XPS and Color Printing Enhancements in Microsoft Windows Vista

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Abstract

The print architecture for the next client version of the Windows Vista® operating system takes advantage of the new open XML Paper Specification (XPS, formerly codenamed “Metro”) and the new Microsoft Windows Presentation Foundation (formerly codenamed "Avalon"). These technologies enable rich end-to-end document and color printing in Windows Vista, with limited down-level support in Microsoft Windows Server® 2003 and Microsoft Windows® XP. This paper provides an overview of printing enhancements enabled by XPS. Application developers and hardware vendors can use this paper to prepare to support XPS in their product plans.

This information applies for the following operating systems:
 Windows Vista
 Windows Server 2003
 Windows XP

For up-to-date information, see “Color Management for Printers” in the Windows Driver Kit documentation at: <http://msdn2.microsoft.com/en-us/library/ms802157.aspx>

The current version of this paper is maintained on the Web at:  [http://www.microsoft.com/whdc/xps/vista\_print.mspx](%20http%3A/www.microsoft.com/whdc/xps/vista_print.mspx)

References and resources discussed here are listed at the end of this paper.

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# Introduction

Microsoft® Windows Vista™ incorporates a new print architecture to better support current and future printing devices and operations. Printing improvements for Windows Vista support rich end-to-end color document and photo printing, and address many limitations of the existing Microsoft Windows® Graphics Device Interface (GDI)–based print path.

The print architecture in Windows Vista is designed to address significant long-term market directions and customer requirements for printing, including:

Increasing demand for color laser printing. Demand for color printing continues to grow in the corporate market as the impact of color printing gains appreciation among corporate and workgroup-level users. The declining cost of color laser printer hardware, maintenance, and cost per page puts color printing technology within the reach of more small business users and cost-conscious enterprises.

Increasing demand for color fidelity. Documents should look the way customers want them to, whether the document is viewed or printed. As color printing becomes more widespread, demand for high-fidelity color output and more predictable quality of print jobs will increase, creating opportunities for applications to offer features such as integrating advanced graphics and color images into standard office documents, slideshows, and charts. Increasingly, powerful applications will make color printing more useful in the enterprise, creating a “virtuous cycle” in which the demand for color printers and more powerful applications will continue to increase.

Increasing use of advanced graphics and color. As graphics libraries become more affordable and accessible, information workers are integrating more graphics and photos into their documents. Many applications now include extensive libraries in the application or through online services. Graphics targeted at knowledge workers include advanced graphics effects such as transparency, gradients, glows, and shading. These effects push the limits of existing systems and devices, as well as the formats and engines that support rendering.

This paper provides an overview of XML Paper Specification (XPS), how Windows Vista uses XPS and Windows color management to improve the printing experience for users, support for XPS in earlier versions of Windows, and benefits of supporting the XPS document format in applications and hardware.

# XPS and Windows Vista

The open XML Paper Specification is the foundation for document and printing improvements in Windows Vista. The specification describes the appearance of paginated documents in an XML-based document format.

The XPS Document format consists of Extensible Markup Language (XML) markup that defines the composition of a document and the visual appearance of each page along with rendering rules for displaying or printing the document.

To obtain a copy of the XPS specification, see "Resources and Next Steps" at the end of this paper.

## **XPS Document Format and the XPS Spool File**

The XPS Document format serves as a document format, a spool file format, and a page description language (PDL) for printers. Consistent use of XPS throughout the system greatly improves print predictability and reliability. Fidelity and performance improve when the document format is the same as the PDL and the spool file. XPS Document processing eliminates the need for any conversions between application and printer, which makes it possible to deliver a WYSIWYG ("what-you-see-is-what-you-get") experience.

The XPS spool file uses the XPS Document format. The XPS spool file is open and extensible, can be viewed using platform services, and can be reintroduced into document workflows.

The markup in the XPS spool file to describe XPS Documents is compatible with the Extensible Application Markup Language (XAML) markup in the Windows Presentation Foundation. Therefore, documents described in the XPS spool file can be rendered natively in Windows Presentation Foundation without data or fidelity loss because no conversion is necessary. The XAML tags in the XPS spool file are XAML representations for existing rendering classes in Windows Presentation Foundation. The XPS Document format is identical to the “print” format and effectively preserves application content and user intent.

