STATUS of DANTE, the Control System for DAFNE

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Abstract

DANTE (DAΦNE New Tools Environment) is the control system for the DAΦNE Φ-factory under construction at the Frascati National Laboratories of the Italian Institute for Nuclear Physics (INFN).

Commercial components have been used extensively: Macintosh™ computers are used throughout the system and LabVIEW®[1] has been chosen as development environment.

Three consoles and ten peripheral computers out of 60 have been installed successfully. The system is now ready for the commissioning of the first part of the accelerator complex.

I. DAΦNE

The DAΦNE accelerator complex [2] consists of a two ring colliding beam Φ-Factory, a 510 MeV e^+/e^- injector for topping-up and of a commercial LINAC operating at the same energy.

From the point of view of the peripheral hardware, the accelerator complex consists of about 1000 devices, which will be controlled by 5 consoles and 60 peripheral CPUs.

II. SYSTEM STRUCTURE

The system is divided into three levels (see Fig. 1):

PARADISE (PARAllel DISplay Environment) is the operator interface level. Several consoles, all equivalent, communicate with the rest of the system through high-speed DMA buses and fiber optic links.

PURGATORY (Primary Unit for Readout and GATing Of Real time Yonder) is the second level of the system. It contains two CPUs:

- CARON receives commands from the consoles and forwards them to the appropriate peripheral CPUs. CARON also uses a polling mechanism to check the status of the peripheral CPUs, relaying to the consoles any error and warning messages.
- LOGGER is in charge of saving the status of all the system elements as well as the log of commands and errors at definite time intervals or at operator request.

HELL (Hardware Environment at Low Level) consists of 60 CPUs distributed around the equipment in VME crates. Each CPU (DEVIL) reads the status and values of a set of elements, checking for any abnormal events and generating appropriate error messages. Every CPU contains a memory that is part of the Real Time database of the whole system. There is a record for every element and this is updated by the DEVIL whenever a significant change in the parameters is detected. These memories are accessed directly from the consoles through direct memory access, taking advantage of high speed buses which do not require any protocol, since all communication is effected through point-to-point links, without a network structure.

Interrupts are neot used anywhere in the system, increasing reliability end ease of debugging.

The structure of the system has been described in detail at ICALEPCS '93 [3].

III. LABVIEW

We have chosen LabVIEW as a development environment, because of the many advantages in human interface design and ease of programmingit provides. After we decided to use it on the consoles, we saw that it would also be extremely useful for the peripheral CPUs and we decided to build our own VME CPUs using the logic board of a commercial Macintosh (LCIII) and designing an interface to VME and VSB. This allowed us to have LabVIEW running on the whole system, with obvious advantages in simplicity and coherence.

LabVIEW has proven reliable and robust and perfectly capable of coping with the requirements of a large system.

110 MBytes of software have been written so far, and we expect the system to grow while new parts of the accelerator complex start functioning.

One of the strongest points in favour of this environment is the large amount of debugging facilities available. These we have found particularly useful during installation.

Speed is not one of the strongpoints of LabVIEW. Hoewever we have very rarely met problems where this is a limitation. In these few cases, such as saving a large cluster of data to memory, we took advantage of the possibility of implementing CINs, which are dedicated subroutines in C that use all of the power of the machine. This limitation will be much less important when machines with the new PowerPC CPUs will become available.

IV. MACINTOSH

The choice of the Macintosh computers has been helped by the large amount of expertise available in INFN on these machines. However, we have had no reason to regret the choice. A very large amount of extremely good and cheap software is available for the Macintosh and we have been easily able to take advantage of it.

TDM (The Diskless Mac) has been used to download the OS and the dedicated applications to all the peripheral CPUs, via ethernet. This makes the system much more controllable, since all of the peripheral software can reside on a single server.

TIMBUKTU is a program that allows one to take complete control of a remote machine (video, keyboard and mouse) through ethernet. We have extensively used this during debugging, to check on the behaviour of the peripheral CPUs from the consoles.

The migration path to the Power PC, which we have not yet used, gives the system the possibility of evolving easily with the growing hardware market.

In one particularly demanding case, where the time requirements where very strict, we have written a routine that effectively turns off all OS interventions on the CPU, giving the application program full control.

V. HIGH LEVEL SOFTWARE

We have developed an interface between LabVIEW and the "physics" environment, which consists essentially of a large body of FORTRAN programs written by the accelerator physicists. Two methods of operation are possible:

- to incorporate FORTRAN routines in a LabVIEW VI to perform complex calculations without rewriting the code;
- to allow access to the Control System from a FORTRAN program, to recover data from the Real Time Database on the peripheral CPUs and send commands to the system.

A large body of FORTRAN routines has been integrated and is available to the programmers, to insure software coherence throughout the many high-level applications that will be written. C is also available to the programmers.

