THE NEW SOFT-IOC-BASED ALARM HANDLER AT THE SPALLATION NEUTRON SOURCE*

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Abstract

The standard EPICS alarm handler tool (ALH) does not integrate well with other EPICS client applications. At SNS, we wanted the ability to incorporate alarm summaries and alarm controls such as masks and resets into screens in the display manager as well as the ability to call display screens from alarm screens. To achieve these aims, we built a soft-IOC-based alarm handler that runs in Linux soft IOCs. A set of scripts builds EPICS databases, display manager screens, and startup scripts for standard Linux soft IOCs from old EPICS Alarm Handler (ALH) or extensible markup language (XML) configuration files. With this new tool the summaries, masks and latch status can be incorporated into other EPICS client applications. In this paper we describe our experience building and using the soft-IOC-based alarm handler everywhere that alarms are defined in the SNS control system.

DEFINING THE PROBLEM: HOW TO INTEGRATE ALARMS

Previous to the development of the soft-IOC-based alarm handler, the Spallation Neutron Source (SNS) controls group had tried a number of different approaches to alarm handling. The cryogenic systems, the IOC (input-output controller) summary and the operator top-level summary screens used a number of EPICS database calculation records to summarize machine status which was then displayed using the extensible display manager (edm). Some systems such as the target system used the standard EPICS alarm handler (ALH) [3]. The calculation records were hard to maintain, operators resisted the use of ALH, and there was no easy way to integrate everything into a single system.

THE SOLUTION: THE SOFT-IOC-BASED ALARM HANDLER

Some of the calculation records used for alarm summaries were already running in soft IOCs – Linux processes sharing Linux servers with other such processes [1]. It seemed reasonable to replace those soft IOCs using scripts to build EPICS databases, displays, logging sequences and start-up scripts from XML configuration files [4]. The new XML files are much easier to maintain than the EPICS databases they replaced. The scripts were then extended to allow the alarm soft IOCs to be built from ALH-style configuration files.

Requirements

The new alarm handler needed to provide all the functionality provided by the systems it was to replace. Some important features are given below.

- It must be possible to group alarms hierarchically, with arbitrary numbers of alarms included in arbitrary numbers of levels.
- Each alarm should be maskable.
- It should be possible to find more information about any alarm. In some cases, this means getting to a display screen; in others, to a web page.
- Alarms should latch so that momentary glitches can be tracked.
- Operators must be presented with audible signals that identify alarms as they happen, such as by output to a voice synthesizer.
- Alarms must be logged.

In addition, when changing the software behind existing operator interfaces, it is very important to ensure that operators are comfortable with the new system. Interfaces with the appearance and functionality of the existing operator interfaces should be created from the new system.

The cryogenic system added a few requirements:

- A delay before latching some alarms must be configurable.
- It must be possible to interface alarms to devices such as phone dialers. This is important to achieve unmanned operation of the Central Helium Liquifier (CHL.)
- It must be possible to add logic to alarm elements.
- It must be possible to use templates and substitutions to configure systems with repeating components.

The IOC snapshot, which displays the status of system processors, added this requirement:

- Device heartbeats need to raise alarms when the process variable (in this case, the IOC heartbeat) has not updated in a specified time period.

Operators had a few wishes:

- Each alarm group should be maskable.
- Alarms only relevant in some machine modes could be masked automatically.
- It should be possible to see the alarm status of devices even if they are masked.

Software Structure

A soft alarm area in the EPICS shared area contains

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- Database templates
- Display screen templates
- Scripts for building the components of the individual alarm soft IOCs.

The soft IOCs are composed of the standard EPICS components:

- EPICS Run-Time Databases
  - Summary process variables
  - Mask process variables for both individual alarm points and for summaries.
  - Time stamps.
  - Logging process variables.
- Sequences to create logging records and to send logs to the Oracle relational database.
- Display screen files – a full-size and a miniature screen for the summary at each level.
- Soft IOC startup script.
- Autosave request files – all of the parameters needed so that the alarm masking survives a soft IOC reboot.
- Archive request files.

IMPLEMENTATION OF THE SOFT-IOC-BASED ALARM HANDLER AT SNS

System and Channel Counts

Soft-IOC-based alarm handlers are operating in ten systems at the SNS, as shown in Table 1.

