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• the first word on oilpatch innovation

cutting the cord

Wireless seismic catching on as explorers gain confidence in maturing technology

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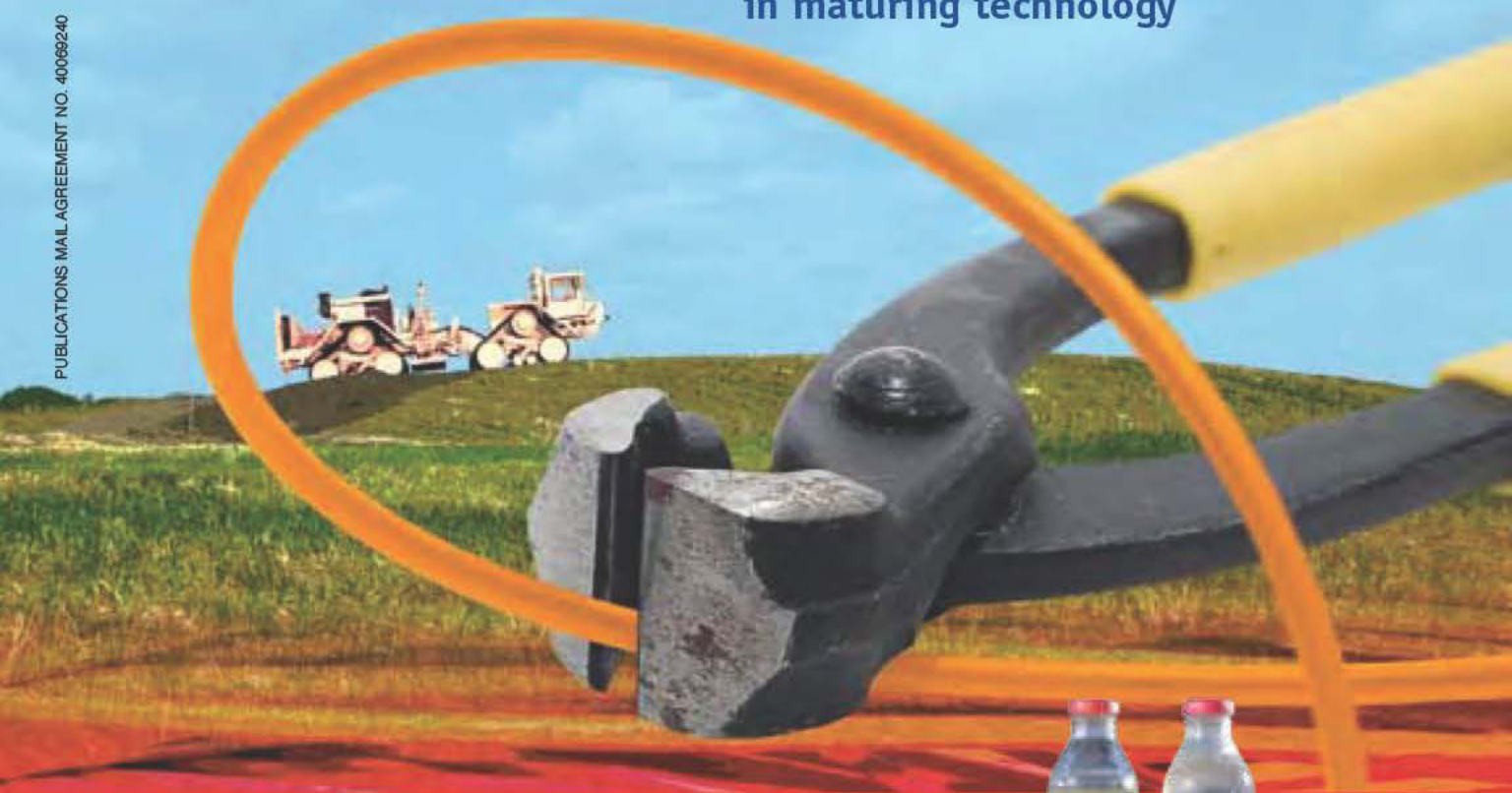

Reduce, Reuse, Recycle—And Cut Costs

Shale gas companies and service providers search for the best water management solutions

editor's view

Letting go

IT HAPPENED ONLY GRADUALLY, ALMOST IMPERCEPTIBLY AT first. When cellular telephones arrived some 30 years ago, they were uncomfortably bulky, had limited range and lacked the reliability and sound quality we had come to expect from land lines, and early uptake was limited. For some business users, the disadvantages were outweighed by the distinct advantage of communication on the go, but when combined with the added expense of a secondary phone, and general resistance to change, there seemed little reason for most consumers to climb onto the bandwagon.

