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After Ten Years of Metafiles--Where Does the Computer Graphics Metafile Fit?

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ABSTRACT

This paper discusses the need at Los Alamos National Laboratory for the Computer Graphics Metafile standard and supporting software. A brief history of metafile usage at Los Alamos is given. This is followed by an overview of our computing environment and a description of our computer graphics system. Issues we face in making the transition from our metafile to a system supporting the Computer Graphics Metafile and related graphics standards is then discussed. Our present graphics software was designed to address specific needs at Los Alamos. The transition to the Computer Graphics Metafile and other related standards can take place only when these needs are met, hopefully in the marketplace.

1. INTRODUCTION

With over 7000 users and millions of dollars invested in existing computer graphics application software, we are slowly and carefully assessing the impact of the Computer Graphics Metafile (CGM) and related computer graphics standards at Los Alamos. How heavily will the CGM be used? Will the CGM become a part of vendor-supported graphics packages? Will we be able to purchase software supporting the CGM in our environment instead of developing our own? There are questions we must answer before we begin the transition from our "home-grown" tools and graphics packages to "standard" graphics. Although we make extensive use of metafiles, our use of the CGM has been limited to a few packages that provide it as "yet another" form of output. This paper describes functionality in our current system that must be available in software supporting the CGM.

1.1. History of Metafile Usage at Los Alamos

The metafile we use was defined in 1976 and modified in 1977 to incorporate the SIGGRAPH Graphics Standards Planning Committee (GSPC) "Core" functionality[1]. It was this metafile that formed the basis for the metafile described in the 1979 GSPC "Core" report[2,3]. For the last ten years, this metafile has been the primary vehicle from which our static hardcopy graphics have been generated. We currently process a gigabyte of graphics metafile information per day. Most of this metafile output is film--either microfiche, 16-mm color movies, or 35-mm slides. In addition to this, many metafiles are displayed on graphics terminals and are never processed as hardcopy output.

1.2. Los Alamos Computing Environment

Los Alamos National Laboratory is home to the world's most powerful scientific computing facility. It serves the scientific and engineering computing needs of over 7000 users who perform research and development related to national security and energy programs. About 5000 of these users work at Los Alamos, while the remainder are located at installations throughout the United States. To support these programs, the Laboratory has developed a state-of-the-art scientific computing network, the Integrated Computing Network (ICN). The various components of the ICN are shown in Figure 1. Computer graphics plays an important role in the visualization of large-scale scientific computations within the ICN.

