SOLEIL CONTROL AND ACQUISITION HARDWARE INSTALLATION AND MAINTENANCE MANAGEMENT

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Abstract

SOLEIL is a third generation Synchrotron radiation source located near Paris, France. Construction began in 2002. The storage ring has been delivering photon beams to twenty beamlines since 2006, with global reliability better than 95%. Fourteen beamlines are currently open to users.

In the space of a few years we have installed and deployed numerous items of hardware, including 153 CPCI systems, 182 PLC systems, 154 Motion Systems. Around 6000 cables are connected to our equipment. We distribute some 600 timing signals, driving over 900 motors; and piloting more than 500 IO CPCI boards. To achieve the high reliability required we have applied industrial installation and maintenance methods. From the beginning we have defined standard products and connections, installation procedures, acceptance forms, and so on. All configurations, cabling folders and acceptance forms are stored in an EDMS (Engineering Document Management Ssystem). We use a CMMS (Computerized Maintenance Management System) to inventory, localize and keep the history of the installed equipment. Each intervention is reported in the CMMS in order to track enhancement requests, maintenance operations, problems and repairs. This organization has enabled us to achieve 99.98% availability of control and acquisition hardware.

ABOUT SOLEIL

The SOLEIL [1] third generation synchrotron light source is based on a low emittance 2.75 GeV electron storage ring 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 serves the international community in many scientific fields, including physics, materials science, chemistry, and biology. Soleil has been in routine operation since January 2007. Around 20 beamlines have already received light, and 14 are open to users.

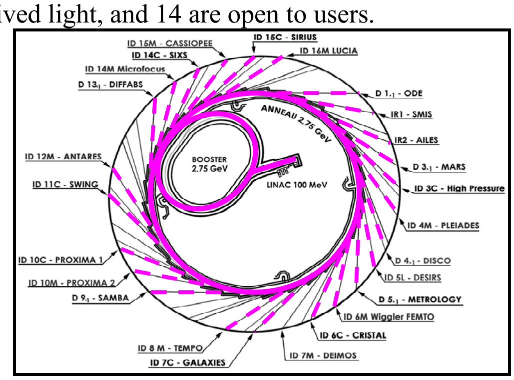

Figure 1: Synchrotron Soleil map.

CONTROLE AND ACQUISITION HARDWARE

The standard hardware components [6] selected for the machine and the experiments are industrial products adapted to the SOLEIL's needs. There are three groups of independent hardware devices.

SIEMENS PLCs are dedicated to slow and safe applications such as vacuum, temperature and interlocks. More than 180 PLCs are used.

Motion control systems are deployed in order to drive around 900 motors. These systems are composed of three racks called ControlBox, DriverBox and VacuumBox which supply standard packaging and connectors to industrial products: Galil DMC-2182 multiaxis controllers, Midi-Ingénierie and Phytron power boards.

Over 150 CPCI systems are dedicated for fast and high performance applications. Each 6U customized rack contains two distinct CPCI systems which can receive 3U or 6U boards: CPU, I/O boards (analog I/O, digital I/O, counter, timing, etc.). External patch panels provide standard connectors for the standardized boards.

Overall, we have to monitor the life and the "health" of 4500 items, as well as the 6000 cables connecting them to the process and the thousands of other interconnection cables.

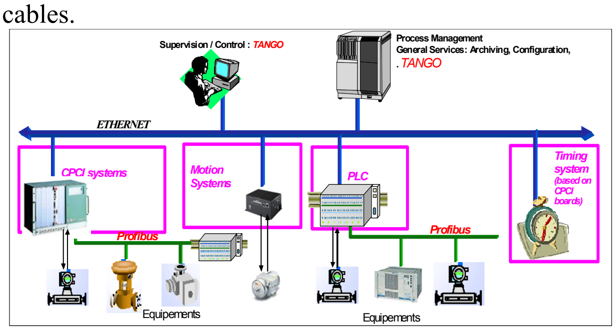

Figure 2: Hardware synoptic.

MAINTENANCE ISSUE

The beam is expected to be available 24 hours a day, 7 days per week. Each year, shut-down periods for maintenance and upgrading of the machine and the beamlines are scheduled on a regular basis. During operation, the Soleil beamlines are open to scientists from all over the world. The allocation of beamtime is scheduled in time slots of appropriate lengths. Any breakdown can seriously disrupt the schedule. Maintenance staff are on 24/7 standby during beam operation to handle blocking problems.

Our main concern, however, is to limit blocking problems. In order to ensure the high reliability of our items, we have defined procedures and integrated them in our process management tools including our Computer-aided Maintenance Management System (CMMS) and Concurrent Version System (CVS). Other computing tools are used, including Schemelec [3] from FTZ for electrical Computer-Aided Design, as well as in-house tools for our process cabling database and acceptance forms.

