IRMIS Approach for Control System Applications

Applications of Interest (AOI)

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Applications of Interest – Overview

- What is an AOI?
- AOI Attributes
- AOI Crawler
- AOI Viewer
- AOI as an Engineer's Tool
- AOI as a Manager's Tool

What is an AOI?

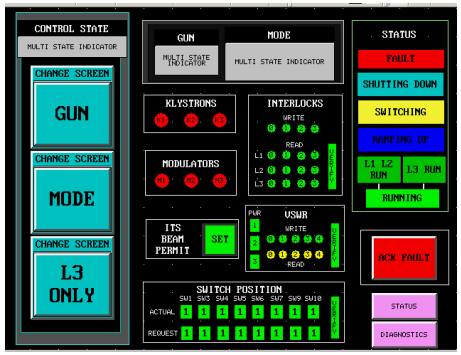
- AOI (Applications of Interest) is a database software application that is to be used as an extension of IRMIS
- Main purpose of AOI is to identify, track, provide links to supporting documentation, and report the state of "applications of interest"
- An Application of Interest is any set of code (source code, databases, sequence programs, configuration files, displays) that performs a function requested by a customer
- Numerous possibilities exist to integrate AOI with file storage utilities such as SVN, PDM Link, ICMS, etc., 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
  - BESOCM Trigger Select System
  - Vacuum Valve Control
  - Power Supply Control
  - And many more...

How to define an AOI...

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

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

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



ACIS

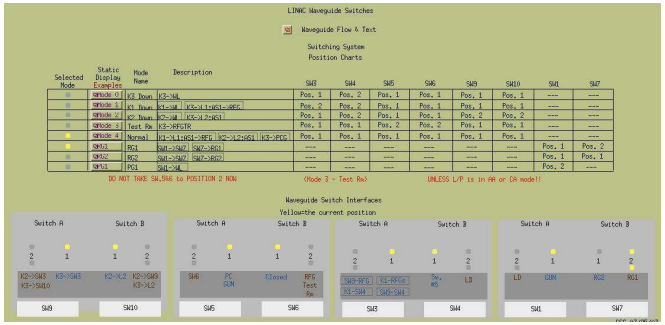
The PLC communicated with other "AOIs"

First there was a PLC for controlling the RF Switches

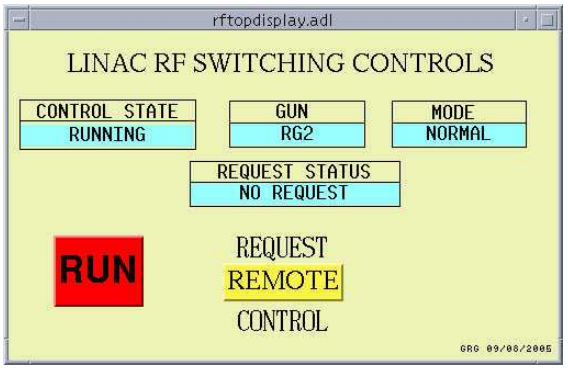
LINAC Interlock
L1, L2 and L3 PLCs

LLRF
Trigger & Interlock
System

MEDM displays monitored RF switch positions



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...

Name:	aoi_sr_absorber_water
Criticality Level:	2
Machine:	Storage Ring
Technical System:	Water
Cognizant 1:	Rick Putnam
Cognizant 2:	Jim Stevens
Customer:	Rick Putnam
Supporting Documents:	URIs...
Top MEDM Displays:	URIs...
UPCs:	iocs5vp, plc_absorber_s5_water, ...
EPICS PVs:	H2O:05:C1:F:OpenM, ...
Revision History:	Upgrading sectors 35 and 36 during April/May 2006 shutdown
Developer Notes:	Open Item: Create MEDM process flow diagrams
General Description:	
Functional Criteria:	
Keywords:	
Status:	under development

Do you know where your AOIs are?

