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THE BOL COMPUTER-HARDWARE CONFIGURATION

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Three computers, two PDP8's and an EL-X8, are linked to the BOL nuclear multi-detector system. The coupling between them, including appropriate display-units allows on-line and off-line visualization of several aspects of the experimental data generated by the detection system.

1. Introduction

The computer configuration, used for control and on- and off-line analysis of nuclear data obtained in the BOL multidetector system[1–3]), consists of 2 DEC-PDP8's and a Philips-Electrologica X8 computer. The configuration is schematically shown in fig. 1. Flexibility is of great importance, since on-line data acquisition and experimental control needs the full capacity of the computer system only for part of the time and since the data analysis consumes most of the EL-X8 machine time. Obtaining this flexibility in machine power required designing and building special interfaces, not commercially available, containing the links between the computers. In the following sections the PDP8 processors and EL-X8 will be denoted as P1, P2 (in general P) and X, for the sake of brevity.

2. Survey

The two small computers P1 and P2 consist of standard (4 k, 1.5 μs, 12 bits) DEC-PDP8 processors with teletype. The detection system is usually coupled to P1. For testing purposes, or in case of failure of P1, it can be coupled to P2. Due to its role in the data acquisition process, P1 is a very busy machine. Data are read in under program-control. P1 also provides the necessary control signals for the detection system. Two autonomous magnetic tape units (Datamec D2020; 556 bpi; 30 ips) are coupled to P1. One of them is used to record experimental data, while the other one can be used as a program library. The units write and read IBM compatible tapes. A scatter-read facility is used with advantage for program reading[4]). Fixed and relocatable binary programs are stored on a disk (DEC, type DF32, 32 k). They can be read under program-control in multiprocessing mode[5]). A display memory with oscilloscope (Nuclear Data, 160 M; Tektronix, RM 503) is connected to P1. A life-display can be produced, either autonomously or fully under program-control. To reduce flicker, memory parts of arbitrary length which are momentarily not of interest can be automatically skipped, using a hardware controlled chaining mechanism. Top views and isometric displays with continuously variable viewing angles are available. Hardware operations and program subroutines can be triggered with a lightpen to allow inspection and modification of data in the core memory of either the display unit or P1.

To P2, which serves part of the time as a satellite processor for X, a Tektronix 611 storage display is connected. Thus, P2 can be operated as a powerful terminal of X, in addition to its use as an independent machine for computing and testing or in cooperation with P1. A fast Tally type 424 paper tape reader and type 420 puncher have been interfaced to P2. Except for the disk interface, all interfaces have been designed and built in our Institute.

The intermediate size Philips-Electrologica X8 computer (48 k, 27 bit, 2.5 μs) has as standard facility an autonomous I/O processor CHARON for slow data transfers, for supervision of direct memory access and for communications with fast peripherals. The configuration further contains a 1000 ch/s paper tape reader (EL 1000), a 150 ch/s paper tape puncher (FACIT) and a 10 lines/s lineprinter. Four teletype consoles are used in timesharing. A magnetic drum (BRYANT, 512 k, 21 ms) functions partly as a system backing store, partly e.g. as a large kicksorter memory for building up multidimensional arrays of experimental data[6]). One of the five available magnetic tape units is used as a permanent program library and file-dump facility. The other 4 are commonly used for data-manipulating purposes. The connection to P1 and P2, which can be switched under program control, allows X to be involved in on-line data taking as well as in display manipulations.

