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MPS VAX MONITOR AND CONTROL SOFTWARE ARCHITECTURE*

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Abstract

The new Machine Protection System (MPS) now being tested at the SLAC Linear Collider (SLC) includes monitoring and controlling facilities integrated into the existing VAX control system [1]. The actual machine protection is performed by VME micros which control the beam repetition rate on a pulse-by-pulse basis based on measurements from fault detectors. The VAX is used to control and configure the VME micros, configure custom CAMAC modules providing the fault detector inputs, monitor and report faults and system errors, update the SLC database, and interface with the user. The design goals of the VAX software include a database-driven system to allow configuration changes without code changes, use of a standard TCP/IP-based message service for communication, use of existing SLCNET micros for CAMAC configuration, security and verification features to prevent unauthorized access, error and alarm logging and display updates as quickly as possible, and use of touch panels and X-windows displays for the user interface.

Introduction

The new MPS [1] can be broken into three separate hardware subsystems each responsible for a piece of the overall machine protection:

Beam control

The beam control subsystem [2] is resident in VME micros located close to beam monitoring devices within the machine. The beam control micros acquire data on a pulse-by-pulse basis from CAMAC modules using MIL-1553 serial protocol, process the data using a downloaded MPS algorithm file, and send the resultant beam repetition rate to a SLC micro called the master pattern generator (MPG). The algorithm file used for data processing contains logic which dictates the repetition rate to be adopted based on which devices are currently tripped. Beam control micros are also known as algorithm processors (APs).

The APs also send trip information and error messages up to the VAX and respond to VAX control and status requests. Communication with the VAX is achieved using the TCP/IP-based area message service (AMS) [3]

SLC micros

Functionality has been added to the existing SLC micros to also configure MPS CAMAC modules and periodically verify that the CAMAC hardware is consistent with the requested settings in the database. The MPG, a special SLC micro, has been enhanced to provide the current repitition rate to the beam control micros and acquire and process the resultant rate requested by these micros. The communication link with the VAX and the SLC micros is SLCNET, a high-speed polled network developed at SLAC.

VAX monitor and control

The existing VAX control system has been enhanced to provide MPS monitoring and control. New and existing programs have been developed or enhanced for MPS and include the SLC control program, MPS controller, MPS event manager, MPS status display handler, and the error manager. Data flow between VAX processes and the interface between these processes and the beam control and SLC micro subsystems are shown in Fig. 1.

SLC Control Program

The SLC Control Program (SCP) provides a user interface for many SLC control functions and has been upgraded to handle MPS requests. There is one SCP process for each user, and each process gets input from a keyboard and touch panel and provides output to a high resolution color-graphic display and standard terminal. If the SCP is run on a VAX workstation, all input/output uses an X-windows interface.

When the SCP receives a MPS user request, it prepares and sends a message to the MPS controller process using a VMS mailbox and waits for a return message indicating whether the request was implemented successfully or not. User requests include:

1. Change MPS State—MPS may be turned on or off.
2. IPL AP—one or all AP's may be booted.
3. Download Algorithm—after an algorithm is changed and recompiled, the user may request that it be downloaded to the AP.
4. Bypass/Unbypass Device—when a beam monitoring device is determined to be unreliable, the user may override the current device state with a bypass value and unbypass the device after it has been fixed.
5. Configure CAMAC Module—settings in the CAMAC module including threshhold and filter values may be changed in the database and the module configured with the new values.
6. Save and Load MPS Configuration Files—a snapshot of the current MPS database information may be saved or restored.

Each MPS user request is associated with a privilege level where lower privilege levels correspond to relatively harmless actions like verification and higher privilege levels correspond to more disruptive actions like downloading new algorithms. Each privilege level is mapped to a VMS account name, and when the user makes a request, the appropriate account name and password must be entered before mail is sent to the MPS controller.