## **The XPS Print Path**

The new print subsystem in Windows Vista implements an XPS print path that supports the new XPS spool file and the Windows Presentation Foundation graphics engine. The GDI print path in Windows XP, which uses GDI-based Version 3 print drivers, is also still available in Windows Vista. Figure 1 shows the additional built-in conversion capabilities that allow Microsoft Win32® GDI-based applications to print to XPS Document devices and allows Windows Presentation Foundation applications to print to legacy printers.



Figure 1. Print Paths in Windows Vista

Printing from existing Win32 applications operates the same as in previous versions of Windows, as do existing user-mode printer drivers.

Software vendors do not need to make any modifications to their applications to print to a XPS Document–based printer. Application output targeted for XPS Document–based printers is automatically converted to an XPS spool file. This conversion process is optimized for print fidelity and spool file size reduction.

The increased benefits of XPS described in this paper are based on adopting Windows Presentation Foundation and XPS Document technologies. The best experience is enabled through full participation by both the software application and the device.

Because Windows Presentation Foundation applications natively output to an XPS Document spool file, these applications can provide the highest fidelity printing experience for the user when targeting an XPS Document–based device.

# How Windows Vista Improves the Windows Printing Experience

Windows Vista printing brings the next generation of document services to the Windows platform, providing high-fidelity and high-performance printing for Windows users and an extensible platform for partner innovation.

## Improved Color Printing

New color management capabilities and the XPS print path in Windows Vista work together to provide a richer, more predictable color printing experience. Enhanced color support enables high-end printing by supporting printing with more than four colorants, which is required for customers with prepress applications. The new print architecture can communicate application-generated extended color information to wide-gamut color printers. Device drivers can access and control color information from within the print pipeline.

Windows Vista makes full use of the Windows Color System, which introduces significant innovations to color management to match color across different software applications, imaging devices, imaging media, and viewing conditions in a predictable, reliable, and consistent manner. The XPS Document is the conduit for sending application color information to the XPS Document–based devices. The XPS Document format applies this technology through native support for the following:

Higher precision, higher dynamic range, and larger gamut color spaces.

Use of CMYK and supporting n-ink systems (greater than four colorants).

Support for named colors.

Through the XPS spool file, the XPS print path delivers this advanced color information directly to the device drivers. Optionally, the device drivers can provide improved color handling:

Automatic color configuration for devices with XPS print path drivers.

The ability to repurpose content in the pipeline for a different print device.

The ability to reliably persist color data from the application to the driver because color profiles and processing instructions can be embedded directly in the spool file.

Improved communication of color capabilities and settings. Applications can control color processing by enabling or disabling system color management in the new print path. Drivers can more completely express color capabilities of their devices.

## High-Fidelity Print Output

XPS Document printers can provide overall improved print and color fidelity. When printing from applications built on the Windows Presentation Framework or when directing output to XPS Document–based printers or drivers, the XPS print path reduces or eliminates image data conversions and color space conversions wherever possible, enabling high-fidelity print output.

XPS printing provides more faithful rendering of graphics attributes such as gradients and transparency though native support of these attributes in the XPS spool file format. The XAML in the XPS Document format is compatible with Windows Presentation Foundation XAML. When printing from a Windows Presentation Foundation application, Windows removes animations and converts video and three-dimensional (3‑D) elements to images. All other graphics data is represented in compatible graphics primitives that are ideal for device consumption. The device or driver directly consumes the printing version of Windows Presentation Foundation output.

During the automatic conversion of output from Win32-based applications to XPS Document–based devices and drivers, print fidelity is enhanced by optimizing for specific GDI raster operations (ROPs) that are used for transparency simulation by GDI+ and gradients. If the application generates a bitmap instead of using ROPs, this optimization cannot be performed.

Fidelity in printing to legacy devices from applications built on the Windows Presentation Framework has been drastically improved in the XPS-to-GDI conversion printing path compared with similar implementations in GDI+, which many applications use. The XPS-to-GDI conversion path tries to algebraically remove transparency (alpha channel in colors and images, and opacity and opacity mask on Canvas) in Windows Presentation Foundation graphics as much as possible, without using GDI raster operations and Postscript bitmasks.

## Improved End-User Experience

Windows Vista introduces two new technologies to improve communication of device capabilities and user intent:

XML PrintTicket. The use of XML PrintTicket enables better communication between the application and the device, and consequently improves end-user experiences. It allows printing components to be more transparent and handle settings migrations more cleanly. In the new application framework built on managed code objects in Windows Vista, the XML PrintTicket is the standard way of describing print job settings.

