white paper

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Introduction

As part of the Microsoft At Work initiative to integrate the office peripherals of the future at the desktop, Microsoft has created the Microsoft At Work™ printing technology, an enabling software architecture that is the basis for a new class of printers optimized for the Microsoft® Windows™ operating system. Microsoft At Work-based printers bring to printing what the Microsoft At Work architecture brings to other office peripherals — unequaled ease of use, unparalleled price/performance, a high level of integration with other office peripherals, particularly the PC, and a consistent architecture that can allow printer manufacturers to quickly create new products that solve real-world problems. This technology was first introduced as the Windows™ Printing System, a cartridge upgrade for the millions of Hewlett-Packard® LaserJet® Series II and III printers already sold. Now, Microsoft is licensing this enabling technology to its original equipment manufacturers (OEMs) to build into their printer offerings.

Key Benefits

Fast, Bidirectional Communication Channel

In many printers today, the communication channel between the printer and PC is slow and unidirectional. A slow communication channel often creates a bottleneck, increasing the time required to print a page. In addition, a one-way communication channel makes it impossible for the user (and the PC) to receive error messages or examine printer status except through the cryptic front panel of the printer.

Microsoft At Work-based printers incorporate a fast, bidirectional communication channel, which eliminates the communication bottleneck and allows the printer to communicate status information to the PC.

Sound and Visual Feedback

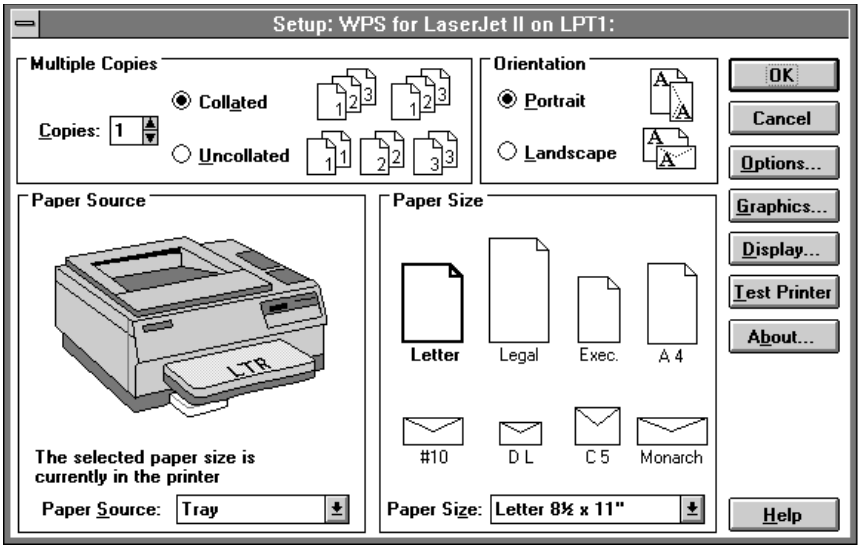
Using a bidirectional communication channel, Microsoft At Work-based printers communicate information to the PC, giving the user feedback on the amount of time required to print the current job and displaying printer error conditions as necessary, such as “out of paper” or “paper jammed.” This feedback is given to the user via the rich audio and visual information available in the Windows environment.

Unprecedented Ease of Installation

For many users, the time between opening the printer box and printing their first document is one filled not with fond memories, but with delays. Microsoft At Work-based printers will greatly change this experience, utilizing the bidirectional communication channel to automatically instruct the host system to load the required driver and choose the optimum communication protocol. This eliminates the need to navigate through a myriad of installation options, and ensures that true plug and play will be achieved.

An Intuitive Graphical User Interface

An intuitive Windows graphical user interface makes Microsoft At Work-based printer features as easy to access as features in any other Windows-based application.



The tight integration between the PC and the printer makes this ease of use possible. Contrast the above setup window with the typical 15-character LCD and buttons characteristic of today's printers.

