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-compatible hardware, is discussed in detail. This paper also mentions some of the PC based geophysical and mathematical processing packages used in research. Systems 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

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 interpretation. Our systems are also used for software development, technical writing and presentation graphics. Each year we evolve our computing systems to meet the ever-increasing needs of our research group. In the past year we have made a number of changes to our hardware and software. Our current systems are more capable than ever, permitting us to handle the processing and storage needs related to multicomponent 3-D processing.

SUN-COMPATIBLE SYSTEMS

The core of the CREWES computer systems is a group of Sun Ultrasparc and Hypersparc workstations. The full list of workstations is available in Table 1. These systems run Sun's version of Unix, Solaris 2.5.1. Interconnected with an ethernet network, they are linked together to form a cohesive operating cluster with a common user database. With the aid of the Network File System (NFS) users' files and system software is made available on all the systems.

Even though the user environment and selection of software is unchanged between systems, some system have been optimized for certain applications (Figure 1). Two systems are configured with dual screens for seismic interpretation. Many of the systems used for seismic interpretation and processing have large amounts of random access memory (RAM). All systems have a minimum of 128MB of RAM, and some have as much as 300MB. To handle memory intesive problems, large amounts of virtual memory is required. Four of our systems have over a gigabyte of virtual memory.

The Department of Geoplogy and Geophysics also has a set of Sun systems. Though starting to show their age, a set of six Sun Sparcstation 2's are still used for teaching geophysical applications to undergraduate and graduate students. These systems are occasionallyused by the CREWES Project to gain access to CREWES systems via the network. The Department also has a Sun 670MP server system. It operates as the primary mail server, web server and network name server for the department.

* This paper is a revision of previous years' computer systems reports

SEISMIC SOFTWARE PACKAGES

Landmark

In May of 1996 Landmark Graphics Corperation made a large donation of software to the CREWES Project. The donation included software for interpretation, processing, visualization and mapping.

As part of the donation, Landmark's Advance Product Group provided several copies of their full suite of processing packages: ProMAX 2D/3D, and ProMAX-VSP. ProMAX is a complete Unix-based environment for the analysis and processing of 2-D and 3-D seismic data. This full featured package performs processes ranging from data-loading to migration. As a data-oriented research group, CREWES has made heavy use of ProMAX for both processing and development of new processing algorithms.

At the time of writing, CREWES had just received new versions of Landmark's suite of interpretation applications. Among the software products are SeisWorks/3D, SeisWorks/2D, StratWorks, RAVE, TDQ, ZMAP, Seiscube and Surfcube. We look forward to using these packages in our future work.

GMA

GMA will soon be augmenting their prior donation of GMA Explorational Software Systems. 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 modelling systems – one for structural modelling, and one for stratigraphic modelling. 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.

Hampson / Russell

Hampson-Russell Software Services donated several licences for their AVO, STRATA, GLI3D and GEOSTAT software packages for Unix. The AVO program 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 for 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. GEOSTAT, a geostatistical analysis package, is the most recent donation from Hampson and Russell. Within days of its arrival at CREWES, it was used to help analyse sand/shale and Vp/Vs ratios for the Blackfoot 3C-3D survey.

Jason Geosystems

Jason Geosystems has supplied CREWES with the "DSite" and "Integrate" software products. DSite is an interactive velocity modelling 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.

Cogneseis/Photon

Congneseis/Photon has continued to provide updates to their latest version SeisX – a seismic interpretation package. This package allows one to display and interpret 2-D and 3-D data, map faults and horizons and visualize them in 3-D. Among the other features of SeisX are grid balancing and interactive phase/amplitude matching between multiple surveys. CREWES has made extensive use of SeisX for projects such as the interpretation of the Blackfoot 3C-3D survey.

Additional PC Based Software

Although the majority of our frequently-used software is Unix-based, there are also a number of Windows and DOS based software packages which we use. MicroSeis' Outrider, Hampson-Russell's AVO and Strata and SIS's Vista 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; however, these machines are used primarily for word processing and drafting. With the increased power of modern PCs and the improvement in operating system options, we hope to make greater use of PC based applications in the future.

PUBLISHING

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. Assembling this document requires a great deal of effort, and each year we attempt to improve the report's quality and streamline the process. This will be the second year that the research report has been assembled completely electronically. The production of last year's report was extremely successful. Fourty Six chapters were produced completely digitally - with duplication performed from eletronic masters. Since the report was totally electronic, we were able to reproduce the report on a compact disk as well as publish it on the World Wide Web. After our experiences last year, we upgraded our word processing systems by adding three new Macintosh systems. We also purchased removable hard disks (Syquest EZ drives) so researchers could store their reports and figures on own hard disks.