Parent AOIs and Children AOIs

AOI Naming Convention

Parent AOI: aoi_sr_absorber_water

Child AOI: aoi_sr_absorber_water_s5

Fields in an AOI Name:

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

AOI Criticality Levels

Level	Classification
1	Radiation Safety System
2	Equipment Protection (Interlocks, Soft interlocks, Absorber water flow, etc.)
2	Injection Beam
2	Machine Studies (Scrapers, Optics, etc.)
2	Storage Ring Beam
3	Storage Ring Performance
3	Operations - Priority 1 (Personal Safety System IOCs, Flag/Actuator Controls, etc.)
4	Operations - Priority 2 (Vacuum pressure readbacks, IOC status display, Control System Operational Tools (MEDM, IRMIS, iocConsole, etc.), Control System Development Tools (PAMS, VisualDCT, etc.))
5	Research & Development (MM1, RF Gun Test Stand, Laser Room, etc.)

AOI Status

- active
- inactive
- decommissioned
- under development

AOI Document Types

- block diagram
- tutorial
- quick reference manual
- troubleshooting procedure
- validation procedure

AOI Crawler

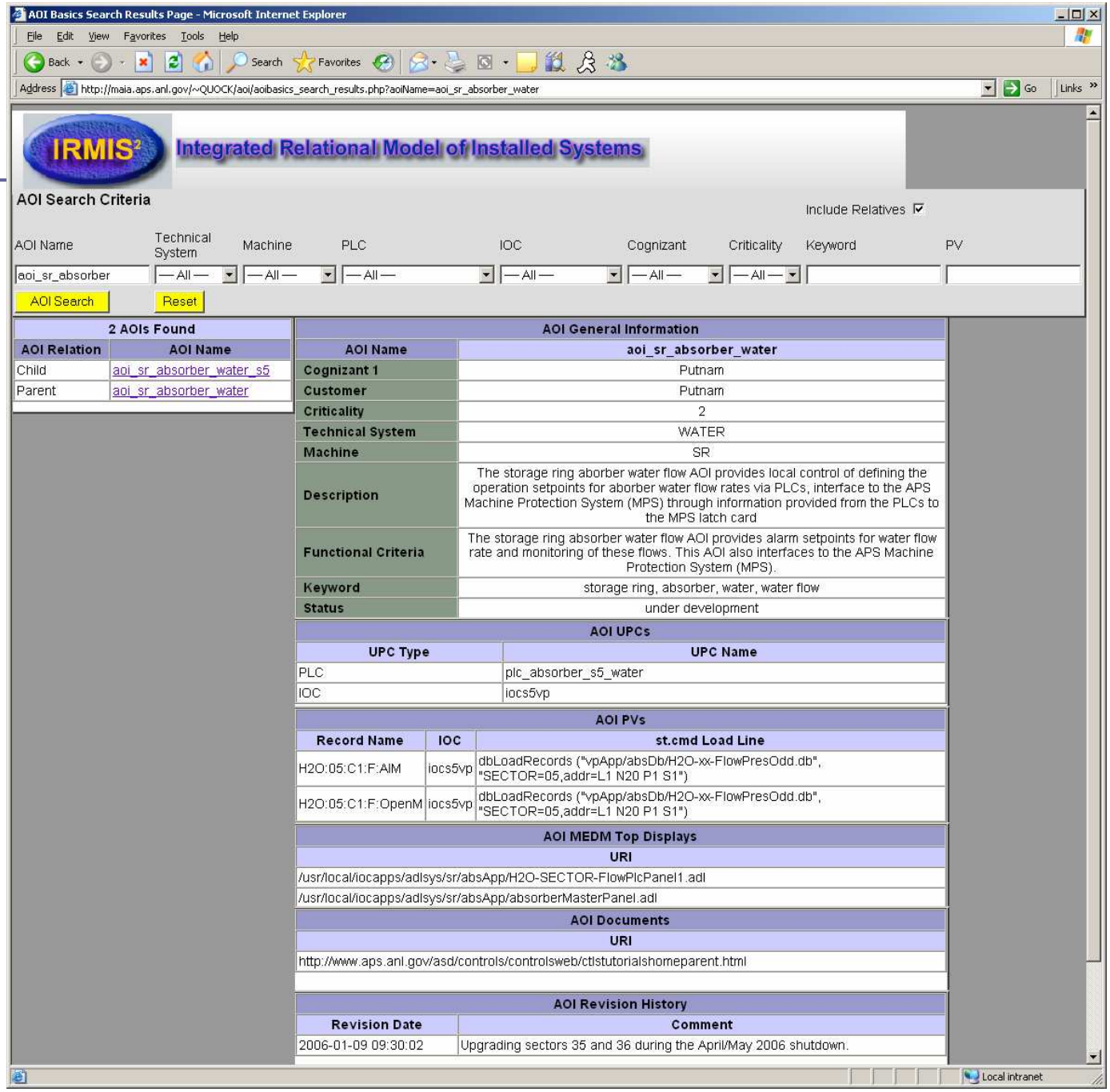
Think of AOI Crawler as being very similar to the IRMIS PV Crawler, but...

