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G&G TECHNOLOGY

Wireless acquisition system proves its worth on Kurdistan survey

A wireless seismic system offers a more efficient way to acquire data in challenging terrain. The system proved its capabilities on a record-breaking survey in Iraqi Kurdistan, facilitating seismic acquisition, despite a regional earthquake and armed conflict between the Kurds and ISIS.

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Seismic systems have been around for a long time. While they were first developed to track earthquakes, the pursuit of hydrocarbons has led to the development of ever-more sophisticated systems to image the Earth's subsurface. In simple terms, a seismic recording system will sense, sample and capture movements of the earth, whether natural or produced by a man-made source of energy. The "sound" waves are captured by tens of thousands of geophones, spread over the area of interest. The captured or recorded data are then processed, using some of the world's most powerful computer hardware and software, to produce the familiar volumes of seismic data, which are the best indication we have, short of the drill bit, of the presence of subsurface hydrocarbon traps.

SEISMIC SYSTEM ADVANCEMENTS

Traditional cable systems have historically been the benchmark against which all other systems are measured. Cable systems originated as analog telemetry systems that sent raw analog signals from the sensors, usually geophones, which measured the change in the velocity of the earth's surface, over great distances to a central recording unit, where they were digitized and recorded. This analog telemetry set a limitation on the number of channels that could make up a system, owing both to the physical size and volume of the cables, and the practicalities of keeping a large number of analog wires in good condition.

The first distributed telemetry systems emerged about 25 years ago. These systems concentrated the output from about a half dozen groups of geophones into a box located remotely on the seismic line, where the data were digitized. These data were then sent to the central recording unit in a digital format. It revolutionized seismic recording systems: cables could be reduced in size drastically, and they often were comprised of only a twin pair of data transmission wires, with a stress member for strength. The number of channels that could be deployed mushroomed from 100 or so, to thousands.

The engineering of these distributed cable telemetry systems was improved, when the collection boxes were replaced with a small single box for each channel, which completely removed the need for analog lead-ins from the geophone arrays to the digitizing boxes. A modern distributed cable telemetry system can now handle 100,000 channels, with some manufacturers claiming one-million-channel capacity. However, the economics of purchasing, and the logistics of fielding, a system of this size have meant that these claims remain purely theoretical.

The advantage of cable systems is that they return QC information to the central recorder and safely record the seismic data in real time. System users have constant knowledge of the state of the seismic units (or spread) to confirm that the system remains within the contract specification, and they can see that the line is quiet before taking a shot.

Unfortunately for cable systems, they also have a down side—the cables, themselves. Despite being a huge improvement on the original analog cables, they are still heavy, high-volume and prone to damage—either from rough handling, malicious damage or both. The cables transmit massive data volumes, so they must be kept in pristine condition, which is not always easy in harsh field environments. Also, cables are susceptible to leakage, which can render them inoperable and in need of replacement before acquisition can begin each day.

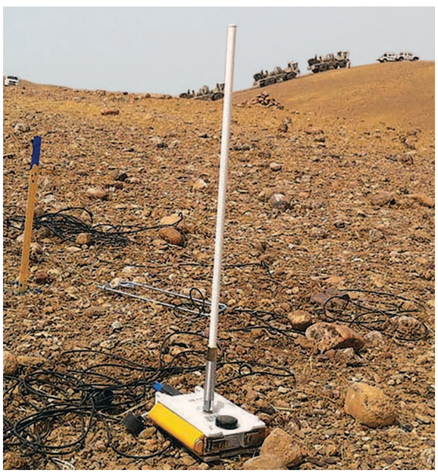
Fig. 1. Typical cable seismic systems use miles of cables for an acquisition project.

When a contractor purchases a cable system, a decision must be made on the maximum receiver interval likely to be encountered. For example, if the receiver interval is 50 m, then 55 m of cable will be needed to allow for contours and detours. However, if somewhere on the line there is a shorter interval, of say 25 m, then the extra cable has to be tied up and carried around, Fig. 1.

Cable systems work well, but their weight, volume and relative fragility have led the industry to envision a seismic world free of cables. A number of existing manufacturers and new companies responded to this market need and developed cable-free systems. Over the past 10 years, the market has seen the rapid adoption of these cable-free systems, especially in North America. Most of these systems are at the other end of the telemetry spectrum to cable systems. These systems have no external method of communication and are, to all intents and purposes, "blind" systems.

