Navigation Sensor Technology Aids Marine Seismic Survey

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A new digital compass provides a clear view of the geology from the seabed.

NCS SubSea, a company that provides survey, navigation, and positioning services for the oil and gas industry, evaluated and approved Sparton Navigation and Exploration to provide integrated navigation sensors for use in the first integrated navigation system for the P-Cable High-Resolution Multi-streamer Seismic system. This technology was developed to provide oil and gas producers with an ultrahigh-resolution image of the geology from the seabed down to approximately 2,000 m (6,000 ft). This information is valuable as it illuminates potential hazards such as gas pockets and chimneys as well as providing a good picture of ancient river channels, ice gouge, and similar features. NCS worked closely with Subsea Systems and Geometrics to devise the proper hardware that would allow for development of an advanced software product that provides proper and precise real-time positioning of the hydrophone array.

NCS was closely involved with both Sub-Sea Systems and Geometrics in developing a navigation and positioning technology that would precisely and continuously provide a real-time position and shape analysis for the P-Cable Seismic system, as well as ancillary in-water equipment.

To achieve this, the companies knew they had to start with a clean slate, meaning they did not want to use any of the existing “off the shelf” products.

A new compass aids in navigating the P-Cable Towed Array. (Image courtesy of Geometrics/Fugro West, Inc)

Product requirements

To commence evaluation of a navigation system, the product requirements had to be defined to ensure the product chosen met the challenges of the multistreamer seismic technology application. As such, the requirements for a navigation system were:

Low cost;

Low power;

Small size and mass;

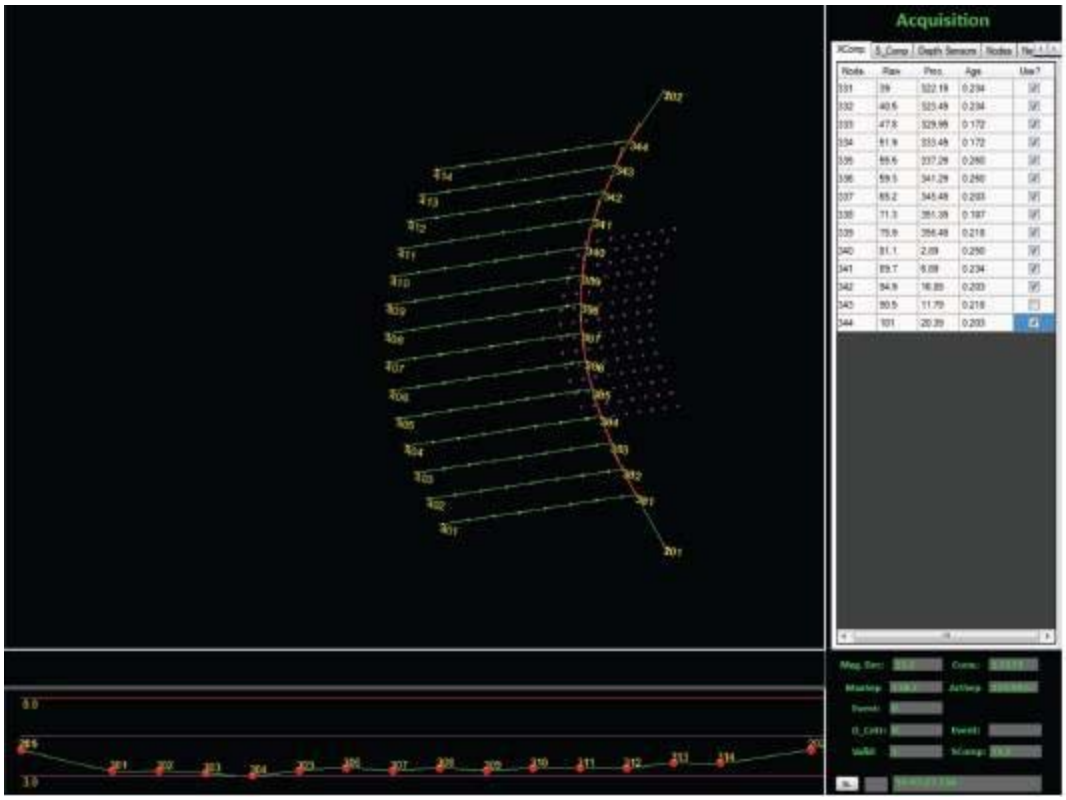
High accuracy;

X,Y, and Z real-time data output;

Robustness to withstand the elements and the rigors

of the application environment; and

Fast update rates.

