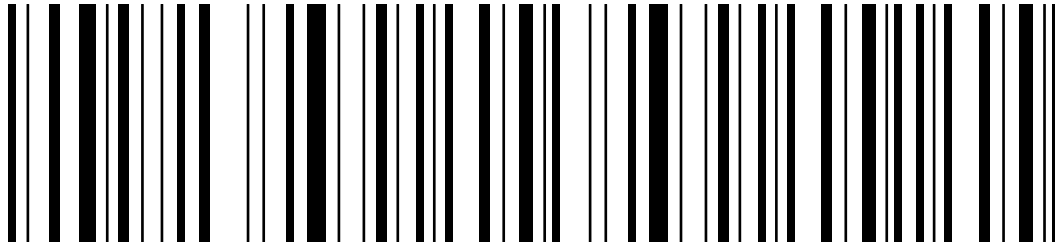# Distributed Label Printing Options for Zebra Printers in IBM AS/400 Network Environments

A P P L I C A T I O N   W H I T E   P A P E R

The purpose of this white paper is to:

- Review the centralized printing model historically found in IBM IT environments;

- Discuss the impact that ERP has had on moving the printing functions to multiple, remotely located areas within the enterprise and the increased value of printing new kinds of information and symbologies;

- Analyze trends that will impact the use and display of information in the future;

- Identify the potential networking and communication problems that distributed printing may force the IT administrator to address; and

- Demonstrate how Zebra Technologies has resolved these issues and provides printing functionality that is not available elsewhere.

After reviewing this white paper, you will:
Develop an understanding of the dynamics that are forcing change in the IBM printing environment; learn about the printing options available to the IT administrator today and the benefits of each; and recognize the role that an IBM business partner can fulfill in providing comprehensive printing solutions that address the productivity and process efficiency demands of other departments.

Zebra Technologies

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Introduction

The growing importance of Enterprise Resource Planning (ERP) is forcing changes in the way the business enterprise operates. The Information Technology (IT) function is under increasing pressure to network computer hosts to a broader selection of peripheral devices, including printing devices. Printing devices can no longer be located solely at a centrally located control center commonly found within IBM mainframe environments. Productivity and process efficiency demands of other departments now require printing devices to be located where labels are applied and related documents are required.

These changes may strain the capabilities of the network and may be constrained by the capabilities of the host system or network connectivity options available in the past. Fortunately, changes in printing technology, network connectivity, and communication protocol now allow greater flexibility in the way information is acquired and communicated throughout the enterprise. These developments can be used to improve the overall ERP productivity and process efficiencies by providing immediate access to printed materials at the locations where they are needed.

ERP-Driven Printing Requirements

a. Labeling Applications Demand Bar Code Printing

Today, business control is expected to cross the entire enterprise. ERP-solution providers supply the means for businesses to track and manage the movement of raw materials, work in process (WIP), and finished goods inventory from their suppliers to their end-user customers. To feed the ERP system, data must be collected for each transaction that occurs along the way. Equipment designed to read bar code and related machine-readable symbologies is the most common means of efficiently and accurately collecting this data. Printing bar codes onto labels and tags allows the item for which a transaction occurs to be identified. Bar code printing for data collection is now common in nearly all commerce and industry.

Bar code labeling for shipping, warehousing, and manufacturing applications is widespread. Common shipping applications include fulfilling compliance labeling requirements defined by an industry group (e.g., AIAG or EIA) or a large customer (e.g., GM or Wal-Mart) to standardize what information is provided in a shipping label and how it is formatted. Compliance labeling allows the recipient of a shipment to determine what has been received from whom, and can include other specific information such as purchase order numbers or lot numbers to assist in determining what to do with the contents. Bar coding also allows the paperwork that comes with the shipment to be recorded and processed more quickly and easily. Bills of lading, certificates of conformance, statements of origin, and other documentation can be properly tagged to items being shipped.

Automotive Aftermarket Distribution Center

WIP Labeling on Reuseable
Tote Container

Inventory Control Labeling in Warehouse

Figure 1. Examples of Product Identification and Inventory Labels

Shipping Labels Applied to Pallet and Contents

Compliance Labeling on Incoming Materials
at Receiving Dock

Figure 2. Examples of Shipping and Logistic Labeling

In the warehouse, bar coding is used to identify raw materials, parts, and products that arrive at the receiving dock. Once identified, the product can be moved to other inventory locations within the warehouse for future use. Each rack or cell location within the warehouse is identified by bar codes as well. Inventory that will be consumed in a manufacturing process can be found in the warehouse and moved to the manufacturing floor. Finished goods inventory or inventory in a distribution center warehouse can be located and taken to the shipping dock for shipment. A shipping label is printed and applied to the product before shipment.

In a discrete manufacturing process, parts or other raw material inventory are located and taken to the manufacturing floor. As parts are consumed and assemblies made into finished product, the WIP items may be subsequently identified with bar codes and other human-readable text. Bar codes usually identify the product, but also may identify serial numbers or lot codes. Once assembly is complete and the finished item is packaged, bar code labels with human-readable text identify the product and its serial number, and provide other pertinent information.

b. Process Requirements for Print-on-Demand Operation

In each of these processes, the bar code provides the ERP system with information about component and inventory movement, consumption, and current stock situation. Bar coding allows enterprise management to determine its purchasing needs, process efficiencies, and sales progress.

To have real benefit, the ERP system requires accurate and immediate real-time data collection and input. That immediacy impacts the enterprise printing operation by providing critical variable information to a printer (such as ship-to information or purchase order numbers) at the same time the label is printed. This information is commonly not available with enough lead time to have labels preprinted for use later. Immediate label application is required because the products or packages are usually in the process of being moved. In operations that obtain labels from a central printing location, process efficiencies are lost by collecting the printed labels and carrying them to the location where the packages are labeled. The chance for error is increased, resulting in rework after placing a label onto an incorrect box. Errors also increase when the printing operation and the label application operation are separated by time and physical space. As a result, and for the highest productivity, *the printing operation responsible for printing variable information must be placed at the same location as the product package that is identified*.

Today, a wide number of bar code symbologies are commonly used in industry and commerce. The most common are Code 3 of 9 and Code 128. In addition, the use of two-dimensional symbologies such as PDF417, MaxiCode, and DataMatrix have become common in document handling and archiving information such as that found in shipping manifests and bills of lading, as well as in manufacturing operations for part or component identification. The ability to print these symbologies accurately in the environment in which they are used is critical.