The electronics of these blind systems are reliable and stable, and offer the contractor the opportunity to maximize crew productivity. The contractor simply deploys the cable-free units on the receiver line and leaves them on the spread, constantly acquiring data, until the energy source has rolled through. Then, they are picked up and taken to the base camp to harvest the data and recharge the batteries. With these systems, the contractor can start acquisition each morning as soon as the shooters or vibrators are ready—there are no delays in waking up when compared to the cable telemetry system, which can suffer from animal bites and condensation overnight.

Fig. 2. A WRU from Wireless Seismic's RT System 2 real-time, cable-free acquisition system in the Kurdistan desert.



The downside to blind systems is that the operator has no knowledge of the system status in real time, since there is no immediate feedback of system QC information or noise levels on the line, which may stray outside contract parameters. Once the acquisition units have been deployed on the line, there are no means of changing system parameters, short of revisiting each acquisition unit individually.

Some systems may have limited QC and data transfer during acquisition, but it is more common for the operator to have to harvest the QC and/or seismic data by visiting the line and physically connecting to the acquisition boxes or establishing a short range Bluetooth or Wi-Fi link, all of which add to the logistical complexity of operations. Some systems have sophisticated "drive-by" or "fly-by" functionality, which can speed up the data downloading process.

After the data are harvested, the required data must be extracted from the total dataset and transcribed—to re-arrange them into shot records that can be sent to the data processing center. This time-consuming task requires the provision of significant infrastructure in the field, powerful computers, and skilled personnel to transcribe the data, which adds to the capital and operational costs of the seismic crew. As a number of field acquisition units are removed from the field to be cycled through the base camp at any given time, the total number of seismic channels on the crew may have to be increased at least 15%, when compared to a cable system, adding further to the capital cost of the crew.

At the end of the survey, all of the acquisition units have to be moved from the line to the base camp for harvesting and battery recharging. For a 3D survey, it can take weeks to complete, delaying the availability of data, in what is known as the "last patch effect."

So, while the blind and stored data systems with limited QC free the contractor from the bondage of cables and enable increased productivity, they introduce a new set of issues for the contractor to overcome. Another solution is required.

WIRELESS TECHNOLOGY

Wireless Seismic, Inc., has developed a cable-free seismic acquisition system that avoids the pitfalls of both cable and blind systems. RT System 2 is a real-time, cable-free system that can scale to the many thousands of channels required for modern 3D seismic surveys, Fig. 2. The system uses a proprietary radio protocol to build a scalable radio network that delivers all of the attributes of real-time QC and data transfer that are standard for a cable system, but without the use of cables. Contractors benefit from the productivity of a cable-free system, with the certainty that the data they are acquiring are within contract specifications. The real-time QC and noise monitoring can be used to determine when operations should be closed down, and when conditions remain acceptable to keep shooting—thus, extending production time and avoiding negative productivity or having to re-shoot rejected records.

The RT System 2 real-time radio network is self-healing and self-sustaining. However, if a break in the radio telemetry occurs, which cannot be repaired automatically, the field units, called Wireless Remote Units (WRUs), keep recording to the end of the record, avoiding the need to re-shoot interrupted records, similar to most cable systems, Fig. 3. The WRUs enter into "autonomous mode" and continue to record to their onboard flash memory.

Once the radio network is restored, the WRUs send the stored data back to the central recorder, either during breaks in acquisition or when network bandwidth permits. Once safely written to disk, the data can be deleted from the flash memory in the WRUs. This "Hybrid Radio Telemetry" feature means that acquisition can continue regardless of the condition of the radio network, giving RT System 2 the same levels of productivity as cable-free systems without the delays and uncertainty of harvesting and transcribing the data. As the data are not stored in the WRU, the issue of theft of the units becomes less critical—if the units are stolen, the much more valuable data are safe.

KURDISTAN WIRELESS SURVEY

The Kurdish Autonomous Region of Iraq contains one of the world's richest petroleum deposits. The region is bounded by mountains on the northeast, and this area contains most of the blocks being awarded for exploration. In the summer of 2014, Asian Oilfield Services Limited (ASIAN) conducted a survey in the southern area of Kurdistan. The 3D survey covered more than 630 km^2 over a variety of terrain—from flat plains with villages to steep hills and rocky cliffs. Laying cables is logistically challenging in the region, due to its rugged environment and very unpleasant working conditions—temperatures easily reached in excess of 120°F during the day. Even though the region is experiencing economic growth, remnants of recent wars are still a major safety concern, while the focus on reducing overhead and manpower was clearly a primary consideration.

ASIAN chose the RT System 2 because of its ability to field a large number of cable-free channels and still deliver data to the central recorder in real time. The survey was noteworthy, because it reportedly set a new record for cable-free acquisition, with continuous real-time data retrieval of over 6,400 channels on the ground from an array of 11,000 deployed and 13,000 channels on the crew, in total. In addition to the world record number of real-time wireless channels, RT System 2 delivered excellent productivity, due to its stability, and because it was consistently live, ready and waiting for the vibrators at the beginning of each day.

