A NEW CONTROL SYSTEM FOR BEAMLINE 5D ON THE SRS AT DARESBURY

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Abstract

As part of the on-going programme to upgrade the SRS control system, a new VME-based system has been developed for the recently installed beamline 5D. The new system supports intelligent instruments using a VME-based front end computer, Ethernet network and a PC-based user interface. This paper describes the architecture and shows how it can be easily configured for other applications.

1 BEAMLINE 5D

Beamline 5D is an advanced vacuum ultraviolet beamline line on the SRS which will be utilised to perform experiments in surface science; investigating the properties of novel magnetic materials and gas phase studies; studying the action of VUV light on gases.

2 HISTORICAL PERSPECTIVE

Traditionally, control of the vacuum pumps and instrumentation, together with vacuum isolation valves, radiation masks and station shutters has been integrated into the main SRS accelerator control system. This utilises a Daresbury designed status control and interlock system [1] to provide low-level plant protection and to provide a standard interface to the higher levels of the control system. This system was originally designed to interface to simple, non-intelligent devices requiring nothing more than ON/OFF/RESET control operations. Plant protection was provided by allocating up to 16 hardware interlocks to each device. Additionally, monitoring and control of analogue signals was possible using CAMAC hosted ADCs and DACs. The user interface is a simple text-based program hosted on a 32-bit mini-computer and uses obsolete Tandy Model 100 portable computers located close to the beamlines as display terminals. This system is not well suited to the control of modern, intelligent instruments and provides only a very rudimentary display of plant status to the user.

At the outset of the beamline 5D project, it was decided that a new, more versatile control system would be required that could offer easy connection to a wide variety of instrumentation as well as being compatible with the latest developments in the main SRS accelerator control system [2,3].

3 DESIGN CONSIDERATIONS

The main considerations taken into account when designing the new system included:

- Compact - ideally, both the control system and the instrumentation should be housed in the same rack.
- Low cost.
- Easily adaptable for other similar applications.
- Support for most modern instrument interfaces (RS232, 422, 485, GPIB etc.)
- Modular - to allow easy development and integration and/or replacement of system components.
- Single network connection.
- VME, OS-9 based.
- Compatible with the rest of the SRS Control system.
- Intuitive, easy to use, PC-based user software.

4 IMPLEMENTATION

4.1 Instrumentation

The control system for the permanent part of the beam line (excluding the experiments) controls the vacuum equipment and instrumentation. This consists of sixteen vacuum gauges, (pirani and cold cathode), eight ion pumps, eight vacuum valves and one radiation stop.

4.2 Front End Computer Hardware

The front end computer (FEC) is an embedded VME system consisting of a Motorola 68030 processor board, Ethernet interface, quad serial interface and Daresbury Laboratory (DL) designed interface to the DL plant highway. The VME modules are all in 3 U format and mounted in an in-house designed ten slot crate with BICC VERO PK series power supplies. The operating system used is OS-9.

The functionality of the FEC can be broken down into three areas, the server to the higher levels of the control system, the interface to intelligent instrumentation over serial communications and the interface to the non-intelligent equipment through the DL plant highway. The communication interface supports the common communications hardware standards, RS 232, RS 422, RS 485 and potentially IEEE 488 GPIB. The DL plant

highway interfaces to Status modules which support non-intelligent equipment (e.g. valves) through a digital interface arranged as 16 inputs for interlocks, 4 control inputs and 3 control outputs.

4.3 Front End Computer Software

The communication equipment is managed through the Comm process (see Fig. 1). This acts to configure the instruments, pass control requests and monitor the current state. It manages this together with multi-drop arrangements, instrument addressing and the instrument specific protocol. The information for all Comm equipment resides in an embedded database, as a shared memory module, structured on a parameter basis.

The non-intelligent equipment interfaced through the DL plant highway is managed by the Status process. This processes information from the plant to a second embedded database for control and monitoring together with managing the interlocks associated with the plant to ensure protection. This is required to run in real time so is backed-up by a watch dog timer in case of software failure.
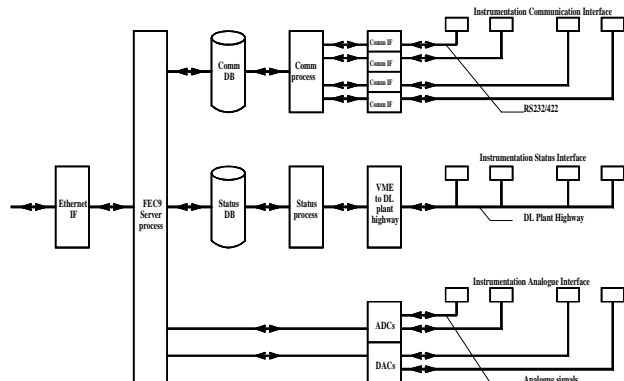

Figure 1: Data flow within the Front End Computer

Data contained in the embedded database is made accessible to the upper layers of the control system through a network server process (FEC9). This process implements a request/reply paradigm based on that developed for the ISOLDE control system at CERN[2] and later adopted for use on the SRS control system[3]. FEC9 consists of two primary components: a general network server section that manages communication with the client machines, and a series of Equipment modules, which are basically device specific subroutines that are called by the network server to read or write plant data. The FEC9 process used on the beamline 5D system is identical to that used on other OS-9 systems within the SRS control system. A DOS version is also available for use on low-cost, low-performance systems.

