PS Land Acquisition Systems: From Centralized Architecture to Autonomous Sources and Receivers*

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Abstract

Application of new technologies to Land acquisition systems has opened the way to various survey architectures. On both the source and the receiver sides, we have the option to keep field equipment centralized (e.g. cable systems) or to have it autonomous thanks to GPS synchronization (e.g. cableless systems). Such flexibility has increased crew productivity to such level that high-density 3-D surveys can now be performed in more difficult areas.

With centralized architectures, receivers are connected via cables to the Central Unit and the sources are triggered by radio from the recorder. Synchronization as well as real time quality control and data recovery are made easy. However, as the spread size increases and the areas to be surveyed get more obstructed, this type of architecture presents some constraints.

The recently availability (2005) of high sensitivity and low power GPS chips has been the enabling technology to move beyond this centralized architecture while preserving accurate synchronization (30 ns). On the receiver side, it is possible to lay-out autonomous field units equipped with GPS, memory, and battery. Such cableless spreads provide the easiest access to difficult terrain, reduced environmental footprint, and more flexibility on spread geometry. The key feature for the latest generation of cableless systems is the harvesting of data in the field using WiFi, rather than waiting until units are returned to the base-camp.

On the source side, vibrators equipped with GPS for both positioning and timing may also be disconnected from the recorder. The Central Unit or the autonomous units record a continuous stream of GPS time stamped seismic samples. As the vibrators record the start time of each sweep, a simple correlation by the pilot is able to extract the corresponding Vibrating Point (VP) from this continuous record. Thus, without waiting for any command, vibrators can sweep as soon as they are ready (ISS from BP) or in

accordance with a predefined GPS time table (V1 from CGGV). Both methodologies enable more than 10 vibrator fleets to operate at the same time. They have increased significantly VibroSeis productivity in open terrain (more than 1000 VP's per hour).

By combining autonomous sources and receivers, a completely different way of performing Land acquisition has been achieved.

Land acquisition systems:

from centralized architecture to autonomous sources & receivers

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Application of new technologies to Land acquisition systems has opened the way to various survey architectures (Figure 1). On both the source and the receiver sides, we have the option to keep field equipment centralized (e.g. cable systems) or to have it autonomous thanks to GPS synchronization (e.g. cableless systems).

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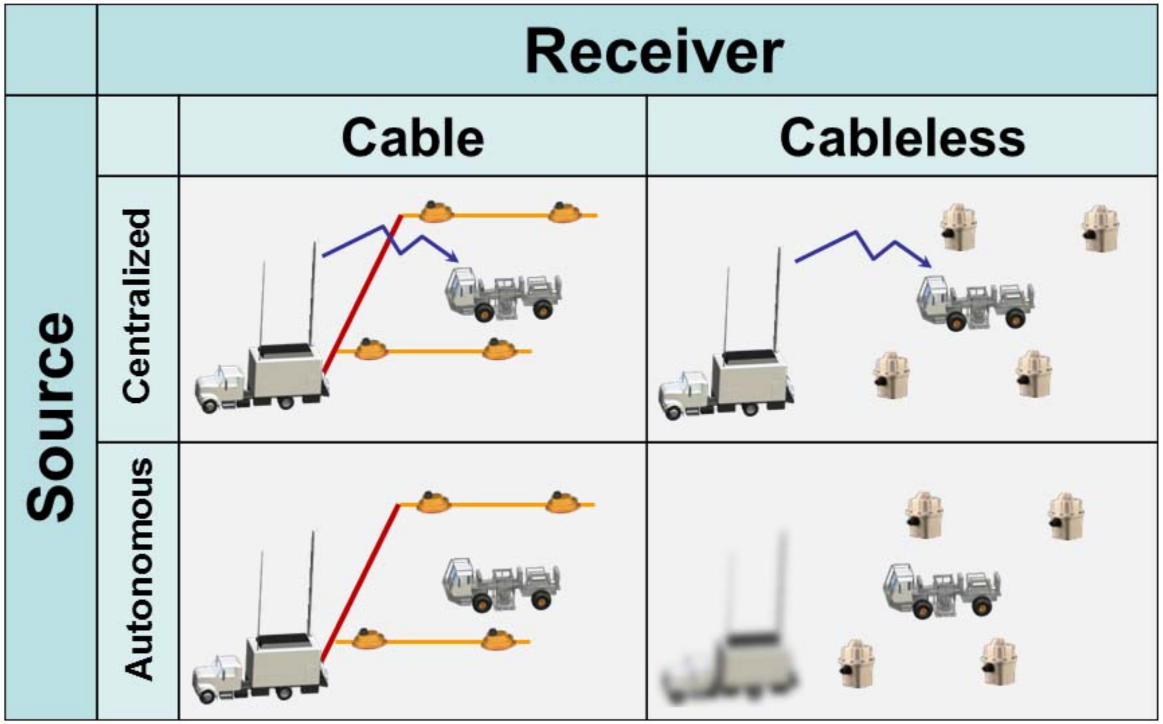


