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HARDWARE TO DRIVE CAMAC SYSTEMS IN MPS

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Introduction

The decision to use CAMAC in the MPS Division (MAC No 22) led us to study the different options to be taken in the future in view of standardizing equipment in the Division (MPS/CCI Note 74-10). Among these options, four main subjects must be considered:

1) choice of crate and power supply (see MPS/CCI Note 74-14)
2) choice of driver (subject of this note)
3) choice of crate controllers
4) selection of the sets of CAMAC modules which will be recommended for use in the MPS Division.

Points 3 and 4 will soon be the subject of future notes complete the overall CAMAC survey which will thus permit an effective homogenization of all the future use of CAMAC in the Division.

We present in this note a description of the hardware options which were studied in making the choice of a standardized CAMAC driver system for future MPS control projects. This study was undertaken by a group consisting of hardware specialists from the CCI, Linac, Booster and AE groups and programmers from the CCI Systems Software section.

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1. Branch or radial CAMAC system? (Figs. 1A, 1B)

The first aim was to decide whether our standard CAMAC system should be based on a branch highway[1] or on a system of crates directly on the unibus of our Front End Computers (FEC's). (This second system, which can be thought of as radial from the FEC, is typified by the CC 11 type of crate controller[2]).

In this context we note that

a) all MPS CAMAC subsystems should have identical drivers;

b) some subsystems will consist of several closely-sited crates while others will extend over 50 - 60 metres and will require the new Serial CAMAC system[3];

c) each subsystem will have a local 'midi' console which will be interfaced through CAMAC to the FEC[4].

We have compiled a table (Table I) to compare the various characteristics of Branch systems and CC 11's and we make notes as follows.

i) Although the CC 11 is slightly cheaper, when considering the total cost of the project we believe that the value of the difference is less important than technical details.

ii) A point in favour of the Branch since all subsystems can be expected to use more than one crate locally (that is near the FEC both physically and logically; hence not on the Serial Highway).

iii) An extra instruction in the CC 11. In a PDP 11/10 this means an extra 8 microseconds approximately.

iv) Most Branch Drivers include a DMA unit whereas with the CC 11 one must buy a separate unit. In addition, this special unit requires 2 Unibus cycles to complete a one-word transfer instead of 1 cycle.

v) No difference.

vi) A very important point in favour of the Branch. The reliability of the process should be independent of all non-vital equipment. As an example, the malfunction of a CAMAC module or crate driving the local console should not affect the CAMAC or the PDP Unibus being used to drive the process.

vii) The current idea in MPS is that we should purchase one of the new Serial Drivers working off a crate dataway and conduct exhaustive trials under MPS conditions of highway length, signal noise and high transmission speeds.

viii) However Serial CAMAC drivers are very new - and the Dataway version is the newest - and we think it advisable to have some form of back-up in case of problems arising from such a new system.

To sum up the table and the above notes, we feel that it is desirable to spend a little extra money to acquire a CAMAC driver which is more flexible, uses less PDP 11 memory, satisfies all MPS CAMAC sub-systems, offers some form of Serial system back-up and is slightly faster. <u>We thus recommend the choice of Branch Drivers</u> for the FEC's.

2. What make of Branch Driver?

The study group then moved on to the question of which make of Branch Driver we should standardize on. Requests were sent to CAMAC manufacturers and the replies are summarized in Table II.

The features we were looking for in our comparison included:

i) the driver should be physically located inside the PDP 11 frame rather than in a separate CAMAC crate

ii) a programmed I/O operation on a 16 bit word should require only two PDP instructions

iii) LAM handling should be performed by the driver hardware as far as possible; this should include hardware interrupt vectoring of the 24 bit graded-L response

iv) there should exist some DMA facilities.

From the table we see that

a) Nuclear Enterprises' unit fails criteria (i), (ii) - unless all I/O is properly structured, and (iii)

b) Kinetic Systems' unit fails criteria (ii), (iii) and (iv). Also, it does not employ the CAMAC X response

c) GEC-Elliot's unit fails criteria (i) and (iv).

This leaves the SAIP and DEC units which are very similar in operation except that the DEC unit has many more modes of DMA. However, considering that our DMA requirements will be fairly modest, that we have had good experience with SAIP CAMAC drivers in the past and that it is much cheaper we recommend the use of the SAIP (Schlumberger) ICP 11 Branch Driver.

(Note: we propose to use only the standard length highway for the moment as we expect to use Serial highways to solve our distance problems.)

3. The future

Having chosen the Branch Driver and the crate for our CAMAC systems we now move on to the question of crate controllers and standard modules. Rather than each CAMAC user individually selecting his own choice of controller and modules, we feel that there should be an MPS-recommended list of controllers and the more commonly-used types of modules - in exactly the same way as there is now for crate and Branch Driver, and for the same reasons of simplified software, hardware, maintenance, availability of spares and reliability of manufacturer. The hardware group chaired by E. Asséo is now looking into these questions and the final list will be kept by K. Hansen (CCI Group).

