EVOLUTIONARY STEPS OF THE ALCONT CONTROL SYSTEM AT JYFL

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During the first five years of operation the control system in the accelerator laboratory proved to be the right choice, but the rapid development of microcomputers required the system to be upgraded. The 1997-98 upgrades improved the system performance, and opened up new possibilities: two major advances from the operators point of view are the remote operation and simplified data-exchange between the control system and the university computer networks.

1 The Past

1.1 Our choice

At the end of the 1980's control and automation systems were in the middle of a hectic evolution and the choice of control system was not too easy. From the choice of several candidates we narrowed the possibilities down to industrial control systems that had proved themselves to be the most reliable in harsh conditions [1]. If Altim Control Ltd. had not been so bold with their new concept Alcont II and trusted on their easy application development tools, our choice might have been different. While other system providers included application design (10 man-years priced at about 60% of the total cost) as part of their offers, Altim Control offered short system training instead. When leaving the application design to us they gained a huge advantage over other system providers even though the hardware was slightly more expensive in comparison with others.

1.2 Setup

In the summer of 1990 the control system was set up on the premises of the new cyclotron laboratory. The original hardware configuration included two design modules (DM1 & DM2), three touch screen monitors, two operator modules (OM1 & OM2) with alarm and report printers, one manager module (MM1) and nine process modules (PM1..PM9). The design modules on the user interface layer of the system used Intel's 25 MHz x386 processor, 2MB RAM and 180MB SCSI hard drives, which represented the top level of micro computers at that time. The user interface consisted of three 21-inch touch screen VGA monitors with process control-customized keyboards introducing switch and knob control. On the process control layer each module was hosted by a VPR-card with Intel's 16 MHz 80c186 processor. Operator modules relayed the communication between the operator and the process, and also contained the backups of applications loaded to process modules. A manager module was dedicated to serial communication between the control system and intelligent devices, such as radiation monitors, vacuum meters etc. The nine process modules may have up to 16 process interface cards, mainly binary- and analog- I/O's, but also other more specialized cards.

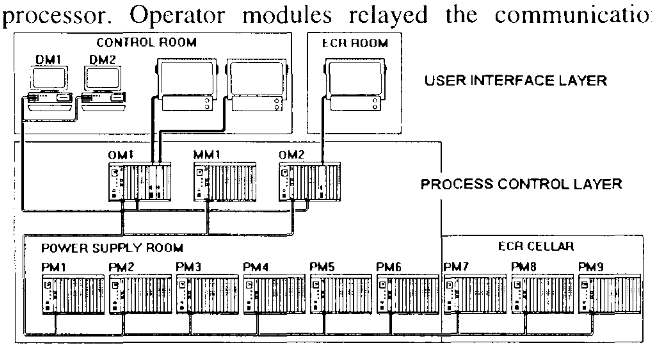

Figure 1: The hardware configuration in June 1990

1.3 The first years of operation

After some business arrangements in 1990, Altim Control's name was changed to Ahlstrom Automation Inc. Application development carried on without any disturbances, and it was ready when the first beam was extracted in January 1992. The first major upgrade then took place in the fall of 1992 when the target hall with beam transport- and delivery lines was taken into use. The control system was expanded with three process modules and one manager module, thus increasing the number of I/Os to ~2000 and the number of serial lines to 72. The newest system software version (operating system) replaced the old. After this upgrade some extra work was needed in order to get the system run smoothly again, but after solving the problems a new setback faced us: Honeywell Inc. had purchased the whole of Ahlstrom Automation. The development of the Alcont control system was killed, leaving only minimal support for systems already sold all around the world.

After two years of silence the new owner became convinced about the advantages and competitiveness of the Alcont control system, and proper funding was addressed to restart the system development. We followed carefully the advances of the system until 1997, when we came to the conclusion that upgrading the control system was necessary: in the age of Pentium processors the x186 and x386 based systems were hopelessly outdated. Over the years the control programs had grown bigger and become more complex, thus demanding more processing power and memory space. After running continuously for more than seven years the design modules and touch screens were living their last days and crying out for replacements. Since the development of the system was heading towards open systems, we could expect relief from the troubles of data exchange between the control system and University network systems. Remote control, i.e. remote operation of the cyclotron, would also be possible after the upgrade.