INSTALLATION PROCESS

The Soleil management has defined a Work Breakdown Structure (WBS) which divides the machine into various sub-projects for each part of the machine – Linac, Booster, Storage Ring, etc. – and each process field – diagnostics, power supply, vacuum, etc. Each beamline represents one WBS. Whenever possible we consider each project independently, but we use the same products and procedures.

The first step is to define our commitment for each WBS. We inventory the electronics needs by completing a standard form. With this form we supply the hardware devices needed, define the cabling folders and write or adapt the embedded software if needed. The second step is to prepare the systems defined, test them in the lab and then install them. At the same time, we check the process cables installed by the infrastructure team. The third step is to connect our hardware devices to the process equipment. We configure the equipment and deploy the low level TANGO [4] software devices in collaboration with the software team. There is a procedure for any standard hardware device. All configuration files and cabling folders are saved on our Linux CVS server and can be restored.

INVENTORY AND TRACKING OF INSTALLED HARDWARE

Each item supplied by the team is individually identified in the TRIBOFILM MAINTIMEDIA CMMS [2], as a “topology” of a “functional class”: a member of a family of devices with its SOLEIL number, serial number, price, receipt date, warranty expiration date and other useful and intrinsic information. For instance, one of our CPCI CPU devices is identified as a topology of the Control and Data Acquisition CPCI CPU family - coded as the CA/PCI/CPU functional class - with the Soleil number CA/PCI/CPU.0190, the serial number 8B18EC3001, the MAC address 00-30-64-08-0A-0C. This CPCI CPU item is physically labeled as the CA/PCI/CPU.0190 functional topology.

Moreover, the MAINTIMEDIA CMMS includes the ability to set topologies in a “geographical tree”, allowing a true representation of the installation: the machine is divided into sections (linac, transfer lines, booster, storage ring, etc.) and each beamline is identified. All cabinets are represented by branches. Any item or topology identified in the CMMS can be set precisely in the geographical tree according to its localization. In our example, the geographical tree shows that the CA/PCI/CPU.0190 topology takes place in the crate CPCI 1B topology, itself located in the cabinet BAI.0811 in cell 10 of the storage ring –ANS-C10-BAI.0811/PCI.2B. If we physically move the item, we also move its topology in the CMMS tree. This movement is recorded in the CMMS database, so we can track all locations of this item during its life.

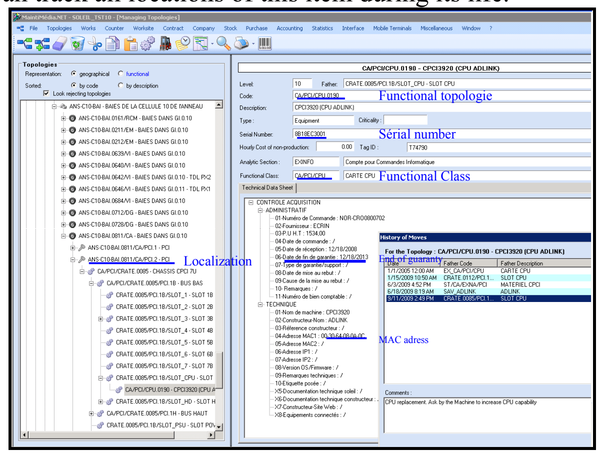

Figure 3: Inventory of installed base.

OPERATION

To keep our installed base operational, maintenance tasks are planned during shut-down periods: tasks can be programmed on a regular basis, on a conditional basis or one time. For instance, concerning motion systems, configuration files are saved every year, firmware is updated only if there is a new version while installation occurs only once. Tasks may also be requested by internal customers through job orders that we can accept or decline. Regular tasks are planned through the CMMS and assigned to a member of the team through a Process Sheet, from which a Work Sheet is generated. Single tasks are planned directly through Work Sheets. Each Work Sheet describes who does what, when and the status. The operator records a brief report after an operation is complete. A link to CVS data can be added. This report may be sent by e-mail or printed.

Each team member is on duty for one week every eight weeks. It is very important to know what others have done and what the procedures are in order to take the right decision or initiative. Internal training sessions are organized to ensure that we are familiar with all standard equipment. All duty operations are stored in the CMMS.

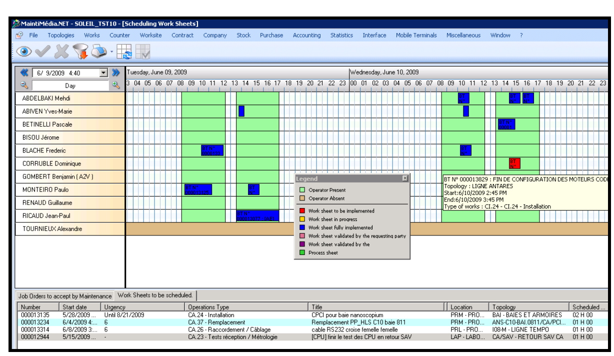

Figure 4: Task planning.

