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Datacomputer Support of Seismic Data Activity

Quarterly Technical Report

May 1, 1976 to July 31, 1976

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1. Summary

The purpose of this project is to provide seismic data storage and retrieval services. These services are to be provided via the Datacomputer being developed and maintained by Computer Corporation of America (CCA) for ARPA under a separate Contract No. MDA903-74-C-0225. The seismic data is to be received over the Arpanet and made available to computers on the Arpanet in a convenient and timely manner.

To provide the requisite services the Datacomputer has been augmented by a mass memory system to provide additional storage and by a small Seismic Input Processor (SIP) to continuously collect real time data over the network, reformat and buffer it, and periodically dump it into the Datacomputer. An Ampex Terabit Memory System (TBM) with a capacity of almost two hundred billion bits has been installed at CCA as the mass memory system. A DEC 11/40 computer with RP04 disks and an Arpanet interface has been purchased as the SIP. The SIP is installed and operational. Development continues on SIP enhancements.

Project activity can be divided into four categories: (1) SIP development and network bandwidth considerations; (2) coordination with the seismic community; (3) TBM acquisition and integration into the Datacomputer; and (4) seismic related Datacomputer development. One section below in this report is devoted to each of these categories.

2. The SIP and Arpanet Considerations

Seismic array data is collected from the SDAC Communications

and Control Processor (CCP) over the Arpanet, buffered, and reformatted, all by the CCA Seismic Input Processor (SIP) which retransmits the data to the Datacomputer. The SIP is equipped with disk storage adequate for twenty-four hour buffering of a 15 kilobit per second data stream.

2.1 Operations

The SIP was operational for most of the months of May, June, and July. Real seismic array data was continuously buffered by the SIP, reformatted, and periodically written into test files in the Version I Datacomputer and later into files in a developmental Datacomputer. Because these Datacomputers used disk storage, the test files were only a few hours long and data was shortly overwritten by newer data. CCP status was also stored during this period and its smaller volume meant that it could be stored and saved in normal files, without overwriting.

Toward the end of July, during the TBM acceptance test, real seismic data and status information were stored for several days by the developmental Datacomputer on TBM tape.

A preliminary SIP Operator's Manual has been prepared and distributed.

Improvements were made in the SIP during the reporting period as described in Section 2.3 below.

2.2 Arpanet Difficulties

For proper Datacomputer support of seismic data activity, high Arpanet bandwidths are required. The Arpanet should in general be able to provide these bandwidths; however, considerable

difficulties have been encountered. It should be pointed out, concerning the discussion below, that Arpanet bandwidth problems are not within CCA's purview. CCA must rely on those responsible for Arpanet operation to provide the required service.

The most intractable network problems encountered are due to limited assembly buffers at the CCA IMP. These problems were detailed in our Quarterly Technical Report covering February 1, 1976 to April 30, 1976.

During the quarter covered by this report, a new network system was distributed to all IMP's which further reduced the inadequate number of reassembly buffers at CCA. (This new network system also required some very minor changes in the SIP software.) Compensating for this, the traffic level to the SIP from the SDAC CCP was reduced by termination of data from the ALPA seismic array and by correction of a problem in the SDAC PLURIBUS IMP, which had previously retained allocation of excessive buffers in the CCA IMP and did not use or release them.

Besides high reassembly buffer requirements, the high bandwidths from the SIP to the Datacomputer along with other traffic require considerable processor power in the CCA IMP.

These problems will become increasingly severe as the seismic traffic grows and the only long-term solution appears to be the installation of a higher capacity IMP at CCA, presumably an appropriately configured PLURIBUS IMP.

2.3 SIP Software

During the last quarter, several enhancements have been made in

the SIP software. The most significant of these relate to disk failure robustness and improved techniques for writing seismic data into the Datacomputer.

2.3.1 Disk Failure Robustness

Prior to this improvement, the SIP could not survive the sudden failure of a disk it was currently accessing. This is undesirable since the SIP has two disk drives and could continue on the other drive. The SIP code was modified to recover from disk failures or from manual intervention at a disk drive (such as manually write locking a disk while the SIP is writing on it). The SIP will transfer buffered data from a write locked disk to the Datacomputer but will not try to write new data on the disk. The SIP was also changed so that it responds properly to interrupts caused by changes in a disk's availability status. The SIP was further modified to probe the disks periodically to detect other status changes which do not cause interrupts.

