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Development of new mass data acquisition system for diagnostics on JT-60U

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Abstract

On JT-60U, two mass data acquisition systems have been acquiring 91 channels of fast-sampling diagnostic data. They are, however, based on rather outdated bus standards and now difficult to update. Therefore we have developed a new mass data acquisition system that has more flexibility and ability to perform a faster data acquisition based on a modern bus standard. The system consists of PXI-based (PCI extensions for instrumentation) digitizers connected to controller PCs, and a server for collecting and processing data from these PCs and transferring them to the main diagnostic computer. Up to now, we have verified that the system acquires 27 channels of data that amounts to 2.2 GB in total, from 3 controller PCs, at a sampling rate of 1 MS/s in a 45 s discharge.

Keywords: JT-60U; Diagnostic data processing system (DPS); TMDS; FDS; MDAS; PXI

1. Introduction

The mass data acquisition systems, TMDS (transient mass data storage system) and FDS (fast VMEbus data acquisition system), are the subsystems of the JT-60U diagnostic data processing system, and have been acquiring 91 channels of fast-sampling data [1–4]. However, they are based on rather outdated bus standards, such as VMEbus and SBus, and now difficult to update. Therefore, we have developed a new mass data acquisition system (MDAS) that has more flexibility in configuring and expanding the system, and ability to perform a faster data acquisition, based on a modern bus standard [5].

The new system consists of modular PXI digitizers widely-used in PC-based measurements, PCs for controlling these modules, and a server for collecting and processing data from controller PCs and transferring them to the main diagnostic computer.

In Sections 2 and 3, we discuss issues to be solved on the current mass data acquisition system, and required specification on the new system, respectively. In Section 4, we report the results of performance test on the new system. Lastly, summary and future plan are given in Section 5.

2. Issues to be solved on the current TMDS/FDS

Currently operating mass data acquisition system consists of five workstations: TMDS (#1, #2 and #3), FDS (#1 and #2). Each workstation controls one or two VMEbus chassis via SBus/VMEbus converter, and each chassis holds VME-based ADC modules. At its maximum, about 1500 MB of data can be acquired with 91 channels of diagnostic ADC at a sampling frequency of 200 kHz (partially 1 MHz) in a 65 s discharge.

Due to the recent progress in fusion plasma research, there is a growing demand for mass data acquisition.

But the current TMDS and FDS systems were developed in 2000 and their buses (VMEbus and SBus) and operating systems (Solaris 2.4 and 2.5.1) are now rather outdated and difficult to update. Moreover, their record format originated with a tape-recording device named mass data recorder (MDR) back in 1985 when the experiment on JT-60 started. They also use a CAMAC-based format conversion module named IMDR, and custom optical transmitter and receiver modules. Likewise, the memory module for data acquisition, named MDMV/A, uses the IMDR's special frame format.

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All of these obstacles make the updating of the current mass data acquisition system very difficult. And to meet the demand for detailed diagnostic data, we have to minimize down time, which also means large modification to the current system at a time is unrealistic.

3. Specification of the new mass data acquisition system

In order to accommodate the growing demands for mass data acquisition, we first considered the expansion of the current system. But to utilize the existing system resources, we would have needed special interface, which would have been far from cost-effective.

Next, we investigated the possibility of using YOKOGAWA'S WE7000 data acquisition system, but abandoned this choice because it used YOKOGAWA's proprietary bus and the module lineups were insufficient to cover the various kinds of existing diagnostic systems.

We thought the tightly bound closed nature and use of custom modules were obstacles to expansion and cost reduction of the current system. Therefore we decided to build a completely new system that was based on open architectures and widely used industry-standard devices.

Furthermore to make the system simpler and more flexible, we assigned data acquiring function and data collecting and processing function to separate machines.

As for the data acquiring part, we decided to employ ordinary PCs equipped with PXI-based modules because of the following reasons:

- All diagnostic systems can upload data with the same mechanism (standardization).
- Adoption of industry-standard hardware and software (generality).
- Capable of combining other manufacturers' equipments (compatibility).
- Adoption of easy-to-use LabVIEW program, with which all persons in charge of diagnostic systems can easily develop or modify their programs (transparency).
- Adoption of commercially available products (low-cost).

Hereafter we call this PC-based data acquiring part MDAS-PC. The schematic picture of the new mass data acquisition system is shown in Fig. 1.

Actual MDAS-PC consists of Windows PC such as National Instruments' (NI) PXI-8350 (Pentium 4, 3 GHz, 1 GB RAM) or DELL's Precision (Pentium 4, 3.4 GHz, 2 GB RAM), PXI-based transient memory type ADC modules such as NI's PXI-6133 (1 MS/s, 14 bit resolution, 8 channels per module), and optical communication modules such as NI's PXI-8336.

As for the data collecting and processing part, we employed a UNIX workstation named MADS-SVR. The roles of MDAS-SVR are as follows: MDAS-SVR first waits for "the end of discharge sequence" signal from diagseq, which distributes discharge sequence information via LAN. Upon receiving this signal, MDAS-SVR collects data from each MDAS-PC using FTP.

After attaching index data (data length, sampling rate, resolution, maximum and minimum of input signal) to the collected data, MDAS-SVR transfers the data to UNIX-ISP, which is the main server of JT-60U's diagnostic data processing system (DPS), using JT-60U's standard network experiment data base (NEDB) protocol.

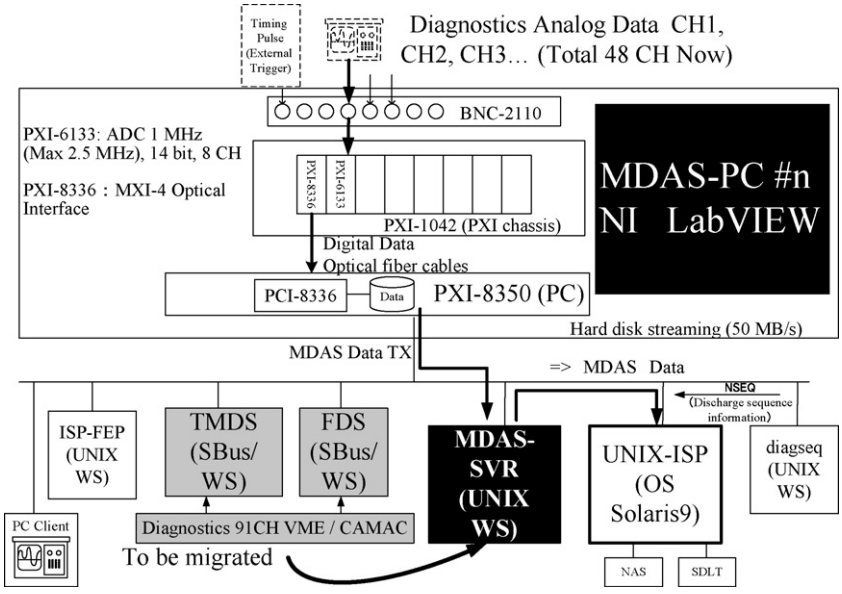

Fig. 1. Outline of New MDAS: MSP-ISP—UNIX-ISP, inter shot processor (UNIX OS); SDLT, super digital linear tape; ISP-FEP, inter shot processor-front end processor (for users); NAS, network attached storage; TMDS, transient mass data storage system; FDS, fast VME data acquisition system; diagseq, interface computer for discharge sequence between the UNIX-ISP, and JT-60 supervisory control systems; MDAS-Server, mass data acquisition system-server; MDAS-PC, controller-PC.