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MULTIMISSION IMAGE PROCESSING AND SCIENCE DATA VISUALIZATION

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ABSTRACT

The Operational Science Analysis (OSA) Functional area supports science instrument data display, analysis, visualization and photoprocessing in support of flight operations of planetary spacecraft managed by the Jet Propulsion Laboratory (JPL). This paper describes the data products generated by the OSA functional area, and the current computer system used to generate these data products. The objectives on a system upgrade now in process are described. The design approach to development of the new system are reviewed, including use of the Unix operating system and X-Window display standards to provide platform independence, portability, and modularity within the new system, is reviewed. The new system should provide a modular and scaleable capability supporting a variety of future missions at JPL.

1. FUNCTION AND ROLE OF THE OPERATIONAL SCIENCE ANALYSIS FUNCTIONAL AREA

The OSA Functional Area is responsible for providing a multimission capability for science instrument data display and analysis supporting flight operations. In support of that role, the functional area provides real and near-real time display of science instrument data as it is received, and provides hardware and software to support data analysis. The OSA functional area also produces archival data products, including digital data records for individual instruments that are transferred to the Planetary Data System, archival quality photographic products, and catalogs describing the content of all data products that are generated.

2. DATA PRODUCT EXAMPLES

Examples of recent data products generated by the functional area include the following:

• Digital image mosaic data products of the surface of Venus generated by merging Synthetic Aperture Radar (SAR) image data acquired from many orbits into rectangular mosaics corresponding to segments of the surface indexed by longitude and latitude. These products were produced as photographic hardcopy and as digital data records produced on CD-ROM media.

• Digital image data products of the Earth and Moon generated from data returned by the solid state imaging (SSI) camera on the Galileo spacecraft. These products were also produced in cataloged digital format on CD-ROM media and as black and white and color photoproducts.

• Photographic products of the Earth and Moon generated from data returned by the near-infrared mapping spectrometer (NIMS) instrument on the Galileo spacecraft. This instrument returns up to 256 spectal bands of information for selected regions of the surface. Special photoproducts are generated showing a false color rendition of the full multispectral image, false color histograms depicting the radiance across all spectral bands, and selected spectra for six different points on the surface depicted as line plots. Digital data records for this instrument are produced on magnetic tape.

• Photographic representation of spectra derived from the plasma wave subsystem (PWS) depicted as a series of false color photographic data products.

These examples indicate the flexibility of the same data processing system to producing a variety of different products for more than one mission and more than one instrument type.

3. CURRENT HARDWARE SYSTEM

The current system configuration is shown in Figure 1. The system consists of four Digital Equipment Corporation VAX computer systems and a variety of peripheral devices. The VAX systems are configured in a cluster configuration, so that the four processors have independent access to shared magnetic disk storage. Approximately 100 GB of magnetic storage are available on the system, reflecting the large storage volumes required to handle the quantity of digital image data returned by the planetary missions. The magnetic storage is augmented by optical disk storage as shown. 64 GB of optical disk storage is available on two jukebox systems.

The system is configured with special purpose peripheral devices designed to support data display and visualization. Dedicated image displays support viewing and manipulation of 24 bit image data and associated graphics overlays at resolutions up to 1024 x 1024 picture elements. Black and white and color film recorders provide high precision film recording on 9 inch wide film at spot sizes starting at 12.5 microns.

4. CURRENT SOFTWARE SYSTEM

The system shown in Figure 1 currently operates under the DEC VMS operating system. JPL's VICAR image processing software system is used for the majority of applications supported by this equipment. VICAR runs under an executive called TAE (Transportable Applications Executive) developed at Goddard Space Flight Center. TAE provides the main user interface with the software system. Over 200 individual applications programs are currently maintained as part of the system. A general purpose subroutine library supports specialized high performance requirements associated with image and signal processing.

Use of a standard image format within the system insures that image and science data acquired from a variety of sources can all be processed by the same applications software, once the data have been converted from the original format to VICAR format.

