CREWES computer systems

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INTRODUCTION

Computers are used at practically every stage of research performed at CREWES. From data acquisition, to processing, to interpretation, to presentation, computers are the primary tools for our researchers. The need for faster computers and more capable software encourages us to find new solutions on an ongoing basis. This yearly report on CREWES computer systems describes the systems and software used to perform our research and produce our results.

COMPUTER HARDWARE

Computers used by CREWES are primarily Unix and Windows systems. Our choice of machines depends upon the availability of software. Most geoscience software packages are written for either Unix or Windows – few currently support both operating systems. From a hardware perspective, there is little difference in the capability of Unix workstations versus Windows workstations, so software availability dictates the choice of system for a particular application.

The most powerful system available to our group is a Sun Ultra Enterprise 450 server. This system was purchased with a grant from the Alberta government's Intellectual Infrastructure Partnership Program, and is operated by the department of Geology and Geophysics. With four CPUs running at 450MHz, 4GB of RAM, and over 300GB of disk, this system is ideal for CPU and memory intensive jobs. CREWES graduate students are the heaviest users of this shared machine, mostly running seismic processing jobs under Landmark's ProMAX processing system, and their own programs coded in Fortran, C, and Matlab.

A dozen other Sun workstations are networked to the Ultra Enterprise 450, allowing additional processing capabilities and points of access. Among the workstations are ones specifically suited for running dual-monitor interpretation packages, such as Landmark's SeisWorks and Paradigm's SeisX. Connected to this network of Sun systems are approximately 600 gigabytes of disk space. A listing of computer systems is shown in Table 1.

Additional seismic processing is carried out on PC systems, situated either in the CREWES work areas, or in a PC-based computer laboratory run by the Geology and Geophysics department. This lab contains a total of 24 PCs comprised of 266Mhz and 300MHz Pentium II systems. CREWES students have access to the machines outside class time. These PCs are configured to dual-boot into either Windows 98 or Redhat Linux, depending on the required application. Interconnected by a high-speed Ethernet network, these systems have been used for parallel processing of seismic data (Ferguson, 1999). The combination of 24 PCs results an extremely high aggregate speed, even though the individual PCs are not particularly fast by today's standards.

Table 1. CREWES Computers and their specifications

Number of systems	Model	Processor	RAM (MB)
1	Sun Ultra Enterprise 450	Quad 450 MHz Ultrasparc	4096
1	Sun Ultra 60	Dual 366 MHz Ultrasparc	1280
5	Sun Ultra 10	400 MHz Ultrasparc	128
6	Sun Ultra 1/140	143MHz Ultrasparc	512
1	SGI Impact	195 MHz R10000	128
1	Sparc 10 clone	Dual 72MHz Hypersparc	284
1	Sparc 10 clone	Dual 60MHz HyperSparc	64
4	PC	500 MHz Pentium III	128
1	PC	400 MHz Celeron	128
1	PC	400 MHz Pentium II	128
1	PC	300 MHz Celeron	128
1	PC	266 MHz Pentium II	64
8	PC	233 MHz Pentium II	128
3	PC	200 MHz Pentium MMX	64
4	PC	166 MHz Pentium	64

CREWES provides PCs to each staff member and supplies common-area PCs for use by students and visiting scholars. The majority of PCs run Windows 98, with a few systems running Windows NT 4.0. In order to maintain consistency in desktop applications, a standard set of software packages is loaded on each system (Table 2).

Table 2. CREWES computer systems and their specifications.

Application	Description
Microsoft Office	Word processing / spreadsheet / email / database
Netscape Navigator	Web browsing / email / scheduling
Adobe Photoshop	Image editing
Deneba Canvas	Technical drawing / image editing
Adobe Acrobat	Document distribution
Hummingbird Exceed	X-Window connectivity to Unix application servers

As in most organizations, the newest and fastest PCs go to those who perform the most CPU intensive work. When new PCs are brought into the group, the older (slower) ones are allocated to staff who use them for less CPU intensive applications (such as writing reports). As a result, new systems are continually being deployed while old machines find new uses.

