Client-server computer architecture saves costs and eliminates bottlenecks

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Workstation, client-server architecture saved costs and eliminated bottlenecks that BP Exploration (Alaska) Inc. experienced with mainframe computer systems.

In 1991, BP embarked on an ambitious project to change technical computing for its Prudhoe Bay, Endicott, and Kuparuk operations on Alaska's North Slope. This project promised substantial rewards, but also involved considerable risk.

The project plan called for reservoir simulations (which historically had run on a Cray Research Inc. X-MP supercomputer in the company's Houston data center) to be run on small computer workstations. Additionally, large Prudhoe Bay, Endicott, and Kuparuk production and reservoir engineering data bases and related applications also would be moved to workstations, replacing a Digital Equipment Corp. VAX cluster in Anchorage.

At the time, this 10-processor VAX cluster was one of the largest VAX installations on the West Coast.

Two of the questions that the multidisciplinary team of computer scientists, end users, management, and vendors would answer were:

Prudhoe Bay field on the North Slope of Alaska.

- Was it technically possible to replace a VAX cluster that occupied over 2,000 sq. ft of floor space and a supercomputer with a network of desktop computers?
- More importantly, did the change make business sense?

Strategy

The company started with a 4-month study that examined the technical and economic feasibility of moving applications to the workstation from both the X-MP and the VAX. Initial benchmarks using BP's existing VAX-based applications demonstrated a 60 to 1 improvement in workstation price/performance over that of the VAX mainframes.

The new computing scheme was estimated to cost $1.5-2 million to implement at the Anchorage site, but could potentially save $2.5 million annually in VAX and X-MP computing costs.

These savings, representing a 55% annual reduction in processing costs, were substantial enough to make a business case for the new technical computing scheme.

The risks for changing were recognized. Implementation of the new technology

on a large scale, software licensing issues, and network performance were all relative unknowns. Technical computing is critical to North Slope oil field management and disruptions can be costly.

Risk management was a priority. BP Exploration could not go it alone, especially in a remote region like Alaska. Therefore, BP solicited vendors' technical know-how and support as an integral part of the project.

In fact, this was a major criterion for vendor selection. A significant partner in the undertaking, International Business Machine Corp., offered ready access to its considerable expertise and personnel nationwide. Hewlett-Packard Co. and Sun Microsystems also provided good follow-up technical support.

Architecture

Most of the Anchorage VAX and X-MP-based applications will be moved to a client-server workstation architecture. The VAX cluster will be significantly downsized but retained for limited use.

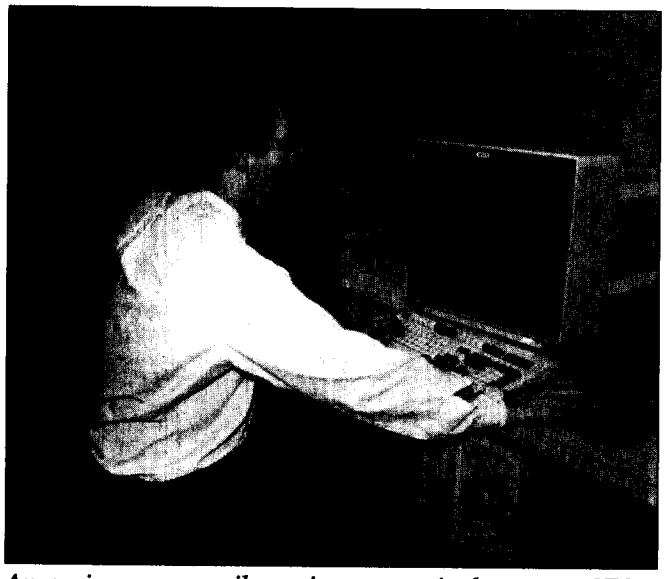
The client-server architecture involves a network of reduced instruction set computing (RISC) based IBM and other workstations linked to a multitude of personal computers. The workstations are dedicated to a number of tasks or functions.

IBM RISC System/6000 workstations, for example, act as servers, each dedicated to a specific function such as data base management, computations, graphics, printing, and file management. Each server can then be tuned to perform its specific function very effectively.

Two primary data bases moving to the data servers in Anchorage are:

- The production data base that contains geoscience and reservoir engineering data.
- The petrophysical log data base that has well interpretation and descriptions of oil deposits and rock types.

The workstation has a space-saving advantage when compared to the VAX 9420.



An engineer can easily review reservoir data on a UNIX workstation.

Through an extensive computer network, the data servers provide information from these data bases to other workstations called compute servers. Compute servers, as the name implies, perform technical computing tasks such as reservoir simulations and visualizations.

Computer graphics generate visual representations of the simulation. The 1,100 Apple Computer Inc. Macintoshes and other personal computers (PCs) already in Anchorage serve as end-user clients that provide BP Exploration engineers easy access to the workstation network via a graphical user interface (GUI).

The client-server project in Anchorage also initiated BP Exploration worldwide to migrate from a variety of data base management systems (DBMSs), including Oracle Corp.'s Oracle and Ask Computer Systems Inc.'s Ingres on the VAXs, to Sybase Inc.'s Sybase.

The standardized DBMSs will greatly ease data access and sharing for the engineers and geoscientists using the system. The data base will provide a much higher degree of data consistency and integrity.

The migration to Sybase was done by a total re-engineering of technical applications.

The business plan for the new computer installation was developed between February and May 1991. The actual conversion process is expected to take approximately 1½ years, to the end of 1992.

The project is well under way, and early results show that the new computer architecture meets the cost-savings objectives and also meets or exceeds the performance of its larger predecessors.

Moreover, response from end users who have switched over to the new architecture has been very enthusiastic.