The XML PrintTicket technology enables all components and clients of the print subsystem to have transparent access to the information currently stored in the public and private portions of the DEVMODE structure in a well-defined XML format. This design resolves current problems in driver upgrade or downgrade and driver mismatch scenarios in drivers designed for the PrintTicket technology. By using PrintTickets to communicate settings, hardware vendors can avoid negative customer experiences on migration efforts.

XML PrintCapabilities. XML PrintCapabilities is a method of publishing configurable device capabilities such as finishing options and page layout options. Printers can use XML PrintCapabilities to describe explicitly all user-configurable attributes of the device and the allowable settings for each attribute. Through the Print Schema Framework, device attributes can be precisely described and efficiently compared. By using the keywords in the Print Schema Keywords document and the structure defined in the Print Schema Framework, devices can enable applications to use device capabilities more effectively.

## Improved Spooling and Rendering

The XPS print path improves spooler efficiency by spooling XPS Documents in a native spool format when printing to XPS-enabled drivers or printers. The simplified spooling process eliminates the requirement to generate an intermediate spool file, such as an enhanced metafile (EMF) data file, before the document is spooled. Through smaller spool files sizes, the XPS print path can reduce network traffic and improve printing performance.

EMF is a closed format that represents application output as a series of GDI calls that in turn require calls into GDI for rendering services. Unlike EMF, the XPS spool format represents the actual visual output without requiring further interpretation when targeting an XPS Document–based driver (XPSDrv). The drivers can operate directly on the data in the format. This scenario also eliminates the data and color space conversions required when using EMF files and GDI-based print drivers.

Spool file sizes are usually reduced when working with XPS Documents or targeting an XPSDrv. Files that rely on using device fonts and files with large vector content may result in a larger spool file, but in many cases spool files are substantially smaller.

Spool file size reduction is performed through several mechanisms in the conversion process:

Font subsetting for all fonts. After the output is processed, it contains only the characters used for the fonts within the file. This optimization provides for radical spool file reduction for documents, particularly those using East Asian font sets.

Identification of common resources. Examples of common resources are logos and image files. The conversion process identifies whether an image is used multiple times within a document and, if so, creates a shared resource in the resultant XPS spool file. This optimization can significantly reduce spool file size for graphics-intensive documents such as Microsoft PowerPoint® files that use the same logos and backgrounds on each slide.

ZIP compression. The final optimization is the ZIP compression implemented as part of the XPS spool file format (XPS Document).

These opportunities for reduction occur any time an XPS Document or XPS spool file is created.

## Extensible Architecture

Extensibility throughout the architecture makes it easier for hardware and software vendors to add differentiating features and capabilities in a modular fashion. Each upgraded and new component within the XPS print path was designed to enable vendor extensibility:

The Print Schema allows for extensibility and will be regularly updated to publicly expose desired device capabilities.

The new filter pipeline used by XPSDrv drivers was founded on the premise of a modular, extensible architecture to allow vendors to provide modularized functionality that can act alone or in an atomic fashion to produce desired effects.

The filter pipeline was also built to support the concepts of direct consumption and scalable consumption:

**Direct consumption** means the device can consume an XPS Document or the XPS spool file without host assistance. For output from a Windows PC, the hardware vendor provides an XPSDrv driver that consists of a configuration module and a null filter pipeline. The configuration module represents the device and expresses the device capabilities to the application, yet does not process the spool file within the driver. The XPS spool file is delivered directly to the printer untouched, where the printer then processes the document in its entirety.

**Scalable consumption** represents an XPSDrv driver that may perform some or all processing on the host. The division between host and device processing is the decision of the hardware vendor, who makes trade-offs based on device capabilities, cost, and target market. Scalable consumption is a powerful concept that provides the hardware vendor with significant flexibility in implementation methodology.

To take advantage of the XPS print path, a hardware vendor should provide an XPSDrv driver. An XPSDrv driver is a filter pipeline that provides driver features such as host-based n-up, watermark, and rendering functions. Graphics processing is performed in a rendering filter and is performed on the visuals represented in the new spool file format. This is a fundamental change to the way rendering operations occur with GDI-based drivers.

The modular construction of the filter pipeline provides a framework for developing function-specific filters. A hardware vendor can create a filter pipeline composed of self-contained filters. If appropriately contained, these filters can then be reused by different drivers and thus different pipelines, optimizing the hardware vendor's investment in XPSDrv development.

