Received by CST

UCRL-93881
PREPRINT

MAR 24 1986

CONF

UCRL--93881

DE86 008016

The TMX-U Computer System in Evolution

T. A. Casper, H. Bell, M. Brown, M. Gorvad,
S. Jenkins, W. Meyer, J. Moller, and D. Perkins

This paper was prepared for submittal to the
Proceedings of the 6th Topical Conference on
High Temperature Plasma Diagnostics, American
Physical Society, Hilton Head Island,
South Carolina, March 9-13, 1986

March 4, 1986

Lawrence
Livermore
National
Laboratory

This is a preprint of a paper intended for publication in a journal or proceedings. Since changes may be made before publication, this preprint is made available with the understanding that it will not be cited or reproduced without the permission of the author.

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

THE TMX-U COMPUTER SYSTEM IN EVOLUTION

T. A. Casper, H. Bell, M. Brown, M. Gorvad, S. Jenkins,

W. Meyer, J. Moller, and D. Perkins

Lawrence Livermore National Laboratory, University of California

Livermore, CA 94550

ABSTRACT

Over the past three years, the total TMX-U diagnostic data base has grown to exceed 10 megabytes from over 1300 channels; roughly triple the originally designed size. This acquisition and processing load has resulted in an experiment repetition rate exceeding 10 minutes per shot using the five original Hewlett-Packard HP-1000 computers with their shared disks. Our new diagnostics tend to be multichannel instruments, which, in our environment, can be more easily managed using local computers. For this purpose, we are using HP series 9000 computers for instrument control, data acquisition, and analysis. Fourteen such systems are operational with processed format output exchanged via a shared resource manager. We are presently implementing the necessary hardware and software changes to create a local area network allowing us to combine the data from these systems with our main data archive. The expansion of our diagnostic system using the parallel acquisition and processing concept allows us to increase our data base with a minimum of impact on the experimental repetition rate.

I. INTRODUCTION

During the past three years, we have operated the Tandem Mirror Experiment-Upgrade (TMX-U) to explore different regimes of performance for a thermal-barrier tandem mirror. This required use of several different diagnostics and, thus, a large expansion of our data acquisition over the design specifications. To respond to the ever increasing demand for diagnostic information, our original centralized computer system for data acquisition and processing for all instruments has evolved to a system that includes a distributed set of "instrument control computers" forming the basis for "smart" diagnostics.

The original TMX-U data acquisition system was configured from five Hewlett-Packard (HP) 1000 computers operating with 390 megabytes of shared disk (which has been expanded to 720 megabytes at present). This system was designed to acquire and process up to 2 megabytes of data from 400 channels, while maintaining an experimental shot repetition rate of less than 5 minutes. (This limit is set by other system parameters, i.e., magnet-cooling and power-supply-charging times.) For the first year, improvements in the data base system kept pace with the increased data demand resulting from rapid diagnostic development. As a result, we maintained a shot cycle of less than 5 minutes.

After this early period of operation, we found that the detailed physics experiments required considerably more instrumentation than originally anticipated; consequently, the data acquisition and computational capabilities of the system were strained. Within three years, the total diagnostic data base grew to exceed 10 megabytes from over 1300 channels; a factor of three over the design specification. The central shared-disk system accounts for

6 megabytes of data and has a repetition rate in excess of 10 minutes with the major limits set by the time involved in accessing the disk (the data base tends to be disk-access intensive) and in outputting hardcopy plots. Improving the CPUs, adding a solid-state memory, adjusting the run-time task-priority structure, and limiting the intershot production of hardcopy plots allows us to hold the acquisition and processing time to 10-15 minutes on the average. This appears to be close to our limit for the existing data-base structure at the 6 megabyte level.

II. DIAGNOSTICS WITH SATELLITE COMPUTERS

Simultaneously with improvements to the main data system and motivated by our need for additional data, we began operating some diagnostics with HP series 9000 instrument-control computers. These computers are well-suited to real-time data acquisition, analysis, and control. Those diagnostics having either a large volume of raw data, or a significant control requirement were initially singled out for operation as "satellite" data-acquisition systems. The plasma-potential diagnostic (PPD, an ion-beam probe), an extreme ultraviolet spectrometer (EUV, an instrument from Johns Hopkins University), and the end-loss ion spectrometer (ELIS) are prime examples.

