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**THE DATA-DRIVEN ALARM SYSTEM FOR THE CERN PS ACCELERATOR
COMPLEX**

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International Conference on Accelerator and Large Experimental Physics Control
Systems
Berlin, Germany, October 18-22, 1993

Geneva, Switzerland
15/11/93

THE DATA DRIVEN ALARM SYSTEM FOR THE CERN PS ACCELERATOR COMPLEX

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The accelerator equipment is driven by a set of object-oriented software modules, arranged in a class hierarchy. An equipment class, when called with the equipment identifier and the selector 'alarm', will return the operational status of the piece of equipment. This is implemented by inheritance of the ALARM class by the equipment class, on top of its normal inheritance. The ALARM class itself is data-driven, with all data derived from entries in a relational database which are down-loaded when the modules are installed. On any operator console, a motif based application can be called which scans any subset of the equipment for alarms and displays the relevant alarm information. The operator can request detailed information about the equipment and the alarm status, and can try to reset the equipment.

1. Introduction

Our new alarm system is limited to checking accelerator equipment and some essential computers and general services because safety is monitored by other systems. The alarm system uses the equipment interface and the working-set concept of the operator interface [1] and also the general philosophy of data-driven software. It gives a general overview of the status of the surveyed equipment but permits also detailed checks and reset of the faulty equipment.

2. Equipment Modules and the ALARM Selector

The accelerator equipment is driven by a set of object-oriented software modules (Equipment Modules or EMs [2]), arranged in a class hierarchy where each class inherits the characteristics of its superclass. Much of the implementation details (addresses, limits, scaling factors) are coded in class and instance variables and most of this is read-only in operation. These read-only values are stored in an Oracle relational database and downloaded into the modules when they are installed in microprocessors, located in the vicinity of the equipment they control.

The alarm system makes full use of this architecture. The variables and methods for alarm checking are defined in a virtual class ALARMS. Any EM can inherit from this class on top of its normal inheritance just by setting a flag and by filling in the necessary parameters in the database. When the EM is installed (in a processor in a VME crate), it is sufficient to address the EM with the equipment identifier and the selector 'ALARM' and the EM will respond with an integer (0 if all OK) which can be decoded as an alarm category and an alarm message.

The ALARM selector calls a unique method which is completely driven by the data in the class and instance variables, which are passed as parameters. This method does several checks in succession:

- It checks the integrity of the link between the microprocessor and the equipment (serial CAMAC, MIL1553 or point-to-point link).
- It determines the desired state of the equipment by acquiring and interpreting the relevant state control sent to the equipment (this is stored in the EM). It does this by recursively calling the EM with the specified selector. It then determines, in a similar way, the actual state (ON, OFF, STANDBY, IN, OUT, ...) and checks whether it is the same as the desired state.
- For each of up to 3 equipment status words, it acquires the word, masks irrelevant data and compares the bit pattern with a reference bit pattern. For each bit (or group of bits) that is different from the reference, an error number and a priority are noted. If there are several errors, the one with the highest priority wins.
- If a value checking mode is specified, the relevant control and acquisition values are acquired and compared with specified limits or absolute and relative tolerances.

If, at any stage, an error is detected, the appropriate error code is returned.

The operator selects the working set for the equipment, which is usually one or more complete accelerators. Calls to the equipment are grouped by class.

3. Alarm Display

The alarm display program runs on any console and has a Motif interface. It scans on a cyclical base

(once every minute) all equipment elements in its acquired working set. The base window is shown in Fig. 1.

