Cable-free Freedom

Cable-free hardware is not new but there is something new in cable-free! Ascend Geo have shown that cable-free technology can revolutionise land seismic acquisition.

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Cable-free operations in Belize resulted in what is thought to be the first discovery through modern cable-free data. To replace or augment cabled systems, new-era systems must be able to cope with all exploration environments

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Early digital cameras had fewer than half a million pixels. They seemed good at the time, but the latest models have twenty times more, and the improvement in image quality is massively apparent. The older cameras simply did not have the resolution for detailed images.

Land seismic systems are similar. Our ability to discern complex reservoir structure is restricted by the number of "picture elements" of the subsurface which are recorded. In 3D exploration, these are called "bins" and are imaged by sensors attached to individual channels of a recording instrument. Currently, a crew with about five thousand channels is considered a major operation.

However, to properly image some reservoirs we may require as many as three million channels, although by cutting several geophysical corners, we can possibly scrape by with just 75,000. In other words, acquisition technology commonly used today is still only the equivalent of a camera with a few hundred thousand pixels. So why has the industry been unwilling to undertake surveys with significantly more channels?

Heavy, expensive cabling

The issue is that, until recently, land operations had to rely on heavy telemetry cabling for remote control commands to travel to electronic ground boxes and to return data from sensors. A survey may require hundreds of kilometres of cabling, linked by thousands of connector contact points. A problem anywhere on this cable or at any single intermittent contact can be enough to bring recording to an expensive halt.

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Offshore deployment of seismic group recorders with floatation collars.

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"Ultra G4" operations on the Texas-Mexico border in summer 2006.

Land digital cable telemetry recorders, first used in 1979, enabled a transition from 2D to 3D acquisition and images improved as a result. But, unsurprisingly after more than a quarter of a century, digital cabling found its limits. Cables are generally by far the biggest cause of downtime and the single heaviest system-specific component, accounting for both the most expensive part of the instrumentation and the highest HSE risk exposure. Despite specifications which hint that some cable systems can acquire channel counts well into five figures, few companies appear to want to use them to meet oil company demands, which may be for twenty thousand channels or more.

Therefore, for geophysics to offer the equivalent of a multi-megapixel image and to bring exploration into the high-definition era, it is necessary to offer systems which do not rely on cables. Although cable-free systems are not a totally new development, so called "new-era" systems are now seen as the solution to many exploration problems, including significantly reduced costs and much improved geophysical images.

Multi-purpose, low power systems

The use of cabled systems is very entrenched in the minds and contracts of land exploration. For the exploration industry to reap the benefits of more universal cable-free usage, hardware must have at least two important attributes.

Firstly, it must be multi-purpose. A single system needs to work with all applications, including better spatial sampling, larger areal cover through improved ranges of offsets and azimuths, and the choice to use geophone arrays as well as point receivers, multi-component if required. Such systems, dependent upon architecture, can be employed to seamlessly expand the channel counts of cable crews by significant factors.

Secondly, ground units must consume very little power. Batteries can be the heaviest element of cable-free hardware, but deployed stations may need to be left unattended for a month or more. Therefore, total energy consumption must be absolutely minimal as it is not feasible to revisit so many ground units simply to change batteries.

Given how various new-era technologies fit into these categories, and judging by the experience of earlier cable-free products, it seems likely that fielding modern instruments with the least geophysical 'bells and whistles' will allow the deployment of the highest number of channels per exploration dollar, perhaps even doubling or tripling the number of channels in an operation when compared to more complex cable-free hardware. This presents an interesting question for explorationists: what features are actually necessary, when the most essential requirements of high data quality and productivity are best met by hardware which can acquire the largest number of channels at the lowest cost?

Coincidentally, the latest cable-free systems take advantage of the same technology that digital cameras use, namely low cost solid-state memory. Not so long ago, memory was a dollar per megabyte, but each ground station can now contain gigabytes, and such capacity is also required

Cable-free operations in Belize successfully crossed areas of uninhabited rain forest, populated by a wide variety of wildlife. Used to replace cabled hardware, the G3 was responsible for the first discovery in that country in an area where 50 dry holes had been drilled previously.

for the latest mega-channel continuous cable-free systems. If sufficient local storage is available there is even less need to return data in real time and, equally essentially, if the boxes can be controlled by a simple radio link, then they can be deployed anywhere that a cabled system can. There are at least five manufacturers with new-era systems and it is possible that by 2010 half of all land channels sold could be cable-free.

