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The Printer Working Group

PWG Raster Format

Status: Approved

Abstract: This specification defines a simple raster format to support printing, scanning, and facsimile without printer-specific driver software on resource-limited clients and printers. The format includes support for a set of standard and device color spaces and bit depths, and defines PWG Semantic Model elements and IPP attributes that enable a client to generate or request a supported raster stream.

This document is a PWG Candidate Standard. For a definition of a "PWG Candidate Standard", see: ftp://ftp.pwg.org/pub/pwg/general/pwg-process30.pdf

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Title: *PWG Raster Format*

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For additional information regarding the Printer Working Group visit:

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About the Internet Printing Protocol Work Group

The Internet Printing Protocol (IPP) working group has developed a modern, full-featured network printing protocol, which is now the industry standard. IPP allows a print client to query a printer for its supported capabilities, features, and parameters to allow the selection of an appropriate printer for each print job. IPP also provides job information prior to, during, and at the end of job processing.

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Implementers of this specification are encouraged to join the IPP mailing list in order to participate in any discussions of the specification. Suggested additions, changes, or clarification to this specification, should be sent to the IPP mailing list for consideration.

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1. Introduction

Historically, printer manufacturers have used a variety of proprietary or device-specific variants of industry standard page description languages (PDLs) to support printing, leading to the proliferation of so-called "printer driver" software for every supported operating system and/or platform.

The objective of the PWG IPP Everywhere project includes the definition of a PWG raster format that can be used for printing, facsimile, and scanning from limited resource clients and printers. After performing a detailed analysis [ANALYSIS], CUPS Raster was chosen because it meets all of the design requirements and uses the fewest resources of the raster file formats considered.

This specification defines a proper subset of CUPS Raster [CUPSRASTER] to serve as the PWG Raster format and includes support for a set of standard and device Color Spaces and bit depths, defines PWG Semantic Model elements and IPP attributes that enable a client to generate or request a supported raster stream for a printer, and registers a new MIME media type and the corresponding IPP attributes with IANA.

2. Terminology

2.1 Conformance Terminology

Capitalized terms, such as MUST, MUST NOT, RECOMMENDED, REQUIRED, SHOULD, SHOULD NOT, MAY, and OPTIONAL, have special meaning relating to conformance as defined in Key words for use in RFCs to Indicate Requirement Levels [RFC2119].

The term CONDITIONALLY REQUIRED is additionally defined for a conformance requirement that applies to a particular capability or feature.

2.2 Other Terminology

Color Component; an individual element or channel for a Color Space or Pixel, for example “Red”, “Green” and “Blue” are Color Components of the “RGB” Color Space.

Color Order; the order of Color Components within the Page Bitmap. These Color Orders are called “Chunked”, “Banded”, and “Planar” in the CUPS Raster Format specification [CUPSRASTER].

Color Space; the interpretation of Pixel color in a page bitmap, for example “RGB”, “Grayscale”, “CMYK”, and so forth.

CUPS Raster; the image file format defined by [CUPSRASTER].

PackBits; a simple run-length encoding algorithm for data compression. Each sequence is encoded as a series of repeated or non-repeated Pixels.

Page Bitmap; a rectangular grid of Pixels.

Page Header; the binary page processing dictionary of Adobe PostScript and raster key values for a Page Bitmap.

Pixel; a set of Color Components representing a single grid point in a Page Bitmap.

2.3 Representation of Octets in Examples

Throughout this specification, octets are represented using pairs of hexadecimal digits prefixed by the string "0x". Multiple contiguous octets may also be combined into a short form similar to that defined in Augmented BNF for Syntax Specifications: ABNF [STD68] with the "0x" prefix replaced by a period ("."), for example 0x12 and 0x34 may be combined as 0x12.34. The short form is used to group related octets for clarity.

3. Requirements

3.1 Rationale for the PWG Raster Format

The PWG IPP Everywhere project needs a standard raster format to support printing, scanning, and facsimile without printer-specific driver software on resource-limited clients and printers. High-level PDLs such as Adobe PostScript [POSTSCRIPT], OpenXPS [OPENXPS], and PDF [ISO32000] are sufficiently generic to be used for basic printing, however they require significant resources in the printer and can be difficult to generate and stream from some environments. Existing standard bitmap image formats have issues as well:

- JPEG: Lossy compression, no multi-page support
- JPEG 2000: Lossy compression, no multi-page support, resource-intensive
- MNG: Resource-intensive and not widely implemented or supported
- PDF/is: Lossy compression, can be resource-intensive, not widely implemented
- PNG: No multi-page support, resource-intensive
- TIFF: Can be resource-intensive, hard to stream, multiple format variants

CUPS Raster [CUPSRASTER] is a simple bitmap container to support printing, facsimile, and scanning on all types of printers. It provides the following features:

- Support for multiple pages
- Support for standard color spaces backed by existing ICC color profiles
- Support for device color spaces backed by printer- or user-supplied ICC color profiles
- Adaptable byte order for encoding and decoding
- A single, lossless compression algorithm that is space, memory, and processor efficient
- Per-page processing instructions based on the Adobe PostScript page device dictionary
- An encoding that can be easily streamed

CUPS Raster has been used over existing print data transports such as the Internet Printing Protocol (IPP) since 1999. CUPS Raster can also be further reduced in size using HTTP or IPP compression algorithms such as Compress and Flate when supported by the client and printer.

However, CUPS Raster supports many more Color Spaces, Color Orders, bit depths, and byte orders than are needed for a modern printer. Moreover, the Adobe PostScript page device dictionary does not map cleanly to IPP or the PWG Semantic Model, leading to additional complexities that would make interoperability difficult.

By defining a proper subset of CUPS Raster, we both enable support for a new class of printer without the use of printer- and platform-specific driver software in the client and greatly reduce the number of variables for interoperability. And by defining which page header fields are mapped to/from PWG Job Ticket elements we also enable a low-cost solution for per-page overrides embedded within a document.

3.2 Use Cases

3.2.1 Mobile Printing to Low Cost InkJet

Jane has a smart phone with Wi-Fi capability and a built-in camera. She prints photos from her phone to a low-cost Wi-Fi inkjet printer. Both the client (phone) and printer have limited memory and processor resources. The printer supports basic raster printing on a variety of media types and sizes.

During printing, her client software queries the printer for supported media, resolutions, and raster modes, produces a printer-ready raster representation of the photo for the selected media, and streams it to the printer for output.

3.2.2 Desktop Printing to Low Cost Workgroup Printer

John has a desktop PC he uses to write whitepapers and other business documents. He prints these documents to a low-cost Ethernet workgroup laser printer with three paper trays and a duplexing accessory. The printer has enough memory to hold a partial image of one side of a sheet.

During printing, his client software queries the printer for supported media, resolutions, raster modes, and duplex support, produces printer-ready raster pages of the documents, and streams them to the printer for output.

3.2.3 Printing Envelopes and Content in a Single Document

Mary is sending acceptance letters to new students at a college. She prints the letters and envelopes using a mail merge program. The printer has stationery and envelopes loaded.

During printing, her client software embeds per-page overrides for media in order to alternate between envelopes and letters. Once completed, she folds and stuffs the envelopes with the corresponding letters and mails them to the new students.

3.2.4 Printing Using Legacy Interfaces

Justin has a desktop PC and a low-end InkjJet printer implementing the standard USB print class. When he connected the printer to the PC, the operating system automatically added a print queue with the correct driver for the printer.

Justin prints photos and documents from a variety of applications on his PC. The printing software on his PC converts those photos and documents into a raster format with embedded page processing instructions to send to the printer.

