ANL/PHY/CP--87784
CONF-9509254--1

THE FINAL PHASE OF THE ATLAS CONTROL SYSTEM UPGRADE

F. Munson, S. Kramer*, and B. Tieman
Physics Division, Argonne National Laboratory, Argonne, IL 60439

ABSTRACT

The ATLAS facility (Argonne Tandem-Linac Accelerator System) is located at the Argonne National Laboratory. The facility is a tool used in nuclear and atomic physics research focusing primarily on heavy-ion physics. Due to the complexity of the operation of the facility, a computerized control system has always been required.

The nature of the design of the accelerator has allowed the accelerator to evolve over time to its present configuration. The control system for the accelerator has evolved as well, primarily in the form of additions to the original design.

A project to upgrade the ATLAS control system replacing most of the major original components was first reported on in the Fall of 1992 during the Symposium Of North Eastern Accelerator Personnel (SNEAP) at the AECL, Chalk River Laboratories.[1] A follow-up report was given in the Fall of 1993 at the First Workshop on Applications of Vsystem Software and Users' Meeting at the Brookhaven National Laboratory.[2] This project is presently in its third and final phase.

This paper briefly describes the ATLAS facility, summarizes the control system upgrade project, and explains the intended control system configuration at the completion of the final phase of the project.

1. INTRODUCTION

ATLAS is a heavy ion accelerator. The facility, which is depicted in Figure 1, is a tool used primarily by physicists in the research of nuclear and atomic physics. ATLAS has been designated a National User Facility, however the facility attracts researchers from all over the world. The facility operates 24 hours a day, seven days a week.

With an accelerator such as ATLAS, charged atoms or ions are accelerated to form a beam of ions. Heavy ions have been defined as those charged atoms that have an atomic mass number greater than 6 (the mass of Lithium). ATLAS has accelerated ion species up to and including Uranium, which has an atomic mass number of 238. These ions are accelerated to speeds of approximately 1/10 the speed of light, and achieve energies capable of providing collisions with other atoms that produce results of interest to the researcher.

The accelerating structures used in the accelerator to impart energy on the ions are called resonators. Resonators patterned after the original ATLAS resonator design have been built at Argonne for facilities at Florida State University, Kansas State University, and the University of Sau Paulo, Brazil.

*Undergraduate Research Participant, supported by the ANL Division of Educational Programs

DISCLAIMER

While ion or particle accelerators differ in many aspects, most use the same basic components. These include a device known as the ion source, the accelerating structure itself, and a beam transport system. Typically the beam transport system includes a host of magnetic or electrostatic devices used to bend, steer, and focus the ion beam, a number of devices for stopping, monitoring, and analyzing the beam, and a vacuum system used to evacuate air from the transport system.

Since the ATLAS accelerator makes use of super-conducting technology, a cryogenic system is employed that is capable of cooling devices to liquid helium temperatures (~ -452 degrees Fahrenheit).

The ATLAS control system performs a variety of functions. The system performs calculations necessary for configuring the accelerator for various beams, provides a database for archiving tune-up configurations, and provides the primary operator interface to the accelerator. This interface makes it possible for an operator to control and monitor nearly every device and parameter associated with the accelerator from a single workstation.

2. THE PREVIOUS SYSTEM AND UPGRADE PLANS

Prior to the start of the upgrade, control and monitoring of the accelerator was accomplished through the use of three Digital Equipment Corporation (DEC) PDP-11 computer systems running the RSX-11M operating system. Control and monitoring of The ATLAS Positive Ion Injector was performed by one of the above mentioned computer systems, while control and monitoring of the primary accelerator section was controlled by a second system. All beam transport components external to the accelerator were serviced by the third system.

A CAMAC serial highway subsystem was used as the primary interface between the computer systems and the various accelerator components.

Control of the accelerator was from one central location in the main control room. Operator interfaces included a variety of touch screens, monitors, terminals, knobs, keypads, and switches. Nearly all of the software for the system was written in-house.