Compliance labeling is critical to identifying product for shipping. As discussed above, compliance labeling demands the precise placement of variable information as part of the text, bar codes, and other symbology into a specific labeling format that can be read by the recipient.

a. Centralized Printing Operation

Historically, IBM facilities had centralized printers situated in the same location as the mainframe. The printing operations used impact or line printing of forms and multi-layer documents and laser printing for print documents. For example, labels could be printed using either technology, but the impact printer is preferred if a great number of labels are to be printed. The type of printing operation performed was almost exclusively for document and forms printing. The information printed onto a predesigned template consisted of text (usually no more than one font style) and seldom contained any bar coding. Printed bar coding was limited to a small number of symbologies.

IBM Infoprint 62
Laser Printer

Photos Courtesy IBM®

Figure 3. Common IBM Laser and Line Matrix Printing Solutions

Centralized printing offers advantages. Specifically, from a process perspective, all print job requests come to the administrator, who feeds them to the host computer. Print jobs are queued and, depending on the existing printing commitments, are often printed overnight for future pick-up by the requestor. Printing centralization allows the efficient use of the printing equipment, and it is easy for the administrator to monitor and control the printing function.

The networking requirements are minimal, and having all printing requirements centralized near the mainframe computer simplifies the administration requirements: a small number of printers can handle all of the facility's printing requirements; the networking requirements are simplified; and only a small number of IT administrators are necessary to manage the system.

The output
of e-business.

e-business

Photos courtesy IBM®

Figure 4. Common IBM Printing Systems

b. Distributed Printing Operation

Today, centralized printing cannot support the many functional areas that demand printer support within an enterprise. Not only does the printing function of individual departments within a facility need to communicate and be networked to the Mainframe host, but the host is also expected to be networked to, and communicate with, other IBM hosts in remote facilities.

The operation becomes more complex. Instead of a single location, the network must manage many printers, each of which handles its own, specific label or printing application. Print job requests may come from anywhere within the enterprise, demand a short queue, and require immediate printing. The printing volume varies greatly by application but is typically smaller per printer. The number of predesigned formats has increased greatly. Text is provided in smooth, non-proportionally pitched fonts. A wide range of machine-readable symbologies, including two-dimensional symbologies that best meet the needs of the application, are supported. In contrast to the organization's emphasis on Efficient Printing Operation, distributed printing must support Application Process Efficiencies and the local printing system is dedicated to the productivity improvements for the local application.

The number of network administrators remains relatively small. However, the network administrator is still expected to monitor and control the printing function. Most systems are unable to provide administrator support and demand local monitoring and control. Selecting the proper printing technology, AFP and IPDS software utilities and tools, and the IBM business partners that can ensure proper connectivity become critical to successful network operation and management.
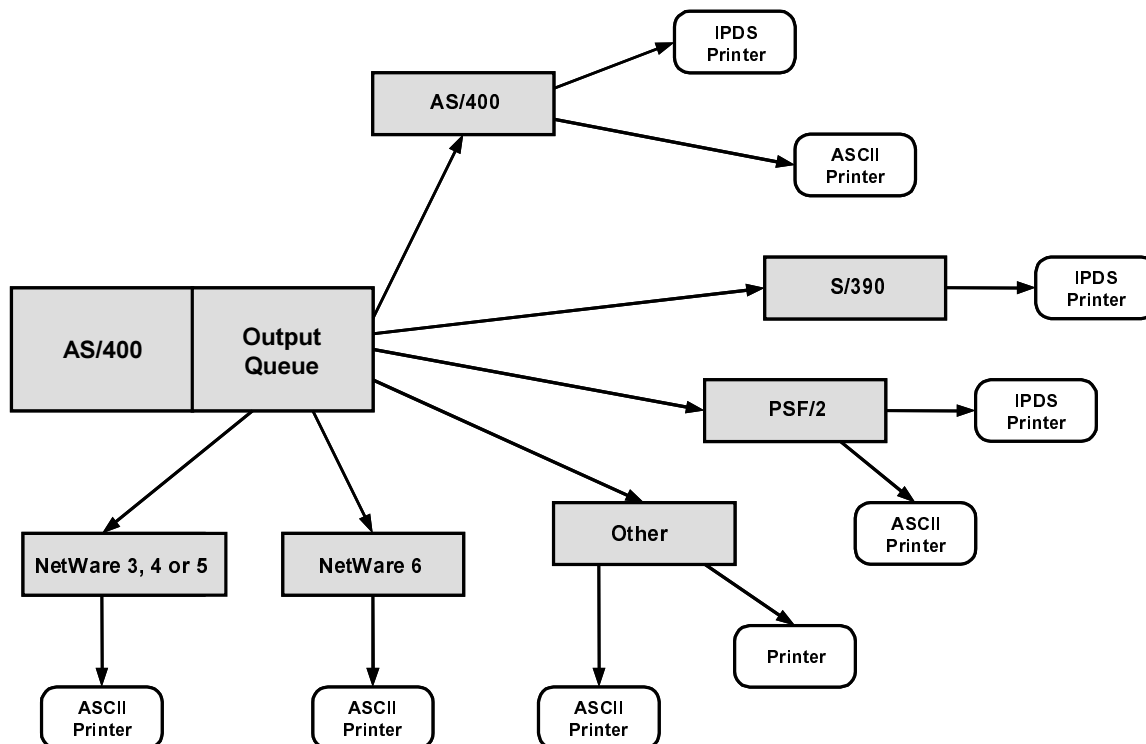
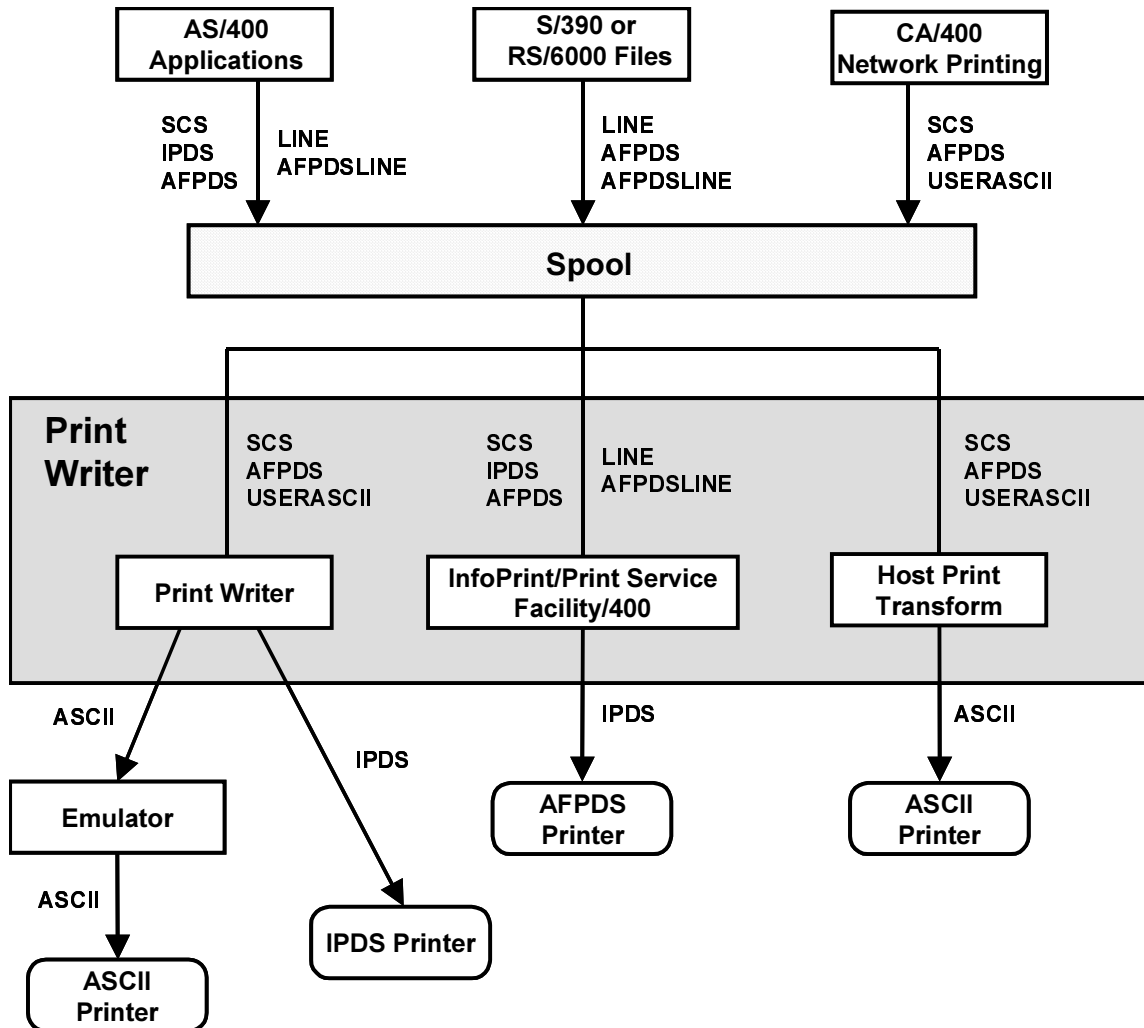**Figure 5.** **Typical AS/400 Remote and Distributed System Printing**