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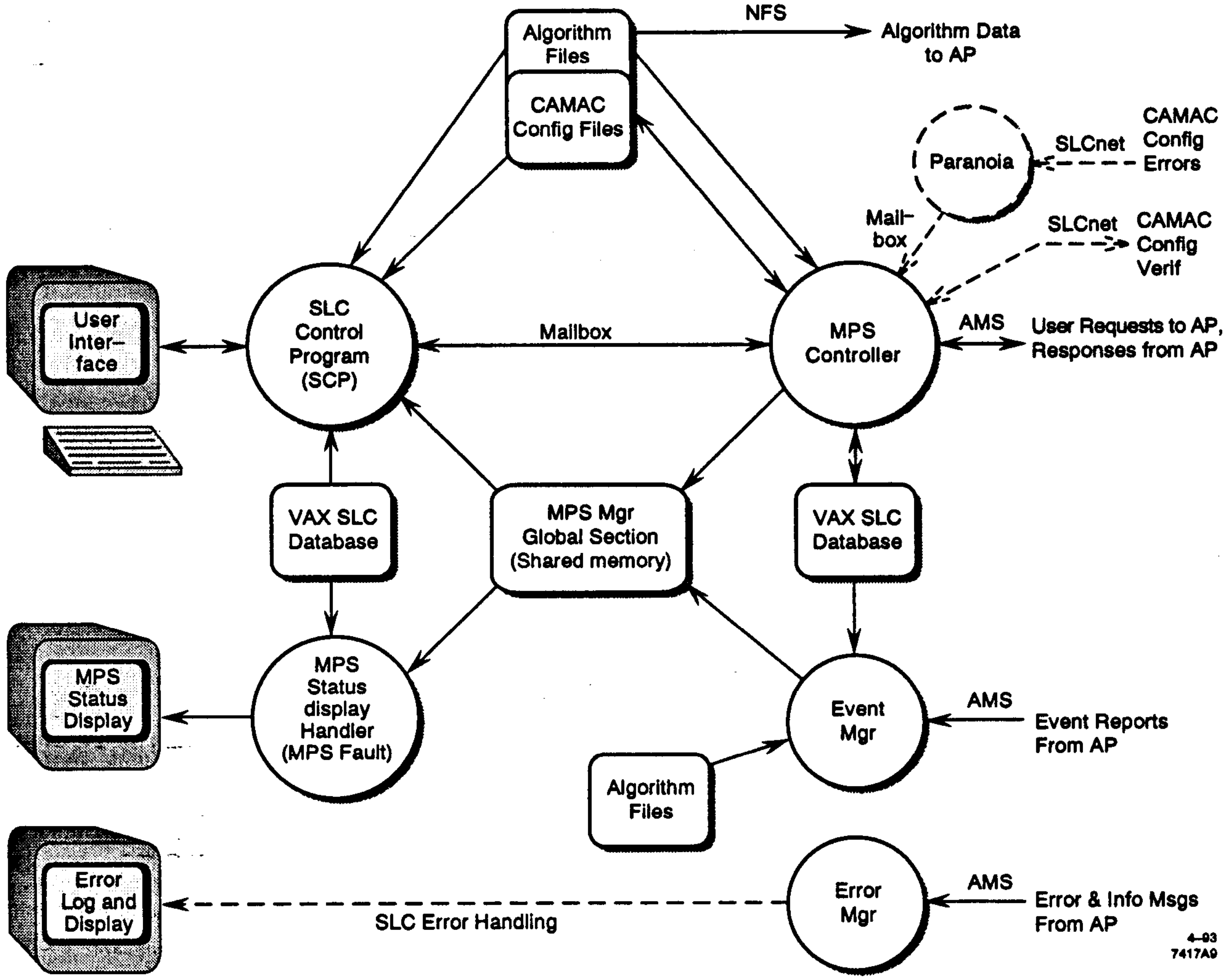

Figure 1. **MPS VAX System Flow**

The SCP also provides a variety of MPS status and information displays for access by any user. These displays include:

1. System Network Display—the overall MPS state and status is shown along with the status of each AP and each MPS VAX process. This display updates periodically.
2. Bypass Display—a subset or all currently bypassed devices are retrieved from the database and shown along with the bypassed state, expiration time, and other relevant information.
3. Device Display—the current device state and associated CAMAC module information from the database are shown for a specified subset of devices.
4. Fault Display—devices which are currently tripped and rate-limiting the beam are shown, along with the current MPS state and requested rate. This display updates as quickly as possible whenever any condition changes. In order to make the display as real-time as possible, the SCP gets its fault and state information from the MPS manager global section which is itself updated by the MPS controller and event manager processes.

Online help provides the user with a description of the action taken when any button is selected on any MPS panel. An online glossary is available to help familiarize the user with important MPS terms. The SCP outputs messages to help guide the user through prompts and warn of potentially disruptive consequences. Detailed error messages are also output when an unexpected condition is detected. Standard functions are used for database displays, paging and printout of output displays, and the configuration file interface.