Faster Performance

Users are often surprised when their current printers rated to print four, eight or more pages per minute run far slower than their rated speeds, especially when printing documents with graphics, which is a typical task. Today's printers incur a large burden when the host translates from Windows to the printer's proprietary imaging languages and then ignores its own capabilities, forcing the printer to do all the work.

Microsoft At Work-based printers exploit the combined capabilities of the PC and the printer, the high-speed communication channel, and tight integration with the PC operating system to provide substantial performance improvements over traditional page description languages.

Lower Cost

Not only do Microsoft At Work-based printers offer greater ease of use, higher performance and new features for their users, they also utilize the same tight integration with the PC operating system to offer substantial cost savings to both users and manufacturers. The efficiency of the architecture allows the use of less memory, less powerful processors and fewer buttons, while at the same time providing improved performance and ease of use.

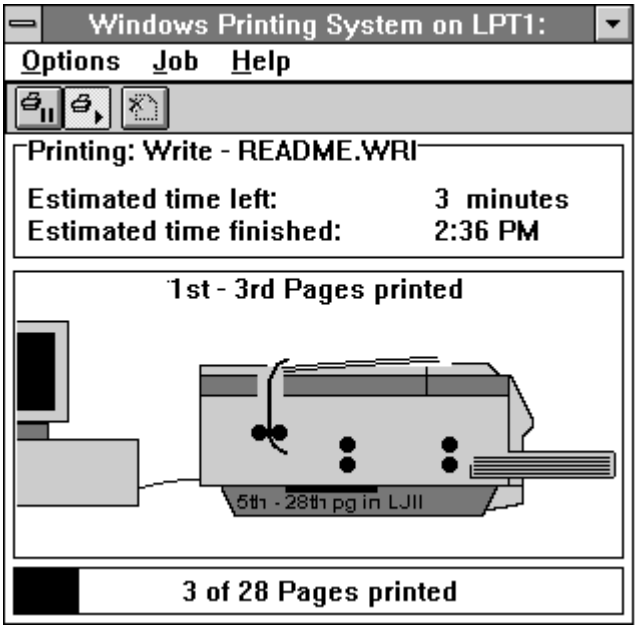
True What You See Is What You Get (WYSIWYG)

With today's printers, users are often surprised when they compare the page they just printed to what they had seen on the screen. The fonts are different, line breaks have changed, new pages are added, and the drawing order has been altered. "What happened?" is a typical response.

Microsoft At Work-based printers use the same font technology and imaging technology as Windows, helping guarantee the highest level of fidelity between the printed page and the image on the monitor. The result is true WYSIWYG, always.