3.3 Out of Scope

The following items are considered out of scope for this specification:

1. Definition of a new file format; we want to minimize the proliferation of file formats and reuse existing formats whenever possible.
2. Extensions to the CUPS Raster format; we want to minimize the proliferation of file formats and reuse the existing CUPS Raster format by defining a simple, backwards-compatible subset of the format for basic raster printing, scanning, and facsimile.
3. Definition of transport protocols, interfaces, or security extensions to be used with the PWG Raster Format.
4. Definition of legacy interface bindings to be used with the PWG Raster Format.

3.4 Design Requirements

The PWG Raster Format design requirements are:

1. Since both the client and printer may have limited memory, a raster format for printing, scanning, or facsimile must be streamable to minimize buffering.
2. Because the printer may have limited memory, the client must be able to discover the supported raster resolutions and how to provide duplex page images – no flip, X flip, Y flip, or rotation by 180 degrees (both X and Y flip) - so that the printer does not need to perform expensive transformations of the client-supplied images.
3. Because the client and printer may not have sophisticated color management capabilities, standard color spaces should be used to foster improved color fidelity.
4. Ability to specify per-page processing instructions derived from a subset of the PWG Print Job Ticket.

The PWG Raster Format design recommendations are:

1. Some form of data compression should be used to limit network bandwidth usage. Text printing favors lossless compression algorithms to preserve edge detail and resource limitations require simpler compression algorithms.
2. A bi-level imaging mode may be useful when printing text and line art.
3. The order of multi-octet values should be predefined to limit the complexity of implementations.
4. While a printer may have limited space for color tables, it should still be possible to support a managed color workflow when both the client and printer are capable. This generally requires some sort of device color space support.

4. PWG Raster Format

The CUPS Raster specification [CUPSRASTER] defines three format variants for the MIME media type “application/vnd.cups-raster”. The following subsections define the subset of the CUPS Raster v2 format used for the MIME media type “image/pwg-raster”.

4.1 File Organization

Figure 1 - PWG Raster File Organization shows the general organization of every PWG Raster file. Each file begins with a 32-bit synchronization word followed by zero or more pages. Each page consists of a header followed by the bitmap image for the page. The bitmap image is compressed using a PackBits-like algorithm to reduce file size without significant overhead. Integer values larger than 8-bits are specified in network byte order. 1-bit bitmap data is provided in network bit order.

4.2 Synchronization Word

The synchronization word is a 32-bit unsigned integer with the value 0x52.61.53.32 (“RaS2”).

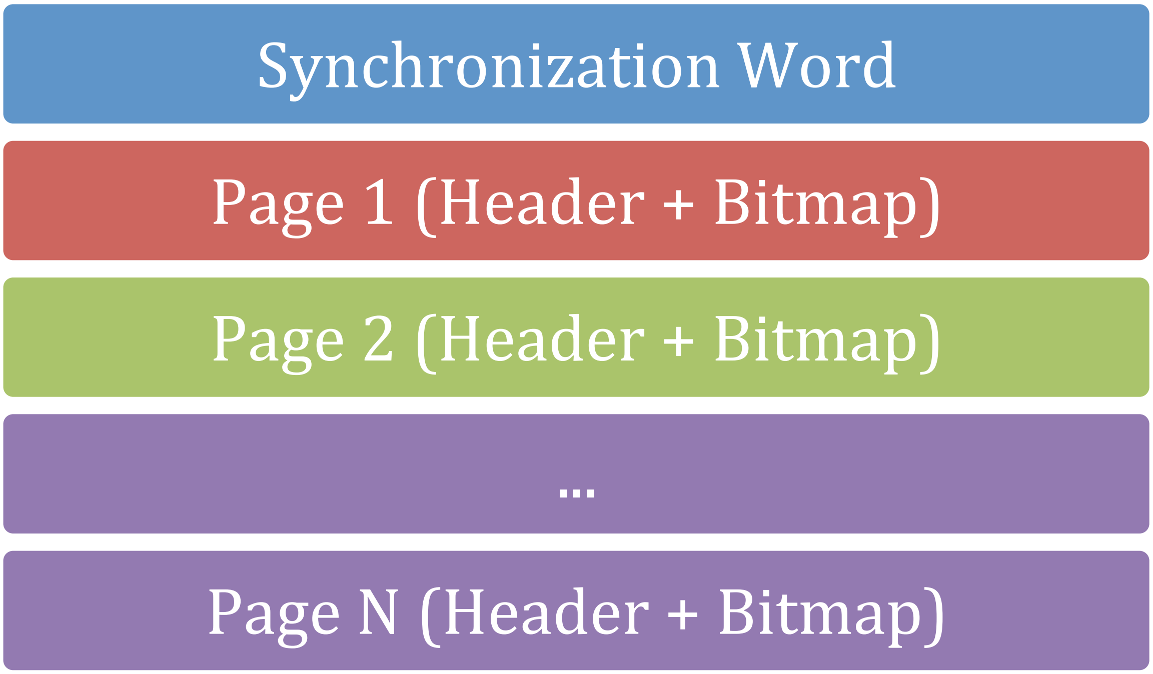

Figure 1 - PWG Raster File Organization

4.3 Page Header

Table 1 - PWG Raster Page Header describes the 1796-octet page header that appears at the beginning of each page. Most of the fields in the header are derived from the Adobe PostScript page device dictionary [POSTSCRIPT]. All reserved fields MUST be 0.

Table 1 - PWG Raster Page Header

Bytes	Type	Name	PWG SM Element
0-63	CString	PwgRaster	
64-127	CString	MediaColor	MediaCol
128-191	CString	MediaType	MediaCol
192-255	CString	PrintContentOptimize	PrintContentOptimize
256-267	Reserved	Reserved	
268-271	WhenEnum	CutMedia	Finishings
272-275	Boolean	Duplex	Sides
276-283	UnsignedInteger x 2	HWResolution	PwgRasterDocument ResolutionSupported
284-299	Reserved	Reserved	
300-303	Boolean	InsertSheet	InsertSheet
304-307	WhenEnum	Jog	Finishings
308-311	EdgeEnum	LeadingEdge	FeedDirection
312-323	Reserved	Reserved	
324-327	MediaPositionEnum	MediaPosition	MediaCol
328-331	UnsignedInteger	MediaWeightMetric	MediaCol
332-339	Reserved	Reserved	
340-343	UnsignedInteger	NumCopies	Copies
344-347	OrientationEnum	Orientation	OrientationRequested
348-351	Reserved	Reserved	
352-359	UnsignedInteger x 2	PageSize	MediaCol
360-367	Reserved	Reserved	
368-371	Boolean	Tumble	Sides
372-375	UnsignedInteger	Width	MediaCol, PwgRasterDocument ResolutionsSupported, Resolution
376-379	UnsignedInteger	Height	MediaCol, PwgRasterDocument ResolutionsSupported, Resolution
380-383	Reserved	Reserved	
384-387	UnsignedInteger	BitsPerColor	PrintColorMode, PwgRasterDocument TypesSupported, Quality
388-391	UnsignedInteger	BitsPerPixel	PrintColorMode, PwgRasterDocument TypesSupported, Quality
392-395	UnsignedInteger	BytesPerLine	MediaCol,

