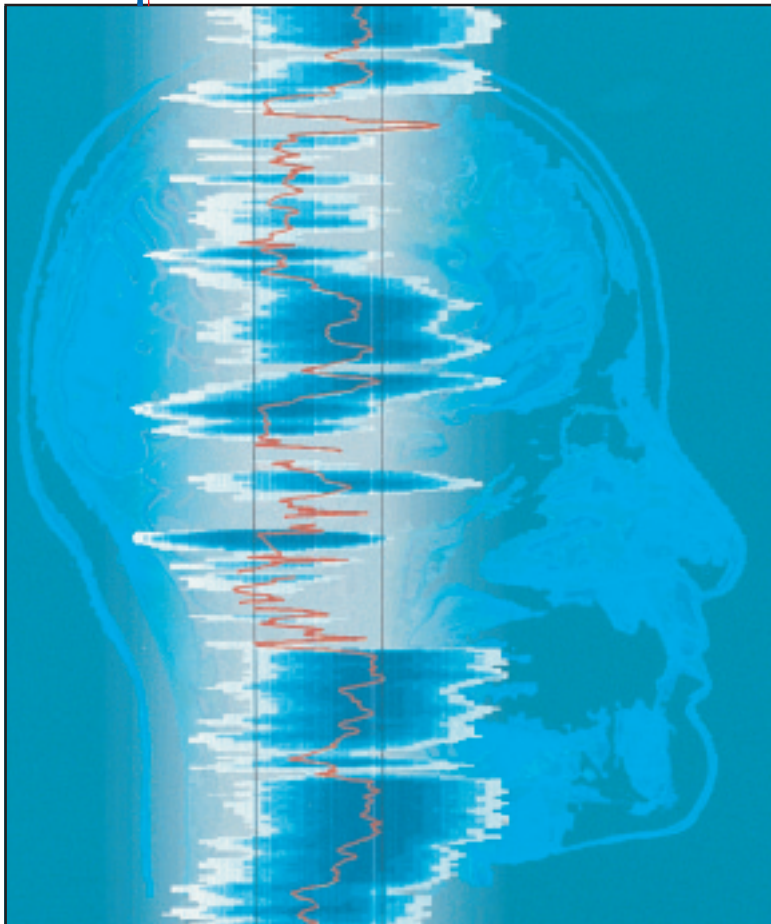


# THE AMERICAN OIL & GAS REPORTER®

JULY 2001

The "Better Business" Publication Serving the Exploration / Drilling / Production Industry

## New Technology



**Internet  
Seismic  
Processing  
Shortens  
Time To  
Drilling  
Decisions**

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# Internet Enabling Remote Processing

By Alexander Mihai Popovici  
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MOUNTAIN VIEW, CA.—Two years ago, the world got excited about the business opportunities that a new “disruptive” technology, the Internet, could create. Disruptive technologies are the Holy Grail of venture capitalists, because they have the potential to displace established, mature companies with good management by startup companies. The startups introduce products that initially underperform the established products in mainstream markets, but have other new features that eventually lead to the displacement of older mainstream technology.

The new products are usually cheaper, simpler, smaller, more convenient to use, and are not developed by incremental improvements over existing products, but by a new approach that initially has worse performance than the leading brands. Eventually, the performance of the new products matches and then exceeds the performance of the mainstream products, and the extra features become a compelling argument for replacing the status quo. The startup companies displace large companies that do not incorporate the new features in their product. New shareholder value is created in the process, hence the interest of the venture capitalists.

About 30 examples of disruptive technologies in various fields are given by Clayton Christensen, in his book *The Innovator's Dilemma*, including:

- Minicomputers replacing mainframe computers;
- Arthroscopic surgery replacing open surgery;
- 8.0-inch Winchester drives replacing 14.0-inch drives;
- 5.25-inch drives replacing 8.0-inch drives;
- Mobile telephone replacing wireline telephone;
- On-line stock brokerage replacing full-service stock brokerage;
- Digital photography replacing photographic film; and
- Digital printing replacing offset printing.

In geophysics, a few disruptive technologies are:

- Digital recording;

- Migration imaging;
- Interpretation workstations;
- Interactive workstation processing; and
- Internet seismic processing.

## Infrastructure Technology

The Internet is an infrastructure technology that is enabling the disruption of many industries. But the Internet itself is a commodity—a medium for delivering services, disseminating information, and doing business. Simply having an Internet strategy or presence is no longer a differentiating characteristic for a business enterprise. The recent burst of the dot-com bubble underscores this fact. The real market showed that selling pet food or shampoo over the Internet is not a high-tech enterprise with large barriers of entry.