Several software packages are used to author the research report. The majority of the report is prepared using Microsoft Word for Macintosh and Microsoft Word for Windows. Diagrams are typically produced using Deneba Canvas on the Macintosh, and Corel Draw on the PC. Most graphs are generated in Mathworks' Matlab - a mathmatical toolbox which includes a number of graphical analysis routines. Seismic plots are usually creating by copying screen displays from seismic processing packages (such as ProMAX) and inserting these displays directly into documents electronically. In the few instances, when digitized graphics are unavailable, a colour scanner is used to import existing graphics into documents.

NETWORK

Our computer environment consists of networked workstations and personal systems which communicate amongst themselves, and with systems connected to the

Internet. Our network is based on the Ethernet standard, running two common networking protocols: IP (TCP/IP) and Appletalk. These protocols 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 University's Department of Geology and Geophysics. This network is built with both coaxial cable and twisted pair cable, providing the electronic links between computers and networking hubs. These networking hubs provide signal conditioning and fault isolation so that the department's network can span four different floors of the Earth Science building while maintaining ethernet's top speed of 10 megabits per second.

Beyond the departmental LAN there is a network that spans the campus of the University of Calgary. Each department of the University has its own subnetwork, and all the subnetworks are joined together through the central campus router. The University router is, in turn, connected to the Internet as shown in Figure 1.

SUMMARY

The CREWES Project has acquired a capable collection of computers and software. The continuing support of our sponsors has allowed us to upgrade and expand our systems. With these improvements, we have been able to investigate new data-intensive, real-world geophysical problems. We would like to thank the sponsors of CREWES and valued software donors for making our research possible.

HARDWARE

Quantity	Model	CPU
6	Sun Ultra 1 Model 140	Ultrasparc 144MHz
1	Sun Sparcstation 10 HS72-D	Dual Ross Hypersparc 72
1	Sun Sparcstation 10 HS66-D	Dual Ross Hypersparc 66
1	Sun Sparcstation 5	TI Microsparc 85MHz
7*	Sparcstation 2	Sparc 40MHz
1*	Sparcserver 670MP	Dual Cypress CY605

Table 1. Workstations Table 2. Tape drives

Quantity	Model
1	Exabyte 8200 8mm
2	Exabyte 8505 8mm
2	Archive QIC
4	Archive 4mm
1	Storage Tech. 1950 9 track

Table 2. Tape drives

Model	Description
Hewelett Packard Designjet 755CM	36" Inkjet printer
Versatec 8224*	24" electrostatic plotter
Versatec 3224	24" colour electrostatic plotter
Veritas VER120	11" thermal plotter

Table 3. Plotters

Quantity	Model
12	Macintosh Systems
5	PC systems

Table 4. Personal Computers

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.

Modelling			
Package	Vendor	Description	Operating System
LogM	GMA	Well log based seismic modelling; display & edit well logs, synthetics, geologic & seismic cross-sections	MS-DOS
STRUCT	GMA	Seismic modelling of structural geology using vertical incidence or normal incidence ray tracing or diffraction modelling	Unix and MS-DOS
AVO	Hampson Russell	Interactive AVO modelling, analysis, and inversion.	Unix and MS-DOS
GLI3D	Hampson 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 modelling	MS-DOS and Unix
MIMIC/QUIK	Landmark	Geologic modelling and ray tracing	Unix

Processing			
Package	Vendor	Description	Operating System
ProMAX 2D/3D	Landmark	Complete 2-D and 3-D seismic processing.	Unix
ProMAX VSP	Landmark	VSP processing system	Unix
Poststack	Landmark	Interactive poststack seismic processing for interpretors.	Unix
Insight	Landmark/ITA	Complete processing package	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
STRATA	Hampson Russell	Post-stack stratigraphic analysis and inversion package, model building, wavelet extraction, seismic inversion	Unix and MS-DOS

Data Analysis / Data Loading			
Package	Vendor	Description	Operating System
Rat	Digirule	Digitizing of well logs, seismic horizons, etc.	MS-DOS
AXXSES	Digitech	Modem access to well data (locations, tops, production, cores, etc.) and well-log digits.	MS-DOS
Matlab	Mathworks	Mathematics and statistics package with 2D and 3D graphing capability	Unix, Macintosh, Windows
Seismic Data Loader	Panther	Simple data loading into Landmark SeisWorks. Tools for manipulating and displaying SEG-Y files.	Unix
GEOSTAT	Hampson Russell	Geostatistical analysis of parameters from well logs or seismic	Unix

