Eurogam

A French-UK collaboration between IN2P3 in France and EPSRC in UK.

The array was operational at the NSF (Daresbury) between Sept 1992 and April 1993 (Phase I) and has been at the Vivitron (Strasbourg) since July 1994 (Phase II).

It is scheduled to continue at Strasbourg until autumn 1996 (or about 4 months before Euroball startup) when the detectors will move to Legnaro for Euroball.

principle laboratories involved:

CCLRC Daresbury, CENBG (Bordeaux), CRN (Strasbourg), Grenoble, Lyon, IPN and CSNSM (Orsay), Liverpool University, Manchester University, York University

Eurogam II

Detectors

- **30 Coaxial Detectors: Ge detector + 10 element BGO shield from Eurogam Phase 1**
- **24 Clover Detectors: 4 element Ge detector + 16 element BGO shield**
- **ancillary detectors: for example 54 element Cesium Iodide inner ball particle detector (Diamant)**

Eurogam II Electronics

Uses integrated electronics with full software control using the VXI (VMEbus eXtensions for Instrumentation) standard.

- **Ge card - total of 6 VXI cards each having 6 channels (one is a spare).**
- **BGO card - total of 6 VXI cards each paired with a Ge card.**
- **Clover card - total of 24 cards. Each card has 4 Ge channels (+ one spare Ge channel) and 1 BGO channel.**
- **Resource Manager (RM) VXI slot 0 card - one per crate**
- **Master Trigger**

VXI Electronics

VMEbus eXtensions for Instrumentation, Rev 1.3, July 1989

Eurogam uses D size cards. That is a triple height (9U) Eurocard module which includes a P3 connector in addition to P1 and P2 which are found in VME modules. The cards are 14 inches high and 13 inches in depth and are placed on 1.2 inch centers (VME cards are 0.8 in). The 1.2 inch module width allows feasible implementation of high density instrumentation modules while allowing enough space for shielding both sides of a module.

The P3 connector includes a 100 MHz clock and sync signal, additional power pins, more ECL trigger lines and 24 additional lines of daisy chain local bus. Also defined on P3 is a "star" trigger system where precision ECL trigger signals are routed through Slot 0 acting as a cross point switch. This allows very precisely matched trigger timing between modules regardless of module position.

A standard VXI crate holds 12 "user" modules plus the slot 0 (Resource Manager) module.

The Cluster card weights approximately 2Kg. Total power consumption of a full VXI crate may be as high as 3KW.

VXI Resource Manager

The VXIbus device protocols define how modules are granted non-conflicting portions of the VMEbus address space. Several devices may exist on a single module, and a single device may consist of multiple modules. 256 devices may exist in any one VXIbus system. A VXIbus system configuration space is defined in the upper 16K bytes of the A16 address space. Each device is granted a total of 64 bytes in this space. Devices requiring additional address space have their address requirements readable in a defined register in the A16 address space. The Resource Manager reads this value shortly after power-on and then assigns the requested memory space by writing the module's new VMEbus address into the device offset register. The Resource Manager may assign space in the A24 and A32 address spaces by this means.

The Resource Managers are interlinked so that signals may be shared between all VXI crates (for example the trigger validation).

The Eurogam Resource Manager contains a standard VME processor module (Motorola MVME147) which provides the communications path between the VXI modules and the control software.

Eurogam II Electronics (continued)

- NAM interface. Multiplexes data from 32 NIM ADCs
- ReadOut COntroller (ROCO) - one per VXI crate
- Total of 4 VXI crates
- DT32 bus
- Hardware Histogramming Unit with 8M channels
- ROHSI + CES HSM (to be replaced by D2VB interface)
- VME to CAMAC interface (Hytec VSD2992)
- FERA to DT32 convertor (CAMAC module)

Hardware Histogrammer

After all VXI crates the DT32 bus passes through a histogrammer unit which is a VME module acting as a spy onto the data. The unit is software programmable to select any specific parameters from any choosen detectors and build histograms via direct memory increment into global dual port memory.

The histograms can be examined using any of the workstations to check the quality of the data and monitor detector performance.

Additionally by histogramming the control tokens generated by the readout system (for example the start event token and end subevent tokens) the histogrammer can be used as a very powerful hardware diagnostic tool.

Currently there are 32 Mbytes of histogramming memory but this can be increased by adding more memory cards into the VME crate.

Ancillary Detectors - CAMAC

For ancillary detectors which do not have purpose designed VXI electronics CAMAC adcs (such as the Silena 4418V and LeCroy 4300b) may be used.

