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Wireless Seismic Capabilities Advance

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SUGAR LAND, TX.–Over the past three decades, the oil and gas industry has experienced a major technological leap in the effectiveness of geophysics, exploration, and production operations. Advancements in seismic data acquisition have led to a huge increase in exploration and production efficiency, enabling more data to be collected more quickly and reliably, with greatly improved images of the subsurface geologic structure.

Although there are many opinions about what the industry's future holds, there is agreement on one indisputable fact: The global demand for energy will continue to grow, and the need for advanced technology will mirror this exponential growth. As seismic technology improves, data acquisition will continue to become more advanced, accurate and reliable, resulting in higher production and meeting the global energy demand for decades to come.

Seismic data acquisition using reflection seismology techniques is the most effective method of subsurface exploration. The ability to acquire and process seismic reflection data through multichannel acquisition systems, resulting in 2-D and eventually 3-D seismic surveys, has made it possible to accurately predict, infer and estimate the position of subsurface geological structures that contain mineral and natural reservoirs.

The size and scale of seismic surveys has increased alongside the significant concurrent increases in computer power over the past two decades. This has helped the seismic industry go from laboriously and rarely being able to acquire small 3-D surveys to now routinely acquiring large-scale, high-resolution 3-D surveys.

However, cables required for 3-D surveying can make obtaining data difficult. Because of the amount of cables on the ground, 3-D seismic crews have to work hard to deploy the equipment, and roads, rivers, railway crossings and inclement weather can be problematic. In other areas, animals destroying or eating the cables are an issue. Some high-channel-count cabled systems have grown so large that it can be difficult to manage and repair cables, except in large desert areas that have no roads, structures or animals.

Wireless, real-time data acquisition systems have proven particularly valuable in difficult-to-access areas such as this mountainous region. Data are transmitted from one rechargeable battery-powered wireless remote unit to another in series to a line interface unit, which collects the data and relays them through an Ethernet port to a computer, armored fiber-optic cable or backhaul radio.

Seismic Data Go Wireless

Geophysicists have wanted to do away with cables since the early years of seismic data acquisition technology, but lacked the technology to do so. The first practical radio seismic recording system was accepted as an alternative to cable-based systems more than 20 years ago.

While the technology reduced the logistics required and made it easy to troubleshoot, it was not as functional as users wanted in a wireless seismic system. This radio-based system could provide status updates on the quality and health of the equipment, but it did not send comprehensive, real-time data (i.e., provide the complete record to the recording).

To view the data and ensure the quality of the shoot, operators had to undertake a tedious data collection process. Signif-

The first widely accepted cable-free seismic systems were introduced a decade ago, and since have grown to more than 25 percent of the world seismic acquisition market. The early units were self-contained systems that digitized data from a sensor and saved them in memory. The next generation of data acquisition systems should be able to leverage numerous advances in wireless transmission, and power and data storage, to further improve efficiency, reliability and overall recording capabilities.

icant system weight; health, safety and environmental risks; and complex networks added further constraints to cabled-based and early cableless systems.

The arrival of wireless technology, with its smaller, more portable and lightweight design, together with its ability to work separately or in conjunction with other cable-based recording systems, has been extremely beneficial to the industry.

As with modern, distributed, cable-based systems, data are digitized at the place of acquisition so that analog signals are not transmitted over distances. This means that when a signal reaches the data acquisition unit, there is no loss in the quality of data because of the quality of the communication link.

The first widely accepted cable-free seismic systems were introduced by a number of companies about a decade ago. These systems offer a type of cable-free acquisition best described as an "autonomous node." The units are self-contained acquisition systems that digitize the data from a sensor and save the information in a memory. They require no connection to the outside world except global positioning satellite for timing and a battery for power.

The data are collected by carrying the actual unit to a base camp where the data are extracted to a computer and reformatted into a suitable seismic record. The data from some versions can be collected with a "drive-by" radio-linked device–daily if desired–to protect the data and get an earlier look at the results.

The Latest Generation

The latest generation of wireless seismic technology has the ability to record higher bandwidths and collect data in real time from tens of thousands of channels. This wireless seismic data acquisition technology eliminates the risk of losing data and having to reshoot because of unit theft, damage, cultural and environmental noise or malfunctions, and issues related to data collection and transcription.

The overall deployment configuration of an advanced wireless recording system resembles the configuration of a traditional cabled seismic system, minus the cables. The primary components consist of:

- Compact wireless remote units (WRUs);
- Wireless infrastructure to transmit seismic data from the distributed modules to a central repository;
- A powerful backhaul system to ensure secure data transportation; and
- A central data management, display, storage and control system.

The WRU is at the heart of the system. It contains a high-fidelity analog-to-digital converter, digital control circuitry, and a two-way radio operating in the 2.4 gigahertz band. Each rechargeable battery-powered WRU digitizes the signals from external analog geophones.