Work will now begin on the software to drive our CAMAC systems based on the description given in CCI/Note 74-15. Also preparations will be made to test one of the new Serial Drivers. In the meantime any queries regarding CAMAC should be made to A. Silverman (on software aspects) or A. van der Schueren (on hardware aspects).

Distribution

CUC
MAC
CCI Computer Section
PS Programmers
PS Electronicians
J.J. Cloye

References

1. CAMAC organization of multi-crate system, EUR 4600

2. CC 11 CAMAC crate - PDP 11 interface type 116, CERN NP CAMAC Note 43-00

3. CAMAC serial system organization, a description, TID-26488. To be adopted by AEC NIM Committee and ESONE Committee

4. See for example Proposed control system for the new Linac, U. Tallgren, MPS/LIN Note 74-6

Table 2

Comparison of Branch Drivers

Firm	Nuclear Enterprises (UK)	SAIP Schlumberger (France)	Kinetic Systems (USA)	Digital Equipment (USA)	GEC-Elliot (UK)
Item	System Crate 9030 Crate Controller 9031 Branch Interface 9032 PDP11 Interface	ICP-11 Branch Driver	KS0011 Branch Driver	CA11-C Branch Driver	System Crate MX2 CTR-2 Controller PTI-11C, D Interfaces BR-CPR-2 Branch Coupler IVG-11 Interrupt vector unit
Price (approx)	£1200 + cost of a CAMAC crate	FF24,000	$ 2700	34,500 SwFr	£1300 + cost of a CAMAC crate
Principal Unibus Registers	Status register Command register Data High byte register Data register 4 BCR (Branch and Crate)	CSR (Control and Status) DHR (data high byte) 512 unibus addresses (NA) Several DMA registers	BDR0 (Crate and Status) BDR1 (NAF) BDR2 (data high byte and C) BDR3 (data)	CCR (Command) DHR (data high byte) 512 unibus addresses (NA) Many DMA registers	CSR (Control and Status) DHR (data high byte) 512 unibus addresses (NA) Interrupt and Demand registers
Programmed I/O (16 bit)	1) Initially load a BCR ~~2) MOV to/from Data reg.~~ 2) MOV to Command reg. 3) MOV to/from Data register	1) Load CF into CSR 2) MOV data to/from appropriate NA	1) Load C into BDR2 2) MOV NAF to BDR1 3) MOV data to/from BDR3	1) Load CF into CCR 2) MOV data to/from appropriate NA	1) Load CF into CSR 2) MOV data to/from appropriate NA
LAM Handling	1 interrupt vector for LAM's Graded-L must be issued and analysed by the service routine	24 interrupt vectors for LAM's A LAM causes automatic hardware-driven graded-L with hardware vectoring	1 interrupt vector for LAM's Graded-L must be issued and analysed by the service routine	24 interrupt vectors for LAM's A LAM causes automatic hardware-driven graded-L with hardware vectoring	20 interrupt vectors for LAM's A LAM causes automatic hardware-driven graded-L with hardware vectoring
DMA	9033 ATC unit (£600) Has 4 separate DMA channels; repeat or scan mode; up to 4096 words	Included in ICP-11 Repeat or scan mode Up to 256 words	None described	Included in CA11-C Many modes including repeat, scan and random addressing	A DMA unit should be available next year. No details yet
Notes	Uses System Crate concept. Up to 8 branches per System Crate Interrupt given for time out, no X response, etc	Long Branch Highway version available 2 Branches per PDP11	No X line Interrupt given for time out, no Q response, etc	Non-DMA version available 4 Branches per PDP11 No Q or no X can be used to give interrupt	Uses System crate concept Up to 4 Branches per System Crate More than one computer can control System Crate

TABLE I COMPARISON OF BRANCH HIGHWAY AND CC 11

	Branch Highway	CC 11
Cost I	Branch Driver 16 000 SF (including DMA) + 5 000 SF for each Crate Controller	5 000 SF for each CC 11 (no DMA) + 2 000 SF for unibus connections + 5 500 SF for DMA (see below)
PDP registers II	512 + 5 per branch (4 branches per PDP) (1 branch = 7 crates maximum)	512 per crate (11 crates maximum)
Program-ming III	i) Load CF into Control Register ii) Move data to/from NA address	i) Given C, calculate address of Control Register for that crate ii) Load F into that Control Register iii) Calculate NA address for that crate iv) Move data to/from that NA address
DMA IV	2 modes of DMA (repeat same NA, increment NA) available in Driver. 1 move takes 1 bus cycle	Must buy separate DMA unit which then allows only indirect DMA - that is 1 move requires 2 bus cycles
LAM V	Automatic issuing of graded -L Hardware interrupt vectoring - 25 vectors per branch	Automatic issuing of graded -L Hardware interrupt vectoring - 8 vectors per crate
Unibus connection VI	Only the Branch Driver is attached to the PDP 11 Unibus. Thus any crate can be put off-line without disturbing the remainder of the system	Each crate sits on the Unibus. With the current proven equipment, switching off a crate disturbs the entire system
Serial systems VII	i) Extended Branch Serial Driver ii) Serial Driver working off a crate Dataway (This is very new and little known)	i) Serial Driver working off a crate Dataway <u>Question</u>: At what line speed is this known to work? (1 MHz - 5 MHz is needed for PS systems)
Back-up for Serial systems VIII	i) Two forms of Serial Driver possible, one of which is thought to work well at NAL (the EBSD version) ii) "In extremis" a long Branch Highway is possible (e.g. SAIP ICP-11A) and a PDP 11 can support 4 Branches	Only solution is the extension of the Unibus which is difficult, and the addition of more CC 11's which each use up 512 memory addresses