- AOI Crawler parses st.cmd files to retrieve information about:
  - UPCs (IOCs, PLCs, LabView, ...) associated with each AOI
  - PVs associated with each AOI
  - And any st.cmd line that the AOI EPICS developer wants to be stored in the AOI database for later viewing directly through IRMIS
    - sequence programs — ld < mpsTesterSingleLatchCard.o
    - configuration data — MpcConfig 0,0x3100,80,3
- Parsing requires unique AOI comment lines in the st.cmd files

Example AOI Marked Up st.cmd 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 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")
```

AOI Viewer



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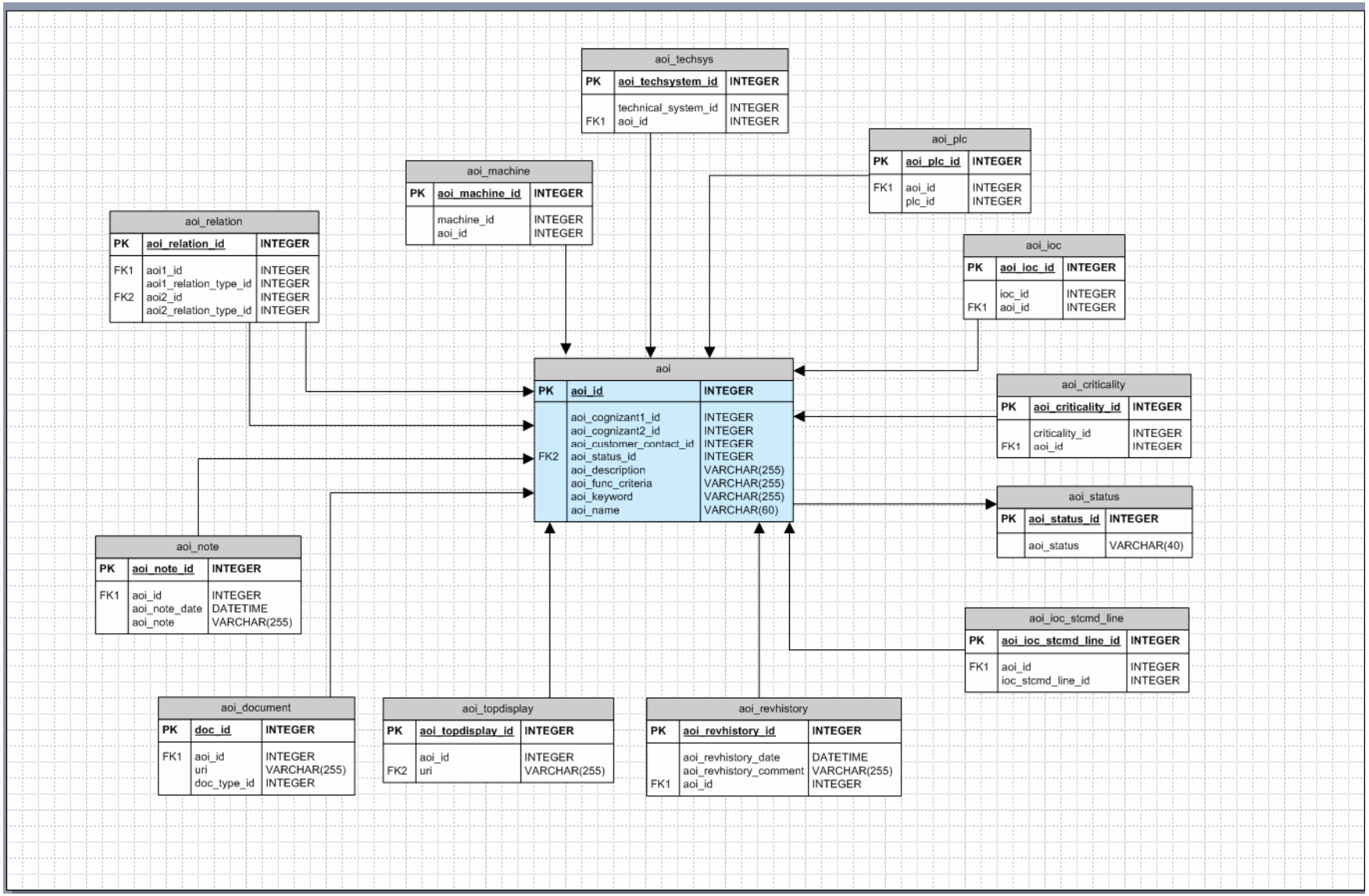
AOI Simplified Database Schema



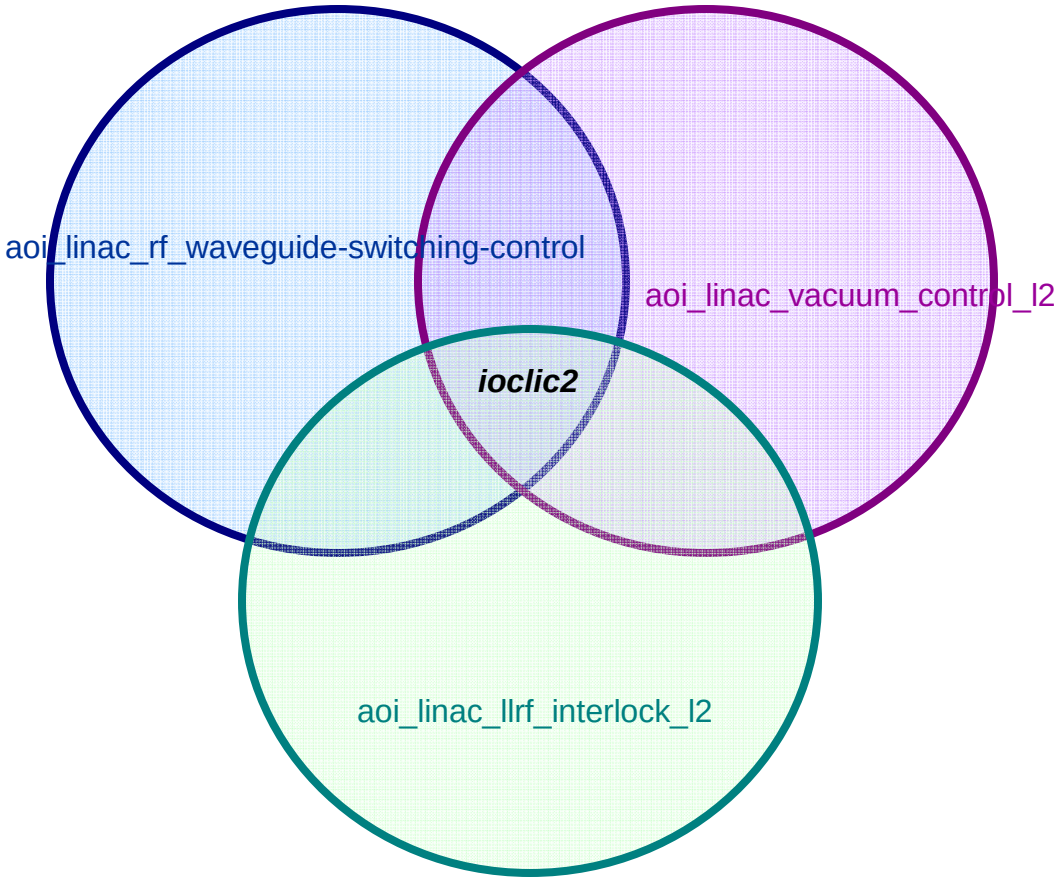
APS LINAC AOIs – 74 Identified so far...

aoi_<machine>_<technical system>_<unique function>_<child>
aoi_linac_acis_epics-monitoring
aoi_linac_besocm_trigger-select
