CREWES computer systems*

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ABSTRACT

This paper describes the computer systems and software used by the CREWES Project. The primary processing system, based on Sun hardware, is discussed in detail. This paper also mentions some of the PC based geophysical and mathematical processing packages used in research. Microcomputers and software used in generating the annual CREWES Research Report are also discussed. After a description of the CREWES network, the paper ends with two lists that detail the project's hardware and software.

INTRODUCTION

The CREWES Project's computer systems are an integral part of the project's research facilities. The primary uses of our systems are seismic data processing and research. We use a variety of hardware and software combinations to aid in our research, and actively pursue new hardware and software solutions to common geophysical problems. In cases where no solutions exist, our research involves developing new software. A secondary use of our systems is to aid in the preparation of papers and documents, such as the annual CREWES Research Report.

SUN SYSTEMS

The computer system that CREWES researchers primarily use is a cluster of networked Sun computers. This cluster contains seven Sun Sparcstation 2's, one Sun Sparcstation 1+, and one Sun Sparcserver 670MP. Six of the Sun Sparcstation 2 workstations are used by the University of Calgary's Department of Geology and Geophysics for teaching geophysical processing. Thanks to the cooperation of the department, these systems are available for CREWES researchers during off-peak hours. The largest Sun computer, the Sun Sparcserver 670MP, also belongs to the department.

The cluster is configured to make the user environment as consistent as possible from one workstation to another. The Sun system is set up with one server system (Sparcserver 670MP) and a number of ancillary workstations (Sparcstation 2's). The server system has the largest and fastest disk drives. These are used to store application programs, user files, and large datasets. Seismic data processing makes heavy use of disk I/O. To reduce the load on the network and improve I/O performance, each of the workstations has a 700 megabyte disk drive attached. These disk drives serve as data work space and provide additional swap space that is required by seismic processing

* This paper is a revision of previous years' computer systems reports by Howell & Bland (1991) and Bland (1992)

software. Since each workstation has its own CPU and disk, individual workstations are unaffected by the processing on other workstations. To make the user environment consistent, all our Sun systems use NFS (the Network File System) to make users' files available network-wide. With the aid of a program called the "automounter" users' files are made to appear local to the system, regardless of whether they reside on the local system, or are connected via network. This network transparency greatly simplifies the use of the system.

SEISMIC SOFTWARE PACKAGES

Advance Geophysical

The CREWES Project just completed an agreement with Advance Geophysical to obtain a number of their software products. ProMAX is Advance's seismic processing system for networked UNIX environments. This software permits interactive and batch processing, with modules that handle steps from demultiplexing to plotting final sections. It includes statics analysis, velocity determination and seismic imaging for 2-D. Advance's soon-to-be-released 3-D processing software will also be supplied, as well as their VSP processing system.

Landmark / ITA

The primary seismic processing packages that run on the Sun systems is currently Landmark/ITA's "Insight". Portions of the software package support a graphical user interface, while other parts are driven by text files containing processing commands. The software provides field tape demultiplexing, pre-stack and post-stack processing, 3-D processing and a variety of interactive picking and display modules. It is capable of processing at high speed, by using a powerful math coprocessor board. This coprocessor, made by CSPI, uses an Intel i860 RISC chip and is capable of 80 million floating operations per second. Although most Insight routines run with or without the coprocessor, it is required for demultiplexing.

Landmark / LGC

Over the past five years Landmark/LGC has donated hardware and software to the University under its University Industry Partnership Program. Landmark continues to support CREWES by providing its latest software releases for the Sun platform. CREWES runs these packages on a dedicated Sun Sparcstation 2 with two 19 inch colour monitors.

Among the software products we have received from Landmark are SeisWorks/3D, SeisWorks/2D, Stratworks, LogEdit, and SyntheSeis. SeisWorks/3D and SeisWorks/2D are seismic interpretation packages used for horizon picking, fault interpretation and correlation, seismic attribute analysis, and data display. Using SeisWorks one can display data with contours, in time slices, and with 3-D perspective. StratWorks is a geologic interpretation package used for stratigraphic correlation of well logs. With it, one can create cross sections, contours, and maps of picked horizons. The last two packages, LogEdit and SyntheSeis, perform well log editing and synthetic seismogram generation, respectively. The CREWES Project will shortly be receiving the recently-released 3DVI and Surfcube software.

On the now discontinued Landmark RT we run "2D Plus", "3D Plus" and "UNISEIS". 2D Plus and 3D Plus perform interactive interpretation of 2-D and 3-D stacked seismic sections. The UNISEIS modeling package performs 2-D modeling using a variety of geometries. Crosshole, VSP, and multi-component seismic have all been modeled on UNISEIS and then processed using CREWES processing systems.