These have FERA readout and the FDT32 module (Fera to DT32 convertor)

- manages interaction with the Eurogam Trigger
- performs readout of the adcs via FERA bus
- performs mapping of the FERA addressing information (VSN & SubAddress) to the DT32 bus addressing (Group and Item)
- outputs the data onto the DT32 bus acting in the role of another ROCO

The VME to CAMAC interface is used only for control, monitoring and diagnostic purposes. Software enables the CAMAC modules to be accessed in a way very similar to that used to access VXI modules and so includes CAMAC adcs into the system in a seamless manner.

Other Components

In addition to the detectors and the VXI modules used to acquire data from them other systems provide and control the services needed for the detectors to operate.

Autofill

Another VME crate which provides for the filling and monitoring of the liquid nitrogen in the detectors.

High Voltage control

Uses LeCroy high voltage units interfaced via a VME module to provide the necessary bias to the GE detectors and BGO crystals.

Eurogam II

Data Acquisition and Control

- Implemented within a distributed computing environment
- All items to be controlled or monitoring are accessed via an ethernet LAN.
- Uses Internet Protocols (UDP/IP)
- The client-server model which is used to build a network of workstations is followed and the data acquisition modules become additional resources on that network
- Experimental control, real time monitoring of data quality and event construction are performed using processors within VME
- Graphical User Interface using UNIX workstations
- No master workstation or Central DataBase

System Software

The user interface to the data acquisition system is via UNIX workstations while all VME cpus run the VxWorks real-time kernel.

VxWorks

The VxWorks kernel was choosen for the real time components because

- **it is designed specifically for real-time control and data acquisition functions within a multi-tasking environment;**
- **it gives very fast handling of interrupts, task scheduling, etc.;**
- **it is UNIX source compatible. All software generation and compilation is performed using UNIX workstations;**
- **it has full support for BSD networking allowing complete integration into a UNIX workstation environment;**
- **source level debugging is available from UNIX workstations using DBX.**

Network Communication #1

Each VXI and VME crate contains a cpu (MVME 147) having an ethernet interface which is a node on the local area network and which also acts as a gateway for other CPU cards in the same crate. The use of UNIX and VxWorks enables common network software to be used in all components of the system

- Internet networking (IP)
- UDP/IP (User Datagram Protocol/Internet Protocol)
- RPC (Remote Procedure Calls)
- XDR (eXternal Data Representation)
- NFS (Network File System).

All communications between applications specific to the Data Acquisition System are based on the Client/Server model using Remote Procedure Calls. Using the network software RPC requests can be made between clients and servers across the ethernet, between VME cpus within a crate across the VME backplane, and within a single CPU or workstation.

Network Communication #2

This allows the software components to communication in a way which is independant of their location.

Fixed UDP/IP ports are used by the servers in order to avoid the delays which the use of dynamic ports and the Portmapper would involve.

Software Components - The Servers

The Eurogam data acquisition system has a small number of server programs which provide access to all the data acquisition resources

- **register server**
- **spectrum server**
- **tape server**
- **message/error logger**

Access is via a RPC service from client workstations

For each server a RPC program protocol is defined which is designed to provide access to the server facilities and to conform with the RPC methodology.

Register Server

A general purpose communications core which can be customised for specific data acqusition control tasks.

- **VXI crate setup and control application**
- **CAMAC crate setup and control application**
- **Histogrammer setup and control application**
- **Detector High Voltage control system**
- **Nitrogen Autofill control system**
- **Event Builder control**

Event Builder

- **Reads raw data from DT32 bus into RAM accessible via VME bus**
- **Checks input data for format and data errors**
- **Generates statistical information on data quality**
- **Performs user specified processing such as shared suppression**
- **Generates reformatted output data**

Eurogam 2 uses single width VME modules each with 2 50MHz 88110 processors

Outputs formatted data via FDDI to the tape server using a multi bufferred RPC procedure

Spectrum Server

- **Provides a common application interface independent of location of the data**
- **Spectrum name determines remote server location**
- **Online (in histogrammer) and offline (on disc) spectra are interchangeable**
- **Workstation based client-end software merges spectra from multiple servers to appear as a single source**
- **RPC program optimised for efficient network access. Supports various high level primitives to allow data to be accessed while minimizing network traffic.**

Register Server

What is a register?

A register is a named abstract object

- The name labels the register
- The class defines how it behaves
- The attribute table configures an individual register

Typically a register represents a group of one or more related control bits on an acquisition card.