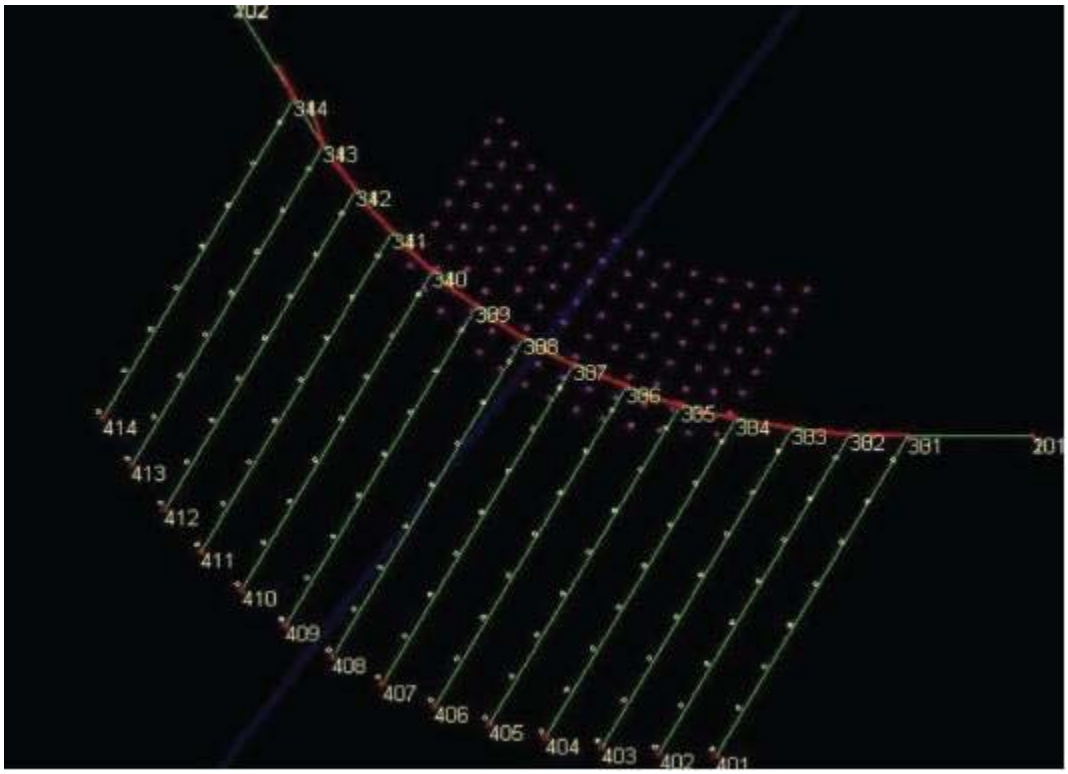


Computed streamer positions are derived using surface GPS data coupled with the heading information from the compass units

With the advent of MEMS sensor technology, the digital compass has emerged as a leader in price-performance, offering a number of advantages to the designer as a method of providing and maintaining accurate heading. A digital compass typically consists of magnetometers (used to measure the earth's magnetic field to determine magnetic north), and accelerometers (used as a tilt sensor to compensate for the orientation of the magnetometers due to pitch and roll). Digital compasses also can be augmented with the use of gyroscopes (angular rate sensors used to compensate for magnetic disturbances and dynamic environments).

Designing the compass

Ultimately, the MEMS-based digital compass design met the product requirements and was selected for testing. Based on positive test results, Subsea Systems and NCS chose the digital compass because of its extremely compact size and three-axis reference output. Another key aspect was the Ethernet capability. The digital compass is integrated at 6.25-m or 12.5-m (20.5-ft or 41-ft) intervals along a towed wire called a "cross cable" between two diverters, which provide the necessary horizontal lift to spread the cable. The digital compass resides in a titanium housing that also serves as an attachment point for a seismic streamer. These seismic streamers also have digital compasses integrated in their tails, meeting another key design consideration; they have to fit inside the existing streamer canister dimensions. The compasses provide accurate and reliable heading information, delivered over the Ethernet backbone, allowing the system to use those headings in conjunction with surface GPS positions to derive the true shape of the cross-cable and the seismic streamers, all in real time. An important design consideration was having a compass that could be integrated inside of the in-water equipment. Attaching external devices that housed digital compasses was not feasible due to the close spacing of equipment while it was being deployed and towed. The Sparton units met this challenge well, allowing for even tighter spacing configurations for the in-water equipment.



