Using SAS/GRAPH® Software on IBM Mainframes with Coax-attached PCs

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Introduction

With the introduction of the IBM-PC, many companies have purchased personal computers in large quantities to increase productivity. The need arose for PCs to communicate with the company mainframe to access corporate data. The need also arose to access mainframe graphics such as SAS/GRAPH. Using PCs as mainframe graphics terminals eliminates the need for separate stand-alone terminals, resulting in a significant cost savings for corporations.

The Micro-to-Mainframe Connection

The preferred method for connecting PCs to IBM mainframes by most large corporations is to use a 3278 or 3279 emulator board. Coaxial cable is used to connect the PC to an IBM 3174, 3274, or 3276 cluster controller. The controller can either be channel attached directly to the IBM mainframe or remotely attached through an IBM 3705 or 3725 communications controller. This type of connection uses synchronous (SDLC/SNA) or bisynchronous (BSC) communications.

The personal computer may be connected to either a CUT or DFT controller port using coaxial cable. CUT (Control Unit Terminal) ports are the most widely used type of controller port. DFT (Distributed Function Terminal) ports are the newer and more sophisticated controller ports that allow multiple host sessions and must be used for certain types of graphics terminal emulators.

PCs may also be connected to IBM mainframes using RS-232 asynchronous communications. This can be accomplished by using modems, a direct RS-232 connection, and/or protocol converters. Using asynchronous communications can involve additional mainframe software products to be installed and modifications to the IBM 3705 or 3725 communication ports.

3278/79 Emulator Boards

The 3278/79 emulator board is a piece of hardware, either a full or half size PC adapter board, that fits inside a PC. A BNC connector on the adapter board is used to connect coaxial cable to the PC. 3278 emulation generally refers to monochrome and 3279 refers to color using the extended attributes of the 3270 data stream.

The emulator boards are equipped with software to perform the actual terminal emulation. File transfer software and other utility software may be furnished with the emulator board.

Digital Communications Associates (DCA, of Alpharetta, GA) introduced the first 3278 emulator board called IRMA. Forte Communications (recently purchased by DCA) was the first company to introduce a 3279 emulator board capable of providing graphics. Other companies that manufacture and sell 3278/79 emulator boards include IBM, CXI (Palo Alto, CA), Micro Plus (Boca Raton, FL), Attachmate (Bellevue, WA), and several others.

Types of 3270 Graphics

Graphics terminal emulation for personal computers using IBM 3270 coax communications are either based on programmed symbols (PS) or all points addressable (APA) graphics protocols.

Programmed symbols is by far the most inefficient graphics protocol. The entire graphics image is generated by the mainframe computer. Each individual pixel and color value is computed on the host. Then the graphics image is subdivided into character cells. The pixel image information along with the character cell data is then transmitted through the 3270 communications network to the terminal or PC where the picture is reconstructed.

An excessive of host CPU time and resources are used to generate programmed symbols. The CPU costs involved to generate a graph can be several times higher when compared to using APA graphics.

APA graphics is a welcomed improvement over the programmed symbols. Instead of using pixel data and character cells, graphics commands are used to describe a picture. Graphics commands are more efficient than programmed
symbols, because graphics processing is performed on the PC, instead of the mainframe.

**Programmed Symbols (PS)**  
- Mainframe performs graphics processing.  
- Pixel image and character cell data.

**All Points Addressable (APA)**  
- PC performs graphics processing.  
- Graphics commands.

**Programmed Symbols**  
The IBM 3279 S3G graphics terminal is based on programmed symbols. Any PC graphics emulation products that emulate this terminal are also based on programmed symbols. Because of the large amount of host CPU processing time and costs involved, high demands on the 3270 communications network, and negative effect on the overall system response time, many corporations are moving away from emulation products based on programmed symbols.

DCA offers two products based on programmed symbols: IRMA 3279 graphics and IRMAX PS. The IRMA 3279 graphics product is basically the same as the older Forte Graph for IRMA. This is a hardware implementation and consists of a full size adapter board that is "piggy backed" onto the side of a full size IRMA board. The IRMAX PS is a firmware/software implementation which requires the ROM chips on an existing IRMA board to be replaced. CXI offers a single full size board called PCIX/GRAPHICS to emulate 3279 S3G programmed symbols. Attachmate offers a software solution to programmed symbols, which is similar in approach to the IRMAX PS product.

**GDDM APA Graphics**  
The IBM 3179/G terminal is based on GDDM APA graphics. Also the IBM 3270-PC/G and 3270-PC/GX personal computers are based on APA graphics. Emulation products based on GDDM APA graphics must be connected to DFT controller ports. If a PC is connected to a CUT controller port, the controller must be reconfigured. This may involve a microcode modification, hardware upgrade, or replacement of the controller entirely.

DCA IRMAX APA graphics, previously known as Forte 3179/G APA graphics, provides emulation of the IBM 3179/G terminal. The IRMAX APA graphics solution is a combination firmware/software solution. This means that ROM (Read Only Memory) chips must be replaced on the IRMA board. Any upgrades to the IRMAX APA graphics product to account for changes in GDDM or new cluster controllers could involve changing ROM chips again. CXI has announced two products called APA/One and APA/Multi which provide 3179/G emulation as well.

