Concurrent Control System for the JAERI Tandem Accelerator

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Abstract

A new control system for the JAERI tandem accelerar is constructed. The system utilizes concurrent processing technology with multi-processor. Transputers are used both for central processor and I/O front end processors.

I. Introduction

Concurrent processing has been growing atractive in many application fields. Especially, concurrent processing with multi-micro-processor has advatages of both good cost to parformance ratio and scalability of the parformance by the number of processing elements.

In logical terms, a control system of an accelerator is a set of various processes controlling and/or monitoring many control objects, accelerator devices. It is one of the most important role of the control system to give us an integrated environment where all of the elements of the accelerator system can be handled smoothly. However some of the activities in the system are not strongly coupled each other. In other words, the control system of an accelerator has natural concurrency. For example, a monitoring of vacuum pumping system is independent from tuning beam transport. The system can be described by a model of concurrent processes communicating with message transfer, naturally.

In the JAERI tandem accelerator, we have been developing a new control system, which is based on the concept of concurrent processing technology. Originally, the control system the accelerator was based on a mini-computer and CAMAC serial highway system for I/O interface[1,2]. But, It has grown difficult to stay on the old base. One of the reasons is the difficulty in maintenance of the old-fashioned computer. Another is shortage of the computing power against the needed expansion of the system. Here we say the expansion as both expansion of functions of the control system and the expansion of the data points following enlargement of the accelerator system. To cope with the situation, we decided to construct a new control system[3,4]. We call the new system Accell.

In the system, we use transputers[5]. The transputer is a high performance, 32-bit, micro processor which supports parallelism at the hardware level. It has communication links to other transputers. These features enable us to construct a multi-processor system and to get large computing power easily within small costs: the performance of the control system can be extended by increasing the number of the processing elements to meet the expansion of the accelerator system.

II. Data point concept

The control system is an environment to manipulate accelerator devices. From this point of view, it is very important to formalize a method of access to the accelerator device, the accelerator data point. The system must enable the operator to select arbitrary data points and to control or monitor them smoothly. For a programmer, the access

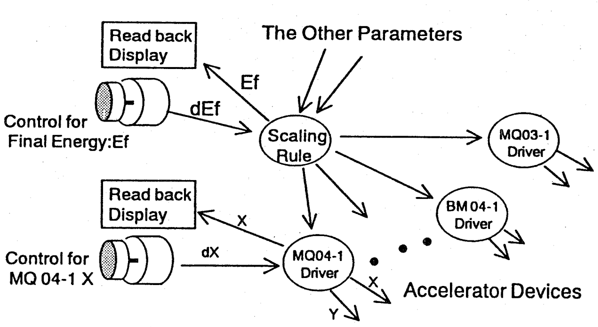

Figure 1: Control with a virtual data point, Final Energy of particle(Ef). MQ 04-1, BM04-1 and MQ03-1 are accelerator devices which affect the final energy. MQ 04-1 X is one of the data points of MQ 04-1. Control from the valuators are given as deviations from the old values of the data points.

method to the data point must be generalized in a simple way, to ease programming of high level functions. Data points all have its symbolic names and they are accessed with its name and logical value of the data. The programmer need not know about CAMAC address nor raw data format of the data points.

We extended the concept of the data point to variables which have no I/O points directly. We call them virtual data points. The category includes the upper or the lower limit value for software range checking of some data point's value. It also includes control parameters for linked control of multiple data points. Many of the control functions of the accelerator can be established as manipulations of the data points.

To adapt the above philosophy to the concurrent programming system, we take a simple architecture so that a process sends a message for every data point access, one by one. Figure 1 shows an example of using virtual data points for linked control in this architecture and it's data flow scheme in the message passing system. Many data points must be tuned to change the final energy of the accelerated particle. Usually, the tuning are made by the operator one by one. The virtual data point named Ef(final energy) and its control process(Scaling rule[6] process) are introduced. The Ef has no directly associated I/O point, but thechange on it is reflected to several data points by the scaling rule process, in a manner where beam transport of the accelerated particle is maintained and the final energy is set to the setting value of Ef. The mechanism follows not only to a step of the change but also to the continuous change of the virtual data point. The operator can scan the final energy, turning a dial assigned to the virtual data point Ef.