A Register may however be purely a software invention (for example it could be a disc file containing a program to be loaded).

Register Server - continued

Register naming allows

- **Pattern matching**
- **Aliasses**
- **No need for the application to know hardware details such as number of hardware channels and individual location**

Pattern Matching

Server recognises * ? [A-C] [23-36] [x,y,z]

Ge[1-12].CFD.*

Ge[?,??].PoleZero

Register Server Functions

Access Control

- Claim and Free Resource

Housekeeping

- Define Register
- Undefine Register(s)
- Inquire Register(s)

Register Access

- Read Register(s)
- Write Regsiter(s)
- Initialise Register(s)
- Read Attribute(s)
- Write Attribute(s)

Register Server - additional #1

Initially each server has a number of application specific procedures which are loaded when the system is booted. Registers are then defined dynamically by the clients using the server protocol and specifying the local procedures in the server to be invoked when the register is subsequently accessed.

The register server allows named items of arbitrary data to be passed between the user interface programs and the server applications. The register name and the server command primitive select the local procedure to be called.

The data can be a single bit to be written to a VXI or CAMAC register or may be up to 1 Kbyte. Larger amounts of data (for example trigger or event builder programs) are handled by passing a filename to a suitable register class.

Register Server - additional #2

The register attributes provide additional information as needed by the application procedures to execute the read, write and initialise primitives. For example, a simple case would be a VXI register and the register attributes would include the VME address offset used to access the register on the VXI card. For a CAMAC register the register attributes would include the CAMAC cnaf data.

The server allows many registers to be accessed by a single RPC request by the use of wild-card techniques applied to the names. The available register names can be obtained by clients from the server thus allowing a number of user interfaces in workstations to access the server with all coordination provided by the server.

Tape Server

Hardware configuration for Eurogam II

- Total of 5 SCSI bus interfaces
- 8 Exabyte 8500 tape drives fitted with robot changers

Receives and controls data flow across FDDI from the Event Builder

Supports up to 4 data streams from the Event Builder

Each data stream may be output to any number of the Exabyte drives in either duplication mode, parallel mode or any combination of these.

The Exabyte 8500 drive can write up to 5Gbyte of data onto a 8mm video cassette at a continuous rate of up to 0.5 Mbyte/sec.

Graphical User Interface

Implemented using TCL (Tool Command Language) by John Ousterhout, University of California, Berkeley.

command language interpreter – tcl-shell

User Interface generated as TCL scripts which are interpreted

No compilation - Just edit script source file and execute or simply type or paste commands into the tcl shell window

Development is VERY FAST

Extensions provided within tcl-shell for

- **XView interface — xv**
- **Eurogram interface — eg**

Online data analysis - Sorting

On-line sort using workstations connected to the FDDI network acting as spies on the formatted data passing between Event Builder and Tape Server.

Any existing off-line sort program may be easily converted to process live data.

One or two packages are provided as part of the system but users may bring their own favorite.

Any number of different sort packages may be run concurrently on the on-line data.

Further Information

By World Wide Web (WWW)

connect to http://nnsa.dl.ac.uk/Eurogam

For this talk connect to

http://nnsa.dl.ac.uk/Eurogam/documents/edoc204/ps

For EG Session The Book connect to

http://nnsa.dl.ac.uk/Eurogam/documents/edoc203/ps

For Tool Command Language connect to

http://nnsa.dl.ac.uk/Eurogam/documents/edoc202/ps

For Netscape postscript viewer use ImageTool for these.

For some documents ImageTool fails and PageView may work better.

Further Reading

EDOC000 Eurogam Document Index

EDOC001 Readout of VXI modules over VMEbus

EDOC002 Discussion paper on histogramming module

EDOC003 Project Management for VXI Data Acquisition System

EDOC004 Singles in Eurogam

EDOC005 Use of VXI lines in the first phase of Eurogam

EDOC006 & EDOC007 superceded by EDOC022

EDOC008 Ge Card Specification (UK Version)