c. Printing in an AS/400 Environment

The AS/400 environment may generate spooled files stored in output queues from different origins and in different formats. Sources of spooled files include AS/400 applications, files created from host systems (IBM S/390), RISC Systems (IBM RS/6000), and PC output directed to an AS/400 output queue via Client Access/400.

The Printer Writer handles spooled files by using one of the following options: Print Writer, Print Services Facility/400 (PSF/400), or Host Print Transform. Each of these printer writer options supports different data streams and printer types. They also allow the conversion of certain data streams to work with Zebra printers. Zebra printers are basically ASCII printers that respond to a Zebra proprietary Printer Page Description Language (Zebra Programming Language, or ZPL). However, Zebra printers can also fully function as IPDS or AFPDS printers with the inclusion of third-party network interfacing devices that are available today.

Zebra printers use data streams generated by the Print Writer, Print Services Facility/400, and Host Print Transform, as shown in Figure 6. If the data stream output is in ASCII (ZPL), IPDS, or AFPDS, the Zebra printer responds by generating and printing a format. In the case of IPDS, the Zebra printer is fully able to support the IPDS command set, including the two-way dialog between PDF/400 and the Zebra printer.

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┌──────────────┐      ┌──────────────┐      ┌──────────────┐
│    AS/400    │      │   S/390 or   │      │    CA/400    │
│ Applications │      │ RS/6000 Files│      │Network Printing│
└──────────────┘      └──────────────┘      └──────────────┘
   SCS    LINE           LINE                 SCS
   IPDS   AFPDSLINE      AFPDS                 AFPDS
   AFPDS                 AFPDSLINE             USERASCII
```

Figure elements:

- **AS/400 Applications** → SCS IPDS AFPDS / LINE AFPDSLINE → **Spool**
- **S/390 or RS/6000 Files** → LINE AFPDS AFPDSLINE → **Spool**
- **CA/400 Network Printing** → SCS AFPDS USERASCII → **Spool**

Spool →

Print Writer
- SCS AFPDS USERASCII → **Print Writer**
- SCS IPDS AFPDS / LINE AFPDSLINE → **InfoPrint/Print Service Facility/400**
- SCS AFPDS USERASCII → **Host Print Transform**

Print Writer → ASCII → **Emulator** → ASCII → **ASCII Printer**

Print Writer → IPDS → **IPDS Printer**

InfoPrint/Print Service Facility/400 → IPDS → **AFPDS Printer**

Host Print Transform → ASCII → **ASCII Printer**

Figure 6. **Print Writer and Data Streams to Zebra Printers**

d. Selection of the Optimal Printing Technology

Three technologies are commonly found in IBM printing solutions: impact and line printers (e.g., the IBM 4232 and 6400 Industrial Printers), laser printers (e.g., the IBM Infoprint 3000 Production Printer and the Infoprint 32 Workstation Printer), and thermal printers. For printing bar codes and two-dimensional symbologies, none performs better than the thermal printer.