CREWES shares network infrastructure with the University's Department of Geology and Geophysics. This infrastructure underwent a number of improvements over the last year – the most important being the installation of three dedicated systems for network management. These systems provide network services such as email, web serving, and a variety of Internet-related network information services. In a sense they are the most important computers, as almost all computing somehow involves the network. Despite their importance, we chose to use off-the-shelf PC

systems running the Linux operating system instead of more conventional (and expensive) network server systems. These systems have been very reliable. As an additional benefit, replacement systems are readily available from computer stores in the event of a failure.

The MACI Project

The Multimedia Advanced Computational Infrastructure Project (MACI) is a five-year, $20 million (Canadian) collaborative capital project, shared among the University of Alberta, the University of Calgary, the University of Lethbridge, and the University of Manitoba. The intent of MACI is to provide computational, multimedia and network resources to support private sector, university, and government researchers throughout the country.

The first phase of MACI (MACI-1) was a $2 Million initial effort focused on supplementing computational and multimedia resources at the Universities of Alberta and Calgary. Under MACI-1, a cluster of Compaq Alpha systems was purchased and installed at the University of Calgary. The configuration has 30 500-MHz Alpha processors, with an aggregate of eight gigabytes of RAM and 100 gigabytes of disk space. CREWES was one of the first groups to use the system. A test run that performed parallel reverse-time migration, showed that these systems are capable of completing immense computing tasks in very little time (Gavrilov et al, 1998). In addition to the Alpha cluster, a 42-processor SGI Origin 2000 system was purchased and installed at the University of Alberta.

The second phase of MACI (MACI-2) has received close to $18 million dollars in funding from government and private grants. In addition to a number of other initiatives, MACI-2 will fund the upgrade the Alpha cluster to 128 CPUs and the SGI Origin 2000 to 96 CPUs. CREWES will continue to work with the MACI project to gain access to these high performance systems.

Figure 1. MACI systems: (left) A tightly networked cluster of 30 Compaq / DEC Alpha systems running at 500MHz installed at the University of Calgary. (right) A 42-processor SGI Origin 2000 installed at the University of Alberta.

COMPUTER SOFTWARE

Seismic Image Software

SIS continues to support CREWES and the University of Calgary by providing the VISTA and OMNI packages. VISTA is a complete 2-D and 3-D processing package, which runs under Window. OMNI is a survey design and analysis package. CREWES has made extensive use of both packages.

Landmark Graphics Corporation

CREWES has a long history of support from Landmark. Landmark continues to provide the latest versions of their geophysical, geological and reservoir engineering applications. Among the most used Landmark applications are ProMAX 2D, 3D and VSP (for seismic processing), and SeisWorks 2D and 3D (for interpretation). Landmark has also supplied many of their other geoscience packages (Appendix A).

Geophysical Micro Computer Applications (GMA)

GMA has donated several copies their suite of seismic modelling and 2D/3D interpretation software to the University. GMA's LogM, Struct, AVO and WavX packages provide solutions for stratigraphic modelling, structural modelling, offset synthetics and modelling, and wavelet extraction. GMA's 2D/3D seismic interpretation system offers an integrated modelling and interpretation environment for Windows.

Hampson / Russell

Hampson-Russell Software Services donated several licenses for Unix based geophysical software packages. Their software includes AVO – for AVO analysis, STRATA – for post stack seismic inversion, GEOSTAT – for geostatistical analysis and mapping, GLI3D – for 3D refraction statics analysis, and EMERGE package – for multi-attribute analysis and reservoir parameter prediction. Using well logs and seismic data, along with seismic attributes calculated within the program, reservoir parameters such as porosity, lithology, and permeability can be computed.

