ADMINISTRATION OF CONTROL SYSTEMS AT THE ADVANCED PHOTON SOURCE USING APPLICATIONS ORGANIZING INDEX*

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Abstract

Applications Organizing Index (AOI) is a relational database tool that has been implemented at the Advanced Photon Source (APS) to aid in the management of over 600 unique control system applications. AOI provides control system developers an intuitive view of and navigation links to the components that make up a single control system, such as source code files, operator displays, process variables, work history notes, programmable components, validation procedures, drawings, and more. The foundation for the Applications Organizing Index tool is the collaborative effort among several Experimental Physics and Industrial Control System (EPICS) sites to build the Integrated Relational Model of Installed Systems (IRMIS) [1], a common relational database schema for documenting large and complex particle accelerator control systems. This paper describes the evolution of AOI as it became populated with APS control systems component data and as users' requests for new features of AOI became apparent.

APS CONTROL SYSTEM DOCUMENTATION RESOURCES

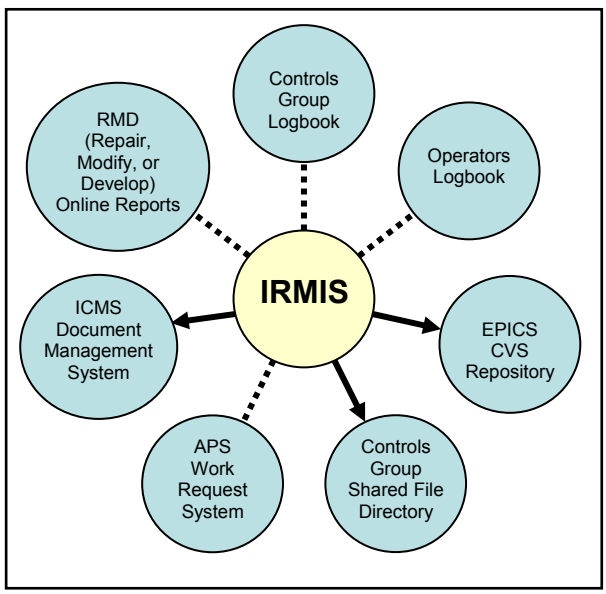

Figure 1: APS controls documentation resources.

As shown in Figure 1, the software resources available at APS for storing information related to accelerator control systems are widespread. These software applications have evolved over the life of APS by different groups, with different initial objectives in mind, and in different software languages and platforms.

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IRMIS

IRMIS is a relational database software tool that was developed to model installed EPICS control system software and associated control system hardware. As shown in Figure 2, the IRMIS application is broken down into nine separate Web-based displays (viewers) that include Applications Organizing Index (AOI), Input/Output Controller (IOC), Programmable Logic Controller (PLC), Component Type, Network, Controls Spares, Process Variables, Installed Components, and Cables. In addition to narrowly defined data views of IRMIS, a Global Search Tool is available for performing a text string search on all categories of IRMIS at once, returning limited information about where the search string was found, and providing links to some of these occurrences in the IRMIS viewers.

Figure 2: APS IRMIS home page.

IRMIS currently also provides information on and links to controls documents stored in the APS Integrated Content Management System (ICMS), the EPICS CVS file repository, and the Controls Group shared file directory. The dotted lines in Figure 1 indicate the potential for future software application integration and sharing of controls related data.

APPLICATIONS ORGANIZING INDEX

The focus of this paper is on the IRMIS viewer Applications Organizing Index and how it has evolved since it was last reported on a year ago [2]. AOI was created to provide a starting point for control systems developers to navigate through the various pieces of

