A STAND ALONE VMEbus 68k TEST SYSTEM RUNNING CP/M

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ABSTRACT

We describe a test system we have set-up to be used in LEP experiments. Under VME standard, "open", stand-alone under CP/M, VAX "like", it is very powerful in CAMAC, VME and FASTBUS applications. An optimized multi-user possibility is set-up just by adding CPU cards.

The FORTRAN 77 native compiler developped by one of us, processes all standard packages available at CERN (CAMAC - FASTBUS- MZCEDEX- HMINI-HPLOT....) with very good performances and makes the system user friendly. PASCAL and C native and cross compilers are available.
An ETHERNET link with a VAX VMS has been developped above level two in C allowing a file transfer of 100 kbits/second.

Performances are competitive with larger configurations. Cheap price makes such a system very promising for future large experiments which need more distributed CPU power, specially for test and monitoring.

1 INTRODUCTION

The most popular computers associated to test systems generally don't meet well the requirements for fast hardware applications. But the simultaneous availability of 68K microprocessors and of the VME bus allows setting-up of new, cheap and well suited configurations. Preparation of LEP experiments leads laboratories in charge of electronic tests to update their system. Several set-ups can be considered, provided they meet CERN standard requirements for CAMAC and FASTBUS both in hardware and software aspects.

L.A.P.P has the responsability to develop CAMAC and FASTBUS hardware units and to set-up a test system of the second level trigger of the L3 experiment.

To achieve our goals we need a powerful "hardware oriented" tool verifying the following requirements:

- Stand alone .
- Fast in hardware debugging and tests.
- User friendly for non informatician people (VAX like) .
- Supporting a fast native FORTRAN 77 compiler .
- Able to use the CERN PRIAM cross software .
- With an efficient connection to ethernet allowing file transfers with a VAX VMS.
- Easily upgradable.
- Cheap (less than 25000 SF totally equipped).

Because VME has been designed to work in a multi-CPU environment, these considerations have oriented our choice to a mono-task mono-user disk operating system. Therefore, a multi-user configuration is set-up just by adding extra CPU cards,in such a way that the multi-user is taken care directly by VME hardware i.e without system overhead for hardware performances.

The popular CP/M system enriched by the Fortran-77 compiler developed by one of us (Hans Von Der Schmitt) fits well our requirements.

The ETHERNET connection will allow the system to be integrated in the L3 ON-LINE configuration to perform trigger tests under VAX's control.

2 SYSTEM OVERVIEW

2.1 HARDWARE

The hardware, built around VME bus, allows to define an "open" system, compatible with a wide range of modules, without excessive manufacturer dependance. We chose the 12 Mhz "ELTEC" CPU driven by the CP/M disc operating system for the following reasons:

This CPU was the fastest 68K available. It includes a 1 Mbytes memory on the board avoiding unnecessary bus access. The same board includes also the floppy disk interface and two RS232 ports. In a multi-CPU environment, these features increase the performances.
The bus arbitration unit is not implemented on our CPU. The Motorola MVME 101, introduced for some extra reason, takes care of this function.

In order to boost the system performances we have added two memories:
The first one is a RAM memory, which emulates a disk, used exactly like a fast disk.
The second one is a ROM module containing utility programs (actually Fortran 77 and libraries).
To avoid the associated back-up constraints, we chose not to use hard disks as mass storage but only two 1 Mbyte floppy disks. While slow, this solution is sufficient.

CAMAC is driven via the DATA-SUD interface.

FASTBUS is driven via the VIOR-FIORI interface and soon via the CFI interface.

ETHERNET is connected via the LRT interface which is a master.

XOP, a fast processor developped at CERN, is driven via its VME interface.

To be compatible with MONICA applications, we have added a MVME 101 CPU with its external RAM memory. As stated before, this CPU is also used as our VME arbitration unit.
The VME address space of the entire configuration is described in figure 1.

2.2 SOFTWARE

In High Energy Physics, the most commonly used machines are VAX and IBM. To avoid users to learn a new system, we have created an environment as close as possible to the VAX context. It has been possible since the very primitive operating system we have selected, let say CP/M, is easily hidden for the most common applications.

