

DATABASE DRIVEN CONTROL SYSTEM CONFIGURATION FOR THE PSI PROTON ACCELERATOR FACILITIES

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Abstract

At PSI there are two facilities with proton cyclotron accelerators. The machine control system for PROSCAN which is used for medical patient therapy, is running with EPICS. The High Intensity Proton Accelerator (HIPA) is mostly running with the in-house developed control system ACS. The control of dedicated parts of HIPA runs already under EPICS. Both these facilities are configured through an Oracle database application suite. This paper presents the concepts and tools which are used to configure the control system directly from the database-stored configurations. Such an approach has advantages which contribute for better control system reliability, overview and consistency.

INTRODUCTION

Control system configuration for HIPA and PROSCAN facility is kept in its own databases HIPADB and PRODB (see Fig. 1). The database information can be split into the following categories :

- Device Reference contains all information about the machine layout in terms of Device names, sections, positions, and their topology.
- IOC (Input Output Controller) configuration for EPICS. The IOC configuration for the ACS control system has been already described in detail in [1].
- Interlock configuration data which are used for the Run Permit system in both facilities HIPA and PROSCAN.
- Beamline Reference data are used to produce input files for the automatic beam control and for the simulation tool Transport as well.
- Archiver configuration for the in-house developed data archiver software.

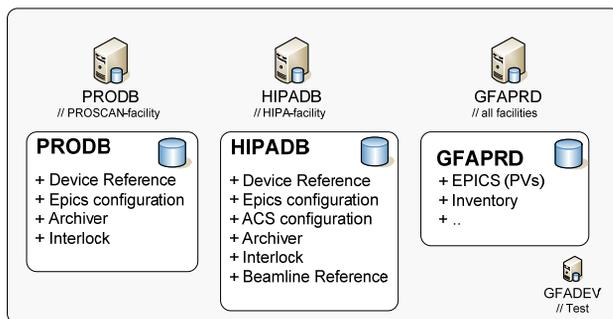


Figure 1: Oracle databases for HIPA/PROSCAN control system configuration.

A third Database GFAPRD displayed on Fig. 1 contains data used for all facilities in common. As an example these kind of information includes

- Hardware Inventory and Computer configuration.
- EPICS PV (Process Variable) names for all facilities.

DATABASE ENTRY

Figure 2 shows the building blocks for the database driven configuration. Oracle Webforms delivered from an Oracle Application Server are used in order to enter the data by the enduser.

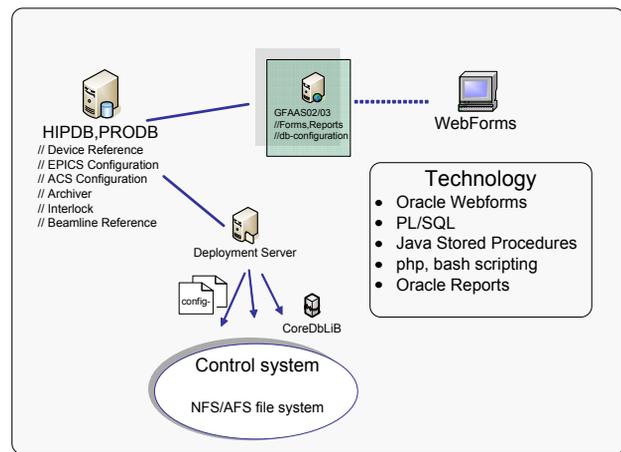


Figure 2: HIPA/PROSCAN Configuration Infrastructure.

PL/SQL libraries are used to provide procedures and functions for database extraction and Java Stored Procedures and php scripts are used to deploy the configuration files on to the NFS (Network File System) shared file system. The deployment itself, is done on a dedicated deployment server and is triggered directly from the Webforms.

The described method has been used in production for many years (since 2002). Several redesigns and adaption has been made in order to fulfil new requirements. One example is the EPICS configuration system which is used for the PROSCAN control system. There are different categories of information which are stored in several database schemas. Each category has its own Webform editor.