aoi_linac_bunch-compressor_motion
aoi_linac_bunch-compressor_scraper
aoi_linac_current_monitor
aoi_linac_diagnostic_bpm
aoi_linac_diagnostic_cerenkov
aoi_linac_diagnostic_ctr
aoi_linac_diagnostic_flag
aoi_linac_diagnostic_flag_bunch-compressor
aoi_linac_diagnostic_flag_station-5
aoi_linac_diagnostic_image-analysis
aoi_linac_diagnostic_oscilloscope
aoi_linac_diagnostic_phase-detector
aoi_linac_diagnostic_video
aoi_linac_facilities_hvac-monitoring
aoi_linac_llrf_interlock
aoi_linac_llrf_interlock_l1
aoi_linac_llrf_interlock_l2
aoi_linac_llrf_interlock_l3
aoi_linac_llrf_interlock_l4
aoi_linac_llrf_interlock_l5
aoi_linac_llrf_interlock_l6

aoi_<machine>_<technical system>_<unique function>_<child>
aoi_linac_rf_autophase-sequencer
aoi_linac_rf_conditioning
aoi_linac_rf_klystron-attenuator-control
aoi_linac_rf_klystron-pulsed-control
aoi_linac_rf_measurement
aoi_linac_rf_modulator
aoi_linac_rf_modulator_l1
aoi_linac_rf_modulator_l2
