations. This is possible because the semantic elements need be instrumented and/or implemented only once, with thin gateways providing the syntactic translation required by the multiple protocol implementations (e.g., IPP, WS-Print, JDF Digital Print, SNMP, CIM).

The trend in both enterprise and SOHO environments has been from locally attached or network connected printers and scanners to MFDs. As the Operating System and Application vendors evolve their systems to take advantage of the more user-friendly 'imaging services' approach, it will benefit device vendors to have a comprehensive, integrated model for these services. Therefore, the immediate goal of the current MFD work has been to extend the Semantic Model to a complete data and operational model of the user facing services common in today's MFDs. This industry-wide, comprehensive model allows the use a common set of MFD semantics that can be applied to different environments and

applications to allow environment specific solutions including Service advertisement, discovery, monitoring, management, job submission and tracking, and that facilitate workflow solutions.

Model Extensibility and Vendor Differentiation

Although adherence to a common model makes use easier for the consumer and benefits both application and device manufacturers, vendors need to differentiate their products by adding features and capabilities. A model that is limited to a common subset of elements and operations does not provide adequate benefit to PWG members. The modeling approach is designed to easily be extended with vendor specific features. The extended capabilities will be discoverable and the application of appropriate features will be easily incorporated into job submissions. Furthermore, the PWG MFD Semantic Model is structured to allow a mechanism for revisions to accommodate the inclusion of additional features. These features may be extensions that are sufficiently common to be incorporated in the core MFD model, or they may be new features made possible by new technology or made necessary by Consumer requirements. Along with extension capability, the model allows for subsets so that resource-constrained or low cost products can be fully integrated into any environment supporting the model.

Value of Web Services Mapping

Although many protocol bindings are possible, there are many benefits to Web Services. The Web Services approach (i.e. SOAP protocol and XML data binding) enables a wider range of tools to be used to implement client and server applications. Even if WSDL or SOAP tools are not used, the XML Schema that describes the message bodies can be used to validate and parse the messages. Furthermore, there is a benefit for development engineers in that XML makes the protocol and any stored document instances human readable.

WS-Discovery provides for the discovery of devices and its hosted services in an ad hoc environment. WS-Discovery can be used in concert with other discovery/Service Location mechanisms (e.g. UDDI, WS-Discovery Remote Extensions, Bonjour) to accommodate discovery in managed environments, enterprises or the Internet.

WS-Security[WSS] provides for both connection and message based security. It codifies mechanisms for message integrity and confidentiality. This provides a mechanism for associating security tokens with message content.

WS-Eventing[WSE] can provide a common framework for event subscription management and delivery. This will provide connect ion oriented event delivery. Extensions are possible to provide a lighter weight event delivery if SOAP over UDP can be applied as a protocol binding for event delivery.

WS-Addressing [WSA] will provide a protocol independent means to identify an instance of an MFD. Included in the WS-Addressing specification are Web Service header elements that can be used to route messages in an asynchronous implementation.

Devices Profile for Web Services [DPWS] provides a common profile for secure Web service messaging, discovery, description, and eventing on resource-constrained devices.

Web Services Business Process Execution Language [BPEL] defines a language for specifying business process behavior based on Web Services. This language can integrate MFDs as on and off ramps for documents in workflows including those in the office.

Because the MDF Semantic Model is an extension of the original PWG Semantic Model, which was manifest in the Internet Printing Protocol (IPP), IPP is retained as the Print Service model. Although IPP was originally intended to be XML, the XML data types were not yet complete when it was being formulated. However, we can leverage existing standards to provide missing functionality in current IPP implementations.

Office Workflows

One of the limitations in the adoption of protocols defined by the PWG has been native support for the protocol in major operating systems. A protocol for all the services hosted on MFDs will allow workflow applications to directly integrate the MFD as on and off ramp for documents. Various vendors can provide innovative solutions to real world problems and integrate devices that implement an appropriate set of PWG services. The processes within the workflow can communicate directly with the devices for document acquisitions, transformation and routing to intermediate or final destinations.

The modeling of MFD services has shown that there is a great deal of commonality in the system and job states, in state transitions and in the life cycles of jobs and documents. The exploitation of this commonality provides an advantage in the development of workflows that utilize MFDs as on and off ramps for documents.

A Web Services binding of the MFD model has the advantage of an existing standard workflow language (Web Services Business Process Execution Language). This workflow language and other Web Service based languages can integrate MFDs into distributed or hosted solutions. Perhaps one of these could be leveraged for device resident workflows (i.e. complex MFD jobs).

