SARAF CONTROL SYSTEM REBUILD

E. Reinfeld, I. Gertz, I. Eliyahu, Soreq NRC, Yavne ANL ISRAEL

Abstract

The Soreq Applied Research Accelerator Facility (SARAF) is a proton/deuteron RF superconducting linear accelerator, which was commissioned at Soreq NRC. SARAF will be a multi-user facility, whose main activities will be neutron physics and applications, radio-pharmaceuticals development and production, and basic nuclear physics research. The SARAF Accelerator Control System (ACS) was delivered while still in development phase. Various issues limit our capability to use it as a basis for future phases of the accelerator operation and need to be addressed. Recently two projects have been launched in order to streamline the system and prepare it for the future development of the accelerator. This article will describe the plans and goals of these projects, the preparations undertaken by the SARAF team, the design principles on which the control methodology will be based and the architecture which is planned to be implemented. The rebuilding process will take place in two consecutive projects. The first will revamp the network architecture and the second will involve the actual rebuilding of the control system applications, features and procedures.

INTRODUCTION

SARAF is currently under construction at Soreq NRC [1]. It will consist of a medium energy (up to 40 Mev) high current (up to 2mA, CW, upgradable to 4mA) RF superconducting LINAC of protons and deuterons. The main accelerator assembly was built and delivered to the SARAF facility in 2007 and two beam lines were constructed by the SARAF team and completed in 2010. The project phase I is planned to be completed during the next couple of months and phase II is planned to start soon after (figures 1 and 2).

The accelerator control system was delivered while in development state and consisted of a number of semi-independent control systems, each designed to control a specific component of the accelerator [3]. Development ceased after delivering the system to SARAF team and was held in breakdown maintenance mode until the first two beam lines were constructed.

This article will describe the accelerator control system rebuilding project which is planned to transfer the control system from development mode into operational mode, and prepare it for phase II of the SARAF project.

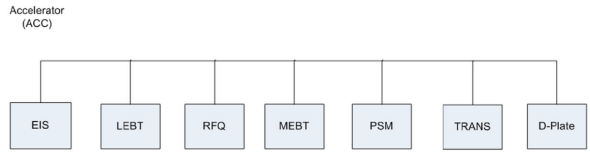

Figure 1: Accelerator overview.

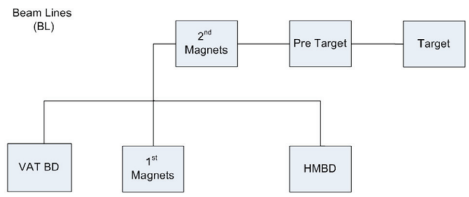

Figure 2: Beam lines overview.

PROBLEM DEFINITION

While preparations took place to the beam lines construction, the accelerator control system (ACS) was not developed further and was kept running with minimal effort and with no dedicated engineering staff.

As the beam lines construction advanced, it became apparent that the control system as a whole needs to be reviewed and assigned with control engineer team in order to "fix" the problems which were encountered by operators on a daily basis.

A review was conducted and as the system was further analyzed it became apparent that in order to prepare the facility for phase II of the project, the current control system which may have been fine for the development and commissioning stages must be overhauled and rebuilt.

The main issues which have to be solved can be summarized by the following list.

1. Lack of knowledge and documentation of the current control system. As the control system delivery was not completed there is close to no documentation at all on the various control components and mechanisms.
2. Fragile infrastructure. Key elements are missing from the control network infrastructure, which potentially can lead to severe consequences.
3. No methodology or strategy. Development of the control system was conducted "on the fly" and with no broad picture overview on how an accelerator control system should be built.
4. Waste of time and resources on keeping the system running. The operators have to deal with a control system which does not fully answer their needs and requirements.

In short, the system required a rebuilding effort that will stream line it into a solid operational control system that will provide a solid basis for further operation and development.

