Control System Studio Training
- Alarm System Usage

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Alarm System Components

- Configuration
- User Interface
- Alarm Server, …
- Control System
Levels Of Complexity

- Use the Alarm System
  - Control Room operator
- Configure the Alarm System
  - Certain operators, IOC engineers
- Alarm System Setup
  - CSS maintainer for site
- Coming up with a good configuration
  - Everybody
Operator Using the Alarm System

- Menu **CSS, Alarm, Alarm Table**
- Ideally: no alarms
Operator Looking at Alarm User Interface

- Other Alarm Views (Context Menu Alarm Perspective)
  - Alarm Tree displays items monitored by the alarm server
  - Area Panel displays state of areas
- Still, all OK
An Alarm Triggers!

Table shows what, when, …

Annunciator would say:

“Minor alarm: Overtemperature”
An Alarm Triggers...

Some operators prefer just the Alarm Table, others also like to look at Area Panel or Tree View

So there is a problem in the Ion Source Vacuum...
Context menu of Alarm

- Guidance

- Links to related OPIs
The Problem is fixed, Alarm clears

- By default, the alarm system latches alarms
  - “Current” severity of PV is **OK**, but **MINOR** alarm is remembered until alarm is ✔ Acknowledged
Guidance, Related Displays, Commands

- Basic Text
- Open EDM/OPI screen
- Open web page
- Run ext. command

Hierarchical:
Including info of parent entries
Merges Guidance etc. from all selected alarms
CSS Context Menus Connect the Tools

Send alarm PV to any other CSS PV tool
E-Log Entries

- “Logbook” from context menu creates text w/ basic info about selected alarms. Edit, submit.

- Pluggable implementation

- Similar: EMail
Alarm System Setup

- **Infrastructure**
  - Separate talks: RDB, JMS, AlarmServer, AlarmConfigTool
  - Assume there is an Alarm Server running

