USING EPIC AS A DEVICE DRIVER FOR SAS/GRAPH SOFTWARE PRINTER GRAPHICS ON THE XEROX 9700 PRINTING SYSTEM

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I. Abstract

This paper reports on the use of the Electronic Printer Image Construction (EPIC) software as a SAS® device driver for printer graphics on the Xerox 9700 Printing System. Image construction is accomplished by EPIC in two phases: Phase I, which is embedded as a printer procedure, and Phase II, the main program, which is run separately. Phase I transforms vector information into a displayable file capable of being printed by the Xerox 9700. Phase II generates the printer control information needed to print the file. The SAS Institute provides this capability with a SAS/GRAPH procedure called EPIC.

II. The Process

SAS System graphics using EPIC are generated by executing SAS with OPTIONS:

\[ \text{OPTIONS..., DEVICE=EPIC...} \]

When a SAS/GRAPH procedure executes, EPIC starts Phase I, i.e., the generation of plot vectors. EPIC uses standard plotting software calls compatible with other vendors, such as CalComp, to provide a set of routines that exploit the graphics handling features of the Xerox 9700 printer. These additional features are categorized as extended graphics routines, used by EPIC to generate custom graphics. Phase II, which is run separately, is responsible for generating the actual printer control information in a file that EPIC can use to generate the printer control information for a plot.

Phase II is responsible for two major tasks: it forms the printer control information from the graphic images on the printer and it forms the printer control information in a file that can be read by EPIC. The printer control information is normally passed to the printer as a file, but it can also be passed to the printer as a string of printer control information.

III. Installation Requirements

The SAS/GRAPH Installation Instructions provide directions for using the Institute provided generalized device driver module called LINKABLE. LINKABLE makes calls to EPIC subroutines that write the actual plot file. In its original form EPIC comes as two programs, one for each phase of plot file generation. A number of changes were necessary to enable the process to be a workable method for plotting.

1) Coding of dummy program PLOTF2.

a SAS/GRAPH procedure generating multiple plots must have proper transition from end of plot to initialization of a follow-on plot. The Institute provides this capability with the dummy routine PLOTF2 (See the Installation Instructions for OS SAS/GRAPH). EPIC
makes the transition to a new plot by a CALL PLOT(0,0,0,23) statement. The code is shown in Figure 1.

2) Phase II EPIC program is converted to a subroutine module.

When a procedure's plots are finished, an exit is provided to routine GMAIN1 and back to the SAS/GRAPH control. To prevent writing a second or subsequent EPIC file over previous output, the GMAIN1 routine calls EPIC phase I (IMAGER). Effectively, each invoked SAS/GRAPH procedure processes all of its plots to a plottable file result. It is not possible to append additional procedures' plot vector information because EPIC phase I output is organized as a direct access (DSORG=DA) file.

3) Phase II SORT routine modifications.

A number of coding changes were provided by Xerox support personnel for the EPIC SORT subroutine. The coding changes can be obtained from the author or Xerox technical support.

All the EPIC FORTRAN compilations used FORTRAN H-Extended with XL specified as a compiler PARM. The EPIC device driver linkedited JCL is shown in Figure 2.

IV. Job Run Requirements

The EPIC plotting procedure is done as two job steps: the SAS procedure step and an Automatic Product Distribution System (APDS) step (a locally written program that facilitates processing and distribution of printed output). The SAS procedure step required that certain DDNAMES be EPIC-reserved names. The reserved DDNAMES are:

- FT01F001 - Vector file (workfile)
- FT02F001 - Image file (plottable output)
- FT03F001 - Sorted vector file (workfile)
- FT05F001 - EPIC and Xerox parameter file
- FT06F001 - EPIC output statistics file

The SAS job step was run on test cases with REGION=1000K and TIME=2 minutes.

V. Computer Run Options

Some options were investigated in using EPIC. Options choices exist for SAS/GRAPH, EPIC, and the Xerox 9700 Printing System. For test runs the SAS OPTIONS were:

```
OPTIONS DEVICE=EPIC NOTERMINAL
UNIT=01 VPPOS=50 HPPOS=120 ROTATE
```

The Xerox 9700 Printing System defines a print job's output using Dynamic Job Descriptor Entry (DJDE) control records. The control records identify a Job Descriptor Entry (JDE) contained in a Job Descriptor Library (JDL). Two separate JDE entries were defined for EPIC: one for simplex printing and one for duplex printing. See the JCL samples for DJDE specifications and Figure 3 for JDE entries.