But 30 years, and numerous technological advancements later, it's hard to imagine a world without mobiles. Resistance to change has given way to the realization that our much-improved wireless devices have innumerable advantages over their land line cousins they are supplanting. They are now being taken up by all but the most resistant to change. Indeed, recent trends indicate more and more consumers are abandoning the old technology altogether, severing their land lines with full confidence in their cell phones' ability to entirely replace them.

A very similar evolution appears to be underway among explorers and their seismic system providers. Cables linking geophones planted into the ground over great distances to enable large-scale seismic acquisition have been a mainstay for decades. And, as new wireless systems began to enter the marketplace over the past decade, they were—like the first cell phones—greeted with skepticism.

As little as four years ago, when *New Technology Magazine* last seriously investigated wireless seismic technology and its uptake in the industry, we found few companies using—or willing to talk positively about—the technology. Technical glitches, dying batteries and the learning curve associated with the new and sometimes complex equipment were among the challenges encountered in early pilot testing.

In the span of a few years, those concerns seem to have been largely dealt with and better, more reliable and more affordable wireless systems are now making deep inroads into the industry, taking as much as a 20 per cent market share and growing, as we report in this issue's cover story.

Industry acceptance of and confidence in wireless and cable-less seismic systems today is such that, looking back, it might seem surprising it took this long for the concept to take hold. Along with the example of cell phones in the consumer market, the increasing use of wireless technology in the production end of the oil and gas industry has also moved well ahead, helping to enable intelligent completions and more efficient ongoing monitoring that has increased production and cut costs.

Moreover, in the exploration sector, it is easy to see how wireless seismic acquisition can create value in reducing the environmental footprint (reducing or eliminating seismic cut lines) and facilitating programs in extremely rugged locations (such as swamps and mountainous terrain) and in areas of greater population density (sometimes right in residential neighbourhoods). The technology also enhances health and safety among employees who no longer need to deal with heavy, cumbersome reams of wire.

As with cell phones—whose subscriber base has shot up from a mere 12 million to over 4.5 billion from 1990 to 2010—wireless seismic's eventual adoption was inevitable as the technology advanced enough to overwhelm the inertia, risk-aversion and skepticism of potential users. Adoption might be even faster if not for the existing inventory of cable systems that seismic providers would prefer to monetize before discarding. The oil and gas industry is often criticized for its slow uptake of new technologies. With a solid record of success now behind it, there appears to be little reason for foot dragging where adopting this technology is concerned. ■ **Maurice Smith**

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Wireless seismic catching on as explorers gain confidence in maturing technology

By Susan Eaton

Originally developed in response to the downtime, maintenance and repair of vast amounts of cables used in seismic land operations, wireless seismic technology has moved into mainstream operations, reinventing the way data is collected in the field and delivering improved safety, production rates and overall data quality in the process. During the past five years, a dozen or so product manufacturers have commercialized wireless (or cable-less) seismic data acquisition systems. Collectively, their annual equipment sales have increased to nearly 20 per cent of the global market share which, until recently, has been dominated by conventional, cable-based land seismic acquisition systems.

Several recent technological advancements have made wireless seismic competitive: large solid-state memory, inexpensive global positioning satellite system (GPS) receivers, enhanced battery technology and low power electronics. Industry leaders in the wireless manufacturing space are FairfieldNodal, INOVA Geophysical Equipment Limited, OYO Geospace Corporation and Sercel Inc.

These manufacturers' wireless systems have been deployed around the world, in harsh climates and rugged terrains. Their nodal systems are equipped with long-life lithium ion or lithium polymer batteries that can withstand Canadian, Alaskan or Siberian winters. At this time, however, only the OYO Geospace seismic recorder (GSR) system is operating in Canada.

