Experience with the Integration of Transient Recorders in the Daily HERA Machine Operation

R. Bacher, M. Clausen, P. Duval and L. Steffen, DESY, Hamburg, Germany

Abstract

Many parameters of HERA machine components like RF systems or quench protection as well as important beam parameters and major parameters from the DESY utility installations are continuously measured by transient recorders. In general, these recorders are not synchronized among one another and sample the data with very different rates ranging from 200 Hz to 50 MHz. At present, work is going on to integrate the existing transient recorders into a global system.

The paper reviews the transient recorder hardware operated at HERA and the problems related to the integration of different types and systems. The proposed trigger distribution based on the HERA Integrated Timing system and a possible software trigger as well as the software concept to archive, retrieve and display the data - together with first results - will be described.

1 Introduction

The HERA accelerator complex is a proton-electron collider. A proton beam of more than 70 mA is injected at an energy of 40 GeV into a ring of superconducting magnets and accelerated to 820 GeV. Electrons are transferred to HERA at 12 GeV and ramped to 27 GeV using conventional magnets. Typical electron currents are about 40 mA. A successful fill remains stored in HERA about half a day. Less than 50 % of the time scheduled for physics experiments can be used for data taking. The remaining fraction is mainly dominated by the filling, ramping and tuning processes. In particular, the filling of protons takes a long time. Therefore, the most unfavorable situation in the daily operation of HERA is the loss of one or even both circulating beams. If the origin of the beam loss can be uniquely identified improvements of the machine operation or the technical components can be performed. However, a loss not understood contains the risk of a new loss during the following run. Besides a reduction of the running efficiency, losses can generate dangerous situations for the superconducting magnets and radiation-sensitive components close to the beam pipe of the physics detectors.

To identify the reasons for beam losses, many parameters of HERA machine components like RF systems or quench protection as well as important beam parameters are continuously measured using transient recorders. In general, these recorders are not synchronized among one another and sample the data with very different rates ranging from 200 Hz to 50 MHz. This lack of synchronization often does not allow us to disentangle the temporal or causal development of a beam loss. At present, work is going on to integrate the different existing transient recorders into a global system. In addition, a new universally usable recorder is currently being developed.

2 Existing transient recorder systems

The existing transient recorders have been already described in detail [1]. They consist of several independent developments of individual groups at DESY. These recorders vary in functionality as well as in performance. About hundred channels of the RF system and HV power supplies are read by PC-based fast ADC boards (Bakker BE 490). More than 1400 channels of the quench production system are read by special electronics in the HERA tunnel, transported through the CAN field-bus and VME CPU and stored on a file server. Other data originate from the post-mortem memories of the beam loss monitors, the beam orbit and the pulses of the kickers and septum magnets.

3 Integration of data sources

While some of the data are already stored on general accessible file servers, other data i.e. from Bakker boards typically are stored on the local disks of distributed PC's. To integrate these type of PC's the software support for the I/O boards has been rewritten to run under another operating system (here: VxWorks) to provide the necessary networking capability. This way the boards can be remotely managed and the data can be stored on a general file server. Additional transient recorders will be integrated in the same manner as well as new recorders currently under development.

4 Software architecture

Since the installed transient recorders are installed and supported by several groups at DESY using different ways to collect and to store the data, a mechanism had to be established to combine the freedom of independent data stores with the requirement to be able to read, plot and correlate the data by one (ore more) common application.

The resulting software architecture is based on the well-established PKTR/net protocol at DESY. This protocol uses the TCP/IP transport and supports asynchronous communications following the client server paradigm. (Fig. 1).