- **Machine, Control System, or at least soft IOC with alarm trigger PVs:**

  ```
  # EPICS (Soft) IOC Database
  # for alarm system demo
  #
  # Execute with
  #   softIoc -s -d alarm.db

  record(ai, "demo:temp")
  {
  field(INP, "20")
  field(EGU, "C")
  field(HIGH, "30")
  field(HSV, "MINOR")
  field(PINI, "YES")
  field(HOPR, "100")
  }"
Configuring the Alarm System

- Open Alarm Tree
  a) Menu CSS/Alarm/Alarm Tree
  b) Use Alarm Perspective

- Select alarm configuration
Alarm Configuration Hierarchy

- **Root**
  - Name of the alarm configuration

- **Area**
  - Top-level elements

- **System**
  - Anything below ‘Area’
  - Can have (Sub-)System below other System

- **PV**
  - Alarm trigger PV
  - Can be below Area or System
Why Hierarchy?

1. Organization
   - Easier to maintain than plain list of PVs

2. Help Operators Locate Alarm
   - Especially when there are many alarms, it can be useful to know where they are
   - Use physical “Areas”, i.e. location along the machine!

3. Guidance, Related Displays
   - Guidance for an Area or System will be displayed for all Subsystems and PVs below that point in the alarm configuration tree
   - Examples:
     - General Ion Source contact information (phone numbers, …)
     - Linac Overview display link
Editing the Alarm Configuration

- Open Alarm Tree
- Log in
- Use Context Menu to add, edit, remove, ...

Add a new Area, System, or PV
Add PV or Subsystem

1. Right-click on ‘parent’
2. “Add …”
3. Check either Area, System or PV
4. Enter name

Online. No search for config files, no restarts.
Configure PV

- Again online
- Especially useful for operators to update guidance and related screens.
PV Configuration

Full Path to PV in Alarm Tree

Description:
Also used for Annunciation

Guidance:
Simple Title & Detail that should help operators handle the alarm

Display Link Options:
/CSS/path/to/display opi
http://www.google.com
https://some.host.org
scriptname arg1 arg2

See online help for more details
Exercise: Edit Alarm Configuration

- Open Alarm Tree View
- Select the Alarm Configuration (‘root’) assigned to your team
- Add areas like “Front End”, “Linac”, “Target”
- Add Systems like “Vacuum”, “Cooling”
- Create simple BOY display that shows alarm trigger PVs and allows you to control them
- Add alarm trigger PVs to alarm configuration
  - Add some simple guidance like “Fix it”
  - Use path to your BOY *.opi as Display Link
Exercise: Use Alarm Configuration

- Switch to the Alarm Perspective
  - Can do that from context menu of alarm tree
- Use the display to trigger an alarm
- See how alarm is indicated in the table, tree, area panel
  - Open the guidance, related display
  - Cause the alarm PV to stop alarming
  - Acknowledge the alarm
General Alarm Server Behavior

- Latch highest severity, or non-latching
  - like ALH “ack. transient”

- Annunciate

- Chatter filter ala ALH
  - Alarm only if severity persists some minimum time
  - .. or alarm happens >=N times within period

- Optional formula-based alarm enablement:
  - Enable if “(pv_x > 5 && pv_y < 7) || pv_z==1”
  - … but we prefer to move that logic into IOC

- When acknowledging MAJOR alarm, subsequent MINOR alarms not annunciated
  - ALH would again blink/require ack’
Logging

- ..into generic CSS log also used for error/warn/info/debug messages
- Alarm Server: State transitions, Annunciations
- Alarm GUI: Ack/Un-Ack requests, Config changes
- Generic Message History Viewer
  - Example w/ Filter on TEXT=CONFIG
Logging: Get timeline

- Example: Filter on TYPE, PV

1. PV triggers, clears, triggers again
2. Alarm Server latches alarm
3. Alarm Server annunciates
4. Problem fixed
5. Ack'ed by operator
6. All OK
Web Report Examples

- Anything is possible
- Examples from SNS
  - Code would need some rework to port to other sites

Statistics based on CURRENT SEVERITY:

- Alarms duration frequency (hh:mm:ss)
  - Within selected time period:
    - start: OK
    - end: OK
  - Total alarms: 9967
  - Total time in alarmed state: 23:04:59
  - Severity counts:
    - MAJOR: 9967
    - MINOR: 0
    - INVALID: 0
    - ERROR: 0
  - Alarm durations (hh:mm:ss):
    - Minimum: 00:00:00 (less than 1 sec)
    - Maximum: 06:29:55
    - Average: 00:56:11
    - Most frequent: 00:00:00 (less than 1 sec)
  - Extreme durations:
    - Less than 1 sec: 5505
    - More than 12 hours: 0

Alarms on time line (10 min slices)

Alarms Active 24.0 h or more

<table>
<thead>
<tr>
<th>PV Name</th>
<th>Description</th>
<th>Path</th>
<th>Alarm Time</th>
<th>...Duration (HH:MM:SS)</th>
<th>Severity</th>
<th>Alarm Message</th>
<th>Current Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEBT_Chipn_PL1_V</td>
<td>Matrix chopper power supply one voltage fault</td>
<td>(Annotation:MEBT)</td>
