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DEVELOPMENT OF A TANGO INTERFACE FOR THE SIEMENS-BASED CONTROL SYSTEM OF THE ELETTRA INFRASTRUCTURE PLANTS

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Abstract

The control system of the Elettra Sincrotrone Trieste infrastructure plants (cooling water, air conditioning, electricity, etc.) consists of several Siemens PLCs connected by an Ethernet network and a number of management stations running the Siemens Desigo software for high-level operation and monitoring, graphical display of the process variables, automatic alarm distribution and a wide range of different data analysis features. No external interface has been realized so far to connect Desigo to the Elettra and FERMI accelerator control systems based on Tango, making it difficult for the control room operators to monitor the conventional plant operation and parameters (temperature, humidity, water pressure, etc.), which are essential for the accelerator performance and reliability. This paper describes the development of a dedicated Desigo application to make selected process variables externally visible to a specific Tango device server, which then enables the use of all the tools provided by this software framework to implement graphical interfaces, alarms, archiving, etc. New proposals and developments to expand and improve the system are also discussed.

INTRODUCTION

Four years ago an Elettra internal project was approved to carry out a general survey on the infrastructure plants acquisition systems, installed sensors, actuators and control software. The first step was to create a plant data base and to optimize the process control software written in several years running on non-homogeneous hardware. The idea was to provide the laboratory Energy Manager with detailed information about the energy fluxes in order to evaluate whether and where to intervene for their possible optimization. From further analysis it became evident that this was not enough. In fact, plant data are necessary also for operators and machine physicists to properly manage the accelerators. A way to exchange information between infrastructure control systems and machine control systems was required to improve the accelerators reliability, implement preventive maintenance and allow for potential energy savings. The final decision was to develop an unified management of the plant monitoring and regulation systems, managing all infrastructure Programmable Logic Controllers (PLC).

Scenarios

Built in different years, two infrastructure plant control systems are operating at Elettra, one for the Elettra synchrotron light source and the other for the FERMI Free Elecron Laser. The first one was based on Siemens S5 PLCs with Citect [1] Supervisory Control And Data Acquisition (SCADA) system for the operator console software. The second one relies on new Siemens S7 PLCs with Desigo Insight [2] supervision for higher-level operation and monitoring, graphics-based display of the process, automatic alarm generation and data analysis.

As first step, we decided to integrate the old Elettra plant control system supervision into Desigo. For this purpose, we had to upgrade the hardware with new Siemens PLCs, porting the control software on them and creating new graphic pages on Desigo. This process is still running.

Furthermore, we had to create a way to exchange data between the Desigo world and the accelerator control systems based on Tango, in order to make process variables visible externally and exploit the tools provided by this software framework.

A Practical Example

The production, distribution and use of energy flows in the infrastructure plants have to be continuously monitored to ensure the proper functioning conditions of the two accelerators.

Each power distribution panel is equipped with an electricity meter. The main hot and cold water flows are controlled by flow meters.

Hot and cold water and electric energy are supplied by two trigeneration plants. This kind of plants burn methane in a combustion engine, which produces electricity. Its high temperature fumes are used to generate hot water for users and for the absorption refrigerators (see Fig. 1). An exhaustive control of the distribution system allows to anticipate possible machine downtime and to intervene directly on the identified breakdown.

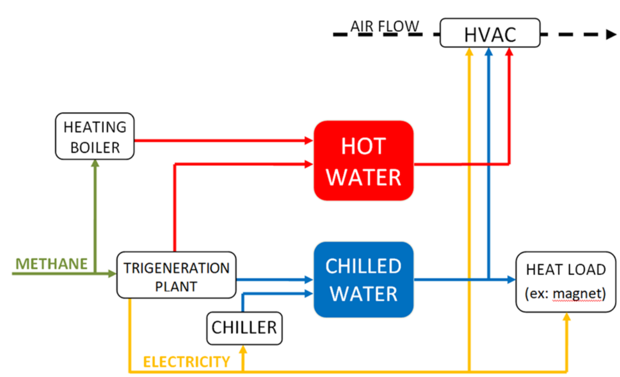

Figure 1: Energy block diagram.

DESIGO ARCHITECTURE

The conventional plants are controlled by Siemens Desigo Insight 6.0, a Building Automation and Control System (BACS) provided with functions such as alarm management, time scheduling and trend logging.

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The architecture can be divided into three layers (see Fig. 2). The top layer, where activities like system data presentation, forwarding, trending, logging, and archival are carried out, is called the Management Layer.

The middle layer is the Automation Layer, where measurements are processed, control loops are run and alarms are activated. The lower layer, known as the Field Layer, interfaces with the field devices (sensors and actuators).