Prudhoe Bay

The Prudhoe Bay resource development team consists of 120 geologists, geophysicists, reservoir engineers, and production engineers. The reservoir engineers historically have been the major users of high-performance computing, especially in the area of reservoir simulation.

Many of the reservoir simulations previously run on the X-MP are now running on RISC System/6000 workstations. The transition has been smooth. Users submit work to these machines in the same way as with the X-MP.

Benchmarks have shown that, while the workstation takes two-to-three times longer than the X-MP to process a job (as measured by the computer's central processing unit), the total time required by the workstation can often be equivalent to or better than the X-MP.

This is because of data communications bottlenecks between the Houston-based X-MP and Anchorage-based users. Time is consumed sending large files back and forth between sites, and X-MP job run-time is further lengthened because the X-MP resource is often shared by many jobs simultaneously.

Even though, on average, BP X-MP's performance ex-

ceeds that of the workstation, many users in Prudhoe Bay have found that the workstation is more than a match for the supercomputer.

For example, computer simulations of Prudhoe Bay can require several days for processing and data transfer between Anchorage and Houston. This often occurs when the X-MP is fully loaded with numerous processing jobs. With a local workstation, these simulations can be completed in less time.

In addition to improving job turnaround, workstations also allow reservoir engineers to do their jobs better by permitting an interactive and much more detailed graphical analysis of their simulation runs. One result is a dramatic improvement in the history matching process. In the iterative process, adjustments are made until the simulation matches historical field performance.

Well-work conversion

User acceptance of the new computer architecture has been enthusiastic. Its use has been endorsed by BP's major partners on the North Slope.

The first Prudhoe Bay petroleum engineering program to be converted to the new workstation network, the well-work evaluation tracking system (WETS), is an example.

WETS contains well work benefits from rig workovers, fracture treatments, acid work, perforations, and gas/water cement squeezes. The program tracks oil production increases that can be used in economic analysis.

Conversion of the system began in October 1991 and was completed by the end of the year. The system, in full use since January 1992, has a RISC System/6000 workstation and a Macintosh user interface.

Because of its effectiveness, WETS has been endorsed as the field's official tracking system not only by BP but also by all of the Prudhoe Bay working interest owners, including ARCO Alaska Inc. and Exxon Co. U.S.A.

Corrosion

The client-server architecture has also found acceptance in corrosion management. As facilities on the North Slope age, corrosion becomes a significant risk that requires stepped-up vigilance and tracking.

By early 1992, 12 incompatible corrosion data bases and applications were re-engineered into a single data base residing on a data server in Anchorage. Immediate access to the data base is now available to Macintosh clients dispersed throughout the North Slope. This enables corrosion engineers to analyze each situation based on the most up-to-date and comprehensive set of information.

Improved inspection coverage, optimized inhibitor rates, and increased correlation between inspection results and chemical use all contribute towards longer equipment life, reduced risk levels, and consequent savings of millions of dollars.

The corrosion management application is designed to be portable enough to use throughout BP Exploration with minor modifications. Duplication of effort and expense can now be avoided in future field developments.

BP's Colombian development, for example, can benefit immediately from this tool.

Endicott

BP's Endicott geosciences group, selected for a pilot project to evaluate whether applications should be moved off the VAX cluster, determined that more than 80% of its work could be run in the new client-server workstation environment.

The only computer programs remaining on the VAX include "legacy" applications, which are not cost-effective to convert, and programs that soon will be obsolete. The Endicott development unit has moved all

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of its reservoir simulation work from the X-MP in Houston to two local RISC System/6000 Model 550 compute servers connected to Macintoshes on the engineers' desks.

Unlike Prudhoe Bay, where very large-scale, full-field compositional simulations still must be run on the supercomputer, all Endicott models, including full-field, are easily accommodated on the workstation. Endicott reservoir simulations now run faster on the workstations than on the X-MP. When the X-MP is fully loaded with processing jobs, workstation turnaround can be as much as three times faster. The resolution of the reservoir models has also improved.

Endicott engineers can now run much larger and more detailed models on the workstations, including full-field models, than on the X-MP supercomputer. The X-MP's high cost of computing placed a major constraint on the work that could be done.

Additionally, Endicott geologists use the personal computers on their desks to access production data bases for all the North Slope fields.

Applications include maintaining monthly production statistics, developing estimates of fluid contacts, maintaining data on original fluid contacts, and tracking fluid movement in the reservoirs.

By using the point-and-click mouse and cut-and-paste function of their desktop computers, engineers now can easily develop their own custom reports. For example, an engineer might extract information for mapping purposes and the associated x and y coordinates relating to the mapped depths. This information then can be placed into a document format, created on a desktop computer.

Worldwide application

Although BP's client-server project in Alaska is still under development, its results and pay-back have been impressive. Indeed, this project, in its early stages considered a maverick, has since become a showcase.

Recently, BP Exploration, worldwide, has declared it will adopt the client-server architecture pioneered in Anchorage to all BP Exploration regions. The scalability of the architecture permits implementation across large sites as well as smaller stand-alone locations.

Also, portability provided by the desktop architecture permits easy installation in remote locations such as Colombia and Viet Nam.

Early estimates now indicate that full migration to this architecture might save BP Exploration between $10 and $20 million in annual technical computing costs worldwide.

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BOOK

Microprocessors in Process Control, *by J. Borer. Published by Elsevier Science Publishers Ltd., Crown House, Linton Road, Barking, Essex, IG11 8JU, England. 398 pp., £75.*

The book describes the technology of measuring, in an industrial context, the most common and most important variables: pressure, level, flow, and temperature. It also provides the established techniques by which a process plant is regulated and controlled.