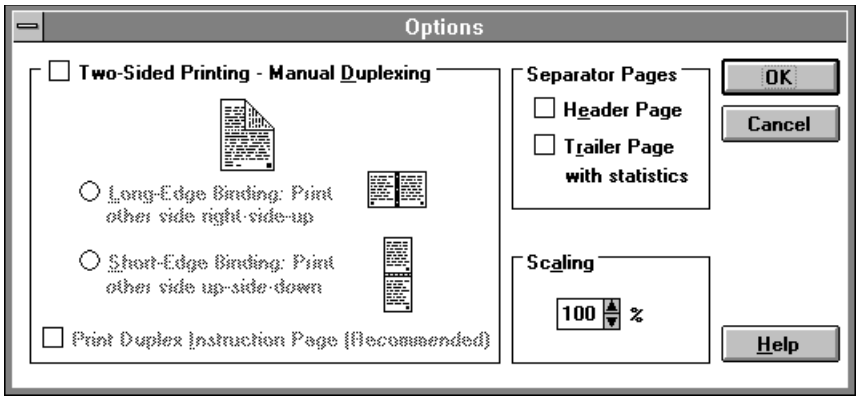
Real-time Status

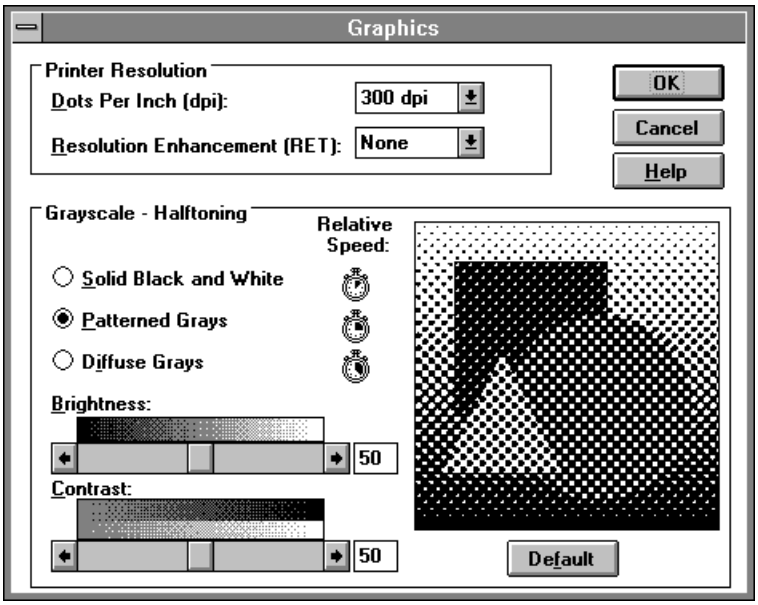
Bidirectional communication between the printer and PC enables the real-time status of the print job, as well as numerous printer error conditions, to be sent from the printer and graphically presented to the user on the status screen.



New Features

Microsoft At Work-based printers capitalize on the unique benefits delivered by the Microsoft At Work printing architecture to offer special features that were previously impossible to provide. These include printer robustness (printers with the minimum amount of memory will always print any page) and a feature that lets the user choose the degree of trade-off between print quality and print time.