Bytes	Type	Name	PWG SM Element
			PrintColorMode, PwgRasterDocument ResolutionsSupported, PwgRasterDocument TypesSupported, Quality, Resolution
396-399	ColorOrderEnum	ColorOrder	
400-403	ColorSpaceEnum	ColorSpace	PrintColorMode, PwgRasterDocument TypesSupported
404-419	Reserved	Reserved	
420-423	UnsignedInteger	NumColors	PrintColorMode, PwgRasterDocument TypesSupported
424-451	Reserved	Reserved	
452-455	UnsignedInteger	TotalPageCount	Impressions
456-459	Integer	CrossFeedTransform	PwgRasterDocument SheetBack, Sides
460-463	Integer	FeedTransform	PwgRasterDocument SheetBack, Sides
464-467	UnsignedInteger	ImageBoxLeft	MediaCol, PwgRasterDocument ResolutionsSupported, PwgRasterDocument SheetBack, Resolution
468-471	UnsignedInteger	ImageBoxTop	MediaCol, PwgRasterDocument ResolutionsSupported, PwgRasterDocument SheetBack, Resolution
472-475	UnsignedInteger	ImageBoxRight	MediaCol, PwgRasterDocument ResolutionsSupported, PwgRasterDocument SheetBack, Resolution
476-479	UnsignedInteger	ImageBoxBottom	MediaCol, PwgRasterDocument ResolutionsSupported, PwgRasterDocument SheetBack, Resolution
480-483	SrgbColor	AlternatePrimary	
484-487	PrintQualityEnum	PrintQuality	Quality
488-507	Reserved	Reserved	
508-511	UnsignedInteger	VendorIdentifier	
512-515	UnsignedInteger	VendorLength	
516-1603	VendorData	VendorData	
1604-1667	Reserved	Reserved	
1668-1731	CString	RenderingIntent	PrintRenderingIntent
1732-1795	CString	PageSizeName	Media, MediaCol

4.3.1 Data Types

The page header utilizes several data types described in the following subsections.

4.3.1.1 Boolean

Boolean fields are 32-bit unsigned (one's complement) integers with a value of 0 (false) or 1 (true).

4.3.1.2 CString

CString fields are 64-octets in length containing up to 63 US ASCII characters followed by an ASCII NUL (0).

4.3.1.3 ColorOrderEnum

ColorOrderEnum fields are 32-bit unsigned (one's complement) integers containing one of the values listed in Table 2.

Table 2 - ColorOrderEnum Values

Value	Keyword	Description
0	Chunky	Chunky pixels, e.g. CMYK CMYK CMYK ...

4.3.1.4 ColorSpaceEnum

ColorSpaceEnum fields are 32-bit unsigned (one's complement) integers containing one of the values listed in Table 3.

Table 3 - ColorSpaceEnum Values

Value	Keyword	Description
1	Rgb	Device RGB (red green blue)
3	Black	Device black
6	Cmyk	Device CMYK (cyan magenta yellow black)
18	Sgray	sRGB grayscale
19	Srgb	sRGB color
20	AdobeRgb	Adobe RGB color
48	Device1	Device color, 1 colorant
49	Device2	Device color, 2 colorants
50	Device3	Device color, 3 colorants
51	Device4	Device color, 4 colorants
52	Device5	Device color, 5 colorants
53	Device6	Device color, 6 colorants
54	Device7	Device color, 7 colorants
55	Device8	Device color, 8 colorants
56	Device9	Device color, 9 colorants

Value	Keyword	Description
57	Device10	Device color, 10 colorants
58	Device11	Device color, 11 colorants
59	Device12	Device color, 12 colorants
60	Device13	Device color, 13 colorants
61	Device14	Device color, 14 colorants
62	Device15	Device color, 15 colorants

4.3.1.5 EdgeEnum

EdgeEnum fields are 32-bit unsigned (one's complement) integers containing one of the values listed in Table 4.

Table 4 - EdgeEnum Values

Value	Keyword	Description
0	ShortEdgeFirst	The short edge of the media is first.
1	LongEdgeFirst	The long edge of the media is first.

4.3.1.6 Integer

Integer fields are 32-bit signed (two's complement) integers.

4.3.1.7 MediaPositionEnum

MediaPositionEnum fields are 32-bit unsigned (one's complement) integers containing one of the values listed in Table 5.

Table 5 - MediaPositionEnum Values

Value	Keyword	Description
0	Auto	Default or automatically selected source.
1	Main	The primary or main source.
2	Alternate	The secondary or alternate source.
3	LargeCapacity	The large capacity source.
4	Manual	The manual feed source.
5	Envelope	The envelope feed source.
6	Disc	The CD/DVD/Bluray disc source.
7	Photo	The photo media source.
8	Hagaki	The Hagaki media source.
9	MainRoll	The primary or main roll.
10	AlternateRoll	The secondary or alternate roll.
11	Top	The topmost source.
12	Middle	The middle source.
13	Bottom	The bottommost source.
14	Side	The side source.
15	Left	The leftmost source.
16	Right	The rightmost source.
17	Center	The center source.
18	Rear	The rear source.

Value	Keyword	Description
19	ByPassTray	The by-pass or multi-purpose source.
20	Tray1	Tray 1.
21	Tray2	Tray 2.
22	Tray3	Tray 3.
23	Tray4	Tray 4.
24	Tray5	Tray 5.
25	Tray6	Tray 6.
26	Tray7	Tray 7.
27	Tray8	Tray 8.
28	Tray9	Tray 9.
29	Tray10	Tray 10.
30	Tray11	Tray 11.
31	Tray12	Tray 12.
32	Tray13	Tray 13.
33	Tray14	Tray 14.
34	Tray15	Tray 15.
35	Tray16	Tray 16.
36	Tray17	Tray 17.
37	Tray18	Tray 18.
38	Tray19	Tray 19.
39	Tray20	Tray 20.
40	Roll1	Roll 1.
41	Roll2	Roll 2.
42	Roll3	Roll 3.
43	Roll4	Roll 4.
44	Roll5	Roll 5.
45	Roll6	Roll 6.
46	Roll7	Roll 7.
47	Roll8	Roll 8.
48	Roll9	Roll 9.
49	Roll10	Roll 10.

4.3.1.8 OrientationEnum

OrientationEnum fields are 32-bit integers containing the one of the values listed in Table 6.

Table 6 - OrientationEnum Values

Value	Keyword	Description
0	Portrait	Not rotated
1	Landscape	Rotated 90 degrees counter-clockwise
2	ReversePortrait	Rotated 180 degrees
3	ReverseLandscape	Rotated 90 degrees clockwise

4.3.1.9 PrintQualityEnum

PrintQualityEnum fields are 32-bit integers containing the one of the values listed in Table 7.

Table 7 - PrintQualityEnum Values

Value	Keyword	Description
0	<default value>	The default print quality.
3	Draft	Draft/fast print quality.
4	Normal	Normal print quality.
5	High	High/best/photo print quality.

4.3.1.10 Reserved

Reserved fields are a sequence of octets initialized to the value 0.

4.3.1.11 SrgbColor

SrgbColor fields are 32-bit integers containing a 24-bit sRGB color value. The upper 8 bits are 0, followed by 8 bits of red, 8 bits of green, and 8 bits of blue.

4.3.1.12 UnsignedInteger

UnsignedInteger fields are 32-bit unsigned (one's complement) integers.

4.3.1.13 VendorData

VendorData fields are a sequence of octets containing vendor-specific data.

4.3.1.14 WhenEnum

WhenEnum fields are 32-bit unsigned (one's complement) integers containing one of the values listed in Table 8.

Table 8 - WhenEnum Values

Value	Keyword	Description
0	Never	Never apply feature.
1	AfterDocument	Apply feature after current document/file.
2	AfterJob	Apply feature after current job.
3	AfterSet	Apply feature after current set/copy.
4	AfterPage	Apply feature after current page.

4.3.2 Bitmap Fields

4.3.2.1 PwgRaster

The PwgRaster field MUST be initialized to the string "PwgRaster" with NUL-padding as required by a CString (section 4.3.1.2).

