PLANS FOR THE DIAMOND CONTROL SYSTEM

B G Martlew, M J Pugh, W R Rawlinson,
CLRC Daresbury Laboratory, Warrington, Cheshire WA4 4AD, UK

Abstract

DIAMOND is a new design for a 3 GeV electron storage ring. It has been proposed as a replacement for the SRS as the UK national light source. There will be a need for a flexible and expandable control system to allow easy monitoring and optimisation of all aspects of the accelerator and its sub-systems. This paper reviews the different options that are available when designing a new accelerator control system and presents preliminary details of a proposed architecture for the DIAMOND control system.

1 INTRODUCTION

DIAMOND is a proposed 3 GeV national light source for the UK. It will use a 16 cell DBA lattice in a racetrack configuration [1]. The storage ring circumference will be approximately 340 m and the design beam current has been set at 300 mA. Preliminary design work has been undertaken on most of the major systems involved in a light source but funding is not yet available to undertake a formal design exercise. Specification of the control system has, so far, only been progressed far enough to produce approximate cost estimates. However, the remainder of this paper summarises the options that will be considered when a formal design exercise is approved.

2 SPECIFICATION ISSUES

2.1 Experience from the SRS Control System

Before considering requirements of the control system for DIAMOND it is beneficial to reflect on some of the experience gained with the SRS control system at Daresbury [2]:

1. The SRS has now been operational for 15 years and will shortly undergo a further upgrade with the installation of new insertion devices that will extend its useful life for at least another 5 years. The control system computers will have been completely replaced or upgraded twice within this 20 year time-scale due to obsolescence. With the pace of computing development continuing to accelerate we can expect to have to upgrade computer systems many times during the lifetime of DIAMOND. Maximum use of widely supported standards in both hardware and software are essential if we are to avoid the need to re-design the control system at each upgrade.

2. The SRS control system, originally designed in the late 1970's, was intended to interface to non-intelligent devices (digital I/O, ADC, DAC). Recent requirements to interface to intelligent and bus-based instruments have been complicated because the software and database structures of the original system were not appropriate for these new devices. This has ultimately led to a programme of upgrading the SRS control system to a more modern, flexible design utilising the CERN ISOLDE system [3]. The specification for the DIAMOND control system should be sufficiently flexible to be able to easily cope with a very wide range of I/O devices, networks and field-busses. It would be a mistake to simplify the initial implementation of the system by tailoring it to specific I/O types.

3. Due to a lack of computer standardisation in the 1970's the SRS control system was implemented using proprietary hardware, operating system and programming languages that are now little used, making both hardware support and software development a difficult and costly exercise. This has led to many problems in recent years which have severely limited the possibility of further development of the system. "Market leader" hardware and software should be used wherever appropriate to ensure continued support and availability.

4. Despite the lack of a Graphical User Interface (GUI), the SRS control system has proved to be very flexible from the operators point of view. It is possible to quickly select parameters from any part of the accelerator and construct a control page for monitoring and control. This facility is particularly useful when investigating machine faults or during beam studies periods. The DIAMOND system must provide a similar mechanism for constructing custom control screens.

5. The SRS makes extensive use of an in-house designed status control and interlock monitoring system to present a consistent hardware interface to the plant for hardware engineers and consistent software interface to the upper levels of the control system. A similar facility will be useful in the DIAMOND control system.

2.2 Operator Interface

Operator consoles must have an easy to use, flexible GUI, be easy to configure and maintain and make maximum use of "market leader" commercial software. Access to many of the facilities available on operator consoles should also be possible (with appropriate security restrictions) on office desktop machines. Ideally, all consoles should be of a common type with the ability to run any control system application, however there may well be a requirement to provide for "non-standard" consoles to support specific applications. The use of standard commercial packages such as Excel, LabView etc. should be supported and encouraged.