VI. Computer Test Results

With limited results, computer resource units (CRUs) generated on runs using SAS/GRAPH with EPIC were similar to TSO interactive plot generations using SAS/GRAPH with DEVICE=IRMS279. Overhead costs for the Xerox 9700 Printing System were not factored into the comparisons. Tests were made to generate output for SAS/GRAPH procedures; GLOT, GCHART, GMAP, and GREPLAY using Institute sample data for DEVICE=TEK4014. The TEK4014 GREPLAY graphics were run from BGLDE, GCHART, GLOT, GSN, and GCONTOUR and GMAP procedures. See the samples at the end of this report.

VII. Some EPIC Plotting Observations

- EPIC provides a good alternative to users needing black and white graphics at printer speed with plot resolution similar to that provided by the TEK4014 device.
- GREPLAY, in general, produces reasonable graphical representations of saved TEK4014 graphics.
- Some options, such as ROTATE and DUPLEX, require reinitialization after each procedure's plots.
- The EPIC sort routine uses a significant part of a job's computer resources and a more efficient routine should be investigated.
- The EPIC graphics options and capabilities should be further investigated and tested to optimize resolution and plot results.

VIII. References

Installation Instructions for DS SAS/GRAPH 82.3 Release

Xerox EPIC Graphics Programming Manual, 950003

Xerox EPIC Technical Reference Manual, 950004

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Figure 1: Dummy Routine PLOTF2 - Multiple Plots/SAS procedure

```fortran
JOB
// EXEC FORTXCL,PARM.LKED='NCAL,LET,MAP,LST'
// FORT.SYSP DD *
// SUBROUTINE PLOTF2
// CALL PLOT(0.,0.,23)
// RETURN
// LKED.SYSLMOD DD DSN=TEC132.SASEPIC.LOAD(PLOTF2),DISP=SHR
```

Figure 2: Relink - EPIC Device Driver

```fortran
JOB
// EXEC FORTXCL,PARM.FORT='NAME=GMAIN1,PARM.LKED='LET,MAP,LST'
// FORT.SYSP DD *
// CALL GINIT2
// CALL IMAGER
// RETURN
// LKED.SYSLMOD DD DSN=TEC132.SASEPIC.LOAD(GMAIN1),DISP=SHR
// LKED.SYSLMOD DD DSN=TEC132.EPIC12.LOAD,UNIT=SYST,DISP=(NEW,CATLG)
// LKED.SYSLIB DD DSN=SYS1.FORTLIB,DISP=SHR
// DD DSN=TEC132.SASEPIC.LOAD,DISP=SHR
// LKED.SYSLIB DD *
// INCLUDE SYSLIB(GMAIN1,PLOTF2.IMAGER,SORT)
// INCLUDE SYSLIB(EPIC,EPICP2)
// CHANGE LINKABLE(EPIC)
// INCLUDE SYSLMOD2(LINKABLE)
// ENTRY EPIC
// NAME EPIC()
// LKED.SYSLMOD DD DSN=SYS1.SAS824.LIBRARY,DISP=SHR
```
Sample 1: GREPLAY on DEVICE=EPIC
Display of DEVICE=TEK4014 plots GSGLIDE, GCHART, GPLOT, G3D

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Sample 2: GPLOT w/BY and Sample GMAP on DEVICE=EPIC

/*
// OPTIONS: DEVICE = EPIC NOTERMINAL UNIT=01 VPOS=50 HPQ=120 ROTATE BORDER;
// GPLOT PLOT TITLE:
/* PLOT RTIME*REC GMAP
/* DATA: *I STATE=1 TO 56; RESPONSE=UNIFORM(9); OUTPUT; END;
/* PROC GMAP MAP=HAPS.US;
/* TITLE SAMPLE MAP;
/* RUN;
/* IN DD DSN=TEC157.DB,DISP=OLD
/* EXEC PGM=EPIC
/* EXEC PGM=EPIC
/* EXEC PGM=EPIC
/* EXEC PGM=EPIC
/* *END /*/