4.4 Network

A standard 10 Mbit/sec Ethernet connection is used to

provide network access to the rest of the control system and to office computers. However, because the system is running at least one real-time process, it was decided not to connect it directly to the general control and office network, but instead, to allocate a class C sub-net for use by this and other similar real-time systems. This arrangement has the effect of significantly reducing the amount of unwanted network broadcast traffic that has to be handled by the processor and thereby ensuring that response of the vital interlock monitoring process is not compromised by network traffic.

4.5 Client System Software

Client access is implemented through a Win32 dynamic link library (DLL) designed to run on both Windows95 and Windows NT 4.0 systems. The DLL provides an Application Programming Interface (API) that can be used by most software development tools.

The DLL works in conjunction with two database files. One database contains parameter addressing information. This allows an application to access plant parameters using only the device name string to identify the parameter - the DLL accesses the database to determine the ultimate network destination of the request. The second database contains status command and reply codes that are used by the DLL to convert plain English requests (such as "ON", "OFF" or "RESET") into the appropriate numeric codes recognised by the FEC. Both of these databases are held and maintained in Microsoft Access but are converted into a custom, binary format before use by the DLL. This is done to improve performance. Normally, all client systems access a single copy of the database held on a central control system server, but provision has been made, through the Windows registry, to access a locally held copy of the database if required.

4.6 Application Software

Through the use of the API implemented by FastRPC.dll, most of the familiar Windows development tools can be used to produce application software. These include Visual Basic, C/C++, LabView and Tcl/Tk [4]. For the beamline 5D project, an active synoptic diagram application was developed using Visual Basic 5 (see Fig. 2). This shows, at a glance, the state of the vacuum system on the entire beamline and, by the use of context sensitive pop-up menus, allows the user to monitor all aspects of the system and to initiate any necessary control operations. This application is installed on a standard PC local to the beamline.
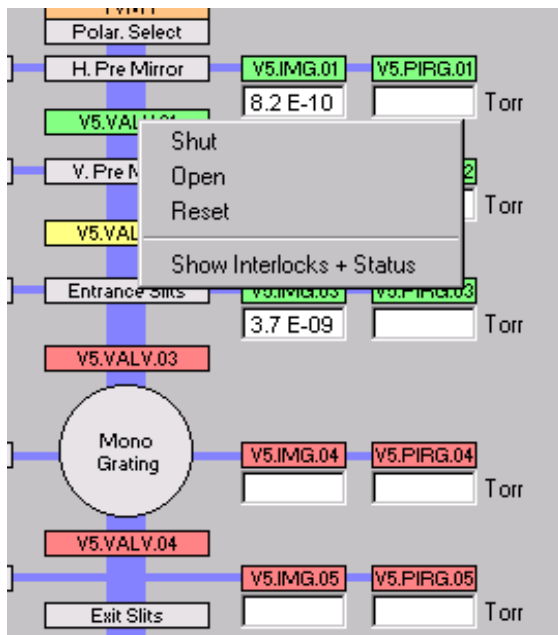
Figure 2: Pop-up menu on synoptic diagram

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While the synoptic diagram is ideal for routine beamline operation by experimental users and beamline technicians, a more versatile package is required for use by control system experts to help in commissioning the system and to aid fault diagnosis. For this purpose, ControlDesk is available. This is a general purpose program, written using Visual Basic 5, that provides direct monitoring and control of any plant parameter(s) within the control system. This same software is used extensively for control of the main SRS accelerator. All of these applications can, if needed, be run from lap-top PCs connected to any convenient network socket.

5 FUTURE DEVELOPMENTS

A development project is currently underway to replace the DL plant highway with CAN Bus. CAN Bus is a high speed (1Mbit/sec) serial bus using a twisted pair and was developed by Robert Bosch initially for the automotive market. This development uses a commercial VME to CAN Bus interface and an in-house designed CAN Bus to Status interface.

To date, the system presented is being applied to integrate a number of new projects into the SRS control system. These include interfacing two new multipole wiggler magnets (motor drives, power supplies and shunts), two beam ports, three new beamlines and two electron beam measurement and protection systems.

By providing a solution that is fully integrated into the entire SRS control system, the way has been opened for new application software developments that could help to automate routine operation of the beamline.