RESULTS

All work is recorded in the CMMS database in order to track enhancement requests, maintenance, problems and actions. The saved data is used to calculate indicators, which can be extracted in two ways:

The first, simpler method, is to use the CMMS itself. Some illustrations are given below:

⇨We are able to know what has happened in a particular place during a specific period. It is useful when we have an Emergency call and we need to know the history of a topology. For instance on a beamline we know when someone on the team changed a parameter or conducted a test on a motion system by looking at work sheets bound to the geographical topology of the beamline. Of course, it assumes that nobody else modifies the installation without our knowledge (for this particular aspect of our job we are always looking for a good solution!).

⇨CMMS gives us failure information on devices. Thanks to CMMS, we have noticed many power supply failures on ControlBox units. Over 15% of our ControlBoxes' power supplies had a failure during the first two years of operation. With the factual data recorded in the CMMS we contacted the subcontractor, who updated all the power supplies of our ControlBoxes (even items that were out of guarantee).

⇨CMMS gives us the age of devices, guarantee dates, history of breakdowns and warranty problems, and so on.

The second method, for high level extraction tool, uses a business intelligence tool, InfoView from Business Objects [5]. This tool collects and consolidates CMMS information and presents it in a secure, personalized view. We can personalize how we view, manage, and distribute contents. Some direct applications are:

⇨Installed base and operation assessment. We can track the evolution of true failures and emergency calls. The objective is to prevent a possible decline of our installed base, and to prevent unjustified emergency calls by user training.

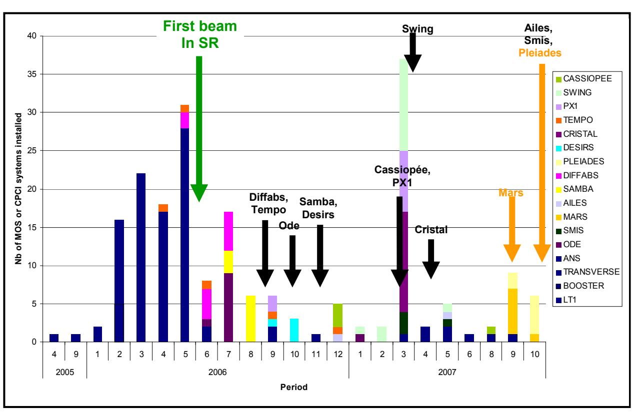

Figure 5: Installation flow during construction phase.

⇨Identification of peak load periods and manpower requirements. During construction of the machine we recorded in the CMMS the amount of work and lead times, which helped us to justify the workload peak during beamline construction.

⇨Indication of task types and quantities over time. We can justify some needs. For instance the CMMS provides objective data to help justify the need for a cabling resource to handle requests.

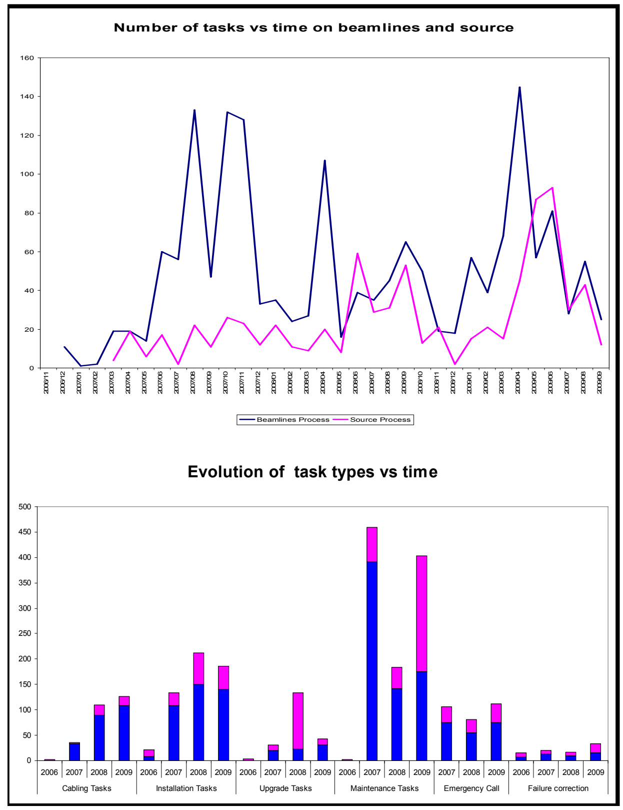

Figure 6: Some high level indicators.

CONCLUSION

Installation and maintenance management requires the collaboration of the entire team. It is strategic to convince everybody of its importance and to discipline oneself. Reliability, which might be expected to be moderate given the age of our facility, is maintained at a high level thanks to this organization and tools: only 3.4% of our work tasks are failures correction and only 1.5% per year of our installed base required replacement. In 2008, only 0.02% of machine breakdowns were attributed to our hardware items. Today this organization is being deployed to the whole installation.

REFERENCES

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