A device independent approach has been taken to support image display on a variety of image display equipment provided by different vendors. The device dependent display and manipulation functions are isolated from the applications programmer; individual programs call a general set of display routines that handle the specific capabilities and characteristics of the hardware displays actually used by analysts in executing the software.

An interface with the Datatreive data base management system is maintained, so that a record is maintained of all data processed by the system. The catalogs generated using Datatreive also include ancillary information relating to the science instrument data (e.g., navigation data, engineering data, etc.).

5. SYSTEM UPGRADE OBJECTIVES

The system shown in Figure 1 was developed starting approximately 10 years ago, and has supported the Voyager, Magellan and Galileo missions. A complete upgrade of this system is planned in time to support Galileo operations at Jupiter. The objectives of the new system design include the following:

- Eliminate dependence on a single vendor for computing platforms.

- Provide a modular scaleable design that can accommodate the variety of missions now under consideration

- Develop a standards complaint system, providing portability and ease of data transfer and exchange

- Maintain the multimission and multiinstrument nature of the current facility

- Provide commercially available visualization software and other commercially available software to minimize in-house development resources required to address new applications

6. SYSTEM UPGRADE APPROACH-- SOFTWARE

The basic software approach that is being taken in the redesign of the system can be summarized as follows:

- Utilize the Unix operating system to provide hardware independence

- Convert the existing VICAR applications capability to Unix, to preserve almost 20 years of investment in a highly flexible multi-instrument and multimission capability

- Utilize the Sybase data base management system, providing a state of the art relational data base capability

- Utilize X-Windows as a standards-complaint image display and manipulation environment, providing vendor independence in selection of high resolution display equipment

- Utilize commercially available visualization packages operating under TAE to augment the VICAR capabilities for data visualization as required

7. SYSTEM UPGRADE APPROACH-- HARDWARE

The hardware approach being taken in the redesign effort can be summarized as follows:

• Utilize Unix based workstations as the basic modular building blocks within a distributed design

• Support data management and file serving from dedicated processors

• Utilize X-Window compliant workstations to support image display functions, establishing vendor independence and portability

• Utilize FDDI as a basic communications backbone within the new system, providing the highest available speed for transfer of image and signal data between nodes

8. SUMMARY

The OSA functional area has a long history of developing and implementing a flexible multimission capability to support production of data products supporting flight operations at a minimal development and operations cost. Technology developments in the ten years since the last major upgrade of the OSA system now make it possible to achieve a standards-compliant modular new design that can be adapted to support multiple missions and different instruments at minimal development cost. Use of a modular design and implementation approach, and utilization of a new generation of standards-compliant hardware systems should also reduce the operations cost associated with support of individual missions.

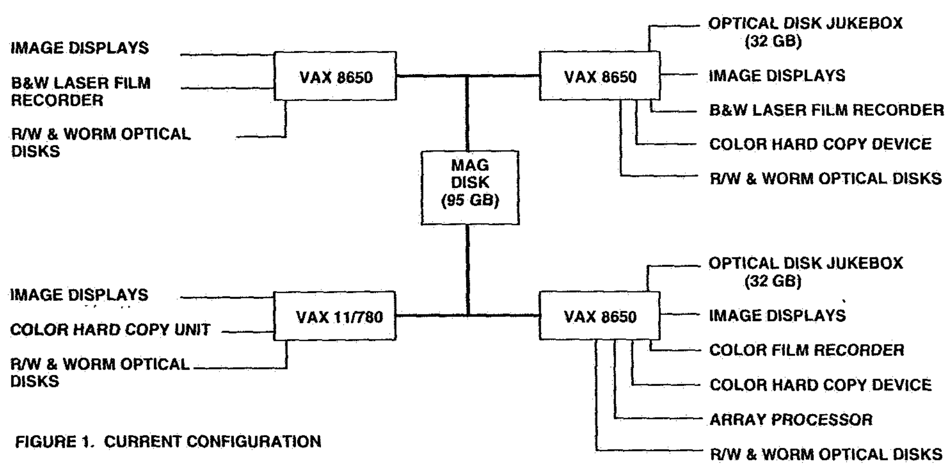

FIGURE 1. CURRENT CONFIGURATION