There is a lot of talk about the New Economy versus the Old Economy. We do not believe there is a “new” or an “old” economy, only the “real” economy—last year’s economy, this year’s economy, and next year’s economy. In a white paper, Bob Peebler, vice president of e-business strategy and ventures at Halliburton, argued the market influence of the New Economy, noting that “Cisco has a market cap of \$400 billion on sales of \$19 billion and earnings of \$3 billion. Exxon has a cap of \$306 billion on revenues of \$241 billion and last year’s earnings of \$13 billion. Exxon, whose earnings are four times greater than Cisco’s, has only 75 percent of Cisco’s market capitalization!”

In the real economy, that means that Cisco is a factor four times overvalued! After the burst of the Internet bubble, Cisco’s market cap fell to \$128 billion. The real economy always wins.

Nonetheless, the Internet is a new and disruptive technology that ushers in a paradigm shift for many industries, and seismic exploration is among them. So while in the long run Internet technology will not differentiate an enterprise from its competitors, it will become a key component of daily operations, and that component will have to be well implemented to leverage the power and competitive advantage inherent in the Internet. As in any paradigm shift, the disruptive technology will differentiate

between those companies that will adapt and survive, and those that will not.

Many exploration organizations, especially smaller independents, have no direct access to high-end seismic imaging technologies because they lack the resources to acquire and maintain the necessary software and hardware, or because their business model requires them to outsource the technology. Existing commercial packages are targeted to run effectively on workstations, not on large parallel systems, so they are ineffective for the high-end applications. As a result, only the central processing departments of large oil and gas companies can afford to employ large-scale parallel computers for imaging three-dimensional seismic data, and even these companies are outsourcing many of their needs.

The rest of the exploration industry outsources all large 3-D seismic imaging projects to geophysical service companies. According to this outsourcing model, the data are sent to the service companies, which process the data and then deliver the final images after several months.

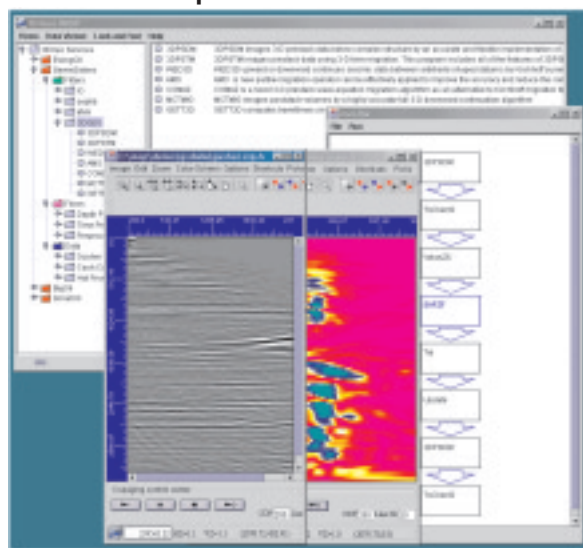
## Internet Seismic Processing

Internet technology has reached “critical mass” faster than any new technology in recent history by reaching 50 million users in only five years. The energy industry alone spent \$3 billion on Internet technologies in 1999, and E&P companies such as Conoco have already used the Internet for collaborative business partnerships and projects. Both Chevron and Schlumberger have established efforts to access, share and distribute well and seismic data over the Internet. Computing resources for production processing and imaging of seismic data are outsourced by several major oil companies for both routine seismic processing and research. For these applications, oil and gas companies usually purchase a set amount of central processing unit (CPU) time and run their own proprietary algorithms on the computers. Access is usually provided through a fast dedicated network connection.

Internet seismic processing creates a software infrastructure that enables geologists and geophysicists in any organization to have direct control of depth-imaging projects and to have access to remote



**FIGURE 1**  
**Graphical User Interface for Internet Processing**



Internet-based GUIs for remote processing services allow the user to navigate the remote server and examine projects, datasets, flows, and processing module parameters while interacting with seismic data, velocity models, migration CRPs and stacked images, semblance panels, etc.

large-scale parallel computers. By enabling remote access to large shared computer facilities, Internet processing software overcomes the economical and operational obstacles that prevent the vast majority of exploration projects in difficult areas to fully benefit from the rapid progress in high-performance computing and seismic processing.

Internet processing technology promises much shorter times between the acquisition of the data and the informed decision on where to drill. Internet pro-

cessing creates a tighter coupling of processing time with interpretation time by giving clients the capability of setting, controlling and verifying the data processing jobs during run time. Oil and gas companies can start interpreting data during the processing time, and therefore, shorten the time to drilling decision.

