Emerging market for seismic acquisition systems without cables still has problems to solve

Doug Crice* looks at the challenges ahead for cable-free land acquisition systems with particular attention to the offering by market newcomer Wireless Seismic.

In recent years increased focus has been placed on improving the performance of seismic acquisition on land, in terms of data quality and cost. As a result a number of new techniques have been developed, which have vastly increased channel counts compared to earlier surveys, and progress on this front looks set to continue. In the meantime, after a painfully slow gestation period, the emergence of commercial cableless seismic systems has become a reality. The role of cableless units has still not been fully resolved: for the time being, they appear to be regarded by contractors as a supplement rather than a replacement for conventional cable systems with applications where access would otherwise be difficult or impossible.

Much of the early discussion associated with cable-free seismic systems has focused on the alleged savings to be achieved by eliminating cables. They don’t require as many trucks or containers to transport them to the work site. The army of workers on the seismic crew can be smaller, and the worker doesn’t need to handle the biggest coil of wire he can carry. Cables don’t have to be laid across roads or rivers, and best of all, it’s not necessary to spend a couple of hours every morning repairing cables damaged by night creatures. Besides the logistic problems, you eliminate much of the HSE exposure – from crew injuries and damage to the environment. Permits are easier to get with cable-free systems.

Since there are logically significant savings from eliminating cables, it’s worth asking why aren’t they being universally adopted? The reasons include the economy, discomfort with the current state of the art, and the shortage of success stories.

There has been a universal slowdown in seismic exploration because the oil companies, in their time-honoured tradition, reduced exploration budgets in response to the lower price of oil. When exploration slows down, seismic contractors shut down some of their crews, and warehouse their equipment. They are reluctant to buy new seismic systems in a down market. To pull some numbers out of the air, you could say that when seismic exploration drops by 20%, sales of seismic systems drop 80%. This boom and bust pattern has been repeated multiple times in the author’s career, and the equipment manufacturers suffer disproportionately in their business.

With the rebound in the price of oil, the market for surveys and exploration hardware is recovering. There seems to be a widespread desire among contractors for more seismic channels – some for new crews and some to bolster existing crews for the larger channel count surveys coming into demand.

However, most of the purchased wireless seismic systems have been small channel count purchases used for what are called ‘infill’ surveys. They are deployed alongside cable crews to collect data in areas with difficult access, to increase spatial resolution in a particularly interesting area, or to lay a grid of three-component acquisition units operated in conjunction with a normal survey. Until recently, there has been almost zero large channel count systems purchased for stand-alone crews, though a few stand-alone rental systems were deployed.

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Figure 1 Wireless Seismic data acquisition and radio relay units in the field. Dual Li-Ion batteries are attached on both sides of the unit.
The momentum is shifting as the exploration economy improves, and will shift more when the market shakes out, leaders appear, and confidence in the hardware grows.

One of the remaining unknowns is ‘how much is the cost reduction from cable free systems?’ While it is easy to imagine significant savings, the industry is still waiting for hard numbers. Only recently have there been purchases of systems large enough to outfit a normal 3D crew. This may give the industry an opportunity to gather some data to quantify any savings.

The cable-free systems can be arbitrarily grouped into three categories: those that store the data in an internal memory for later harvesting (often called ‘blind’ recording systems), semi-blind systems that store the data in an internal memory but have enough communication capability to provide some real-time QC and sometimes partial seismic records, and potentially, systems that deliver the complete data record to the central recorder in real-time.

Blind recording systems require two kinds of faith: belief that the equipment is working, and confidence in the survey parameters. Concern about equipment reliability was an early, misplaced concern – generally modern electronics are reliable and there is enough redundancy in a 3D survey that a few defective units are not a concern in these days of 400-fold stacks. Reports from the field claim that better than 99% of the data is routinely recovered. On the other hand, confidence in the survey itself may never be settled in the minds of some customers. When the cableless system is a small patch in a larger cable survey, one can easily determine if the noise levels are low enough, that you are putting enough energy into the ground, and that the geology is cooperating by producing nice reflectors in the raw records. It’s a different paradigm if the entire survey is blind and the data isn’t collected until the boxes roll beyond the active spread.