2.3 Servers & Networking

The DIAMOND control system should use standard network hardware and software components (Ethernet/FDDI and TCP/IP). Dedicated servers should be provided to centralise many of the auxiliary functions (file storage, printing, database storage, data archival etc.). Easy access to these servers should be possible from any part of the office network. Extensive use should be made of WWW servers to provide on-line documentation as well as providing up-to-date accelerator status information and news to the outside world.

2.4 Process Systems

It is important that this layer combines both good real-time processing capability with the ability to provide a flexible hardware and software structure to allow quick and easy expansion of the system. Modularity of both the hardware and software together with the adoption of a ROM-able real-time operating system are essential in meeting these aims. Provision of high performance network interfacing is also an obvious requirement.

2.5 Plant Interface Systems

This is one of the most contentious areas of control system design because the boundary between control system responsibility and plant can be hard to define. Here we must balance the need to provide flexibility against the advantages to be gained from imposing standard interface guidelines. On older control systems, like the SRS, it was possible to define very tight guidelines for plant I/O. However, new systems must support a wide range of interfaces, often proprietary, for practical and economic reasons. There will also be a need for a consistent interlock monitoring system on DIAMOND.

3 OPTIONS

3.1 In-house Design and Build

In the past this approach has been taken by nearly all major accelerator projects. However, over the last 5 or 6 years this has changed for two principal reasons: 1) The increasing importance of standards in computing has meant that portability of software and hardware from one platform to another has become much more of a reality, and 2) the increasing complexity required from accelerator control systems (GUIs, Networking, Databases etc.) means that the manpower requirements to implement a medium/large scale control system from scratch are prohibitive and often are just 're-inventing the wheel'. For these reasons in-house design is unlikely to be a realistic option for DIAMOND.

3.2 Commercial Solutions

Many industrial control/monitoring packages are commercially available but most of these are SCADA (Supervisory Control and Data Acquisition) type systems intended for small to medium scale systems. They tend to be insufficiently flexible or expandable to be serious contenders for medium to large accelerator control systems. The only likely candidate for scientific/accelerator control systems is VSystem/VAccess from Vista Control Systems Inc.

3.3 Collaborative Systems

Collaborative control system designs present a very attractive option for the designers of new accelerator control systems. They can provide a very easy (and inexpensive) way of implementing a system while still allowing full control over future developments and enhancements to the system. The EPICS system [4,5] has become dominant in this area over the last few years although other smaller and less formal collaborations exist; the CERN ISOLDE system has been recently used for the SRS Control system upgrade project [3] and on HERA at DESY.

4 CURRENT PROPOSAL

Figure 1 shows the proposed structure for the DIAMOND control system. The currently favoured options for the 4 layers are briefly outlined below.

4.1 Layer 1 (Operator Interface)

Microsoft Windows NT is a very strong candidate in this area. It provides a robust, high-performance operating system, excellent built-in support for graphics and networking and the ability to run a vast range of high quality "market leader" software packages. It also supports a range of hardware platforms - Intel x86/Pentium, Alpha AXP, MIPS R4x00 and PowerPC. Provision for UNIX/X-Windows applications can be supported through X server packages or by a dedicated UNIX workstation.