4.3.2.2 HWResolution

The HWResolution field consists of two integers representing the cross-feed and feed resolutions of the page bitmap in pixels (dots) per inch and MUST be initialized to one of the supported values reported by the "PwgRasterDocumentResolutionSupported" element in the <service>ServiceDescription group.

4.3.2.3 LeadingEdge

The LeadingEdge field MUST be initialized to 0 if the "FeedDirection" value for the given media or input tray is 'ShortEdgeFirst' and 1 if the value is 'LongEdgeFirst'.

4.3.2.4 Width and Height

The Width and Height fields MUST be initialized to the full width and height of the current page in addressable units as defined by the HWResolution field. Thus, each page bitmap provides a "full bleed" page image. The choice of values MAY be influenced by the values of the "PrintColorMode", "Quality", and "Resolution" elements in the <service>DocumentProcessing group.

4.3.2.5 BitsPerColor, BitsPerPixel, ColorSpace, and NumColors

The BitsPerColor, BitsPerPixel, ColorSpace, and NumColors fields MUST be initialized to values corresponding to a “PwgRasterDocumentTypesSupported” value, as defined in Table 12. The choice of values MAY be influenced by the values of the "PrintColorMode", "Quality", and "Resolution" elements in the <service>DocumentProcessing group.

4.3.2.6 BytesPerLine

The BytesPerLine field MUST be initialized to the number of octets for a single uncompressed line in the page bitmap, as described by the following formula:

$$\text{BytesPerLine} = \text{TRUNCATE}((\text{BitsPerPixel} * \text{Width} + 7) / 8)$$

4.3.2.7 TotalPageCount

The TotalPageCount field specifies the number of pages in the entire file or 0 if the total number of pages is not known when the file is produced and corresponds to the "Impressions" element in the <service>JobDescription group.

4.3.2.8 CrossFeedTransform and FeedTransform

The CrossFeedTransform and FeedTransform fields specify the orientation of the page bitmap in the CrossFeed and Feed directions, respectively. Values of 1 indicate normal orientation, typically left-to-right for the CrossFeed and top-to-bottom for the Feed directions, while values of -1 indicate reversed orientation, typically right-to-left and bottom-to-top respectively. The values are determined using the value of the "Sides" element in the <service>DocumentProcessing group and the value of the "PwgRasterDocumentSheetBack" element in the <service>ServiceDescription group. Table 9 shows the values for backside images; frontside images always use the value 1.

These fields are used to convey the coordinate system used for the backside image for duplex printing or scanning - page bitmaps MUST always be produced using the printer's "native" coordinate system to minimize resource requirements on the printer.

Table 9 - Transform Values for Backside Images

Sides	PwgRasterDocument-SheetBack	CrossFeed-Transform	Feed-Transform
OneSided	<don't care>	1	1
TwoSidedLongEdge	Flipped	1	-1
TwoSidedLongEdge	ManualTumble	1	1
TwoSidedLongEdge	Normal	1	1
TwoSidedLongEdge	Rotated	-1	-1
TwoSidedShortEdge	Flipped	-1	1
TwoSidedShortEdge	ManualTumble	-1	-1
TwoSidedShortEdge	Normal	1	1
TwoSidedShortEdge	Rotated	1	1

4.3.2.9 ImageBoxLeft, ImageBoxTop, ImageBoxRight, and ImageBoxBottom

The ImageBoxLeft, ImageBoxTop, ImageBoxRight, and ImageBoxBottom fields specify the area, in pixels, that contains non-empty content and corresponds directly to the ImageBox element in the PWG Semantic Model. Pixels are measured from the beginning of the page bitmap, so the coordinates reflect the orientation specified by the XFeedTransform and FeedTransform fields.

All fields MUST have the value 0 if the ImageBox is unknown.

4.3.2.10 AlternatePrimary

The AlternatePrimary field specifies the color to use for bi-level or monochrome page bitmaps as an sRGB color value. Black (ColorSpace=3) values are mapped proportionally from no ink (pixel = 0; typically white) to the specified sRGB color mapped to the corresponding device colorants (pixel = 1, 255, or 65535 depending on the BitsPerColor value).

4.3.2.11 VendorIdentifier, VendorLength, and VendorData

The VendorIdentifier, VendorLength, and VendorData fields allow a vendor to embed arbitrary data in a page header. They should be initialized to the value 0 when not used.

The VendorIdentifier field contains to the USB vendor identification number for the vendor providing the data.

The VendorLength field specifies the number of octets that are used in the VendorData field.

The VendorData field contains the vendor octets.

4.3.3 Page Processing Fields

The page processing fields in a page header allow the Client to supply basic job intent information inline with the document data.

Most features supported by the page processing fields require the printer to do logical grouping. For example, when printing duplex pages the printer MUST treat pairs of images as the sides of a single media sheet, finishing and output bin values apply to any run of pages with the same page processing field values, and so forth.

Printers MUST support pages with different page processing field values to support common mail merge and automation use cases where a mix of normal pages, letterhead, and envelopes may be present in a single file.

4.3.3.1 CutMedia

This field indicates whether output should be trimmed (cut) and corresponds to the 'Trim' values in the "JobFinishings" element of the <service>JobProcessing group.

4.3.3.2 Duplex and Tumble

These fields specify the duplex printing mode for the current page. Table 10 lists the supported combinations for a given value of the "Sides" element in the <service>DocumentProcessing group.

Table 10 - Supported Duplex and Tumble Values

Duplex	Tumble	Sides
FALSE (0)	FALSE (0)	OneSided
TRUE (1)	FALSE (0)	TwoSidedLongEdge
TRUE (1)	TRUE (1)	TwoSidedShortEdge

4.3.3.3 InsertSheet

This field specifies whether to insert a single blank sheet prior to the current page, using the media defined by the current page header and corresponds to the Semantic Model element of the same name in the <service>DocumentProcessing group.

4.3.3.4 Jog

This field specifies whether to jog (offset) pages in the output bin and corresponds to the 'JogOffset' values in the "JobFinishings" element of the <service>JobProcessing group.

4.3.3.5 MediaColor

This field specifies the media color name corresponding to the "MediaColor" sub-element of the "MediaCol" sub-group of the <service>DocumentProcessing group. When the empty string, the default media color is used.

4.3.3.6 MediaPosition

This field specifies the media input tray or source corresponding to the "MediaSource" element and "MediaSource" sub-element of the "MediaCol" sub-group of the <service>DocumentProcessing group. Table 5 provides a list of MediaPosition values with their corresponding "MediaSource" values. When 0, the default media source is used.

4.3.3.7 MediaType

This field specifies the media type name corresponding to the "MediaType" element and "MediaType" sub-element of the "MediaCol" sub-group of the <service>DocumentProcessing group. When the empty string, the default media type is used.

4.3.3.8 MediaWeightMetric

This field specifies the media weight in grams per square meter and corresponds to the "MediaWeightMetric" sub-element of the "MediaCol" sub-group of the <service>DocumentProcessing group. When 0, the default media weight is used.

4.3.3.9 NumCopies

This field specifies the number of copies of the current page to produce and corresponds to the "Copies" element of the <service>DocumentProcessing group. When 0, the default number of copies is used.

4.3.3.10 Orientation

This field specifies the orientation of the page and corresponds to the "OrientationRequested" element of the <service>DocumentProcessing group.

4.3.3.11 PageSize and PageSizeName

The PageSize field specifies the width and length of the current page in points. When the width and length are 0 the default media size is used, typically as defined by the Width, Height, and HWResolution fields for the page bitmap. The PageSize field corresponds to the "MediaSize" sub-group of the "MediaCol" sub-group of the <service>DocumentProcessing group.