Figure 1: Different land acquisition architectures

The impact of the Global Positioning System (GPS)

While GPS positioning has been used for several decades (Figure 2), the impact of GPS timing on land acquisition is recent (2005). By enabling the time-stamping of all seismic samples in the recorder as well as in the autonomous receiver stations, GPS timing offers the possibility to synchronize all elements of an active spread.

The same flexibility exists on the source side: GPS provides the start time (T0) of each shot point used as reference to extract the corresponding data from the records.

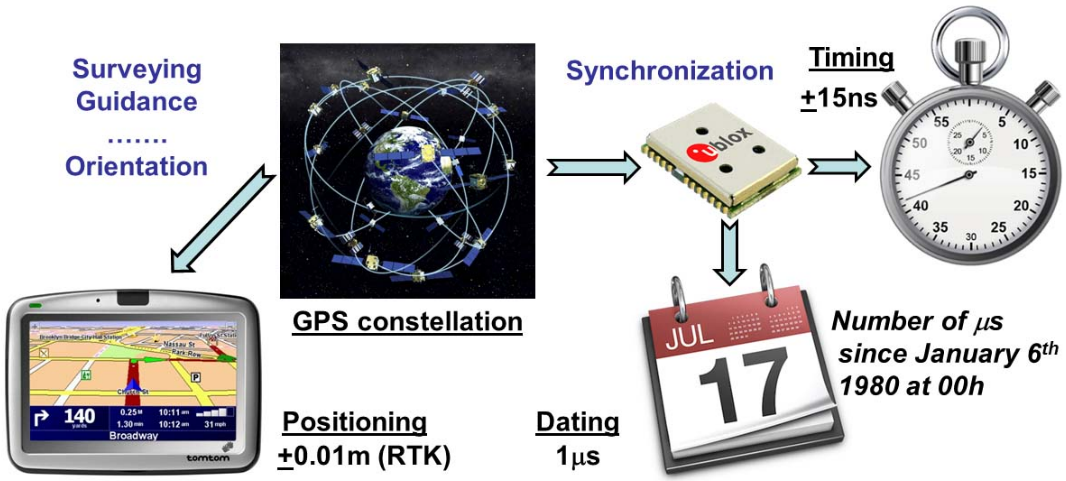
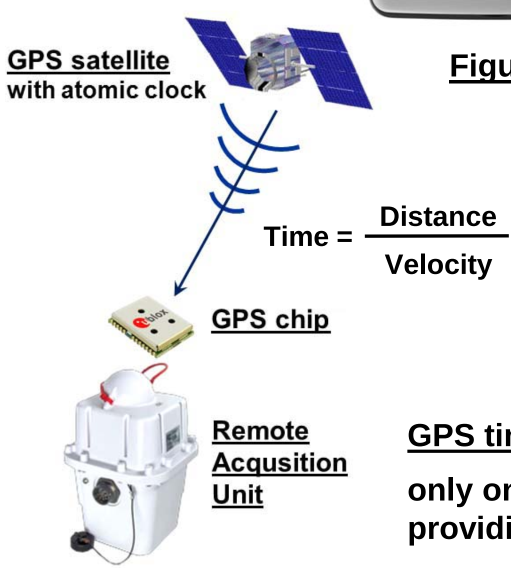