ALARM Program						
GROUP MEMBERS		MORE DETAILS		COMMANDS PAGE		RESET EQUIPMENT
MASKED EQUIPMENTS		MASK EQUIPMENT		UNMASK EQUIPMENT		OTHERS ACCELERATORS
						EXPLOITATION
LPI Machines		TOTAL ERRORS COUNT: 16		MASKED EQUIPMENTS: 3		Thu Oct 14 07:51:29 1993
Time	OB Name	Class	Element	Equipment Description	Faults Description	Faults
☐ Thu 07:45	HR.KFI71	POV	9051	---	WARNING: BAD STABILITY	1
☐ Thu 07:45	HTE.VVS-20	BVVS	9012	---	QUAD CHANNEL OFF	11
☐ Thu 07:45	VL.PDK13-PHAS	PHAS	8002	---	STE:WATCH-DOG; ST:TESTBIT A2	2
☐ Thu 07:48	VL.PDK03	PDDL	8001	LPI MODULATOR-KLYSTRON 03	MODULATOR HV FAULT LEVEL 4	1
☐ Thu 07:48	VL.PDK13	PDDL	8002	LPI MODULATOR-KLYSTRON 13	MODULATOR HV FAULT LEVEL 3	1

Fig. 1 : Upper part of the main alarm display

The main part of the display shows the equipment faults, one line per element or group of elements with the same error message. Below (not shown here) is the status of the relevant microprocessors and of some general services. On top of the window are a number of buttons for obtaining additional information, in general for the active fault line (selected with the cursor). The operator can:

- Show the detailed list of elements in the fault group.
- Show general information about any element in the group and the meaning of any bit in the

status and control words (Fig.2). The static part of the information for this comes from the database.

- Control the equipment
- Try to reset the equipment by sending a reset sequence to each element in the group.
- Mask the element by setting a flag in the EM.
- Show masked equipment and unmask some elements.
- Select another working set, corresponding to an accelerator or a group of accelerators.
- Get details and control over any element in the working set, whether it is in fault or not.

Detailed informations on equipment : VL.PDK03-PHAS (no description)		
OB Name : VL.PDK03-PHAS		CCSACT
Member number : 8001		CCAD
Host name : dlilgump		SAGD
Class name : PHAS		QUAD ON/OFF
Class number : 102		QUAD STATUS
Camac address : L1 C13 M9 A0		QUAD ERRORS
CCSACT : 0000000000000010		
CCAD : 0000000000000010		
bit	Value	Meaning
bit 0 :	0	0-OPEN-LOOP
bit 1 :	1	0-CLOSED-LOOP
bit 2 :	0	0-CALIBRATION
bit 3 :	1	EQUIPMENT NOT OK
bit 4 :	1	EQUIPMENT NOT UP
bit 5 :	1	EQUIPMENT IN LOCAL CONTROL
bit 6 :	0	I-CAL-IN-PROGRESS
bit 7 :	0	I-EXT-INTERLOCK
bit 8 :	0	I-RF-SYNC-FAULT
bit 9 :	0	I-CALIB-FAULT(SEE 13 OR 14)
bit 10 :	0	I-SERVO-FAULT(PHAS<CCV)
bit 11 :		
bit 12 :	0	I-KLYSTRON-NOT-READY
bit 13 :	0	I-ANALOG OVERFLOW (>5VOLTS)
bit 14 :	0	I-ANALOG-TOO-LOW
bit 15 :		
no fault		not set

Fig. 2.: Details about an alarm

Conclusions

The alarm system is conceptually simple and yet powerful and reliable. The alarm checking is done close to the source and the polling mechanism eliminates the central alarm concentrator. Reliability is further enhanced by doing a full check each time instead of only reporting state changes. All this is possible because the polling mechanism itself is efficient. The system is very useful for keeping accelerator downtime low and an alarm window with the interesting subset is usually permanently displayed on a workstation close to the operator. Maintenance of the alarm system is easy because including new equipment involves no change of code but only an update of the database through a dedicated menu and data entry forms.

References

- [1] The Operator Interface to the Equipment of the CERN PS Accelerators, J.Cuperus, F.Di Maio, C.H.Sicard, this conference.
- [2] Process Equipment Data Organization in CERN PS Controls, L.Casalegno, J.Cuperus, C.H.Sicard, Int. Conf. on Accelerator and large Exp. Physics Control Systems, Vancouver, Nov. 1989.