INTRODUCTION

With the exploding market of new hardware and software products, the personal computer is quickly becoming a versatile work station for the SAS/GRAPH® software user. Its use as a host graphics terminal has become a popular choice for the PC user who needs access to large mainframe data bases and production jobs. Because there are so many choices in hardware and software, configuring the PC as a host graphics device can be a complicated issue. Several factors, such as host communications software, communications boards, display adapters, and emulation software must be considered. This paper will analyze these factors and provide information on the different ways to use the PC as a host graphics terminal.

THE PROCESS

There are three very basic steps in generating host graphics. Software, running on the host, must generate graphics commands in the language that the target device can understand. The commands must then be sent to the device, and the device must be able to interpret those commands and create a graph.

For this process to work, the IBM PC must be attached to the host computer. Many standard personal computers do not come with the equipment needed to provide a host connection. The transformation of the PC into a terminal requires the following items:

- hardware in the PC that establishes the physical connection between the host and the PC
- software in the PC that can handle communications to and from the host
- a graphics display adapter in the PC
- hardware or software that can take graphics commands from the host and convert them into a format that the graphics adapter can use to generate a display on the monitor

There are many different combinations of hardware and software that can be used to fulfill the above requirements. The products that you use and how they will fill these needs are dependent on how the PC will communicate with the host. Host systems provide two choices for host communications: asynchronous or synchronous (SDLC or Bisync, referred to as '3270'). Synchronous communications are normally used with an IBM mainframe, while asynchronous communications can be used with an IBM
mainframe or a minicomputer. Both types of communication dictate the rules that are followed for data transfer between the host and any peripheral devices.

ASYNCHRONOUS COMMUNICATION

Asynchronous communication sends data character by character and does not base its signals on any timing from the host. The host and peripheral device can send information at the same time (much like a telephone line). Asynchronous communication has the following characteristics:

- RS-232 cable is used for the physical connection
- data are transmitted using ASCII representation
- data are often transmitted at a low baud rate

This type of communication is used when the PC is connected to a minicomputer or to an IBM host through an asynchronous line. In many cases, a protocol converter is required for the asynchronous terminal to communicate with the IBM host with full screen capabilities.

SYNCHRONOUS COMMUNICATION

Synchronous (or 3270) communications protocol used on IBM hosts controls the transfer of data by host timing signals. Data are transmitted in blocks and are sent in one direction at a time. Synchronous communication has the following characteristics:

- coax cable is used for the physical connection
- data are transmitted using EBCDIC representation
- data are transmitted at a high baud rate

This type of communication is used when the PC is connected directly to a 3174 or 3274 control unit and does not require any additional mainframe hardware (such as a protocol converter).

USING THE PC AS AN ASYNCHRONOUS TERMINAL

To use the PC as an asynchronous terminal, the following are needed:

- a serial (asynchronous communications) port on the PC
- a modem or line into a communications port of the host computer

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In order to attach the PC to a host computer on an asynchronous line, the PC must be equipped with a serial communications port or an internal modem. The communications port is usually the standard 9- or 25-pin RS-232 connector and the RS-232 cables are plugged into them directly.

Normally, a RS-232 cable runs from the PC's serial port into a modem, protocol converter, or directly to the communications controller. In any case, all the communication between the PC and host or the between the PC and the protocol converter follow the asynchronous communications protocol.

Terminal emulation software performs two functions. It must be able to transmit data from the PC to the host and then accept data from the host and display it on the monitor. Many terminal emulators perform these functions for text but cannot be used to display host graphics. In addition to sending and receiving data, graphics terminal emulators can take the commands sent by the host and translate them into a format that can be displayed by the graphics adapter.

In order to display SAS/GRAPH output, graphics emulation software must emulate a terminal that supports graphics and SAS/GRAPH must provide a driver for it. For example, if the terminal emulator provides DEC VT240 emulation, DEV=VT240 may be used in a GOPTIONS or OPTIONS statement. If the graphics terminal emulator you plan to use is not documented in the list of supported graphics terminals, contact the Technical Support Department at SAS Institute to see if a device driver is available. SAS/RTERM® software is a terminal emulator, supplied by SAS Institute, that supplies TEK4105 emulation.

The display adapter board provides a port for the connection between the monitor to the PC and must be able to receive commands from the terminal emulation software and generate a graphics image. The three most common boards are the IBM Color/Graphics adapter (CGA), the IBM Enhanced Graphics Adapter (EGA), and the Hercules® Graphics Card (HGC).

The differences between these boards include the number of available colors, the resolution, and the amount of display memory available on the board. These differences become very important when purchasing a terminal emulator. The graphics display adapter installed in the PC will normally limit the resolution or the number of colors that can be used with the terminal emulation software. For example, a CGA display adapter can display 3 colors at a maximum resolution of 320 x 200 regardless of what colors or resolution the terminal emulator is
capable of using. So, even though a Tektronix 4105 graphics terminal can display eight foreground colors at a resolution of 480 x 360, software using a CGA board to emulate the same terminal can only produce three foreground colors at a time at a resolution of 320 x 200.