Figure 2: GPS is not only used for positioning but also for timing & dating

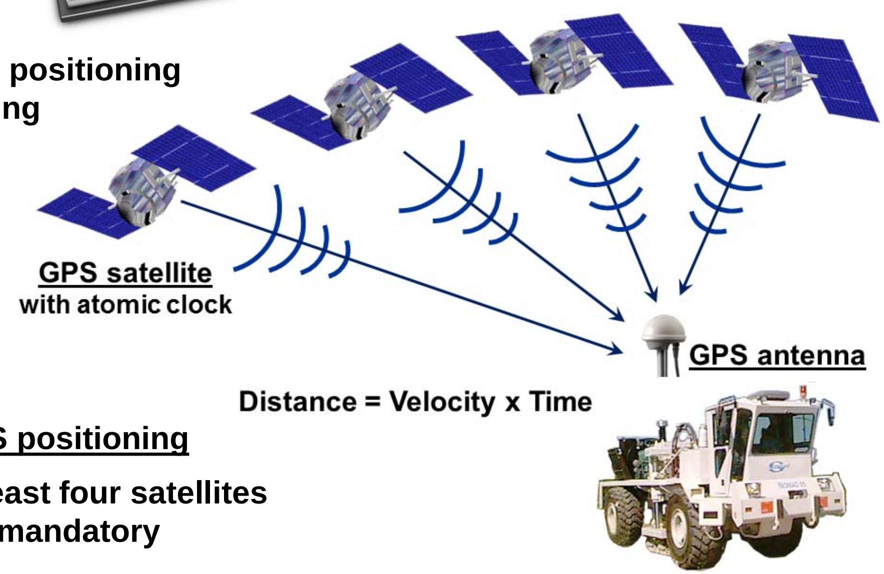


GPS timing

only one satellite required providing position is known

GPS positioning

at least four satellites are mandatory



The centralized architectures

With centralized architectures, receivers are connected via cables to the Central Unit and the sources are triggered by radio from the recorder (Figure 3).

Synchronization as well as real-time quality control and data recovery are made easy. However, as the spread size increases and the areas to be surveyed get more obstructed, this type of architecture presents some constraints.

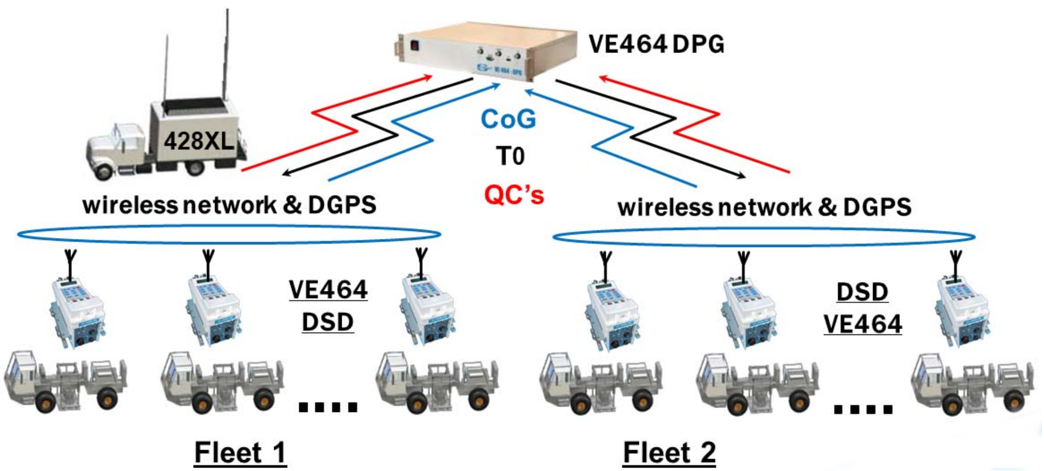


Figure 3: Vibrator Electronics (VE) centralizes exchanges between the vibrators and the recorder

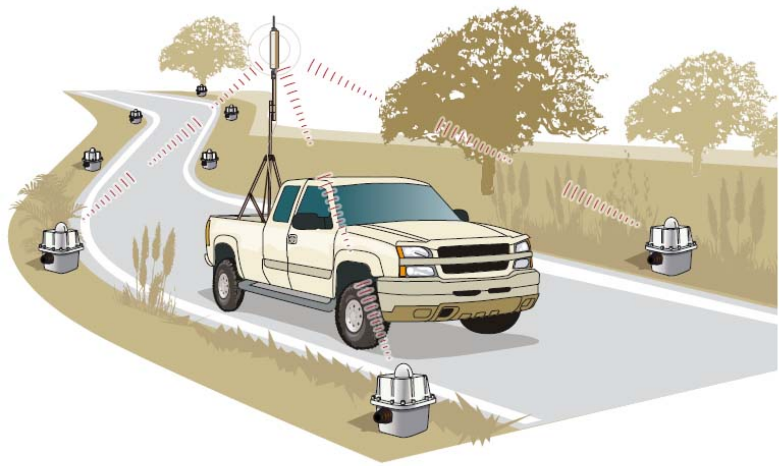


Figure 4: autonomous field units may be remotely harvested

The autonomous architectures

On the receiver side, it is possible to lay-out autonomous field units equipped with GPS, memory and battery. Such cableless spreads provide easier access to difficult terrain and reduced environmental footprint. They offer more flexibility on spread geometry. For those equipped with WiFi, data may be remotely harvested (Figure 4).