EDOC009 Germanium Card Specification

EDOC010 Options for Eurogam Anti-Comptoning

EDOC011 Sorter Specification

EDOC012 Event Builder Specification

EDOC013 VME addressing Scheme

EDOC014 Event Builder and Sorter Control

EDOC015 Overview of Eurogam Data Acquisition System

Further Reading

EDOC016 Specification of the Data Acquisition for Eurogam

EDOC017 Ethernet Communications

EDOC018 Remote Procedure Call

EDOC020 Network Tape System

EDOC021 Network VME System

EDOC022 Eurogam Trigger System

EDOC023 Resource Manager VXI Meeting

EDOC024 Eurogam Frontend Crate Server

EDOC025 Real Time Kernels

EDOC026 Event by Event Data Formats

EDOC027 Tape Standards

EDOC028 HV Control specification

EDOC029 Crates, Racks, Power Supplies and Cooling

EDOC030 VXI Resource-Manager Basic Software

EDOC031 VXI line usage

EDOC032 VXI Basic Data Base Structure

Further Reading

EDOC033 Eurogam Sort Language

EDOC034 Eurogam Register Server Protocol

EDOC035 Eurogam VXI Line Use

EDOC036 Eurogam Sorting Parameters

EDOC037 Event Builder Software Specification

EDOC038 Remote Procedure Call - C library

EDOC039 Network Tape System - C library

EDOC040 Using Sun RPC

EDOC041 Untitled

EDOC042 Short Note on VxWorks Implementation

EDOC043 Eurogam diagnostic software

EDOC044 Online analysis software requirements

EDOC045 Eurogam Suppression

EDOC046 Detector position numbering scheme

EDOC047 Naming scheme for Eurogam detectors

EDOC048 Eurogam detector angles

Further Reading

EDOC049 Data Formats

EDOC050 Eurogam Hardware Meeting Minutes

EDOC051 Phase 1 System Interconnections

EDOC052 Eurogam Software Meeting

EDOC054 Liquid Nitrogen Autofill Control System

EDOC055 Eurogam Master Trigger Module

EDOC056 Eurogam Readout Controller

EDOC057 VXI Resource Manager

EDOC058 FIC8230 to GEC parallel link

EDOC059 Eurogam histogrammer Specification

EDOC060 Eurogam Spectrum Servers - Online Histogrammer

EDOC061 Unified Spectrum Format

EDOC062 Spectrum Access

EDOC063 Specification of the VXI Readout Mechanism

EDOC064 Eurogam hardware event format usage

Further Reading

EDOC065 Autofill control system specification

EDOC066 Eurogam Database Requirements

EDOC067 Diagnostic procedures for Eurogam

EDOC068 Prototyping a sort language

EDOC069 Rack Monitoring

EDOC070 The next generation of the NSF interactive graphics system

EDOC071 Germanium Card Specification

EDOC072 General Purpose Interface (GPI)

EDOC073 Event Format[Sorting+Storage]

EDOC074 Eurogam Sort Reference Card

EDOC075 DT32-bus specification

EDOC076 Specification of the VXI Readout Mechanism

EDOC077 Readout Controller Specification

EDOC078 Spectrum Access Server Protocol

Further Reading

EDOC081 Eurogam Event Builder Language

EDOC082 Reference Card for Eurogam Event Builder Compiler

EDOC083 Software system structure

EDOC084 Test of the Event Builder

EDOC085 VXI/VME integrated data acquisition and control

EDOC086 Miscellaneous EuroGam Papers

EDOC087 Eurogam Register Server - C library

EDOC088 Eurogam Register Server - Commands

EDOC089 Message Handling System

EDOC090 Message Handling System - C library

EDOC091 Message Handling System - Commands

EDOC092 Spectrum Access Server—C library

EDOC093 Resource Sharing in EuroGam

EDOC094 EGlib

EDOC095 EuroGam Software Installation Manual

EDOC096 EuroGam Spectrum Access Server—Commands

Further Reading

EDOC097 Eurogam Tape Server

EDOC098 Autofill users manual

EDOC099 Technical Manual for High Voltage Server

EDOC200 High Voltage server manual

EDOC201 Rate Monitor technical manual

EDOC202 Tool Command Language

EDOC203 EG-Session: The Book

EDOC204 Eurogam II: The talk

EDOC210 Register Server implementation for CAMAC

ED0C212 Register Definitions for the FDT32 module

ED0C212 Register Definitions for the LeCroy 4300B ADC

ED0C213 Register Definitions for the Silena 4418/V ADC

Further Reading

ED0C214 (Charissa) Register Definitions for the RSM (EC592A)

EDOC215 (Charissa) Register Definitions for the LeCroy 2375 module

EDOC216 (Charissa) Register Definitions for the LeCroy 4208 TDC

EDOC217 (Charissa) Register Definitions for the Event Controller

EDOC218 (Charissa) Register Definitions for the LeCroy 2551 scaler

EDOC219 (Charissa) Register Definitions for the LeCroy 2277 TDC

EDOC220 (Charissa) Event Control Module User Manual