Jason Geosystems

Jason Geosystems has supplied CREWES with the Jason Geoscience Workbench (JGW). Using the workflows contained within JGW, one can interpret seismic data, build geological and velocity models from various data, estimate wavelets from single or multiple wells, perform trace-based and model-based inversions and model using a variety of stochastic techniques.

Paradigm

Paradigm supports the University by providing several copies of the SeisX 2D and 3D seismic interpretation package. This package allows one to 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.

Additional Software

CREWES uses a number of other packages in addition to those already mentioned. Some, such as MicroSeis Outrider and Schlumberger's SDL (formerly Panther), have been donated, while others have been purchased (often with an educational discount). A full list of software is available in appendix A.

PUBLISHING

The writing and publishing of the CREWES research report is a major operation. This year, 48 authors contributed to the report producing over 60 chapters, and totaling more than 800 pages. The report contains hundreds of diagrams, seismic sections and images. The report is produced using a digital authoring workflow. Authors write their individual chapters, adhering to a pre-defined format and structure defined by a Microsoft Word template. When the papers are completed, they are electronically submitted to an Internet-based database using a web browser interface. All Microsoft Word documents are converted to Adobe Acrobat's Portable Document Format (PDF) before being sent to our print shop via the Internet. Using a digital duplicating system (a Xerox Docutech printer/copier), the print shop creates first-generation paper copies of the report. This digital printing technique results in sharper text and higher quality images (Foltinek, 1996).

New to this year's report production is the integration of the Internet-based database for management of the research report production. The database helps us

keep track of all the papers and their authors. As the size of the report has grown, we've found it an increasingly complex task to maintain all the report information, especially keeping it accurate and up-to-date. Using the new database, authors are able to update information about their own papers, changing the authorship, title, page count, section, and abstract information as required. This system also permits electronic submission of papers from anywhere on the Internet. Many of the papers in this report have travelled around the globe a number of times during the writing and reviewing process. With authors in North America, South America and Europe, this system has already proven itself to be very useful.

The internet-based paper submission system[1] was developed in-house and uses a standard SQL database management system combined with web server extensions written in Perl.

NETWORK

The CREWES computer systems are all interlinked with an Internet-protocol network. This network is directly connected to the Internet via a 10 Mbit/s network. Within the University, different departments are interconnected through various network routers, bridges, and switches. The network media used to connect the majority of systems is 100 Mbit/s Ethernet. CREWES only has a handful of legacy systems still using the slower 10 Mbit/s Ethernet – the change to 100 Mbit/s Ethernet started two years ago, and finished early in 1999.

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.

REFERENCES

Gavrilov, D., Lines, R.L., Bland, H.C., Kocurko, T., 3-D Depth migration: parallel processing and migration movies, CREWES Research Report, 1998, v. 10, ch. 14

Foltinek, D.S., An overview of cross-platform document technology, CREWES Research Report, 1996, v. 8, ch. 30

Ferguson, R.J.,Prestack depth migration by symmetric nonstationary phase shift, CREWES Research Report, 1999, this volume

[1] The software is available to all sponsors.

APPENDIX A - 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 not be considered a source of authority for product information. Some listed packages are available on operating systems other than those indicated – only listed are the versions used by CREWES.