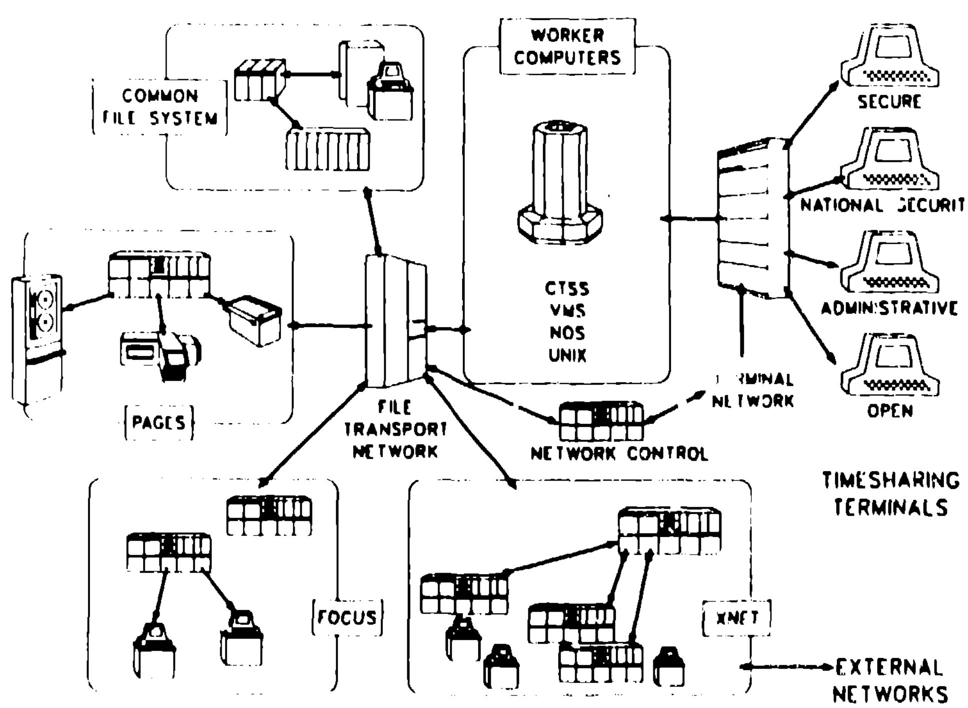

Figure 1. The Los Alamos Integrated Computing Network.

One of the key hardware components of the ICN is the Print and Graphics Express Station (PAGES). PAGES is an ICN node to which text or graphics metafiles are sent for processing. PAGES is controlled by two DEC VAX-11/785s that drive three Xerox 9700 laser printers, four FR-80 COM recorders, a Dicomed D48 COM recorder, and a variety of paper plotters. PAGES currently processes more than 2 gigabytes of information daily, which contributes to a total output of 3 million pages of print per month, 6 million frames of microfiche per month, and about 250,000 frames of 16- and 35-mm film each month.

2. LOS ALAMOS INTEGRATED GRAPHICS SYSTEM

The discussion that follows describes our current graphics system and identifies key areas that are important to our user community. A successful transition to a CGM-based environment must include most of the capabilities described.

2.1. Utilities, Libraries, and Device Drivers

Most of the computer graphics generated at Los Alamos is via the Integrated Graphics System. Figure 2 illustrates the graphics software components that make up this system. This software is provided on all the computing systems at Los Alamos, which allows our users to choose the system best suited to their application program, independent of their computer graphics needs. We would expect a CGM-based environment to be available on an equally wide variety of operating systems.