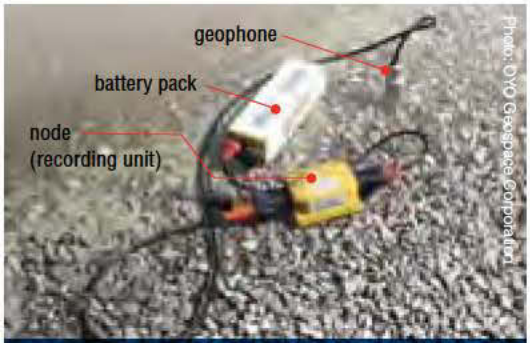
Conventional seismic data acquisition employs long cables—attached to strings of geophones via take-out connectors—which convey geophysical data, in real time, to a recording truck where it's viewed by field staff and, remotely, by geophysicists sitting in an oil company's office. In stark contrast, most autonomous wireless systems—composed of hundreds or thousands of stand-alone nodes each equipped with solid-state memory, a GPS receiver, a battery and a geophone or a string of geophones—collect data, often for weeks at a time, before being retrieved from the field for data downloading.

As wireless technology leads a paradigm shift in the seismic industry, the inability to view data in real time—in many systems—is testing the mettle of geophysicists and it's forcing them to take a giant leap of faith. At the same time, geophysicists are rethinking how, where and when they conduct seismic field operations.

Steve Mitchell is vice-president of the systems division of FairfieldNodal, a privately held seismic acquisition company and manufacturer of completely wireless nodes from Houston, Texas. Mitchell calls wireless seismic "faith-based" shooting. "Part of my job is helping geophysicists get over the psychological hump of shooting blindly," he said.

Mitchell's sentiments are echoed by Larry Herd, president of RPS Boyd PetroSearch, a Calgary-based geophysical consulting firm. "The learning curve involves building a trust in the wireless technology," he said. "There's not a traditional geophysicist on the planet who doesn't want to see his data acquired in the field, in real time." Herd, the president of the Canadian Society of Exploration Geophysicists, was one of the early adopters of wireless seismic in Canada. "There's a huge amount of data [and dollars] stored in the autonomous nodes, often for a couple of weeks," he said.

For the past two years, Herd's team at RPS Boyd PetroSearch has been using a cable-less recording system manufactured by Houston-based OYO Geospace, an early entrant in the wireless space and the current leader in global market penetration. Herd has acquired numerous 2-D and 3-D seismic programs in western Canada, during both the summer and winter shooting seasons.



OYO Geospace seismic recorder components.

Initially nervous about shooting blindly with GSR technology, Herd placed monitor nodes (or digital storage units) in the field, reaping the data daily to ensure that its quality was satisfactory. After just a few days, however, Herd's concerns about data quality—and the system's reliability—evaporated and he ▶

Photo illustration: Andrew Brien, source images: Joey Podlubny, INOVA, Photos.com

cutting the cord

gained the confidence to shoot blindly. "We were immensely impressed with the system," he said.

"I think we're seeing a paradigm shift in how we acquire seismic data," added Herd. "We have yet to realize on the cost savings, but I think that it will come with more experience and competition in the industry."

David Monk is Apache Corporation's director of geophysics worldwide and a distinguished adviser within the firm. Monk leads Apache's vanguard of geophysical technology innovation and he's field tested many of today's commercially available wireless systems. "Apache is not afraid to go in early with new technology," said Monk.

Weighing in on the debate over real-time viewing of seismic data, Monk, president-elect of the Society of Exploration Geophysicists, said, "Initially I was skeptical, but I'm not sure that it's an issue anymore. As long as you're confident that each one of the nodes is working, you're going to acquire data."

A Sercel UNITE remote acquisition unit with a single analog geophone sitting on its external battery in Alaska.

Photo: Kurt Linden of BP

Monk has used cable-free seismic acquisition to solve other logistical problems. When cables and radio transmissions were prohibited across the Chilean-Argentine border, he shot sources on the Chilean side and used OYO's GSR nodes to record seismic data returns on the Argentine side. And he's used INOVA's FireFly nodal system in Mendoza, Argentina, where Apache acquired two 3-D programs in the Malbec vineyards and up the sides of snow-capped mountains.

Monk pointed to rat infestation problems in west Texas and the southern U.S. states. "Cows, rats, sheep, you name it—every animal chews cables." A simple solution, he explained, is to switch to cable-free seismic acquisition.

"The more complex the system is, the more likelihood for problems," explained Monk. "A system that is truly without cables is the way to go."

When wireless isn't wireless

But not all of the new wireless seismic data acquisition systems are truly "wireless" or "cable-less." Wireless manufacturers have all dispensed with the kilometres of backbone cables, the conventional recording configuration that conveys data to a recording truck. Yet, with the exception of FairfieldNodal, the manufacturers still employ short cables connecting the node (data recording box) to the external battery and to either a single geophone or a string of typically three to 12 geophones. In the Middle East's desert terrain, geophones are often combined in a long string of up to 72 geophones per receiver channel or node.