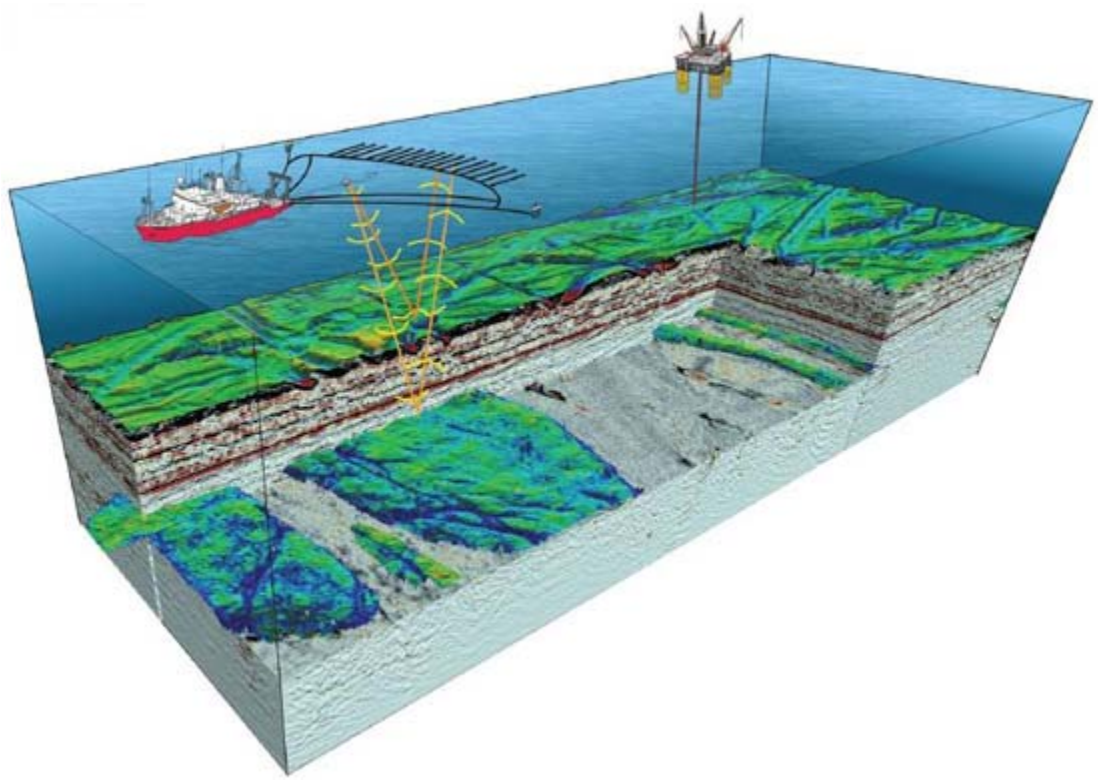
The effectiveness of the software repre sentation is due in part to the Sparton compass. (Image courtesy of Sparton Navigation and Exploration)

Vision of efficiency

The computed positions of the streamers and the cross cable are derived using surface GPS data coupled with the heading information from the compass units. Note the digital compass heading information in the data form top right of the figure.

Eddie Majzlik, technical manager and product development lead for NCS, said, “We were able to easily interface with the Sparton personnel and communicate not only on a highly technical level but also on a common sense level; they were able to understand our needs, able to articulate that understanding very well, and revert in a timely manner with something that met the scope and worked very well. Ultimately, they provided a three-axis digital compass that was small in scale, large in functionality, robust enough for the offshore subsea environment, and allowed for communication and data transfer via Ethernet.”

NCS SubSea and Geometrics/P-Cable technicians were able to see immediate commercial success, and they credit Sparton with playing a critical role in the process.



The schematic shows the P-Cable system being towed behind the vessel and the subsequent types of near-seabed surface geologic features that are imaged. (Image courtesy of P-Cable 3D Seismic)