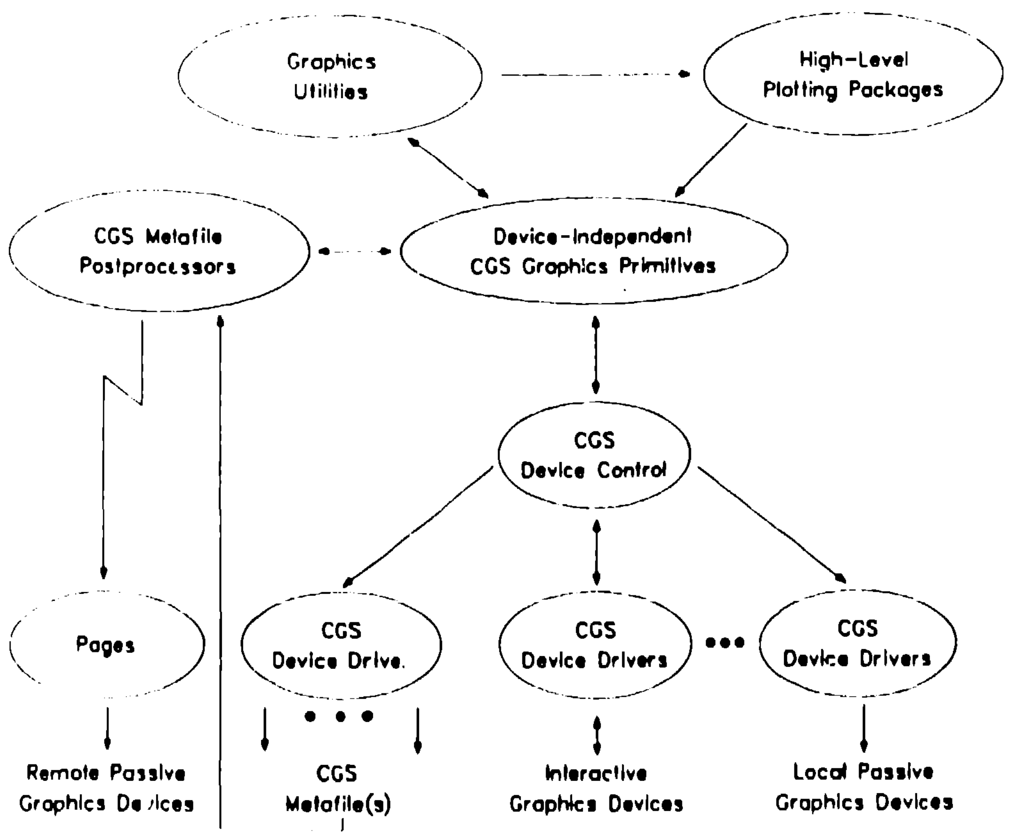

Figure 2. The Los Alamos Integrated Graphics System.

The Common Graphics System (CGS) is a subroutine library containing device-independent graphics primitives, primitive attributes, and device control functions. The higher-level graphics utilities, plotting packages, and user application programs are built on this device-independent foundation. Included here are local packages providing higher-level plotting subroutines, vendor packages such as DISSPLA, and public domain software such as the NCAR graphics package and Movie.BYU.

Below the CGS foundation are various device drivers that interface to CGS and translate "virtual device" information generated by CGS into the form required by various physical graphics devices. A special device driver records this "virtual device" information as a CGS metafile. This interface has been optimized to allow CGS metafiles to be efficiently generated both in time and space[4]. Efficient generation of the CGM will be important to our large scientific modeling programs and will be high on our priority list when evaluating software supporting the CGM.

2.2. Metafile Movers and Translators

Once a CGS metafile is generated, it can be processed in two ways. The first way is to use a metafile mover. A metafile mover records information in the metafile header about how the metafile is to be processed and then sends it through the network to the PAGES system. There it is processed on the specified hardcopy device. We are evaluating the impact of translating the CGM directly on the PAGES system.

The second way is to use a metafile translator to process and display a metafile on a local device or terminal. These translators are CGS application programs that read CGS metafiles and use CGS device drivers to display the images on the user's device. This provides consistency in the displayed images independent of whether they are displayed directly as they are generated or saved as metafiles and later postprocessed to the device. We will expect similar consistency of displayed images using the CGM and supporting software.

In 1980, our metafile was extended to provide a mechanism allowing rapid random access to any individual image. We have since written metafile translators that take advantage of this capability. Our most popular and most heavily used translator allows metafile images to be viewed randomly; that is, any individual image can be immediately accessed and displayed. Additionally, selected frames can be stored in different metafiles or selected frames from several metafiles can be merged into one metafile. A limited amount of editing capability is provided to change existing images or combine several images into one.

This utility is successful because of its ability to quickly access any image of a metafile without sequentially processing preceding images. Information allowing efficient random access to individual images will have to be added to the CGM before it can replace the CGS metafile. This information could be added to the CGM as either application data or an escape in the same way that it was added to the CGS metafile[5].

2.3. Additional Metafile Tools

Many of our external users have expressed their need for support of their graphics devices. We support the most popular graphics devices by providing CGS device drivers. We also provide the ability for users to write their own device drivers; however, this has not worked in practice. As an alternative, we have provided a package that allows our users to easily write CGS metafile translators using device drivers provided in one of our vendor graphics packages. This has satisfied those users with unique devices. They don't have interactive access to the device and can't run their programs on all our systems, but they do have a path to obtain their output. We expect vendors to provide similar capabilities using the CGM as a means of integrating various vendor products.

