

Applications of Interest: A Relational Database Approach to Managing Control System Software Applications

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Applications of Interest (AOI) - Overview

- IRMIS Background
- What is an AOI?
- AOI Attributes
- AOI Crawler
- AOI Viewer
- AOI as an Engineer's Tool
- AOI as a Manager's Tool
- Summary of AOI Principal

What is an Application of Interest?

- AOI (Applications of Interest) is a database software application that is used as an extension of IRMIS
- Main purpose of AOI is to identify, track, provide links to supporting documentation, and report the state of control system “applications of interest”
- An Application of Interest is any set of code (source code, databases, sequence programs, configuration files, displays) that performs a controls function requested by a customer
- Numerous possibilities exist to integrate AOI with file storage utilities such as SVN and Integrated Content Management System (ICMS), APS operations logging utilities such as the Controls Group Logbooks, APS online work request procedures, and more...
- Examples of AOIs at APS
 - LINAC RF Switching Control System
 - Vacuum Valve Control
 - Machine Protection System (MPS)
 - Over 130 AOIs cataloged already for the APS linac, expect to exceed 300

IRMIS Background Information

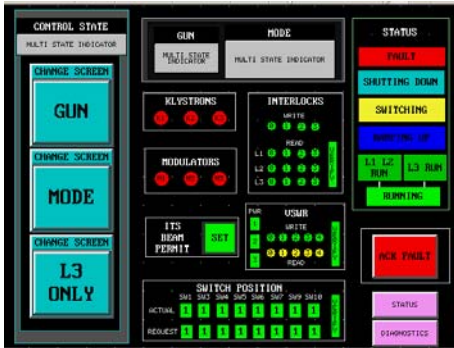
- IRMIS is the collaborative effort between several EPICS sites to build a common relational database schema for documenting large and complex accelerator control systems
- At the Advanced Photon Source, IRMIS is a collection of Java, PHP, and Perl tools that search and populate a MySQL database
- IRMIS stores information on programmable control devices such as IOCs and PLCs, and the process variables and interconnecting hardware shared among these devices
- The user interface for IRMIS is organized into the separate viewers:
 - IOC
 - PLC
 - Component Type
 - Network
 - Controls Spares
 - Cables
 - Applications of Interest

SVTS	IOC	REC_NAME	TYPE
booster	iocbpm1	iocbpm1.iocScanPeriod	ao
booster	iocbpm1	iocbpm1.iocScanRate	longin
booster	iocbpm1	iocbpm1.iocScanRate2	ao
booster	iocbpm1	iocbpm1.iocScanRate3	ao
booster	iocbpm1	iocbpm1.iocScanRate4	ao
booster	iocbpm1	iocbpm1.iocScanRate5	ao

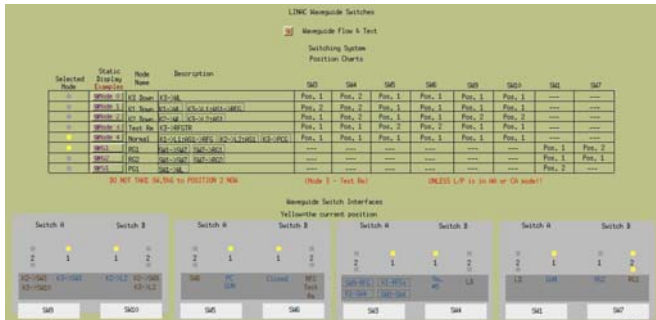
How to define an AOI...

...Let's start with LINAC RF Switching Control System example

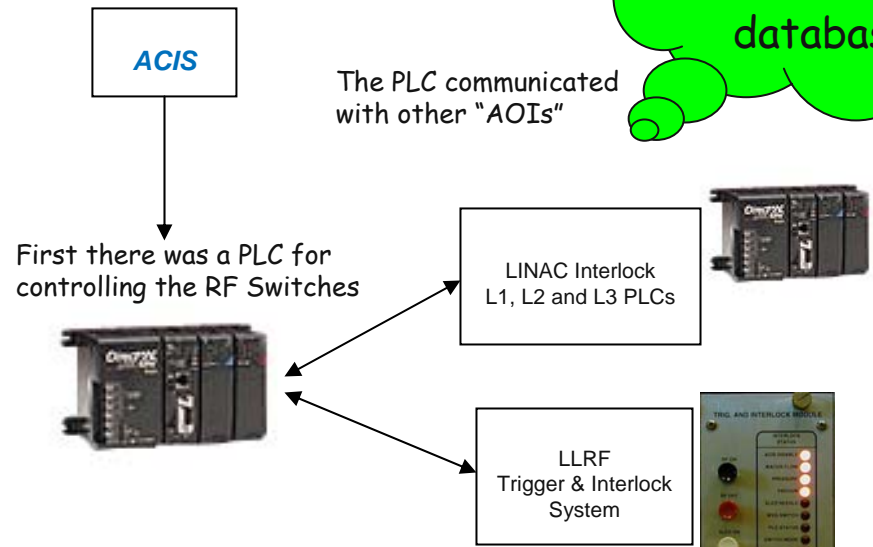
The PLC had Touch Screens with built-in logic for User Interface Control