So, the blind and semi-blind systems, reliable as they are, leave some problems common to both types.

First of all are the logistics of collecting and transcribing the data. Some vendors address this better than others, but in general, someone has to visit each unit and either collect the data or collect the whole box, move the data or box to the central recording system, and transcribe the data into a standard SEG file. This potentially burdensome exercise is when you get your first look at the quality of the reflections. Some users are uncomfortable with this time delay. Most bird dogs (client representatives) like to see the data right now. It’s their job to evaluate the contractor’s product for the oil company on an ongoing basis, and they are not comfortable waiting a few weeks to see how the data looks. From the contractor’s standpoint, if there is a problem, they would also like to know right away so they can adjust their survey immediately rather than going back and repeating a few weeks of expensive surveys.

This evaluation of the survey is a significant issue. Virtually all the cable-free systems provide for performance tests of the hardware: noise, dynamic range, harmonic distortion, timing, location, and geophone tests. Few or none of them evaluate the actual seismic record. Real time evaluation seems to be important. A survey of users (Gelb Consulting market feasibility survey in 2009 commissioned by Wireless Seismic) found that ‘When considering whether to use a [cableless/wireless] seismic recording system, 63% of oil and gas company respondents rated real-time data collection and real-time instrument quality control to be very important.’ If the oil companies want to see real-time data, that’s a hurdle that the blind recording systems may be unable to overcome, at least for a significant segment of their customer base.

Looking at it from another standpoint, if there are different systems available in the market and some are blind recording while others offer real-time data collection, the momentum will shift to the real-time system even if only half the customers have a preference, and even if there’s a price premium for real-time data.

Another concern is security. If a passer-by should take an interest in the little box along the path, and decide to take it home for a souvenir, that can generate problems. While the cost of the box is significant, the value of the data inside may be more so. If you had real-time data retrieval, you would know immediately if one or more of your acquisition units walked away, in time to replace or possibly retrieve it (or them).

So, why don’t there seem to be any real-time systems available? The short answer is bandwidth: the availability or capability of carrying large amounts of data through the
Land Seismic

airwaves. ‘How can that be?’ you say. The wireless router in my notebook computer can download 5 Mb of data over the DSL phone line, enough for 500 geophone stations sampling continuously at 2 ms. Router to router communication is much faster, enough for thousands of channels. Can’t we just move some of that low-cost, high-speed communication capability out to the field? There are problems to address: protocols, range, collisions, interference, and power. If you take an ordinary mesh network to the field and expand it thousands of nodes, they bump into each other across the airwaves. When that happens, bandwidth collapses to an unacceptably small number. You can solve the range issue with bigger antennas and batteries, but then you are trading a logistically burdensome cable for another logistically burdensome system.

Mesh network cableless seismic systems have been developed, but the bandwidth problems prevent them from growing large enough to compete with full cable systems. One solution is to add infrastructure – fibre optic backbones or distributed radio towers for example – but such a system quickly comes up against the logistic problems of cable seismic systems for more than several hundred channels.

Power becomes a concern also. A cable system can get by with a single automotive battery that supports perhaps 50 geophone stations. A wireless system needs a battery at every node. The battery needs to be small and lightweight so the crew member can service a number of nodes efficiently, and the battery needs to last a reasonable amount of time. The solution is to design the remote unit to use very little power, so that the battery can be small enough, and last long enough between replacements in the field. This task becomes easier if there is no radio, or if the radio is off most of the time. Some of the blind systems go so far as to turn on their GPS just occasionally to discipline the internal clock. Most cable-free systems use Lithium batteries despite their higher cost, shipping problems, and complex control electronics, because their power to weight ratio is higher and they operate at Arctic temperatures when necessary. Ultimately however, small batteries are incompatible with high bandwidth wireless communication.