On the source side, vibrators equipped with GPS for both positioning and timing may also be disconnected from the recorder(s). Without waiting for any command, they can sweep as soon as they are ready (ISS™ from BP) or in accordance with a predefined time table (V1 from CGGV). The Central Unit or the autonomous units record a continuous stream of GPS time stamped seismic samples from which SP's will be extracted.

Towards new land acquisition architectures

In practice, these different architectures should not be considered as exclusive from each other. As survey size increases, terrain conditions diversify requiring the simultaneous use of different architectures, particularly on the receiver side.

Today, more and more hybrid spreads including a mix of cable and cableless systems are used (Figure 5). They may be juxtaposed (infill mode, to be able to lay out continuous receiver lines even in obstructed areas) or superimposed (multi-spread mode to adapt receiver interval or sensor type to different target depths or reservoir studies).

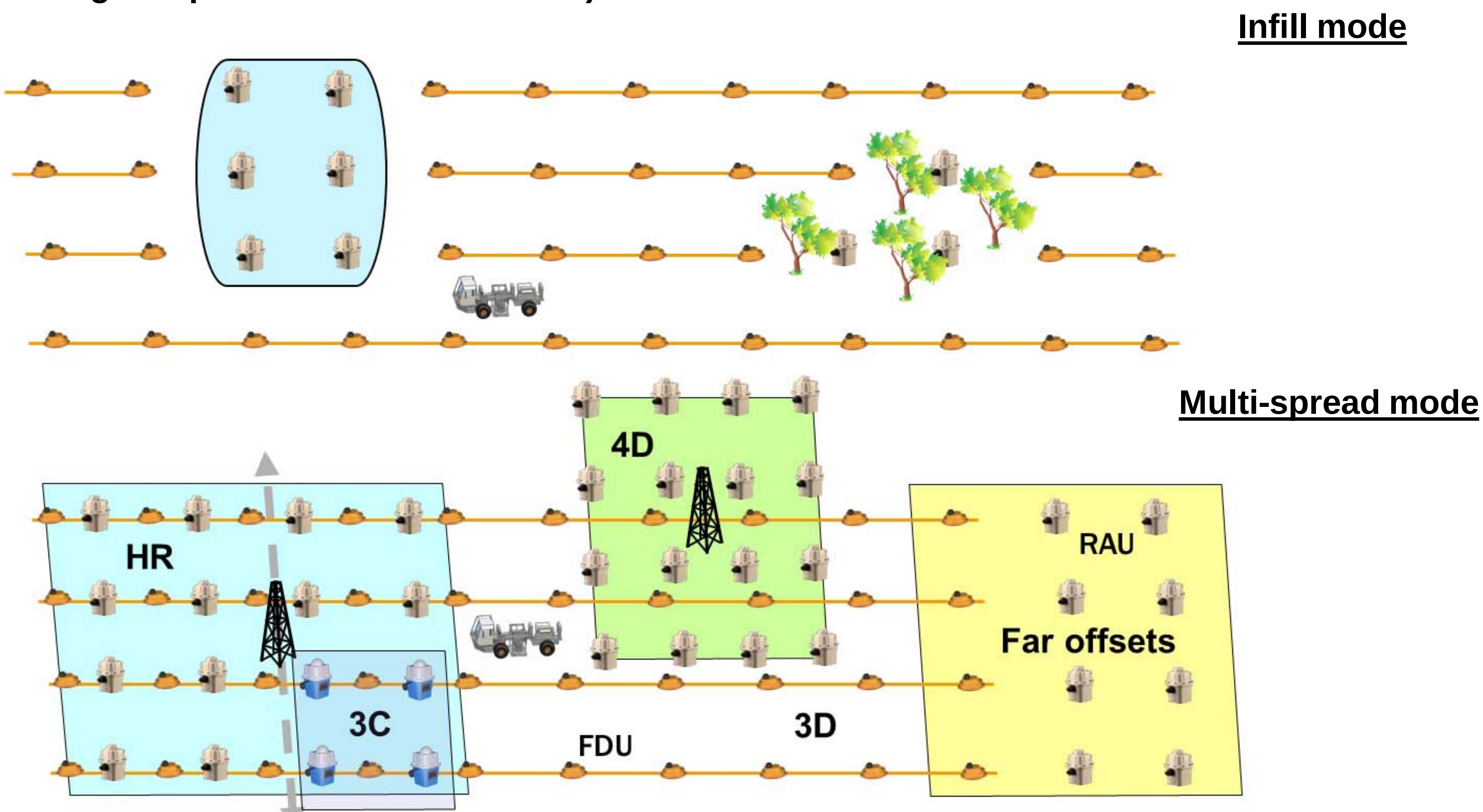


Figure 5: infill & multi-spread modes combine different architectures