

# THE INTEGRATION OF BOOSTER AND STORAGE RING CONTROL SYSTEMS IN THE SYNCHROTRON RADIATION RESEARCH CENTER

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## Abstract

The old booster control system of SRRC is a turnkey project from a foreign vendor in 1992. Since then, differences in design philosophy, inconvenience to maintenance staffs, and other inherited aspects have led to the replacement of the old MULTibus based local system with VMEbus based Intelligent Local Controllers (ILC). This change, it enables us to integrate the booster control system into the storage ring's system. This means the two original heterogeneous and unrelated systems become a homogeneous and unified aggregate from both the machine researcher, and operators' points of view. The benefits from this project are a more versatile environments for machine research, a more open architecture for machine upgrading or modifying capacity, less effort for machine maintenance, and a more advanced methodology for machine performance enhancement.

## 1 INTRODUCTION

Machine operators or researchers of SRRC used to control the accelerator facilities by two separated, differently designed graphic user interface consoles. That led to frequent complains about inconvenience to operation, unstable booster environment, and difficulty in measurement of some booster parameters. Owing to these incentives, we have spent almost one year to study and accomplish this project. The booster's old control system architecture is depicted in Fig. 1 [1], while the modified configuration is described in Fig. 2. Based on these two figures, we can summarize important differences that are stated as follows. First, the VAX workstation has been replaced by a Unix workstation. Second, the Ethernet IEEE 802.2 data link layer protocol is changed to a TCP/IP suite. Third, VMEbus based intelligent local controllers replace the old MULTibus based one. Last, some new interfaces have been installed on VMEbus based ILCs in order to correct drawbacks of the old system, and enhance capabilities of the modified system. After the replacement and integration is finished, the control system of the booster will become embedded in the general control system of SRRC that enables further machine expansion, accelerator researching, facility improvement, beam quality diagnosis, and direct comparisons between performances of the booster and

storage ring. Above all, the SRRC has an open and unified control system from now on.

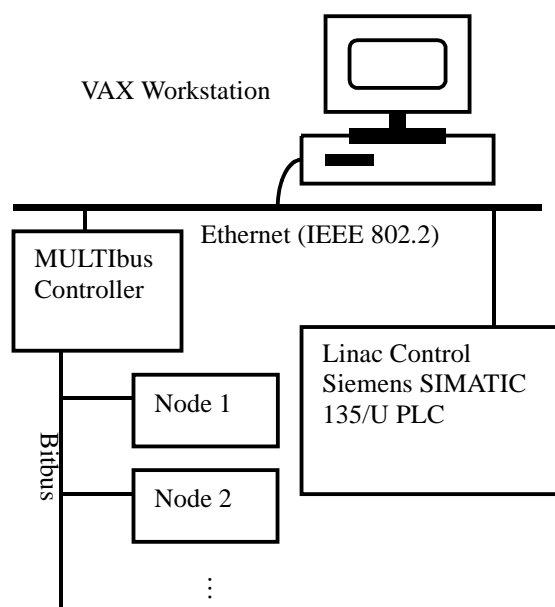


Figure 1: Old architecture

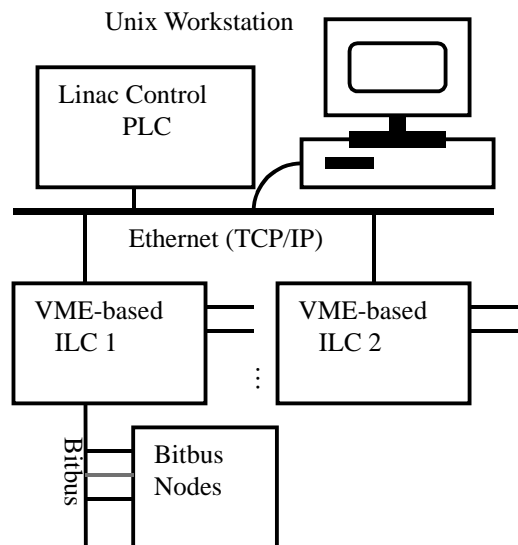


Figure 2: Modified configuration

## 2 HARDWARE MODIFICATIONS

### 2.1 Unix Console

Since the storage ring control system has been migrated to the Unix environment, the first step toward integration is to have both subsystems running under the same operating system. Hence, the old VAX workstation has been eliminated, and replaced by the Unix console workstation where the storage ring's control system resides.