2.3.2 Improved SIP-Datacomputer Transmission

In the past, the SIP transferred data for all files for one hour before writing any data for the following hour. This caused a reference pattern characterized by switching rapidly from one large file to another.

In a TBM based Datacomputer, rapid references to many large files may cause thrashing and excessive staging delays. Since parts of the files will normally be staged to secondary storage, it is best to make many references to one large file before going on to the next. The SIP code was modified so that when more than one hour of buffered data was present it would send the data intended for one Datacomputer file for several hours,

then advance to data intended for the next Datacomputer file, rather than sending all the data for one buffered hour before advancing to the next buffered hour.

Another problem with past SIP/Datacomputer interaction was the practice of initializing complete files with default values so that data could be added via an update in place. The complete initialization of seismic files would be a very lengthy process for some of the planned monthly files. In addition, the Datacomputer can now append to the end of a file as efficiently as it can update in place. For these reasons, and since the seismic data is normally written by the SIP in chronological order, the SIP code was modified to append data to seismic files wherever possible. In the case of gaps in the data, the gap area is filled with default values and when the missing data arrives, an update in place is performed.

2.3.3 CCP Changes

A new version of the CCP was brought up during this quarter. This impacted the SIP because the CCP began sending an extremely high volume of status messages mixed with bad checksum data messages. Appropriate defensive modifications were made in the SIP.

3. Coordination with the Seismic Community

CCA continued to cooperate with VSC and SDAC in the retrieval of real seismic data available from test files in the developmental Datacomputer. Jerry Farrell of CCA assisted the Lincoln Laboratories ASG in planning for seismic data use.

CCA also continued to assist SDAC in developing files that will be written directly by SDAC (i.e. this data will not be routed through the SIP). These are anticipated to be the ILPA data files, event summary files, seismic waveform files, and the instrument status and calibration file. Problems were encountered with the event summary file due to a table (the "do stack") size limitation and limits on maximum description length in the Datacomputer. These were overcome by increasing the size of the table and by making minor changes to the event summary file description.

4. The TBM

An Ampex Terabit Memory System (TBM) is being integrated into the Datacomputer to provide the required large amount of on-line storage. The TBM has required site modifications at CCA.

4.1 Site Preparation

All site work for the TBM at CCA is now complete.

Problems with the humidifier component of a new Trane air conditioner which were reported last quarter have been overcome.

4.2 Acceptance Testing

Agreement on the TBM acceptance test procedure was reached in June, after protracted negotiations. The test was completed on July 31. The TBM hardware performed very well during this test, exceeding the acceptance criterion by a considerable margin. All four drives were used and 253,295 seeks, 179,767 block reads, and 31,022 block writes were performed. No bad tape blocks were

encountered, all data written out was easily retrieved, and there was no unscheduled system down time for hardware reasons.

There were, however, a number of software problems encountered which resulted in some down time. By agreement with Ampex, partial payment is being withheld pending fixes to these software problems. Additional funds are still being withheld pending installation of certain software TBM features required for convenient TBM operation at CCA.

5. The Datacomputer

The seismic related Datacomputer work this quarter involved preparation for use of the TBM and initial efforts toward implementation of the file groups feature.

The large size of TBM blocks led to space shortages in the virtual memory of Datacomputer subjobs. Temporarily, buffers assigned to inversion information were used, making the inversion feature and TBM usage incompatible. The problem was solved by implementing a new set of inferior forks under the Datacomputer subjobs to increase the available virtual memory.

A feature was added to the Datacomputer to permit the assignment of all newly allocated space in a sub-tree of the Datacomputer directory to a particular TBM tape reel. Operator commands were added for activating this feature and setting such volumes. This capability permits greater manual control of the allocation of large files to TBM reels.

On July 1 work began on implementation of the file group feature.

This enhancement gives the user control over how to break up large volumes of data into physically smaller and more manageable units. Each unit can be individually accessed, dumped, validated, etc. At the same time, the user can create one or more groups out of a subset of these logically related units or subfiles. When a request is issued on a group, the system decides which subfiles must be accessed.

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