Data are transmitted from WRU to WRU in series down the line, where they are collected by a line interface unit (LIU), which acts as the interface between the network of WRUs and the backhaul system. The LIU has an Ethernet port that can be connected directly to a computer, or more commonly, to an armored fiber-optic cable or a backhaul radio. Once the seismic data are converted to Ethernet packets, a high-bandwidth backhaul system is employed to transport the packets to the central recording unit in real time.

Options for the backhaul system include radio-based communication on high-capacity, unlicensed frequencies; armored fiber optics; and third- and fourth-generation virtual private networks for urban and suburban deployments. Multiple backhaul technologies can be utilized on the same seismic spread through flexible "mix-and-match" combinations.

The central recording system gathers data from the lines through the backhaul and can perform synchronous and asynchronous stacking and correlation. It typically is installed in a recording truck. Because data are gathered in real time, the operator can observe the noise monitor and quickly verify system status and data quality.

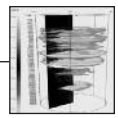
Value Of Technology

Wireless data acquisition systems offer many advantages to both the seismic service companies collecting the data and the oil and gas operating companies that use the processed images to make drilling decisions. These wireless technologies have made data acquisition much more efficient, flexible, and cost effective. Operators generally have a choice between operating with a much smaller field crew or collecting the data much faster than with a traditional cabled system.

Improvements in subsurface image resolution have been made possible as more channels of equipment are deployed and new operational methods, such as point-source/point-receiver, are implemented. Wireless systems can adapt easily to survey designs with unique geometries, and have given the industry the ability to maximize reservoir illumination.

Real-time data acquisition technology also has reduced the decision-making timeline during exploration and production. By mitigating risk and minimizing downtime, users of this enhanced technology have noted significant reductions in both the time and cost associated with acquiring seismic datasets.

Wireless, real-time data acquisition systems have proven particularly valuable



in difficult-to-access areas, including mountainous and urban regions, as well as in politically or economically unstable countries. The technology allows operators to obtain cost-effective data in areas where terrain limits the accessibility for cable-based operations, or local environmental or cultural issues may be of concern.

In one instance, for example, a seismic data contractor was able to operate in a remote, mountainous region using about half the normal size of a surveying crew required for an 8,000-channel survey.

As with every area and function within the oil and gas sector, the lack of skilled workers impacts data acquisition. By using wireless, real-time data acquisition systems, service companies and operators can reduce cost by limiting the maintenance required and completing jobs with less human capital. This benefit also reduces a company's environmental footprint, minimizes the impact on local communities, and improves overall safety of workers.

Potential Of Wireless

While it is always difficult to determine accurate figures for market share, it appears that wireless seismic systems have grown to more than 25 percent of the world seismic acquisition market from virtually nothing only five years ago.

Wireless systems are used and accepted widely in the United States, where users are more ready to adopt new technology that leads to lower costs. As a result, the majority of wireless seismic recording applications have been in the North American onshore market.

Wireless systems have not been adopted as quickly abroad. But, as global energy demand continues to increase, it is very likely that an uptick will occur in the use of wireless seismic data acquisition.

Although advances in technology have improved the data acquisition process, more improvements can be made, specifically to the amount of cables that are required for telemetry and for connecting sensors to the acquisition units. The next generation of data acquisition systems also should be able to leverage numerous advances in wireless transmission, and power and data storage, which will further improve the efficiency, reliability and overall recording capabilities of wireless solutions.

Future wireless systems should give geologists and geophysicists the ability to customize survey designs for a specific subsurface and deliver enhanced image quality. The technology also must improve the productivity of land acquisition operations and minimize still more the operator's environmental footprint, since the industry can only assume that environmental regulations will become more stringent.

Wide scale adoption of 3-D data acquisition technology in the oil and gas industry was a slow process that occurred over time. Yet today, operating companies cannot imagine trying to run their operations without 3-D capabilities.

Further adoption of advanced seismic technologies almost certainly will not take as long, and the next generation of professionals using wireless seismic data acquisition will be one step closer to a completely wireless system that is even more flexible and economical.

The evolution of seismic data acquisition has proven beneficial to geoscientists, geophysicists, and the oil and gas industry. Although certain challenges still need to be addressed, wireless seismic data acquisition systems offer far more advantages, compared with wired systems. These include:

- Significantly lower costs and risks;
- Reduced crew and equipment requirements;
- The ability to work through agricultural fields efficiently and easily; and
- Less troubleshooting and repair time because there are no cables.

As oil and gas and service companies strive to acquire high-quality and cost-effective seismic data and efficiency, more emphasis will be placed on wireless systems, especially as oil and gas development occurs in more difficult geographic settings such as mountainous and urban terrain, or other environmentally sensitive areas. ❐

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