Device Reference Editor

Device Reference holds everything about definition and organization of all the elements in the PSI proton accelerator complex as seen by the operator. This may be a bending magnet, quadrupole, profile monitor, a pump etc. Each element has a unique name (up to 8 characters)

according to our Device Naming convention and is arranged into machine parts. Each element is connected to a parent according to the physical arrangement along the beamline. Device listings (“Holy Lists”) may be produced from this information. The Device Reference tables are directly connected to the EPICS configuration and Beamline Reference tables.

EPICS Configuration, IOC Setup

The definition of the IOC configuration consists of defining a name, attributes like the EPICS version and a set of startup script lines. According to the placement (slot, channel) of hardware modules the corresponding DriverConfig strings must be filled in. For each module one or more configuration strings can be defined in the form DriverConfig (p1,p2,..). Each record in the DriverConfig table has a unique key which is used in the Template record definition. The configuration of Soft IOCs without connection to a piece of hardware is supported as well.

EPICS Configuration, Templates

With a Template editor we can setup and maintain a pool of EPICS templates with its records and field values and their logic (forward links etc). New templates can be uploaded from the NFS file system. Minor changes in the template structure (add a new record, field) can be handled by the editor itself. For each template the macro variables with default values can be extracted.

EPICS Configuration, Macro Substitution

The substitution of the macro variables is the final stage of configuration. For a given Device eg. a magnet, the Device name is mapped to the corresponding IOC configuration slot together with the corresponding Template. From the Template Designer’s point of view we have implemented two constraints. It’s not allowed to have more than one references to the IOC configuration slot. Each Template must have at least one macro called \$DEVICE. This macro is automatically replaced by the Device name which is optional connected to the Device Reference table. All other macro values can be manually defined in the substitution editor.

DEPLOYMENT & TEST

The deployment of IOC specific configuration files which can be triggered by the “install button” from the Webform is shown in Fig. 3. For the selected IOCs the following tasks are done on the deployment server :

- From the set of IOC configuration tables the common startup script together with a driver config script is generated.
- A unique substitution file for each IOC is generated which contains all the macro values with a reference to the corresponding template.

- At the end all files are deployed to the NFS file system structure and the IOC can be rebooted through the corresponding BootServer.

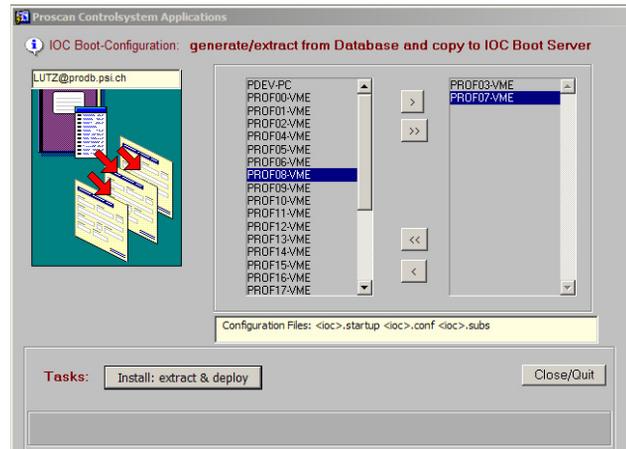


Figure 3: Deployment of IOC configuration files.

The database relevant tasks which are done on the IOC boot server are explained in Fig. 4. During the IOC boot process all the created record names together with some useful attributes like RecordType, IOC name, timestamp etc) are loaded into the EPICS PV database. New records are inserted, and records which do not exist anymore will be marked as deleted.

The information in the EPICS PV database is used by several database tools. Findrecords is a comandline tool which allows to query the PV database with several filter option. “duprecords” lists all duplicated records inside a facility. “capv-view” is a Java application which lets filter all the PVs by IOC and Device name. After setting the filter all PVs values are displayed. The corresponding Web-Tool has been developed using Microsoft .NET technology. In the web-based Inventory tool the PV names together with the current values can be displayed as well. Database Reports are used to display or check the Device Reference-PV database relationship.

