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STATUS OF THE ATLAS CONTROL SYSTEM UPGRADE

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ABSTRACT

Certain components of the ATLAS control system are two generations behind today's technology. It has been decided to upgrade the control system, in part, by replacing Digital Equipment Corporation (DEC) PDP-11 computers with present-day VAX technology.

Two primary goals have been defined for the upgraded control system. The first of these goals is to keep additional "in-house" written software to a minimum, while providing the portability necessary to ensure the continued use of existing software. In an attempt to achieve this goal, commercially-available software has been utilized to provide a foundation for the final control-system configuration. The second goal is to develop the new control system, while not interfering with accelerator operations.

This paper describes some of the motivation for upgrading the ATLAS control system, the basic features of the new control system, and the present status of the system's development.

1. Introduction

The present control system consists of a minimum of seven CPUs. Five of the CPUs are part of complete computer systems that include disk drives and operator interfaces. Three of these computer systems are DEC PDP-11s running the RSX-11M operating system, while the other two are PCs running a version of PC-DOS.

The computer systems are interfaced to a variety of accelerator components through the use of two I/O subsystems.

The first subsystem is made up of two independent CAMAC serial highways. One CAMAC highway supports the PII (Positive Ion Injector) LINAC. The other highway supports the rest of the accelerator facility, and includes a fiber optic link to an ion-source high-voltage platform.

The second subsystem is a combination serial RS-232 and IEE-488 communication structure, which also includes a fiber optic link to an ion-source high-voltage platform.

Operator interface for control and monitoring of the accelerator and its injectors is achieved through the use of three separate control consoles that are serviced by one or more of the above mentioned computer systems.

2. Upgrade Motivation

A variety of reasons motivated the ATLAS operational staff to take a serious look at the present control system. Below are listed some general observations:

- The system is based primarily on technology that is two generations behind present-day technology.

- At the Fall 1987 DECUS (Digital Equipment User's Society) Symposium it was announced at one of the RSX SIG (Special Interest Group) meetings that future releases of RSX-11M would contain only "bug fixes", and would not receive any new development work.[1]

- Task sizes may soon exceed the limits of the PDP and RSX. In December 1986 the system was upgraded to RSX-11M Plus in order to make use of the "I and D" space feature. This was not an "end all" solution to the task size problem.[1]

- There is very little commercially available software for the RSX-11M operating system. Software such as database management systems, spread sheets, graphical user interfaces, and plotting packages are in short supply. Consequently, nearly all software needs to be written "in-house".[1]

- Operator interfaces, primarily older technology touch screens, have become cumbersome to use, and inflexible to design changes.[1]

- To the credit of its early designers, the majority of the "accelerator" portion of the control system is at least twelve years old and is adequate. However, making additions and modifications is becoming exceedingly more difficult and time consuming.

- The control system consists of several computer systems that are virtually isolated from each other, and they do not share information in any meaningful way.

- Finally, the system severely restricts the learning process for those involved in maintaining the system. An archaic system does not allow for keeping up with present day technology.

3. Design Considerations and Goals

It was decided that any upgrade to the present ATLAS control system should provide a system that was modular, fast, secure, capable of expansion and modification with minimum effort, "operator friendly", and conformant to certain standards to ensure long-term viability.[1]

It was recognized early on that the following factors needed to be considered when developing the overall upgrade concept:

- It is crucial that the new system be integrated into the overall control system without interfering with accelerator operations.

- The ATLAS facility exists in a DEC environment, and local expertise is primarily with DEC systems.[1]

- The facility has a heavy investment in the CAMAC subsystem.[1]

- Nearly all of the software presently being used has been written in house. Consequently every effort should be made to provide the portability required to allow the continued use of this software.

- Much of the commercially-available control-system hardware and software is designed and marketed for industrial applications, and their use with various systems at ATLAS is doubtful. Most of these systems are either too slow or did not support the CAMAC subsystem.[1]

- In spite of the control system software availability issue, the size of the ATLAS staff is such that commercially-available software should be acquired when appropriate.

