References

Barker, R. D. (1981)—'The offset system of electrical resistivity sounding and its use with a multicore cable', *Geophysical Prospecting*, Vol. 29. No. 1.

Sakayama, T. & Shima, H. (1985)—'An attempt to improve accuracy of analysis in vertical electrical sounding; (1) Joint analysis, using different combinations of electrodes'. (Japanese), Proceedings of the 72nd SEGJ Conference.

Shima, H. & Sakayama, T. (1985)—'An attempt to improve accuracy of analysis in vertical electrical sounding; (2) Noise reduction by a synthetic potential method'. (Japanese), Proceedings of the 72nd SEGJ Conference.

Koefoed, O. (1979)—'Geo-sounding principles, 1; Resistivity sounding measurements', Elsevier, Amsterdam.

The Relevance of Network Computing Concepts in the Geophysical Workstation Environment

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Summary

Graphics workstations, considered a novelty a few years ago, are now justifiably accepted as productive geophysical tools. This paper is aimed at highlighting the true significance of the workstation, particularly in the light of potential developments in the area of network computing. Emergent technology in this area will provide user-transparent facilities for high-speed distribution of both data and tasks across a heterogeneous network of workstations, mainframes and file servers. Such technology would facilitate the introduction of truly interactive processing, providing transparent access to diverse high-performance resources via the convenience of a workstation interface.

Introduction

Graphics workstations, considered a novelty a few years ago, are now justifiably accepted as productive geophysical tools. This paper is aimed at highlighting the true significance of the workstation, particularly in the light of potential developments in the area of Network Computing. This discussion focuses on the computer-intensive seismic industry, but our comments are more generally applicable.

Evolution of seismic computation

The past twenty years have seen a number of fundamental changes in our approach to seismic computation, prompted by a continual improvement in the price-performance ratio of computer technology over this period.

The late 60's saw the appearance of minicomputers specifically designed for seismic data processing (e.g. Command, Timap-I). These single-tasking fixed-point systems gave way to floating-point machines (Tempus, Timap-II) and subsequently to multi-tasking virtual machines (Tempus 32, Timap-4). Traditionally, seismic computers have necessarily required specialised vector processing units. These have evolved from 'high speed' arithmetic units for time domain convolution (Control Data's SPAM), through integer array processors (Raytheon ATP), to floating-point APs (IBM 3030, FPS 120B). The necessity for these traditional attached APs has been removed with the advent of modern vector computers (Cray, Convex, Alliant).

The means of user interaction with the computational unit has also evolved, in a similar fashion to that observed in other forms of technical computation. Batch input via paper tape and cards has given way to time-sharing systems using dumb terminals, intelligent terminals and ultimately dedicated graphics workstations, which are themselves full virtual computers. A natural offshoot of this movement of compute power towards the user has been the development of small stand-alone processing and interpretation systems based on PCs and workstations (e.g. Landmark). Whilst this trend is an aid to professional productivity, it may also imply isolation from centralised data bases, and from those peripheral facilities expected by users reared on conventional multi-user systems.

Multi-disciplinary nature of seismic data analysis

Seismic data analysis is an application which incorporates a variety of computing disciplines. Data sets are large, implying a priority for efficient methods of storing, accessing and sorting. At the same time, high performance in computation and increasingly sophisticated graphics are required. There is obvious scope for leading edge disciplines including Artificial Intelligence and Pattern Recognition.

Unfortunately, rather than attempting to integrate many disciplines, individual hardware manufacturers have tended to specialise in a more restricted niche. For example, organisations such as FPS and Cray have tended to focus on computation, whilst workstation vendors (Sun, Apollo), have concentrated on providing increasingly sophisticated user interfaces.

As indicated above, seismic system builders have traditionally attempted to satisfy their multi-disciplinary needs by custom building hybrid machines. Such an approach may imply compromises between competing disciplines. Additionally, it results in system specific programming, and reduces flexibility in terms of incorporation of new technology.

Towards an ideal integrated system

What would be some of the characteristics of a more ideally integrated system for seismic computation?

Such a system would tolerate greater flexibility in the selection of diverse hardware, permitting the integration of a range of special purpose CPUs, from compute-efficient vector machines, through graphics workstations, to low-end PCs. Each machine in the system would have access to data and peripherals on any other machine. Further, and more significantly, there would exist the facility to transparently distribute the compute load (even with a single program) across all available CPUs in an optimum fashion.

In such a system the graphics workstation would assume a pivotal role as the stable user interface. It would provide transparent access to a highly variable computing resource, able to expand or contract to suit different applications (and changing economics). Thus, for example, a user processing a VSP with a single onsite workstation would see the same 'virtual' processing system as a user in a major supercomputer centre.

Until the present, it has been impossible to conceive of approaching such objectives without incurring a massive programming overhead.

The promise of network computing

Emergent technology in the area of network computing has the potential for realisation of these ideals. One recently developed architecture, termed Networked Computing System, provides user-transparent facilities for high-speed distribution of both data and tasks across a heterogeneous network of workstations, mainframes and file servers. Task distribution is achieved by a Client, Broker, Server model which allows CPUs to advertise unused cycles for utilisation by applications emanating from other CPUs in the network. From the viewpoint of the applications programmer, the mechanism of task distribution is simplified by use of high-level declarative statements inserted in existing code.

Such a networking mechanism would permit fuller exploitation of the inherent partitionability of seismic data. It would simplify real-time process monitoring via multiple-CPU intercept and display techniques. In brief, it would facilitate the introduction of truly interactive seismic processing, providing transparent access to diverse high-performance resources via the convenience of a workstation interface.

A Study of Surface Seismic Waves with the Assistance of a New Tool — Particle Motion Records

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Summary

It has been recognised for a long time groundroll has an elliptical, vertically polarised particle motion. Body waves have a rectilinear particle motion. Interference between bodywaves can result in an elliptical type motion. Particle motion records provide a means of identifying these seismic waves and understanding the result of their interference upon particle motion. This is useful when assessing the results of filter techniques based upon either the ellipticity, or phase difference between components, of groundroll motion.

Introduction

Dobrin performed a series of surface wave experiments (Dobrin, 1951) which established groundroll was vertically polarised with a retrogressive, elliptical particle motion. His results confirmed the theoretically derived results of Lamb (Lamb, 1904).

Further empirical studies (Rene *et al.*, 1986; Heath and Evans, 1987) have shown groundroll motion to be more complex than suggested by Dobrin. Rene used hodographs to describe and characterise different modes of groundroll based upon their type of particle motion.

Digital filter techniques have been proposed to exploit the polarised, elliptical nature of groundroll to either enhance (in the case of seismologists) or remove (in the case of explorationists) recorded groundroll signal. Proposals have been made by E. A. Flinn (1965) for signal separation using rectilinearity and direction of particle motion, R. S. Simons