Integration Feasibility of the Existing Linac Control System and the Ring EPICS System at KEKB

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Abstract

In the KEKB project both the ring and the linac accelerators are to be upgraded from the TRISTAN project. It was recently decided to employ EPICS control software for the KEKB ring controls. It is reasonable to use such mature collaboration-based software when we start to build a new control system. However, at the linac side, which will be upgraded from 2.5-GeV to 8-GeV, we have been operating a new control system separately, employing international and de-facto standards with an object-oriented design since two years ago.

We are thus searching for a scheme to make these two control systems come together, since it is important to have tight control communication between the linac and ring in order to achieve a higher luminosity in physics experiments. In this report, several schemes for the integration between the ring and the linac are discussed.

1. Introduction

At the KEK electron/positron linac, re-formation of the accelerator for the B-Physics (KEKB) project with an improved beam current and energy started in 1994 [1]. We will upgrade our linac energy from 2.5-GeV to 8-GeV by 1998. A control system is also being prepared for it employing international and de-facto standard systems with object-oriented design [2]. It improves both functionalities and reliability [3].

In the project the linac should provide beams of better quality, stability and availability in order to achieve a higher luminosity in the ring. Thus, cooperation is indispensable between the control systems at the KEKB ring and linac. Extensive studies must be carried out in order to understand the correlation between the operational parameters in both accelerators with common database and accelerator-analysis codes.

Recently, at the KEKB ring controls it was decided to employ EPICS (Experimental Physics and Industrial Control System) [4], and control software is being reconstructed while maintaining most of hardware resources from the TRISTAN project.

On the other hand, at the linac we have been gradually rejuvenating the system since we must continue beam injection to the Photon Factory (PF) ring during the improvement. It is reasonable to employ EPICS as a result of the international software-sharing effort when a new control system is designed. However, the issue of integration with the existing linac control system remained.

In the former TRISTAN project, accelerator operation was separated at the linac and ring control rooms. Although some control information could be exchanged for the last part of the linac, it was not much used during normal operation. In the KEKB project, it is necessary to merge at least the beam handling console.

If possible, it is very desirable to design a common control architecture. Fortunately, we use a similar hardware architecture in both of the new control systems. There should be a possible scheme to shift over toward common EPICS controls.

In this paper we consider the technical aspects of the integration feasibility of the existing linac system and the ring EPICS system. Operational aspects will be considered elsewhere.

2. Control System Cooperation Between the Linac and Ring

In order to achieve system cooperation between the KEKB linac and ring, the operational procedure and control-room usage are under discussion. From a technical point of view, there are several possibilities. The use of EPICS at the linac is of course one of them. Below we describe four major possibilities.

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2.1. Employment of EPICS at Linac

In order to integrate two control systems it is most favorable to employ EPICS at the linac control system replacing existent one, since common resources can be shared between two control systems without much effort. This scheme should be taken if the both control systems would be designed again.

However, for PF ring injection we cannot shut down the linac accelerator for a long period during the KEKB upgrade, and much manpower will be necessary to follow a gradual accelerator improvement. It is thus quite difficult to replace software during this period.

Although the equipment access method over the network was standardized at the linac, we have not established only one standard method for the graphical operator interface. And we mainly use three methods: MS-Windows GUI applications, DOS based touch panel systems and Tk [5] based X-Window GUI applications. Because of such a variation it will take some time to re-design the graphical operator interface under EPICS.

Also, equipment-control software based on object-oriented design at the linac does not match the channel-oriented EPICS software. It may be thus necessary to redesign the structure of most application software for controlling the linac.

In order to fill the differences between equipment access methods it is possible to develop special EPICS records, such as magnets and klystrons. Although we may emulate our current access method on EPICS IOC (Input Output Controller), those pieces of software will become large, and we have to modify not only client applications, but also the EPICS source tree.

If we change to EPICS environment, it will be attractive to implement such records to fulfill the equipment-oriented design at the IOC level. However, during the construction time, such a complication should be avoided and more simple scheme should be implemented.

2.2. EPICS Capability in the Current Linac Control System

The current linac-control system comprises VME front-end systems, Unix systems and operator interface subsystems. If it is possible to implement the EPICS IOC capability into the current VME systems, both the current linac software and EPICS client software can be executed, and a gradual transition to EPICS can be accomplished.

One of the authors (k.f) studied such a feasibility [7]. As a result, this idea came up: if we emulate some VxWorks system calls, which EPICS IOC utilizes, in a thread environment, we should be able to execute EPICS IOC codes, although dynamic symbol manipulation is technically not easy to implement.

On the linac VME, while the OS9 operating system is currently employed, most software is written for both the OS9 and LynxOS operation systems. We had a plan to move to LynxOS, which is currently suspended. Also, on LynxOS we can use the POSIX thread (pthread) environment, which is one of the standard thread specifications. Though the code is not yet finished, an implementation has been attempted on LynxOS.

Therefore, such transition is possible. However, software development is too much compared to the amount of sharable resources. Since thee transition from OS9 to LynxOS has been suspended for certain reasons, this scheme is not so feasible now.

Perhaps it is an interesting issue to adopt POSIX real-time standards to the EPICS IOC, since it would expand the EPICS application area. It should be discussed not only for KEKB integration, but also for more general areas.