### 2.2 VMEbus Controller

The local controller of the old booster control system is a MULTibus based single board computer (SBC) running under the iRMX II real-time operating system from Intel [1]. Among our storage ring's system, we have *de facto* adopted a VMEbus based system for local controllers [2,3]. For the purpose of unifying the overall configurations of the control system, we had to replace the old MULTibus based local controller with VMEbus based ILC. Also, another ILC was installed to communicate with the Siemens SIMATIC 135/U PLC system. We have chosen the CES 8061, PowerPC-based VMEbus SBC module running under the control of Lynx real-time operating system.

Fig. 2 shows the SIMATIC 135/U PLC system, which has been modified and equipped with TCP/IP embedded networking packages from Siemens. That enables the PLC communication protocol to be Ethernet TCP/IP, which is the built-in networking protocol on our existing ILCs, instead of the aged and scarcely used IEEE 802.2 data link layer protocol. With this capability, the upper level Unix workstation can control all functions of the PLC, which is a basic requirement of our integration.

### 2.3 Bitbus Network

In the old system configuration, a Bitbus network is used to control front-end devices. Each node is programmed to run device control commands requested from the upper level VAX workstation [1]. For the sake of budget and manpower limits, Bitbus nodes are still integrated into the modified system and are controlled by one of the ILCs such that all front-end devices can function as usual and desirably. The VMEbus-compatible Bitbus controller board is installed on one ILC that consists of an Intel Bitbus enhanced microcontroller to implement the Bitbus message structure, protocol, I/O command set, and to provide all of the control functions for an extended Bitbus environment. We have kept most of the Bitbus nodes unchanged but replaced some unstable and obsolete nodes, which are power supply control and slow timing systems, with efficient, economical alternatives in order to improve the performance of the booster.

## 3 SOFTWARE MODIFICATIONS

### 3.1 Software on Workstation

Since the Unix workstation has replaced the VAX one, the control database of the booster, which resided on the old VAX system, was integrated into the storage ring's main control database. We have put a lot of effort to examine and summarize all the signals recorded in the booster's control database [1]. Finally, we have picked up those necessary signal entries and transplanted them into the SRRC main control database. With these augmented entries in the main control database, our X window based facility control application is able to function completely and flawlessly [2,3]. The graphic user interface page of this application related to the booster is shown in Fig. 3. It is much more animated and convenient than before. By running that application, first line users should sense distinct differences between the old and new systems.

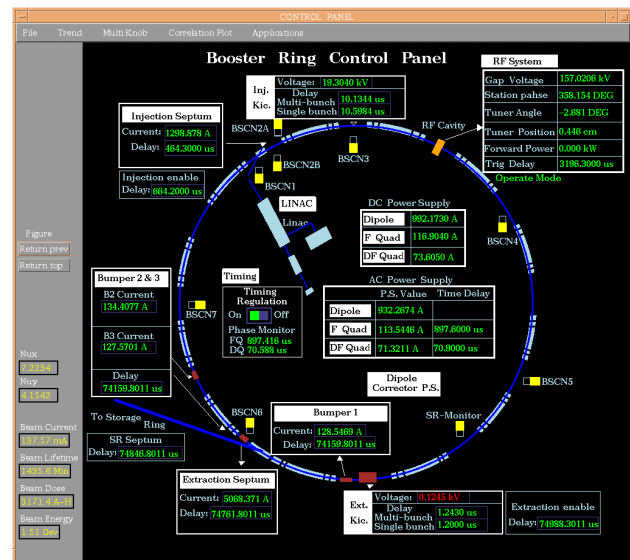


Figure 3: Updated graphic user interface

### 3.2 Software on Intelligent Local Controllers

Since the old MULTibus based local controller has been replaced by VMEbus based ILCs, all device control applications and software developing system had to be rewritten and replaced. The overall configurations of the control system in SRRC are described thoroughly within the 1994 published articles [2,3]. The main difference between then and current ILCs is that the new Lynx operating system replaces the old pSOS+. Basically, general functions of all software running under the Lynx are pretty much the same as the pSOS+, but the programming environment and system services have been modified in order to adapt to the new Lynx operating system. Therefore, the integration process includes software migrating and rewriting on local controllers.