Low-resolution line printers are typically limited to tractor- or pin-fed, continuous, fanfold forms. Laser printers are designed for printing paper documents. By contrast, thermal transfer printers are designed to be simple to maintain and operate, can accommodate a wide assortment of label and tag materials of various sizes and shapes, and print at high resolutions and at speeds comparable to a 65-page-per-minute laser printer. Better yet, the one quality that truly separates the thermal printer from the other technologies is its ability to print a crisp, clean bar code with the high contrast and line definition that are so critical to ensuring a first-time readable bar code.

An easy-to-read bar code is critical in many applications. For example, a failure to scan may actually result in penalties or charge-backs, as is the case in compliance labeling for the auto and retail industries. When bar codes are not easy to scan, new internal processes must be added (e.g., establishment of inspection stations or planned rework stations) that cause undue complexity and incremental process costs.

Figure 7 demonstrates the scalloped shape of the dot matrix print pattern and the voids found in bars printed with laser technology. These defects degrade the readability of the bar code or symbology. In contrast, the thermal transfer printer is designed to print bar codes' straight edges and continuous black bars. The ability to print dark, crisp images does not diminish over the life of the thermal printer supplies, unlike worn impact printer ribbons or depleted laser printer toner cartridges.

| Dot-Matrix/Impact Image | Laser Image | Thermal Transfer Image |
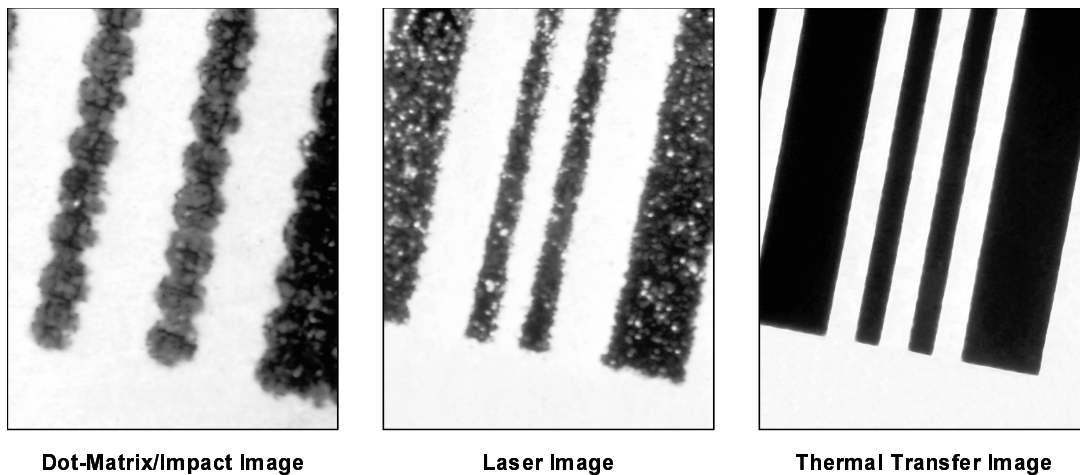
Figure 7. Bar Code Print Quality for Three Commonly Available Printing Technologies

Thermal printers are designed to print nearly any font, graphic, or format. Zebra printers support the printing of special fonts and symbologies that are generally not supported by IPDS or AFP printing solutions.

e. Zebra Printers in a Distributed Printer Network

Zebra printers are versatile in terms of their placement within an AS/400 network. Likewise, the ability to provide data to the printer or initiate printer commands is not limited to location or to an input device. For example, one common distributed printing application is the label printing function on a remote shipping dock. The dock may be in the same facility as the AS/400 server, but it can just as easily be located in a different facility, or even a different country.

Figure 8 shows that the printing command can be initiated in a number of locations or situations, including:

- A remotely located PC or workstation;
