Peripheral Crate VMEbus Controller

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Dynatem D360

25 MHz 68360 based VMEbus Single Board Controller (3U VME card supporting A24 D16 transfers)

Operating System: µCLinux (burned on a Flash PROM)

Communicates with Linux PC (in USC55) via 10BaseFL Ethernet (10BaseT has magnetic components) (Dynatem comes with RJ45 connector for 10BaseT, but does not work in a magnetic field. We removed the RJ45 and replaced it with our own 10BaseFL adapter board). A commercially available 10BaseT to 10BaseFL box is used on the PC end.

Software for PC-D360-VME communications has been written and tested. (TCP sockets opened on both ends, Dynatem holds code to translate the commands in packets to VME addresses).

Radiation tolerant

- Tested with 63 MeV protons. (At UCD cyclotron)
- Observed 35 upsets in a fluence of $0.74 \times 10^{11}$ p/cm$^2$.
- Recover from upsets with “system reset”. Requires 47 resets in 10 LHC-years. (Probably more frequent reboots will be required due to other causes).

Speed

- Transfer rate: 10 Mb/s bit rate, throughput ~ 2.5 Mbits/s achievable. (This includes Ethernet overhead).
- Speed of loading FPGA firmware to EPROM dominated by required erase/program delays on chip.

Cost ~ $1100 per unit (Cheap compared to most SBC’s)

Using the Dynatem as the EMU peripheral crate controller is a proven solution. It is available, relatively cheap, and the required software has already been developed. The bottom line is, it will work. However this does not necessarily mean that everyone is satisfied with the characteristics of the Dynatem solution.
A VMEbus Controller with Gigabit Ethernet

A custom board designed and developed at OSU

Based on XILINX Virtex-II Pro

- XC2VP4 – FF672 FPGA
- Built in RocketIO™
  - Supports Gigabit Ethernet
  - 8B/10B Encoding, SerDes, Clock Recovery included (no Logic Cells used)

Optical transceiver (for Gigabit Ethernet)

VME Interface Buffers

Command FIFO (for buffering VME commands)

Flash Memory (for storing configurations)

Flash PROM (for storing the firmware)

So why are we developing a new controller? There are advantages over the Dynatem.
Advantages

General Advantages
- Communicates with stand-alone PC (in USC55) via Ethernet
- GbE network cards commercially available (with optical fiber connections).
- Customizable firmware.

Advantages Over Dynatem
- A much simpler crate controller.
- No 10BaseT to 10BaseFL converters needed.
- No operating system or software on the controller.
- No sockets to open for each connection.
- All programming done on PC.
- Customized packets reduce overhead (explained on next slide)
- Faster: transfer rate ~ 1 Gb/s bit rate (compare to 10 Mb/s) through-put ~ 600 Mb/s (compare to 2.5 Mb/s)
- Less expensive: ~ $600 per unit (compare to $1,100 per unit)

General Advantages
Communicates with stand-alone PC (in USC55) via Ethernet
GbE network cards commercially available (with optical fiber connections).
Customizable firmware.
Dynatem has software which is customized.

Advantages Over Dynatem
A much simpler crate controller.
From the point of view of user interaction with the controller.
No 10BaseT to 10BaseFL converters needed.
The usual GbE is over fiber, but can be over copper.
No operating system or software on the controller.
Only firmware which is stored on a PROM and loaded in 10’s of milliseconds on power up or reset.
No sockets to open for each connection.
Driver communicates directly to network card
All programming done on PC.
Code is in fewer modules
Customized packets reduce overhead (explained on next slide)
Faster: transfer rate ~ 1 Gb/s (compare to 2.5 Mb/s) 
Actual bit rate is 1.25 Gb/s because 8 bits are encoded into 10 bits.
Less expensive: ~ $600 per unit (compare to $1,100 per unit)
**Advantages**

Packet Structure in use with Dynatem (with TCP/IP):

- **Customized Packets (with GbE)**
  - Can eliminate TCP/IP layer
  - Can utilize jumbo packets (9000 bytes of data)
  - Bit rate is 100 times faster than 10BaseT

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Customized Packets (with GbE)

Can eliminate TCP/IP layer

Can utilize jumbo packets (9000 bytes)

You have the potential for packing 1283 (A24 D16) VME commands in a single packet \( \Rightarrow \frac{8995}{(9000 +38)}=99.5\% \)

Bit rate is 100 times faster than 10BaseT
Hardware Development

Non-Restrictive board design.

Even though we may not utilize or implement some VME64x capabilities, the board is designed to be compatible with almost all VME64x functionality.

Sent to PC house last week.

Most parts are on hand.

Board Stuffing to take place next week.

Firmware Development

Will be developed in stages.

RocketIOTM implementation has been previously tried and tested.

Start with rudimentary A24 D16 VME master.

Add other functionality, flexibility, configuration control, and robustness as progress is made.

This means unpacking GbE, buffering to the FIFO, transfer from FIFO to VME port, conform to timing requirements, fill a buffer with any read data, create packet, and send to GbE.

Add other functionality, flexibility, configuration control, and robustness as progress is made.

This includes other transfer modes, define command structure or custom protocol structure for local and VME commands, add mechanism for setting and saving particular configurations, saving a default configuration, develop handshaking to deal with reset or full buffers, add status and monitoring and error reporting, add modules for system timer, arbiter, interrupt handler, etc.
Any Questions?
Distributing GbE to 60 Crates

- Need a Level 2 GbE Network Switch
  - Level 2 means MAC address level.
  - Must have optical fiber outputs.
- Commercially available
  - Netgear makes one with 12 GbE fiber optic outputs for about $2000.

This slide is not intended to be shown unless questions arise about distributing commands to 60 crates.