The PageSizeName field specifies a named size as defined by the PWG Standard for Media Standardized Names [PWG5101.1]. When the empty string, the default media size is used. The PageSizeName field corresponds to the "Media" element and "MediaSizeName" sub-element of the "MediaCol" sub-group of the <service>DocumentProcessing group.

4.3.3.12 PrintContentOptimize

This field specifies the general document type corresponding to the "PrintContentOptimize" element of the <service>DocumentProcessing group.

4.3.3.13 PrintQuality

This field specifies the relative print quality for the page and corresponds to the "Quality" element of the <service>DocumentProcessing group. Valid values are 0 for the default print quality, 3 for draft quality, 4 for normal quality, and 5 for high quality.

4.3.3.14 RenderingIntent

The RenderingIntent field specifies the colorimetric rendering intent for the page and corresponds to the "PrintRenderingIntent" element of the <service>DocumentProcessing group. When the empty string, the default rendering intent is used.

4.4 Page Bitmap

The page bitmap is compressed using a PackBits-like algorithm. Pixel color values are packed into an integral number of octets. 8 pixel color values are packed into a single octet for compression when BitsPerPixel is 1.

Each line of raster data begins with a repetition count from 1 to 256 that is encoded using a single octet containing "count - 1".

After the repetition count, whole color values for that line are run-length encoded using a PackBits-like run-length encoding algorithm: 1 to 128 repeated colors are encoded using an initial octet containing "count - 1" followed by the color value octet(s) while 2 to 128 non-repeating colors are encoded using an initial octet containing "257 - count" followed by the color value octet(s).

4.4.1 Sample Gray Bitmap

The 23x8 1-bit sGray image shown in Figure 2 would be encoded as the following 21 octets.

```
0x00 0xFE.8F.78.F7
0x00 0xFE.76.77.67
0x03 0x02.77
0x00 0xFE.8E.38.E3
0x00 0x02.FF
```

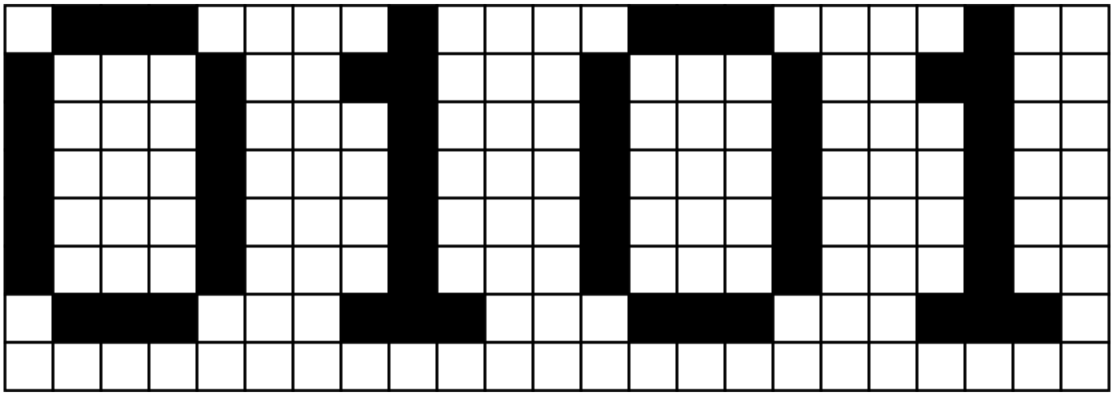

Figure 2 - Sample Gray Bitmap

The unused trailing bits (1 bit in this example) can have any value, and in this example we use a value of 1 to improve the compression slightly.

The first line (0x00) is a sequence of three octets (0xFE.8F.78.F7).

The second line (0x00) is another sequence of three octets (0xFE.76.77.67).

The third through sixth lines (0x03) contain a sequence of three repeated octets (0x02.77).

The seventh line (0x00) is a sequence of three octets (0xFE.8E.38.E3).

The last line (0x00) is a sequence of three repeated octets (0x02.FF).

4.4.2 Sample sRGB Bitmap

The 8x8 24-bit sRGB image shown in Figure 3 would be encoded as the following 87 octets:

```
0x00 0x00.FF.FF.FF 0x02.FF.FF.00 0x03.FF.FF.FF
0x00 0xFE.FF.FF.00.00.00.FF.FF.FF.00 0x02.FF.FF.FF 0xFF.00.FF.00.FF.FF.FF
0x00 0x01.FF.FF.00 0x02.FF.FF.FF 0x02.00.FF.00
0x00 0x02.FF.FF.00 0x02.FF.FF.FF 0xFF.00.FF.00.FF.FF.FF
0x00 0x00.FF.FF.FF 0x02.FF.FF.00 0x03.FF.FF.FF
0x00 0x07.FF.FF.FF
0x01 0x07.FF.00.00
```

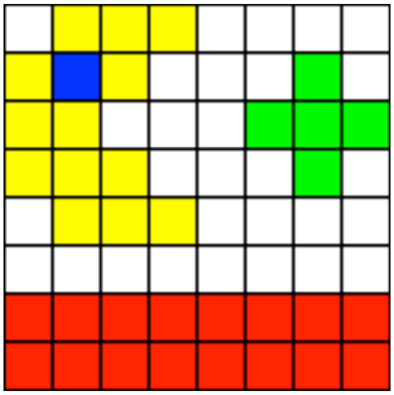

Figure 3 - Sample Color Bitmap

The first line (0x00) contains 1 white pixel (0x00.FF.FF.FF), 3 yellow pixels (0x02.FF.FF.00), and 4 white pixels (0x03.FF.FF.FF).

The second line (0x00) contains a sequence of yellow + blue + yellow pixels (0xFE.FF.FF.00.00.00.FF.FF.FF.00), 3 white pixels (0x02.FF.FF.FF), and a sequence of green + white pixels (0xFF.00.FF.00.FF.FF.FF).

The third line (0x00) contains 2 yellow pixels (0x01.FF.FF.00), 3 white pixels (0x02.FF.FF.FF), and 3 green pixels (0x02.00.FF.00).

The fourth line (0x00) contains 3 yellow pixels (0x02.FF.FF.00), 3 white pixels (0x02.FF.FF.FF), and a sequence of green + white pixels (0xFF.00.FF.00.FF.FF.FF).

The fifth line (0x00) contains 1 white pixel (0x00.FF.FF.FF), 3 yellow pixels (0x02.FF.FF.00), and 4 white pixels (0x03.FF.FF.FF).

The sixth line (0x00) contains 8 white pixels (0x07.FF.FF.FF).

The seventh and eighth lines (0x01) contain 8 red pixels (0x07.FF.00.00).

4.4.3 Sample DeviceCMYK Bitmap

The 8x8 24-bit DeviceCMYK image shown in Figure 3 would be encoded as the following 108 octets:

```
0x00 0x00.00.00.00.00 0x02.00.00.FF.00 0x03.00.00.00.00
0x00 0xFE.00.00.FF.00.FF.FF.00.00.00.00.FF.00 0x02.00.00.00.00
      0xFF.FF.00.FF.00.00.00.00.00
0x00 0x01.00.00.FF.00 0x02.00.00.00.00 0x02.FF.00.FF.00
0x00 0x02.00.00.FF.00 0x02.00.00.00.00 0xFF.FF.00.FF.00.00.00.00.00
0x00 0x00.00.00.00.00 0x02.00.00.FF.00 0x03.00.00.00.00
0x00 0x07.00.00.00.00
0x01 0x07.00.FF.FF.00
```

The first line (0x00) contains 1 white pixel (0x00.00.00.00.00), 3 yellow pixels (0x02.00.00.FF.00), and 4 white pixels (0x03.00.00.00).