SAS/GRAPH device drivers for asynchronous terminals will try to use the hardware capabilities of a device. Many terminal emulators do not perform hardware functions, such as polygon fill. In these cases, it may be necessary to prevent the driver from using the hardware capabilities. The following values can be used in the GOPTIONS statement to disable the use of the hardware features:

- NOSYMBOL disables hardware symbol-drawing capability
- NODASH disables hardware dashed-line capability
- NOCHARACTERS disables hardware character sets
- NOFILL disables hardware rectangle-fill capability
- NOPOLYGONFILL disables hardware polygon-fill capability
- NOPIEFILL disables hardware pie-fill capability
- NOCIRCLEARC disables hardware circle-draw capability

USING THE PC AS A 3270 TERMINAL

To use the PC as a 3270 terminal, the following is needed:

- a coax port in the PC
- a line into a 3174/3274 control unit
- communications hardware/software in the PC
- hardware/software capable of converting graphics commands into a format for the graphics display adapter
- a graphics display adapter

The 3270 boards that provide the PC with the coax port are unique in that they can usually perform several of the required functions listed above. While a serial port provides only the physical connection, the 3270 boards and their software provide the physical connection as well as the ability to handle communications to and from the host, and can display text on the PC monitor. However, many 3270 boards, like IRMA™, PCOX™, or Forte Pj™ cannot handle host graphics.

In order to display host graphics with a 3270 emulator board, software and hardware that can handle 3270 graphics streams are required. Several vendors market products that combine hardware and software that can handle host graphics, such as IRMAX APA™, IRMAX PS™, PCOX APA™ and ATTACHMATE 3-N-1™.
The software is normally a part of the board's control program and like the asynchronous emulation software, it must interpret commands sent by the host and convert them into a format that the display adapter can use to create a picture on the monitor.

3270 graphics boards and their software provide two types of graphics: programmed symbols (PS) or all-points-addressable (APA). The device driver that is used with SAS/GRAPH is dependent on which type of graphics the board supplies.

Programmed symbol graphics means that the picture is assembled on the host and is then broken down into cells or programmed symbols. Once the symbols have reached the terminal, they are reassembled and displayed all at one time. If the 3270 board provides this type of graphics, the GDDM79 device driver should be used. If GDDM is not available on the host, contact the Technical Support Department at SAS Institute for details on how to use the IBM3279 native driver.

When all-points-addressable graphics are being used, a vector file is sent from the host and is rasterized by the hardware/software on the device. With this type of graphics, the GDDMPCG driver should be used. If GDDM is not available on the host, contact the Technical Support Department at SAS Institute for details on how to use the IBM3179 native driver.

If the 3270 board installed in the PC does not provide graphics capability, there are some software packages that can provide an alternative. The next version of SAS/RTERM will not require that the 3270 board provide graphics capability and will be able to produce graphs on boards like IRMA", IBM PC3278/79", and PCOX". GDDM/PCLK® and ATTACHMATE EXTRA CONNECTIVITY SOFTWARE" are software packages that will also help to produce graphics on a PC that has a non-graphics 3270 board.

The display adapter requirements for 3270 graphics remain the same as those for asynchronous emulation. However, it is recommended that the EGA board be used since the resolution and color available with the CGA board is very poor.

**THE IBM 3270 PC**

The IBM 3270 PC is unique in how it can be used as a host graphics terminal. If asynchronous communication is used, the IBM APA board replaces the need for a graphics display adapter. The other requirements, such as the serial port and terminal emulation software, remain the same. If the IBM 3270 PC is attached to the host on a coax line, a programmed symbols adapter must be used. In this case, the GDDM79 or IBM3270 device driver may be used with SAS/GRAPH.
CONCLUSION

To use an IBM PC as a host graphics device, several factors must be considered. The first and most important decision is how the PC and mainframe will communicate. The hardware and software required by the PC will be dependent on the choice between synchronous and asynchronous protocol. Once a method host communication has been established, the following options are available:

- **Use the PC as an asynchronous terminal**
  
  This requires a serial port, graphics terminal emulation software, and a graphics display adapter. The SAS/GRAPH device driver that is used is determined by the graphics terminal the software is emulating.

- **Use the PC as a 3270 terminal**
  
  This requires a 3270 board that can provide a coax connection and a combination of hardware and software that can provide host graphics support. The SAS/GRAPH device driver that is used is determined by the type of graphics the hardware and software provide.

For further details on how an IBM may be utilized as a host graphics device, see the Chapter 7, "Using Your PC as a Host Graphics Terminal" in **SAS/GRAPH Hardware Interfaces for Personal Computers**.

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