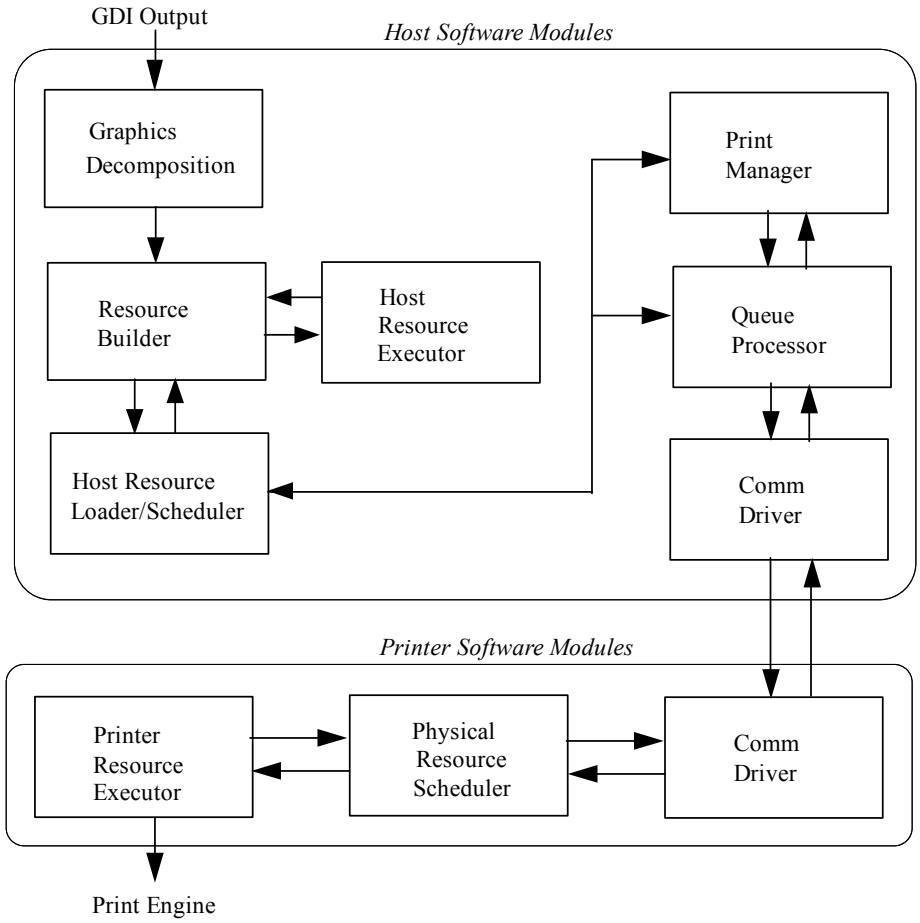


Microsoft At Work-based Printing: An Explanation

When faced with the inefficiencies of current printing solutions, Microsoft engineers decided to approach the problem with a clean sheet of paper. Their approach was to examine printing from a system perspective, looking at how the PC and the printer could cooperate to produce better results. In doing so, they formulated a solution that solved all of the identified problems — Microsoft At Work-based printing.

Microsoft At Work-based printing is at the core of the Windows Printing System. Essentially, it extends the definition of "the system" to encompass the Windows operating system, the imaging model, the CPU and memory on both the PC and the printer, and the communication channel. The print job is actually optimized to fully and effectively use all available system resources. A bidirectional link is created between the PC and the printer and used to determine the capabilities of the printer, to get status from the printer, and to manage printer memory. At the same time, the capabilities of the host are determined. Using the information about system resources, and additional information about each page to be printed, the Microsoft At Work printing architecture manages documents printed by the user — for optimum print speed, ease of use, and reliability.

The block diagram below illustrates an implementation of the architecture for an intelligent printer with on-board formatter. An explanation of each block follows:



To print with a Microsoft At Work-based printer, the user selects it just like any other printer in Windows, and the document gets printed. However, the operations that translate a document to a printed page are very different, and the Microsoft At Work printing architecture provides many features not offered by competing methods.

First — as with all printers — the Windows Graphic Device Interface (GDI) outputs the metafile representation of the document to the printer driver in Microsoft At Work. Next, the **Resource Builder** translates this metafile from the procedural domain into the data domain. The Resource Builder creates **Resources**, **Resource Primitive Lists**, and **Resource Dependencies**, the complexity of which depends on the capabilities of the system.

A Resource can be one of several things:

- **A glyph set**, or table containing different bitmapped characters within a font-like family, each bitmap uniquely referred to by its index
- **A bitmap**, or an image area represented by an array of dots
- **A brush,** or patterned tile bitmap, “painted” over a region to give it a particular pattern
- **A Resource Primitive List**, which includes drawing primitives and commands to describe where to place the previously described resources on the page
- **A Supervisory Primitive List**, which includes commands that control memory management of printer resources and page and job control

- **Immediate Control Primitives,** which are commands sent from the host to the printer to obtain bidirectional printer status information

An important characteristic of each Resource is that the Resource Builder knows exactly how long it will take to render it on the printer. As part of the development process for a Microsoft At Work-based printer, project engineers precisely quantify the time required to render each Resource. These quantities — and the software that uses them — are known as **Cost Metrics**.

Cost Metrics allow the Resource Builder to vary the complexity of the Resources and of the Resource Primitive Lists depending on the capabilities of the host computer and the printer. The workload to print the page is optimally balanced between the printer and the host, providing improved performance and excellent memory management, and allowing Microsoft At Work printers to use less memory and less powerful CPUs than printers designed around other architectures. Additionally, this technology guarantees that every page sent to the printer can be printed by that printer.