- A remotely located AS/400 server or the AS/400 server itself;
- A programmable workstation located at the shipping dock; or
- A 3270-emulation terminal at the shipping dock.
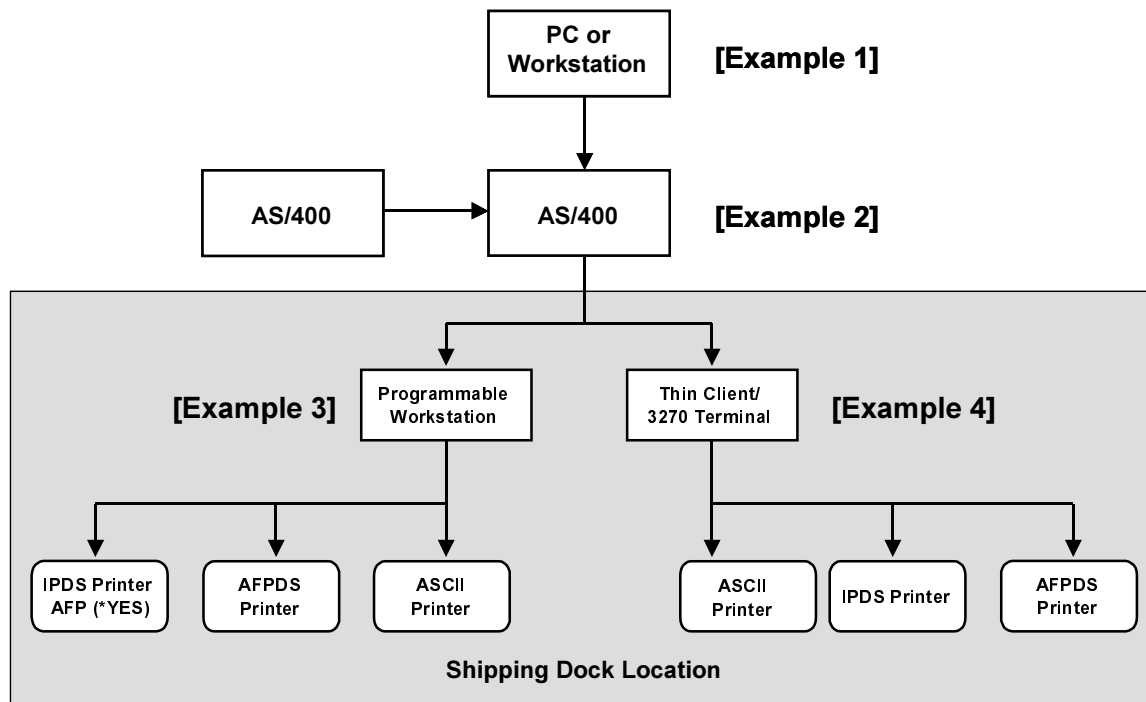
Figure 8. Information Flow Alternatives for Initiating a Remote Shipping Label Application

Example [1]: A remotely located PC or workstation
A separate department or facility can initiate label printing by having the printing application software send a print command via the AS/400 server to the printer. Variable data can reside in the remote workstation, the AS/400 server, or other ODBC storage locations. The information sent to the AS/400 server is in ASCII format, but from the AS/400 server it can remain in ASCII format or be changed to an IPDS/AFPDS and communicated directly to the printer, or communicated to the Zebra printer via a terminal at the shipping dock.

Example [2]: A remotely located AS/400 server or the AS/400 server itself
A print job can be initiated by a remotely located AS/400 server or by programming that resides in the AS/400 server. Variable data incorporated into the print application can be located in the AS/400 server or at other ODBC storage locations. In each case, the print command can be sent from the AS/400 server and communicated directly to the printer, or communicated to the Zebra printer via a terminal at the shipping dock.

Example [3]: A programmable workstation located at the shipping dock
Printing application software can reside on a workstation at the shipping dock. The workstation itself can initiate the printing operation with the printer.

Example [4]: A 3270-emulating terminal at the shipping dock
The printing application software can reside on the AS/400 server or workstation. The 3270 terminal is located at the shipping dock and is used as an input/output device to provide additional variable information or confirm that the printing process is being completed.

In each of these examples, the Zebra printer can be configured to accept IPDS, AFPDS, or ASCII data to perform the printing operation.

Figure 9 shows a number of methods for incorporating Zebra printers into the AS/400 network. Zebra printers can be used in a number of wired Ethernet environments using ZebraNet PrintServers or available third-party interfaces. Additionally, Zebra printers operate in IEEE 802.11 wireless Ethernet networks using Zebra's wireless card slot. Zebra supports client servers by using available third-party interfaces that allow ASCII or IPDS communication to the printer. Zebra also supports token ring networks that use twinax or coax interfaces, as well as terminals or interfaces using serial or parallel communication.
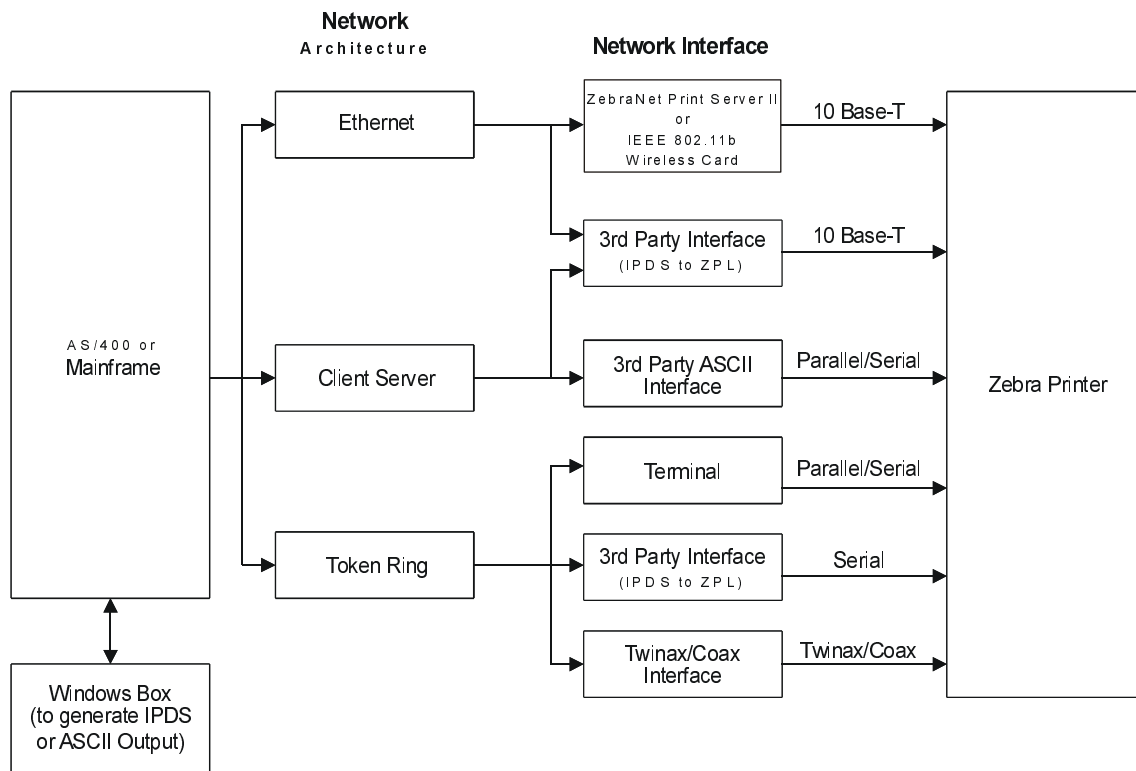
Figure 9. AS/400 to Zebra Printer Network Connectivity Solutions