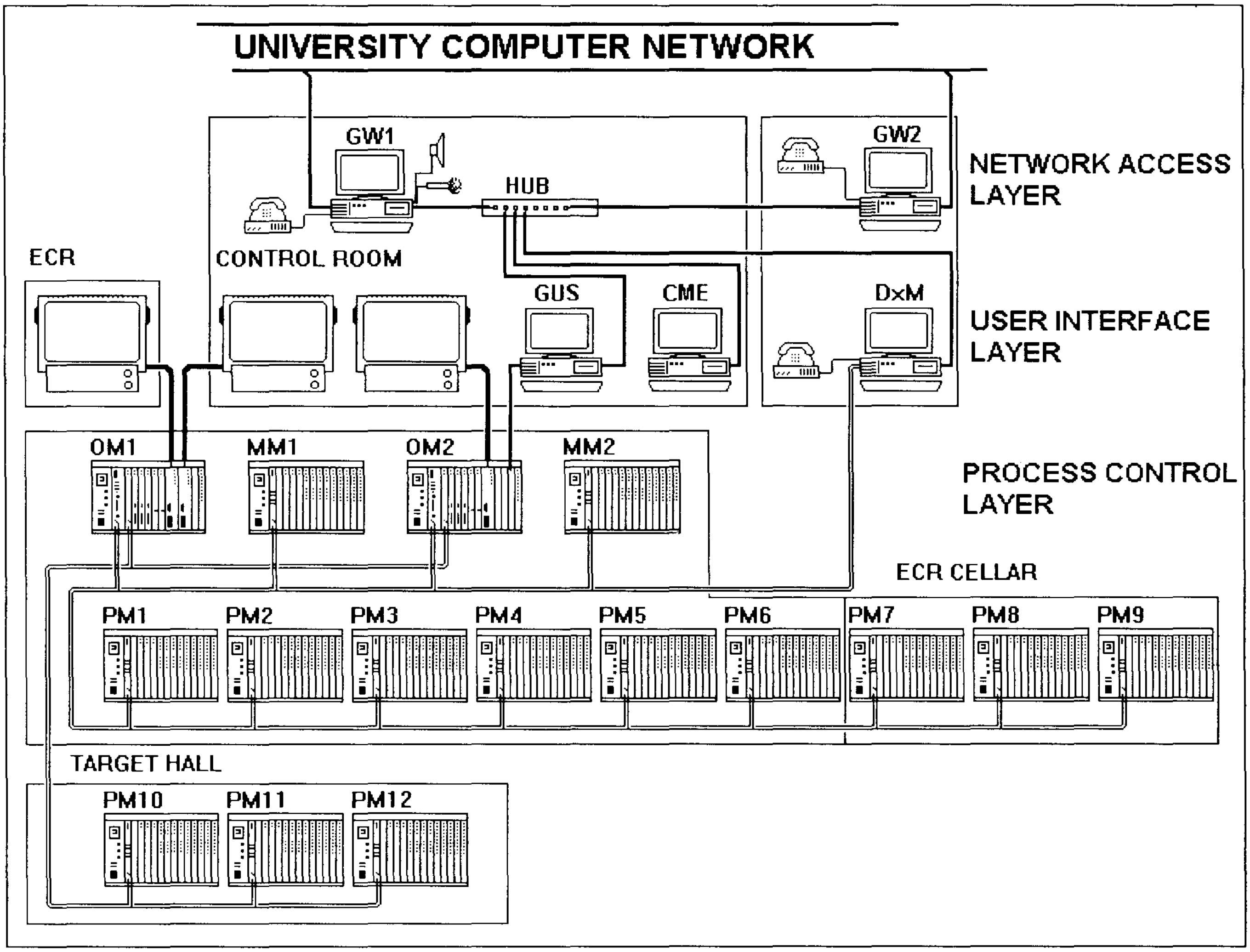

Figure 2: The hardware configuration of the control system in June 1998

2 The Present

After receiving the funding for the upgrade we were able to start the three-phased upgrade project. In the first phase we had to upgrade the system software to the level that would allow us to exploit the next generation of processor cards. The two old design modules would also be replaced with a new one. The second phase (spring 1998) would give us the advantage of GUS (Global user station with standard Windows NT4.0 operating system) which would replace one of the touch screens and provide the benefit of remote operation. The third and final phase would take place in the autumn of 1998, with the release of the new Windows NT-based design module.