The real-time noise monitor became very useful in confirming system operation, setting the Vibroseis sweep parameters, and in making informed decisions when

Fig. 3. WRUs sending data and communicating with each other alongside a cliff in the mountainous region of Kurdistan.

Fig. 4. The wireless system was able to be deployed by fewer people than an equivalent cable system.

wind noise rose to excessive levels, and when noise from road construction started on the line segments. The real-time QC helped to optimize data quality, particularly to improve ground coupling by identifying poor geophone plants—a significant problem in Kurdistan's arid, rocky terrain.

In mid-August, production was disrupted by an earthquake, measuring 6.2 on the Richter scale, close to the Iranian-Iraqi border. RT System 2 was able to monitor the background seismicity, due to aftershocks, and inform the client's decisions to hold production when the tremors occurred.

The real-time capabilities of the system were put to use in a far more dramatic way, when the increase in ISIS activities, not far from the survey area, resulted in conflict between ISIS and the Kurdish Peshmerga (*Editor's note: The Peshmerga is the military wing of the Kurdish regional government*). Noise generated by the artillery bombard-

Fig. 5. Local farmers were able to plow around the WRUs.

ment between the two sides was monitored by the RT System 2, which, despite being out of earshot, swamped the seismic records. The system's real-time QC was able to see clearly the extraneous noise on the spread, and the client was able to halt production until the bombardment ceased.

Regulations required a relatively high percentage of local labor for the crew, Fig. 4. Some very basic training was necessary for the unskilled labor, including simple tasks, such as attaching geophones or batteries to the WRUs. Deployment was much easier with a much smaller crew and lower HSE exposure when compared to a cable crew. In some locations, during the survey deployment, the ground was so steep that the units had to be secured, to stop them from sliding down the slopes.

The lack of cables meant that the lines could run easily through the villages, and ASIAN knew immediately when the villagers interfered with the WRUs. Occasionally, disgruntled villagers stole some of the wireless remote units during the survey. However, because the RT System 2 transmits data in real time, the thieves only stole the hardware—the much-more-valuable data were already stored safely at the central recorder.

The survey also included a large section over agricultural land. The farmers were able to continue preparing their fields for planting by simply plowing around the WRUs, a task which would have been very difficult to do if they were required to avoid cables, Fig. 5.

There are some new skills involved in troubleshooting the wireless equipment, and Wireless Seismic has a team of customer support engineers that provide training for system users. These support engineers are used to working in jungle, arctic, and desert conditions, while remaining sensitive to local customs and indigenous people. One or more Wireless Seismic field engineers are sent out with every system purchased, until the customer is skilled enough to take over, as with the Kurdistan deployment.

The system was laid out in the general configuration of a cable system, with receiver lines and a cross-line backhaul, to connect the individual receiver lines to the central recorder. Data were transmitted along the receiver lines of WRUs toward the backhaul in a relay fashion. The backhaul, also wireless, is comprised of high-bandwidth commercial radios. The survey recorded data from a fleet of four vibrators controlled by the acquisition system. ASIAN deployed up to 320 stations on each receiver line with up to 20 active receiver lines. Additional receiver lines were deployed and rolled into active status from the central recorder, with 34 lines typically being deployed on the ground. For this survey, the crew deployed 20 live backhaul masts, with two radios on each mast, to relay the data up and down the backhaul line. It was not necessary to use optional fiber-optic backhaul cables on this survey.

With the RT System 2 seismic data acquisition system from Wireless Seismic, it is now possible to collect data from tens of thousands of seismic channels, in real time, without the use of cables. System users can enjoy simultaneously the security of real-time acquisition, freedom from cumbersome cables, and all of the environmental and HSE benefits they bring without the uncertainty, delays and in-camp infrastructure of blind systems. WO

JOHN FLAVELL SMITH joined Wireless Seismic in April 2012 as director, International Business Development and was appointed V.P. Global Marketing in November 2013. An industry veteran of over 35 years, he was a co-founder and COO of Greenrock Energy, a renewable energy services firm, and a co-founder and director of Vibtech, which developed the first real-time wireless seismic systems. After Sercel acquired Vibtech in 2006, Mr. Smith served as V.P. Corporate Development. His experience also includes Digicon-Far East, WesternGeco, Concept Systems, and Wood MacKenzie. He has a BS degree in Ecological Sciences from Edinburgh University and an MBA from Bath University.