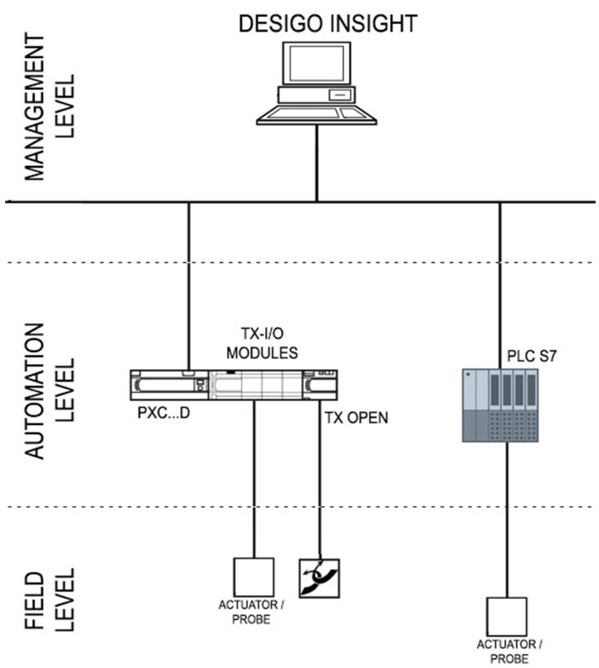

Figure 2: Architecture scheme.

Desigo uses open standards to connect various automation stations with data interfaces. Our infrastructure employs different interfaces to communicate with two device families: BACnet (Building Automation and Control network) protocol for the Siemens PX automation stations and OPC (Object Linking and Embedding for Process Control) server for the Siemens S7 controllers.

Solution Adopted

For the data exchange between Desigo and Tango a shared database was used in order to keep the two systems isolated (see Fig. 3). There were not particular restrictions regarding the choice of the database, we opted for Microsoft SqlServer since it is the standard used by Desigo.

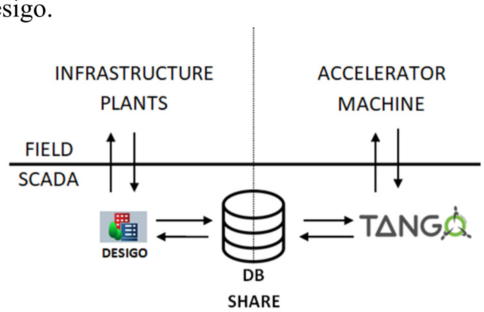

Figure 3: Communication flow.

At scheduled time intervals, Desigo writes the values measured on the field in this exchange database, which can be accessed by Tango.

Two tables have been created within the database: DEVICE_LIST and DATA_LOG.

The DEVICE_LIST table (Table 1) stores the list of data points which have to be read by Desigo and links the Desigo naming tag to the Tango conventional naming. The field "polling_time" defines the sampling period required for a specific variable. Tango device servers have also write access to this table in order to add variables to read or change the polling time dynamically.

Table 1: DEVICE_LIST

Name	**Description**
aDevice	Desigo TAG NAME
aDescription	Text description
polling_time	Sampling period
aUm	Unit of mesure
aTangoDesc	TANGO DEVICE NAME

The DATA_LOG table (Table 2) stores the variable values recorded by Desigo and made accessible to Tango.

Table 2: DATA_LOG

Name	**Description**
Id	Unique identification
aDevice	Desigo tag device
aValue	Variable value
aDatetime	Value date time

Desigo writes the data into the shared database using Cicode, a programming language designed for equipment controls in Desigo. It is a structured language similar to Visual Basic or C, provided with functions to access real-time data points in the SCADA and to interface with various components in the computer, such as the database and the communication ports.

The program flow is as follows (see Fig. 4):

- In the SCADA system a scheduled event is configured, which starts the Cicode script on a regular basis (1).
- The script retrieves from the DEVICE_LIST table the list of the data points which have to be read (2)(3).
- For each data point the script retrieves the values using the Cicode method TagRead (4).
- Desigo reads its internal database to find out which automation station is connected with that data point and retrieves the value (5).
- The script writes on the DATA_LOG table using the Cicode method SQLConnect and then moves on to the next data point (6).

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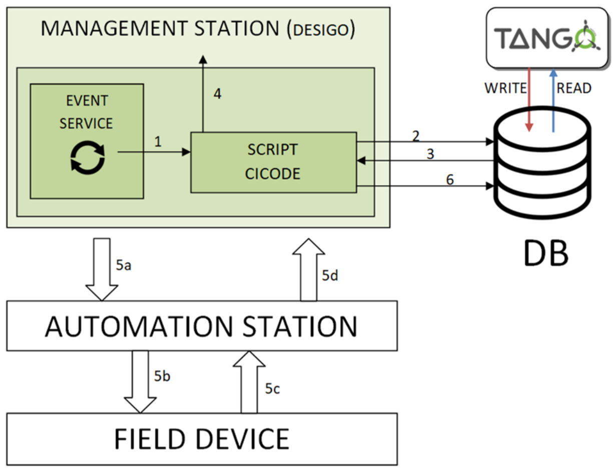

Figure 4: Program flow.