2.1 Network access layer

A new feature of the control system is the Network access layer formed by two computers GW1 and GW2. They are both equipped with two network adapter cards and routing/remote access service programs and they act as gateways between the University computer network and the control system. Modems provide both connection to the University network and connection to the control system for remote operation or diagnostics. GW1 is also equipped with a soundcard and headset so that the remote operator can have full duplex Internet call connection to the control room even if the regular phone lines are not available.

2.2 User interface layer

2.2.1 GUS – Global User Station

The most significant change on the user interface layer is GUS, which in future will replace the old touch screens. The hardware is a normal commercial PC-computer powered with Intel's 200MHz PII processor. The user can now easily access process diagrams in the standard Windows NT 4.0 workstation environment and operate the processes with a mouse and a normal keyboard. GUS could also be equipped with a touch-screen interface and traditional knob and switch. GUS connects to the system via Ethernet bus, allowing multiple devices to connect to one interface. Each of our old touch screens need their own processor/display controller cards (OPI-interface), and they can be used only for process control.

2.2.2 Remote operation

The control system is very reliable and easy to use. In 1997 the operation time of the cyclotron was 6700 hours, from which 2/3 was run by student-operators. The operators are trained for two weeks in cyclotron operation, but sometimes in problem situations they have to call the regular cyclotron crew to troubleshoot, and sometimes the situation demands personal presence. If this happens at night it can be considered a major nuisance or at least uncomfortable. After installing commercial remote control software (pcANYWHERE) to GUS, and to the cyclotron crew's home computers, we now can troubleshoot, check and control the system comfortably from home/anywhere via moderate speed modem lines.

2.2.3 DxM – Design module

The third system enhancement is the replacement of our old design modules DM1 and DM2 with one 166MHz Pentium PC. For the time being the operating system is still DOS 6.22 + Windows 3.11, until the NT-versions of DM software are released in the autumn of 1998. DM's software also includes new tools for application development, which are briefly introduced below:

The most important of the application development tools is the block editor, which is used to create the control programs. Block, model and application libraries contain useful and tested program modules that can easily be modified with tools from toolbar or drop-down/pop up menus. Connections between program modules can be made with virtual wires, flags or name-connections. Parameters can be given as constants or variables. Prior to uploading the application into the control system it can be simulated to check the proper operation in every conceivable situation.

When the application is ready a user interface, the process diagram, is needed. These diagrams are created with a simple graphics editor, where the passive diagrams are drawn and the active elements, effects, are defined. Effect-libraries contain a wide selection of effects with multiple purposes: number fields, blinking characters, curves and process-symbols –to mention but a few.

The design module is also remotely accessible. This feature is particularly useful when we need system support from Honeywell. The support team can diagnose problems and even fix the system remotely!