4.1 Central event server

To accomplish the main requirement of the transient recorder system: data correlation, it is necessary to keep track of timing information of the different data stored on disk. The central event server is designed with the following functionality:

- receive triggers from the HERA Integrated Timing (HIT) system

- receive requests for event numbers from archive servers
- generate event numbers (UNIX time stamp)
- after a trigger, or a request for an event number from one archive server, the event server will distribute the event number to all registered archive servers (including the one originating the request)
- store event number on disk
- receive acknowledgements from archive servers including information about stored device information
- add archive server-, device server- and comment-information to each event number
- keeping event numbers valid for a predefined time period (typically 4 sec)

In addition to the functions generating and storing event informations the event server has to communicate with the display applications to:

- provide stored event numbers within a given time period
- provide information about archive servers and device servers which stored data for a given event number

Besides these central functions the event servers keeps track of the currently connected archive servers, their names and the adjacent device servers.

4.2 Archive server

Besides the basic functionality to store the data of a transient recorder the archive server has to store additional information together with the data. These will allow identifying timing information as well as the hardware setup of the transient recorder itself. These informations will be necessary to display data from different recorders by means of a common display tool in the same diagram.

Archive servers support internal and external triggers to start an archiving process. If the archiver will receive an event number from the event server it will decide according to the additional event code whether this will cause a readout of the served devices. On the other hand the archive server will store data from auto-triggered devices and send a request for an event number to the event server, which in addition will inform the other archive servers by distributing the event number.

Similar to the support for client applications on the event server, the archive server has to provide detailed information for (display) clients:

- the event numbers for which data have been stored (redundant information to event server)
- the number and names of device servers
- the devices and their properties
- the setup data of the transient recorders
- the data itself

Some redundant functionality to the event server will be implemented on the archive server to be able to store, find and access the archived data without a running event server.

4.3 Client applications

Since the development of the transient recorder system is carried out by several groups at DESY, the goal is, to be able not only to share the applications for the event server and the archive server but also to use a common display application even though the individual groups use different platforms for their daily work. In this case the two major platforms for operator applications are workstations running MS-Windows and UNIX workstations with X-Window displays.

If PC-based X-Server are not applicable the obvious way to share applications between these two operating systems is to use a Web based application. It was agreed that the interactive features of the client application should