Hampson / Russell

Hampson-Russell Software Services donated their AVO, STRATA, and GLI3D software packages for Unix. These versions use the OSF/Motif interface and multiple windows for improved usability. The AVO program from Hampson-Russell is an interactive pre-stack AVO analysis and inversion package. It allows well-log plotting and editing, synthetic model building and AVO inversion. STRATA is an interactive post-stack stratigraphic analysis and inversion package, which allows model building, wavelet extraction and seismic inversion. Both AVO and STRATA include a processing module to allow post-stack processing, display and hardcopy output. The GLI3D package creates a near-surface geological model which is used to calculate static corrections for 2D and 3D datasets.

Petcom

Petcom Software and Services has provided their well log analysis package, LAS. This program runs on IBM PC compatible systems and can edit logs, create crossplots and perform petrophysical analysis, including porosity, water saturation, complex lithology and shaliness estimations.

Jason Geosystems

Jason Geosystems is providing their DSite and Integrate software products. DSite is an interactive velocity modeling tool based on generalized inversion theory. By combining seismic,well logs, and geology, DSite creates an interval velocity model that is consistent with both the input data and the geology.

"Integrate" allows the user to tie a well log to seismic data, and perform wavelet deconvolution. The data can be inverted using sparse spike or recursive trace inversion to create a detailed acoustic impedance model. Geological constraints can also be applied to the model to provide estimates of porosity, pay, and lithology.

GMA

Last year, GMA donated six complete GMA Explorational Software Systems to the University of Calgary. This software runs on PC-compatible systems and is available to CREWES researchers through the facilities of the Department of Geology and Geophysics. Their system includes the packages: STRUCT, LogM, Wave-X, and GrITS. Two of these packages, STRUCT and LogM, are modeling systems – one for structural modeling, and one for stratigraphic modeling. Wave-X is a wavelet extraction program that can interactively extract shaping or matching filters. The final program, GrITS, is used for stratigraphic interpretation of 2-D seismic data.

ADDITIONAL PC BASED SOFTWARE

Although our primary scientific workstations are Unix-based, there are also a number of excellent MS-DOS based software packages which we use. Hampson-Russell's AVO and Strata and SIS's Vista and FDTools are examples of such geophysical packages. A number of others are listed in the software list at the end of this paper. The project also uses PC and Macintosh based packages for performing mathematics, statistics and graphing. One of the most popular Macintosh packages we use is Deneba's Canvas. This software is used for making drawings for the CREWES Research Report, as well as slides and overheads for the annual CREWES sponsors' meeting and tutorial day. Our most heavily used PC programs, however, are word processors.

Document preparation

Each year the work of the CREWES Project is summarized in its research report. The report is a very complex document, with contributions from a large number of authors. Each contributing paper typically includes diagrams, plots, pictures and tables. In an attempt to simplify the management of this document and to ease its assembly, we have attempted to produce as much of the report as possible by computer. Having an electronic copy of the report enables us to archive the report in a form that won't degrade over time. This permits us to make first-generation quality reprints of papers.

The majority of the report is prepared on Apple Macintosh computers using Microsoft Word and Aldus Pagemaker for word processing. Many of the diagrams are produced using Deneba's Canvas drawing package, while most graphs are produced by Cricket Graph or Matlab. Some of the other images were scanned from paper originals using a flat-bed scanner and Adobe Photoshop software. A smaller portion of the report was generated using PC word processing packages, such as Wordperfect and MS Word for Windows.

In the past year we have attempted to streamline our electronic archival of the CREWES research report. The ultimate goal is to distribute and archive the entire report on CD-ROM. At this point we have set up a system in which papers are archived on a single hard disk connected to our Sun cluster. Using the Macintosh's built-in network file sharing, our Macintosh computers are able to access this disk to retrieve archived papers. Our primary stumbling block has been the storing of photographic and seismic figures. When digitized, they tend to take up a great deal of room and the scanning (digitizing) process is a slow, painstaking procedure. It is hoped that developments in scanning hardware and software will allow us to reach our goal of full electronic archival in the near future.

NETWORK

Due to the distributed nature of our data processing facilities it has been vital that all our systems communicate easily and rapidly. To reach this goal we use an Ethernet based network running two common networking protocols: IP (TCP/IP) and Appletalk. These support features such as file sharing, remote system access, printer sharing and electronic mail.