Another area where we have integrated new graphics capabilities has been via PostScript. PostScript files have become the Laboratory-standard format for integrated text and graphics[6]. We have written translators to convert CGS metafiles into PostScript format. We have recently updated one of our text formatting packages to convert CGS metafiles and include specified images into formatted text in PostScript format. This is becoming a heavily used product. We will write a PostScript device driver for CGS so that PostScript files can be generated directly from CGS application programs. A vendor-supported tool providing this capability using the CGM would be useful.

2.4. Support Requirements for a CGM-Based Environment.

To summarize, a successful transition to a CGM-based environment must include the following:

1. Vendor software supporting the CGM available on most of our operating systems.
2. Efficient generation of the CGM for our compute intensive scientific modeling programs.
3. Consistency of displayed images, whether displayed directly on the device or via metafile translation.
4. Rapid random access to individual images in a CGM.
5. CGM-based graphics editors.
6. Multiple vendor products integrated via the CGM.
7. Translators between the CGM and other graphical formats.

3. CURRENT USE OF THE CGM

So far, the discussion of the CGM has been in the context of what is needed to replace our current metafile and related software. We are actively beginning to support the CGM as we provide new capabilities for our users.

3.1. CGM Subset

One shortcoming of the CGS metafile is a lack of raster capability. We are in the process of evaluating and providing raster graphics support for our user community. Several software packages exist that provide subroutines to generate raster graphic images. What they lack is a common output format. We have written a prototype system to generate a raster subset of the CGM to satisfy this need. This system will be used to evaluate the suitability of the CGM to support the raster needs of these software packages and our user community. Our hope is that we can eventually use vendor software to translate and display this subset of the CGM.

Another area where we expect to use the CGM is as a vehicle to integrate vector and raster graphics. A recent meeting of representatives of several DOE laboratories discussed the need to share and coordinate raster-based graphics software. It was agreed to define a system based on a subset of the proposed Computer Graphics Interface (CGI) standard. This system would provide a limited set of vector and raster functions on which higher-level software could be provided. This system would drive raster graphics devices directly and would also generate a subset of the CGM containing raster and vector information. We plan to add a CGM device driver to our CGS system and are evaluating the feasibility of adding the CGI raster functions from our prototype raster system.

3.2. Networking

Perhaps the biggest payoff in actively supporting the CGM is in the rapidly growing area of workstations and networks. We have seen an explosive growth in the use of workstations in the last several years. Along with this increased use of workstations has come a variety of workstation-dependent graphics software packages. Our users want to use their workstations to generate computer graphics, but they also want to use our PAGES system and existing software in the ICN to display and manipulate these graphic images. We do not have the personnel necessary to provide translators on all these workstations to generate our CGS metafile. We are relying on vendors to provide CGM generators on their workstations as a way of integrating these diverse environments.

4. SUMMARY

Our CGS metafile has been successful in meeting our needs and will continue to do so for some time to come. We are slowly and carefully moving in the direction of the CGM. We look forward to vendor-provided and vendor-supported software that can displace the need for our locally developed and supported software. This will require widespread adoption and support of the CGM in an integrated fashion across the industry. We are patiently waiting for this to happen.

5. REFERENCES

1. Status Report of the Graphic Standards Planning Committee of ACM/SIGGRAPH, Computer Graphics, Vol. 11, No. 3, Fall 1977.

2. Warner, J. R., "Device Independent Intermediate Display Files," Computer Graphics, Vol. 13, No. 1, March 1979, 78-109.

3. Status Report of the Graphic Standards Planning Committee of ACM/SIGGRAPH, Computer Graphics, Vol. 13, No. 3, August 1979, Part IV.

4. Reed, T. N., "Experiences in the Design and Support of a Graphics Device Driver Interface," Eurographics '81 Proceedings, September 1981, 281-289.

5. Reed, T. N., "A Metafile for Efficient Sequential and Random Display of Graphics," Computer Graphics, Vol. 16, No. 3, July 1982, 39-43.

6. Vigil, M., and Bouchier, S., "Text and Graphics at Los Alamos: A System Viewpoint," ACM Mountain Proceedings, April 1986, 101-107.