Table 1: Soft-IOC-Based Alarms at SNS

System	PVs	Summaries	ALH Format
Accelerator Cooling	599	43	Yes
Conventional Facilities	270	72	Yes
Cryogenics	540	56	No
High Power RF	5611	52	No
Integrated Controls	2509	266	No
Personnel Protection	723	148	Yes
Target	545	84	Yes
Target Moderator	567	18	Yes
Timing	454	7	Yes
Vacuum	218	27	Yes
Totals	12036	773	

The process variable (PV) counts given in Table 1 are those being monitored by the soft IOCs. The soft IOC logic uses a large number of PVs for its logic; for example, the accelerator cooling system soft IOC uses 8677 PVs to monitor 599 points and serve 43 summaries.

All alarms are logged to XML-like files that are sent periodically to the Oracle relational database to make it possible to search through the alarm histories and to create alarm statistics.

Upon the occurrence of any of a subset of the alarms, a message is sent to a speech synthesizer in the control room.

Screen Examples

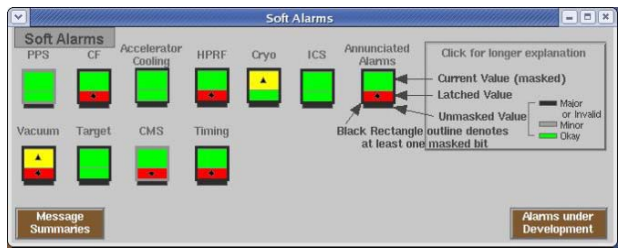

Figure 1: The Top Alarm Summary displays the status of all the alarms in the system. Since EPICS process variables provide the status, the information can be used in any EPICS client application.

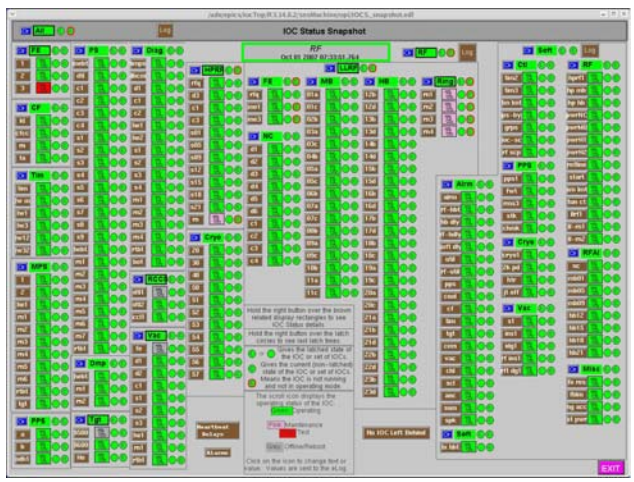

Figure 2: The IOC Status Screen was one of the previous status displays that the new alarm system had to replicate.

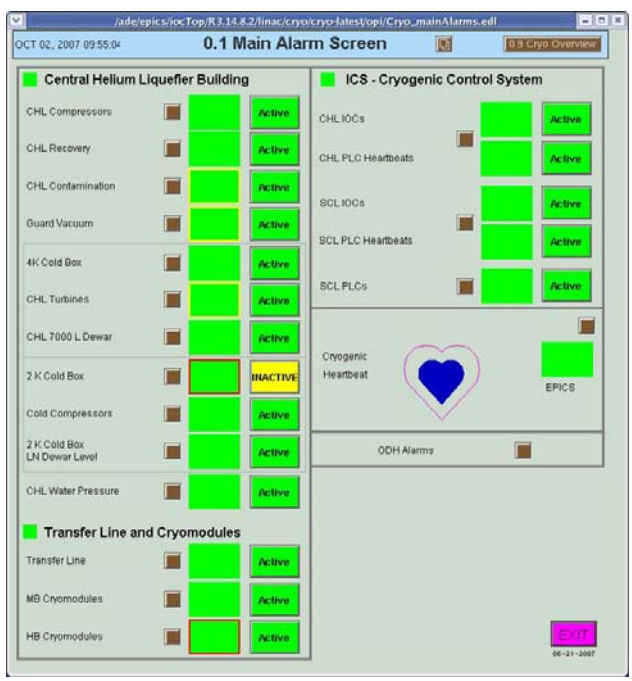

Figure 3: The Cryogenic Alarm Screens existed prior to the new alarm system, and would continue to be required.