The CREWES Project makes use of the LAN (local area network) running throughout the department of geology and geophysics. This LAN is connected to the Internet: a network that connects most Canadian and American universities as well as commercial organizations and research organizations around the world. Network access is made possible through a connection to the University of Calgary's network, which is part of Internet. This connectivity allows us to exchange information and data with others doing research in similar fields. Internet has also been very useful for obtaining free software developed at other universities.

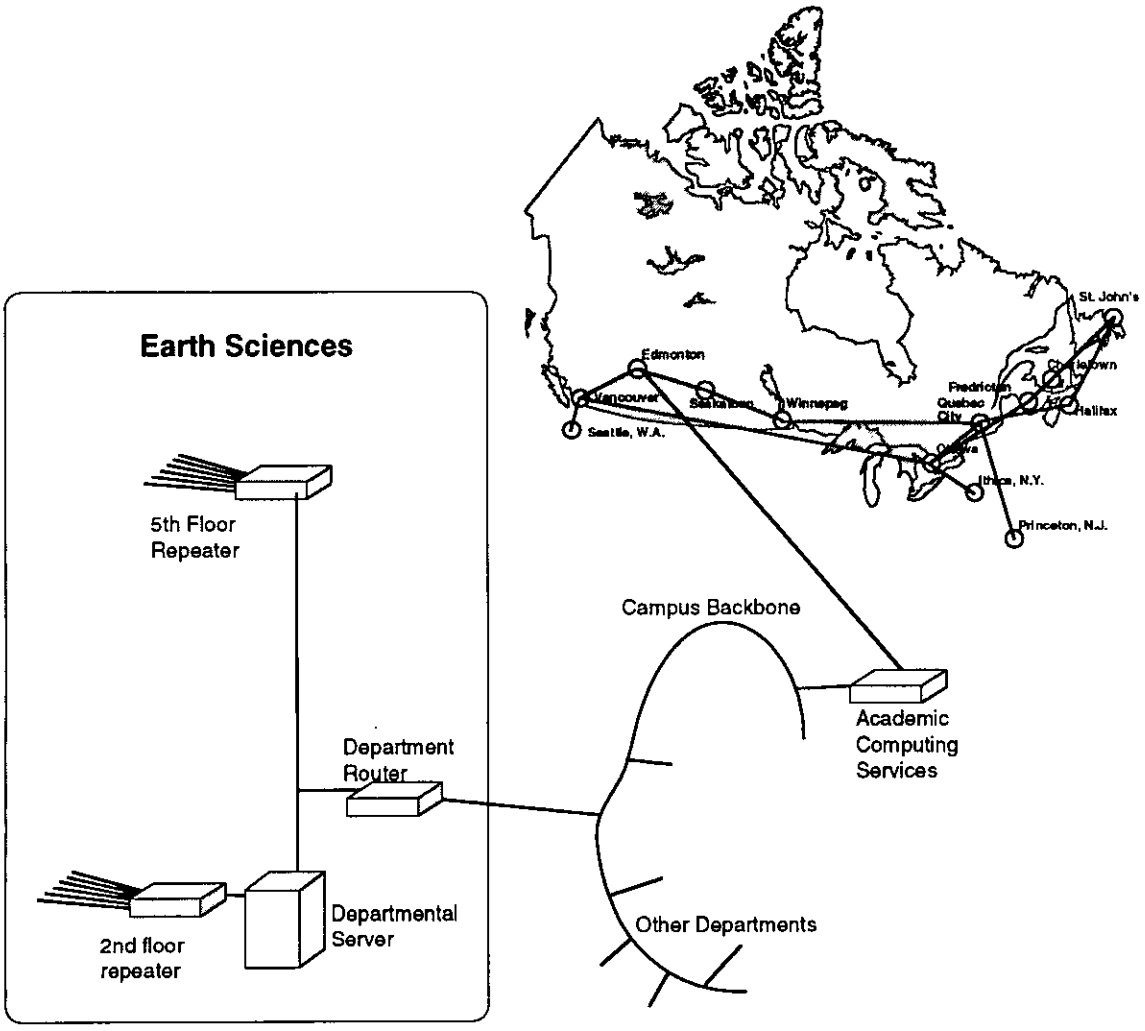

FIG 1: Departmental network connection to the Internet

All computer systems support at least the minimum of IP network programs: Telnet and FTP. These are programs for remote system access and network file transfers respectively. Many of the UNIX and DOS computers have the additional capability of supporting NFS (the Network File System). NFS allows disk drives that are connected to any single computer to be accessed from all other computers on the network. Whereas NFS comes standard with Sun's operating system, DOS support for NFS is provided by software from the Beame and Whiteside company. Although software can be purchased for our Macintosh systems to work with NFS, we have

decided to make our Sun systems Appleshare compatible. "Appleshare" (to be discussed later) is Apple's non-compatible equivalent to NFS. The union of NFS and Appleshare on our network give us formidable file sharing capabilities.