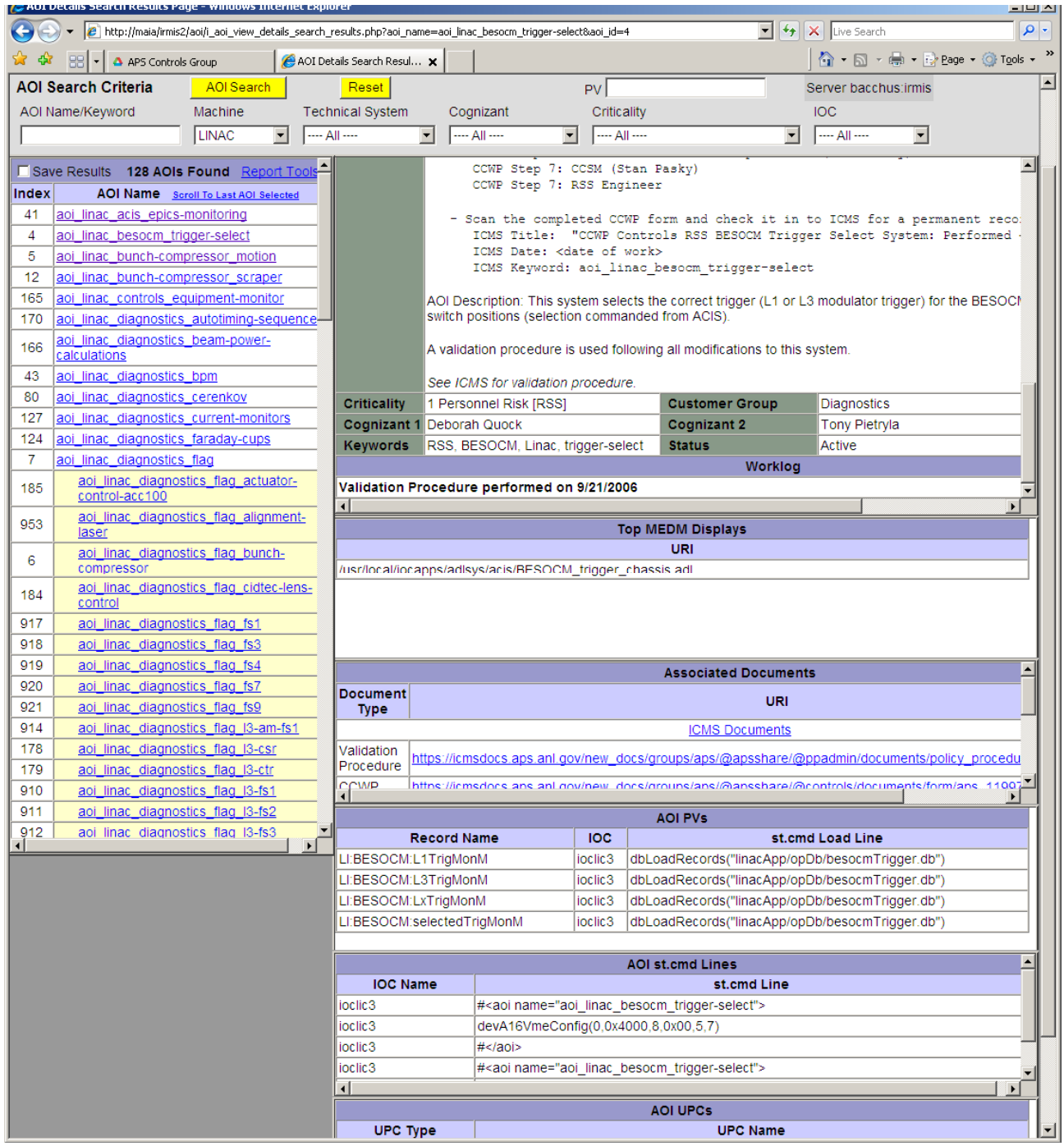

Figure 3: IRMIS Applications Organizing Index (AOI).

information that make up a distinct control system application, such as engineering drawings, validation procedures, distributed real-time control system databases, source code, and user displays. Examples of distinct control system applications viewed in this manner at the APS include the storage ring vacuum control system, linac water leak detection system, and booster diagnostic flags.

User Interface

The AOI viewer provides text search fields for entering the AOI name, keyword, or EPICS process variable name; and drop-down lists for selecting accelerator machine, technical system, AOI cognizant, operations criticality, and IOC name. These search fields can be used to define a unique set of requirements for querying the database and displaying a list of matched AOI names.

Information on AOIs is displayed in IRMIS in three successive levels of detail as it is requested by the user:

1. list of AOI names,
2. general information on a specific AOI (manually entered by user), and
3. AOI crawler discovered relationships (automated script).

