IMPROVED ALARM TRACKING FOR BETTER ACCOUNTABILITY*

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Abstract

An alarm system is a vital component of any accelerator, as it provides a warning that some element of the system is not functioning properly. The severity and age of the alarm may sometimes signify whether urgent or deferred attention is required. For example, older alarms may be given a lower priority if an assumption is made that someone else is already investigating it, whereas those of higher severity or alarms that are more current may indicate the need for an immediate response. The alarm history also provides valuable information regarding the functionality of the overall system, thus careful tracking of these data is likely to improve response time, remove uncertainty about the current status and assist in the ability to promptly respond to the same warning/trigger in the future. Since one goal of every alarm display is to be free of alarms, a clear and concise presentation of an alarm along with useful historic annotations can help the end user address the warning more quickly, thus expediting the elimination of such alarm conditions. By defining a discrete set of very specific alarm management states and by utilizing database resources to maintain a complete and easily accessible alarm history, we anticipate facilitated work flow due to more efficient operator response and management of alarms.

INTRODUCTION

It has been more than ten years since the alarm system used at the Collider-Accelerator Department at Brookhaven National Laboratory has had a significant upgrade. The original system was designed more than twenty years ago. The Department's growth over the years has created the need for more innovative presentation and management of alarms. One of the goals of the new system is to provide a clear and concise, yet complete, alarm management state of the machine. This addresses two goals. The first optimizes the utilization of screen real estate without adversely effecting the ability for an operator to be notified of an alarm or its severity. The second provides operators the ability to quickly address and respond to an alarm. A high level summary screen is used to accomplish the first goal while the combination of a discrete set of alarm management states and the ability to attach annotations to alarms can be used to accomplish the second goal.

SUMMARY DISPLAY

The summary display provides a simple overview of the overall state of alarms. Alarms are grouped by machine to allow for a quick determination of where the problem areas may be. An example of the summary screen is shown in Figure 1. The complex is broken down into eight machines. For each machine the current number of new alarms that have yet to be addressed by an operator are indicated by the number below the machine name. Color is used to represent the alarm with the most severe alarm level. There are five alarm levels. Green represents the least severe alarm, followed by blue, orange and brown. Red is used to identify the most critical alarm. The number appearing in parentheses represents the number of active alarms that are currently under investigation by an appropriate expert.

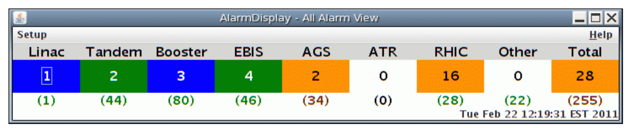
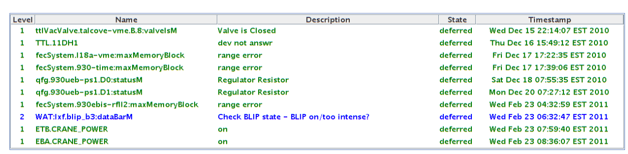


Figure 1: Summary Screen.

Interaction with the summary screen is also possible to allow an operator to obtain more details. The operator can obtain a quick view of individual alarms for a specific machine by clicking the right mouse button. The result is displayed in Figure 2. Displayed information includes individual alarm level, name, description, state and the time of occurrence.



Level	Name	Description	State	Timestamp
1	ttlVacValve.talcove-vme.B.8:valveIsM	Valve is Closed	deferred	Wed Dec 15 22:14:07 EST 2010
1	TTL.11DH1	dev not answr	deferred	Thu Dec 16 15:49:12 EST 2010
1	fecSystem.l18a-vme:maxMemoryBlock	range error	deferred	Fri Dec 17 17:22:35 EST 2010
1	fecSystem.930-time:maxMemoryBlock	range error	deferred	Fri Dec 17 17:39:06 EST 2010
1	qfg.930ueb-ps1.D0:statusM	Regulator Resistor	deferred	Sat Dec 18 07:55:35 EST 2010
1	qfg.930ueb-ps1.D1:statusM	Regulator Resistor	deferred	Mon Dec 20 07:27:12 EST 2010
1	fecSystem.930ebis-rfll2:maxMemoryBlock	range error	deferred	Wed Feb 23 04:32:59 EST 2011
2	WAT:lxf.blip_b3:dataBarM	Check BLIP state – BLIP on/too intense?	deferred	Wed Feb 23 06:32:47 EST 2011
1	ETB.CRANE_POWER	on	deferred	Wed Feb 23 07:59:40 EST 2011
1	EBA.CRANE_POWER	on	deferred	Wed Feb 23 08:36:07 EST 2011

Figure 2: Individual alarm details obtained by right mouse clicking over one of the machines in the summary screen.

The summary screen also provides the user the option to display a more comprehensive and interactive view. Some of the features of this display include options for obtaining alarm response instructions, diagnostic tools, setting masks, filters and viewing past alarm logs.

ANNOTATIONS AND STATE CHANGES

A discrete set of states is defined to disseminate information about the current condition of an alarm with regard to the recovery process. There are six discrete states for an alarm as seen in Table 1.