For instance, when using a Windows Printing System cartridge in a Hewlett-Packard LaserJet III connected to an Intel® 386 PC, better performance is obtained by rendering TrueType® glyphs on the host than by sending the outlines to the LaserJet to be rendered there by the resident 68K processor. A Microsoft At Work-based printer would actually know this in advance of printing the job from the Cost Metrics of the TrueType font, and would automatically render the fonts on the host PC. If the Cost Metrics of a band show that it can't be rendered in its current form in the printer in time to prevent an error, then the Resource Builder will have it rendered in a form that can be processed in the printer. In the most extreme case, the Resource Builder will have the Resource Executor prerender the band into a bitmap and then send the rendered bitmap to the printer.

The **Host Resource Loader/Scheduler** combines the created Resources, Resource Primitive Lists, and Resource Dependencies with printer commands. This part of the system tracks the Resources so that the driver knows which Resources exist, where they are, when they are going to be needed, and any dependencies between them.

The data stream that the Host Resource Loader/Scheduler outputs will generally be spooled and then fed into the **Print Manager**, just like any other Windows-based printing job. This is the same Print Manager that ships with Windows™ for Workgroups. It differs from the Windows 3.1 Print Manager in that it has been modified to interface with a new module known as the **Queue Processor** (QP). The QP formats the data for communication to the printer, accepts information from the printer through the bidirectional link, and manages communication with the user through a special user interface created for this purpose. The QP is responsible for communicating error messages and printer status to the user.

The **Physical Resource Scheduler** processes the printer commands. For an intelligent printer (one with an embedded processor), the Physical Resource Scheduler resides in the printer. For a sleek printer (without formatter and embedded processor), the Physical Resource Scheduler resides in the host. This module manages the Physical Resource Scheduler in the printer (if the printer is intelligent) and makes sure that the Resource Executor can keep up with the engine.

The **Resource Executor** renders Resources into bits, which are then printed by the laser beam print engine. For an intelligent printer, a Resource Executor resides both on the host and in the printer; for a sleek design, a single Resource Executor resides on the host.

Communication with the printer is managed by the **Communications Driver**, which sets up and maintains the bidirectional link to the printer. Eventually, this Communications Driver will support the Extended Capabilities Port (the high-speed parallel-port protocol

jointly developed by Hewlett-Packard and Microsoft), as well as a standard Centronics® port.

The First Microsoft At Work-based Printing System: Windows Printing System Version 1.0

The Microsoft At Work-based technology described above first appeared in the form of a packaged retail product, the Windows Printing System version 1.0, introduced in early 1993. Version 1.0 concretely demonstrated to users, potential OEM partners, and industry experts Microsoft's vision for printing in Windows. Since its release, Windows Printing System version 1.0 has gained rapid market acceptance.

Aiming for the most expedient way to impact the industry, Microsoft targeted Windows Printing System version 1.0 at the huge installed base of HP® LaserJet Series II and III printers. Together these printers represent more than 50 percent of the entire installed base of laser printers — about 7 million units.

Microsoft At Work-based Printers: Some Possibilities

Microsoft is now working with OEMs to introduce Windows-optimized printers designed from inception around the Microsoft At Work Printing Software technology. Due to the scalability of the Microsoft At Work printing architecture, OEMs have the option to develop a wide variety of Windows-optimized printers spanning the range from formatter-less ink jet to high-end networked laser printers.

The most important consideration for OEMs is their choice of market segments and the needs of customers in those chosen segments. Once those choices are made, the Microsoft At Work printing architecture provides sufficient flexibility to develop a highly targeted solution. The following chart is not meant to encompass all the possibilities for Microsoft At Work-based printers, but is meant to assist in the analysis of possible Microsoft At Work-based solutions.

Printer Category	**Customer Priorities**	**Required and Optional Features**
Mono ink jet	Ease of use Price Print quality	Install GUI
Color ink jet*	Ease of use Price Speed for color	Install GUI Performance
Sleek laser* (Formatter-less)	Ease of use Laser print quality Price/performance Windows-centric	Install and GUI Performance Cost savings
Intelligent laser (Standalone)	Ease of use Laser print quality Multiemulation support Price/performance	Install and GUI Performance Support for finer resolution (higher dpi) Standalone support for MS-DOS®
Intelligent laser* (Networked)	Network support Ease of use Performance Laser print quality Multiemulation support	Microsoft At Work install and GUI Network bidirectional status and control Performance Support for finer resolution (higher dpi) Standalone support for MS-DOS

*Microsoft At Work software deliverables for these printers planned for 1994 availability.