Plans for the upgrade called for initially replacing all of the PDP-11's with a DEC MicroVAX running the VMS operating system as the primary computer system. This machine would ultimately be replaced by a machine utilizing current RISC technology. Graphical workstations would be provided, which were capable of running the "X" windowing system as operator interfaces. Control and monitoring from locations other than the main control room would be accomplished using "X" terminals, or PC's used as "X" terminal emulators. These PC's would be used for remote monitoring displays, and as remote control diagnostic tools.

The staff responsible for the ATLAS control system consists of one full time system manager/programmer, one full time accelerator operator/programmer, and one part time co-op student/programmer. The responsibilities of the staff include installation and maintenance of all computer systems, and their peripheral equipment, installation and maintenance of the CAMAC system up to and including the CAMAC modules, and installation and maintenance of all software used on the system.

The size of this staff, given its responsibilities, provided a strong predilection for procuring a commercially available control system software package. Therefore, based on the size of the staff, and on other considerations, the software package marketed under the name "Vsystem" by Vista Control Systems, Inc. would be acquired.

All of the previously described systems would be linked by Ethernet into a local area network configuration. The new system would be based on the "Vsystem", and would incorporate relational database technology.

Due to the large investment in CAMAC components, the CAMAC I/O subsystem would be retained.

3. UPGRADE PHASE ONE

The end of this phase found two I/O subsystems in place. The first was the original CAMAC serial highway, which provides the interface for almost all accelerator components to the computer system. This subsystem includes fiber optic links to an ion source high voltage platform. This platform typically operates between 100 and 150 kV above ground potential.

The second subsystem was the new addition. This was an Ethernet based local area network (LAN), which is used to connect the various control system computers.

At this point in time the CAMAC subsystem remained physically connected to the PDP-11's, and communications from a newly acquired MicroVAX to CAMAC was performed via Ethernet through one of the PDP-11's. This scheme allowed both the old and new computer systems to share the CAMAC subsystem, and this approach provided for little or no interruption of normal operating schedules.

Two new database structures were created during this period. The first was the more dynamic Vsystem run-time database. The design philosophy was to create many small run-time databases rather than one or two large databases. These databases were device oriented. As an example, all beam transport devices such as focusing and steering elements, as well as bending magnets, were placed in one database, while other devices that had different requirements for control and monitoring were placed in other databases. Since the MicroVAX would ultimately be the only direct link to the CAMAC subsystem in the future, these run-time databases were installed on the MicroVAX. This configuration would eliminate, in the future, any need for CAMAC I/O requests to be transmitted over the Ethernet.

The second, more static, database was also installed on the MicroVAX. This is a relational database. Originally this was a DEC product called "Rdb", but the product has since been purchased by Oracle Corporation, and is now called "Oracle Rdb". Fortunately, functionality has remained the same.

The Rdb database contains information such as a device's name, physical location in the facility, chassis rack location, associated channel name in the Vsystem run-time database, and any other information about the device that would be inappropriate to store in the Vsystem run-time database.

Three methods are provided to gain access to the data in the Rdb database. The first method allows control processes to query and update data via code written in the Structured Query Language (SQL). The second method is simply using an interactive terminal session to manipulate data using SQL. The third approach provides the operator with an easier to use interface. This interface is a Borland product called Paradox running on a PC. The implementation of this interface provides the operator with a "point and click" windowing environment for manipulating data in the Rdb database.

After the first phase of the upgrade was completed, control and monitoring of the positive ion injector was integrated into the main control system, thus eliminating one of the three PDP-11's. In addition all processes used for the control and monitoring of all beam transport devices were moved to the newly acquired MicroVAX, and a graphical workstation was installed in the main control room as an operator interface. The MicroVAX was configured, and functioned as the network/cluster server.

4. UPGRADE PHASE TWO

During the second phase of the upgrade, the roles of the PDP-11's and the MicroVAX were reversed from what was earlier described. Handlers were written to use Vista CAMAC library routines. Handler names in the Vsystem run-time databases were changed to the new handler names, and the databases were re-generated. The MicroVAX was connected directly to the CAMAC serial highway using a Kinetic Systems 2060 Q-Bus interface.

