

INITIAL EXPERIENCE WITH DATABASE APPLICATIONS*

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Abstract

The Spallation Neutron Source (SNS) Project relies on a single relational database as its main repository for accelerator information. Every hardware component is represented in this repository with data ranging from equipment location to calibration results. In addition, the database provides configuration information for control console software and EPICS Input-Output Controller (IOC) software. An initial suite of database applications has been deployed to support installation, integration, and commissioning of the SNS accelerator. This paper presents an overview of these applications, describes the initial experience, and discusses plans for the future.

INTRODUCTION

The SNS project is a partnership involving six U.S. Department of Energy (DOE) national laboratories: Argonne, Brookhaven, Jefferson, Los Alamos, Lawrence Berkeley, and Oak Ridge. The project is described in more detail on the SNS Web site [1].

The SNS Project set out with two goals in mind regarding the creation and development of its supporting relational database. First, there was the realization that there needed to be a realistic or reasonable approach to data integration. Data entry and capture had to be handled in a way that would not discourage the use of the database. Second, the end users should have the ability to use the database in the true sense of a relational database. The data captured within the database should be accessible using any related data, thus offering an end-to-end data navigation.

The SNS database is based on ORACLE 9i, Enterprise Edition RDMS. The client tools are powered by 9i Application Server and include JSP, Servlets, and PLSQL-generated HTML.

During the design of the entities within the database, the relationship and/or differences between devices and equipment became the main implementation concept. The database is designed to hold data that are directly related to virtual hardware (devices) and actual hardware (equipment). Devices are defined as an instance within the installation of equipment. This means that a device is more the function of hardware and the position of the hardware within the accelerator. For example, a device that is considered a specific BPM is defined by the fact that it is associated with a specific quadrupole and that it has a specific position within the beam line. Equipment is defined as the actual hardware. If hardware is replaced, there is an implementation of new equipment, but the

device remains the same because the same function is being performed.

DATABASE SUMMARY AND STATUS

The SNS database is divided into six application subject areas: EPICS [2] (devices, signals, process variables, MPS, and coordinates); Cable; Electronic Logbook; Operations; Equipment (manufacturer/model, calibration, association with beam line device); and Magnet (measurements). Currently there are 161 tables within the database, and this number is expected to grow to 300 within the next three years. Within the tables are 5,700 device records and 41,000 parameter records.

The SNS project is still currently in the construction phase, and it is approximately 40 percent complete. Although the population of the database will never technically be complete, the population of the SNS database is estimated to be at about 30 percent of where it will be when construction is completed. Most of the data currently contained within the database matches the current phase of construction.

The applications currently in use with the database include: LabVIEW, XAL, Rack Profile, Web PV Data Applications, Electronic Logbook, Java EPICS RDB Interface (JERI), Bypass Request System, Equipment Tracking, Web Reports (Discoverer), and two commercial products (ProjectWise and DataStream).

SNS Electronic Logbook (ELog)[3]

The SNS Electronic Logbook is the tool for logging and communicating accelerator operations. It has been developed using WebObjects, deployed using Oracle 9i/AS J2EE on Solaris, and uses the SNS database. The ELog allows viewing and editing of entries from any standard Web browser. The ELog, in combination with the SNS database, supports a combination of multiple logbooks, password protection, threaded and searchable entries, and capture of images and attachments. The entries are available for immediate viewing and can be displayed in many different formats including chronologically or by category of entry.

Future enhancements will include more user customization (date and number formats, etc.), a MathML editor for equations, and severity indicator (normal, note, repair, etc.). The ELog will also be integrated with other applications to allow automated entries. For example, an EPICS process variable will be monitored to trigger an automated entry. Other plans will allow the user to send an e-mail notification containing relevant ELog data.