These requirements lead to the development of a new system that utilizes a DEC platform, with PC support, and provides for CAMAC interfacing.[1]

4. New System Description

The overall concept of the new control system in its simplest form is depicted in Fig. 1. The control system makes use of two subsystems.

The first of these subsystems is a local area network (LAN), which incorporates use of an Ethernet backbone to connect the various computer systems that make up the control system. Through the use of a router the control system LAN is linked to the Division-wide LAN. The use of the router ensures that the Division-wide network traffic does not interfere with the control system, while at the same time the router maintains a link with the Division network.

The control system LAN is configured for "cluster" operation using DECnet software. The cluster has been configured for a mode of operation that employs a single disk storage system that is used as the system disk for all central processing units (CPUs) that are part of the cluster, and one single CPU acts as the cluster server.

The second subsystem is a CAMAC serial highway. The highway is operated in a "byte-serial" mode. That is, eight bits are transmitted simultaneously upon every transmission cycle. Except for the addition of CAMAC crates, and a new "serial highway driver", the CAMAC system is being retained in its present configuration for the new control system.

The heart of the system is a MicroVAX computer system. This machine contains the necessary "run-time" databases, and ultimately will provide the only direct link to the CAMAC subsystem through the use of a "serial highway driver" that will be connected directly to the bus of the MicroVAX. With this configuration values from the run-time databases are sent directly to the CAMAC driver and do not travel over the network. In addition, the MicroVAX acts as the network/cluster server described earlier.

Given the power of today's PCs, an attempt was made to locate a process control software package that would run on a PC, provide a CAMAC driver, and fulfill a variety of special needs of the ATLAS accelerator. None were found, some were too slow, and most did not support CAMAC. After sme investigation into a variety of software packages that were designed to be process-control applications, it was decided to purchase the product called Vsystem. Vsystem is marketed by Vista Control Systems, Inc. located in Los Alamos, New Mexico.

5. Database Management

The new system is currently being serviced by two database management systems (see Fig. 2). The first is a DEC product called RDB. The present implementation of RDB consists of the "development" option running on the VAXstation and the "run-time" option running on the MicroVAX. The second is a Borland product call Paradox that runs on a PC that is attached to the network. The RDB database is "device" oriented and contains device related information. The PARADOX database is "Vsystem channel" oriented and it contains only that information required by the Vsystem run-time database. Both database management systems are based on the relational database concept. This allows data associated with particular device types to be organized and stored in separate tables.

The RDB database contains device information such as the device's name, facility location, chassis rack location, associated channel name in the Vsystem run-time database, etc. Provisions have been made to allow for the merging of the two databases into one RDB database.

The Paradox database, as mentioned earlier, is currently used to store all Vsystem channel information needed to generate a run-time database. A report in the form of an ASCII file is created from the database that meets the Vsystem formatting requirements. This file is then copies to the VAX for the purpose of generating the Vsystem run-time database.

In addition a Paradox product called SQL LINK provides a low-cost front end to the RDB database located on the VAX. This gives the user the ability to manipulate data stored in the RDB database using a PC that is connected to the network without the need for learning the structured query language (SQL). Although this approach seems promising, further testing needs to be performed.

6. Upgrade Transition Procedure

At least two schemes were devised to ensure that the development of the new system did not interfere with accelerator operations, and to allow the old system to run simultaneously with the new system during the upgrade transition period. Both procedures use fundamental approaches.

The first scheme enables the new system to be phased in without making physical changes to the CAMAC interfacing. It involves communication between one of the existing PDP-11s and the new MicroVAX. Since the MicroVAX is not presently interfaced directly to the CAMAC subsystem and the PDP-11 is, the Vsystem running on the MicroVAX issues CAMAC requests to the PDP-11. The PDP-11 then executes the CAMAC request. If for example, an operator uses a Vsystem control tool to request a change in the value of some CAMAC device, that request is passed on to a communication process using the VMS "mailbox" feature. This communication process then transmits the CAMAC request over Ethernet to a receiving process running on the PDP-11. The CAMAC request is then issued to the PDP-11's CAMAC driver and then on to the device. (See Fig. 3.)