Modelling

Package	Vendor	Description	System
LogM	GMA	Stratigraphic modelling system	Windows / Unix
STRUCT	GMA	Seismic modelling of structural geology.	Windows
AVO	Hampson Russell	Interactive AVO modelling, analysis, and inversion.	Unix
GLI3D	Hampson Russell	Static corrections using a near-surface geological model	Unix
EMERGE	Hampson Russell	Multi-attribute analysis and reservoir parameter prediction	Unix / Windows
Geological Workbench	Jason Geosystems	Geological models from interpretation or well data. Velocity models from interpretation or seismic data.	Unix
Osiris	ODS Holdings	2-D and 3-D solution to the wave equation for an arbitrary horizontally stratified medium	Unix
Outrider	MicroSeis Technology	Multicomponent modelling	Windows
MIMIC+ / QUIK+	Landmark	Geologic model building, depth conversion and visualization / Forward ray-trace modelling for calculating the 2D and 3D seismic response to depth models	Unix
VESPA+	Landmark	Viscoelastic wave equation modelling for flat, multi layered earth models	Unix
TDQ	Landmark	Time-to-depth and depth-to-time conversions, 3-D velocity model building using both seismic and well logs.	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
ProMAX 3DPSDM	Landmark	3-D prestack depth migration	Unix
ProMAX MVA	Landmark	Depth-domain migration velocity analysis and modelling in complex geologic/velocity situations	Unix
Poststack	Landmark	Interactive poststack seismic processing for interpreters.	Unix
Poststack ESP	Landmark	(Event Similarity Prediction) - highlights discontinuities in seismic data caused by faulting or stratigraphic variations using feature scanning and edge detection techniques.	Unix
PAL	Landmark	Post stack attribute library, provides horizon and volume oriented seismic attribute extraction.	Unix
Vista	Seismic Image Software	Interactive seismic processing from shot record to final stack, synthetic seismograms.	Windows
STRATA	Hampson Russell	Post-stack stratigraphic analysis and inversion package, model building, wavelet extraction, seismic inversion	Unix
Seismic Unix	Free from C.W.P.	2-D seismic processing.	Unix, Windows

Data Loading / Management / Analysis

Package	Vendor	Description	System
Caravel	Discovery Bay	Synchronized display and analysis of multiple seismic data sets	Unix
Formatter	Discovery Bay	Data access from multiple SEG-Y formats.	Unix
SEA	Discovery Bay	Seismic Energy Analysis	Unix
Matlab	Mathworks	Mathematics and statistics package with 2D and 3D graphing capability	Unix, Windows
Seismic Data Loader	Panther	Simple data loading to/from SeisWorks / SeisX / SEG-Y formats.	Unix
GEOSTAT	Hampson Russell	Geostatistical analysis of parameters from well logs or seismic	Unix / Windows
EDM	ITS	Seismic data management	Windows
OpenWorks	Landmark	Data management of seismic, well, interpretation, engineering, production data.	Unix

Interpretation

Package	Vendor	Description	System
2D/3D	GMA	Interpretation of 2-D / 3-D seismic data	Windows
SeisWorks - 2D / 3D / Zap!	Landmark	Seismic interpretation with horizon picking, fault interpretation and correlation, seismic attribute analysis and data display. 3D automatic horizon tracking.	Unix
StratWorks	Landmark	Geologic Interpretation, well log correlation, cross-sections and mapping.	Unix
SeisCube	Landmark	Interpretation, visualization, and animation of data volumes in three dimensions.	Unix
Rave	Landmark	Finds, visualizes and studies relationships among various seismic and reservoir attributes in map and cross section views.	Unix
Zmap+ full configuration	Landmark	Integrated surface mapping and modelling using data and interpretations from seismic, geologic, petrophysical, and 3D geocellular models. Line gridding, mistie resolution, map migration and time-depth conversion.	Unix
SeisX	Paradigm	2-D and 3-D seismic interpretation and visualization	Unix
Raymap+ / Siva+	Landmark	Map migration and depth conversion in complex exploration plays. Produces depth models from interpreted seismic time data. SIVA+ uses interactive model based ray racing to compute interval velocity maps from seismic trace or stacking velocity data	Unix
Openvision	Landmark	3D visual of combined seismic, well and engineering data	Unix

Well Log Analysis

Package	Vendor	Description	Operating System
LogM	GMA	Entry, computation and management of well logs. Can generate synthetic seismograms.	Windows
PetroWorks	Landmark	Graphical well log editing, analysis and interpretation	Unix
Syntool	Landmark	Synthetic seismogram generation	Unix
Quikwell+	Landmark	Tools for seismic well log analysis, log editing, and interactively building stratigraphic or structural models	