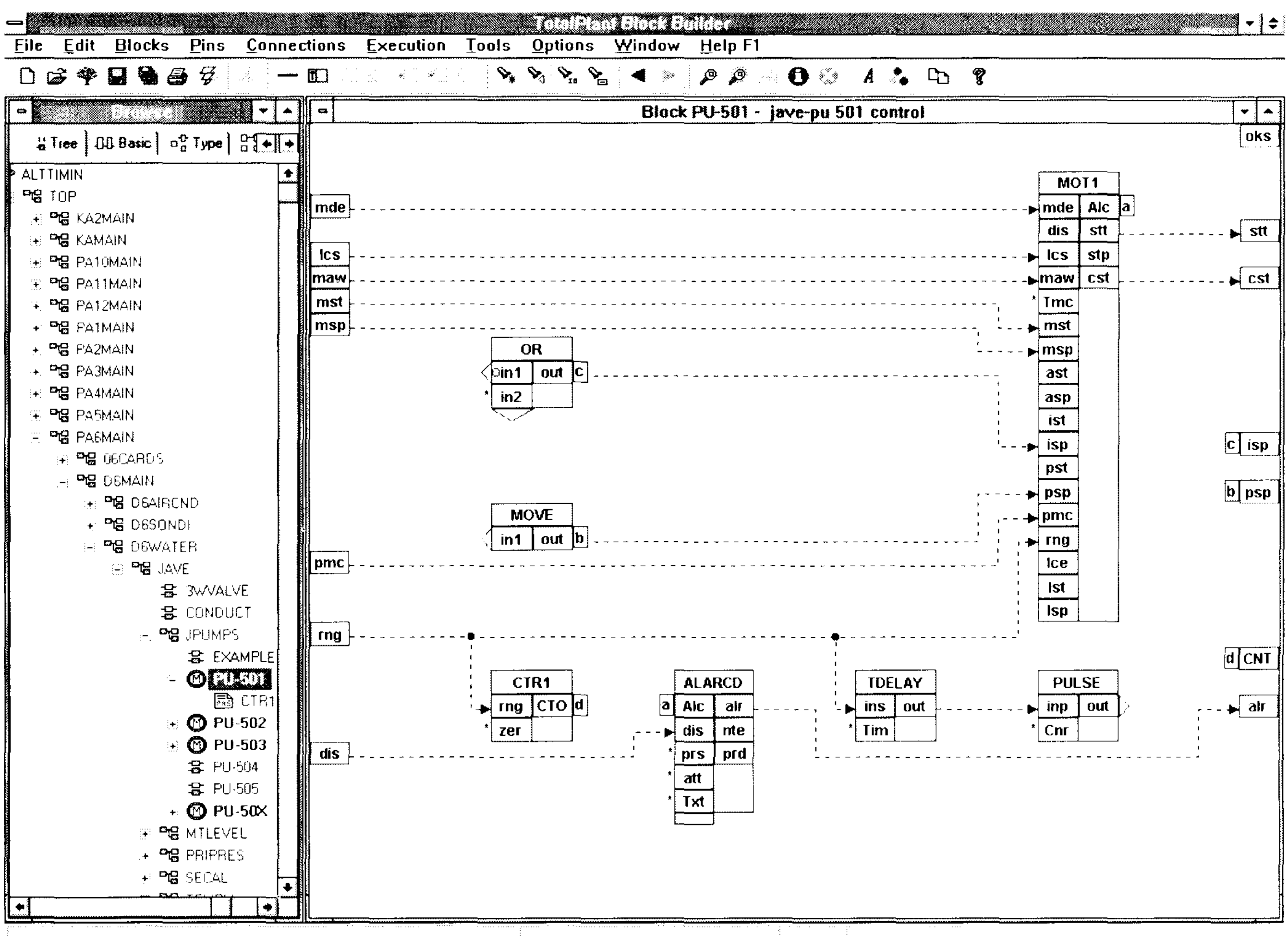

Figure 3: Cooling pump control program in the block editor

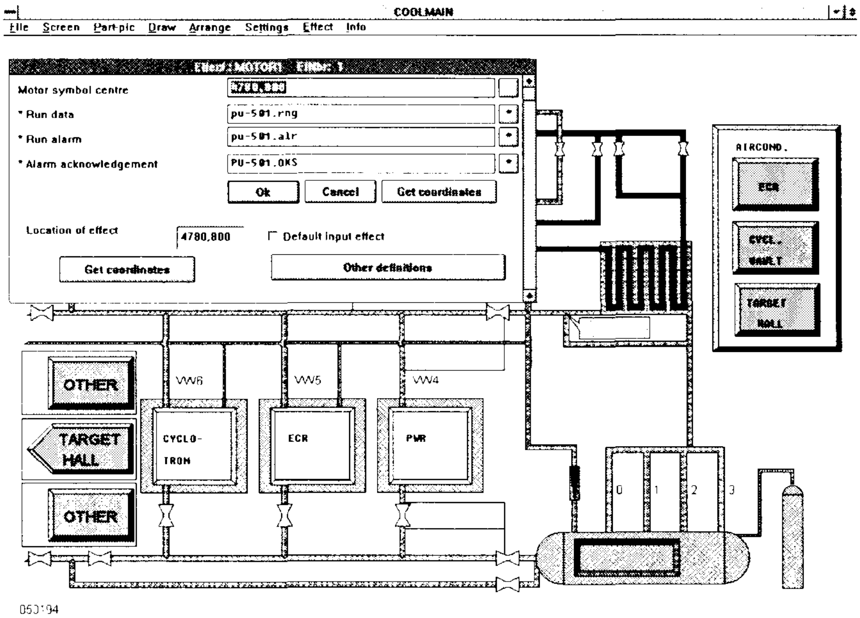

Figure 4: This figure shows how to define a pump effect in the graphics editor for the cooling system of the accelerator.

2.2.4 CME – Current measurement computer

Another novelty on the user interface level is CME: an NT-workstation: (A 133 MHz Pentium PC running LabVIEW 5.0 and pcANYWHERE software for remote access) dedicated to beam current measurements, and even though it

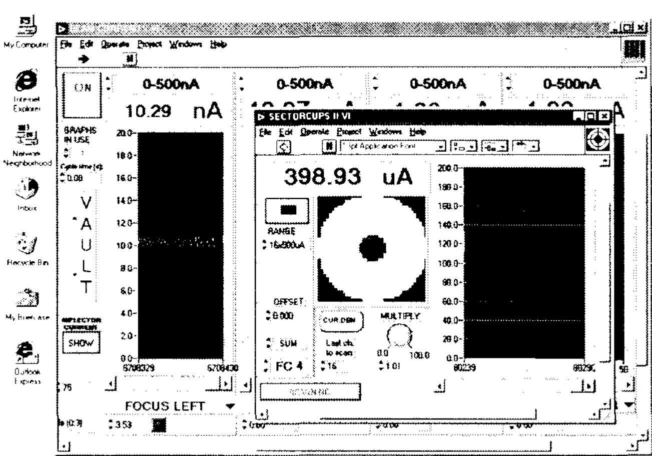

Figure 5: A view of the beam currents.

has physical connection to the control system it presently gives no feedback to control processes. This is one of our future projects.

2.3 Process control layer

2.3.1 Operator modules

Before the upgrade, the operator modules were the bottleneck of the control system. Uploading the application raised the processor load on both modules to 100% and upload was seldom flawless. Replacing the VPR-processor cards with newly released XPR-processor cards solved the problem. The leap from the 16 MHz x186 processor to the 100 MHz x486 processor truly multiplied the processing power. The old and slow (250 kb/sec) interface cards were removed and the design module was connected directly to system highway (1Mb/sec). With these enhancements application uploads are now really fast and reliable. Non-volatile memory cards were also added into the operator modules. System backups are stored into these cards so that the system startup can be done even if the battery-secured memory cards and the design module fails.

2.3.2 Manager module

The main task of the manager modules in our control system is serial communication. The number of intelligent field-devices is gradually increasing and along with them grows the load on the manager modules. MM1 could not be boosted up with the processor card replacement since there were no drivers for the MCL-serial communication interface card. Instead we installed three new SCI-serial communication interface cards, each having its own processor and application memory. Transferring part of the serial communication programs to these cards took some of the load off the host VPR.

In the future, when automatic start-up and shutdown sequences with data storage and retrieval are in use, manager modules will play the leading role. Then we will definitely need still more processing power, not to mention memory space.

3 The Future

The upgrade has been successful, and it did not affect the normal operations of our accelerator. The properties of our control system have improved enormously and we have good reason to be satisfied. After finalizing this upgrade next fall, and possibly replacing one or two of our old processor cards, the system resources should suffice far into the future.

References

[1] P. Taskinen, J. Lampinen and K. Loberg, *The control system of Jyväskylä K130 cyclotron* (Martin Ziegler, 12th international conference on cyclotrons and their applications, 1989)