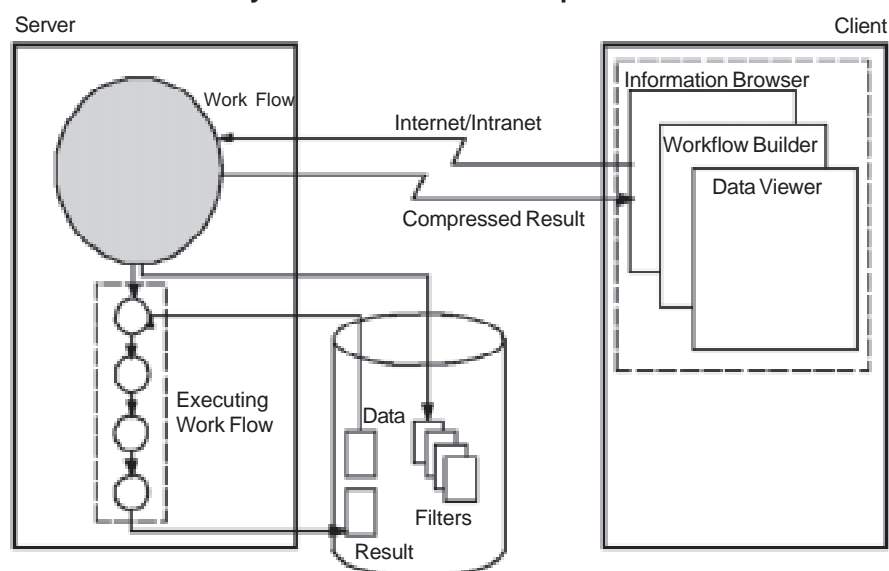
### Paradigm Shift

There have been many significant paradigm shifts in geophysics, and the

industry is in the middle of another one with the industrywide impact of e-commerce. The adoption of rapidly evolving Internet/intranet infrastructure and platform-independent programming languages is allowing companies to take advantage of the flexibility and technology leverage inherent in this new information paradigm.

While the brave new world of the Internet and the associated information technology explosion offer unprecedented opportunities, there are many implementation and data security issues that warrant attention. The challenges are all surmountable by intelligent design that leverages existing technology. The upside for the geophysicist/user is a set of globally accessible processing and interpretation tools available on demand, as needed, without the burden of software upgrades, equipment purchases and hardware administration.

**FIGURE 2**  
**System Architecture Components**



Web-based seismic processing seamlessly integrates the client-server paradigm over the Internet.



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Internet seismic processing technology integrates a graphical user interface (GUI) with state-of-the-art software applications to give users a flexible and dynamic new solution for processing geophysical data (Figure 1). Flexible client-server architecture is the foundation for the technology. The user can access the processing system using a Java-enabled computer and standard Web browser connected to a local- or wide-area network. Server-side processing is used to control compute-intensive applications such as 3-D depth migration, while the client builds processing flows and conducts interactive quality control and model building.

Java is ideal for Web-based processing, since the programming language was designed specifically for networking and is capable of dealing with security and parallel distributed computing—both of which are key issues for geophysical applications. The Java client-

server design allows processing systems to leverage the “write once, run anywhere” capabilities of advanced GUIs and process management tools, while using highly optimized seismic imaging algorithms running on specialized high-performance computers for the number-crunching tasks.

The essential components of a global system architecture for Web-based processing are schematically represented in Figure 2. The key elements are the computational server, the client, and the Internet/intranet connection. Key features include platform independence, multiuser access, flexible security mechanisms (such as user authentication and authorization based on standard application programming interfaces), transparent encryption, data compression, and advanced user interface capabilities.

The server launches and manages the compute-intensive work flows. The seismic work flows execute program modules written in a computationally efficient language (such as C or Fortran) and are compiled for a specific platform. The processing modules are efficient in processing large amounts of data and can take advantage of parallel architectures and distributed computing.

The client is used to construct and manage (execute, interrupt, stop) work flows, as well as display seismic sections, velocity models, gathers and semblance data sets, allowing direct data interaction such as picking and velocity model building and editing (Figure 3). As an intuitive GUI, the client masks all details related to the specific platform that the server and interpretation modules are running on. The user interacts with a mouse-driven interface, where the projects and the seismic modules (filters) are organized hierarchically. The GUI gives users access to a dialog system, where they can enter or modify job parameters.

### Collaborative Processing

Collaborative Internet seismic processing essentially means peer-to-peer (P2P) technology applied to interactive seismic processing. With the implementation of P2P, Internet seismic processing becomes a tool that facilitates the communication between members of a geographically distributed exploration team, providing them with the tools that help them easily share information, regardless of physical distance between members of the team. Of course, team members' workstations must be able to access one another over the Internet or

a private network.