Microsoft At Work Printing Software: Deliverables for OEMs

Microsoft is licensing its Microsoft At Work Printing Software to printer manufacturers to enable them to develop a new class of Windows-optimized printers. Deliverables are being made available to support development of both intelligent and host-based (formatter-less) Microsoft At Work-based printers.

Consistent with all Microsoft At Work software products, System Adaptation Kits (SAKs) are the vehicle for delivering Microsoft At Work Printing Software to our OEMs. These SAKs will provide OEMs the means to implement Microsoft At Work-based printers to their exact specifications using their chosen print engines.

Microsoft At Work-based Printers: Intelligent Printer SAK

Planned for general availability in first quarter 1994, the System Adaptation Kit for implementing intelligent Microsoft At Work-based printers will include the following key elements:

- "Cascade" optimized controller reference design
- Source code for the printer firmware in the port of Microsoft At Work Printing Software to Cascade
- Source code for the printer software in Microsoft At Work Printing Software ported to 68K-based controller
- Source code for the host software in Microsoft At Work Printing Software
- Source code for the bidirectional communications software in Microsoft At Work Printing Software
- Extensive documentation to support rapid and efficient adaptation
- Specifications and operation theory for major software modules
- BIOS interface specification and test tool for Microsoft At Work Printing Software
- Test tools and test cases
- Tools to create custom bitmaps of customer printers
- Electronic copy of Microsoft At Work Printing Software version 1.0 user documentation
- Tools to create online help files
- Tools for developing localized versions of Microsoft At Work Printing Software
- PCL® 4.5, ported to Cascade, to be optionally available from a third-party ISV

Optimized Controller Designs: Intelligent Microsoft At Work Printing Software-based Printers

Microsoft is developing optimized controller designs for Microsoft At Work Printing Software to streamline the development efforts of OEMs. These controller designs and Microsoft At Work software licenses will be provided to licensees. OEMs will be able to use these designs as they are, or use them as reference designs for their own custom designs. Since the Microsoft At Work printing format can coexist with other emulations, OEMs can license TrueImage® page description language from Microsoft, or include their own PCL or PostScript® to provide optional standalone support for the MS-DOS operating system.

These controllers will have an Extended Capabilities Port (ECP) on board. ECP is a new high-speed parallel port protocol jointly developed by Microsoft and Hewlett-Packard, that gives extremely high-speed bidirectional I/O while using standard Centronics cables and connectors. Also, Microsoft has developed a proprietary, high-speed, bidirectional protocol that allows an ECP-equipped printer to gain much of the benefit available from ECP without requiring hardware changes on the PC.

Cascade is the first optimized controller reference design for Microsoft At Work Printing Software. Cascade is based on the AMD 2920X device architecture. The RISC-based 2920X family was the logical choice for the first Microsoft At Work Printing Software controller reference design, due to its highly integrated, low-cost architecture; optimum performance; scalability; and immediate availability. Due to the inherent advantages of the 2920X

architecture, printers based on the Cascade controller and Microsoft At Work Printing Software are expected to be price/performance leaders.

The advantages of basing printers on reference controller designs that are optimized for Microsoft At Work Printing Software include the following:

- Fastest time to market
- Lowest development cost
- Lowest development risk
- Low cost of goods sold
- Excellent price/performance of the printer

Porting Microsoft At Work Printing Software to Existing Controller Designs

The intelligent Microsoft At Work Printing Software SAK will also accommodate the needs of OEM partners planning to port Microsoft At Work Printing Software to their own, existing controller designs. To support this need, the SAK includes a BIOS interface specification, portable Microsoft At Work Printing Software in object and source form as required, tools for testing Microsoft At Work Printing Software and BIOS, documentation, and software licenses. (BIOS is the interface between the Microsoft At Work printing Software and the printer's operating system.)