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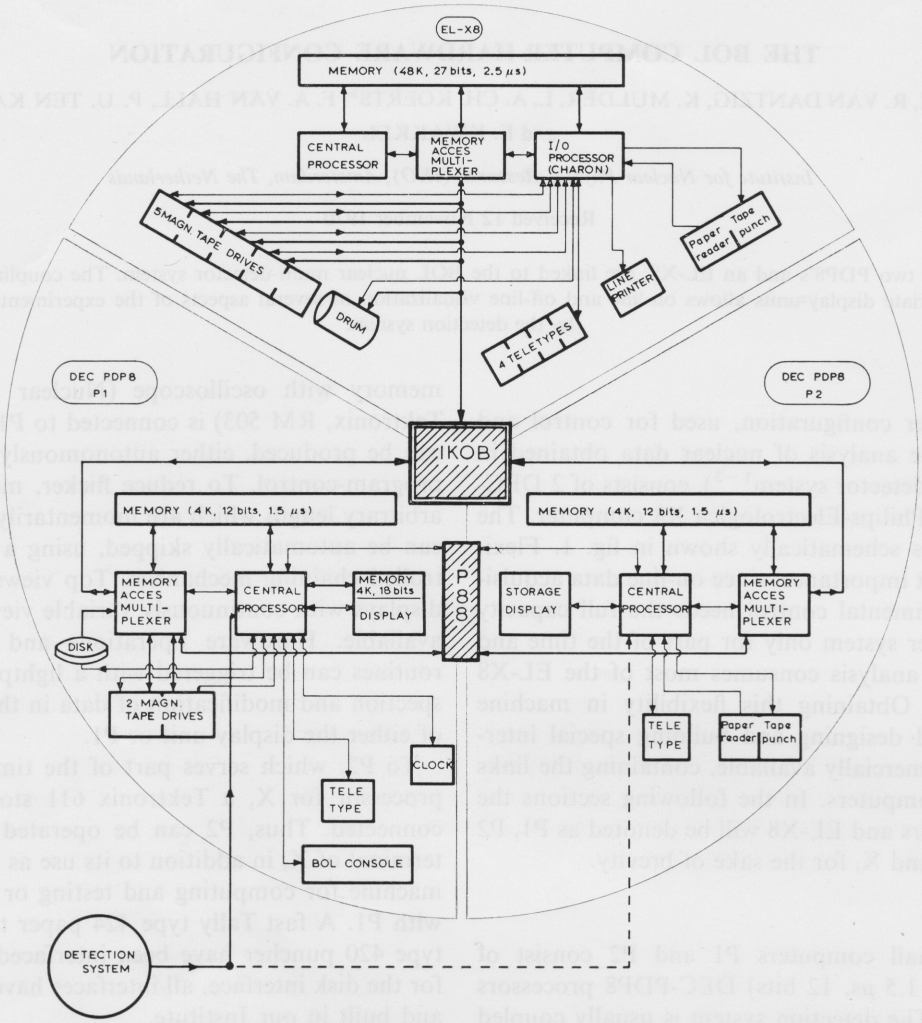

Fig. 1. Configuration of computers and interfaces for BOL. Heavy solid line: Fast data-transfer. Solid line: "Slow" data- and logic-transfer.

3. X–P link (IKOB)

All data communication is accomplished in a direct memory to memory transfer mode. The design was based on the philosophy that P should be relieved from administrative actions as much as possible, by using the sophisticated I/O facilities of X[7]). Information transfer is possible in both directions. In the transfer, X-words of 24 bits, corresponding to 2 (12 bits) P-words are handled as a unit. The communication is defined in terms of conversations. Both P and X may initiate a conversation. In the conversation structure two types of sentences appear: introductory sentences and main sentences. Introductory sentences are in general short transports to and from fixed memory positions in P and X with control announcements, often delivering information about the handling of following main sentences. The latter, usually containing the actual data, can be transferred between arbitrary memory regions on both sides. The transfer specifications, which remain stored in the interface registers during a complete transport, are provided by X as far as possible. Transports initiated by P are triggered by a request signal from P, announcing the presence of an introductory sentence containing the relevant data. X is programmed to have normally available a sufficiently large free memory area to admit immediate transportation on P's request.

X, upon initiation of a transport, specifies both the direction of the transport and the mode (P-conscious or P-unconscious). With P in the last mode X can load programs in the core memory of P and start them. In conversations in this mode administrative tasks of P are reduced to a minimum. The transfer mechanism includes possibilities for scatter-read and gather-write.

If the P-address reaches during transportation a preset value, the transport is interrupted and P interrogated. P may then specify new values for first and last P-address and let the transport continue. This provides a scatter-read/gather-write facility as well as a way for optimal use of P memory in cases where large data blocks are transferred. The end of transports is announced independently to X and to P in the P-conscious mode (in the P-unconscious mode P is a slave of X). The transfer rate is about 16000 X-words per second for blocktransports. From the point of view of X, P deviates from an ordinary peripheral mainly in its ability to initiate actions on its own initiative. A detailed description of the logic is given in ref. 8.

The achieved flexibility in data communication contributes suitably to help the physicist in choosing appropriate procedures for adjusting, checking and controlling the experiment.

4. P1–P2 link (P88)

This link allows bi-directional data transfer through the PDP8 3 cycles databreak[9]) facility and through programmed word transfers. Data transfers in both directions are independent. Transfer rates up to ≈ 100 kHz may be achieved for both modes of operation. Program overhead will be in general significantly higher for word transfers than for databreak transfer. Therefore the word transfer mode is primarily used for the transmission of control parameters while databreak data transfer is used for transmission of the actual data.

The coupler consists of two identical interface panels, one located near P1 and the other located near P2. In each interface a single data register is used for both types of data transfer. Only a few instructions are needed for controlling P88. Programmed word transfer is achieved by using two instructions, essentially loading and reading the data register. For databreak transfers the wordcount and current address are core-memory registers in the 3-cycle mode. Their position in core-memory for both in- and outgoing datachannels can be set to arbitrary values with a load instruction. The transfers then are initiated by setting the input- and/or output-channel-select bits of the command-status register.

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