MPS Status Display Handler

The MPS status display handler uses data from the MPS manager global section to update the MPS status display on an overhead terminal in the control room. The MPS status display is similar to the SCP fault display described earlier in that it shows all currently faulted devices and the current beam repetition rate along with up-to-date status information.

This display provides a quick summary to the user so that prompt action can be taken to either correct any situation causing a device fault (i.e., by correcting the beam orbit) or bypass the unreliable faulted devices. Also, this display shows verification errors detected in any MPS subsystem in enough detail to allow easy diagnosis and correction.

MPS Controller

The MPS controller process is the overall coordinator of all MPS subsystems. It services all MPS requests from other VAX processes including user requests from the SCP and halt requests from the error manager, and deals with CAMAC configuration errors sent by the SLC micros through PARANOIA, a process that receives asynchronous SLCNET messages. It periodically checks the health of the MPS by verifying that the networks and micros are still active, sending verification requests to the micros and checking their responses for validity and consistency, and checking the status of other MPS VAX processes. If any error is found, MPS is halted either immediately or after an appropriate number of warning messages are output depending on the severity of the error. All verification errors are updated in the MPS manager global section and reported to the standard error handler for logging and broadcasting to all SCPs,

The controller is also the keeper of the database and updates information pertaining to overall MPS state and status, the status and configuration data for each AP, information about each bypassed item, and the configuration data for each CAMAC module. On user request, current MPS configuration data from the database is saved to a file or loaded back into the database. When a user request causes the CAMAC configuration data to change in the database, SLCNET messages are sent to the affected SLC micros to update the CAMAC hardware. The controller periodically checks that the current data in the database matches the values in the "ideal" or golden configuration file.

When the user requests a change in MPS state, the controller sends AMS messages to the APs and SLCNET messages to the MPG in the sequence required to produce a smooth transition to the on or off state. When a new algorithm needs to be downloaded to an AP, the controller checks the algorithm for validity, copies it from the library to the production directory, updates the database, and sends a message to the AP to read in the new file. When the user requests an AP IPL, the controller halts MPS, resets the AP hardware, spawns a subprocess to load the AP with an image residing on the VAX, updates the database, sends a message to the AP with algorithm and bypass information, and turns MPS back on.

When a device is bypassed, the controller updates the database with the device identification, bypassed state, and time at which the bypass expires. When the device is unbypassed, the entry in the database is erased. For both actions, the controller sends a message to the affected AP containing the location and value of the bypassed bits in the raw data acquired from the CAMAC modules. When a bypass expires, the controller automatically unbypasses the associated device.

MPS Event Manager

The MPS event manager receives and processes event buffers from the event task on an AP and updates the MPS manager global section with current faults, repetition rate, and status of the AP. There is one event manager process for esch AP in the system, and each event manager writes to its own slice of the global section. The AP sends an event buffer both periodically (i.e., every 5 s) and whenever it either finds a trip or has an error that results in a rate change. Each event in the event buffer contains the raw data read from the CAMAC modules, indication of which CAMAC modules could not be read, the current rate broadcast to the AP, the new rate requested by the AP, and the AP status. Events are buffered by the AP to prevent a flood of AMS messages when rate-changes happen at a very high frequency.

The event manager runs the raw data through the same algorithm as the AP but unlike the AP, which must process and send results at a very high rate, the event manager has the time and access to the database to do extra processing. It translates faults which are just bits to the AP to device and state names that are understandable to the user. The CAMAC module name and location are determined for any port which could not be read by the AP. The current and requested rate integer values are translated to meaningful character strings. Since the event manager uses the same algorithm and data as the AP, it also checks that it gets that same results as the AP, providing extra verification of AP functionality.

Error Manager

The error manager is a simple process which receives error message buffers sent using AMS from any micro task and then forwards these messages to the standard SLC error handler for logging, display, and broadcasting to the SCPs. Error messages are buffered on the micro side to prevent a flood of AMS messages when a flood of errors are experienced by the micro. If an error is associated with a particular SCP process, that SCP identification is included in the buffer so that the error is sent to just that SCP instead of all SCPs. If a fatal error is detected from an AP, error manager also sends mail to the MPS controller to halt MPS.

References

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