STATUS OF THE SOLEIL CONTROL SYSTEM

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Abstract

The present paper provides an overview of the SOLEIL control system – the world's first 100% TANGO-controlled accelerator. The aim is also to provide the reader with some feedback after the first year of machine operation.

ABOUT SOLEIL

The SOLEIL [1] 3rd generation synchrotron light source is based on a low emittance 2.75 GeV electron storage ring that was commissioned in 2006 at Saint Aubin, France. The facility provides a high-intensity photon beam covering a wide spectral range – from ultraviolet light to hard X-rays. SOLEIL will serve the international community in many scientific fields, including physics, materials science, chemistry, and biology. Around 10 beam lines have already received light, and the first users are expected by the end of 2007.

ADOPTING TANGO

A Little Bit of History…

In 2002, the SOLEIL computing team was seeking its core software technology for both accelerators and beam lines. In order to make an objective choice, we decided to specify an ideal modern control system and to compare the resulting requirements with existing offers. Among the available solutions, the TANGO [2] framework was in phase with the SOLEIL medium and long-term expectations. Although it was an emerging project under development at ESRF [3], TANGO already fulfilled SOLEIL requirements in terms of:

- open source and collaborative development;
- long-term maintainability;
- enhancement potential;
- pure object-oriented technology.

The TANGO Collaboration

SOLEIL's selection of TANGO boosted its development and attracted similar projects. Today, TANGO is the core component of close collaboration among five European light sources: ESRF, SOLEIL, ELETTRA, ALBA, and recently, DESY.

From a technical point of view, TANGO implements advanced control system services as built-in features. Synchronous and asynchronous communication mechanisms, events, distributed logging ... are all now part of the TANGO core library. This "all you need is inside" approach coupled to a rich client offer provides a global solution for large-scale distributed control systems implementation.

TANGO remains in a state of continual evolution. Ongoing collaboration maintains medium- and long-term perspectives with respect to potential enhancements and add-ons [4].

CONTROL SYSTEM ARCHITECTURE

Its underlying CORBA [5] technology, permits TANGO to provide a natural way to implement *service-oriented control systems.* In this approach, the control system actors – called *devices* in TANGO jargon – are totally disconnected from each other. This allows the developer to respect the *separation of concern* paradigm on a system-wide level and offers a clear view of each component to the operator. Specifically, each TANGO device acts as a service provider*. It then becomes straightforward to hierarchize the control system by aggregating component services. The main advantage of this design is to factorize (or share) a service by embedding the application logic into the associated TANGO device – rendering control room clients pure display applications [6] [7]. The SOLEIL control system strictly follows those concepts. Figure 1 illustrates an example of the approach described.

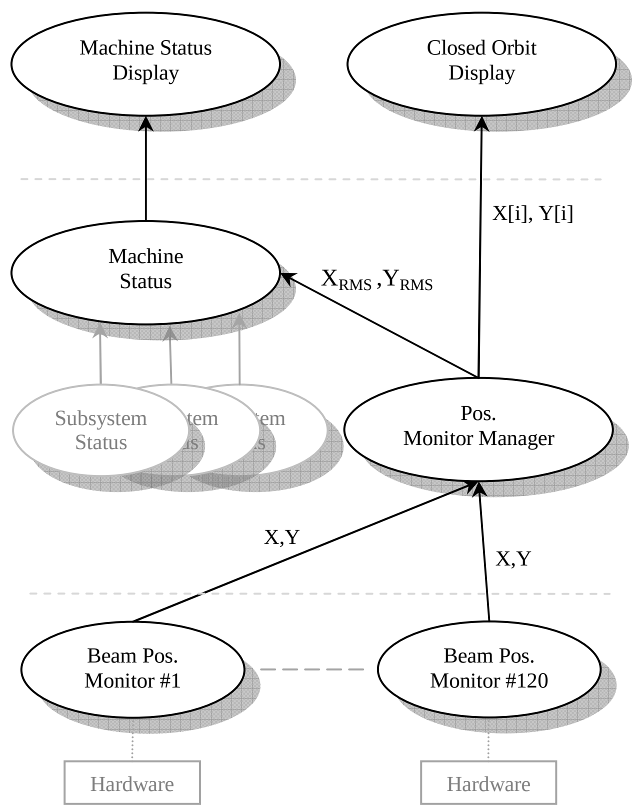

Figure 1: Hierarchical view of the beam position data dispatching.

* a TANGO device is conceptually a distributed object which interface is composed of attributes (e.g. data) and commands (e.g. actions).

