CERN SAFETY ALARM MONITORING SYSTEM

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Abstract

The CERN Safety Alarms Monitoring (CSAM) system is designed to acquire and transmit reliably to the CERN Fire Brigade all alarms generated by a large number of safety alarm equipment distributed around the sites and in the underground tunnels and caverns. The quality and accuracy of the information provided by CSAM is crucial to permit a rapid and efficient intervention by the Fire Brigade. The CSAM project was launched in 1999 to replace the previous alarm system which used obsolete technology and operator devices. The new system is in operation since 2005 and signals from all the alarm equipment on the CERN sites are now handled by the new system. The migration/installation process was terminated in June 2006. This paper presents the system architecture, the deployment process and the lessons learnt implementing an alarm system in an accelerator environment.

INTRODUCTION

The CERN Safety Alarm Monitoring (CSAM) system [1] is the alarm transmission and supervision system for the Organisation in the LHC era. Its objective is to help to safeguard human life, property and the environment. The system acquires and transmits alarms generated by safety equipment such as fire detection devices, gas detection devices, emergency stops, flooding detectors, blocked lift, emergency calls and others. These devices are located in surface buildings (offices or laboratories), in underground caverns, on all CERN sites, and around the accelerators and experiments. The alarm information is transmitted using a redundant cable topology to the Safety Control Room (SCR) for immediate intervention of the CERN Fire Brigade (FB).

Alarm information is also transmitted to the CERN Control Center (CCC) that has a double back-up function with respect to safety alarms: firstly, it is available to be used by the FB if the SCR by accident is not operational, and secondly, it complements the FB's safety interventions with potential technical interventions. In addition, the system has to cope with the upgrading of existing safety alarm systems for all CERN sites to obtain homogeneity with LHC site installations, maintenance and operation.

CSAM DESCRIPTION

Main Function

The CSAM system provides the Fire Brigade with an information sufficiently detailed and complete to identify easily and without ambiguity the nature of a given problem and the problem's exact location in a very special environment, 24 h/d, 365d/y. Its main functions include:

- Acquisition of the generated alarm signals from the alarm devices.
- Transmission of the alarms to the SCR/CCC.
- Display of the alarms in the SCR/CCC.
- Display of alarms in a Local Alarm Display.
- Event logging.
- Generation of alarm inhibit, maintenance and test reports.
- Safety actions.
- Real time availability monitoring.

The CSAM system has adopted a flexible system architecture for the integration of the existing CERN-wide safety alarms and has the capacity to integrate new, additional alarms from new accelerators and experiments using both software and hardware features.

The system is designed to guarantee a service uptime of 99.8% in a continuous non-interruptible mode. This service uptime includes maintenance interventions and other alarm operations, e.g. the introduction, modification and elimination of alarms.

System Architecture

In line with the IEC 61508 standard [2], the design of the system focused on two main objectives: functional performance and Safety Integrity Levels (SIL).

The architecture of the system is shown in Figure 3. For the functions requiring a SIL2 level, a redundant 1oo2 architecture is implemented from the alarm acquisition to the alarm display stage. As the alarm system is distributed over a huge space, CERN has subdivided the areas surveyed into 33 safety zones to enable efficient fire brigade interventions. For each safety zone, a dedicated Local Safety Alarm Controller (LSAC) guarantees a reliable alarm acquisition and a local alarm display. All alarms acquired by the 33 LSACs are transmitted to a Safety Alarm Monitoring Centre (SAMC) that processes the alarms and acts as a server for the Human Computer Interfaces (HCI) in the FB control room (SCR) and in the CERN Control Center (CCC). In parallel to the SAMC, a Central Safety Alarm Controller (CSAC) acquires and displays on a large mural synoptic any presence of any alarm in any safety zone. The communication with external systems is done by the Safety Alarm Gateway with External Systems (SAGES).

The implementation of the system in the SCR is shown in Figure 1. Two SCADA clients are equipped with two screens each. The first screen is reserved for the alarm display on the synoptic views of the CERN 33 safety zones. The second screen displays the alarm information in a list format. Firemen acknowledge the incoming

alarms directly from the HCI which was not possible with the previous alarm monitoring system.

Figure 1: CSAM HCI consoles in the SCR.

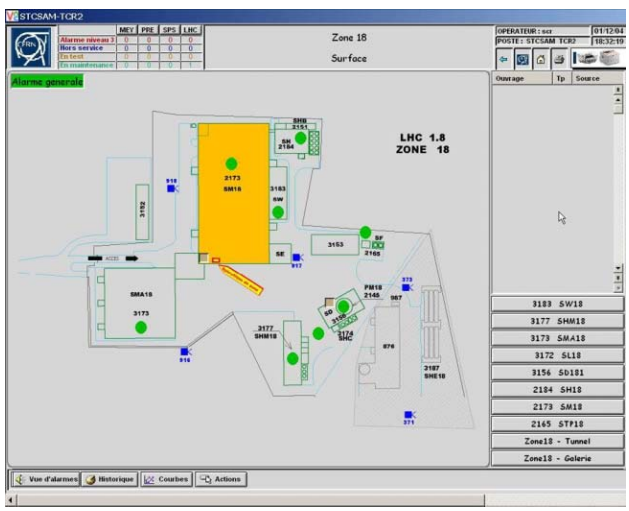

Figure 2: Alarm synoptic view on the CSAM HCI.

