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Cable-free nodes: Destination land

Self-contained, autonomous nodal systems are on the fast track to become the seismic data acquisition method of choice.

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In order to meet operators' needs to acquire the best possible image of the subsurface in the most effective and efficient manner, geophysical providers are working diligently to bring sophisticated cable-free nodal systems to the marketplace.

One example is Fairfield Industries' Z 3000 deepwater system. The 10,000-ft (3,000-m) depth-rated system earned its commercial credentials in mid-2006 at the BP-operated **Atlantis** field in the Gulf of Mexico, where more than 900 individual nodes were successfully deployed — and later retrieved — in water depths up to 7,220 ft (2,200 m). Fairfield recently kicked off a second Z 3000 project in the deepwater Gulf.

But deepwater is only the beginning.

In fact, nodes are anticipated to become the next-generation systems for land seismic application, according to Dennis Freed, technical marketing manager at Fairfield. He noted current land systems — both cable and minimal cable configurations — are lacking in myriad ways when it comes to meeting the future needs of the industry.

"Cables, sensors, connectors and such can wreak havoc on a company's seismic survey budget," Freed said. "Besides the considerable time entailed in troubleshooting for the invariable leaks and continuity problems in the survey, there's the expense of initial cost, maintenance and replacement of these various components.

"Already there are some minimal cable systems available where cables are not required to interconnect the individual acquisition modules," Freed noted. "Even so, they do have cables to interconnect one piece of equipment to another or use a string of geophones as their sensors.

"Nodes, on the other hand, are entirely cable-free," he emphasized. "Each node is a self-contained sensor — the sensing element typically is a geophone — with batteries and a highly accurate clock."

The increasing number of recording channels used in seismic surveys is a major driver in the move away from cables. Freed anticipates field crews will be recording 30,000 channels in the near future and possibly as many as 250,000 channels by the year 2025. To connect this quantity via cable would be unmanageable.

Data harvesting

Acquiring the seismic data is only part of the very complex picture that characterizes a seismic program.

Once the acquired data are amplified, digitized and filtered, they must be placed onto some form of storage medium via some type of data harvesting methodology.

Currently, data telemetry and data storage are the two data harvesting techniques used by the industry.

"The data telemetry method requires each remote acquisition unit to acquire, digitize, filter and ultimately transmit the data to the central recorder where the data are placed onto a storage medium," said Scott Labaume, director of sales and marketing at Fairfield. "The central recorder controls all timing and synchronization operations of the data acquisition system, meaning a single failure at the central recorder will cause the entire system to cease to function."

Figure 1. This is a photo of a new type of RF telemetry system that is now being marketed. This type of system establishes numerous miniature communication cells where the individual remote units communicate to and from the central recorder via predetermined cells. The individual remote units connect with their individual cell via spread spectrum communications. Each individual cell is then linked to the central recorder for command and control of the spread.

All the major manufacturers have developed systems that use the data telemetry method of data harvesting, according to Labaume. Each has its own proprietary method of transmitting the data to the recorder, using one of two telemetry modes: real time or reasonable time.

Using the real-time telemetry mode, all data acquired during one sample interval must be transmitted from the remote units to the central recorder before the next sample interval.

Depending on the channel count of

Figure 2. This image shows the typical spread cables used by today's cable telemetry systems to communicate from the various remote units to the central recorder via an interconnecting cable. Although the occasional optical or RF repeater may be used to overcome obstructions, the system communicates entirely via cables. The cables may use twisted-pair copper or fiber optics as the telemetry medium.

the survey, the required aggregate baud rate may be out of range for twisted pair copper telemetry cables but still in range for the more expensive fiber-optic telemetry. In fact, a combination of the two may be used, depending on the required data telemetry rate.

Still, real-time telemetry appears to be only a temporary data transmission solution, according to Labaume.

"To accommodate the 30,000 and upward channel count systems of the near future, telemetry rates approaching one gigabyte per second will be necessary," he said. "This mode of telemetry will not address a system of that size."

An alternative transmission mode is reasonable time telemetry, which uses the time lapse between records to send the data back to the central recorder, i.e., the data from one record are received by the central recorder while the remote acquisition units are acquiring data from the next record.

This particular transmission mode, which uses radio frequency (RF), allows more time to transmit the acquired data. In turn, the telemetry rate required for the data transmission may be significantly reduced, Freed noted.

"To give an example, a seismic data system acquiring 4,000 channels of 24-bit Delta-Sigma data for an 8-second record — with one record acquired every 60 seconds — requires transmission of a total of 48 million bytes of data or 384 million bits of data," Freed said. "In reasonable time mode, only a 6.4 Megabit per second telemetry rate is required compared to the 48 Megabit per second for the real-time mode. But even this exceeds current radio frequency technology as required by the seismic industry.

"The bottom line here is that for either type of telemetry, an increase in the number of channels demands increased data telemetry rates," Freed noted. "The existing systems are rapidly approaching their limits."

Given the limitations of data telemetry, a number of equipment manufacturers have opted to go with systems that harvest the data via field data storage. The remote acquisition units store the acquired data internally in FLASH memory. The data are retrieved manually during field operations.

Theoretically, data harvesting via field data storage allows for essentially an unlimited number of channels.

A major drawback indigenous to current field data storage systems for land is that in nearly all cases, the remote acquisition units are linked back to the central recorder for command and control. In order for the recorder to transmit start and stop commands to the remote units, a clear RF communication link must be established between the recorder and every field unit. In obstructed terrain, repeaters are necessary; however, if one repeater goes down, then all of the remote units and/or additional repeaters depending on that repeater are down as well.

Battery life in the remote acquisition units is another concern with this data harvesting method. Failed batteries necessitate field visits to pick up and then re-deploy the units, adding time and cost to the survey as well as a larger footprint.

"It's clear that the next step to accommodate the huge channel counts of the future entails a system that overcomes the limitations created by any communication link between the central recorder and the remote acquisition units," Freed said. "This means the next-generation land application must be a completely autonomous and self-contained system with exceptional battery life, the same as our proven deepwater Z 3000 system.

"Once in place on land, the self-contained cable-free remote units will acquire data until the entire swath, zipper or patch being recorded is completed," Freed added. "Each remote unit will be constantly acquiring and storing data internally with no communication between any central recorder and/or the other remote units."

Without the need for a central recorder, the next generation land system will be comprised of:

- Remote acquisition unit;
- Unit deployment pack;
- Source coordinator;
- Data harvester; and
- Data sorter.

"It's only a matter of time before this next generation system becomes a reality," Freed predicted. E&P