Effective Standards and the PWG

Experience has shown that the PWG standards are most widely implemented when they define specific protocols and managed information. Abstract specifications without interoperable implementations are perceived to be of reduced value. However, defining capabilities and characteristics in the abstract is often necessary preparation for the concepts to be durable and the various binding-specific standards to be reasonably cohesive. For example, the value of PWG Semantic Model v1 is realized in its concrete mapping to IPP, UPnP Basic Print, Java Print APIs, WS-Print, LDAP Printer Schema, SLP Printer Template, etc. But without the abstract Semantic Model, there might well have been little consistency among these various concrete, applied standards. Similarly, the benefits of PWG Semantic Model v2 will be realized in mapping of abstract elements of all of the MFD imaging services to concrete protocols

Many of our participating printer vendors already instrument some the elements in Semantic Model v2 and make them accessible through proprietary means. And there may some belief that fully proprietary solutions provide more advantageous product differentiation than adherence to standards. But such approaches complicate the job of third parties to provide compatible solutions and ultimately weaken the functionality and flexibility hard-copy device vendors can provide to their customers. Proprietary solutions often result in de-facto standards when PWG members are left with the choices of limiting their potential market or reverse engineering and emulating other vendor's approaches rather than providing their own proprietary solution which may or may not be incorporated into third party solutions. De facto standard implementations are seldom standard since they are not developed on an industry-wide basis and often are not even documented. Third party solutions developers, to make their products address as wide a base as possible, typically water down their application to deal with the least functional implementation.

Vendor differentiation advantages come best not from fully proprietary solutions but from being able to leverage vendor-specific extensions to standard, well supported capabilities, giving their products an edge in the target marketplace. The Semantic Model was designed with this capability fully integrated throughout the data model.

So, for the benefits of the Semantic Model V2 to be realized, the model must be mapped to a concrete consumer-usable capability. A comprehensive effort to demonstrate interoperable implementations will afford the opportunity to showcase the usefulness of standard access to these data elements. Many vendors already have a Web Services framework implemented on their platforms; the addition of new Web Services can be done with reduced effort compared to other protocol bindings. A protocol binding for the PWG Semantic Model version 2 results in a verified unified model that encompasses job submission and monitoring as well as service and device monitoring and management.

The Internet Printing Protocol becoming the Imaging Peripheral Protocol

A transition from IPP v2 to a Web Services based Print Service can be accomplished by a Web Service Gateway front end to an existing IPP service or a gateway that is bound to the same platform APIs used by the IPP service. A Web Services binding for IPP allow resolution some of IPP limitations, including its inability to easily extend data types. IPPv2 would require an update to the specification to extend the registered tags corresponding to data types. Moving to an XML encoding allows for the use of all the defined XML data types. For example, moving IPP to an XML encoding reduces the scope of "attribute-fidelity" to be element-wide instead of operation-wide, allowing a more expressive Job Ticket.

Because Semantic Model v2 views all MFD Services in a way analogous to the IPP View of the Print Service, the Web Services based Print Service protocol derived from IPP can be expanded to include other MFD services. The MFD protocol and associated data model has the advantage of exposing device aspects(e.g. InputTrayMediaSizeName, InputTrayCurrentLevel, DeviceId) of MFDs as well as the service aspects(e.g. PrinterState, PrinterStateReasons). The short term benefit is that this enables the protocol

to encompass system monitoring and management in addition to Job submission, monitoring and control. The long-term benefit is an integrated Imaging Peripheral Protocol that utilizes the standard Web Services capabilities, which will continue to expand.

Semantic Model V2 also suggests a way to address the bothersome issue of the plethora of device drivers. Imaging Service interoperability can be tightened up through mandatory support of a small set of document formats. Implementation of the Transform Service would permit on-device repurposing of documents for the hosted services. For example a print subsystem that is limited to a possibly non-standard set of PDL (e.g. PostScript with vendor extensions) can make use internally of the Transform Service to allow support of mandated document formats. The Print Service could advertise its support for the mandatory document format (e.g. PDF) and internal to the device the submitted client's document could be run through the Transform Service to convert it from PDF to suitable PostScript with vendor extensions prior to submission to the native print subsystem.

Current State and Tasks

Specification of the Print, Scan, and Resource Services are complete, covering the semantics of image acquisition, hard copy output and the handling of Jobs, Tickets and Templates. These Services account for the majority of the functionality inherent to an MFD, although it is likely that some service specific semantics will be added as the remaining services are fleshed out. Currently under development are Copy and FaxOut, which rely heavily on the semantics from Print and Scan. The specification of EmailOut and Transform Services should be straightforward, given the similarities to existing services. FaxIn and EmailIn Services have jobs initiated by inbound traffic, a significant difference from the job lifecycles associated with the other services, and the specification of these Services will require more thought. Specification of the Overall MFD Service that allows control of the hosted services and provides access of system wide data will then follow.

As the various services are defined, XML schema has been used to model the data and the operation messages. WSDL has been used to model the operations offered by the services. This has both been an editorial convenience and promotes rapid prototyping of the services defined. It is unclear at this time whether WSDL 1.1 or 2.0 would be used for a Web Services binding. Tools exist to assist in the conversion.

The data model for the device aspects is also mostly complete. The data represented by the Printer MIB is in place. Device data that is associated with subunits used by services such as FaxOut is under development. New emerging standards such as Power Monitoring and Management are being incorporated as the standards are being defined. Individual services will provide access to the data associated with the subunits used by the service. The Overall MFD Service will allow access to device data across the system.

Proposed Timeline

The MFD Service Specifications under development can be completed by Q1 2010. They can move to Last Call Q2 2010, provided that someone will step up and complete a prototype. The remaining MFD Service Specifications can be completed by Q4 2010. The development of an Imaging Peripheral Protocol with a Web Services Binding can begin Q3, although it is not clear how long such an undertaking would take. However, with the WSDL and Schema defined, development should be expedited by the use of existing tools.

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