Previous versions of Windows required printer drivers to have a printer interface DLL for printer configuration and control and a printer graphics DLL for processing and rendering the actual document content to be printed. Printer drivers written for Windows Vista require the same functions as in previous printer driver versions. An XPSDrv driver communicates with devices and applications through XML PrintTicket and XML PrintCapabilities. Additional interfaces providing the enhanced XML PrintTicket and XML PrintCapabilities functions of Windows Vista printing must also be added.

# Support for XPS in Earlier Versions of Windows

Microsoft recognizes the need to provide an infrastructure that both advances the state of the art in printing and supports the installed base of clients, servers, and devices. In addition to Windows Vista, Microsoft will deliver support for XPS-based technologies for Microsoft Windows Server™ 2003 and Windows XP through the Microsoft WinFX™ Runtime Component 3.0. XPS printing will work in Point and Print scenarios with these operating systems. Support for XPS in earlier versions of Windows will provide extensive endorsement for XPS Document–based solutions and increase the effective market opportunity for vendors providing XPS Document–based solutions.

## **Transparent Conversion of Output for Win32 and Windows Presentation Foundation Applications**

Although rendering output differs significantly between Win32 and Windows Presentation Foundation applications, the XPSDrv driver model enables both application types to print to a single driver. Output destined for printing is converted appropriately between the application types and the driver types, enabling a full support matrix between Win32 and Windows Presentation Foundation applications printing to GDI-based and XPS Document–based printers. Microsoft will make the XPSDrv infrastructure available for use in Windows XP and Windows Server 2003.

## **Consistent Filter Pipeline Model**

The filter pipeline on Windows Vista and earlier versions of Windows supports the same interfaces for filters, plug-in model, pipeline configuration file, and event logging. The differences are few, most notably in the reduced support for notifications in earlier versions of Windows. For Windows Vista, the rendering filter has complete control of notifications and can send notifications about any type of “part” that the filter is processing (document, page, font, image, and so on). For scalable consumers in earlier versions of Windows, notifications happen only at page boundaries.

## **XPS Document**–**based Print Processor**

Microsoft plans to provide an XPS Document–based print processor that enables XPSDrv on Microsoft Windows Server 2003 and Windows XP. The XPS Document–based print processor hosts XPSDrv drivers and communicates with the existing spooler on these operating systems. Certain XPS print path features are available only on Windows Vista, so the XPSDrv driver must be able to degrade gracefully on earlier versions of Windows.

# Resources and Next Steps

Microsoft encourages customers and vendors to pursue these advances by taking the following steps.

#### Device manufacturers, firmware engineers, and driver software engineers:

Review all technical documentation about the XPS Document format to better understand printer consumption challenges and opportunities.

Consider implementation opportunities to take advantage of the architecture’s support of scalable and direct consumption. This can maximize your software development resources across product lines.

Consider providing updated drivers for the installed base to take advantage of improved printing capabilities enabled through XPSDrv drivers.

Familiarize yourself with areas of extensibility to host your value-added functions.

Design support for the Microsoft XML PrintTicket and XML PrintCapabilities interfaces into GDI-based drivers for Windows Vista and later versions of Windows.

#### Application developers:

Review the impacts to your support organizations of print problems associated with printing of advanced graphics and consider migrating those functions to the Windows Presentation Foundation.

Review the Windows Presentation Foundation APIs, the new XPS Document format, and the additional configuration interfaces such as the Microsoft XML PrintTicket and XML PrintCapabilities interfaces.

Consider how these new features can be phased into existing applications or designed into new applications.

Verify printer type before rasterizing transparencies and gradients in GDI applications. If targeting an XPSDrv printer, Windows Vista can attempt to optimize print fidelity of transparencies and gradients.

#### Feedback:

For questions about XPS and color management in Windows Vista,, send e‑mail to prninfo@microsoft.com.

#### Resources:

XPS Specification and Reference Guide
<http://www.microsoft.com/whdc/Device/print/metro.mspx>

XPS Print Path FAQ
<http://www.microsoft.com/whdc/device/print/metro_FAQ.mspx>

Printing - Architecture and Driver Support:
<http://www.microsoft.com/whdc/device/print/default.mspx>

Windows Image Color Management
<http://www.microsoft.com/whdc/device/display/color/default.mspx>

Windows Vista Developer Center
Windows Vista Beta 1, WinFX Run-time Components Beta 1, and Microsoft WinFX SDK Beta 1 can be downloaded from this site.
<http://msdn.microsoft.com/windowsvista/>