The state of land seismic

Doug Crice[1] assesses the prospects for improvement for the land seismic equipment industry.

Introduction

It has been said that when the oil and gas industry catches a cold, geophysical contractors get the flu, and the equipment manufacturers get pneumonia. This metaphor describes the leveraged financial impact of the periodic collapses in the price of oil. The oil companies cut back on exploration, and the contractors reduce the number of active crews. Surplus equipment is warehoused and the contractors stop buying hardware altogether. Why buy gear when you have it on the shelf?

The low oil prices have decimated seismic system sales. With a few exceptions, hardly anyone is buying anything except in less-developed nations where oil is essential to the economy. This is happening during what would normally be exciting times in the industry. For example, in the last few years the average number of channels on a seismic crew has increased from a few thousand to tens of thousands. Bigger and denser spreads have become common as new processing algorithms have been developed to give interpreters better looks at the subsurface.

Are things getting better? If you follow the daily news from industry magazines, it appears that the oil companies are learning to live with $50 oil. For many, profits and cash flow are positive while reserves are declining. The inventory of drillable prospects is diminishing and geophysical contracting is looking up. Some are profitable and a few crews are being brought back off furlough. Will the equipment manufacturers be next for improved performance?

Historically, sales of acquisition hardware have fluctuated widely based on three factors:

The first is the price of oil as already discussed. When the price of oil goes up, the oil companies pay for more seismic surveys to build up their inventory of drillable prospects. When the price goes down, drilling becomes less economical, prospects have reduced value, and the oil companies scramble to preserve profits for their investors.

The second major factor has been the growth in the number of channels on a seismic crew. High resolution 3D surveys require more channels, which means the manufacturers sell more hardware.

The third factor is obsolescence. When new technology becomes available, the equipment manufacturers introduce new products, and the geophysical contractors will replace their older equipment to become more efficient or to support the requirements of their customers.

When a generation of seismic acquisition equipment becomes obsolete, contractors will replace the installed base of systems. There are no more DFS-V's collecting data on 9-track tapes. Probably many people reading this have never seen a DFS-V[1] or even know what one is.

The major innovations of late affecting the business of seismic exploration were the transition from geophone strings to single geophones[2] (used in higher density arrays), and from cable-based systems to cableless. The two worked in synergy, since much of the benefit of cableless would be lost if large strings of geophones were still carried in the field.

Geophysical contractors have always been interested in operating seismic systems without cables for smaller headcount and working in areas where cables were logistically difficult: e.g. rough terrain, jungle, or urban areas. And as channel counts increased, it became increasingly difficult to handle the cables required for large surveys, typically with well over 100 km of wire.

Modern electronics gave the vendors the tools needed to build practical systems without cables. After a couple of false starts, they produced a variety of cableless systems that can be

[1] The DFS-V was the fifth in a series of seismic recording systems manufactured by Texas Instruments circa 1980. It was a very successful product; well over 1000 systems were sold. During that particular oil boom, 2D crews were being added at the rate of several per month in the quest for what was then expensive $40 oil. Data was recorded from 120 channels on 9-track tape. Texas Instruments, now a massive semiconductor business, was started as a subsidiary of geophysical contractor Geophysical Service Inc. to provide instruments for their seismic exploration business.

[2] When 2D surveys were the norm, geophones were deployed in linear arrays ('groups') spread over tens of metres designed to reduce surface waves. They no longer made sense for 3D surveys, because the arrivals came from all directions, and surveyors took to bunching all the geophones in the group tightly together. This of course made little sense, and a single geophone became the logical substitute. High-output geophones were developed to replace the clusters, reducing the burden on the field crew, except in a few locations where single-point geophones were less successful.

[1] Wireless Seismic
[*] Corresponding author, E-mail: dcrice@wirelessseismic.com

Figure 1 Left: Geospace GSR, an early market leader in the autonomous node market segment.
Right: Wireless Seismic RT2 delivers seismic data to the dog house in real time over a radio link.

Figure 2 Integrated Autonomous Nodes containing electronics, battery, and geophone. On left, Dynamic Technologies Smart Solo, Center, Geospace GCL, Right, Innoseis Tremornet.

grouped into two architectures: 'autonomous nodes' and 'real-time wireless' (Figure 1).

Autonomous nodes

An autonomous node is a stand-alone, battery-powered acquisition unit, usually one channel but sometimes three or four, which collects seismic data. They are sometimes referred to as 'blind' systems because the majority of the seismic data is collected weeks after the survey begins when the patch is rolled (picked up and moved further down the survey area).

Acceptance and adoption of blind node systems took a little time. Contractors were nervous about working for weeks without seeing the seismic data. The client representatives (birddogs) were unhappy because there was no data to review. Extra testing was required to fine-tune the survey parameters to allay concerns about data quality.

Initial concerns about reliability were quickly dispelled. The units proved to be quite reliable and there was enough redundancy in the array that an occasional lost unit was not an issue.

