CREWES computer systems

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INTRODUCTION

The Consortium for Research in Elastic Wave Exploration Seismology (CREWES) makes great demands of it's computing facilities. As the need for greater computational speed and data storage has grown, the consortium has continually needed to upgrade and expand its systems. In order to carry out leading edge research, it has acquired some of the world's best geophysical software, either by direct purchase or through the generosity of donors. This yearly report on the state of computing in CREWES will describe the systems and software used to perform our research and present our results.

COMPUTER HARDWARE

The computers used by CREWES include several high-speed workstations and desktop systems. A comprehensive list of systems can be found in table 1.

In the past year, CREWES has undertaken a plan to provide it's staff and students with better access to computers by purchasing twelve low-cost desktop systems. Of these systems, eleven are Intel Pentium systems running Windows NT or Windows 95, and one is a PowerPC based system running MacOS. In addition to providing network access to existing systems (mostly Sun UltraSparcs), these new systems also provide a significant boost to the overall available computing horsepower. It is remarkable how these low-cost consumer systems perform nearly as well as expensive workstations from traditional Unix system manufacturers.

Most of our efforts in system improvement have gone toward increasing disk storage capacity. Over the past three years, CREWES has acquired large amounts of seismic data, either through it's own acquisition programmes, or from data donations from industry partners. To help our researchers work efficiently with this data, CREWES has added eight 22GB disk drives to its Sun processing cluster. With the addition of these new disk drives, the total CREWES disk capacity has grown close to 500GB. We feel very fortunate that the price of disk space is at an all time low, and hope that the trend will continue into the foreseeable future!

The University of Calgary's Foothills Research Project recently purchased a Silicon Graphics Octane system in conjunction with CREWES. This system, fitted with dual SI texture-map displays, is capable of running complex visualization tasks such as voxel rendering and visualization complex 3-D geometries.

In addition to the CREWES computer systems, systems operated by the Department of Geology and Geophysics are available for CREWES-supported students. Though starting to show their age, a set of six Sun Sparcstation 2 systems are still used for teaching geophysical applications to undergraduate and graduate

students. 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.

Table 1. CREWES Computer systems and their specifications.

	Computer name	Model	Processor speed	RAM (MB)	Disk (GB)
	Siku	Sun Ultra 1/140	143MHz UltraSparc	128	48
	Sogo	Sun Ultra 1/140	143MHz UltraSparc	168	37
	Surna	Sun Ultra 1/140	143MHz UltraSparc	128	46
	Sarod	Sun Ultra 1/140	143MHz UltraSparc	128	69
	Sho	Sun Ultra 1/140	143 MHz UltraSparc	128	20
	Sabar	Sun Ultra	143 MHz UltraSparc	128	23
*	Dweezil	SGI Impact	195 MHz R10000	128	30
	Kalimba	Sparc 10 clone	Dual 72MHz Hypersparc	284	99
	Marimba	Sparc 10 clone	Dual 60MHz HyperSparc	64	43
	Sax	Sparc 5 clone	85 MHz Microsparc	64	10
	Bass	Sparc 2	40 MHz Sparc	24	1
	Bombo	ECI PC	166MHz Pentium	64	4
	Bland	ECI PC	200MHz Pentium	128	4
	Simin	ECI PC	200MHz Pentium	64	4
	Potter	ECI PC	200MHz Pentium	64	4
	Forgues	ECI PC	200MHz Pentium MMX	64	4
	Stewart	ECI PC	200MHz Pentium MMX	64	4
	Bancroft	ECI PC	166MHz Pentium	128	6
	NT1	ECI PC	166MHz Pentium	64	4
	NT2	ECI PC	200MHz Pentium	64	4
	Bhoffe	ECI PC	200MHz Pentium MMX	64	4
	Kiwi	ECI PC	200MHz Pentium	32	4
*	Lawton	Dell latitude	150MHz Pentium	32	4
*	Lines	ECI PC	200MHz Pentium MMX	64	4
	Eiffel	ECI PC	166MHz Pentium	64	4
	Kazoo	Apple Macintosh 7300/200	200MHz PowerPC	128	9
	Gallant	IPC PC	90MHz Pentium	64	2
	Volcano	Dell latitude	200MHz Pentium	32	2
	Elastic	PC	133MHz 586	32	4
	Bassoon	Apple Macintosh 6100/66AV	66MHz PowerPC	32	2
	Euphonium	Apple Macintosh 7500/100	100MHz PowerPC	64	2
	Bongo	Apple Macintosh 7100/80	80MHz PowerPC	32	2
	Shawm	Apple Macintosh 7200/90	90MHz PowerPC	40	2
	Rebec	Apple Macintosh 7200/90	90MHz PowerPC	40	2
	Shawm	Apple Macintosh 7200/90	90MHz PowerPC	40	2
	Harmonica	Apple Macintosh 7100/80	80MHz PowerPC	32	2
			Total	2844	527

* Purchased with funding from other sources.