The second line (0x00) contains a sequence of yellow + blue + yellow pixels (0xFE.00.00.FF.00.FF.FF.00.00.00.00.FF.00), 3 white pixels (0x02.00.00.00.00), and a sequence of green + white pixels (0xFF.FF.00.FF.00.00.00.00.00).

The third line (0x00) contains 2 yellow pixels (0x01.00.00.FF.00), 3 white pixels (0x02.00.00.00.00), and 3 green pixels (0x02.FF.00.FF.00).

The fourth line (0x00) contains 3 yellow pixels (0x02.00.00.FF.00), 3 white pixels (0x02.00.00.00.00), and a sequence of green + white pixels (0xFF.FF.00.FF.00.00.00.00.00).

The fifth line (0x00) contains 1 white pixel (0x00.00.00.00.00), 3 yellow pixels (0x02.00.00.FF.00), and 4 white pixels (0x03.00.00.00.00).

The sixth line (0x00) contains 8 white pixels (0x07.00.00.00.00).

The seventh and eighth lines (0x01) contain 8 red pixels (0x07.00.FF.FF.00).

5. Semantic Model Elements

This specification defines three new PWG Semantic Model elements in the <service>ServiceDescription group.

5.1 New <service>ServiceDescription Elements

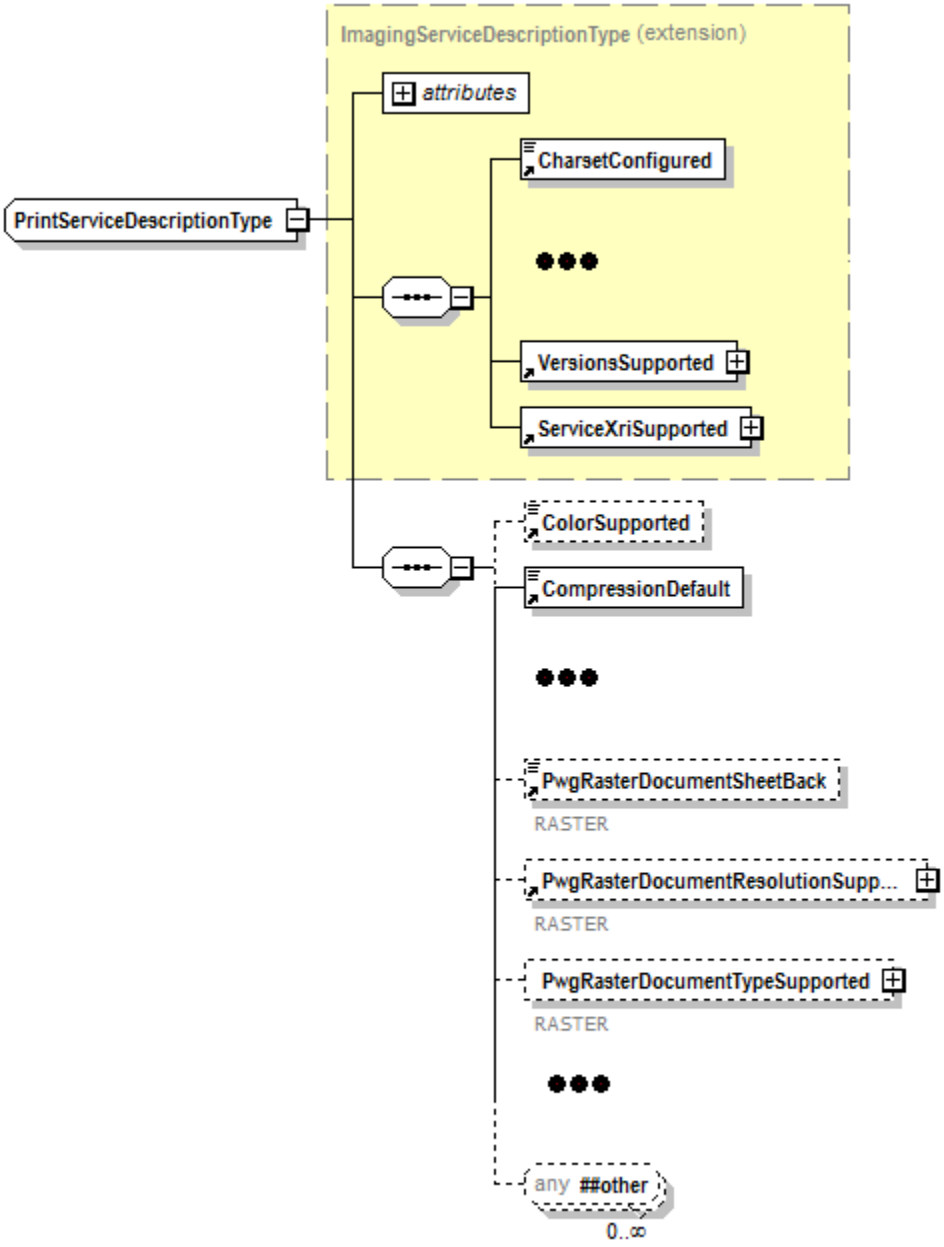
ImagingServiceDescriptionType (extension)
attributes
CharsetConfigured
PrintServiceDescriptionType
VersionsSupported
ServiceXriSupported
ColorSupported
CompressionDefault
PwgRasterDocumentSheetBack
RASTER
PwgRasterDocumentResolutionSupp...
RASTER
PwgRasterDocumentTypeSupported
RASTER
any ##other
0..∞

Figure 4 - New <service>ServiceDescription Elements

Table 11 - New Service Description Elements

Element	DataType	Description or Keyword
PwgRasterDocument-ResolutionSupported	complex	see 5.1.2
Resolution	complex	the supported sequence of resolutions in CrossFeed and Feed direction for PWG Raster files
CrossFeedDir	int	allowed values for resolutions, in dots per inch, in CrossFeed direction [RFC2911 para 4.1.15]
FeedDir	int	allowed values for resolutions, in dots per inch, in Feed direction [RFC2911 para 4.1.15]
Units	keyword	allowed units for resolutions; MUST be "Dpi"
PwgRasterDocument-SheetBack	keyword	see 5.1.1; *PwgRasterDocumentSheetBackWKV*
PwgRasterDocument-TypeSupported	list of keywords	see 5.1.3; *PwgRasterDocumentTypeWKV*

5.1.1 PwgRasterDocumentSheetBack

This CONDITIONALLY REQUIRED element specifies the bitmap coordinate system for the backside of duplex sheets. Printers with duplex printing capabilities MUST support this element. The following keyword values are defined:

'Normal' - the backside has the origin at the top-left corner of the bitmap,
'ManualTumble' - the backside has the origin at the top-left corner of the bitmap for 'TwoSidedLongEdge' and the bottom-right corner (rotated 180º) of the bitmap for 'TwoSidedShortEdge',
'Rotated' - the backside image has the origin at the bottom-right corner (rotated 180º) of the bitmap for 'TwoSidedLongEdge' and the top-left corner of the bitmap for 'TwoSidedShortEdge', or
'Flipped' - the backside image has the origin at the bottom-left corner (X flipped) of the bitmap for 'TwoSidedLongEdge' and the top-right corner (Y flipped) for 'TwoSidedShortEdge'.

Figure 5 visually shows the effect of each value on the bitmap image. The top of each page represents the first line of raster data that is transferred, with pixels being transferred from left to right. Also see Table 9 for the values that must be used for the CrossFeedTransform and FeedTransform page header fields.

