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SAMS — The Synchronization and Monitoring System for ATF Data Acquisition*

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Abstract

SAMS performs much of the synchronization of the distributed data acquisition system for the Advanced Toroidal Facility (ATF). SAMS is responsible for propagating shot information and managing the data system directories and logical names. This paper describes how SAMS communicates with other processes, both within the VAX cluster that supports most of the ATF data acquisition and on VAXes that are connected to the cluster via DECnet.

Introduction

The ATF is a stellarator at the Oak Ridge National Laboratory (ORNL) that is scheduled to begin operation in mid-1987.[1] The data acquisition system for ATF is an independent set of tasks distributed across several VAX computers. The activities of those tasks are coordinated by SAMS (Synchronization and Monitoring System). To this end, SAMS' primary duties are to keep track of shot numbers, propagate timing signals, maintain a shot data base, and maintain a set of shot-related logical names. SAMS can also keep current data in memory for fast access by analysis tasks.

ATF Data Acquisition System Architecture

The ATF data acquisition system architecture is highly distributed.[2] Data are to be acquired and/or analyzed on multiple nodes of the ORNL Fusion Energy Division (FED) VAX cluster and also on one or more VAXes that are remote from the cluster but connected to it by DECnet. In addition, the data acquisition and analysis processes themselves may run as subprocesses of SAMS, as detached processes, or as terminal-bound processes, if operator input is required. Regardless of the method by which the processes are run, the same set of calls is used to communicate with SAMS. In fact, the same process may be written to run by any of the above methods. In addition to providing considerable flexibility in implementing data acquisition and analysis processes, the distributed nature of the data system minimizes the chance that a failure in one data process can affect another process.

A set of subroutines has been provided to communicate with SAMS. These calls provide a high-level interface for the calling program and eliminate the need for the program to understand the communication mechanisms. The same set of calls is used regardless of the system on which the program is being run. Therefore, a program may be written, linked, and tested on one system, and the same executable image may be copied to another system to be placed into production.

All data management is done by the ATF data management software.[3] Therefore, SAMS does not need to understand the data storage/retrieval system. However, for convenience, SAMS provides two services to the data management software. First, SAMS maintains a logical name that identifies the disk and directory where data are to be stored. (SAMS creates the directory if necessary.) Second, SAMS can maintain current data in memory using global sections to provide very fast access for data analysis programs.

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SAMS Modes

SAMS may be invoked in any one of three modes: test, system, and watch. Regardless of the mode, the same image is invoked. A qualifier specified in the startup command determines the mode in which SAMS will configure itself.

Test Mode

Test mode is the default configuration for SAMS. In this mode, SAMS permits testing of data acquisition and analysis software independently of other activity on the system. SAMS will maintain a shot counter and simulate the occurrence of timing signals that are unique to the job in which SAMS is running. A single operator command can initiate an entire sequence of timing signals, or individual signals can be generated by separate commands, depending on the type of testing to be done. Unusual conditions, such as aborted shots, can also be tested. When run in test mode, SAMS defines a job-wide logical name, which will be translated before an identical system-wide logical name defined by system mode SAMS. This permits the interface routines of the data acquisition program to recognize the existence of the test mode SAMS and to use locks and mailboxes that communicate exclusively with the test version of SAMS.

When testing a data acquistion or analysis program, the tester invokes SAMS and then starts the program to be tested as a subprocess. The program may do I/O to the terminal, including VMS Debugger interaction. However, any unsolicited input will be directed to SAMS to be interpreted as commands. This permits the tester to put breakpoints in the program, run the program until it is no longer expecting terminal input, and then issue a command to SAMS (to initiate a shot timing signal sequence, for instance). When the program encounters a breakpoint, it will enter a Debugger interactive session.

System Mode

System mode is the "operational" mode for SAMS. Exactly one system mode SAMS must be present on each system for which shot information is required. One system mode SAMS is designated the "master" SAMS and maintains the official shot number, date and time. The master SAMS normally runs on one of the cluster nodes and generates timing signal information for all data processes on the cluster. (The system mode SAMS on the other cluster nodes maintain only the shot-specific logical names and global sections for the individual nodes.) The master system SAMS is the only SAMS to acquire timing signals from the Master Timing Generator (MTG), which generates the timing signals for ATF. This is done via a BiRa Digital Input 322 CAMAC module. The master system SAMS is also responsible for maintaining a database of shot numbers, times, and statuses.