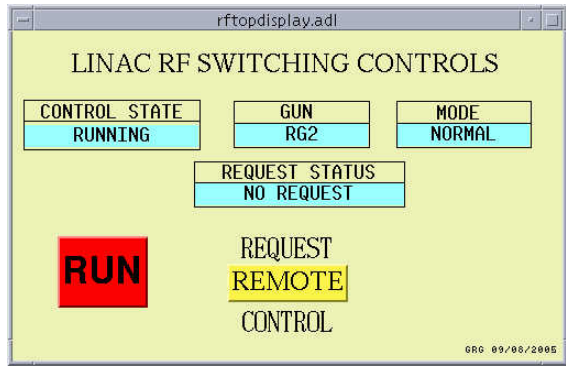
MEDM displays monitored RF switch positions



How do we store all this information in an AOI database?



Then along came request for remote control from the Main Control Room - MEDM displays with built-in logic



Start by defining the *attributes* of the AOI...

AOI attributes defined by controls developers:

Attribute	Example
AOI Name	aoi_sr_mps_system_latch-card
Cognizant 1	Marty Smith
Cognizant 2	Ned Arnold
Customer Group	Controls
Criticality	2 Equipment or Beam Inhibit Risk
Description	The latch cards are installed in 20 VP IOCs around the ring.
Status	Active
Functional Criteria	A validation procedure confirms the functionality of the system after every shutdown.
Keywords	MPS, latch card, beam inhibit
Notes	Request was made to Operations Group on 10/29/06 to add list of process variables to dump data printout following an MPS trip.
EPICS Top Displays	- /usr/local/iocapps/adlsys/srbpm/miscApp/mainMPS.adl - /usr/local/iocapps/adlsys/sr/mpsApp/MPS-latchMasterPanel.adl
Revision History	Storage ring MPS latch card consolidation project began April/May 2006 shutdown. New EPICS sequence program was installed for sectors 1 through 14, and 35 through 40.
Documents	ICMS

AOI Naming Convention

- A two-level hierarchy relationship of parent-child is used to identify closely associated AOIs
- Example

Parent AOI: `aoi_linac_diagnostics_flag`

Child AOI: `aoi_linac_diagnostics_flag_fs-1`
 `aoi_linac_diagnostics_flag_fs-4`
 `aoi_linac_diagnostics_flag_fs-7`

- Fields in an AOI Name:

`aoi_<machine>_<technical system>_<unique function>_<child>`

AOI Criticality Levels

1. Personnel Risk [e.g., Radiation Safety System]
2. Equipment or Beam Inhibit Risk
3. Beam Performance Risk
4. General Operations
5. R&D [e.g., Test Stand]