The Appletalk networking protocol shares some of the features of the IP protocol: file sharing (called Appleshare), client/server communications, and printer sharing. Using the CAP Appletalk software for our Suns, the Sun systems can be used as file servers for our Macintoshes. Users can save their Macintosh files directly into their accounts on the Sun systems in the same manner that they would store their files on a personal floppy disk. User files can then be backed-up on a frequent basis from one central location. The Sun systems benefit from Appletalk as well. Using the Appletalk protocol, the Sun systems can print to any of the Appletalk network printers, such as our Apple LaserWriter printers.

Electronic mail is supported on all Unix, MS-DOS and Macintosh systems. The electronic mail packages on personal computers communicate with the Suns for mail delivery and retrieval by accessing the users' accounts on the Sun system. We have found electronic mail to be popular for exchanging research ideas with collegues abroad, and for communicating with software suppliers.

Another important use of our network is to perform remote backup of our Macintoshes and PC's, over the network, to tape drives connected to our Sun systems. Public domain software called "MacDump" allows us to do this on our Macintoshes. On our PC's we use a file archiving program to copy the entire contents of a hard disk to a file on a Sun hard disk (via NFS). We then copy the archive file to tape for off-line storage.

ACKNOWLEDGEMENTS

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REFERENCES

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Bland, H.C., 1992, CREWES Computer Systems: CREWES Research Report, v. 4, ch. 25

HARDWARE LIST

Sun Sparcstation 2
- two 19" colour displays
- Exabyte 8200 tape drive
- Disk space totalling 4.5 gigabytes

Sun Sparcstation 1+
- 19" colour display
- Quarter inch cartridge tape drive
- Disk space totalling 700 megabytes

Sun Sparcserver 670MP (University owned)
- 9 track "round reel" tape drive
- Versatec Plotter Controller
- Quarter inch cartridge tape drive
- CD ROM drive
- Disk space totalling 8 gigabytes

Six - Sun Sparcstation 2 (University owned)
- 19" colour display
- Archive Python DAT tape drive
- Disk space totalling 800 megabytes per workstation

IBM RT/Landmark
- Disk space totalling 900 megabytes
- Dual 19" colour graphic displays
- 9 track "round reel" tape drive
- Colour thermal transfer plotter

Personal Computers
- Zenith 286 (IBM PC compatible)
- 3 Apple Macintosh IIsi
- Apple Macintosh SE/30
- Apple Macintosh Plus
- IBM PS/2 Model 70

High Capacity Data Media capabilities
- 9 track "round reel" tape (1600, 6250 BPI)
- Quarter inch cartridge
- DAT (Digital Audio Tape)
- Exabyte (8mm Video Tape)
- CD ROM

Plotters/Printers
- Versatec C2700 Thermal colour plotter
- Versatec 8242A 42" plotter
- Versatec 8224 24" plotter (University owned)
- Versatec ECP42 42" colour plotter (University owned)
- Versatec 3224 24" colour plotter (University owned)

SOFTWARE LIST

The following list describes all the software we use on a regular basis. This list excludes system software, compilers, system utilities and lesser-used software. Although care has been taken in preparing this list, it is likely that portions of the list are inaccurate or out of date. For this reason, this list should be considered a guideline only, and not a source of authority for product information

Modeling			
Package	Vendor	Description	Operating System
MIMIC	Sierra	Geologic modeling and mapping; preparation of models for ray tracing	UNIX
QUIK	Sierra	2D & 3D seismic ray tracing field short records, CMP gathers, stacked sections before and after time migration, VSP, P, S, and converted waves.	UNIX
VESPA	Sierra	Wave equation migration; shot records, VSPs, offset VSPs	UNIX
SLPR	Sierra	Display of results on screen or hard copy	UNIX
UNISEIS	Applied Geophysical Software inc.	2D Ray-trace modeling for offset, normal incidence, normal emergence, VSP, or crosshole geometries. P, S and converted waves	AIX (RT)
LogM	GMA	Well log based seismic modeling; display & edit well logs, synthetics, geologic & seismic cross-sections	MS-DOS
STRUCT	GMA	Seismic modeling of structural geology using vertical incidence or normal incidence ray tracing or diffraction modeling	MS-DOS
AVO	Hampson and Russell	Interactive AVO modeling, analysis, and inversion.	UNIX and MS-DOS
GLI3d	Hampson and Russell	Static corrections using a near-surface geological model	UNIX
DSite	Jason Geosystems	Velocity modelling based on Generalized Inversion Theory	UNIX
Integrate	Jason Geosystems	Seismic inversion to an impedance model using sparse spike or recursive trace	UNIX
Outrider	MicroSeis Technology	Multicomponent modeling	MS-DOS

