A BOTTOM-UP APPROACH TO AUTOMATICALLY CONFIGURED TANGO CONTROL SYSTEMS


Abstract

ALBA maintains a central repository, so called "Cabling and Controls database" (CCDB), which keeps the inventory of equipment, cables, connections and their configuration and technical specifications. The valuable information kept in this MySQL database enables some tools to automatically create and configure Tango devices and other software components of the control systems of Accelerators, beamlines and laboratories. This paper describes the process involved in this automatic setup.

INTRODUCTION

ALBA is the first Synchrotron Light Source built in Spain[1]. Its 3 GeV Storage Ring has been commissioned during 2011, receiving in 2012 the first users for the 7 beam-lines. Most of ALBA control system [2] have been developed on top of Tango Control System [3][4].

An amount of 5531 devices are controlled up-to-now in ALBA accelerators (linac, booster and storage ring) using 150 control Linux PCs. Those devices are accessed from the control system using several hardware interfaces (ethernet, fiber optics, serial lines, GPIB, PLC inputs, …) that had to be configured in the Tango database.

To populate the tango database, information related to hardware configuration and connections has been imported from ALBA's Cabling and Controls Database (CCDB) [5]. The cabling database keeps information of all hardware connections and the network configuration of all ethernet equipments. We used this information already in CCDB to automatize the creation and configuration of several control subsystems, like vacuum, front-ends, motor controllers and EPS [6]; speeding-up the process and minimizing the errors.

THE CABLEING AND CONTROLS DATABASE

The Cabling and Controls database was developed in-house by ALBA management and information software section (MIS) to be used as the main knowledge support for design, control, tendering, progress follow up and a search tool providing multiple views of the system.

This MySQL database has been used since 2007 to keep a knowledge base of all the equipments and devices used at ALBA accelerators and beam-lines. The Cabling database keeps all the information about equipment types, cable configurations, connections between devices distribution of hardware in racks, routing of cables between equipment and network configuration. It also provides fast access to all available documentation for each type of equipment. It actually contains in 346 racks with 6326 equipments of different 638 equipment types. These equipments are connected using 17623 cables of 292 different cable types with a total length of 167,43 Km.

Figure 1: Diagrams of every subsystem have been produced prior to its introduction in our cabling database.

Introducing Cables in the Cabling Database

Filling this database required and intensive effort by a group of engineers (one dedicated to each subsystem). They introduced most of the information in the cabling database during 2008, although installation continues and the database is updated almost daily. All the documentation used to populate the database has been kept attached to each equipment and rack; so it is possible to download original diagrams (Fig. 1) and equipment manuals from the CCDB web client (Fig. 2).

The maintenance of the database is managed by a group of electronic engineers. Modification or insertion of new cables in the database is done using spreadsheet files, that contain source and destination equipment-terminal pairs and cable types. Every file is cross-checked prior to insertion to avoid errors and collision with previous data.

The Cabling Database API

The common method for visualization and modification of information in the cabling database is the CCDB web client. This tool browses all the information in the database and provides many methods for viewing and exporting the data to text files. The first integration with...
the control system was based on reading these exported files, but soon a better interaction was needed to guarantee a system up-to-date.

Now the CCDB database becomes available to the control system using the CCDB python API. This python module provides methods to search for equipments and get lists of connections, names and network information. Some translation features have been added to the API to store links between every Control and Hardware object, this links will allow every single script to update or cross-check the properties of a Control object from the CCDB.

Figure 2: The cabling database web client.

**GENERATING A CONTROL SYSTEM**

**Creating Vacuum Controls Devices**

The accelerators vacuum control, with 1496 devices, is the largest control system in our Tango database. Creation of vacuum devices have been done automatically for all subsystems, using the cabling database python API to extract all needed information and all connections between equipments.

For each vacuum device (gauge, pump or valve) that belongs to our accelerators we obtain:
- Port and controller reading the device.
- Serial line and Controls computer connected to the controller
- PLC managing the pressure interlock
- Valves controlled by this interlock.

A Tango database entry is generated for each device and every configuration value. We initially used the same text format as Jive (the default Tango configuration tool), but finally we moved to comma-separated values files. A column based format allowed us more flexibility to add some Tango information like device host and run-level. These methods for massive insertion and modification of Tango information like device host and run-level.

Another example are the sizes of ion pump, this value will be used by the control system when converting the current readings to an estimated pressure value. In some cases the sizes of ion pumps change. For example, when vacuum sections are replaced by insertion devices. These changes must be updated in the Tango database and the information is queried from CCDB.

**Configuring Devices**

There are many parameters that are configured in the Tango control database using the information updated from the CCDB. The most common is the number of ports to be used in those devices that have multiple configurations (serial lines, ADC’s, ion pump splitters), the device configuration will get this value from the CCDB to configure which channels will be used and which will be ignored when connecting to the hardware. Also dynamic attributes will be created for used channels only.

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Information relative to networking (IP, masks, host-names, routing) helped to control or update existing hardware that is interfaced with the control system using TCP/IP. This allows to check and restore the status of these devices (splitters, Icepaps, DAQs,) after a powercut.

**Keeping the Databases up to date.**

During the last year several modifications have been done in our accelerators. Diagnostic elements have been moved and several vacuum chambers have been replaced by new insertion devices. These changes required to modify racks and cables and introduce the new equipment and connections in the graphical applications.

In case that any change of the routing is done, the technicians will update the information in the CCDB and the control system can detect the change and advice to update it. New CSV files, containing device names and all its property values, are extracted from either CCDB or
Tango databases and are compared to detect missing information, errors or not applied changes.

**INTERACTION WITH GRAPHICAL INTERFACES**

The information available in the cabling database is used to extend the displays of the control system and allocate equipments in generic browsers. The cabling API enables applications to sort and search by location of controllers or by location of the gauges connected to them (racks and equipments in tunnel don't follow the same name). It allows to group equipments affected by same logics and also make them findable in the racks area when searching for problems.

![Figure 3: Tango devices can be shown in trees using the physical connections between equipments.](image)

This extra information is added to the GUI's in two ways:
- In the Tango Database, adding cabling names as aliases of devices or labels of attributes (Fig. 4).
- In cabling-enabled widgets, browsing widgets (Fig. 3 and Fig. 5) that translate Tango names into CCDB to group the devices or attributes using their location or connections.

![Figure 4: Names of vacuum gauge ports are labelled with the tag of the device connected to them.](image)

When ports of a same controller are used to read different equipments (e.g. an in-vacuum mono-chromator and a mirror separated by valves) the grid widget (Fig. 5) scans the controllers in the vacuum rack and then it obtains the experimental instrument connected to each port. This information is used to reorganize values in panels and assign labels to pressure values.

![Figure 5: Labels from cabling are used to group in grids the experimental equipment pressures.](image)

**CONCLUSIONS**

Automated creation and configuration of big Control systems is a recurrent topic due to its applications in big facilities, reducing the amount of work and human errors when configuring thousands of devices. Acquiring and maintaining a cabling database is hard to do in a running facility, but it is a unique opportunity for new machines as this kind of database is a valuable tool at all levels.

An important application of automated configuration is the fine-tuning of the whole control system, modifying configuration parameters in many devices at the same time (new time-outs in all serial lines, different polling period in different groups of devices, update all host names at once). We used it during commissioning to optimize our control system performance, having also a fast way to do configuration roll-back.

We have now an automated way to load new values to all properties: reducing the time needed to deploy generic systems in beam-lines or adding subsystems once the machine was already operating (insertion devices). A lot of work has been saved and a lot of extra information became available to users.

**REFERENCES**