PURCHASING ACCELERATOR SUBSYSTEMS AS TURNKEY COMPONENTS

S. Hunt, PSI, Villigen, Switzerland

Abstract

Many new accelerator projects are purchasing complex components as turn-key systems rather than building them in-house. If not managed efficiently this can cause problems in integrating these components with the global accelerator control system. Having these components delivered with a 'foreign' control system can cause performance bottlenecks and problems of maintenance. Later replacing these controls is often necessary, but is time consuming and expensive. At SLS we avoided these problems by having the external companies deliver these systems (including Linac and RF) with Epics [1]. To ensure compatibility, we supplied the necessary hardware, and provided the companies with training and support. This ensured a relatively trouble free integration, and contributed to the very fast commissioning of the SLS.

1 INTRODUCTION

When building accelerators and other large scientific projects, such as high energy physics experiments, there has always been a difficult decision if to build components in-house or purchase from industry. The amount of industrial participation often varies, and may include consultancy only, provision of labor, series production, prototype construction, design, requirements capture, or complete turnkey solutions. Systems provided by industry may be of the shelf, modified from standard products, or totally new designs. The scale of components built with some level of industrial participation may be individual small components to complete accelerators.

2 WHY BUILD IN-HOUSE

2.1 Maintenance

Having systems built in-house means the expertise to maintain and develop the systems are readily available. Local staff will have a much deeper knowledge of the system than would otherwise be the case.

2.2 Consistent standards

Following laboratory standards of construction, wiring and documentation, can improve the ease of use of the systems for staff. Local safety procedures, regulations and conventions are more likely to be followed.

2.3 Cost of manpower

In many laboratories the full economic cost of in-house manpower is not taken into consideration when evaluating the cost of projects. Staff may already be in place, which can make it seem cheaper to build in-house.

2.4 Control over schedule

It may be considered dangerous to rely on the supply of schedule critical components from outside sources. It can be frustrating to feel powerless to accelerate progress by directly increasing resources to a project. However building in-house is often no guarantee of delivering on time, and penalty clauses in contracts can act as a powerful incentive for companies to deliver on schedule.

3 WHY BUY FROM INDUSTRY

3.1 Economies of scale

Industrial suppliers may have economies of scale in providing components to more than one laboratory, or to other types of customers. Many multi-use technologies are now used in accelerators and this has an impact on price.

3.2 Lack of expertise or manpower

Laboratories may not have enough competent staff to produce the systems in-house. This is often the case at smaller institutes and new laboratories, a fact they can then use to their advantage by making them more likely to make use of the benefits of using outside companies. Larger established laboratories may have lower staff levels than in the past.

3.3 Price effects of competition

Competitive bidding tends to result in lower prices for systems. Single sources of supply, whether from industry or in-house groups almost always results in higher costs. It is often worthwhile to compare even a preferred in-house price to an external bid.

3.4 Access to new technologies and ideas

Industry may be able to offer alternative approaches and technologies. These may have been developed from projects far removed from the accelerator domain.

4 CAN LARGE SYSTEMS BE DELIVERED WITH INTEGRATED CONTROLS

Accelerator and large experimental physics control systems have largely evolved over the years in a similar direction. This has been mainly towards a distributed computer system, with control and monitoring of signals carried out in a high performance, often real-time, environment.

Many of the controls requirements, even of a modern high performance accelerator, can be carried out using industrial process controls technology. However there is a significant, and perhaps growing class of requirement that cannot. Many of the latest accelerators have very demanding requirements for example for beam positioning and stability, and these requirements translate into stringent controls requirements.

We are therefore faced with the choice of using two systems, one high performance and one low performance, or having one, high performance, system cover all requirements. As signal densities can be very high in high performance systems, cost per channel can be as low or lower than low performance industrial I/O.