Processing

Package	Vendor	Description	Operating System
Insight	ITA	Complete processing package including demultiplexing, pre-stack and post-stack processing with interactive displays	UNIX
ProMAX ProMAX 3D	Advance Geophysical	Complete 2-D, 3-D processing package.	UNIX
ProVSP	Advance Geophysical	VSP processing system	UNIX
Vista	Seismic Images Software	Interactive seismic processing from shot record to final stack, synthetic seismograms.	MS-DOS
FDTools	Seismic Images Software	Design 3D surveys, acquisition parameters	MS-DOS
Vista Vision	Seismic Images Software	Seismic plotting program for Vista output files	MS-DOS
Wellpro	Genix Systems	Interactive VSP processing	MS-DOS and UNIX
PCVSP	Kostelnick	One layer crosswell & VSP ray tracing	MS-DOS
STRATA	Hampson and Russell	post-stack stratigraphic analysis and inversion package, model building, wavelet extraction, seismic inversion	UNIX and MS-DOS

Interpretation

Package	Vendor	Description	Operating System
SeisWorks/3D SeisWorks/2D	Landmark	Seismic interpretation with horizon picking, fault interpretation and correlation, seismic attribute analysis and data display	UNIX
StratWorks	Landmark	Geologic Interpretation	UNIX
2D Plus	Landmark	Interpretation of 2D seismic stacked sections; automatic horizon picking, computer contouring and mapping; attribute analysis	AIX (RT)
3D Plus	Landmark	Interpretation of 3D seismic stacked sections; automatic horizon picking, computer contouring and mapping; attribute analysis	AIX (RT)
GrITS	GMA	Stratigraphic interpretation of 2-D seismic data.	MS-DOS

Mathematics

Package	Vendor	Description	Operating System
Matlab	Mathworks	Mathematics and statistics package with 2D and 3D graphing capability	UNIX and MS-DOS
Theorist	Prescience	Mathematics and statistics package with 2D and 3D graphing capability	Macintosh
Cricket Graph	Cricket Software	Graphing; simple statistics and data manipulation	Macintosh

Well Log Analysis			
Package	Vendor	Description	Operating System
LogEdit	Landmark	Well log editing	UNIX
SyntheSeis	Landmark	Synthetic seismogram generation	UNIX
Wave-X	GMA	Wavelet extraction from well logs	MS-DOS Macintosh
LogM	GMA	Entry, computation and management of well logs. Can generate synthetic seismograms.	MS-DOS
LAS	Petcom	Log editing, crossplots and petrophysical analysis	MS-DOS

Document Processing			
Package	Vendor	Description	Operating System
Word	Microsoft	Word processing with equation capability	Macintosh MS-DOS
Wordperfect	Wordperfect Corporation	Word processing with equation capability	MS-DOS
Expressionist	Allan Bonadio Associates	Visual mathematical equation editor	Macintosh
Canvas	Deneba	Drawing, slide making	Macintosh
Photoshop	Adobe	Scanning and image processing (colour and B/W)	Macintosh

Miscellaneous			
Package	Vendor	Description	Operating System
Rat	Digirule	Digitizing of well logs, seismic horizons, etc.	MS-DOS
AXXSES	Digtech	Modem access to well data (locations, tops, production, cores, etc.) and well-log digits.	MS-DOS
Quattro	Borland	Spreadsheet with graphing, database, statistics and data manipulation capabilities	MS-DOS

Networking			
Package	Vendor	Description	Operating System
HCL-eXceed/W	Hummingbird Communications	X-Window server software for PC's under Microsoft Windows	MS-DOS
BW-NFS	Beame and Whiteside	TCP/IP software, including Telnet, FTP, and NFS. Also supports network printing.	MS-DOS
CAP	Free	Appletalk support for UNIX systems. Supports file sharing, printing services, and backup	UNIX
Eudora	Qualcomm	Internet Electronic mail with full graphical user interface.	Macintosh MS-DOS