But primitive does not mean not efficient. On the contrary, the mono-task/mono-user feature is a great advantage for speed and efficiency.

The multi-cards possibility being arbitrated by hardware directly on the bus, we take advantage of this feature.The multi-users possibility is implemented just by adding extra CPU cards. So, in a multi-users configuration, speed penalty will appear only during conflictual access to the bus. It is reduced to a minimum by using CPU cards with a large memory on board and with direct access to peripherals.

If a file has to be edited, a full screen editor behaving just like the VAX EDIT is invoked by the command: EDT Filename.

Cross-compiling is a very useful tool, but we have to remember that object file has to be downloaded after each modification of the source code. Downloading of large files via RS232 line, can reach up to one hour.Such a procedure becomes unusable for development of large programs. As FORTRAN is the most common language in our applications we feel important to use a native compiler.

The FORTRAN 77 native compiler developped by one of us (HVS) ensure compatibility with CERN utility standard packages as:

- MZCEDEX : command processor and menu facility.
- HMINI and HPLOT : standard graphic packages.
- CAMAC : standard ESONE calls
- CERN FASTBUS :

This compiler is available in the native mode and as cross compiler on the VAX VMS.It satisfies almost all F77 requirements except real*8 and direct access for files manipulations. Its run-time performances have been particularly developed.
Some performances of the compiler are summarized in table 2.

As for an example, the development of a F77 program will be achieved as follows:

FOR test (compilation: produces ASM code, then object code)

LINK test (links program with FORTRAN libraries)

TEST (starts execution of program TEST)

If the program has to be recalled from VAX, the sequence available is the following one:

HOST (transparency on host)

SUP (initiates on VAX the facility for file transfer)

XFER (on CP/M initiates file transfer)

is the host a VAX ? (Y/N)
host file name:
local file name:
host to local ? (Y/N)

The file transfer is initiated and is available in both directions, either for text files or 68k images which are decoded from S format to binary format to be stored on the CP/M mass storage.

For small tests, a basic-like language may be useful, we intend to install PILS on our system before the end of 85.

In the LEP context with ETHERNET environment, it is obvious that a fast connection with the usual host (VAX) will be a major feature and will make possible a new range of applications during setting up of the experiment . A task to task link above ETHERNET has been realized and is described in a following subsection.

3 DEVELOPMENTS AT LAPP

3.1 VME

Initially, we chose to built the test system around the VME bus, because VME is an industrial standard, able to manage multi-master configurations with good performances. We have never foreseen to perform development on VME, but we'll certainly be obliged to understand why mixing units from different manufacturers in a same crate is not straightforward. We have to understand and solve this problem because we need at least three masters in the same crate. We hope the problem will be solved by using a more efficient general purpose arbitration unit... which has been missing up to now.

As many modules are provided with fixed addresses, especially in the short I/O range, we often had to reconfigure our VME space.

3.2 CAMAC

With the VME-CAMAC interface, we have run CAMAC under excellent conditions: Being our system a mono-user one, we can switch CAMAC on and off at any time.

After optimisation of the CAMAC library, CAMAC cycles (standard ESONE calls), have been measured at less than 60 microseconds with the 12 MHZ CPU.

In our FORTRAN compiler , the CAMAC interface is a part of the VME memory.This allows FORTRAN programs to run CAMAC cycles in a few microseconds.

3.3 FASTBUS

Developments will increase in the next months at LAPP. The L3 trigger is largely based on FASTBUS. FASTBUS is actually running on our VME system and the last FB package has been implemented. The commonly used test programs(FBMON,FDMTST) are being implemented. We have tested that we are really able to compile and link FBMON locally as well as with the cross-compiler (4500 FORTRAN lines giving 19000 assembly code lines).

The first large FASTBUS prototype, a 500 components module developped by CAD, with a local developed integrated circuit on board, is just completed. Hardware debugging and maintenance tests will be performed with this system.