FairfieldNodal has miniaturized the memory, battery and geophone, encasing them in a compact unit, called ZLand, and eliminating the need for cables. ZLand evolved out of FairfieldNodal's marine autonomous nodes, which have been deployed on the sea floor for a decade—via ropes in waters up to 700 metres in depth and with remotely operated vehicles in waters up to 3,000 metres in depth. In an evolutionary trajectory that took just a few years, FairfieldNodal's equipment has transitioned from the marine to intertidal to land environments.

Photos: FairfieldNodal

FairfieldNodal recently sold autonomous marine and land channels to SAExploration, a seismic acquisition contractor, for deployment in a marine-transition zone-land seismic acquisition project for Apache in Cook Inlet, Alaska.

First-time wireless user

Houston-based Southwestern Energy Company cut its teeth in the Fayetteville and Marcellus shales in the United States. In 2010, it acquired a 2.5-million-acre block in northern New Brunswick where it's chasing the Frederick Brook Shale, an emerging resource play.

When Michael Rhodes, Southwestern's geophysical operations manager, was planning the company's inaugural seismic project in New Brunswick, he evaluated both wireless and cable systems. During the summer, Southwestern's 610-kilometre-long, helicopter-supported program was acquired by the Canadian division of Geokinetics Inc. with OYO's GSR system. This was Southwestern's first wireless acquisition program.

"We wanted to avoid wetlands, rivers and human culture," explained Rhodes. "We needed to keep our footprint low—no cables crossing homeowners' driveways—ensuring that the landowners had as good an experience as possible.

"Your doghouse is not really a recording house," explained Rhodes, describing the differences between wireless and cable-free seismic. "They're still monitoring the quality and timing of the seismic sources, from dynamite and vibroseis trucks, but the doghouse becomes a central command post to organize the movement of people and the pick-up and layout of equipment.

"I definitely think wireless seismic is a game changer," Rhodes said. "There's certainly a place in our seismic arsenal for cable-less seismic."

Describing the system as "straightforward," Rhodes experienced a less than one per cent failure of the system's channels. The program, however, experienced vandalism and theft of the GSR units and batteries. "We lost about $100,000 of equipment."

LOW IMPACT

▲ When used in a survey in Cook Inlet, Alaska, FairfieldNodal's intertidal Z700 and small-sized, cable-less ZLand nodes were fast and easy to deploy in the field and had minimal impact on the local ecosystem.

Cable systems aren't immune to vandalism either, said Monk, whether in North America or around the world. "People seem to want to cut cables," he explained. "And, in the developing world, these cables have real value to people."

Eyes wide open...

Not all wireless systems require blind faith in seismic acquisition. Sercel's UNITE and INOVA Geophysical's FireFly systems—both early entrants to the wireless marketplace—are equipped with real-time data transmission from the autonomous nodes to the recording truck. Sophisticated in design, technology and flexibility, these two systems can harvest seismic data at regular intervals, enabling geophysicists to follow data acquisition in real or close-to-real time. The FireFly and UNITE acquisition systems have been deployed on all continents in challenging terrains and environments.

Robin Ellis is Sercel Inc.-USA's vice-president of sales for North and South America. According to Ellis, Sercel has the second-largest installed channel base, just after OYO Geospace. Based in Houston, Ellis described a recent acquisition job for Petróleos Mexicanos (Pemex), the Mexican national oil company, where seismic data were harvested every 48 hours, as per Pemex's instructions.

Sercel harvesting antenna and remote acquisition units (RAUs) during the pre-project check and configure process. A hand-held wireless harvester downloads seismic data.

Photos: SERCEL Inc.-USA

Sercel's UNITE cable-free seismic acquisition system has a built-in anti-theft device. As soon as the battery is unplugged, Sercel's remote acquisition units (RAUs) wake up, sending out their position every 10 minutes. GPS reception works well, even under a dense tropical rainforest canopy.

Ellis related an incident in Colombia where "box-napping" occurred on several occasions. While negotiating the returns of the RAUs, data was harvested wirelessly, unbeknownst to those holding the RAUs.