III. THE HARDWARE ARCHITECTURE OF THE SYSTEM

FIgure 2 shows an Image sketch of the system. It is divided into 1)a host system using a workstation, 2)the central system, 3)the serial high way drivers and 4)CAMAC serial highway system. The main roles of the host system are to support execution of the central system and to work as a part of man-machine interface. Data needed to control the accelerator are extracted from a data base on the host system and sent to the central system at start up time. A bit map display of the host is embedded in the operator console of the accelerator. A X-window[7] based program is used on the display. The central system is a multiprocessor(of four T800[5] transputers with

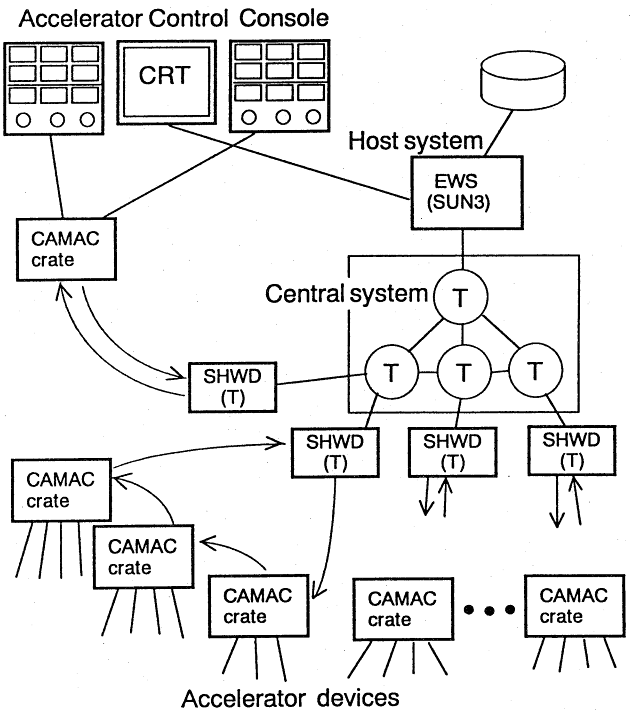

Figure 2: Image Sketch of the New Control System.

1Mbyte local memory now). It works as a main element of data processing. The serial highway drivers are front end processors of the central system to CAMAC system. They have charge of low level control of the CAMAC serial highway. They also do several kinds of event detection and data format conversion to make the load of the central system light. The CAMAC serial highway system is almost the same as the old system. Sixteen CAMAC crates are distributed on the four serial highways. Two of them on a highway are for the control console. The control console has assignable valuators(we call them shaft encoders), assignable and dedicated meters etc. for controlling and monitoring data points.

IV. SYSTEM SOFTWARE: MONITOR PROCESSES

Basically, access of arbitrary process to any data point is allowed in our system(shown in fig.3a). It is accomplished by a mechanism which enables arbitrary process to process communications. Communication in the transputer architecture is s point to a point, thus it need some additional mechanism to relay the communication messages. We put special system process on every transputer in the central system for the purpose. We call it

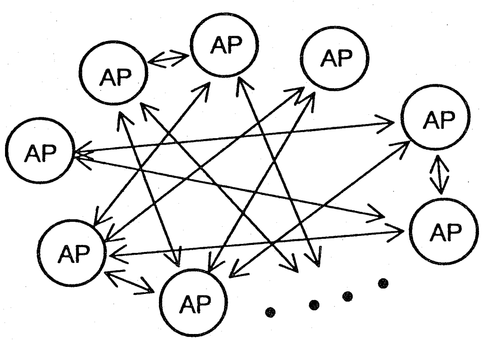

Figure 3a: Message Passing in the Central System. Arbitrary process to process communication is allowed. AP denotes application process.

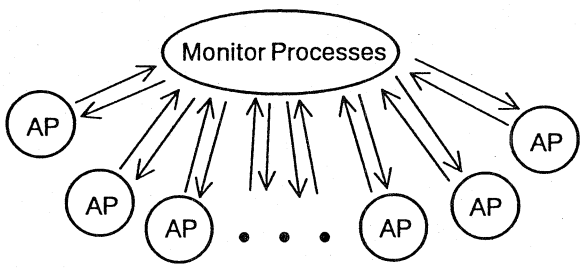

Figure 3b: Message Passing through Monitor Processes. The monitor processes relay arbitrary process to process communication in the central system.

monitor. The monitors relay arbitrary process to process communications. The process which needs monitor's help for communication is called application process(abbreviated to AP). Figure 3b shows the scheme of the communication through the monitor. A message port number is used to designate destination of the message. The monitor has additional functions of controlling the message traffics and collecting logs for debugging or system monitoring.

V. Experience of the system operation

The system has been working from September 1992. The reliability of the system has been good enough. On the other hand, the system doesn't achieve the level of performance which we have desired. The reason is mainly due to poor performance of the message transfer between application processes. In our analysis, it appears that the poor throughputs of the monitors are degrading the performance of the system. And we are working on improving the monitor.

VI. References

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