aoi_linac_rf_modulator_l3
aoi_linac_rf_modulator_l4
aoi_linac_rf_modulator_l5
aoi_linac_rf_modulator_l6
aoi_linac_rf_monitor-xmitter
aoi_linac_rf_source
aoi_linac_rf_water-load-temp-monitor
aoi_linac_rf_waveguide-switching-control
aoi_linac_rfgun_scraper
aoi_linac_rfgun_smart-monitor-sequencer
aoi_linac_sf6_control
aoi_linac_timing_dmu
aoi_linac_timing_main
aoi_linac_timing_src-select
aoi_linac_vacuum_control
aoi_linac_vacuum_control_l1
aoi_linac_vacuum_control_l2

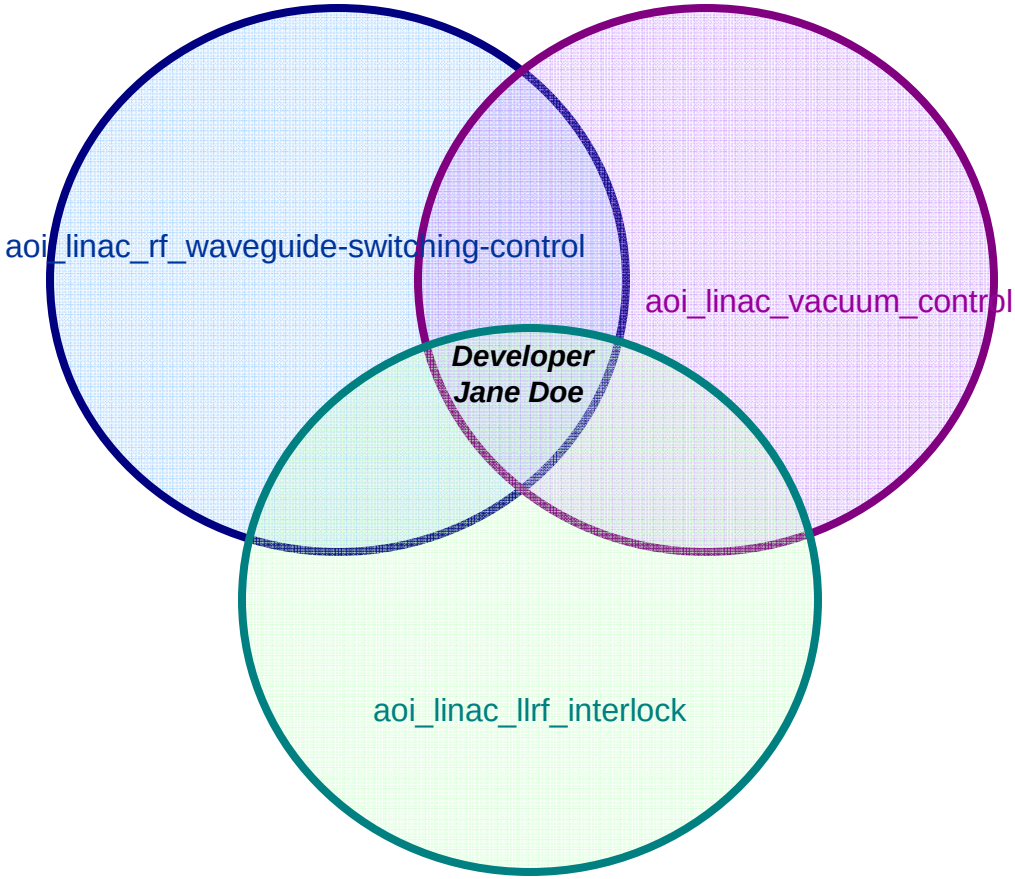
AOI as an Engineer's Tool

What happens if ioclic2 fails?



AOI as a Manager's Tool

What control systems are assigned to Jane Doe?



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*.

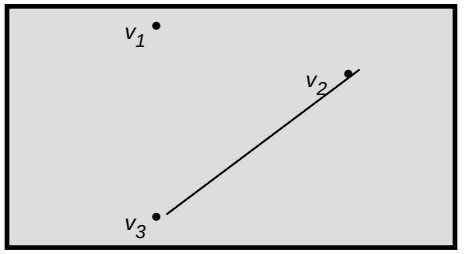
The dissimilarity function *S* is used to compare AOIs in pairs. Given the vertices

$v = (p_1, p_2, p_3, p_4, p_5, p_6, p_7, p_8)$ 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

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

Similarity Graph



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

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

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 $S(v,w) <$ 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.

Summary

- AOI is a software application that organizes the pieces of control system applications in a manner that engineers and managers can quickly and easily interpret control system information
- Unique Applications of Interest are identified for each significant control system
- Built on the foundation of a relational database (IRMIS). Query capabilities of AOI provide alternative "views" of control system information.
- Geared towards interacting with EPICS control system software (st.cmd files, EPICS records, MEDM displays, etc.)
- AOI query results can be displayed in tables, graphs, statistical reports, dynamic MEDM displays, and more