THE EXPERIENCE OF USING CAMAC PRODUCTS IN ACCELERATOR CONTROL

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Abstract

This paper presents the CAMAC configurations used in our institute. The comparison of the features of CAMAC, VME and PLC is described. The author's opinion is given at the end.

1 INTRODUCTION

CAMAC is an acronym for Computer Automated Measurement And Control. CAMAC is an internationally accepted group of standards (ANSI/IEEE standards 583, 595, 596, 675, 683, 726, and 758) that fully define this modular real-time interface concept for configuring high performance data acquisition and control systems. CAMAC offers a choice of more than 1200 I/O interface modules and a high-speed serial highway from a number of manufacturers. CAMAC is a real-time system standard that has been proven and continues to withstand the test of time. Because CAMAC is a computer-independent standard, users can choose the computer that best fits their needs today and easily upgrade in the future with minimal costs.

These CAMAC products form the backbone of the hardware of HIRFL control system. (HIRFL stands for Heavy Ion Research Facility in Lanzhou) They were employed in 1980s. Because the replacement of hardware is very expensive and we have to make full use of the existing hardware, the HIRFL control system is still using and buying CAMAC up to now. As a CAMAC user of more than 20 years, we like to share our experiences on this matter.

2 CAMAC CONFIGURATIONS USED IN OUR INSTITUTE

In our institute, the CAMAC products are used in the HIRFL control system and the data acquisition systems for experimental physics.

CAMAC standard had been introduced to our institute since 1975 when we started to consider the construction of HIRFL. Most of the CAMAC products we used were from the Kinetic Systems Corporation (KSC), United States. Several architectures have been used which will be shown below. Different type of computers and their operating systems have been employed with CAMAC systems, they are: Z80 with CROMICO, PDP11- or LSI11- with RT11 or RSX11M, VAX8350 cluster with VMS, PC-AT or PC286 or PC386 or PC486 with DOS, and now Pentium PC with Windows.

The architectures we have used for ion beam diagnosis and the control of DC power supplies for various magnets of HIRFL were like follows:

[LSI-11—3923—3992—3936]—[3936—3952—modules]series—circuits—devices

This was a CAMAC system with the host PC built in the main crate. The circuits were equipped at home. Here, the symbol [....] stands for a CAMAC crate. The module numbers are of KSC. (it is the same below)

VAX8350—JY411—[3952—3992/3936]main-series—[3936/3952—modules]sub-series—circuits—devices

PC—2925—[3920—3992/3936]—[3936/3952—modules]series—circuits—devices

PC-network—2926(or2927)—[3922—modules]—circuits—devices

PC—2926—[3922—3992/3936]—[3936/3952—modules]series—circuits—devices

So you may see that the basic hardware of the existing control system is based on two decades' old technology. Most of the electronics circuits installed were home made one decade ago. It is a harsh electromagnetic environment for the circuits.

The technical requirements of the accelerators and experiments have many common points. The architectures we have used for data acquisition systems for experimental physics were like these:

[LSI-11—2923—modules]—circuits—devices

PC—2925—[3920—modules]—circuits—devices

PC—CCV—[CAMAC modules]--circuits

PC—CVC—[CAMAC modules]—circuits

Ethernet was employed at the link between PC and CVC. CVC is an acronym for CAMAC Computer VSB, which was developed by GSI. VSB is an acronym for VME Subsystem Bus.

3 COMPARISON

So far, the VME system is dominant in the current accelerator control system in the world. However, there are still a significant number of CAMAC systems being used.

CAMAC is an open architecture with 24 bit, 1-5 M HZ, 25 station and TTL level., which may be used with any computer and by any operating system. So it is easy to upgrade to other computer systems. It is accomplished by replacing only the interface device to the host computer and software driver package, and the I/O chassis (CAMAC crates) and modules remain intact. The computer independent high-speed interfaces are available for many kinds of computers. CAMAC is total compatibility among vendors.

VME is an industrial bus standard developed in 1970s and became an international standard in 1983. VME is 32/64 bit, 40-160 M HZ, 20 or 13 slots, TTL level and the data rate may be very high. It is widely used in a central-distribute system by the scientific, industrial, aerospace, and defense users in Europe and America. VME is used for the high performance I/O. It can be mixed with CAMAC because they are compatible to certain degrees. But only 68000 based can be built in the VME chassis. VME CPU is Motorola CPU, not Intel CPU. Therefore multi-processor upgrade is more difficult in VME processor solutions.
VME has been extended to include instrumentation in VXI standard, which provides a more thoroughly defined standard, resolving many of the issues of incompatibility among vendors. VXI stands for the VME bus extensions for Instrumentation. Many control systems of scientific community are moving to VXI and future-bus standards. It has good prospect in China. But it needs a technical training service for many institutes in China.

CAMAC approaching its 30-year's history, is still going strong while many of other I/O standards immediately following CAMAC have disappeared. It took a while for VME to establish its position. Based on the same function, CAMAC costs typically higher than VME on hardware, and less on software development.

The programmable logic controller (PLC) is becoming used widely used in accelerator controls. The PLC has very low price, industrial robustness, ease in addition or removal, interchangeability, and is easy to make a simple logic flow. Following its industrial origin, PLC were used in various auxiliary systems, such as: utility control, fire alarm, interlock system, machine access control, and front-end level devices. But now some PLC systems are expanded into the main accelerator control systems. For the demand of small budget and limited manpower for the construction and normal operations, the PLC becomes a good solution.
Field-bus is a big topic in industry. Field-bus will be required to connect control equipment and devices of various types at the front-end of accelerator control system. It is indeed convenient if the controlled devices could be plugged into the control system. There are many field-busses available, such as: Bit-bus, Multi-bus, Fast-bus, Future-bus etc. I cannot discuss them because I know little of them. But I know that it may be necessary to integrate both industrial equipment and custom designed devices in an accelerator control system and most of the controls for DC power supplies of various magnets are slow and sequential operating not requiring fast real-time control. Anyway, flexibility and modularity are needed and the cost consideration is extremely important.

4 REMARKS

The main job of the control system is to assist the operators and physicists in continually improving and optimizing the operations for the beam tuning. The I/O interface hardware on any reasonably sized control system is very expensive and disruptive to replace. Many people have recognized that the choice of a proper hardware- engineering standard is essential to ensure the success of their control projects. The increasing presence of commercial industrial control systems in accelerator controls raises the questions of their integration into the general control infrastructure. At the same time, the rapid development of technology makes the lifecycle of products shorter. So, new system will become obsolete soon. We feel this configuration has serious drawback comparing with the very rapid change of the hardware and software. It needs upgrade of course. It is a compromise on the understanding of the requirements, the performance and expense of the different solutions. Since each institute may have different backgrounds and weighing factors, no universal solution exists. Clearly, the previous technical history of an institute will influence decisions for the projects of their control systems both new construction and upgrading. Anyway, an older system has to be steadily replaced by current hardware and software technology.

A common saying goes: "What suits me doesn't suits you." and "All roads lead to Rome."