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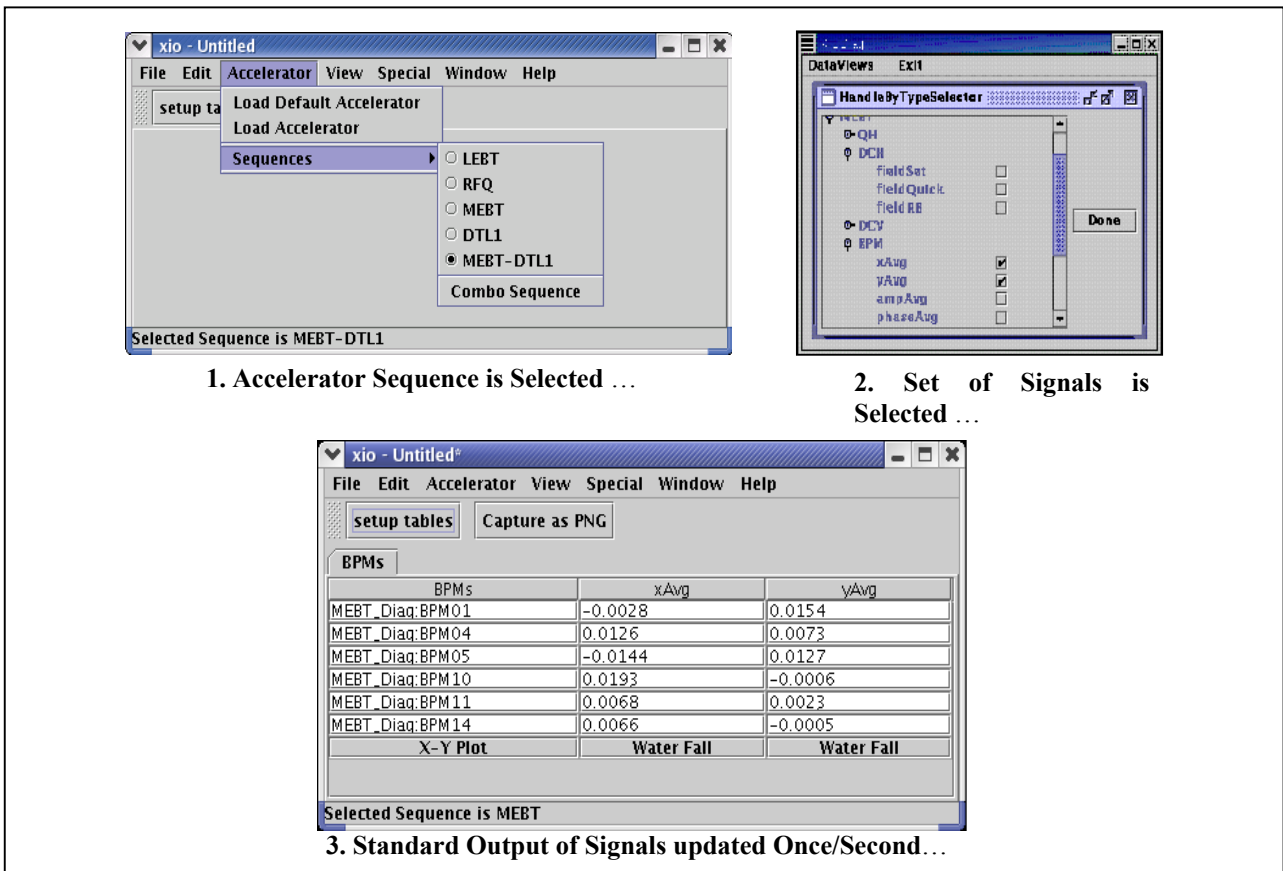


Figure 1: XIO Signal Browser Application Process

Real-time Applications

The SNS database stores process variables for beam-line devices and gives users the ability to write applications that access these records and use them in an ad-hoc type of implementation.

One implementation is the magnet current-to-field transformation process. This application allows users to pick magnet measurement variables from the SNS database via a Java program and display the Spline fit. The application provides a pick list of valid magnets and gives the user the ability to save the resulting data to the database. The magnet settings and readbacks are made available in “Field” units as well as current. Future uses will be the use of these values during the configuration of the magnets.

The XIO Signal Browser application is initialized with information from the database. The database provides users a hierarchal view of the accelerator, with a sequence and device-type structure. For each device type, the valid list of process variables is available. After selecting the portion of the accelerator of interest and the signal types of interest, tables displaying the live values are produced. This process is shown in Figure 1. Also, live plots of the selected process variable values vs. position along the beam line are available, as well as color-rendered waterfall plots vs. an additional time display axis.