## 4 COMPARISONS

We have replaced the troublesome Bitbus power supply control node with our own RS232/RS422 interface. Hence, we are able to augment the regulating process for dipole AC power supplies and to enhance the injecting efficiency of the booster ring. One can see the significant difference of booster beam currents in Fig. 4 and Fig. 5, which demonstrate that the modified system is much more stable and efficient than the old one.

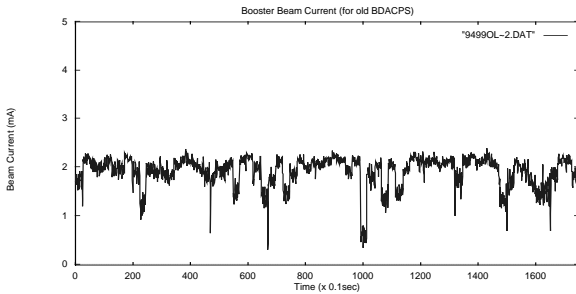


Figure 4: Beam current before integration

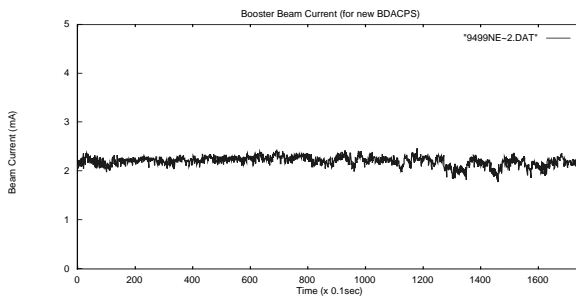


Figure 5: Beam current after integration

The old control system of booster was notorious for operating inconvenience and too many time-consuming, warming up procedures. We have remedied these drawbacks with an automatic booster operation interface. The graphic user interface of automation significantly offloads burdens of machine starting up and operations (Fig. 6).

## 5 CONCLUSIONS

The integration project has involved a lot of tedious prerequisites, such as original manual reading, old software comprehending, control logic realizing and testing, etc. Those are the reasons why we have hesitated to take the first movement before. Now that the integration stage has been carried out, further enhancements of the booster are possible. Imminent projects include 1.5 GeV energy upgrades for the booster and storage ring, topping up injection mode, and beam quality analysis of the booster. Other advantages obtained from the integration project are a more open system

architecture, friendlier operating environment, and less effort to troubleshoot the facility. The PLC system and Bitbus end nodes, are the constituents with the least or no modifications. Since the internal implementations of these components are still not fully comprehended to us, further investigation and realization are on the way. Whether to replace or refine these two subsystems will be determined.

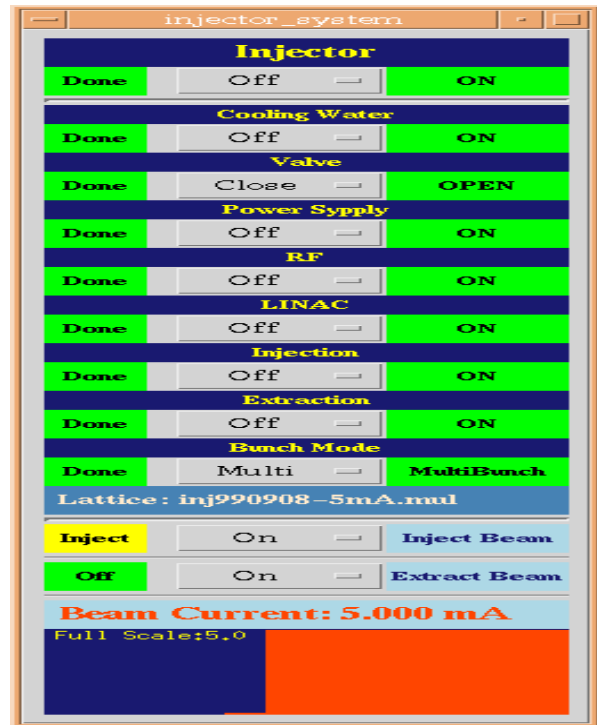


Figure 6: Automatic graphic user interface

## 6 ACKNOWLEDGMENTS

Last but not least, all authors would like to render sincere appreciation to those that supported and helped us to accomplish this project.

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