SOLUTION DEFINITION

To rebuild the system a methodical approach is planned, in order to address the issues described above systematically. Planning a strict method and following it in the implementation stages is important for standardization. An effort is made to complete each phase of the project as planned.

Revamping the infrastructure could be done in parallel, and was launched as a secondary project. This project is planned to upgrade the SARAF network capabilities in term of bandwidth, introduce network elements which were missing or not up to date, introduce cyber security protection suite tailored according to current standards for national infrastructure and should provide a solid foundation to the control system rebuilding project. The network revamp was defined as a necessary goal that is part of the control system base.

The control system rebuilding road map is described in figure 3.

Several constraints have to be taken into account when implementing the solution. The main constraint is that the rebuilding process will be done while the accelerator is still operational and a long period of shut down time is not planned. This means that the rebuilding process will be done on a living system and calls for careful planning and structuring of the rebuilding process, especially when migrating the software and tools, and when replacing specific applications.

IMPLEMENTATION

The project was divided into several consecutive phases. Each one consists of several action blocks which can be done in parallel to prevent bottle necks and to allow progress in various subjects by different teams.

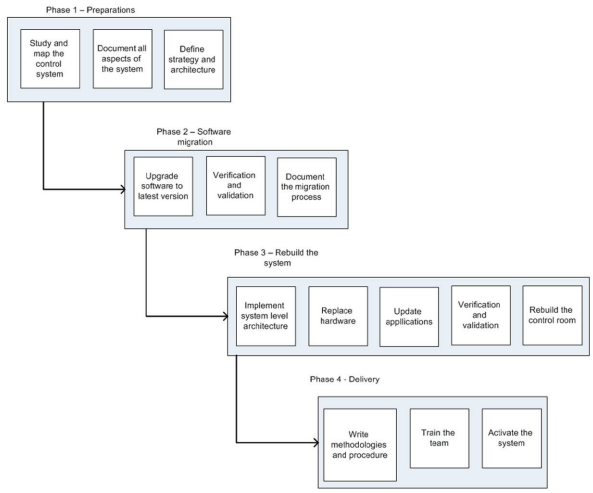

Figure 3: Project phases.

Phase A - Preparations

This phase creates a concrete control system knowledge base in the facility and defines the structure of the rebuilding project. This phase involves a thorough mapping and documentation of the entire control system. It involves reverse engineering efforts of the facility team members including the operators and engineers. At this point every major issue or bug found while reviewing the system will be cleaned and the applications will be updated wherever possible.

Mapping the system includes mapping I/O points, hardware, software and tools and reorganization of the system data.

Phase B – Software Migration

The SARAF control system is based on Labview 8.2.1 software. Some of the new control hardware is not compatible with this version as well as tool kits needed for new instalments. In this phase the software will be migrated to the latest stable version of Labview, and the entire application suite and control system will be migrated as well.

This will be a challenging step as the accelerator will be operational when the migration process takes place, and so both versions will coexist in the control system until all the applications are replaced.

Phase C – Rebuild the System

This phase will introduce new capabilities to the system, starting with a higher level of hierarchy to support flow control and implement the architecture designed in phase I of the project. This phase will see replacement of obsolete hardware, major update to all relevant application and should result in a stream lined and robust control system.

The last step of this phase will be the rebuilding of the control room according to modern design principals which will allow higher flexibility for operators and designers to work in.

Phase D – Delivery

The last phase will see the delivery of the control system to the SARAF team. After writing down operation methodologies, the team will be trained to use the system and the new tools introduced to it.

The following period will be to activate the control system and to monitor it for bugs and fine tune it according to operators needs.

SUMMARY

The SARAF facility has reached a maturity level to transfer it from the development state it was delivered, into an operational state. Two projects were launched to address the transfer, one to address infrastructure issues, and create a work environment which is stable and robust. The second is to rebuild the control system and create a basis for the future phases of the SARAF project, and to assimilate the engineering methodologies needed to operate and support a system of this kind.

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