Unlike test and watch modes, special privileges are required to invoke SAMS in system mode. As a result, SAMS may be invoked in system mode only from an account which limits the user to a predefined menu of possible activities.

Watch Mode

In watch mode, SAMS may be used to investigate the status of other SAMS processes operating in test or system mode. All operator commands are disabled except those which display information. Likewise, all communication with other SAMS processes or with data processes is disabled. A watch mode SAMS can be used to display timing signal information and information about the ATF locks. In the future, most of

SAMS' internal data structures will be kept in global sections. This will allow a watch mode SAMS to display the status of those structures for other copies of SAMS.

Communications With Data Processes

SAMS communicates with the data processes by means of a set of logical names, mailboxes, and locks. Logical names are used to determine the type of SAMS with which the processes are communicating (test or system) and the names of the mailboxes via which the communication is done. SAMS maintains a single mailbox into which requests from data processes are placed. This mailbox is primarily used to receive connection requests from data processes and requests to maintain global sections in memory. Each data process maintains its own mailbox for receiving responses to its requests to SAMS.

Timing signal information is passed via a set of VMS locks. One lock is used for each timing signal. The lock value block is used to pass the shot number, date and time, and status information. This provides fast, cluster-wide distribution of timing signal activity. To protect against a terminal-bound data process acquiring a lock after a CTRL-Y is pressed but while the image has not yet been run down, a handler has been written to force image run-down when CTRL-Y or CTRL-C is pressed.

Communications Among SAMS Processes

The distributed nature of the ATF data acquisition system requires that shot-related information be available on several processors. This information includes the occurrence of timing signals, the shot number, and the shot date and time. A set of logical names that contains the shot information and specifies where data are to be stored for the shot must be maintained. SAMS must also maintain a set of global sections that contain data from the most recent shot(s).

All copies of SAMS other than the master system copy are essentially slaves and must obtain shot number, signal, and time information from the master SAMS. The mechanism used by a slave copy of SAMS depends on whether the slave is in the cluster with the master or is on a remote node reachable only by DECnet. Since the VMS locks used by SAMS to distribute timing signal information are cluster wide, slave SAMS running in the same cluster as SAMS simply receive their information via those locks. In this case, the slave SAMS merely have to maintain the ATF logical names that are shot number dependent and manage global sections.

Slave SAMS on remote nodes do not have access to the timing signal locks of the cluster. In this case, DECnet is used. The master SAMS declares itself to be a DECnet object and can support multiple links to remote systems. Each remote SAMS connects to the master SAMS via a DECnet link and receives the shot information via that link. In this case, the slave SAMS must recreate the timing signal locks for its own system and manage the logical names and global sections. In all cases, the information on shot number and time is obtained from a single source — the master copy of SAMS.

Actually, all system copies of SAMS connect to the master SAMS via a DECnet link. This permits interrogating the master SAMS for the most recent shot information as part of the startup procedure. For copies of SAMS running in the cluster, however, this is the only use of the DECnet link.

Operator Interface

SAMS is invoked as a "foreign command," with qualifiers defining the mode in which SAMS is to operate. Once invoked, SAMS provides a large number of operator commands. All commands have a DCL-like syntax, which is easily understood by users familiar with VMS. Commands and qualifiers may be truncated to the shortest unique string. The commands allow the operator to alter SAMS operation (such as the way in which timing signals or errors are logged) and to examine the contents of most internal data structures. Common command sequences may also be entered via command procedures (files containing the commands). However, procedures may not be nested. Documentation is available both in the form of a reference manual and as on-line help.

Virtually all initial configuration information is passed by operator commands. This includes the initial shot number (if necessary) and the name and type of the CAMAC module that communicates with the MTG. At startup time, a logical name and/or a qualifier may be used to identify command procedures for SAMS to execute as part of the startup sequence. These commands usually identify the CAMAC modules to be used and initiate the data acquisition processes to run as subprocesses of SAMS.

Conclusions

SAMS is a central part of the ATF data acquisition system. It provides services to data acquisition and analysis processes, both for shot timing activity notification and for data management. The various modes in which SAMS can be invoked and the extensive operator interface provide substantial flexibility and ease in developing, testing, and monitoring the activities of the data processes as well as SAMS itself. SAMS also permits data processes to be run on virtually any FED VAX, either as part of the cluster or connected to the cluster via DECnet.

References

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