UNITE's CAN cell antennas and Wi-Fi link enable the real-time harvesting—and transmission to the recording truck—of seismic data and the downloading of the vital statistics of the node, its battery level, sensor quality, GPS lock and memory status. "We located the boxes while the negotiations were taking place and we actually retrieved the data," chuckled Ellis, describing this covert "drive-by" data downloading technique.

Without disrupting production operations, stationary and portable antennas—carried by people, vehicles, boats and helicopters—can harvest data from multiple RAUs from distances between 100 and 1,000 metres line of sight.

Sercel's UNITE system can also be used in the autonomous mode where the seismic data is stored in memory until harvesting. Sercel, one of the largest seismic companies in the world, designs and manufactures seismic equipment for the marine, transition zone and land environments. UNITE has been deployed for the real time micro-seismic monitoring of subsurface hydraulic fracturing operations, measuring ground motions in the x, y and z axes. "You don't want to be laying out cables on a rig site due to heavy truck traffic," explained Ellis.

Launched in 2010, Houston-based INOVA Geophysical is jointly owned by BGP, a wholly owned subsidiary of China National Petroleum Corporation (51 per cent) and the world's largest onshore geophysical service contractor, and ION Geophysical Corporation (49 per cent). In September, INOVA unveiled the next generation FireFly, its cable-free nodal system that provides a bidirectional radio connection between a central location and the nodes deployed in the field.

Photo: SERCEL Inc.-USA

Photo: OYO Geospace Corporation

Eliminating the need to mobilize field crews, the radio link gives the operator node control, including node status and geophysical trace quality control. FireFly's next generation nodes are constructed with a new rugged aluminum enclosure to protect ground station electronics.

The re-engineered design supports INOVA's proprietary VectorSeis 3-C digital sensors, other manufacturers' 3-C analog geophones, as well as traditional geophone arrays, making it extremely attractive to mix and match components.

Hawk, INOVA's newest addition to its cable-less acquisition portfolio, was also launched in September. Hawk is an autonomous nodal system that can be used independently—or teamed up with FireFly—in areas where radio infrastructure is cost-prohibitive. Like FireFly, Hawk is designed with the same sensor support flexibility. Both Hawk and the next generation FireFly cable-less acquisition systems benefit from Connex, a proprietary field operations management tool designed to streamline field processes, which include stake-less surveying, navigation, program planning, quality control and operational analysis.

Glenn Hauer is INOVA's senior vice-president of product development. "Cable-less seismic acquisition requires a new operational paradigm," said Hauer. "Crews who use these systems for extended periods of time, and over several jobs, will result in more efficient production for oil and gas companies." Added Hauer, "Instead of managing cables, crews will need to become proficient in battery management—and larger battery charging infrastructure—as well as larger in-field computing infrastructure." ▶

CLIMATE COMPATIBLE

▲ Top: A wireless harvester crew in an airboat in a Louisiana swamp downloads seismic data from a Sercel UNITE remote acquisition unit equipped with a single hydrophone for swamp operations. The external battery package has a solar cell integrated into it. Below: OYO's GSR recording seismic being shot near Fort MacKay, northeast Alberta.

Developing wireless seismic data acquisition protocols

RPS Boyd PetroSearch's first couple of cable-less seismic programs involved a steep learning curve. On the fly, Herd, his client's technical team and Eagle Canada Inc., the seismic acquisition contractor, developed protocols for efficiently deploying and retrieving OYO's GSR autonomous nodes. In the process, they received a crash course on interpreting meteorological data, measuring wind speeds and tracking train schedules.

The signal-to-noise ratio of seismic records can be adversely impaired by wind noise (which gets recorded along with sound waves passing through the earth) or by a train crossing the seismic program.

Cable systems can measure, in real time, the wind's impact on seismic data quality. For the GSR cable-less system, Herd and his team developed ingenious protocols: noise monitors were placed in and around 3-D programs, monitoring wind noise, in real time, in the recording truck. When the wind noise degrades the seismic data quality—independent of using a wireless or cable crew—data acquisition is temporarily shut down.

Photo: FairfieldNodal

One man can easily carry a FairfieldNodal ZLand node six-pack and the hand-held terminal to start them.

Robert Wood is the president of Calgary-based Eagle Canada. According to Wood, Eagle Canada and its U.S.–based parent company, Tidelands Geophysical Company, have purchased 19,000 channels of OYO's GSR system during the past two years alone. And, between the two companies, they've got an additional 80,000 channels of conventional cable systems.