**Tektronix CX APA Graphics**  
Another solution for APA graphics using IBM 3270 coax communications is to emulate the Tektronix CX line of terminals. Tektronix (Beaverton, OR) developed an entire line of graphics terminals that provide IBM 3279 emulation and Tektronix graphics. These terminals include the CX4106, CX4107, CX4109, and CX4111. Tektronix CX APA graphics, unlike GDDM APA graphics, operate with both CUT and DFT controller ports, and provide graphics pass-through capability. Graphics commands are used to describe pictures in a similar fashion to the IBM 3179/G terminals. However, the Tektronix 4100 series graphics protocol is generally recognized as the more efficient graphics protocol.

Teknigraphics (Houston, TX) introduced the first Tektronix graphics emulation software for coax-attached PCs connected to IBM mainframes. Teknigraphics offers two products based on Tektronix APA graphics: GRAPH-TEK 4010 provides monochrome graphics, and GRAPH-TEK 4105 provides Tektronix color graphics. Using the Tektronix CX graphics protocol, direct Hewlett-Packard plotter support is provided. SAS/GRAPH can transmit HPGL graphics directly from the IBM host to a plotter attached to the serial port of a coax-attached PC.
3270 Graphics Product Overview

Digital Communications Associates

IRMA 3279 PS
IRMAX PS PS
IRMAX APA APA

CALL
PCOX/Graphics PS
APA/One APA
APA/Multi APA

Attachmate
3270 Host Graphics PS

Teknigraphics
GRAPH-TEK 4105 APA
GRAPH-TEK 4010 APA

Using SAS/GRAPH
SAS/GRAPH users currently have the option of four types of graphics terminal emulators for use with coax-attached PCs. These are:

IBM 3279 S3G
IBM 3179/G
Tektronix 4010
Tektronix 4015

When using SAS/GRAPH, the appropriate GOPTIONS command must be used to specify the terminal type accordingly. For the above four terminal types, the following GOPTIONS statements should be used respectively:

GOPTIONS DEVICE=IBM3279;

GOPTIONS DEVICE=IBM3179;

GOPTIONS DEVICE=TEK4010
GSASPROTOCOL=GSASTKCX;

GOPTIONS DEVICE=TEK4105
GSASPROTOCOL=GSASTKCX;

PC Graphics Display and Hardcopy

One of the major considerations when using a PC as a replacement for a mainframe graphics terminal is the resolution of the graphics adapter board being used. The IBM CGA (Color Graphics Adapter) is generally not acceptable. This adapter board was the first graphics board introduced for the PC. The most common CGA resolutions used are 640x200 black & white, and 320x200 with four colors. The IBM EGA (Enhanced Graphics Adapter) provides a 640x350 resolution, 16 colors, and a 64 color palette. This provides adequate resolution for emulating 3179/G and Tektronix 4105 terminals. The Hercules monochrome graphics adapter board provides 760x348 resolution adequate for Tektronix 4010 graphics.

Graphics hardcopy is also a very important consideration. Most graphics terminal emulators have the ability to produce a "screen dump" of what is on the display, to a dot matrix or color ink jet printer, by pressing the Shift-PrtSc keys.

Most APA graphics emulation products are able to capture the actual graphics commands that are used to draw the picture. These graphics commands are stored in a PC disk file which can later be displayed again without using the host. Extended PC graphics hardcopy is usually also provided. These PC graphics data files can be output to a large variety of dot matrix printers, color printers, laser printers, plotters, and camera film recorders.

Graphics Editing of SAS/GRAPH locally on a PC

Graphics editing of these graphics capture files is also important. Many times, a SAS/GRAPH user may want to annotate a graph with text, or move legends and titles, which may not easily be done using SAS/GRAPH. Also, by using the PC to perform minor changes to your SAS/GRAPH picture, there is savings in host CPU costs.

SAS/GRAPH pictures can be imported into PC graphics editing programs, such as Lotus Freelance Plus, using a Teknigraphics GRAPH-TEK conversion program. The user can create complex graphics on the mainframe using SAS/GRAPH. Then the graphics picture can be interactively displayed using a coax-attached PC with GRAPH-TEK and captured to a PC disk file. The PC graphics file is then converted to an ANSI CGM (Computer Graphics Metafile) file which can then be imported into Lotus Freelance Plus. The SAS/GRAPH picture can then be edited locally on the PC using Freelance Plus and output to local PC graphics hardcopy devices. This approach utilizes the PC as an intelligent graphics workstation, and goes two steps further than dumb graphics terminal emulation.
1. Create graphics using mainframe software.

2. Interactively display and capture graphics using coax-attached PCs and GRAPH-TEK software.


4. Utilizes PC as an intelligent graphics workstation.
Summary
A personal computer can indeed replace a dedicated mainframe graphics terminal. There are many benefits including cost savings and increased flexibility. When choosing a graphics emulation product for IBM coax-attached PCs, it is important to remember that APA graphics is more efficient than programmed symbols and that a software only solution is more desirable than a hardware solution. In the IBM 3270 coax environment, Tektronix CX APA graphics is an attractive alternative to GDDM based graphics. Using a PC as an intelligent graphics workstation with SAS/GRAPH can provide extended graphics hardcopy and local graphics editing.

Illustrations
The top graph was produced by SAS/GRAPH mainframe software.

The bottom graph shows what can be done by editing the top graph using a graphics editing program on the PC.

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