VI. STATUS

We have installed the part of the system necessary for the commissioning of the LINAC, which will be the first part of the accelerator complex to start functioning.

Three consoles are operative, together with the second level (Purgatory) and ten out of the sixty peripheral DEVILs.

Work is in progress on the installation of the remaining parts of the system, firstly the transfer lines, then the Accumulator and finally the two rings. We expect to be able to anticipate the needs of the accelerator physicists throughout the whole commissioning stage.

VII. ACKNOWLEDGEMENTS

We would like to thank the Accelerator Group of the LNF for continuing discussions and encouragement.

VIII. REFERENCES

[1] LabVIEW® National Instrument Corporation, 6504 Bridge Point Parkway, Austin, TX 78730-5039
[2] G. Vignola et al., talk presented at the San Francisco Particle Accelerator Conference, May 1993.
[3] G. Di Pirro et al., DANTE: a control system based on Macintosh and LabVIEW, talk presented at the Berlin ICALEPCS '93.

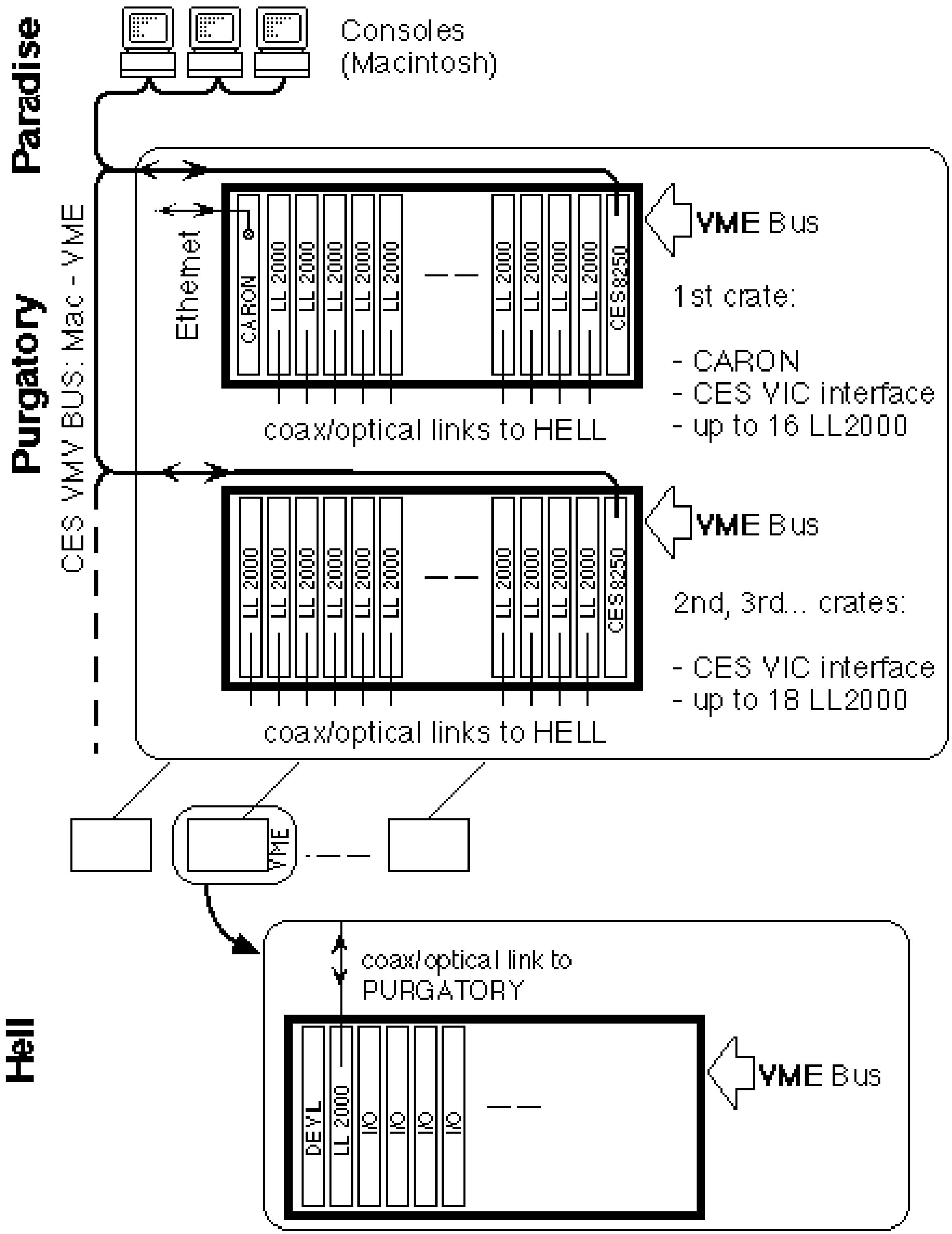

Fig. 1: Control System Schematic Diagram