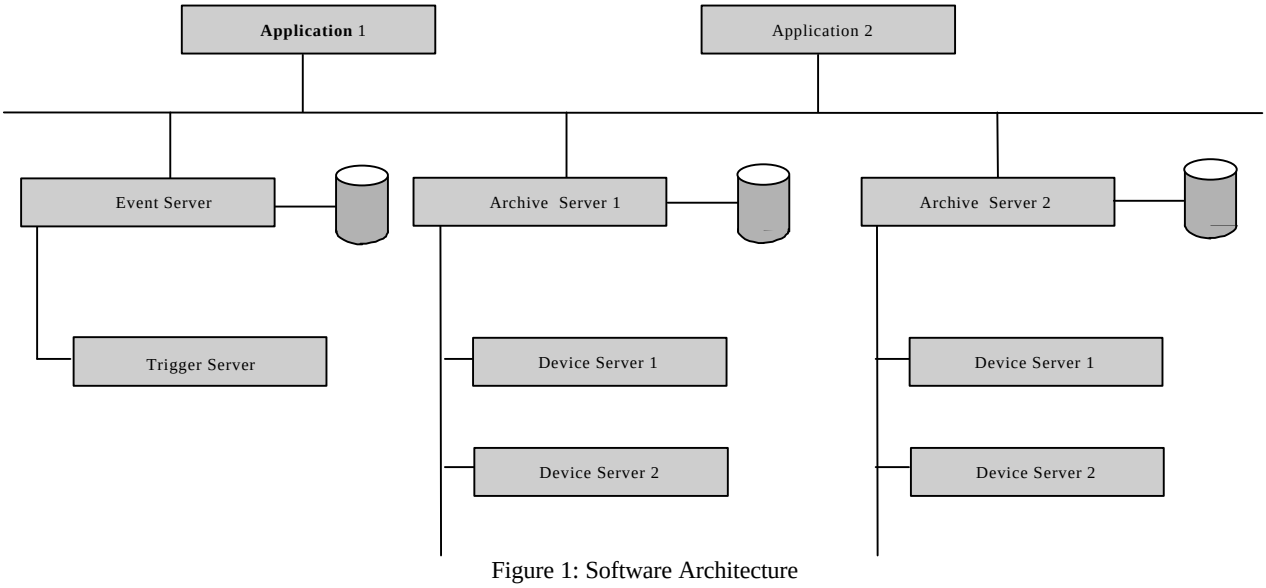

Figure 1: Software Architecture

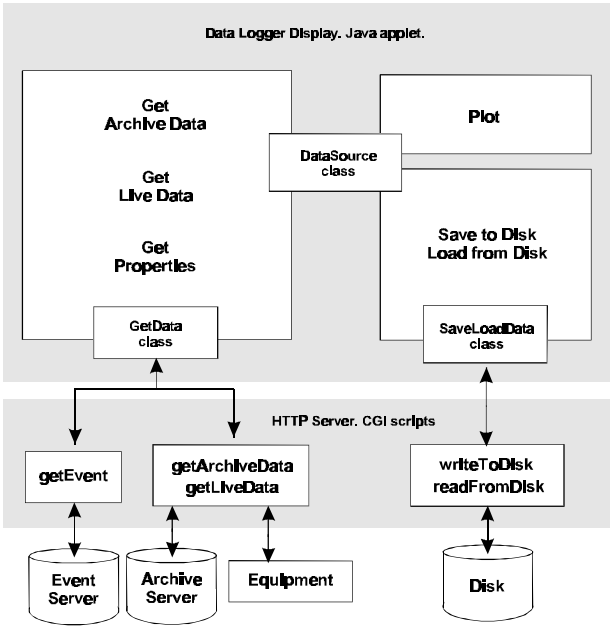

Fig 2: Client Application

be similar to a Visual Basic or Motif based program. Driven by these requirements a test was carried out to find out whether Java applets running under a Web browser would perform adequately. The proof of principle was possible with the Java-Class library from KL-Group for the charts and the Symantec Cafe development toolkit for Java. Even though the functionality running a Java 1.1-applet under different Web browsers and different versions showed astonishing results the performance was promising. Hoping for a reliable implementation of the fundamental Java classes in all common Web browsers it was decided to implement the client application completely in Java.

The data transport between the Java applet and the data servers is initially implemented in a CGI on the Web server from which the applet is loaded. In the final implementation of this communication the CORBA transport will be implemented. First test have already shown that this will lead towards better performance and more flexibility for the location of the data servers

The initial functionality of the client application can be summarize as follows (Fig. 2):

- A display to be able to select a certain time period in which the user is interested.
- Communication with the event server to retrieve the event numbers registered within the given time period including the informations about the archive- and the device server, which stored data for the event numbers.
- A display for the resulting informations from the event server and the possibility to select an individual device server to get more detailed data about the channels and their properties stored on the archive server.
- Communications to the archive server to extract device informations and to retrieve the stored data.
- A chart to display one or more data sets from one or more different archive servers.

In addition to the possibility to display data from the archive server it was found to be useful to display also online data from the running equipment. This function has also been implemented.

In the next step the settings of the chart including the channel properties will be stored on a common disk to be able to retrieve previous setting in a new session.

5 Status and outlook

The software modules for the event server have been implemented and tested. Several archive server have started operations shortly before the end of the 1997 HERA run and write their data to a central file server. The interface programs for the event server and the archive server are implemented and need final testing.

The client display program has been implemented in Java and tested with the event server. The initial version of the display program is running and collecting data through a CGI on the Web server. More functionality will be implemented in the display program and tested against more device and archive servers as they come online.

It is planned to use CORBA as a transport for the Java applet before the next HERA run in April 1998.

References

[1] R. Bacher, M. Clausen, P. Duval and L. Steffen: “The Usage of Transient Recorders in the Daily HERA Machine Operation” PAC-97 Vancouver