Options for AOI Status

- Active
- Inactive
- Decommissioned
- Under Development
- Other

AOI Crawler

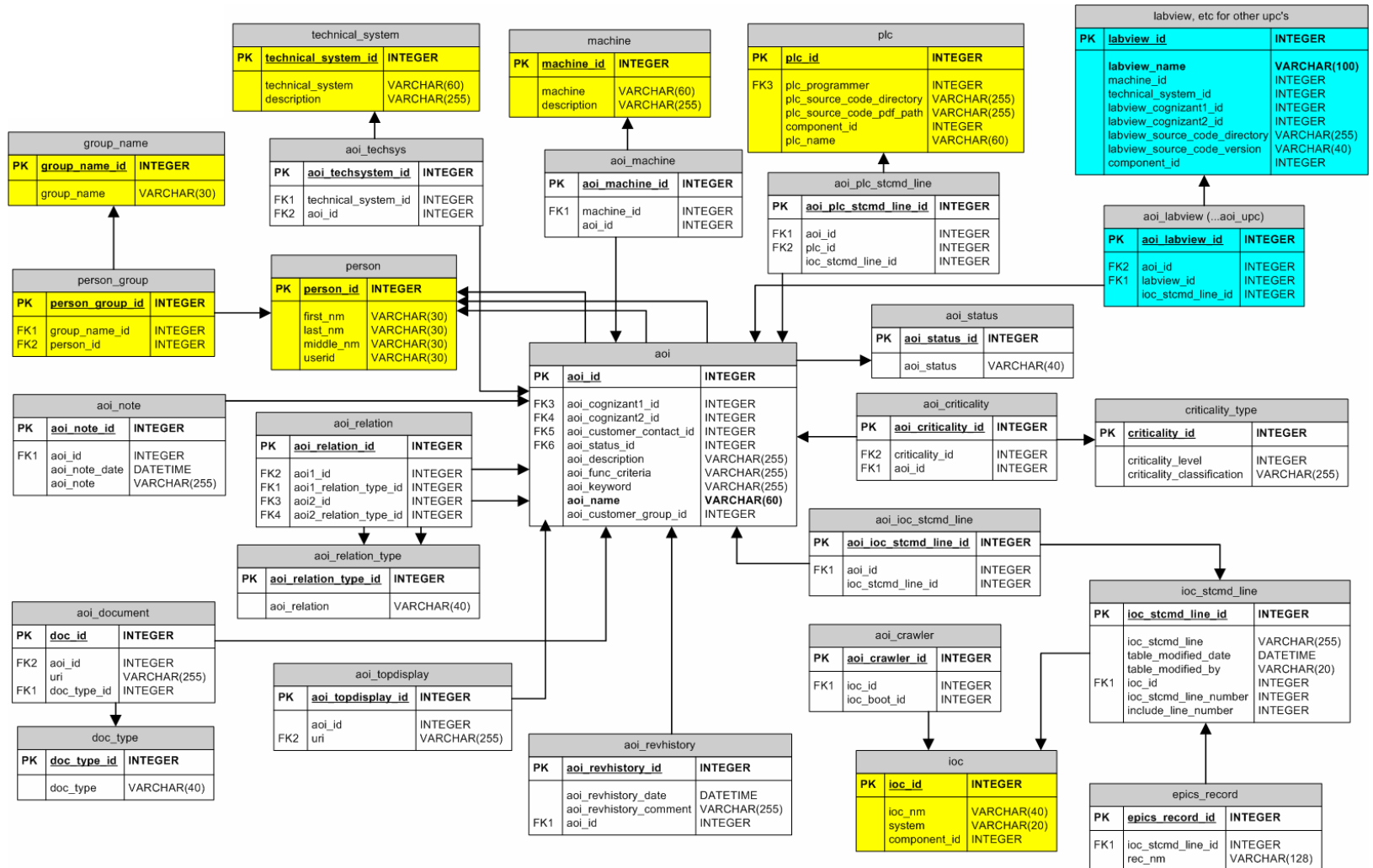
- AOI Crawler parses EPICS IOC startup command files to retrieve information about:
 - User programmable components (IOCs, PLCs, LabView, ...) associated with each AOI
 - Process variables (PVs) associated with each AOI
 - And any startup command line that an AOI EPICS developer wants to be stored in the AOI database for later viewing directly through IRMIS
 - *sequence programs* *Id < mpsTesterSingleLatchCard.o*
 - *configuration data* *MpcConfig 0,0x3100,80,3*
- AOI Crawler is written in Perl, runs continuously
- AOI Crawler writes information to a MySQL relational database
- Parsing requires unique AOI comment lines in the startup command files

Example AOI Marked Up IOC Startup Command File

```
.  
. .  
# Absorber Databases  
#dbLoadRecords ("vpApp/absDb/H2O-xx-FlowPres.db", "SECTOR=05, NODE=18")  
#dbLoadRecords ("vpApp/absDb/H2O-xx-FlowPres.db", "SECTOR=06, NODE=20")  
  
#<aoi name="aoi_sr_absorber_water_s5">  
  
dbLoadRecords ("vpApp/absDb/DL250stat.db","name=S05:H20:PLC,addr=L1 N20 P1 S1")  
dbLoadRecords ("vpApp/absDb/PlcVersionInfo.db","name=S5VP:H20:PLC,addr=L1 N20 P1 S1")  
dbLoadRecords ("vpApp/absDb/H2O-xx-FlowPresOdd.db","SECTOR=05,addr=L1 N20 P1 S1")  
dbLoadRecords ("vpApp/absDb/H2O-xx-FlowPresEven.db","SECTOR=06,addr=L1 N20 P1 S1")  
dbLoadRecords ("vpApp/absDb/H2O-SECTOR-PW-SH-Temp.db", "SECTOR=06")  
  
#</aoi>  
  
dbLoadRecords ("vpApp/facilitiesDb/Ambient-SECTOR-Temp.db", "SECTOR=05, NODE=18")  
dbLoadRecords ("vpApp/facilitiesDb/Ambient-SECTOR-Temp.db", "SECTOR=06, NODE=20")  
. . .
```

