Internet-Based Seismic Processing: The Future of Geophysical Computing

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Summary

There have been many significant paradigm shifts in geophysics, and we are in the middle of another one with the industry-wide 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 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 which 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.

Introduction

We describe a flexible client-server processing system that has been designed explicitly for Internet/Intranet use and has been tested and used on both. The server-side process controls compute-intensive applications such as depth migration while the client builds processing flows and allows interactive QC and model building. The power of the system lies in the extreme ease of integrating processing modules in the system, and in the platform independence of the client, which can be delivered to the user as a Java standalone client or as a Java applet. For the user, this means that access to the powerful processing system is attained with any Java-enabled computer and web browser. We call this design the Internet Seismic Processing System (INSP).

Internet technology has reached "critical mass" faster than any new technology in recent history by reaching fifty million users in just five years. The energy industry alone has spent three billion dollars on Internet technologies in 1999 alone, and companies like Conoco have already used the Internet for collaborative business partnerships and projects (Upstream, 2000). Both Chevron and Schlumberger have established efforts to access, share, and distribute well and seismic data over the Internet (WSJ, 2000). 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 companies usually purchase a set amount of CPU time and run their own proprietary algorithms on the computers. Access is usually provided via a fast dedicated network connection.

What we describe here is a targeted seismic solution which includes a graphical user interface, seismic applications, and a flexible and dynamic system. The GUI is written in the Java programming language, allowing client portability and access from any type of computer on either a local or wide-area network. This takes advantage of the fact that Java was designed specifically with networking in mind 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 of INSP allows us to leverage the "write once, run anywhere" capabilities for the GUI and process management while using highly optimized seismic imaging algorithms running on specialized high performance computers for the number-crunching tasks. The computational modules, launched by the Java server, are written in C and Fortran to take full advantage of the computational efficiency offered by those languages. This model is similar to the JavaSeis system implemented at ARCO for distributed parallel computing (Hassanzadeh and Mosher, 1996). JavaSeis has been extensively prototyped at ARCO in conjunction with the ARCO seismic benchmark suite of processing algorithms, and has successfully demonstrated the utility of this approach on ARCO's network (Hassanzadeh and Mosher, 1998).

Internet-based seismic processing

The Advantages of INSP

Java programming and Internet concepts offer many potential advantages to the user. INSP 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 local-area network. This overcomes the economical and operational obstacles that often prevent many exploration projects in difficult areas from fully benefiting 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 he/she can collaborate with geographically remote colleagues and team members by accessing and examining the same data files and processes. For ship-board processing, satellite data links can allow land-based geophysicists to QC and process data as it is acquired using the ship's computers.

INSP can speed processing turn-around time 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.

Under the INSP model, the geophysicist does not have to concern himself with operating systems, software versions, which software to buy, or which hardware to buy. The geophysicist can concentrate on science and exploration goals, not get bogged-down with computer issues. The client-server package is written entirely in Java, which makes it completely portable. All that it is required for INSP to run is the Java Runtime Environment (JRE) installed on both the server and client machine. Most recent operating system distributions come with JRE preinstalled, and for those that do not, it can be easily downloaded from the web. Running the INSP interface application as an applet eliminates the need for software upgrades on the client side.

INSP System Components

The global system architecture of INSP is schematically represented in Figure 1. The essential components of this architecture are the compute server, the client, and the Internet/Intranet connection. INSP was built using the latest software technology and tools available today. Key features include: platform independence, multi-user access, flexible security mechanism that includes user authentication and authorization based on standard Application Programming Interfaces (API), transparent encryption, data compression, and the latest advances in user interface design.

Computational Server

The server runs on a computational machine which launches and manages compute-intensive workflows. These seismic workflows execute program modules written in a computationally efficient language such as C or Fortran and are compiled for a specific platform. These processing modules are efficient in processing large amounts of data and can take advantage of parallel architectures and distributed computing.

Portable Interpretation/Processing Client

The client has two main functional modules: one is the Information Browser/WorkflowBuilder used to construct and manage (execute, interrupt, stop) flows, the other one is the DataViewer, which can display seismic sections, velocity models, gathers and semblance data sets (Figure 2). The DataViewer allows direct data interaction such as picking and velocity model building and editing. The core of the graphics is based on the Java Graphics subsystem. The Java Graphics subsystem API is a generic, low-level API that covers a broad spectrum of graphics, and is designed to serve all manner of graphics needs. It provides the underlying support for graphics on the Java platform. Swing, used to build the GUI relies on the Java Graphics subsystem API for all drawing operations.

The client is an intuitive GUI that masks all details related to the specific platform the server and the 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 data files used as input for the workflows, the results of the workflow, and even the saved workflows are organized hierarchically. Through the GUI, the user has access to a dialog system, where he can enter or modify job parameters in user-friendly environment. The dialogs are designed to offer incremental levels of access to module parameter complexity, allowing the user to choose between required, typical, and full sets of parameters. The graphic appearance of the dialogs is customizable according the user's preference. All the graphic components used to build the interface are standards included in the Java Swing API.