While this approach places a lot of traffic on the Ethernet, initial tests seem to indicate that performance times are acceptable for the immediate future. Once development has reached a point where the old system can be phased out, the MicroVAX will then be interfaced directly to the CAMAC subsystem. Since the Vsystem run-time database resides on the MicroVAX, all CAMAC request traffic will be removed from the network.

The second scheme provides the operator with the option of using the old or new control system during the upgrade development period. To make this possible, it is necessary to ensure that both old and new database information is consistent.

The old system database is updated in the following fashion: A process running on the MicroVAX is constantly scanning the Vsystem run-time database. If a change in data is detected, that change is transmitted over Ethernet in much the same way as described above to a receiving process on the PDP-11 where the old database resides. The receiving process then passes the new data to another process that is responsible for writing the new data to the old database. (See Fig. 4.)

Updating the new Vsystem run-time database with changes in the old database is handled somewhat differently. In this case a copy of the old database is copied over Ethernet using the DECnet copy server facility to the MicroVAX periodically (nominally once every minute), whether a change in the old database has occurred or not. In the MicroVAX, a process copies the entire contents of the old database into the new Vsystem run-time database. (See Fig. 4.)

This mode of operation does have its limitations. A device could conceivably be called up on both the old and new systems (there is no lock-out implemented), which could lead to obvious problems. In addition, there are brief periods of time (one to two minutes) when the databases are not consistent. This implies that a device should not be called up on one of the control systems in less than approximately one minute of having been detached from the other system. This operation policy does not seem to hinder operational efficiency in any way, especially when one is reminded that this is intended to be a temporary mode of operation.

7. Present Status

Effort directed at upgrading the old control system has provided the following accomplishments:

- A local area network "VAX cluster" has been configured which currently consists of a MicroVAX, a VAXstation, and a PC.

- A scheme has been devised and put into operation that has allowed for a smooth transition from the old system to the new system with virtually no accelerator down time to date.

  This includes the use of the CAMAC subsystem by both the old and new systems without the need for hardware changes, and the updating of databases in both systems to allow for devices to be controlled by either system.

- Two relational databases have been configured for use by the new system. One database is configured under the VAX based RDB, and the other is configured under the PC based PARADOX. Provisions have been made to merge these two databases into one in the future if so desired.

- The present control system is divided into two main parts. These are the "accelerator" control system and the "beam line" control system. To date all graphics display available to the operator on the old "beam line" control system have been recreated, and are available on the new system.

- Both the VAXstation and the PC have performed as operator consoles in a test mode.

  Although only operated in a test mode, in principle, the new control system is prepared to replace the "beam line" portion of the old control system.

In the past the old control system seemed to place obstacles in the path of improving operational efficiency. It is hoped that the major limitation of the new design will be the imagination of its users.

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8. References

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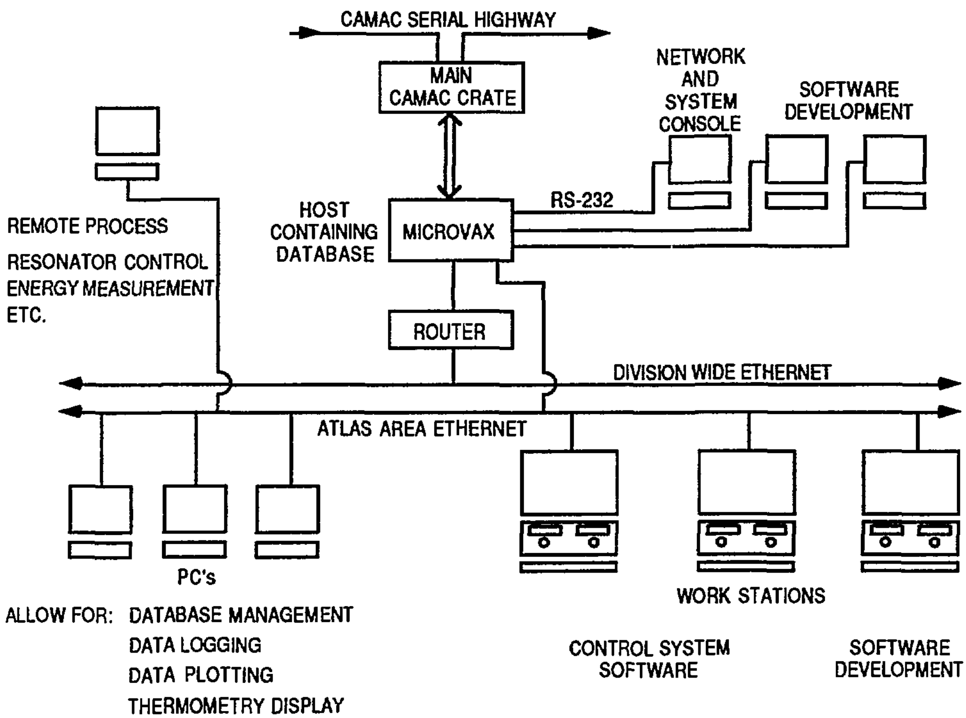