COMPUTER SOFTWARE

Landmark Graphics Corporation

CREWES continues to reap the benefits of a large software donation from Landmark Graphics Corporation. Landmark supplies CREWES with many of it's geophysical, geological and reservoir engineering applications. Among the most used Landmark applications are ProMAX 2D, 3D and VSP (for seismic processing), SeisWorks 2D and 3D (for interpretation), and RAVE (for visualizing relationships among various seismic and reservoir attributes).

Geophysical Micro Computer Applications (GMA)

GMA has donated several copies their GMAPlus suite of geophysical applications to the University. Their applications are primarily used on PC systems running Windows NT and Windows 95. GMAplus LogM is a stratigraphic modeling system with a number of log, synthetic, and cross-section related facilities. GMAPlus Struct is a comprehensive structural-modeling package. GMAPlus 2D and 3D are interpretation packages for 2-D and 3-D seismic datasets. The GMAPlus suite applications all feature a number of screen and hardcopy display options.

Hampson / Russell

Hampson-Russell Software Services donated several licenses for Unix based geophysical software packages. Their software includes AVO - for AVO analysis, STRATA - a post stack seismic inversion program, GEOSTAT - for geostatistical analysis and mapping, and GLI3D - for 3D refraction statics analysis.

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.

Cogneseis

Cogneseis has continued to provide updates to their latest version of 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.

Discovery Bay

This year, the Discovery Bay Company donated their seismic analysis system to the University of Calgary. It includes Caravel, for synchronized display and analysis

of multiple seismic data sets, SEA, for seismic energy analysis, and Formatter, for seismic data reformatting

Additional Software

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

PUBLISHING

Each year the work of the CREWES Project is summarized in the 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. Creating this document requires a great deal of effort, and each year we attempt to improve the report's quality and streamline the authoring process. The entire report is now composed fully electronically – gone are the days of tape and scissors! Paper duplicates of the report are produced from electronic masters rather than photocopying (Foltinek 1996). The result is a report with superior image quality and improved renditions of seismic plots. Another benefit of electronic publishing is that the entire report is easily transferred to CDROM or our Internet web site. These forms of distribution help us reach a greater audience within our sponsoring companies.

NETWORK

The CREWES computer systems are all interconnected with an Internet-protocol network. This network is directly connected to the Internet via a high-speed interconnect. Within the University, different departments are interconnected with a combination of 10Mbit/s Ethernet, 100Mbit/s Ethernet and FDDI. A number of network routers, bridges and switches are also involved in providing connectivity throughout the University campus.

The Department of Geology and Geophysics (the location of CREWES), connects most of its systems are connected using 10BaseT Ethernet running at 10Mbits/s. Network hubs are distributed about the Earth science building interconnecting laboratories and offices using a star topology. This shared-bandwidth network is adequate for most non-seismic data transfers. Within CREWES, the volume of network traffic requires a more capable network. A series of Ethernet switches (manufactured by 3COM) interconnect clusters of workgroup computers in the geophysics area. One switch is devoted to CREWES systems; another switch connects the Foothills Research Project. Connecting these switches, is a small 100Mbit/s Ethernet network. Certain large file servers bypass the switch altogether – they reside directly on the 100Mbit/s network. This hybrid of 10Mbit/s and 100Mbit/s networks appears to adequately handle our network needs. As more systems with 100Mbit/s Ethernet are purchased, our network will gradually shift to one based entirely on 100Mbit/s Ethernet. Looking ahead, new networking technologies such as gigabit Ethernet are likely to replace our current (and near future) networking

endeavors. We particularly look forward to the day when we can process seismic data over the network at near the same speed as we process locally stored seismic data.

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

Foltinek, Darren S., Cross-platform document technology, Volume 8, 1996, ch. 30.

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.

Modeling			
Package	Vendor	Description	Operating System
LogM	GMA	Stratigraphic modeling system	Windows
STRUCT	GMA	Seismic modeling of structural geology.	Windows
AVO	Hampson Russell	Interactive AVO modeling, analysis, and inversion.	Unix
GLI3D	Hampson Russell	Static corrections using a near-surface geological model	Unix
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 modeling	Windows
MIMIC/QUIK	Landmark	Geologic modeling 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 interpreters.	Unix
Vista	Seismic Images 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

Data Analysis / Data Loading			
Package	Vendor	Description	Operating 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, Macintosh, 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

Interpretation			
Package	Vendor	Description	Operating System
2D/3D	GMA	Interpretation of 2-D / 3-D seismic data	Windows
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 surface and fault mapping	Unix
SeisX	Cogneseis	2-D and 3-D seismic interpretation and visualization	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