Describing OYO's GSR system as robust and user-friendly, Wood said his oil and gas company clients quickly morphed into "believers" of the cable-less acquisition system. "Obviously we're convinced [about the technology] in Canada and the United States—we're starting to get a big following."

To date, Eagle's largest wireless seismic acquisition project was a 650-square-kilometre 3-D program in western Canada. Lost channels in this program, said Wood, were calculated at less than one per cent, which is on par or even better than a conventional cable system.

With wireless bluetooth links mounted in helicopters, Eagle can conduct quality control—before and during shooting—of a large 3-D seismic program, sending data to the doghouse (recording truck) on the node's vital statistics, including the health of its battery life, memory functions and geophones. Quality control (and trouble shooting) can also be conducted with a hand-held or a truck-mounted bluetooth version. The frequency of data quality checks, explained Wood, is dictated by the oil company client and generally decreases as the client becomes comfortable with the cable-less recording technology.

Battery longevity in Canadian winters, where temperatures can dip below minus 40 degrees Celsius, is a significant operational concern. However, according to Herd, OYO's GSR lithium ion batteries worked flawlessly for weeks on end. In order to extend battery life, each node contains a GPS receiver and a disciplined clock that is programmed to put the unit to sleep when the day's recording has concluded and to wake it up the next morning in time for shooting operations.

Photos: Sercel Inc.

Wireless systems have an advantage in Canada's harsh and snowy winters, explained Herd. "There are horror stories of crews digging cables out with shovels and of damaging the cables in the process."

Health, safety and environment advantages

According to Herd, health, safety and environmental issues were the key drivers behind switching to wireless seismic acquisition. He's impressed by the technology's flexibility to skid or offset receiver locations—a flexibility that's not available in a cable system—increasing seismic data coverage in environmentally inaccessible areas. Further, a wireless system facilitates navigation around shut-outs, which are private or public lands where seismic data acquisition is prohibited and where cables couldn't be laid.

Mitchell described the flexibility of wireless systems another way: "Imagine sprinkling nodes wherever you want or wherever you can get a permit."

The environmental footprint, Herd said, is dramatically reduced with a wireless system. "We're not dragging cables and geophones from A to B, through crops and wet areas." The lighter-weight equipment, he explained, reduces injuries, including tripping and slipping while manhandling cables. "Our clients appreciate a safer field project and wireless definitely contributes to zero harm."

Wood concurs. Safety of field personnel has been improved using cable-free. Lighter equipment means less helicopter time, fewer people on the crew and a different type of personnel in the field. "Jug hounds

GOING WIRELESS
◀ The Sercel UNITE digital recording box, geophone and battery with a solar cell. In the distance is a recording truck with an antenna, which receives data from the digital field recording units. Foreground: Sercel wireless harvesting antenna on its tripod.
▼ OYO's GSR system being deployed by Eagle Canada, including their trailer-mounted battery and data download racks.

Photos: OYO Geospace Corporation

[they lay down cables and geophones] have been replaced with line viewers skilled in electronics," he said. "Line trucks are a thing of the past," he added, extolling the many virtues of Kubotas, rough terrain vehicles that Eagle now uses to lay out its seismic equipment.

Cables here to stay.... For a while

Some of the cable-less manufacturers also produce cable acquisition systems that incorporate analog and digital geophones—running the gambit of single channel, multi-channel, azimuthal, swamp phones and hydrophones—which facilitates the mixing and matching of cable and cable-less systems at the manufacturer level.

Because many seismic acquisition companies have made substantial investments in cable systems—investments that need to be recouped—they're unlikely to switch to wireless recording systems overnight, unless, of course, their oil company clients demand wireless technology. Instead, seismic acquisition companies are purchasing autonomous nodes to interface with their cable systems, creating hybrid systems with enhanced flexibility for deployment in environmentally sensitive and logistically challenging areas where cables aren't the best option.

"It's hard to beat cables for large areas of uninhabited desert," said Monk, wearing his global seismic acquisition hat. "Cables are cheap and out there.

"Giving up cables comes with a downside," he added. "Each receiver station requires a battery and this is not necessarily your regular flashlight battery."

For example, a 10,000-channel seismic program, with one channel per node, would require 10,000 batteries. Current state-of-the-art batteries are lithium ion or lithium polymer—they're expensive, and often attractive to others.

"Battery management may become as big a problem as cable management was," explained Monk, suggesting that improvement in battery technologies, even transitioning to fuel cells, is likely to enhance program logistics in the future. ■

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