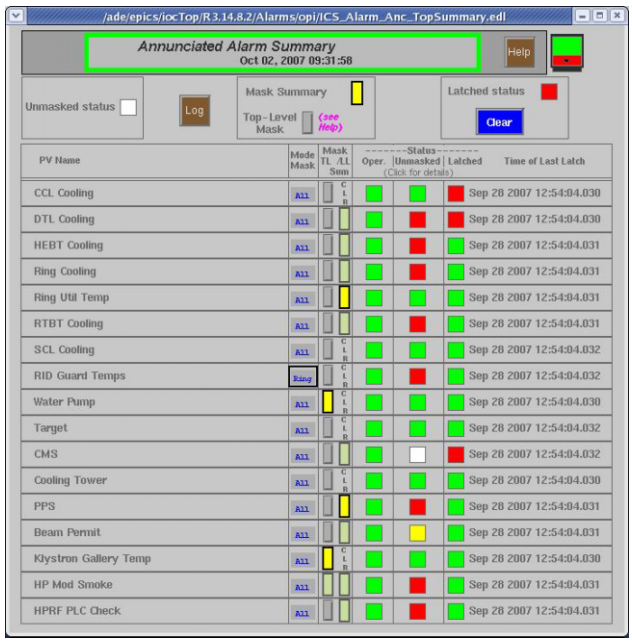

Figure 4: The Annunciated Alarm Summary and the soft IOC that provides its data and functionality is built automatically using the Soft Alarm scripts.

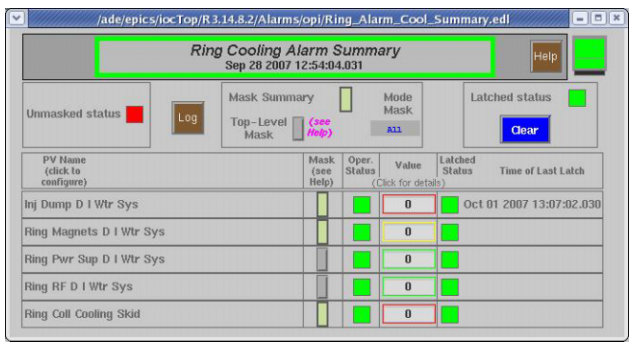

Figure 5: Another automatically created screen, the Ring Cooling Alarm Screen, shows individual alarm status bits.

EXPERIENCE WITH THE SOFT-IOC-BASED ALARMS AT SNS

The alarms are in constant use, both in the Central Control Room and in the CHL Control Room. Operators use the top-level alarm screen, the automatically created lower-level alarm screens and the masking facilities all the time. Occasionally, they refer to the alarm logs to find out the sequence of alarm events.

The main objection the operators have to the new soft-IOC-based alarm system is the many screens they have to drill down through to get to the actual alarm. This might be improved somewhat by more rational alarm configuration.

Most of the operators and control system engineers who have configured alarms have used the traditional EPICS ALH-style configuration files rather than the new XML-style configuration files [2]. This might be because of familiarity or because of a lack of clear documentation for the new XML format. The soft IOCs created by operators to summarize machine states have not yet been converted to the new alarm handler, though operators have said it would be a good idea.

The Linux server that runs the alarm soft IOCs and several other soft IOCs – a Hewlett Packard DL360 Intel 32 bit machine – is only about 10% busy, and thus can easily accommodate all the alarms the SNS needs in the foreseeable future.

THE FUTURE OF THE SOFT-IOC-BASED ALARM HANDLER

At the SNS, several systems need to be configured to complete the alarm systems, notably the low level RF systems and the power supply systems. The front end alarm configuration needs improvement to reduce the number of nuisance alarms before it is ready for full deployment.

A number of improvements should be made to the existing configuration files so that operators could click on any alarm summary or alarm point and get to more information about the system. Some of the capabilities have not really been used; for example, the machine mode could be used to reduce unwanted alarms in many more areas.

It could be useful to incorporate alarm summary process variables into more control system screens.

An attempt was made to create a configuration interface and an operator status display interface using CSS/Eclipse (Control System Studio) [5], [6]. CSS would make it possible to enable operators to go directly to the alarm point, as they have requested. Also, an interface could be created to make alarm configuration self-explanatory. This approach seems hopeful, but much more work is needed to make it useful.

REFERENCES

[1] P. Gurd, G. Lawson, D.H. Thompson, E. Williams, "The Application of Linux 'Soft' IOCs for Status Summaries at the Spallation Neutron Source," ICALEPCS 2005, Geneva, November 2005.

[2] J. Munro, R.E. Battle, E. Danilova, R.L. Sangrey, E. Williams, "A Proposed Alarm Handling System Management Plan for SNS with Application to Target Control System," ICALEPCS 2007, Knoxville, October 2007.

[3] http://www.aps.anl.gov/epics/extensions/alh/index.php The EPICS Alarm Handler.

[4] http://en.wikipedia.org/wiki/XML XML.

[5] http://css.desy.de/content/index_eng.html CSS.

[6] K. Kasemir, "Control System Studio Applications," ICALEPCS 2007, Knoxville, October 2007.