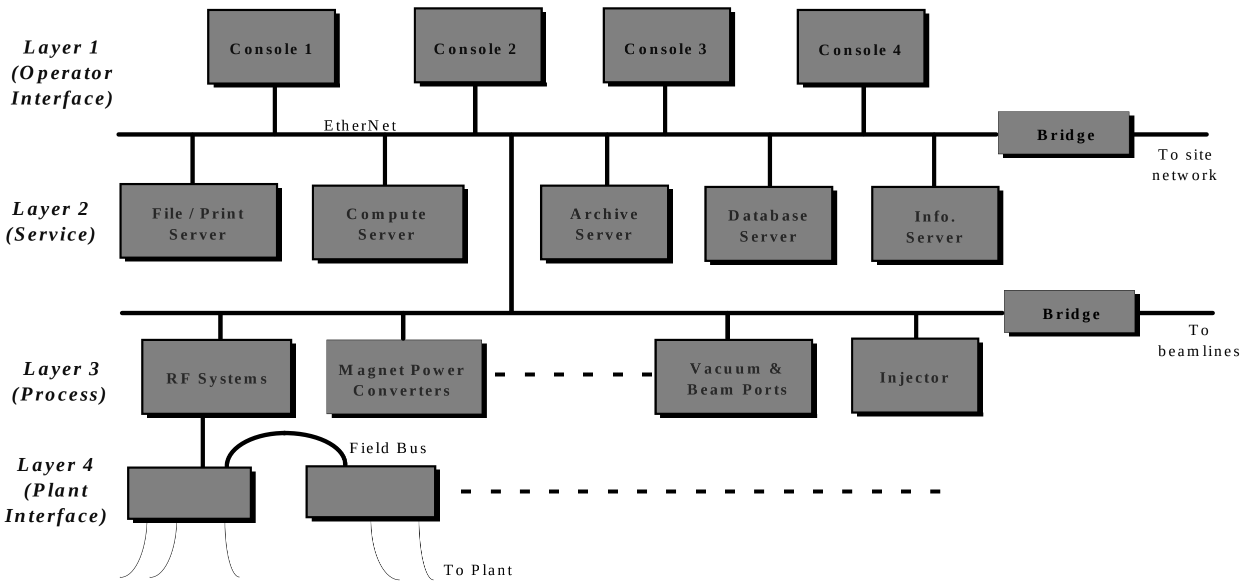

Figure 1: Proposed Structure of DIAMOND Control System

4.2 Layer 2 (Service)

This layer can be provided by a mix of Windows NT Server systems and UNIX-based server systems as appropriate. These servers are not strictly part of the control system (except Database and Archive Servers) but provides ancillary services to the rest of the control system (and the outside world).

4.3 Layer 3 (Process)

The most suitable arrangement for this layer will be VME/VXI based crates using Motorola 680x0 series processors. Existing projects on the SRS have used the OS-9 real-time embedded operating system but VxWorks will also be a very strong option. Both this layer and layer 4 (see below) should make maximum use of modular I/O hardware such as Industry Pack (IP) modules for network, field-bus and direct I/O.

4.4 Layer 4 (Plant I/O)

The plans for this layer are presently unclear. It may consist of either direct I/O to layer 3 for simple sub-systems or through a field-bus/Ethernet link for more complex plant areas. CANbus will be a strong contender for field-bus use as it is already being used to implement an upgrade to the status control and interlock monitoring sub-system of the SRS control system.

5 CONCLUSIONS

During the process of upgrading the SRS control system to use the CERN ISOLDE system the great benefits from using Windows NT as an operator interface have become clear. It provides an environment that most operations and accelerator physics staff are already familiar with and several users of the system are now developing their own applications. A great deal of work stills remains to be done to fully identify the requirements of the control system for DIAMOND and then to ascertain the most appropriate solution to the problem. The availability of support for Windows NT consoles in the EPICS collaboration has made this a system which fits most of the basic requirements for the DIAMOND system and we propose to fully investigate this option.

REFERENCES

[1] 'Further Design Progress on DIAMOND, the Proposed New UK National Light Source', M W Poole, V P Suller, these Proceedings.

[2] 'The Control System for the Daresbury Synchrotron Radiation Source', D E Poole, W R Rawlinson, V R Atkins, Proceedings of the Europhysics Conference on Computing in Accelerator Design and Operation, September 1983.

[3] 'Present Status of the SRS Control System Upgrade Project', B G Martlew, M J Pugh, W R Rawlinson, these Proceedings.

[4] 'EPICS: A Control System Software Co-Development Success Story', M Knott, D Gurd, S Lewis, M Thuot, Proceedings of the 1993 International Conference on Accelerator and Large Experimental Physics Control Systems, October 1993.

[5] 'Distributed Software Development in the EPICS Collaboration', L R Dalesio, M Kraimer, W Watson, M Clausen, Proceedings of the 1995 International Conference on Accelerator and Large Experimental Physics Control Systems, October 1995.