Having successfully completing these tasks, the need for the second of the three PDP-11's was eliminated. The one remaining PDP-11 now communicates to CAMAC via the MicroVAX. Once again this approach provided a convenient method for porting processes from the old system to the new system without interfering with the accelerator's operating schedule.

During this second phase six PC's running Pathworks, and operating as "X" terminal emulators were installed to provide remote monitoring and control of virtually any parameter of the accelerator. Primarily these units are used as remote monitoring displays.

An additional workstation (a DEC ALPHA running Open VMS) was added to the main control room providing the operator with two interfaces to the control system.

In addition applications had been written to execute on the MicroVAX and on a PC running in Paradox, to archive accelerator tune-up configurations. This allows previous accelerator tune-up configurations to be restored.

By the end of the second phase of the upgrade the majority of all the remaining processes used for accelerator control and monitoring were moved to the MicoVAX. This accomplishment provided complete control of the accelerator and beam transport devices using the new control system.

5. THE FINAL PHASE

When the final phase of the upgrade project is completed the control system will be configured as shown in Figure 2.

The present software and database configuration is as follows:

- Vsystem provides the basic software interface to the system's hardware.
- There are approximately 40 Vsystem Vdb databases.
    - The smallest of these contains 2 channels.
    - The largest contains 1320 channels.
- The Rdb database contains approximately 65 tables and views.
- There have been approximately 25 control and monitoring facility specific programs written by ATLAS staff. Almost all of these are written in FORTRAN.
- There have been approximately 20 handlers and conversion routines, implemented as shareable images, written by ATLAS staff.

The present hardware configuration is as follows:

- All control system computers are linked via Ethernet.

- The system's boot node/cluster server is a DEC MicroVAX 4000 model 200 with 64 Mb of main memory running VMS and DECnet.

- Three work stations running VMS and DECnet are utilized...

    - A VAXstation 3100 model 76 with 16 Mb of main memory is used for software development.

    - A VAXstation 4000 model VLC with 16 Mb of main memory is used as an operator's console in the main control room.

    - An ALPHA Station 200 model 4/100 with 32 Mb of main memory is also used as an operator's console in the main control room.

- Eight PC's with 486 type CPUs running Pathworks are used...

    - One of these PC's is used in the main control room for database management, and other miscellaneous tasks by the operator. This machine uses Micro Soft (MS) Windows as an operating system.

    - Another PC is used for software development. This machine runs DEC's Excursion under MS windows.

    - The remaining six PC's are used for remote display and monitoring. These machines run MS DOS and DEC's DEC Windows for DOS. Since these machines contain no hard disks, they boot DOS from a 3.5 inch diskette. The remaining software plus an initial Vdraw display is down-loaded over the network when the control system is started.

- Three Hytec knob units are used as operator interfaces. Two are located in the main control room, while the third is at a remote location.

- The I/O subsystem is CAMAC, and it is interfaced to the MicroVAX via a Kinetic System model 2060 Q-Bus to CAMAC serial highway interface. The highway operates in the "byte-serial" mode at 2.5 Mhz.

- There are 15 CAMAC crates on the serial highway.

There are approximately three processes still executing on the last PDP-11, which need to be ported to the new control system. Unfortunately these are complicated applications dealing with automatically tuning the accelerator for a particular beam, and automatically adjusting the accelerator's output energy. For this reason they will take longer to rewrite.

However, when the final phase is completed all processes will have been moved to the new computer system, and the last PDP-11 will be retired.

The MicroVAX will be replaced by a machine using the latest RISC technology. This machine will be connected directly to the CAMAC serial highway thus completing the initial goals of the upgrade project.

Work supported by the U.S. Department of Energy, Nuclear Physics Division, under contract W-31-109-ENG-38.

REFERENCES

1. F. Munson, M. Ferraretto, and B. Rutherford, "Status of the ATLAS Control System Upgrade", informal report (Sept. 23, 1992).

2. F. Munson, and M. Ferraretto, "Upgrading the ATLAS Control System", informal report (Sept. 8, 1993).