Java EPICS RDB Interface (JERI)

JERI is a Java-based tool that allows the SNS database to be used in combination with EPICS, the SNS control system. JERI facilitates the import and export of the main EPICS database files (.db, .dbd, .libobjs, archive request files and alarm handler files). File imports use the SNS database for data validation as well as for data storage. Because of the interface with the SNS Database, the EPICS files that are created from the database inherit valid process variable names as related to specific devices. Files that are imported to the database are checked for validity against the SNS database. Process variables that violate the SNS naming standard or use invalid category codes are allowed to be loaded but are marked as invalid, and the user is given a report of invalid records. JERI also includes wizard users to generate new SNS devices and signals identifiers that will comply with the SNS standard and gives the user access to other EPICS-related tables including the records in question.

The SNS MPS is fully managed within JERI. Default mode masks are assigned to all pertinent device types and are automatically assigned to a channel when a signal is added to that channel. The signal itself is validated so that signals that do not belong on an MPS are not accepted. Any changes to the MPS mode masks are automatically recorded in the MPS and Operations logbooks in the SNS Electronic Logbook. Also, when the

MPS startup, mode mask, template, substitution and archive request files are generated using JERI, this event is also recorded in the SNS Logbook.

JERI also gives users the ability to manage the cables within the SNS project.

Included in JERI are reporting capabilities that allow users to see standard summaries and also allow users to define reports specific to their needs.

LabVIEW[4]

At SNS, LabVIEW has become one of the main software tools implemented for data acquisition. Because of the use of a LabVIEW template and standardization, the numerous implementations all interact with the SNS database in the same way. Also, a single LabVIEW program can insert data related to tests run on multiple devices or tests run on one device multiple times in to the database. LabVIEW programs and the interaction with the database eliminate the possibility of user-created errors. Hand-entered data entry can be virtually eliminated.

The Cable Time Domain Reflectometry (TDR) program is an example of LabVIEW's interaction with the SNS database. Cable data, including a cable number, has been loaded into the SNS database during the time of cable installation. Barcodes have been attached to the cables as an indicator of the cable number. A technician runs a LabVIEW program that interacts with a TDR, scans the barcode, follows prompts for hooking up the cable, and the resulting TDR is stored in the SNS database. Engineers can use a similar LabVIEW program to extract and analyze the TDR data and determine if adjustments need to be made.

Equipment Tracking

Because the SNS database is used to track the SNS equipment, many tools and applications have been made available that allow users to capture and access this data. As equipment is received at SNS, an equipment ID is applied. This ID may be attached using a barcode. As the ID is applied supporting data is also entered into the database. A Web-based entry form can be used or data can be supplied by vendors in a pre-specified format and pulled into the database. This data are then used to track installation, spares, or as needed by installation teams. The SNS database is used to also capture the equipment's acceptance test data, and once received, its calibration and maintenance data.

An example of this is a simple Web page interface that accepts a barcode entry and then inserts a record to the

database that indicates the equipment has been installed, fixed, updated, etc.

Integration with Commercial Applications

Currently there are two main commercial applications that are integrated with the SNS database: ProjectWise and DataStream. ProjectWise is used as the SNS Project's document repository and DataStream is used for SNS equipment maintenance and tracking. ProjectWise stores documents in a manner that allows categorization and searching. DataStream gives SNS the ability to manage maintenance schedules and upgrades or failures of equipment. Both of these applications provide the users with reporting functions that help summarize the data that have been captured.

FUTURE PLANS

The SNS database goal is to continue to try and achieve end-to-end data integration of the data within the database. Data input and validation has only just begun. Many applications will be developed in the future that will take advantage of the opportunities that this relational database provides.

An example of a plan for the database is its use during the configuration of diagnostic's IOC. As an IOC is installed, a remote management system (i.e., Altiris) will be used to configure it. Currently Altiris is already used to manage SNS computers and collaboration with the IT group is in progress to apply this process to the diagnostic group's network attached devices. This process will extract data from the database to make the configuration specific to the device it will support. For example, something as simple as an IP or computer name can be added, or calibration numbers may be used as needed to support the software installed.

Also, Oracle Files (previously ORACLE Internet File System [iFS]) is under evaluation for use in live design and with configuration files. It is viewed from network as a versioning file system, but a database is the backend. File system transactions can trigger procedures (like virus scans, translations, etc.).

REFERENCES

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