Implementation Strategies and Guidelines

In order to respect time, cost, and manpower constraints, we have decided to focus on "off the shelf" hardware and software solutions integration, and to dedicate home developments to very specific projects. In this context, TANGO will act as the glue combining those heterogeneous solutions into a coherent whole.

Long-term maintainability was also a major constraint. As an approach to achieving this requirement, the concept of *hardware abstraction* has been applied to all generic hardware functions. For instance, video-hardware details are masked in plugins, which are themselves dynamically loaded and managed by a shared library providing advance image acquisition features to the TANGO device developer. The latter can then focus on the application logic instead of struggling with hardware details or "reinventing the wheel" in each project. Moreover, supporting a new piece of hardware simply requires writing a new plugin itself supporting a well-defined and documented interface. Finally, this approach eases software maintenance, since similar applications have similar implementations and any team member can potentially fix a problem in a code he/she did not write.

Due to lack of manpower, software development effort-sharing among all teams involved in the control system was mandatory. For instance, on the client-side of the control system, high-level and user-friendly interfaces provide both machine physicists and operators with total autonomy in development of machine operation applications. At SOLEIL, control room applications have been written and are maintained by their users.

Implementation Details

SOLEIL control is based on a classical three-layer design. However, this vision is purely logical, since any control system actor may be reached from any other (i.e., there is no network or software barrier between TANGO devices running in the control system).

The lowest layer is mostly (and obviously) composed of TANGO devices that provide access to the hardware. Those devices are hosted on compact PCI (cPCI) crates running the Windows or Linux operating systems*. The cPCI crates host the processor unit (CPU), the common data acquisition hardware, a bridge to a PROFIBUS fieldbus to which vacuum equipments and power supplies are connected, and the timing system local agent [8]. Currently, 105 CPUs are on this control system level. On the network side, each cPCI crate is connected to the control system via a 100-Mb Ethernet switch, which is itself connected to a 1 Gb fiber backbone.

The intermediate (or middle) control system layer hosts the so-called *logical TANGO devices*. At present, these services are distributed over 40 quad processor Linux servers. This layer has no well-defined hierarchical structure, since the relation between the devices is application- (or service-) dependent. We can define it as the level at which devices not directly linked to hardware run. This software layer also hosts peripheral services such as a Java based archiving system [9].

Finally, the client layer constitutes the highest control system level. It is mostly composed of graphical application that can be displayed on any of the 30 X terminals installed in the control room.

Software Deployment

Large-scale software deployment requires efficiency and coordination. Poorly designed or tricky deployment processes may influence machine operation and consequently, beam time availability. This is particularly true in the early stages of a project – when bug fix and enhancement releases follow one another. At SOLEIL, TANGO is also deployed on beam lines, and its ubiquity reinforces the need for an efficient deployment process.

To achieve such a goal, several system administration techniques have been coupled. First, a database is used to store the information associated with each TANGO device to be compiled then deployed. This information – which contains data such as a programming language identifier, the target operating system, CVS module name, CVS release tag – is used to perform a batch compilation of the 295 classes developed at SOLEIL. The compilation process is spread over two machines for each target platform and takes less than two hours to complete. In case compilation fails, the developer automatically receives an email alert containing the compiler log. Once compiled, the devices are pushed into a file server repository accessible from any host within the control system. TANGO administration tools are then used to selectively restart the devices and allow users to benefit from bug fixes and/or service enhancements.

FEEDBACK EXPERIENCE

The aim of this last chapter is to provide the reader with some feedback after a year of routine operation.

Machine Commissioning

The first stored beam was obtained June 2nd 2006 – four years after construction started. Adoption of the strategies and guidelines detailed in the previous chapter, allowed most of the systems and commissioning tools to be available from day one. As far as TANGO is concerned, the control system was very stable and never prevented the commissioning process from progressing. The SOLEIL computing team had to face classical problems of software bugs, systems setup, and tuning, but the current level of stability was quickly obtained.

Status

The TANGO database reports that 9319 devices are currently running within the control system. Among this population, 7452 are actual control system services (the remaining device being deployed for the purpose of TANGO processes administration). If we compare this figure to the number of executable binaries generated by the batch-compilation process, it gives an average value of 25 instances per binary. This is mostly due to the fact that a synchrotron is composed of almost identical cells. Note that those figures do not take into account devices deployed on beam lines. A quick evaluation yields approximately 15.000 devices after 5 years of operation for both the machine and the first twenty beamlines.

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