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Rapid Change in Land Geophysics

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Summary

Land seismic exploration is inexorably moving to hardware which does not use digital cabling for data acquisition. Almost all major oil companies are now in some way "bought in" to the necessity of this change and most system manufacturers already offer some form of "new era" cable-free product.

As well as HSE and cost improvements, cable-free products can also be thought of as providing low cost fold. But differing system technologies offer widely varying approaches to how data can be improved. The issue for any exploration environment is to consider whether and how each new technology could be incorporated to solve specific local problems.

Cable-Free Background and Present Capabilities

The first cable-free systems date back many decades; maybe the father of them all was the Seismic Group Recorder pioneered by Amoco, designed in the seventies. The first SGR instruments were "shoot blind" so after deployment of a ground unit there was no way to know remotely if it was still working. Although some initially mistrusted this approach, the system soon gained a reputation for productivity improvement and, at its peak, twenty crews were operational with up to 200 channels – very impressive for that time. The system also proved reliable with as few as 1% of deployed traces being unusable – a figure as good as most cable systems today!

It is noteworthy that, as with modern cable-free hardware, the SGR was developed to improve exploration by getting rid of cables. However, a major difference is of course that the latest cable-free systems are capable of deployment of tens of thousands of channels.

Therefore, while it is obvious that cable-free systems are not new, there is something new in cable-free and some so-called "new-era" systems are already showing themselves to be the solution to various exploration problems. In just a few recent years, they have been field-proven in places as diverse as the rain forests of Central America, the deserts of Texas/Mexico and the dense agricultural areas of central Europe. One system was responsible for a major find in an area where 50 dry holes had been drilled previously; another showed itself capable of being used with twice the in-line and cross-line density for a similar price compared to a cable system, showing better quality data as a result.

New-era cable-free systems have been used in both stand-alone mode and integrated with different cabled systems, recording 2D, 3D and 3C/9C data so they are genuinely the most flexible of multi-purpose instruments. Figures have been presented showing cuts in crew personnel by as much as 40% at the same time as reducing survey duration by a factor of three. It is possible that such performance is the reason that some predict that by 2010, fifty percent of all channels sold will be cablefree.

Cable-Free Applications

Seismic crews have almost always had to compromise between operational cost and the number of channels that can be employed, and this latter figure is usually what determines fold and thus image data quality.

Cable-free systems are able to change significantly the point at which such compromises need to be made. Therefore, what cable-free systems bring is "affordable fold".

Even within the last five years, a large crew would be considered to be one with just a few thousand channels. But cable-free systems have already been shown capable of offering a similar number of channels with much fewer personnel, or using the same number of personnel to run several times as many channels. Additionally, the demand for far higher channel counts has meant discussion of "mega-channel" operations, perhaps requiring one hundred thousand channels within the next year or so. This should not be seen as science fiction. Moore's law predicts that, with the right technology, there could be a seismic land crew with one million channels by around 2020. Probably, few markets will need such trace density, but a technology which makes this possible will offer serious advantages to crews with less grand ambitions.

However, a little-discussed side of cable-free is its ability to augment existing cabled systems. New-era systems should be considered as complimentary to cabled systems as well as potentially its replacement. This ability to seamlessly augment current cable instruments allows existing seismic hardware inventory to be continued to be used alongside the latest land acquisition hardware – an existing cable system with any number of channels can be expanded by the addition of new-era ground units. In this way, existing cable inventory is used, and cable-free channels in large numbers can be deployed with few extra crew personnel to massively improve the data quality above what is economically possible with just a cable system. This is the best of all worlds to contractors and oil companies alike.

Therefore, new-era systems can also be thought of in terms of the cost per channel to augment a cable system. Thus, rather than simply thinking of the cost of using a complete system to perform a survey, new-era systems allow end-users also to consider the incremental cost of adding fold, and with cable-free instruments that incremental cost can be incredibly low.

This paper believes that the paradigm of seismic acquisition will now change; a process which has in some places started already.

Varieties of Cable-Free

However, cable-free hardware and acquisition techniques must be better understood in order to get maximum advantage. They should not be considered as simple variations on cable exploration. Even the most modern cable-free systems offer different approaches.

Broadly they fall into two categories – those which try to transmit some sort of information from each ground unit over some period of time, perhaps just system status or the entire seismic record. Others modern systems are, like the SGR, "shoot blind". The first category generally are more expensive, use far more battery power, and may require special radio licencing – often an issue in India. The second category, since they are the simplest systems to built and to deploy, are also usually the lowest cost to acquire and the lowest cost to use, thus "incremental fold" comes at a lower cost with such hardware.

Another issue is the ability of a cable-free system to use the widest range of sensors so that all types of geophysical acquisition can be undertaken. This includes point receiver, standard arrays and 3C. When the system is used in the "augmentation mode", clearly it is necessary to use the same sensors as those already being used with the existing cable system.

Whatever type of new-era system is used, its most important characteristic is its power requirement since electrical power accounts for the heaviest single weight element of this new technology, and weight difference, when multiplied by a factor of some thousands, makes a lot of difference to field costs. Additionally, some applications for cable-free need ground units deployed for up to a month. If some tens of thousands of them are deployed, it is impractical to think that some many batteries can be changed during this time, thus they need to be extra-low power and this has a profound effect on system design.

Specific Conclusions/Impact

The field of cable-free systems is changing very rapidly. In the last year alone there has averaged some important new-era milestone almost every month. This paper investigates the latest cable-free advances and operations, and considers its benefits and applications with specific regard to the local environment, and looks at the differences between the emerging cable-free technologies, offering real field studies and data comparisons.

In a fast moving economy where growth is dependent on some way on local energy supplies, cable-free land acquisition offers particular advantages to the Indian market. This new technology has the potential to permit greater reserves to be discovered rapidly both from existing and new fields, with higher efficiency and lower environmental impact, and also allow existing seismic system inventory to be used to even greater effect.