Collaborative Internet seismic processing implements a new approach to collaboration for explorationists. There are competing technologies that attempt to achieve a similar result. One approach, for example, is to use an extension of the X protocol, designed to work over wide-area networks. Essentially, with such a configuration, there is a central geophysical application running on the server and there are thin clients accessing this application over the network. The thin clients are either standalone programs or Web browser plug-ins that act as an X server that the remote central application uses to display its graphical output. While this approach has the advantage that the central application runs without modification, the drawback is that network communication is slowed by a whole series of X events (such as mouse moves) being sent over the wire to and from the clients. If more than one client is involved, all clients must use the server as a relay, further slowing user interaction and collaboration.

Using Java for network communication, a certain amount of computing is transferred from the server to the clients. While the most significant amount of the processing is left on the server (an imaging computation, for example, is certainly done on the server), the client handles most of the interaction-related tasks, such as generating the picks and moving the picks within the data cube or browsing locally through the data cube. When similar actions need to be performed on the peer clients, only the control information is transferred over the wire directly to the client(s), instructing it/them to replicate the actions. This results in faster communication and an almost instantaneous real-time experience.

### Potential Advantages

Java programming and Internet concepts offer many potential advantages to users. Internet seismic processing provides a software infrastructure that enables geologists and geophysicists to have direct control of depth-imaging projects and to have access to remote, large-scale parallel computers as effortlessly and effectively as if they were employing a workstation linked to their companies' own local-area networks. This overcomes the economical and operational obstacles that often prevent many exploration projects in difficult ar-

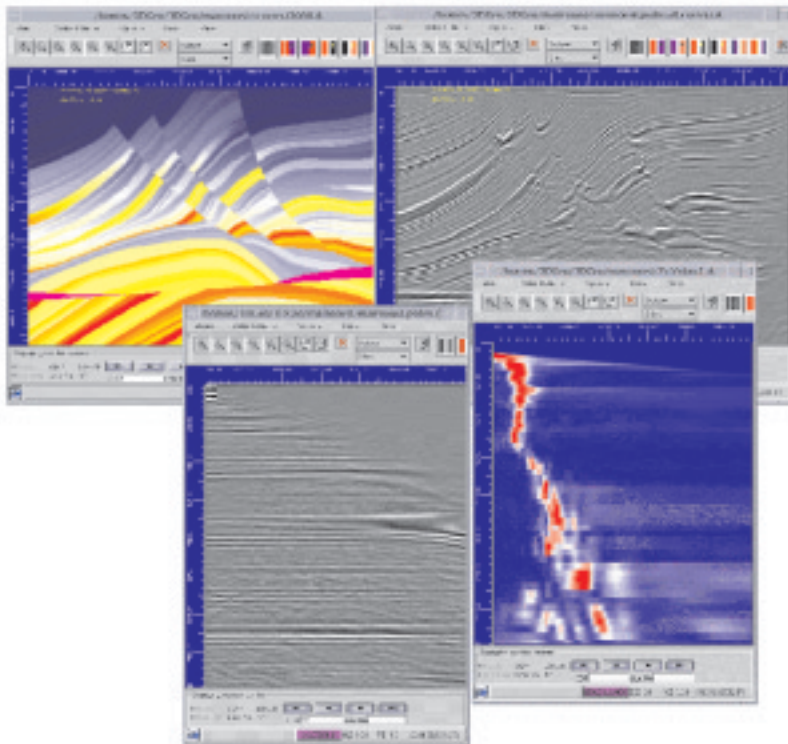


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**FIGURE 3**  
**Remote Work Flow Management and Image Display**



Multiple data sets can be viewed concurrently over the Internet, allowing a remote user to QC processing jobs, interpret results, build velocity models, and perform processing tasks such as picking or editing.

Users can benefit from high-performance computing and advanced processing algorithms.

These resources can be made globally available wherever there is Internet access. The geophysicist can be in the field, and use computing resources from a central location, or collaborate with geographically remote colleagues and team members by accessing and examining the same data files and processes. For shipboard processing, satellite data links can allow land-based geophysicists to quality control and process data as it is acquired using the ship's computers.

Internet-based processing can also speed processing turnaround times and optimize results because it allows the interaction of interpreters at all stages of data processing, and gives them the ability to make changes and alter the processing sequence as the job evolves. This is especially critical in velocity depth model building where interpretation input can be critical to obtaining the best depth-migrated image.

Another main advantage is that geophysicists are freed from many time-consuming software and hardware issues, such as operating system or software compatibility. With the latest software technology and processing tools, along with the high-performance computing resources required to run them, built into Internet processing services, geophysicists can concentrate on their core competencies: applying their geoscientific expertise to help their companies attain their exploration and production goals.

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