Comparison of Development Options: Intelligent Microsoft At Work Printing Software Controllers

OEMs must choose to either base their controllers on an optimized reference controller design or use the tools in the Microsoft At Work Printing Software SAK to port Microsoft At Work Printing Software to an existing controller design. Each option has advantages and disadvantages. The following comparison chart is provided to help analyze these options:

Consideration	**Optimized Controller Design**	**Software Adaptation Kit**
Least time to market	4	
Lowest development cost	4	
Lowest cost of goods sold	4	
Maximum design flexibility		4
Lowest development risk	4	

Host Software Adaptation: Intelligent Printers Based on Microsoft At Work Printing Software

The SAK also allows OEMs to develop custom, localized host software for their intelligent Microsoft At Work-based printers. To streamline customization, the SAK includes Microsoft At Work Printing Software host software in object and source form as required, test tools, printer bitmap creation tools, documentation, and so on.

Microsoft At Work-based Printers: Host-based Printer SAK

Microsoft is currently developing Microsoft At Work software for implementing host-based printers. The following delivery mechanisms are planned:

Engine Interface Kit: Host-based Printers Using Microsoft At Work Printing Software

This kit will provide OEMs with the information necessary to create print engines that will be ready to work with our Microsoft At Work Printing Software host-based software solution. It incorporates an ECP interface, as well as support for high-speed communication over standard Centronics-based communications links.

System Adaptation Kit: Host Software for Host-based Printers Using Microsoft At Work Printing Software

This kit will contain the object code of the host software required for the sleek printer design, as well as source code for those sections that need to be customized for each new printer.

Summary

Microsoft At Work Printing Software is an enabling software technology for developing a new class of printers optimized for the Windows environment. Based on its patented Microsoft At Work printing technology, Microsoft developed the Microsoft At Work Printing Software to achieve its vision of extending to printing what Windows has brought to end users of PC applications. Printers optimized around the Microsoft At Work technology are expected to have a strong competitive advantage in the Windows environment.

Microsoft brings to this market an unparalleled reputation for developing superior operating systems and applications software and strong skills in marketing those products. Our OEM partners provide strong skills in developing and marketing printers. Together a successful new class of Windows-optimized printers will be created to meet a critical end-user need.

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Overview of the Microsoft At Work™ Software Architecture

On June 9th, 1993, Microsoft Corporation announced the Microsoft At Work™ software architecture, a set of modular software technologies designed to bring ease of use, compatibility, and an enabling platform to devices in the workplace such as copiers, telephones, fax machines, printers, and handheld systems. These software components will be embedded inside these devices and in Microsoft® Windows™ based PCs to address many key problems that exist in the workplace today - devices are difficult to use, they don't connect with Windows based PCs directly, and they cannot be easily programmed or customized to meet the needs of individuals and businesses.

Users will realize these benefits by using graphical user interfaces on devices such as copiers and telephones that make all features easy to access and use, and by having control of and connections to devices from Microsoft Windows based PCs. The Microsoft At Work software architecture offers full compatibility with the Microsoft Windows operating system, ensuring that data can move freely between Microsoft At Work based devices and the PC. This compatibility also allows the over 300,000 developers in the world today to use their existing development tools and knowledge to write applications that run on the Microsoft At Work platform.

Since the June 9 announcement, Microsoft has delivered the first Microsoft At Work software in Microsoft Windows™ for Workgroups v3.11, and multiple office equipment manufacturers are expected to ship devices based on Microsoft At Work software in 1994. Over 60 companies from the telecommunications, office automation, and personal computer industries are working with Microsoft to develop compatible hardware and software products.