3.4 NETWORKS

ETHERNET is the most popular LAN used at CERN. Most mini's such VAX's, APOLLO's UNIX VME systems can communicate on ETHERNET via TCP/IP. TCP/IP however is UNIX oriented and except for the VMS VAX, not adapted outside UNIX environment. Another problem is the cost of the connection. Among the ETHERNET cards presently on the market, there are intelligent ones, with firmware on board up to level 4 (transport in ISO model). This solution is attractive but expensive ($4000) and in fact only adapted to UNIX systems. Moreover, it requires to install the TCP/IP package on VMS VAX ($4000) which doubles the overall price. In fact for a VME UNIX or UNIX like system the connection would actually equal the total price of the system.

For small, low-cost systems another solution was suitable. A classical scheme, particularly developed at CERN is the SERVER/CLIENT couple.
A SERVER, installed on the HOST is waiting for requests from different CLIENTS and must be able to satisfy several of these requests.

We have realized such a connection above level 2 of ETHERNET, with the present restriction that the SERVER on the VMS VAX is able to satisfy only the request from one VME's CLIENT.
The software has been derived from the existing package developed at CERN (Ben Segal, private communication) for the link between the PRIAM VAX UNIX and the MOTOROLA MVME CPU running MONICA in VME.

This sofware, written in C had to be adapted to other machines (VAX VMS and CP/M VME 68k). The development, started last spring is now completed. It has been facilitated by the portability of the C language and the support we found at CERN. However this implementation has obliged us to considerably modify the original software.

The encountered difficulties were both on software and on hardware.

For the hardware the board delivered by LRT at the end of july 85 presented a serious bug. This bug did not appear systematically on all cards delivered at CERN, and consequently slowered its debugging. After having delivered a packet the card was unabled to "hear" any incoming packet unless a carrier was present on the cable just before.

This has been temporary solved by preceeding each VME destination packet by any packet bringing the required carrier shot.
The sofware also carried up some difficulties. The native VME/C compiler delivered by WESTERN DIGITAL comprises some bugs and does not implement some features of the C language.
All these considerations have obliged us to modify the code written for a VAX (we had previously developed the SERVER/CLIENT couple between two VAX's).

This solution, which exhibits a connection cost of about $1000 (plus transceiver)allows a 100 kbits/sec file transfer between the VAX VMS and a VME system.

3.5 L3 DEVELOPMENTS

Our main applications with this system are done on L3 experiment and specially on the second level trigger
In this framework we are developping some new, fast FASTBUS interface (slaves and master),as well as some CAMAC modules.
Using VME CP/M system in this context allows us to replace heavy slow VAX's by little, fast, self configurable 68000 cpu's. One of these systems will stand on the L3 experiment as the second level survey and maintenance system.

4 CONCLUSION

We presented a stand-alone 68K test system running the standard FORTRAN CERN packages.
Very good performances obtained in CAMAC and FASTBUS meet well requirements needed for hardware developments.
The new coming tools as : native F77 compiler, VAX compatible screen editor, remote login, file transfer... make the system powerfull and user friendly for program developments and hardware tests.
The ETHERNET connection will allow the system to be integrated in the L3 on-line structure to perform second-level trigger tests "in situ" under VAX's control.

This system has been running for six months without serious problems. Its low cost, (less than 25000SF totally equipped), with all needed interfaces needed in CERN experiments, boosted by 5 Mbytes memories (RAM+mass storage) makes it very attractive. If desired, the multi user feature can be obtained virtually by adding extra CPU's, or by using the CERN cross software on the VAX and downloading S records from VAX to VME.
To go further, we have to investigate the multi-master aspect. This work has pointed out the problem of hardware compatibility between some VME manufacturers.

ELAPSED TIME TO COMPILE MZCEDEX AND MZCOMM ON

ELTEC VAX

MZCEDEX.FTN
MZCOMM.FTN
|| RTFMAIN
v

RAMDISK
RTFMAIN (EPROM)

	12 MHZ	8 MHZ	NATIVE	CROSS
MZCEDEX.S MZCEDEX.LIS	5'45	9'50	1'00	8'50
‖ AS68 → MZCEDEX.O JADDR.O	1'00	2'20	----	----
‖ LO68 → MZCEDEX.68K	0'10	0'15	----	10'

2496 LINES - 68K