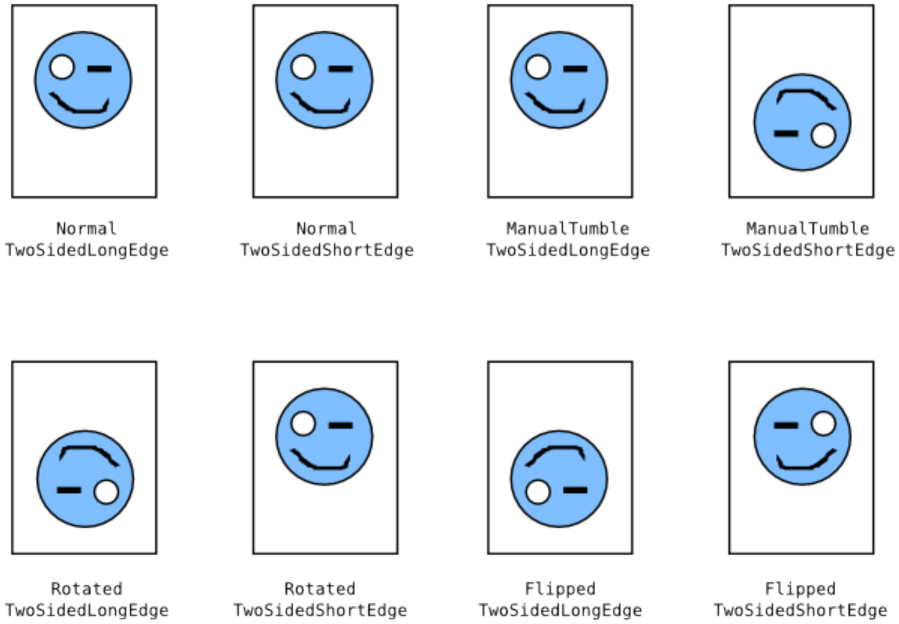

Figure 5 - PwgRasterDocumentSheetBack and Sides

5.1.2 PwgRasterDocumentResolutionSupported

This REQUIRED element lists the supported page bitmap resolutions in dots per inch. Printers MUST be capable of accepting or producing "image/pwg-raster" streams for the highest reported resolution on the largest supported media. Printers MUST support at least one resolution less than or equal to 360 dots per inch and SHOULD support at least one resolution greater than or equal to 600 dots per inch.

5.1.3 PwgRasterDocumentTypeSupported

This REQUIRED element lists the supported page bitmap color configurations. Table 12 lists the standard keywords and the corresponding page header field values.

Table 12 - PwgRasterDocumentTypeSupported Keyword Values

Keyword	BitsPerColor	BitsPerPixel	ColorSpace	NumColors
Black_1	1	1	3	1
Sgray_1	1	1	18	1
AdobeRgb_8	8	24	20	3
Black_8	8	8	3	1
Cmyk_8	8	32	6	4
Device1_8	8	8	48	1
Device2_8	8	16	49	2
Device3_8	8	24	50	3
Device4_8	8	32	51	4
Device5_8	8	40	52	5
Device6_8	8	48	53	6
Device7_8	8	56	54	7
Device8_8	8	64	55	8
Device9_8	8	72	56	9
Device10_8	8	80	57	10
Device11_8	8	88	58	11
Device12_8	8	96	59	12
Device13_8	8	104	60	13
Device14_8	8	112	61	14
Device15_8	8	120	62	15
Rgb_8	8	24	1	3
Sgray_8	8	8	18	1
Srgb_8	8	24	19	3
AdobeRgb_16	16	48	20	3
Black_16	16	16	3	1
Cmyk_16	16	64	6	4
Device1_16	16	16	48	1
Device2_16	16	32	49	2
Device3_16	16	48	50	3
Device4_16	16	64	51	4
Device5_16	16	80	52	5
Device6_16	16	96	53	6
Device7_16	16	112	54	7
Device8_16	16	128	55	8
Device9_16	16	144	56	9
Device10_16	16	160	57	10
Device11_16	16	176	58	11
Device12_16	16	192	59	12
Device13_16	16	208	60	13
Device14_16	16	224	61	14
Device15_16	16	240	62	15
Rgb_16	16	48	1	3
Sgray_16	16	16	18	1
Srgb_16	16	48	19	3

6. Conformance Requirements

6.1 PWG Raster Consumer Requirements

To claim conformance to this specification, a PWG Raster consumer MUST:

(a) support the "image/pwg-raster" MIME media type as defined in section 4 of this specification and
(b) conform to the Security Considerations defined in section 8 of this specification.

6.2 PWG Raster Producer Requirements

To claim conformance to this specification, a PWG Raster producer MUST:

(a) generate document data conforming to the "image/pwg-raster" MIME media type as defined in section 4 of this specification and
(b) conform to the Security Considerations defined in section 8 of this specification.

6.3 Generic Printer Conformance Requirements

To claim conformance to this specification, a Printer implementation MUST:

(a) support all PWG Semantic Model elements as defined in section 5 of this specification,
(b) support the PWG Raster Consumer requirements as defined in section 6.1 of this specification,
(c) support PWG Raster streams at the highest reported resolution reported by the “PwgRasterDocumentResolutionSupported” element and largest media size reported by the “MediaSupported” element, and
(d) support PWG Raster streams with all resolutions reported by the “PwgRasterDocumentResolutionSupported” element as defined in section 5.1.2 of this specification.

If a Printer supports scanning and the creation of documents with the PWG Raster Format MIME media type, it MUST also:

(a) support the PWG Raster Producer requirements as defined in section 6.2 of this specification.

A Printer implementation SHOULD:

(a) support the "FeedDirection" element defined in the PWG Semantic Model.

6.4 Generic Client Conformance Requirements

To claim conformance to this specification, a Client MUST:

(a) support the PWG Raster Producer requirements as defined in section 6.2 of this specification,
(b) explicitly identify the supported values of all Semantic Model elements defined in section 5 of this specification,
(c) produce PWG Raster streams at an orientation, resolution, and size as reported by the "FeedDirection", “PwgRasterDocumentResolutionSupported”, and “MediaSupported” elements and as defined in section 5.1.2 of this specification, and
(d) produce PWG Raster streams using Color Space and bit depth values as defined in section 5.1.3 of this specification.

If a Client supports scanning, it MUST also:

(a) support the PWG Raster Consumer requirements as defined in section 6.1 of this specification.

6.5 IPP Printer Conformance Requirements

To claim conformance to this specification, an IPP Printer implementation MUST:

(a) support the PWG Raster Consumer requirements as defined in section 6.1 of this specification,
(b) support all IPP attributes defined in section 10 of this specification,
(c) support PWG Raster streams at the highest reported resolution reported by the “pwg-raster-document-resolution-supported” attribute and largest media size reported by the “media-supported” attribute, and
(d) support PWG Raster streams with all resolutions reported by the “pwg-raster-document-resolution-supported” attribute as defined in section 5.1.2 of this specification.

An IPP Printer SHOULD:

(a) support the IPP “compression” attribute with the values “compress”, “deflate”, and/or “gzip” to further reduce the size of PWG Raster documents, and
(b) support the "feed-orientation" Job Template attribute defined in section 7.1 of PWG 5100.11 [PWG5100.11].

6.6 IPP Client Conformance Requirements

To claim conformance to this specification, an IPP Client MUST:

(a) support the PWG Raster Producer requirements as defined in section 6.2 of this specification,
(b) explicitly identify the supported values of all IPP attributes defined in section 10 of this specification,
(c) produce PWG Raster streams at an orientation, resolution, and size as reported by the "feed-orientation", “pwg-raster-document-resolution-supported”, and “media-supported” attributes and as defined in section 5.1.2 of this specification, and
(d) produce PWG Raster streams using Color Space and bit depth values as defined in section 5.1.3 of this specification.