<td>2009-03-16 12:17:55</td>
<td>42:08:57</td>
<td>MAJOR</td>
<td>LOLO_ALARM</td>
<td>MAJOR</td>
</tr>
<tr>
<td>MEBT_Chipn_PL2_V</td>
<td>Matrix chopper power supply two voltage fault</td>
<td>(Annotation:MEBT)</td>
<td>2009-03-16 15:17:55</td>
<td>42:08:57</td>
<td>MAJOR</td>
<td>LOLO_ALARM</td>
<td>MAJOR</td>
</tr>
<tr>
<td>HEBT_CothC1_C1C</td>
<td>HEBT_CothC1_C1C (Annotation:HEBT_CothC1_C1C)</td>
<td>2009-03-14 20:22:50</td>
<td>83:53:42</td>
<td>INVALID</td>
<td>INVALID</td>
<td>READ_ALARM</td>
<td>MAJOR</td>
</tr>
</tbody>
</table>
Creating a good Alarm Configuration

B. Hollifield, E. Habibi,
"Alarm Management: Seven (??) Effective Methods for Optimum Performance", ISA, 2007
Alarm Philosophy

Goal:

Help operators take correct actions

- Alarms with guidance, related displays
- Manageable alarm rate (<150/day)
- Operators will respond to every alarm (corollary to manageable rate)
What’s a valid alarm?

- **DOES IT REQUIRE IMMEDIATE OPERATOR ACTION?**
  - What action? Alarm guidance!
    - Not “make elog entry”, “tell next shift”, …
  - Consequence of not reacting?
  - How much time to react?
How are alarms added?

- **Alarm triggers: PVs on IOCs**
  - But more than just setting HIGH, HIHI, HSV, HHSV
  - HYST is good idea
  - Dynamic limits, enable based on machine state, ...

  Requires thought, communication, documentation

- **Added to alarm server with**
  - Guidance: How to respond
  - Related screen: Reason for alarm (limits, ...), link to screens mentioned in guidance
  - Link to rationalization info (wiki)
Example: Elevated Temp/Press/Res.Err./…

- Immediate action required?
  - Do something to prevent interlock trip

- Impact, Consequence?
  - Beam off: Reset & OK, 5 minutes?
  - Cryo cold box trip: Off for a day?

- Time to respond?
  - 10 minutes to prevent interlock?

- MINOR? MAJOR?

- Guidance: “Open Valve 47 a bit, …”

- Related Displays: Screen that shows Temp, Valve, …
Avoid Multiple Alarm Levels

- Analog PVs for Temp/Press/Res.Err./…:
  - Easy to set LOLO, LOW, HIGH, HIHI

- Consider:
  - Do they require *significantly different* operator actions?
  - Will there be a lot of time after the HIGH to react before a follow-up HIHI alarm?

- In most cases, HIGH & HIHI only double the alarm traffic
  - Set only HSV to generate single, early alarm
  - Adding HHSV alarm assuming that the first one is ignored only worsens the problem
Bad Example: Old SNS ‘MEBT’ Alarms

- Each amplifier trip: $\geq 3$ identical alarms, no guidance
- Rethought w/ subsystem engineer, IOC programmer and operators: 1 better alarm

<table>
<thead>
<tr>
<th>#</th>
<th>Date</th>
<th>Type</th>
<th>Name</th>
<th>Severity</th>
<th>TEXT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2009-03-16</td>
<td>13:46:20.255</td>
<td>talk</td>
<td>MAJOR</td>
<td>MEBBIT two power amplifier trip</td>
</tr>
<tr>
<td>2</td>
<td>2009-03-16</td>
<td>13:46:19.962</td>
<td>talk</td>
<td>MINOR</td>
<td>MEBBIT two power amplifier trip</td>
</tr>
<tr>
<td>3</td>
<td>2009-03-16</td>
<td>13:45:56.241</td>
<td>talk</td>
<td>MAJOR</td>
<td>MEBBIT two power amplifier trip</td>
</tr>
<tr>
<td>4</td>
<td>2009-03-16</td>
<td>13:45:25.963</td>
<td>talk</td>
<td>MAJOR</td>
<td>MEBBIT two power amplifier trip</td>
</tr>
<tr>
<td>5</td>
<td>2009-03-16</td>
<td>13:45:25.891</td>
<td>talk</td>
<td>MINOR</td>
<td>MEBBIT two power amplifier trip</td>
</tr>
<tr>
<td>6</td>
<td>2009-03-16</td>
<td>13:45:25.884</td>
<td>talk</td>
<td>MAJOR</td>
<td>MEBBIT two power amplifier trip</td>
</tr>
<tr>
<td>7</td>
<td>2009-03-16</td>
<td>13:23:09.202</td>
<td>talk</td>
<td>MINOR</td>
<td>MEBBIT two power amplifier trip</td>
</tr>
</tbody>
</table>
Alarm Generation: Redundant Pumps the wrong way

- Control System
  - Pump1 on/off status
  - Pump2 on/off status

- Simple Config setting: Pump Off => Alarm:
  - It’s normal for the ‘backup’ to be off
  - Both running is usually bad as well
    - Except during tests or switchover
  - During maintenance, both can be off
Redundant Pumps

- **Control System**
  - Pump1 on/off status
  - Pump2 on/off status
  - Number of running pumps
  - Configurable number of desired pumps

- **Alarm System:** Running == Desired?
  - ... with delay to handle tests, switchover

- Same applies to devices that are only needed on-demand
Weekly Review: How Many? Top 10?

Alarms Statistics, last 10 days, pattern: %

Pattern: %, 17-Mar-2009 00:00 for 0 days 24 hours (~)
Summary

- Easy to use
  - Check alarms in Table, Tree, Panel
  - Fix it: Read Guidance, use Display Links
  - ✔ Acknowledge

- Configuration
  - Can be changed online
  - Operators can update guidance or add better display links

- Alarm System Setup
  - Somewhat Involved, but only once

- Coming up with a good configuration
  - Hard