PROJECT IMPLEMENTATION

In line with the IEC 61508 standard, the first project phases included the creation of the functional safety management [3], a detailed analysis of the system requirements and the allocation of the SIL. As the system implementation was contracted to an industrial partner, detailed technical specifications for the tendering process were also prepared. The maximum SIL offered by the system was fixed to SIL2 and included as a contractual engagement from the contractor of the system performance.

The supply contract execution was divided in three work packages. Each work package corresponds to well identified IEC61508 lifecycle phases.

The execution of the WP01 started in 2001. It included four phases:

- WP1 Phase 1 included the production of the CSAM User, Functional, Safety and Product Requirements Allocation (IEC61508 Phase 6, 7 and 8).
- WP1 Phase 2 included the CSAM Realisation phase (IEC61508 Phase 9).
- WP1 Phase 3 was dedicated to the CSAM pilot installation and commissioning on one Safety Zone. (IEC61508 Phase 12).
- WP1 Phase 4 consisted of the CSAM Acceptance test (IEC61508 Phase 13).

Successful completion of WP01 in December 2004 triggered the start of WP02-Phase 1: the installation and commissioning of the LSACs in all safety zones, successively replacing the existing system. The CSAM installation and subsequent commissioning of each safety zone were systematically followed by the system acceptance tests (WP02-Phase 2). The complete installation of CSAM was successfully terminated in June 2006. The system integrates today about 1500 level-3 alarms acquired via dry contacts from the detection devices. In addition, the system manages about 6500 alarms acquired through a high level communication protocol with the detection devices, thus providing detailed information about alarm location. The final contractual acceptance will be organized in July 2006: it will include an overall safety validation test executed by the CERN Safety Commission.

The objective of the WP03 is to provide an efficient and structured Operation and Maintenance service. The key success indicators for this workpackage will be based on the measurements of the CSAM functional safety requirements. The system availability is considered to be the main performance indicator. Two other factors: the number of maintenance interventions required and the meantime-to-repair will however also be taken into account when considering the overall system performance.

CONCLUSIONS

The CSAM system was successfully installed on the numerous CERN premises, replacing the old system which was not conforming to the INB regulations. The strict application of the functional safety standards and underestimation of the required resources caused some delays in the initial phase of the project. The initial delays were largely compensated with the accelerated execution of the installation phase.

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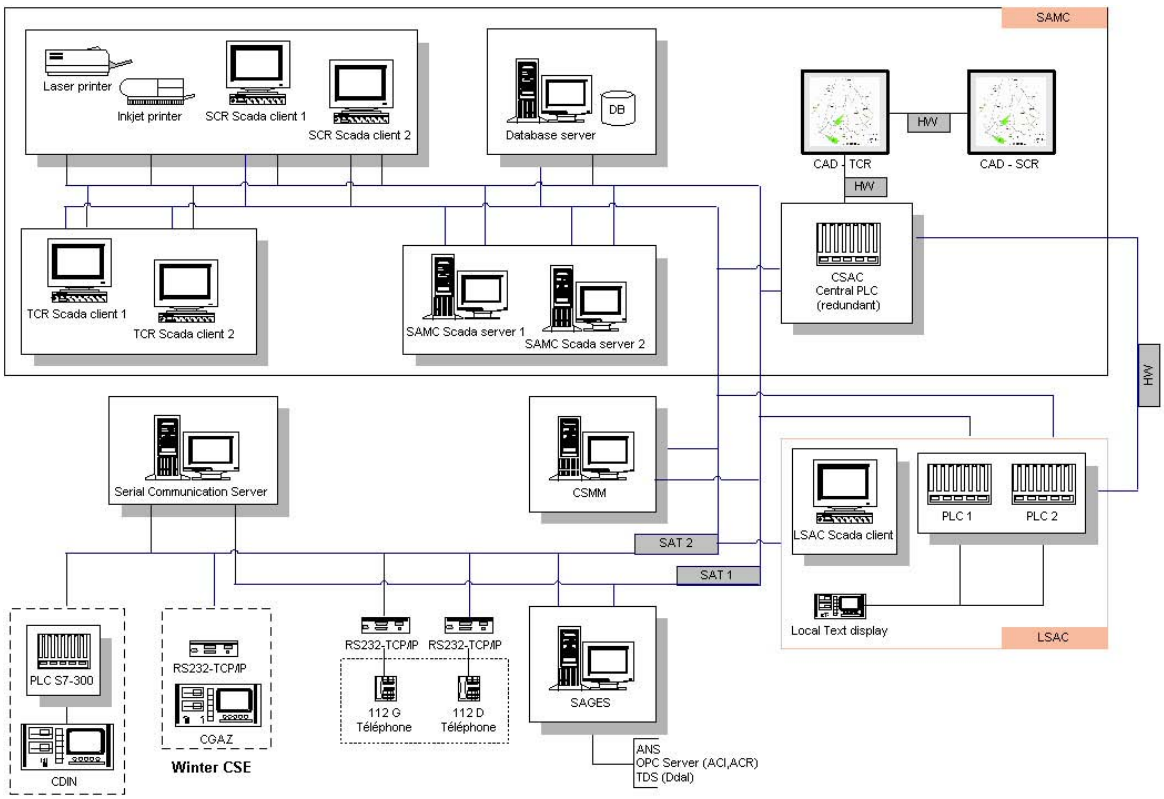

Figure 3: CSAM hardware architecture.