Information on the specific controls application named aoi_linac_besocm_trigger-select is shown in Figure 3. In this example, the search result for AOIs with value of LINAC for category Machine is shown on the left-hand side – 128 AOIs were matched. When a user selects an AOI name from the resultant list, the details about that specific AOI are then displayed on the right in tabular format. The display as shown here has already been further expanded (downward) to show its related data as discovered by the AOI Crawler.

Each AOI has the attributes:

- AOI Name
- Cognizant 1
- Cognizant 2
- Customer Group
- Criticality (Ranging from 1 to 5 with 1 being the most severe)
- Description
- Keywords
- Status (Active, Inactive, Decommissioned, Under Development, and Other)
- Worklog (time stamped user entry of work performed)
- EPICS Top Displays
- Associated Documents
- EPICS Process Variables
- IOC startup file command lines
- User Programmable Components (UPCs) such as PLCs and IOCs

Software Architecture and Mechanics

The attributes of each AOI are stored in the IRMIS MySQL relational database. An AOI Crawler that is written in Perl language runs continuously, parses IOC startup command text files by searching on XML style markup tags (elements) that include AOI names, and uses this IOC extracted information to automatically populate the AOI attributes: EPICS process variables, IOC startup command lines, and UPCs. The remaining AOI attributes are entered manually through an AOI editor display. The AOI user and database interfaces are built with PHP objects and functions, JavaScript functions, HTML, and Cascading Style Sheets (CSS).

Two levels of authentication are required before a user can access the AOI editor. The first authentication step is employee verification using LDAP. The second authentication step is identification of the user's role at the APS. Once these two levels of authentication have succeeded, a unique PHP session ID is setup for the user that persists for the remainder of their AOI editing session.

Documents that have been contributed to the APS ICMS can have keywords as an attribute. To facilitate the association between AOIs and their supporting engineering documents, the name of an AOI is entered as a keyword attribute in the ICMS document. A search within ICMS can be launched directly from the AOI viewer with a specific AOI name as the keyword search criteria, and the resultant list of ICMS documents is displayed automatically in ICMS software.

APS AOI Workshop Meetings

Currently, there are 680 AOIs entered in the IRMIS database. These AOIs were populated in three main stages of employee effort according to machine location. The first stage focused on the LINAC, which was reasonable in scope and yet included a complete set of typical accelerator applications. The AOI software user interface and database schema evolved rapidly during this stage of data entry. The next major stage of AOI data entry was organized with weekly meetings attended by the primary EPICS developers of control systems located in the PAR and Booster sections of APS. These meetings were run as workshops with team-based goals for helping each other identify, correctly name, markup IOC startup command files with AOI tags, and enter AOI data into IRMIS. The final round of AOI data entry was self-driven since by then all developers in the Controls Group had experience with defining and entering AOI data. The AOIs currently defined in IRMIS at APS are shown below categorized by machine.

- Linac - 128
- PAR and Booster - 166
- Storage Ring - 265
- Miscellaneous - 121

The AOIs that have been associated with EPICS IOC startup command files, EPICS MEDM displays, and ICMS documents are as follows:

- AOIs having IOCs (247/680 → 36%)
- IOCs having AOIs (262/299 → 88%)
- AOIs having ICMS documents (29/680 → 4%)
- AOIs having MEDM displays (410/680 → 60%)

CONCLUSION

As seen by above report, there is still much work left to be done to get AOI-related documents entered into ICMS and identified with AOI names, and to completely define all IOCs with AOI markup tags. Future enhancements to AOI include:

- implement AJAX technology to dynamically enable the user display,
- create a tabbed layout for easier user navigation,
- launch MEDM displays directly from URLs, and
- access ICMS through Web Services, and possibly other APS applications shown in Figure 1.

REFERENCES

[1] D. Dohan, N. Arnold, "Connection-Oriented Relational Database of the APS Control System Hardware," PAC 2003, 2327 (2003).

[2] D. Quock, et al., "Applications of Interest: A Relational Database Approach to Managing Control System Software Applications," PCaPAC 2006, JLAB-ACO-07-62893 (2006).