One approach

Wireless Seismic claims a solution in that it can deliver thousands of channels of data to the doghouse in real-time. The company did a ‘proof of concept’ field survey in July 2008, collecting real-time data from a line of wireless acquisition nodes operated side-by-side with a conventional system. This modestly successful result triggered growth by the company; it recruited experts in seismic system design in Houston and software and wireless engineers in the Denver area.

So, how can thousands of channels of data be delivered to the doghouse? Think of a back haul and cross line structure as used in a conventional cable system, but replace the cross line with an array of wireless data acquisition units, and replace the back haul with a high-speed radio link. Wireless Seismic calls this an ‘ordered mesh’ network, forcing the communication paths in such a way to prevent interference, keeping the bandwidth up, and operating with low power consumption.

Let the last upstream acquisition unit sample the seismic vibrations and every few milliseconds transmit the data down to the next unit in line. Let that unit collect its own data, add it to the data from the farthest unit, and send it down to the third unit. The process continues, with each unit passing the accumulated data down the line in what is analogous to a bucket brigade, except that the buckets get a little fuller at each link. At the end of the line the data goes into a unit called the base station. The wireless nodes operate in the 2.4 GHz band, which for practical purposes is worldwide legal without requiring licensing. ‘How can that be?’ you say. The wireless router in my notebook computer can download 5 Mb of data over the DSL phone line, enough for 500 geophone stations sampling continuously at 2 ms. Router to router communication is much faster, enough for thousands of channels. Can’t we just move some of that low-cost, high-speed communication capability out to the field? There are problems to address: protocols, range, collisions, interference, and power. If you take an ordinary mesh network to the field and expand it thousands of nodes, they bump into each other across the airwaves. When that happens, bandwidth collapses to an unacceptably small number. You can solve the range issue with bigger antennas and batteries, but then you are trading a logistically burdensome cable for another logistically burdensome system.

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Its wireless remote unit contains 24-bit acquisition and self-test circuitry and GPS in a waterproof aluminum case. Dual Li-Ion batteries on either side power the unit for about two weeks and can be ‘hot swapped’ when required for continuous recording. The high-gain antenna is rugged enough to be used as a handle. An industry standard connector accepts existing geophone strings. One of the factors for success is that the radios only need to communicate over one group interval, a very short distance by radio standards, and can work through brush as necessary. The transmit power level is automatically adjusted to maximize battery life. If there is a serious blockage in the path, a spare unit can be placed as a repeater.

The base station contains its own GPS which provides master timing sent periodically up the cross line along with commands from the central unit. A commercial 5.8 GHz radio connected to the base station relays data to the central recording system, delivering continuous data downstream. Because the line taps are generally farther apart than the group interval, these radios are higher power and are used with taller antennas. They are still man-portable and can be set up in a few minutes by one or two people. If needed, a short fibre optic cable can be stretched between line taps to work through heavy brush. The line tap system requires more logistic effort, but will support hundreds of wireless remote units, so the cost of hardware and deployment is modest in this context.

The central recording system is a workstation with multiple displays running a Windows operating system. The user interface will be familiar to any experienced observer and the learning curve is short. Once operators sit down in the doghouse, they might mistake it for a standard cable recording system. It even includes a real-time noise monitor so operators can be warned about transient vibrations or dead traces within the spread. The ‘state of health’ of the acquisition units, as well as the seismic data is monitored from the central unit. Small portable systems with a few hundred channels can also be operated from a notebook computer.

Is the data real time? That depends on your definition, but it arrives at the doghouse within a couple of seconds for the largest system, effectively about as fast as a cable system can display a record. The Wireless Seismic system is designed to scale up to many thousands of channels and its long range plans call for evolution to support massively high channel count systems.

Will this company meet the desire of the oil companies for real-time, high-channel count, cableless seismic systems? Can contractors get away from the problems of blind recording? Will another company provide a real-time acquisition system? Companies are working towards that goal. What we can say is that all this innovation and competition bodes well for the seismic industry.