5 PROBLEMS WITH INDUSTRIAL PROCESS CONTROLS IN AN ACCELERATOR ENVIRONMENT

5.1 Timing

Many accelerator components have stringent requirements for timing and synchronization. Actions and measurements have to be synchronized to high accuracy, for example for injection, extraction, ramping, or data taking. Often software and hardware timing events are needed, and have to be dynamically modified in a flexible manner. These facilities are not available in PLC systems.

5.2 Data archiving and correlation

Data archiving and trending are available in process control systems, but often with limitations on the number of channels and frequency of update. The lack of accurate timestamp information makes exact correlation difficult. And it is also very difficult to compare data from PLCs with information from the high performance systems.

5.3 Alarms

A single, unified system to monitor, classify, and display alarm information is a vital tool in running a modern accelerator. It may be necessary to monitor tens or hundreds of thousands of channels, often from multiple locations. It might also be necessary to dynamically modify alarm limits, or mask alarms (for instance when changing accelerator operating mode or particle type) at run time. It might be necessary to have an associated first-fault system with mili-second or micro-second resolution.

5.4 Speed, accuracy and resolution

PLC systems typically have analogue I/O with relatively low measurement rates, low resolution, and low accuracy. Modern high performance accelerator controls systems typically have much faster ADCs and DACs, often with 18 or 20 bit resolution, and much better accuracy.

5.4 Special interfaces

Accelerator and large experimental physics control systems need many different interfaces not widely available in industrial systems. Examples of such devices are waveform digitizers, charge ADCs, scalers, high voltage power supplies, etc. These devices are widely available in Camac and VME. Even such common interfaces as GPIB are not well supported in PLCs.

6 EXPERIENCE AT SLS

Due to tight timescale and manpower constraints at SLS, it was decided to purchase a number of large accelerator systems from industry. These included the complete Linac, and the Booster and Main Ring RF Modulator systems. An early decision was made by the SLS controls group to attempt to have these systems delivered by the vendor using our standard controls hardware and software.

6.1 SLS Linac

The complete SLS 100 MeV electron Linac was purchased as a turnkey system from Accel. As part of the contract they agreed to deliver the system using EPICS controls. This was made possible by providing Accel and their subcontractors PPT, with a thorough introduction to Epics tools and hardware used at SLS. The complete system was delivered on time, on a tight time schedule. The low level controls and user screens delivered are totally and seamlessly integrated into the SLS control system, and have needed only very minor modification.

6.2 RF Modulator system

Five turnkey RF modulators were ordered from Thomcast AG. Each modulator has stringent requirements for controls. Thomcast engineers were trained on using Epics with our standard controls VME hardware. After only two days of training they were able to start to implement the RF control systems, using hardware supplied by SLS. Support was available but rarely needed. One comment we received back was that it was very easy to make the transition from programming a PLC system to using Epics. The company has subsequently delivered similar RF systems with Epics controls to the Shanghi Synchrotron Light Source, and has further orders and interest.

6.3 Hydrostatic leveling system

The hydrostatic leveling system was also ordered as a turnkey system. In this case we were unsuccessful in getting the company to adopt Epics as a control system. This was thought to be acceptable as the HLS system is less tightly coupled to the rest of the accelerators as the Linac and RF systems. The systems adopted is based on CAN bus and software on an NT PC. Delays in the control system implementation meant the HLS system was not available at ring commissioning. Not having this system tightly integrated into the accelerator control system has meant difficulty archiving, correlation, and handling of alarms. Two of the twelve machine sectors have subsequently been directly connected in parallel to the Epics control system using our standard VME crates and analogue I/O modules. This process took less than two weeks of work and provides better resolution, less noise and faster update rate. This will probably be extended to all sectors and replace the existing system.

7 LEASONS LEARNED

- Don’t confuse advantages of having industry supply turnkey systems with using low performance industrial (PLC and SCADA) systems
- Don’t underestimate the ability or willingness of industrial partners to use your control system if it is well designed and easy to use.
- Understand the limitations of industrial controls when making your decisions.

REFERENCES

[1] L. Dalesio et al., “The Experimental Physics and Industrial Control System Architecture: Past, Present and Future”, ICALEPCS 1993, Berlin.