Having achieved reasonable success with these early endeavors, we began to install most of the new diagnostics with their own dedicated computers. We presently have 14 such diagnostics operational, providing an additional 7.5 megabytes of data as indicated in Table I. Some advantages of these systems are as follows:

1. Flexibility and mobility of the diagnostics since they are self-contained units with their own data acquisition and analysis capabilities--a smart diagnostic.
2. Hands-on operation of the instrument and data--the physics staff has greater ability to interact with the data/instrument in real time as compared with those systems in the central computer.
3. Parallel acquisition and processing providing "unlimited" expansion without sacrificing the shot-repetition rate.

There are, however, a few drawbacks from such a system:

1. Local data bases proliferate with no centralized control; we have lost our common data base.
2. Control over and integrity of the software is more difficult to manage.
3. Relatively few members of the physics staff can directly access the data.

It is our opinion, however, that the positive aspects far outweigh any of the potential drawbacks.

III. THE DISTRIBUTED SYSTEM

We still need a common data archive to allow for data comparisons and correlations. For this reason, we are implementing a shared resource management scheme, which is presently constructed around HP's SRM (Shared Resource Manager), to network these satellite systems. The throughput of this off-the-shelf system is about 30 kilobytes/s, too slow for a large volume of data. Therefore, we archive the raw data locally and pass only highly processed data through the SRM to a central computer for tape archival and

correlation-type analyses. A block diagram of the networked computer system is shown in Fig. 1. Note that the new central computer (the HP 1000A) has access to the shared disk of the original computer system and that this constitutes a fast data link between these systems. All (processed format) data is assembled into a global data file in this central computer, where additional processing can be done along with hardcopy and tape archival.

At present, we have implemented only file transfer to the central computer and have not yet implemented the data base. We will be bringing up those portions of the data base that are operating on the shared-memory system and are required for data archival, plotting, and hardcopy. This will be done during our next TMX-U machine-maintenance cycle starting this month (March 1986). Currently, we are transferring a few critical files of data from selected satellite systems through the SRM and the central computer to the original shared-disk system. We are able to do this automatically and within the 10 minute shot cycle. We have thus validated operation of most (slow) links between the various computers and use them routinely and reliably. The transfer speed and processing capabilities will increase considerably when our high speed links are available along with the data-base software on the central computer. Once we have completed this local area network for our HP computers, we will extend it to communicate via fiberoptics to our User Service Center computers.

IV. SUMMARY

Having experienced a rapid and substantial growth of the TMX-U diagnostics data base, we implemented a distributed data acquisition and processing system allowing us to further expand our diagnostic system without

erosion of the experimental shot-repetition rate. We have a local area network connecting various satellite computers that form the basis for intelligent, mobile diagnostics with a limited amount of file transfer capability. We are presently completing the necessary hardware and software modifications that will allow us to have a full local area network consisting of all 14 diagnostic systems currently operational, using the HP-9000 instrument control computers and the original HP-1000 shared-disk system for a total of 13.5 megabytes of data per shot within a 10 minute cycle. This system will then be linked to our User Service Center to expand our off-line and possibly our on-line computing capabilities in that facility.

ACKNOWLEDGMENTS

This work was performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under contract number W-7405-ENC-48.

PW602043/MM

Table 1. Diagnostic systems using satellite computers for data acquisition, analysis, and archival.

Diagnostic	HP-computer	Data size	Channels/comments ^a
Plasma potential diagnostic	9836	32 K ^b	4
22-channel extreme UV	9920U	16 K	22
1024-channel EUV	9836	32 K	1024
Fast video camera	320	1 M ^c	Typically digitized
Video (or IR) camera	9920	200 K	Many frames digitized
Secondary electron detectors	9920U	32 K	16
Fluctuation diagnostic	9920U	128 K	4
X rays	520	286 K	6
X-ray camera (under development)	9920U	4 M	Images
Ion gauges	9920U	1.7 M	9
	9816	64 K	4
End-loss ion spectrometer	9836	256 K	128
	9920U	256 K	128
Time of flight	520	<u>500</u> K	1
TOTAL 7.5 M			

^aTotal data available on video tape is 120 megabytes of which about 6 megabytes include plasma data of interest. The value indicated corresponds to the volume of data typically digitized and analyzed.

^bK = kilobytes.

^cM = megabytes.

FIGURE CAPTION

Figure 1. Block diagram of the TMX-U computer with the local area network.
Broken lines indicate communication paths under development.

T. A. Casper et al. - Figure 1