XML Style
Tags

AOI Database Schema



AOI at Work

AOI Edit Basic Search Results Page - Microsoft Internet Explorer

Address: http://maia/~quock/aoi_viewer_editor/action_aoi_edit_tools.php

AOI Search Criteria

AOI Name: Machine: Technical System: PLC: IOC: Cognizant: Criticality: Keyword: PV:

AOI Name
4 AOIs Found

- [aoi_sr_mps_system](#)
- [aoi_sr_mps_system_latch-cards](#)
- [aoi_sr_mps_system_local-fault-cards](#)
- [aoi_sr_mps_system_main](#)

Edit Tools

Create New AOI - Required Fields

Define AOI General Information

AOI Name: Machine: Technical System: Unique Function: Children (Optional):

Cognizant 1: Cognizant 2:

Customer Group: Criticality:

Description: Status:

Optional Fields

Define AOI General Information

Functional Criteria: Keywords:

Define AOI Note

Note:

Define AOI MEDM Top Displays

URI

Top Display:
Top Display:
Top Display:
Top Display:
Top Display:

Define AOI Revision History Comment

Comment:

Define AOI Documents

URI

Document Type:

Similarity Graph Analysis of Applications of Interest (AOI)

Example of AOI Properties Defined Numerically

AOI	Criticality	Technical Systems	Machines	PV Writes	PV Reads	PVs to Other PVs	Documents	UPCs
1	2	1	2	21	32	5	5	3
2	4	1	1	11	100	26	2	1
3	1	2	1	35	84	15	6	2

Similarity graph analysis of an AOI is based on the principle of comparing the absolute value of the differences in the AOI properties.

Let p_i be the value of property i . A graph vertex v is then defined as $(p_1, p_2, p_3, p_4, p_5, p_6, p_7, p_8)$ where each vertex in the graph corresponds to an AOI. That is, v_i corresponds to AOI i .

The dissimilarity function S is used to compare AOIs in pairs. Given the vertices

$$v = (p_1, p_2, p_3, p_4, p_5, p_6, p_7, p_8) \text{ and}$$

$$w = (q_1, q_2, q_3, q_4, q_5, q_6, q_7, q_8)$$

we define the dissimilarity function S as

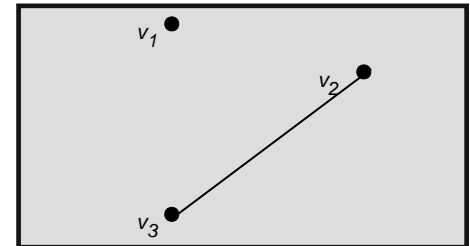
$$S(v, w) = |p_1 - q_1| + |p_2 - q_2| + |p_3 - q_3| + |p_4 - q_4| + |p_5 - q_5| + |p_6 - q_6| + |p_7 - q_7| + |p_8 - q_8|$$

For the three example AOIs given in Table 1, the dissimilarity function S for each AOI pair is

$$S(v_1, v_2) = 107, \quad S(v_2, v_3) = 60, \quad S(v_1, v_3) = 81$$

The value of S for a given pair of AOIs can be used as an indication of how similar or dissimilar the AOIs are. The higher the value of S , the more dissimilar the AOIs. Classes of AOIs can be defined in terms of a range of S values. For example, we could consider all dissimilarity functions $S(v, w)$ that have a value less than 80. In a similarity graph, an edge is inserted between vertices v and w for each $S(v, w) < \text{fixed number}$. The class of $S < 80$ would then include AOIs 2 and 3 in our example above. By graph analysis, vertices are said to be in the same class if there is a path connecting them.

Similarity Graph



Summary of Applications of Interest

The IRMIS viewer Applications of Interest enables quick and intuitive access to control system information by:

- Parsing EPICS startup command files for current database load lines, and thus, current process variables (PVs)
- Acting as the central starting point for locating pertinent engineering drawings, procedures, revision history, etc. for a specific AOI
- Easily identifying closely associated AOIs through the naming convention and parent-child hierarchy structure
- Providing links to other IRMIS viewers to search for associated hardware and software details

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