Figure 10 shows the types of application data output that Zebra printers can support. They include:

(a) AFP and IPDS output communicated to the Zebra printers via a third-party IPDS to ZPL interface;

(b) legacy ZPL or Zebra BAR-ONE output directed to the Zebra printer without interface requirements; and

(c) ASCII data output used in a number of Windows® printer drivers, label printing application software programs, and other specialized software programs.

Application Output　　　　　**ZPL Conversion Method**
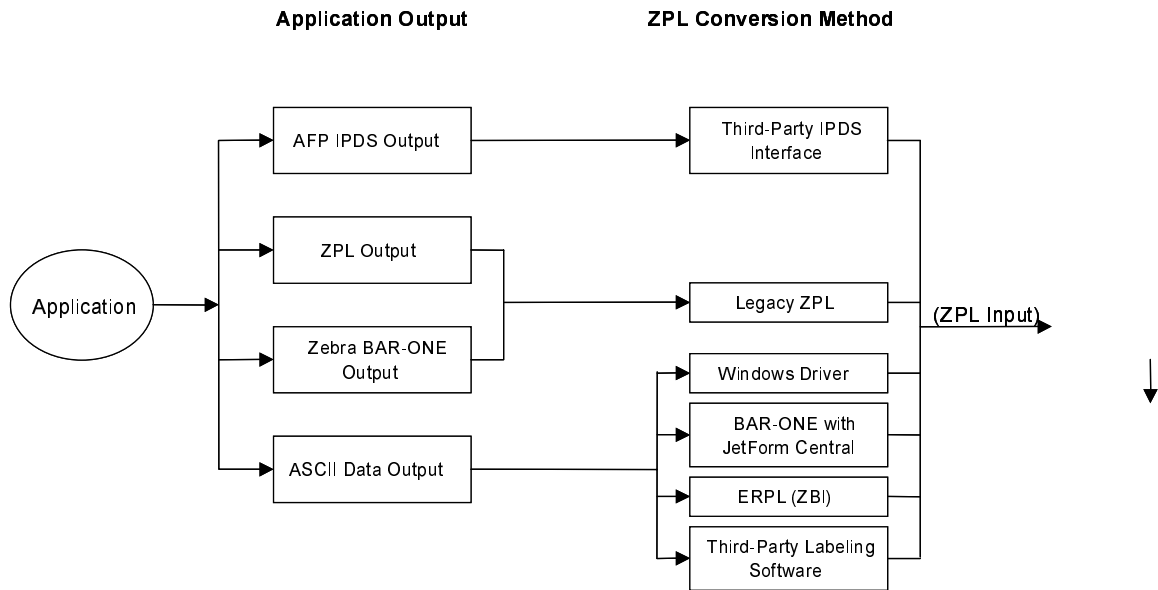
Figure 10. Managing Application Data Output for Zebra Printers

In all cases, the objective is to convert the incoming data stream or operational print command into a ZPL format that the Zebra printer can use. Third-party interfaces are available for IPDS and AFPDS communication, and a large number of application software providers (including Zebra) have developed and readily market label preparation software and other specialty software programming.
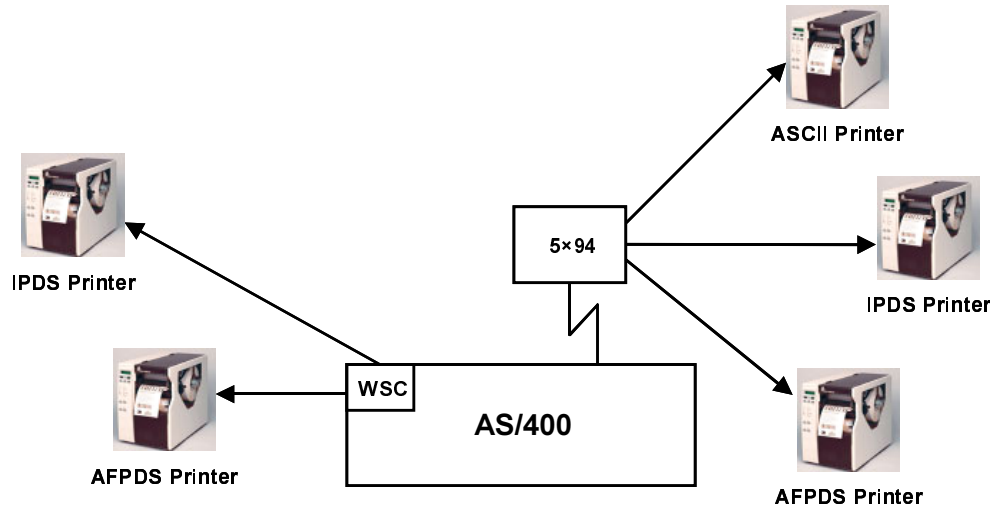
Z e b r a   P r i n t e r s   i n   A S / 4 0 0
N e t w o r k   C o n f i g u r a t i o n s

Zebra printers support any AS/400 network configuration in which an IPDS, AFPDS, or ASCII printer can be attached to the AS/400 system, as shown in Figure 11.
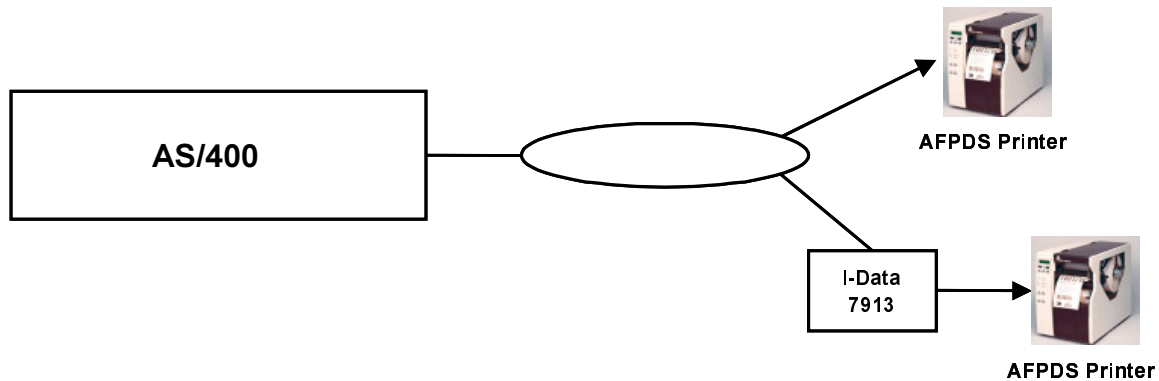
Zebra printers can be attached directly to AS/400 workstation controllers by twinax cable. The same printers can also be attached to a Remote Control Unit IBM 5×94.

Zebra IPDS printers can be attached to the network via TCP/IP token ring or Ethernet, as shown in Figure 12. The two-way communication between the AS/400 system and the printer with the Zebra IPDS printer enables the same general level of print functionality, print management, and error recovery for LAN/WAN-attached IPDS printers as that in twinax-attached printers.

Zebra ASCII printers can also be attached to the network using token ring or Ethernet connections. See Figure 13 for the attachment means for these configurations.

Figure 11. Zebra Printers Attached to Workstation Controller or IBM 5×94
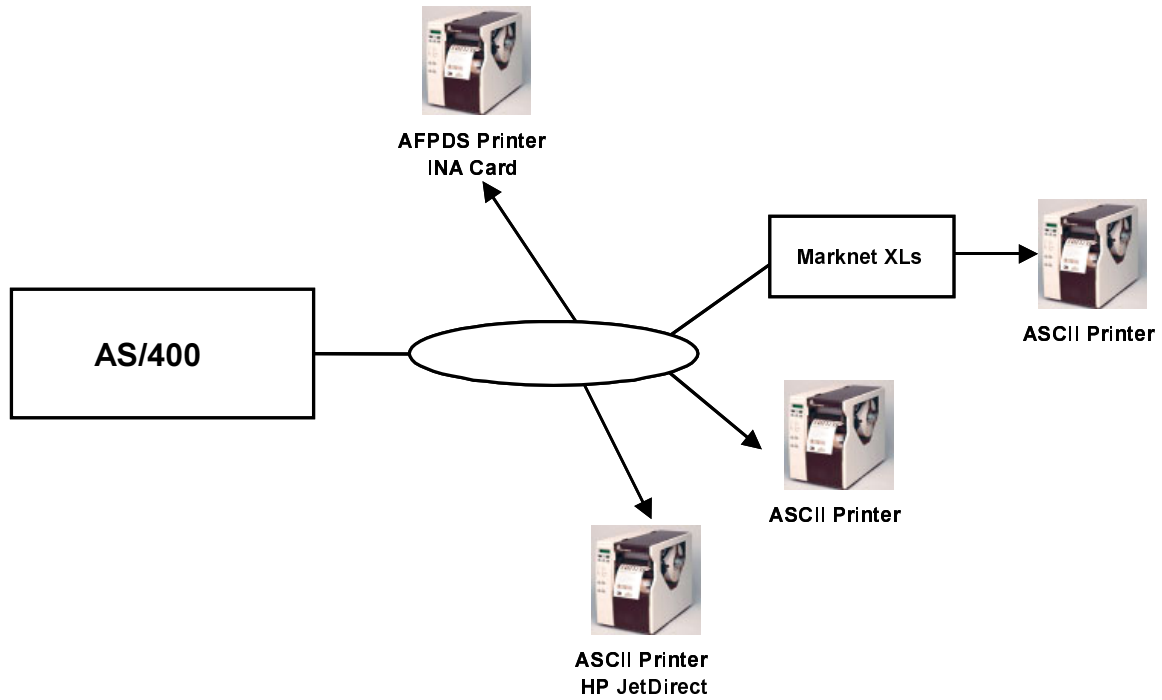

Figure 12. Zebra Printers LAN-Attached as IPDS Printers

Figure 14 shows how Zebra ASCII printers can be locally attached to an AS/400 system through IBM Info Window displays 3477, 3486, 3487, 3488, and 3489. The Zebra ASCII printer also can be attached remotely using an IBM 5×94 remote control unit through twinax cable.

All Zebra ASCII printers can be connected to PCs using standard parallel and serial ports. PC5250 sessions are used to print AS/400 spooled files on the PC. Alternatively, the AS/400's Network Printing function allows PC users to identify the attached Zebra printer as their network printer (see Figure 15).