Cable-free seismic leads Belize discovery

Aspect Energy, a medium sized US oil company and major user of land seismic services, was one of the most aggressive in pursuing new-era technology, and in 2001 set up Ascend Geo LLC., to develop a cable-free instrument, known as 'Ultra'. Two generations of product were built in the lab in order to perfect the continuous record technique, before the third generation, 'G3' Ultra, was successfully tested in Belize in 2004. In 2005 the G4 was launched as a commercial product.

As well as the rain forests of Central America, Ultra has now been field-proven in operations as diverse as built-up suburbia in Texas, deserts in the southern USA and the villages of Europe in winter. It has been used both in stand-alone mode and integrated with different cabled systems. It has recorded the greatest variety of data with the largest range of sensors, including 2D, 3D, 3C/9C, and passive recording, showing off its ability to meet all new-era requirements while demonstrating major improvements in production. Similar productivity benefits were noted by BP when an alternative cable-free system was used in the United States recently, with personnel cut by about 40% and total survey duration reduced to just one third of a cable system project.

What this proves is that cable-free is already changing land exploration. As systems and operations are refined, the situation will get even better. Interest is growing rapidly, to the extent that many companies no longer ask for comparisons with cabled recorders but want instead to know how the various cable-free systems differentiate themselves. It is these differences which permit one system to handle a mere twenty thousand channels while another copes with a hundred thousand.

The future is cable free

Cable systems will, of course, have a place for a while, as productivity and HSE are not always the overriding issues for operations. Sometimes real-time data is important, and the most likely on-going role for existing cabled hardware is to be coupled with cable-free recorders to allow real-time acquisition from selected parts of the spread while massively increasing channel count. This also offers a pain-free way for contractors to move into cable-free, using their cabled systems with perhaps 5,000 channels beside an appropriate cable-free system with many more channels. Such seamless integration of these two different recording technologies is a must, to allow contractors continued use of their costly inventory of geophones and to depreciate their existing cabled products.

An exciting era has commenced and a growing acceptance of the need to change how we undertake acquisition offers more freedom to explore. No one can be sure where cable-free will lead and it is easier to comment on what route the future will not take rather than what will definitely come to pass, but for the right technology, the sky's the limit.

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Seismic Group Recorders

The 'father' of cable-free systems was the Seismic Group Recorder (SGR), pioneered by Amoco in the seventies for the same reasons that the latest systems have been designed - to improve productivity by getting rid of cables. The application was initially developed for operations with around 200 channels, mostly in Louisiana and the Rocky Mountains. It was subsequently further developed for the transition zone, allowing it to work in environmentally sensitive areas such as oyster beds.

Early SGR systems were "shoot blind", with data recorded on a magnetic tape inside each ground unit which, once deployed, was impossible to monitor remotely to ensure it was still working. While many people initially disliked this approach, the SGR found popularity as it demonstrated significant productivity improvements. At its peak, twenty SGR crews were operational. A figure of a mere 1% unusable traces became quite common once shoot blind operations were perfected, a level quite acceptable in cable systems today!

Shooting blind did not go down well with everyone, so systems were developed which could radio back a short data packet indicating that the ground unit was still working; a sort of "shoot with a squint in one eye"! A prime example of this was I/O's RSR system, which became system-of-choice for various contractors, accounting for some of the largest land operations in North America. Finally, there were instruments which sent the entire seismic record back over a period of time using a form of VHF communication.

Each system had its pros and cons. Generally, the more data you wanted and the quicker you wanted it, the more expensive and power hungry the system became and the more radio bandwidth it needed. This meant that fewer channels could be used per dollar of exploration budget - an important lesson for modern systems. Essentially, if companies need information back during acquisition, then fewer channels can be operated, potentially reducing image quality.