An IPP Client SHOULD:

(a) support the IPP “compression” attribute with the values “compress”, “deflate”, and/or “gzip” to further reduce the size of PWG Raster documents.

7. Internationalization Considerations

Because PWG Raster streams contain no localizable text, there are no internationalization considerations for the PWG Raster format.

8. Security Considerations

The security considerations for IPP are described in Section 8 of RFC 2911 [RFC2911]. Consumers of PWG Raster streams MUST range check all page header and bitmap values to protect against integer and buffer overflows.

9. IANA Considerations

9.1 MIME Media Type Registration

Name : Michael Sweet

E-mail : msweet@apple.com

MIME media type name : Image

MIME subtype name : Standards Tree – pwg-raster

Required parameters : NONE

Optional parameters : NONE

Encoding considerations :

> 8-bit (raw) binary data.

Security considerations :

> Raster data can be very large, which could fill a filesystem and cause a denial of service or system failure. Raster data contains no executables or macros. Authentication and access control are normally handled by the Internet Printing Protocol and Hyper-Text Transport Protocol.

Interoperability considerations :

> NONE

Published specification :

> ftp://ftp.pwg.org/pub/pwg/candidates/cs-ippraster10-20120420-5102.4.pdf

Applications which use this media :

> CUPS
> IPP Everywhere
> IPP Scan

Additional information :

1. Magic number(s) : 0x52.61.53.32

2. File extension(s) :

3. Macintosh file type code :

Person to contact for further information :

1. Name : Michael Sweet

2. E-mail : msweet@apple.com

Intended usage : Common

Used for printing "raw" image data in formats acceptable to printers.

Author/Change controller :

The Printer Working Group
c/o The IEEE Industry Standards and Technology Organization
445 Hoes Lane
Piscataway, NJ 08854
USA

9.2 Attribute Registrations

The attributes defined in this document will be published by IANA according to the procedures in RFC 2911 [RFC2911] section 6.2 in the following file:

http://www.iana.org/assignments/ipp-registrations

The registry entries will contain the following information:

```
Printer Description attributes:                      Reference
-----------------------                              ---------
pwg-raster-document-sheet-back (type2 keyword)       [PWG5102.4]
pwg-raster-document-resolution-supported (1setOf resolution)
                                                     [PWG5102.4]
pwg-raster-document-type-supported (1setOf type2 keyword)
                                                     [PWG5102.4]
```

9.3 Attribute Value Registrations

The keyword attribute values defined in this document will be published by IANA according to the procedures in RFC 2911 [RFC2911] section 6.1 in the following file:

http://www.iana.org/assignments/ipp-registrations

The registry entries will contain the following information:

```
Attributes (attribute syntax)
  Keyword Attribute Value                            Reference
  -----------------------                            ---------
pwg-raster-document-sheet-back (type2 keyword)       [PWG5102.4]
  normal                                             [PWG5102.4]
  manual-tumble                                        [PWG5102.4]
  rotated                                              [PWG5102.4]
  flipped                                              [PWG5102.4]

pwg-raster-document-type-supported (1setOf type2 keyword)
                                                       [PWG5102.4]
  adobe-rgb_16                                         [PWG5102.4]
  adobe-rgb_8                                          [PWG5102.4]
  black_1                                              [PWG5102.4]
  black_16                                             [PWG5102.4]
  black_8                                              [PWG5102.4]
  cmyk_16                                              [PWG5102.4]
  cmyk_8                                               [PWG5102.4]
  device1_16                                           [PWG5102.4]
  device1_8                                            [PWG5102.4]
  device10_16                                          [PWG5102.4]
  device10_8                                           [PWG5102.4]
  device11_16                                          [PWG5102.4]
  device11_8                                           [PWG5102.4]
  device12_16                                          [PWG5102.4]
  device12_8                                           [PWG5102.4]
  device13_16                                          [PWG5102.4]
  device13_8                                           [PWG5102.4]
  device14_16                                          [PWG5102.4]
  device14_8                                           [PWG5102.4]
  device15_16                                          [PWG5102.4]
  device15_8                                           [PWG5102.4]
  device2_16                                           [PWG5102.4]
  device2_8                                            [PWG5102.4]
  device3_16                                           [PWG5102.4]
  device3_8                                            [PWG5102.4]
  device4_16                                           [PWG5102.4]
  device4_8                                            [PWG5102.4]
  device5_16                                           [PWG5102.4]
  device5_8                                            [PWG5102.4]
  device6_16                                           [PWG5102.4]
  device6_8                                            [PWG5102.4]
  device7_16                                           [PWG5102.4]
  device7_8                                            [PWG5102.4]
  device8_16                                           [PWG5102.4]
  device8_8                                            [PWG5102.4]
  device9_16                                           [PWG5102.4]
  device9_8                                            [PWG5102.4]
  rgb_8                                                [PWG5102.4]
  rgb_16                                               [PWG5102.4]
  sgray_1                                              [PWG5102.4]
  sgray_16                                             [PWG5102.4]
  sgray_8                                              [PWG5102.4]
  srgb_16                                              [PWG5102.4]
  srgb_8                                               [PWG5102.4]
```

10. IPP Printer Description Attributes

This specification defines three new IPP Printer description attributes. Table 13 lists the attributes. Semantic model keyword values follow the usual conversion from 'ExampleKeyword' (Title Case form) to 'example-keyword' (hyphenated words form).

Table 13 - IPP Printer Description Attributes

Element Name	IPP Attribute Name
PwgRasterDocumentResolutionSupported	pwg-raster-document-resolution-supported
PwgRasterDocumentSheetBack	pwg-raster-document-sheet-back
PwgRasterDocumentTypeSupported	pwg-raster-document-type-supported

10.1 pwg-raster-document-resolution-supported (1setOf resolution)

This REQUIRED Printer attribute lists the supported page bitmap resolutions in dots per inch.

10.2 pwg-raster-document-sheet-back (type2 keyword)

This CONDITIONALLY REQUIRED Printer attribute specifies the bitmap coordinate system for the backside of duplex sheets. Printers with duplex printing capabilities MUST support this attribute.

10.3 pwg-raster-document-type-supported (1setOf type2 keyword)

This REQUIRED Printer attribute lists the supported Color Space and bit depth combinations.

11. References

11.1 Normative References

[CUPSRASTER] M. Sweet, “CUPS Raster Format”, http://www.cups.org/spec-raster.html

[ECMA388] "Open XML Paper Specification", ECMA-388, June 2009, http://www.ecma-international.org/publications/standards/Ecma-388.htm

[ISO32000] "Document management — Portable document format — Part 1: PDF 1.7", ISO 32000-2008

[POSTSCRIPT] Adobe Systems Incorporated, "PostScript® LANGUAGE REFERENCE, third edition", 1999

[PWG5100.7] T. Hastings, P. Zehler, "Standard for The Internet Printing Protocol (IPP): Job Extensions", PWG 5100.7, October 2003, ftp://ftp.pwg.org/pub/pwg/candidates/cs-ippjobext10-20031031-5100.7.pdf

[PWG5100.11] T. Hastings, D. Fullman, "IPP: Job and Printer Extensions - Set 2 (JPS2)", PWG 5100.11, October 2010, ftp://ftp.pwg.org/pub/pwg/candidates/cs-ippjobprinterext10-20101030-5100.11.pdf

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[PWG5101.1] R. Bergman, T. Hastings, "Standard for Media Standardized Names", PWG 5101.1, February 2002, ftp://ftp.pwg.org/pub/pwg/candidates/cs-pwgmsn10-20020226-5101.1.pdf

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Implementers of this specification document are encourages to join the IPP Mailing List in order to participate in any discussions of clarification issues and review of registration proposals for additional attributes and values.

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