Refer to Figure 16. Print Services Direct is provided by Print Services Facility/2 (PSF/2) and Print Services Facility/6000 (PSF/6000). When PSF Direct is attached to printers, the AS/400 maintains printer control and all available IPDS messages are directed to the AS/400.

The PSF Distributed Print Function (DPF) is provided by Print Services Facility/2 (PSF/2). See Figure 17. With PSF/2 attached printers, the PSF/2 controls the printers and the AS/400 system is not notified of any printer messages.

Figure 13. Zebra Printers LAN-Attached as ASCII Printers
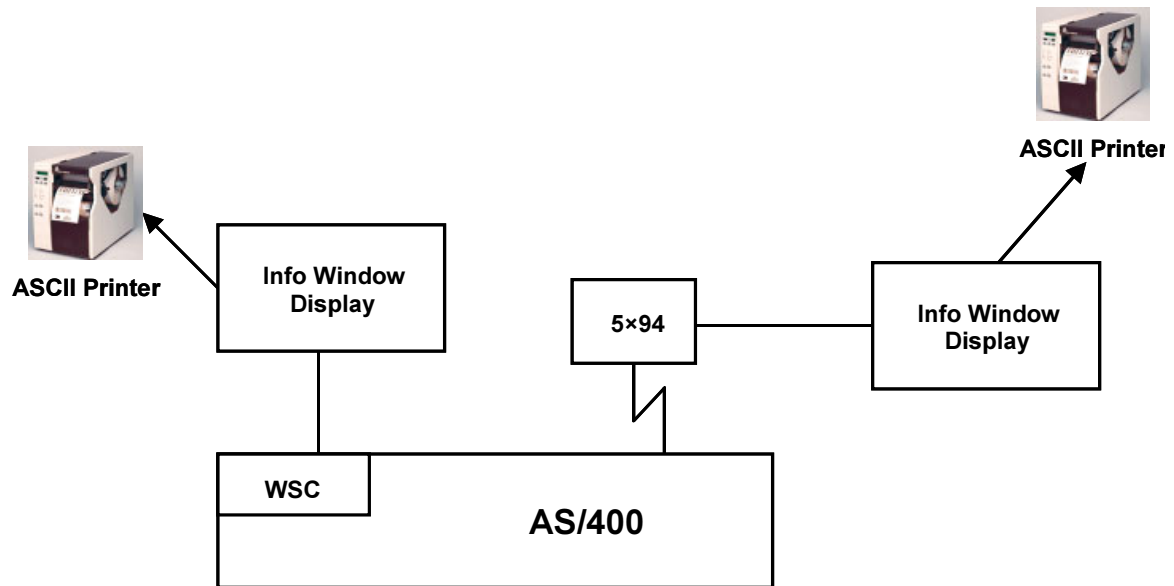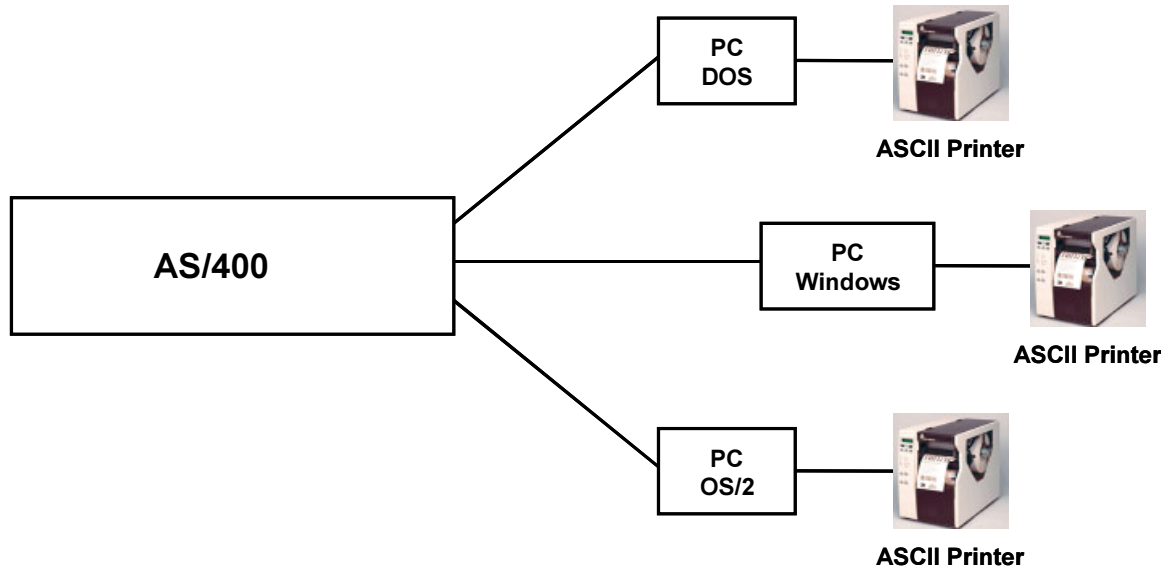

Figure 14. Zebra Printers Attached to Displays

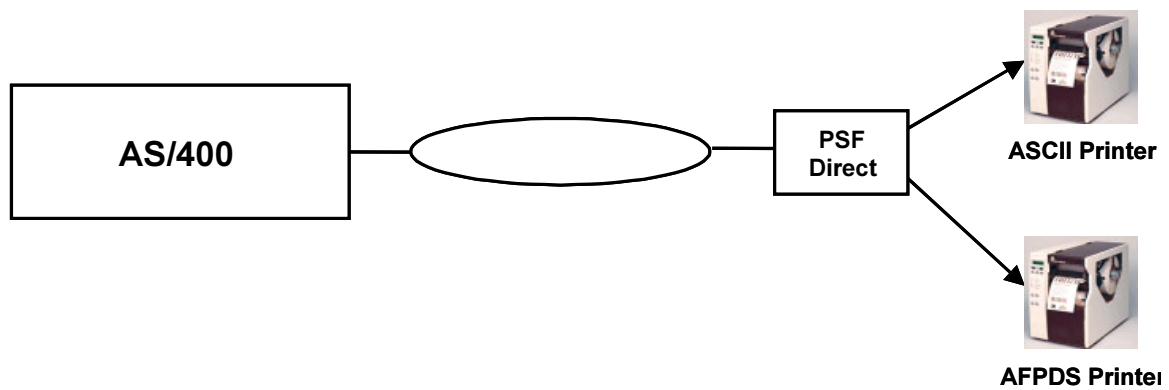**Figure 15. Zebra Printers Attached to Personal Computers**

Figure 16. Zebra Printers Attached to Print Services Facility Direct
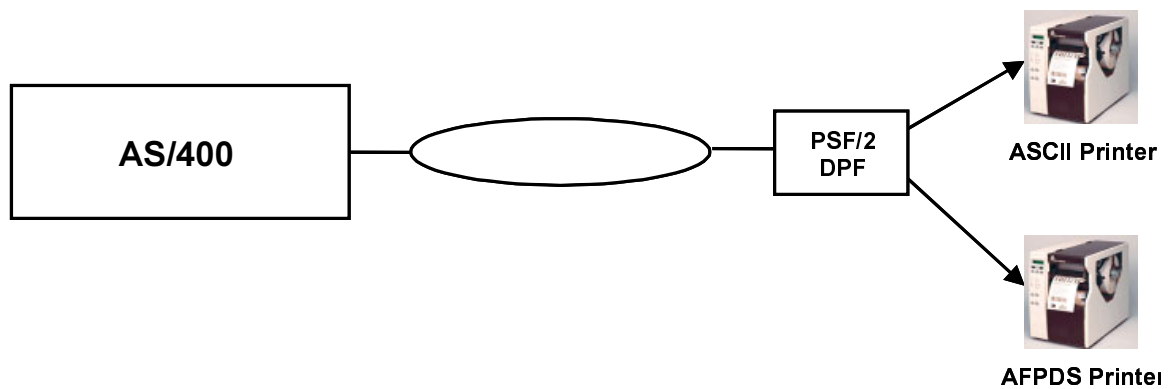

Figure 17. Zebra Printers Attached to PSF/2 Distribution Print Function

For Ethernet-attached printers that are directly networked to the AS/400, a number of printing options are possible. Zebra printers incorporate added control and management features in the printer. These are enabled by using Zebra's ZebraNet PrintServer II Ethernet interface or Zebra Partner Solution. The features available through ZebraLink™ include simple printer configuration and network management tools and unique "problem alert" messaging capabilities. Additionally, a broad connection protocol selection is available, including AFP/IPDS, FTP, HTTP, POP 3, and others. With the ZebraNet PrintServer, you are not limited to using standard LPR printing. Zebra printers support seven network printing options: FTP, HTTP, IPP, LPR, Socket, POP 3, and IPDS.

	Zebra (via ZebraNet PrintServer II)	Zebra (via Zebra Partner Solution)	HP
For Network Management:			
HP Configuration	X		X
(HP Admin, HP Jet Admin)			
IPDS		X	
WebView	X		
Alert	X		
SNMP/E-mail	X		
For Connection Protocol:			
FTP	X		X
HTTP	X		
IPP	X		
LPR	X	X	X
Socket	X		X
POP 3	X		
IPDS	X	X	

Figure 18. Ethernet Network Printing Options

With the exception of IPP, which is Internet-related, and IPDS, which is specific to IBM network communication, these options are network-independent delivery mechanisms.

1. FTP—ZPL files can be sent to the printer via an FTP client as a standard ASCII file.

2. HTTP—Using the script option of the print server's homepage, type ZPL into a specified location on the Web browser and send it to the printer.

3. IPP—Using third-party IPP clients, send print jobs via the Internet.

4. LRP/LPD—Sometimes referred to as queue-based printing, LPR/LPD is the standard in network printing.

5. Raw-socket connection—Connect directly to the printer via the network, bypassing everything in between. This option integrates ZPL into existing programs, such as VB and other scripts.