Interpretation			
Package	Vendor	Description	Operating System
GrITS	GMA	Stratigraphic interpretation of 3-D seismic data	MS-DOS
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, well log correlation, cross sections and mapping.	Unix
SeisCube	Landmark	3-D cube animation	Unix
Rave	Landmark	Reservoir characterization	Unix
Zmap+	Landmark	Interpretive surfaceand fault mapping	Unix
SeisX	Photon	2-D and 3-D seismic interpretation and visualization	Unix

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

Document Processing			
Package	Vendor	Description	Operating System
Acrobat	Adobe	Electronic publishing.	Macintosh
Corel Draw	Corel	Drawing, slide making	MS-DOS
Word	Microsoft	Word processing with equation capability	Macintosh MS-DOS
Expressionist	Waterloo Maple Software	Visual mathematical equation editor	Macintosh
Canvas	Deneba	Drawing, slide making	Macintosh
Photoshop	Adobe	Scanning and image processing	Macintosh

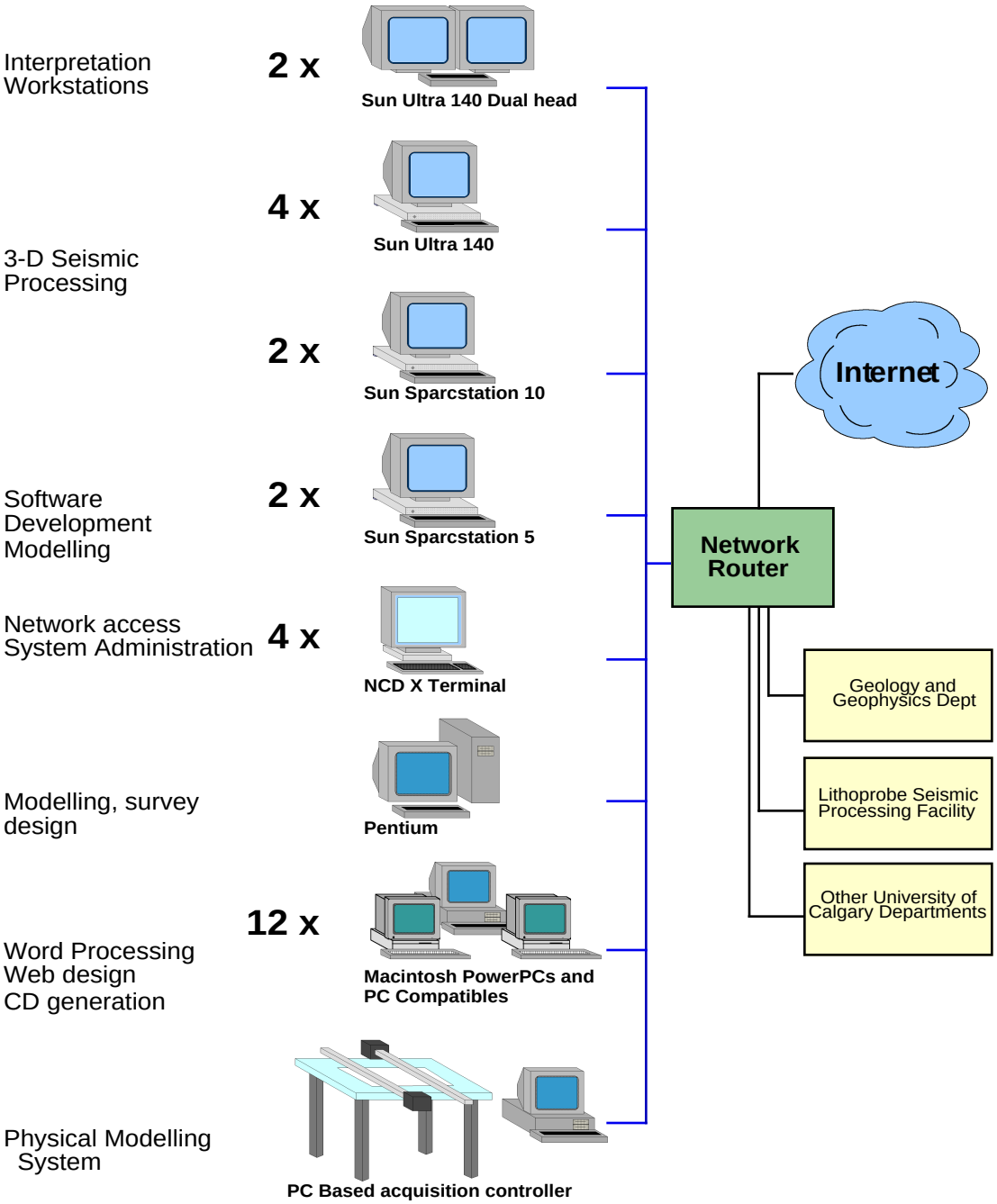

Fig. 1. The CREWES Computer systems include a variety of systems all connected by an ethernet network.