Every new alarm may progress through several states before it clears. Some alarms may clear on its own without a state change. The current state of an alarm is the first signal to an operator that provides an indication of whether or not some action is required. The operator or system expert controls the state of an alarm and can update it at any time via the user interface (Fig. 3).

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Current and past states for every alarm can be viewed with this interface. Additional information is also available to aid in the recovery process. This information includes the time when the alarm entered a particular state, the user who made the state change and any comments associated with that state. A complete history is also available to view previous instances of the same alarm. This is useful for discovering a recovery process or for identifying problematic alarms.

Table 1: Alarm Management States

State	Definition
New	Alarm has arrived and has not been investigated by an operator.
Seen	Operator has detected the alarm and assumes some responsibility to follow up.
Assigned	Operator can not resolve alarm independently. Alarm is forwarded to another group.
Deferred	Investigation is complete but resolution is not immediately possible (ring access, extensive work required).
Orphaned	Alarm is expected to persist. It is not expected that anything will be done about the alarm any time soon.
Cleared	Alarm has been resolved and is no longer visible on alarm screen (latched alarms may persist).

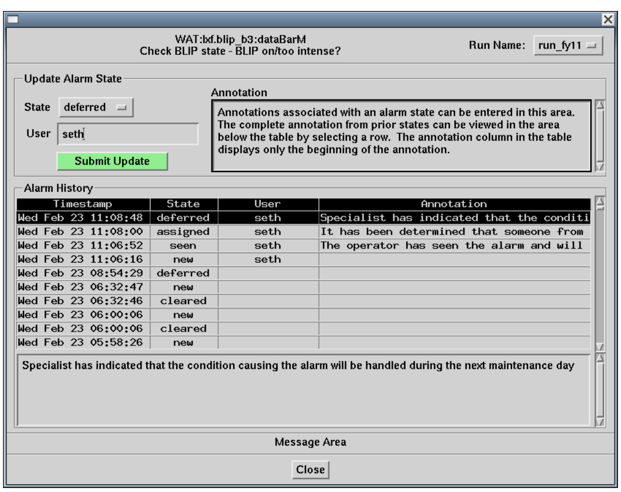

Figure 3: Alarm Display User Interface.

FILTERS

The main alarm display window (not pictured) can be customized to the particular requirements of the user through the use of alarm filters. Although it is anticipated that the use of filters will not be common practice for operators, they do provide a very useful function to system experts. These filters allow the user to hone in on specific types of alarms and are useful to system experts who may have a narrow focus.

There are several levels of filtering including a user defined filter that provides simplified regular expressions. The interface presented to the user starts with a broad scope filter on the left hand side and becomes more focused with each subsequent column. The user may be interested in defining one specific condition or some combination. Each condition is combined using a logical 'and' except for the user defined filter which uses the 'or' condition. The example shown in Figure 4 defines a filter where only new RHIC power supply alarms from the location at 1004B will be shown in the main display. Setting up a filter gives the user control to identify only the relevant alarms.

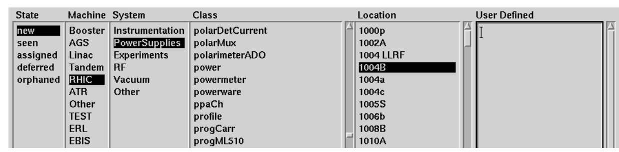

Figure 4: Alarm Filter Interface.

DATABASE LOGGING

Every alarm in the system is stored in a database. Each record includes all the relevant information about an alarm. This information can be used to provide easy access to a historical view of the accelerator state over any time period. Additional details associated with each record can be used to analyze and diagnose previous incarnations of an alarm.

SYSTEM COMMISSIONING

The importance of a reliable alarm system can not be overstated. Therefore, careful steps must be taken during the commissioning of the new system. Failure conditions must be anticipated and addressed. In order to accomplish this task the new alarm system has been set up to run in parallel with the current operational system. Careful analysis of alarm records between the two systems has taken place in order to guarantee that alarms are not missed. Special procedures have been set up to periodically check the integrity of the new system. Failure conditions have been pursued along with recovery process techniques. It is anticipated that several months of commissioning will uncover most conditions that have otherwise not been explored.

Running the new system in parallel allows operators to gain confidence in the new system and to become accustomed to new and changed functionality. The goal is to complete the transition over the next few months.

FUTURE WORK

The transition of the new alarm system to an operational state will not necessarily signify the end of the development process. A second phase of development that addresses presentation and handling issues is planned. This development phase will not impact the communication aspect of the system and therefore should not effect reliability when the new system becomes operational.

For example, there is a plan to provide a customized view of old alarms by taking advantage of database queries. An interface will be designed to allow the user to provide very specific conditions for viewing old alarms. A related activity will allow the user to replay machine alarm conditions between two time periods. This will be viewed as a diagnostic tool that will enable the user to get real time visual feedback on the state of alarms through the user interface.

There are additional plans that focus on operator support. The tendency for alarms to be missed can sometimes be enhanced during shift change. For example, an operator may be responsible for several alarms that may fail to get transferred to the new operator during the shift change. The plan will be to allow the Control Room Coordinator the autonomy to automatically transfer alarms between operators. This would help alleviate the possibility of missed alarms.