6. POP 3—With proper configuration, users can send ZPL files to a predefined e-mail address. The printserver checks this e-mail box at user-specified intervals and prints the contents.

7. IPDS—Using third-party IPDS to ZPL interfaces, send print jobs to the Zebra printer.

Zebra is the Best-of-Class Thermal Transfer Printer Partner

a. Broadest Product Line; Largest Installed Base

Zebra Technologies offers the broadest thermal printer product line available and is recognized and preferred by more than 90% of Fortune 500 companies. In business for over three decades, Zebra is ISO 9001-certified and has an installed base in excess of two million units.

Zebra offers over three dozen printer models. Zebra portable printers are designed to operate throughout a standard 8-hour shift without recharging. Zebra heavy-duty, high-speed shipping label printers are designed to print continuously for 24 hours a day, seven days a week operation at the fastest print speeds available in the industry (up to 12″ [300 mm] per second, or the equivalent of 55 pages per minute for the 8-1/2″ [210 mm] wide model). Printers are available with print widths from 2″ (50 mm) to 8-1/2″, print resolutions from 150 dpi to 600 dpi, and with the widest selection of options, network interfaces, accessories, supplies, and software. Zebra printers offer coax/twinax, 10 Base-T Ethernet, IEEE 802.11 wireless Ethernet, serial, or parallel interfaces and operate in networks communicating in IPDS or AFP protocols. Zebra printers are designed for tough industrial environments or as a desktop printing application in online business applications. Zebra offers tested supplies, software, options, and support. Detailed descriptions of Zebra products can be found at www.zebra.com.

b. Consistent Printer Page Description Language

From the beginning, Zebra has maintained the philosophy that its Printer Page Description Language, ZPL, would stay consistent across the entire product line and remain backward-compatible. This belief ensures that application software packages and legacy software developed in the past can communicate with today's Zebra printers. Aside from Zebra's reputation for printer reliability, this is the key reason that Zebra printers are selected over other thermal transfer printers.

c. IBM and Zebra Support

Zebra offers IBM customers a one-year standard warranty on Zebra printer products.

Service support tools are available 24 hours per day for self-diagnostics and problem solving from our Internet site. Worldwide telephone support is available during the workday from 3:00 am (through support locations in the UK) to 5:30 pm CST (09.00 to 23.30 GMT). Field service is available from our business partners (including **IBM Certified Service Worldwide**), and Zebra Depot Repair services provide a convenient way to repair and refurbish printers, bringing them to the latest revision levels and extending their warranty.