Fig. 1

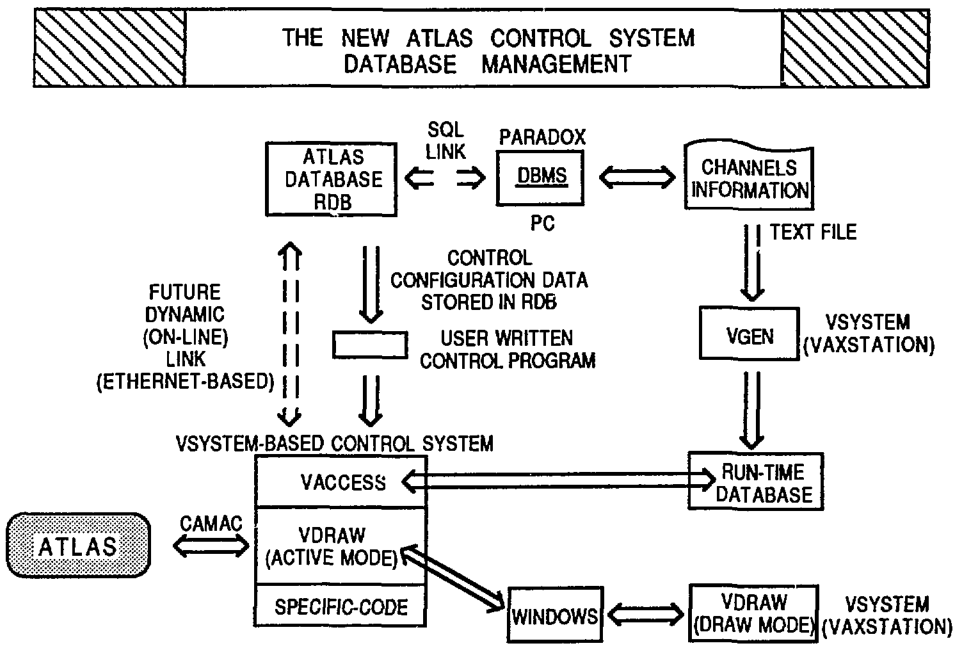
THE NEW ATLAS CONTROL SYSTEM
DATABASE MANAGEMENT
SQL LINK
PARADOX
ATLAS DATABASE RDB
DBMS
PC
CHANNELS INFORMATION
TEXT FILE
CONTROL CONFIGURATION DATA STORED IN RDB
FUTURE DYNAMIC (ON-LINE) LINK (ETHERNET-BASED)
USER WRITTEN CONTROL PROGRAM
VGEN
VSYSTEM (VAXSTATION)
VSYSTEM-BASED CONTROL SYSTEM
VACCESS
RUN-TIME DATABASE
ATLAS
CAMAC
VDRAW (ACTIVE MODE)
SPECIFIC-CODE
WINDOWS
VDRAW (DRAW MODE)
VSYSTEM (VAXSTATION)