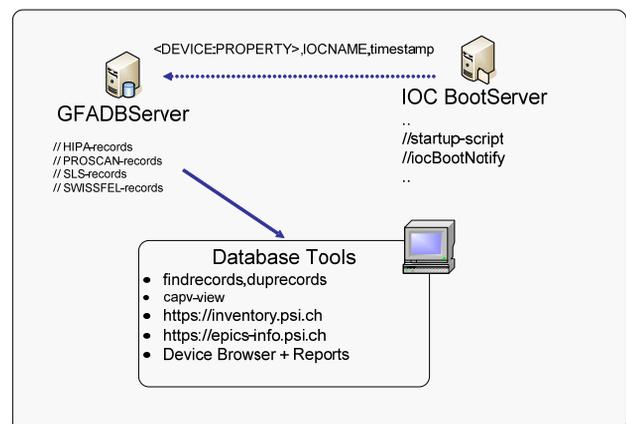


Figure 4: Loading EPICS record names during IOC boot process.

The following table shows some statistics about the number of EPICS IOCs, Devices and PVs in the PROSCAN control system. PROSCAN operates with 27 VME IOCs which are configured with 70 templates. Only 3 Soft IOCs are used. In summary PROSCAN is controlled with 1700 Devices and 50000 records. The values for the HIPA EPICS control system (eg. 50 IOCs + 100 templates) mentioned in table [1] are estimated values as most of the systems are running with the ACS control system.

Table 1: Statistics PVs IOCs Templates

DB (Facility)	PVs (record:device)	IOCs (vme+soft)	Templates
PRODB	50000:1700	27+3	70
HIPADB	100000:2700	50+5	100

HIPA values are estimated, 90% is still under ACS Control

APPLICATION CONFIGURATION

Interlock Data

Interlock holds data tables for description of the Run Permit system. Interlock modules are organized into areas, groups and sections. Each module is mapped to an IOC slot and has configurable input/output function tables. The Interlock tables feed data input for the Interlock monitor application.

Beamline Reference Data

In order to specify input information for the calculation of beam envelopes using the Transport code [2] the Beamline Reference Editor is used to fill the data sets which are connected to the Device Reference tables. Each entry consists of a predefined Transport type code, driftspace and an optional value string, together with a 4 char Transport Label. Depending on the type code the required driftspace is automatically filled in. This configuration is mainly used in the HIPA facility. The input files can be generated and deployed to the file system on request. These files are used in the control room during Beam Setup and Tuning. A second customer is the automatic beam control application.

Archiver Configuration Data

For the HIPA/PROSCAN facility an in-house developed archiver software for data archiving is used. The configuration file with all the PV-Names together with the corresponding logging period (5 sec, 1 min, per hour, per shift) is configured by a dedicated Configuration Editor. The Editor is connected to the EPICS PV database and supports functions like adding/removing PVs and restart the archiver server which is running on a dedicated machine.

DATABASE TOOLS

Device Browser

With the Oracle Reports tool an EPICS Device browser based on html pages has been developed. On a start page the user can enter some query conditions and gets afterwards information about Devices, EPICS templates, macro substitutions and IOC configurations.

Database Reports

Several Paper Layout reports have been built using Oracle Reports Builder. After building a report the corresponding executable (rdf-file) is delivered to the Application Server, see Fig 2. The Intranet Webuser can retrieve the new report with information in different output formats (html/pdf/xls). This includes Device Reference lists, dedicated information about Interlock database, Magnet parameter settings, database statistics etc. These Reports are permanently modified and built on request.

CONCLUSION

The database driven configuration has been successfully implemented in both facilities PROSCAN and HIPA for operation with two different control systems. There are many advantages for using this method :

- A lot of information about the configuration of the control system is kept in a single database instance.
- It helps a lot when upgrading tasks have to be done.
- The whole system is maintained by only a few persons (in our case 3-5).
- Applications are configured centrally. Additional applications can be easily integrated.
- Documentation of the system can be easily derived from database reporting.

Besides these positive aspects one negative aspect has to be mentioned. It is not easily editable as with text files on a file system. Therefore it is not well suited in a Test & Development scenario.

REFERENCES

- [1] H. Lutz, D. Anicic et al "Migration of the Configuration Database for PSI Cyclotron Accelerators", ICALEPS'03, Gyeongju Korea, Nov 2003
- [2] http://people.web.psi.ch/rohrer_u/trans