TANGO IMPLEMENTATION

In order to integrate the data coming from Desigo in the existing Elettra control system, a Tango device server has been developed together with a number of Cumbia [3] based graphical panels. A dedicated virtual machine has been arranged to host the Tango Database and the historical database HDB++ [4] with the corresponding device servers for data archiving.

ODBCConf Tango Device Server

A Tango device server has been developed to read Desigo variables from the Microsoft SqlServer and export Tango attributes. Tango attributes are created dynamically starting from a device property in which the desired name, type and description are specified. Supported attribute types are: DevDouble, DevBoolean, DevLong and DevString; only scalar types are allowed.

To query the Microsoft SqlServer database the libodbc library from the unixODBC [5] project has been used. The query is built at runtime, starting from a template saved in a Device Property. It reads from the tables DEVICE_LIST and DATA_LOG the values and timestamps belonging to a list of attributes (aTangoDesc column) which are more recent than a given time stamp (aDateTime column). Both the list of attribute names and the time stamps are filled in the query at runtime.

The ODBCConf device server runs periodically the query at a configurable period (the default value is one minute), querying for values newer than the ones read in the previous iteration. The result of the query is then parsed to set attributes value and to push archive and change Tango events.

Cumbia GUIs

At present two panels (see Fig. 5) developed using the Cumbia graphical library have been installed in the control room to display the attributes exported by the ODBCConf device servers.

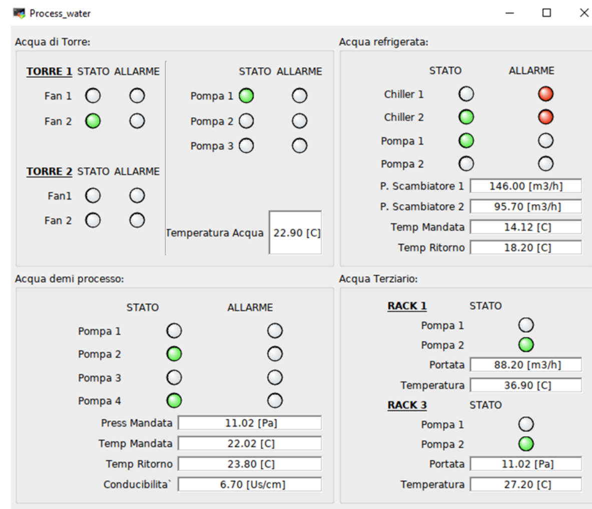

Figure 5: Example of Cumbia graphical panel.

This control panels have no writing capabilities as explicitly requested by the infrastructure plant manager. The only way to change values or send commands is operating through Desigo interfaces.

Archiviation with HDB++

Attributes exported by the ODBCConf device servers are archived in a dedicated HDB++ MySQL database deployed on the same virtual machine running the Tango Database and ODBCConf device servers. The archived data can be displayed by means of an in-house developed web-based application called E-Giga [6], and correlated with data retrieved from the other HDB++ databases of Elettra and FERMI.

Alarms

Some of the attributes exported by the ODBCConf device servers are used in formulae of the Tango Alarm System [7] and produce acoustic notifications in the control room whenever particular conditions of the infrastructure plants can potentially affect the correct operation of the accelerators.

Tango Naming

One of the difficulties we have encountered concerns the selection of a proper naming convention in Tango, which has to be meaningful to the heterogeneous users of these data, namely control room operators, plant managers and Energy Manager. It has been decided to compose Tango attributes names with a first part describing the physical quantity, followed by the location where the quantity is measured. For example, the Desigo variable S10_A_BsEdSS_AhuCBSS_Sen_TRB becomes temp_hutch_tf_ehf, which stands for the temperature of the TeraFermi (TF) beamline hutch located in the Experimental Hall Facility (EHF). For the domain/family/member of the device, we decided to specify the geographical location and the name of the plant (es. ehf/infra/hvac).

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FUTURE DEVELOPMENTS

At present the migration of the Elettra plant control system to Desigo is ongoing and we plan to complete it by the end of the year.

In order to allow the Energy Manager to perform more detailed analysis, the available data will be increased.

The possibility to correlate data from the accelerators with the ones from the infrastructure plants open the door to new perspectives, such as for instance the development of predictive algorithms to foresee failures on the machine. Moreover, the analysis of data relevant to the production, distribution and use of the energy in the infrastructure plants, can contribute to define new policies for the implementation of energy efficiency actions.

We are also investigating the possibility to upgrade the Desigo Insight 6.0 version to the new Desigo CC (Control Centre) platform. Desigo CC is based on global communication standards, allowing external applications to read and write real-time data via a REpresentational State Transfer (REST) service interface. Third party devices using proprietary protocols can also be integrated directly through Desigo CC drivers.

CONCLUSION

The long process to integrate all infrastructure plant control systems under a unified environment has started. The first results are encouraging, since we can now easily provide data to control room operators to monitor the conventional plant parameters, essential for the accelerator performance and reliability, as well as to the Energy Manager for the optimization of the plants performance and the implementation of energy saving programs.

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