The autonomous nodes were first to market because they are easier to design. The architecture is reasonably simple using modern affordable A/D converters, microprocessors, and gigabyte memory chips. They use GPS for location and precise timing, and store the data internally. Units evolved, and with few exceptions, they collect excellent data. Some later units offered short-range wireless links to monitor instrument health, battery, and most significantly: seismic background noise. This QC data can be retrieved by driving past the units, or even flying by with helicopters or, more recently, drone aircraft.

There are differences in the products. Some manufacturers that recognize the need for efficient downloading of the data and charging batteries have done a better job of solving that problem, paying as much attention to field procedures as to the unit itself. You can sometimes tell from the design if a product was developed in an area where wages were low and could be neglected in the field logistics. Some manufacturers, recognizing the need for continuous QC of the instrument and the seismic noise, have done a better job of meeting that requirement. The Sercel WTU-508 node integrates with their 508XT cable-based system for continuous QC data and the complete seismic file can be retrieved by Wi-Fi with drive-by or fly-by.

Development continues while the industry waits for the market to recover. The latest trend is a switch from the separate battery-unit-geophone combination (Figure 1, left) to an integrated module with no exposed connectors (or no connectors at all), see Figure 2.

There are probably too many vendors in the autonomous-node market segment. When you consider that just two manufacturers in the West supply all the cable-based systems that the market needs, you might ask if 11 suppliers can remain viable in the cableless market.

Real-time wireless cableless systems

A real-time wireless system is one that delivers the data to the recording truck continuously or generally in a short time after it was collected by the nodes. In the cab is a reasonably powerful computer, usually with multiple screens. One screen will display seismic sections for selected portions of the array to let the operator and birddog examine the record quality and adjust acquisition parameters to fine tune the data or if conditions change over the spread. Other screens will display continuous background noise levels, QC checks on the nodes, and a map of the survey. The

Figure 3 Wireless Seismic real-time multi-screen display of the seismic record, survey map, noise levels, status of the individual modules and other parameters.

Autonomous node vendors		website
Dynamic Technologies	Smart Solo	www.smartsolo.com/
Fairfield Nodal	Zland	www.fairfieldnodal.com/
Geophysical Technology	NuSeis	www.geophysicaltechnology.com/
Geospace	GSX, GCL	www.geospace.com/
Innoseis	Tremornet	www.innoseis.com/
Inova	Hawk	www.inovageo.com/
iSeis	Sigma	www.iseis.com/
SAS	Orion	www.sasgeo.com
Sercel	Unite, WTU-508	www.sercel.com/
SKBSP	Scout	www.skbsp.ru/index.php/en/land-seismic/scout
World Sensing	Spidernano	www.worldsensing.com/product/spidernano/
Real-time wireless vendors		
Wireless Seismic	RT2, RT3	www.wirelessseismic.com

Table 1 List of manufacturers of cable-free seismic systems.

Figure 4 Integrated real-time wireless seismic acquisition module from Wireless Seismic designed for surveys of up to 250,000 channels or more.

data will be saved from the shots on digital media in a standard SEG format and copies can be delivered to the client as requested, sometimes by satellite. As a result, the birddogs are able to do their job.

Some benefits are obvious, while others are subtle. Noise is monitored continuously in the case of wind or traffic. If some of the units are stolen or destroyed, you know it immediately and the data is safely in the cab. The operator can run daily tests or even change shooting parameters in response to varying conditions.

Microseismic monitoring has traditionally been done with cable-based systems. The problem is that many frac sites are cluttered with vehicles, roads and other artifacts of the process making it difficult to lay cables. Autonomous nodes are logistically more convenient, but the trend is towards real-time frac monitoring in which the processed data can be sent in real time by satellite to the end-user client, which provides immediate feedback to the frac control computers.

With autonomous nodes, downloading the data ties up much of the inventory of devices, raising the effective system cost and delaying delivery of the seismic data from the last patch of receivers as the project is completed.

Wireless Seismic Inc's real-time seismic recording system[3] RT2 was used on a 7500-channel survey in Kurdistan in 2013 and expanded to 13,000 channels in 2014. The system uses wireless nodes with radio-based cross lines and backhaul reminiscent of a cable-based system approach. This radio relay architecture allows for short range radio transmissions of the wireless units (which reduces the power requirements) and overcomes complex terrain issues. The company has recently launched the RT3, which comes in an integrated package with geophone, battery, acquisition system and radio to support over 250,000 channels in real time.

Conclusion

These are exciting times in the industry, with an unprecedented level of innovation and competition in the seismic acquisition business. It is clear that the equipment suppliers are doing their part to help create better seismic data for the industry. That they have continued to invest despite the dearth of orders is a tribute to their vision for the future, and the fact that some of us have been through this business cycle a few times in the past.

References

Crice, D. [2014]. A cable-free land seismic system that acquires data in real time. *First Break*, **32** (01), 97-100.

[3] Some autonomous node systems can be integrated with Wi-Fi communications accessories to bring home some data in real time, but the power requirements and logistics make these impractical except for a small portion of the array.