

1 Introduction

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

- 4 1) Reaffirms the value of PWG modeling work and its benefits to PWG members and the industry
5 as a whole.
- 6 2) Outlines the next steps necessary to realize these benefits, building upon the foundation laid by
7 the MFD modeling effort. As the Modeling work nears completion, a shared understanding of
8 what comes next and why is important.
- 9 3) Examines the realization of the MFD model to various concrete mappings. The industry will
10 benefit from this work only by the application of the model in various network environments.
- 11 4) Proposes a realization of the MFD model in a concrete mapping to Web Services. A proposal of
12 how we can utilize the modeling work in real-world situations is explored. The mapping can help
13 in addressing existing problems as well as in allowing additional functionality through the
14 application of existing Web Service Standards.
- 15 5) Considers how the MFD modeling work can be part of an evolutionary path to advance the
16 Internet Printing Protocol to an Imaging Peripherals Protocol (i.e. A protocol for all the user
17 facing services hosted on an MFD).

18 Evolution of Semantic Model

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

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

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

39 applied to different environments and applications to allow environment specific solutions including
40 Service advertisement, discovery, monitoring, management, job submission and tracking, that facilitate
41 workflow solutions.

42 **Model Extensibility and Vendor Differentiation**

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

55 **Value of Web Services Mapping**

56 Although many protocol bindings are possible, there are many benefits especially in the area of Web
57 Services. The Web Services approach (i.e. SOAP protocol and XML data binding) enables a wider range of
58 tools to be used to implement client and server applications. Many vendors already have a Web Services
59 framework implemented on their platforms; the addition of new Web Services can be done with
60 reduced effort compared to other protocol bindings. Even if WSDL or SOAP tools are not used, the XML
61 Schema that describes the message bodies can be used to validate and parse the messages.
62 Furthermore, there is a benefit for development engineers in that XML makes the protocol and any
63 stored document instances human readable. Web Services brings with it a suite of standard protocols
64 and best practices that can be leveraged to provide useful features in an MFD protocol.

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

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

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

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

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

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

83 **Office Workflows**

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

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

95 A Web Services binding of the MFD model has the advantage of integration with existing standard
96 workflow languages (e.g., WSBPEL). The WSBPEL workflow language and other Web Service based
97 languages can integrate MFDs into distributed or hosted solutions. It is possible that one of the existing
98 workflow languages could be leveraged for device resident workflows (i.e. complex MFD jobs).

99 **Effective Standards and the PWG**

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

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109 Many of our participating printer vendors already instrument some of the elements in Semantic Model
110 v2 and make them accessible through proprietary means. And there may be some belief that fully
111 proprietary solutions provide more advantageous product differentiation than adherence to standards.
112 But such approaches complicate the job of third parties to provide compatible solutions and ultimately
113 weaken the functionality and flexibility that hard-copy device vendors can provide to their customers.
114 Proprietary solutions often result in multiple de-facto standards. PWG members are left with the
115 choices of limiting their potential market or reverse engineering and emulating other approaches to
116 integrate with specific third party solutions. De facto standard implementations are seldom standard
117 since they are not developed on an industry-wide basis and often are not even documented. As a result
118 of the variety of implementations, third party solutions developers, to make their products address as
119 wide a base as possible, typically water down their application to deal with the least functional
120 implementation.

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

125 So, for the benefits of the Semantic Model V2 to be realized, the model must be mapped to a concrete
126 consumer-usable capability. A comprehensive effort to demonstrate interoperable implementations will
127 afford the opportunity to showcase the usefulness of standard access to these data elements. A Web
128 Services protocol binding for the PWG Semantic Model version 2 results in a verified unified model that
129 encompasses job submission and monitoring as well as service and device monitoring and management.

130 **The Internet Printing Protocol becoming the Internet Multifunction** 131 **Protocol (IMFP)**

132 A transition from IPP v2 to a Web Services based Print Service can be accomplished by a Web Service
133 Protocol Gateway front end to an existing IPP service or a Protocol Gateway that is bound to the same
134 platform APIs used by the IPP service. A Web Services binding for IPP allows resolution of some of the
135 limitations of IPP, including its inability to easily extend data types. IPPv2 would require an update to
136 the specification to extend the registered tags corresponding to data types. Moving to an XML encoding
137 allows for the use of all the defined XML data types.

138 Because Semantic Model v2 models all MFD Services in a way analogous to the IPP model of a Print
139 Service, the Web Services based Print Service protocol derived from IPP can be expanded to include
140 other MFD services. We have found commonality in the Service, Job and Document attributes as well as
141 the operations that act upon them. The MFD protocol and associated data model has the advantage of
142 exposing device aspects(e.g. InputTrayMediaSizeName, InputTrayCurrentLevel, DeviceId) of MFDs as
143 well as the service aspects(e.g. PrinterState, PrinterStateReasons). The short term benefit is that this
144 enables the protocol to encompass system monitoring and management in addition to Job submission,

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145 monitoring and control. The long-term benefit is an integrated Internet Multifunction Protocol that
146 utilizes the standard Web Services capabilities, which will continue to expand.

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

156 **Current State and Tasks**

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

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

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

178 **Proposed Timeline**

179 The MFD Service Specifications under development can be completed by Q1 2010. They can move to
180 Last Call Q2 2010, provided that someone will step up and complete a prototype. The remaining MFD

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181 Service Specifications can be completed by Q4 2010. The development of an Internet Multifunction
182 Protocol with a Web Services Binding can begin Q3, although it is not clear how long such an
183 undertaking would take. However, with the WSDL and Schema defined, development should be
184 expedited by the use of existing tools.

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