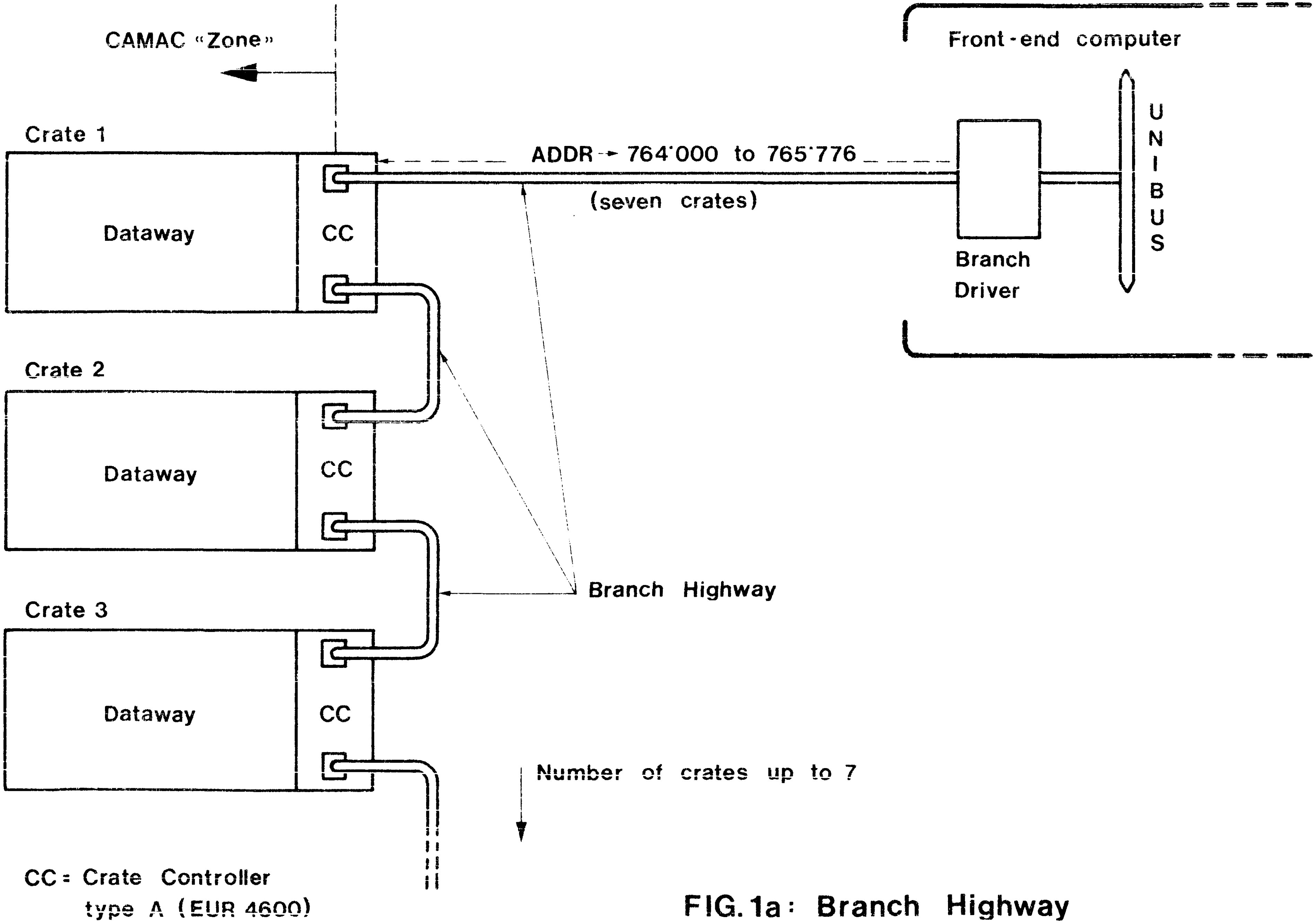

FIG. 1a: Branch Highway

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