Fig. 2

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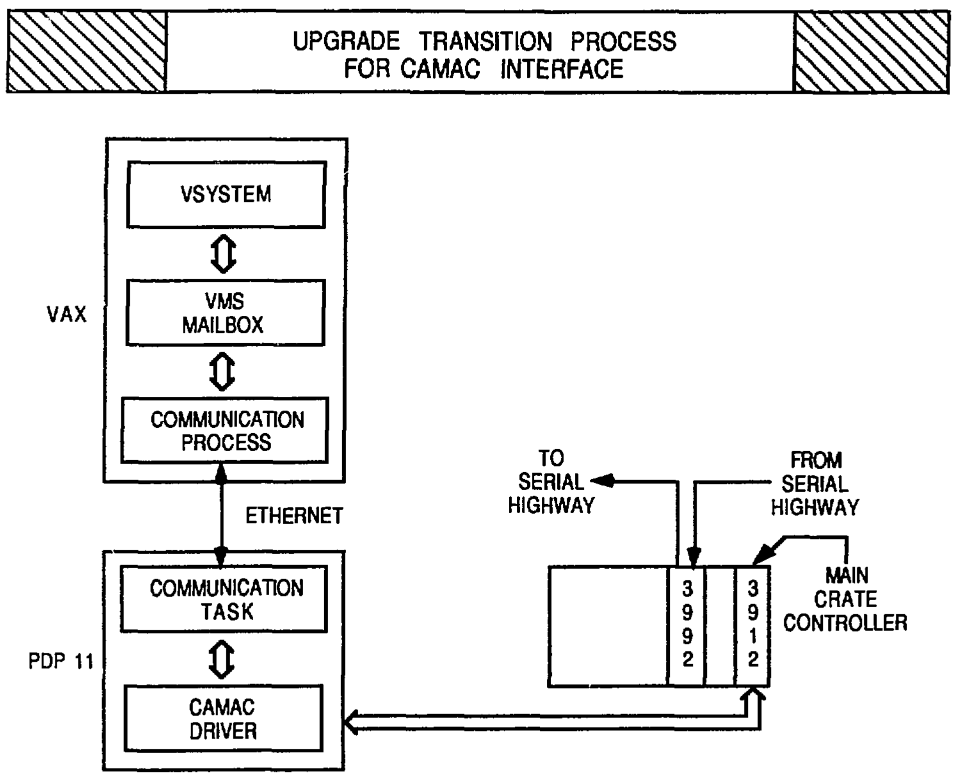

Fig. 3

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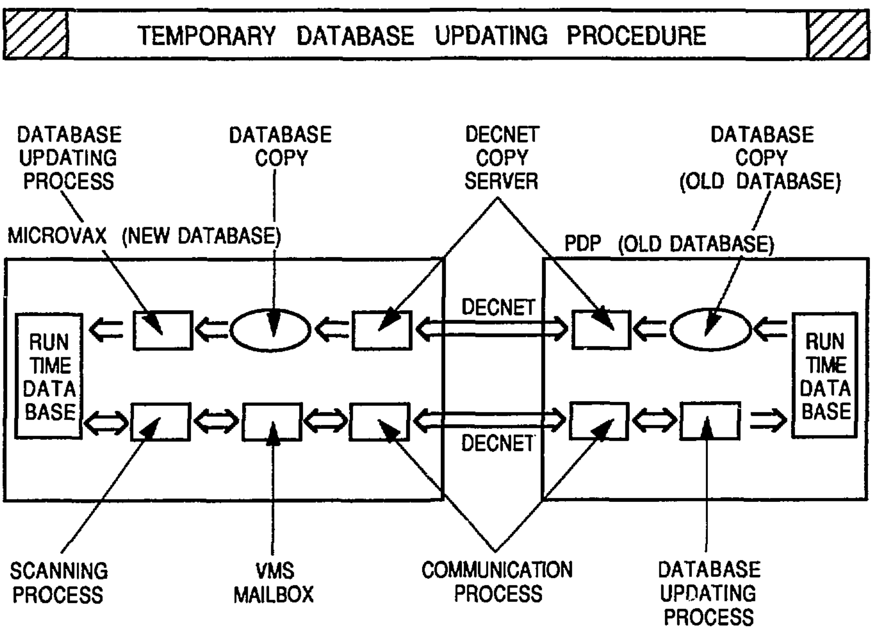

fig. 4