2.3. Communication Protocol Conversion

In the linac-control system we implemented our own control protocols both between the Unix's and VME's and between the Unix's and operator interfaces. On the other hand, in the EPICS the Channel Access protocol is used between the IOC's and OPI's. If we can convert one of these protocols into the other, two control systems can communicate with each other.

The server program for the EPICS Channel Access is being developed in the EPICS collaboration, called Portable CA server [8], in order to enable access to external controls from EPICS Channel Access clients. Since several sites seem to use it without any problems, the Portable CA server should be installed at the linac in order to make EPICS clients reach linac controls.

After we write protocol conversion routines for the linac equipment, EPICS Channel Access clients will see the linac accelerator as one large IOC. Although it's asymmetric as Fig. 1 and we cannot share low-level controls between the linac and ring, such a solution is very simple to implement.

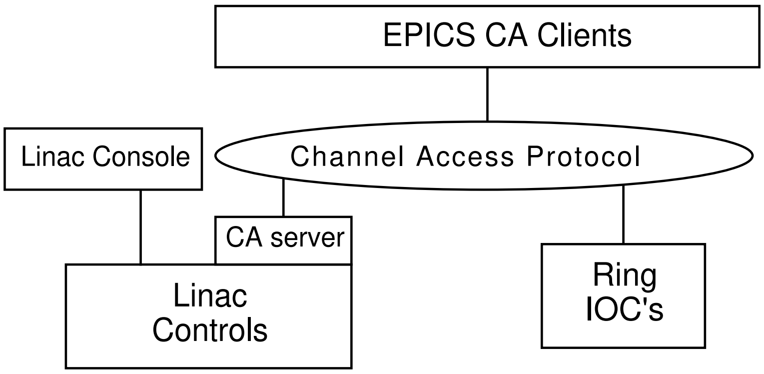

Figure 1: CA server implementation at Linac to enable common applications.

If it is necessary to reach an IOC in the ring side, we may call Channel Access library routines from inside the linac operator interface. At least at the beginning, some kind of security should be checked between the linac and ring controls.

2.4. *Common Upper Level Control Protocol*

A Channel Access server described in the previous section is a practical solution in a one-to-one conversion. However, we must soon think about the Photon Factory ring as one of the downstream accelerators for the linac. Also, physics experimental groups and other facilities may be loosely combined.

In such a multi-architecture situation it is natural to design a common upper-level protocol. Also, several groups are working to implement it. The CICERO project is a development collaboration based on CORBA (Common Object Request Broker Architecture). In the EPICS collaboration cdev (control device) [9] is proposed as the common API, and implementation is made available.

Since cdev is designed object-oriented, it should be easy to write an interface to the linac control protocol. Although the link at the top level with cdev is not efficient in speed, software design will be clear.

Although cdev over the distributed network is not yet defined well, we expect that ACE (Adaptive communication environment) or CORBA will be soon applied to cdev. Fig. 2 shows such a common environment.

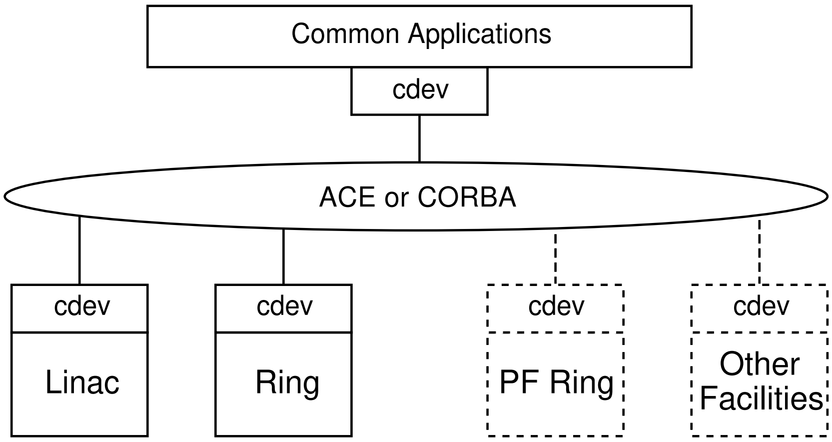

Figure 2: Possible integration of control systems at KEKB with cdev and ACE or CORBA. Common Applications may communicate with any control systems.

Although this scheme is a favorable, and will provide a common application environment, the number of existent general application programs is small. Since most EPICS clients use only the CA protocol, we hope that more application programs will be developed on cdev. For a long run this scheme is considered to be chosen, and also seems to be promising.

3. Other Services

Other services, such as computer resources, computer networks and relational databases, as well as their management, can be combined more easily compared to the control protocols. Since our manpower is very limited, we should pay attention to merge such services.

4. Conclusions

The above discussion shows two feasible schemes for merging the existing linac control system and the EPICS ring control system. One is to employ the CA server at the top of linac controls for a short-term solution.

The other is to implement a cdev environment over the top of the two control systems as a long-range plan. We need to design a network-communication interface and a set of common control application programs in the EPICS collaboration.

If the cdev adoption is successful we may skip EPICS employment at the linac side. Of course, in order to save manpower, we may design new sub-systems with EPICS. We don't have any problems with such mixed architectures, since cdev can manipulate all communication between them.

With those considerations in mind we hope to achieve successful results out of the KEKB project.

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