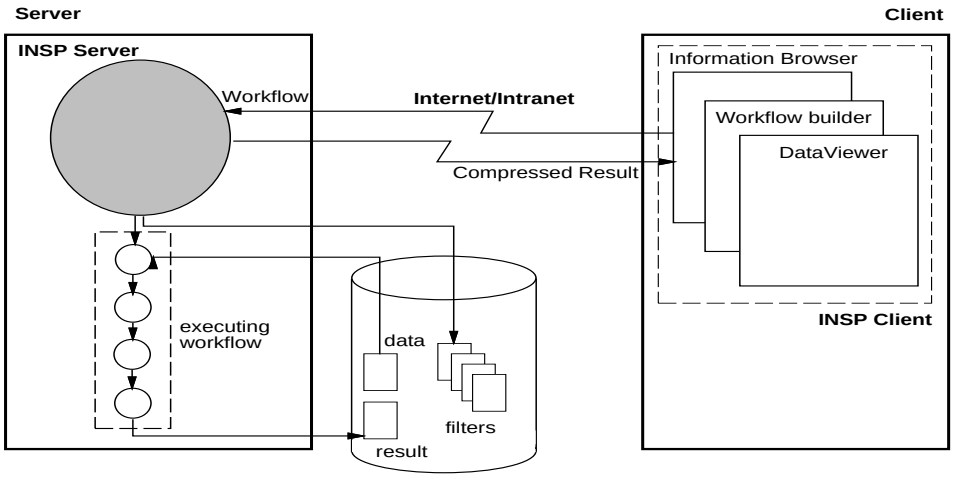

Figure 1: INSP seamlessly integrates the client-server paradigm over the Internet.

Internet/Intranet connection

The network communication protocol used by the clients to talk to the server is implemented using RMI (Remote Method Invocation) API. The Java Remote Method Invocation system allows an object running on one Java Virtual Machine (VM) to invoke methods on an object running on another Java VM. RMI provides for remote communication between programs written in the Java programming language. This mechanism is used for the implementation of a proprietary authentication protocol within its dedicated authentication layer. The core of the authentication layer is JAAS (Java Authentication and Authorization Service), which is a framework and standard programming interface for authenticating users and assigning privileges. Below this level, and on top of TCP/IP, we optionally and transparently layered a Secure Socket Layer (SSL). SSL is today's *de facto* security standard over the Internet. However, if the system is used inside a secure intranet, such as a corporate intranet, the SSL layer can be disabled, thereby increasing network transfer speed. Additionally, INSP takes advantage of the Java-native feature of having signed code; When code is loaded, it is assigned permissions based on the security policy currently in effect. The policy, specifying which permissions are available for code from various sign-ons and locations, is initialized from a configurable policy file.

Conclusions

The potential of Internet-based seismic processing in geophysics is significant because it makes seismic depth imaging and other compute-intensive technologies accessible to a large community of users while providing an efficient resource distribution and allocation to all potential users requiring access to high performance computing facilities and state-of-the-art software. Internet computing allows greatly increased interaction between the client and contractor, thereby increasing the quality of the final seismic image and in turn reducing exploration risk and offsetting the high costs of exploratory drilling and failed reservoir management projects.

References

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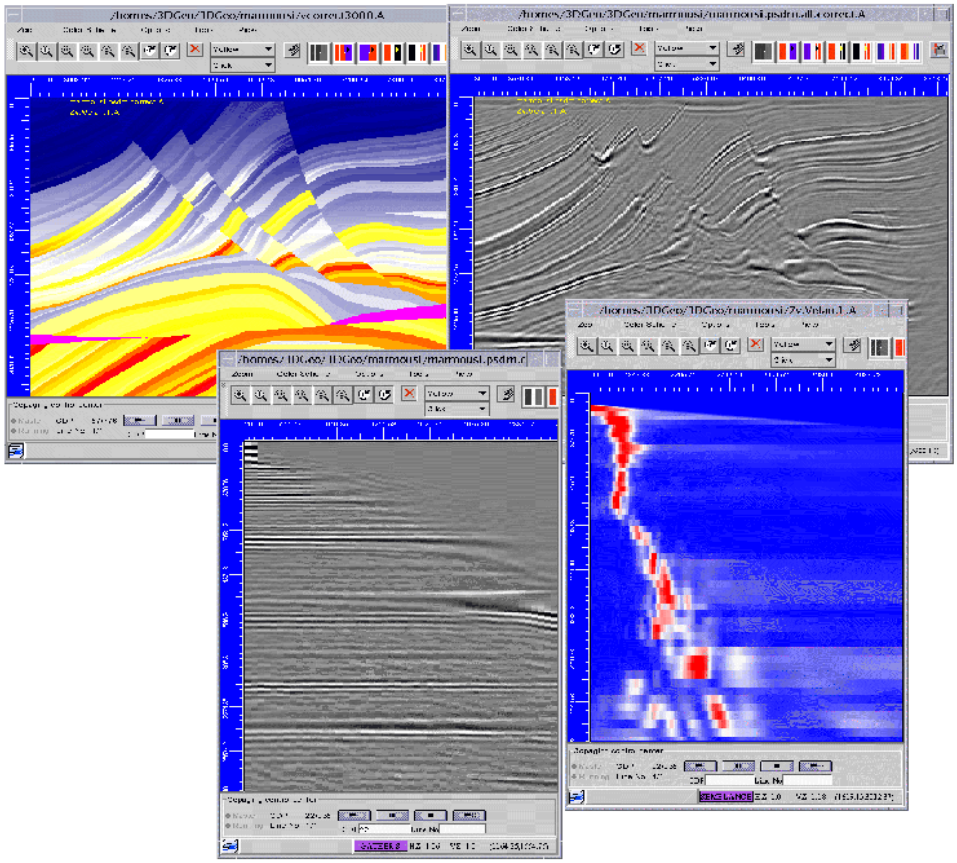

Figure 2: INSP allows many data sets to be viewed concurrently over the Internet, allowing user interaction and QC of processing jobs.