MantaRay; The next step in ocean bottom node deployment and recovery

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Introduction

The first ocean bottom node survey, for hydrocarbon exploration, was acquired over the Atlantis field of the Gulf of Mexico in 2004. At the time the method was constrained by the inefficiency of the node deployment and recovery solution resulting in survey designs utilizing relatively sparse receiver grids compensated for with dense source grids. Even with these node and source sampling grids the project efficiency was constrained by the receiver platform. Since then, seismic contractors have innovated and invested to improve the efficiency of the receiver resource with new deployment methods such as node-on-a-rope and improvements in the ROV solution; including multiple ROV's and larger node capacity sleds/ baskets. However, with the industry desire to improve receiver sampling and the growing industry acceptance of aggressively blended sources we can expect the receiver resource to continue to limit OBN efficiency for a proportion of the designs. In this paper we describe a new method to deploy and recover ocean bottom nodes with the advantages of ROV deployment but with greater value for the client and faster deployment and recovery speeds.

MantaRay – Automated and Tetherless Node Deployment and recovery with ROV precision

MantaRay is the combination of well established technologies and applications integrated to accommodate tetherless and automated node deployment and recovery.

- Saab Sabretooth Autonomous Underwater Vehicle (H-AUV). The unit is an AUV with work-class ROV capabilities which include large payload, ROV manoeuvrability and hovering functionality. The unit loaded with 30 Manta nodes can achieve a maximum speed of 4.5 knots compared to a ROV which has a maximum speed of 1.5 knots. It is fully electrical and does not suffer from the maintenance demands and reliability issues of high pressure hydraulics common with ROV's. The unit has a maximum dive depth of 3000m. The underlying technology includes mission planning and automated collision avoidance through a forward looking sonar. Positioning is achieved through a DVL and USBL aided inertial navigation
- Proprietary deployment and recovery sled and variable buoyancy system
- Node detection and recovery through a combination of stereographic cameras and 3D visual recognition
- through artificial intelligence applications
- Seabed anomaly identification and avoidance through 3D imaging and visual identification and sonar reflection processing fused in the onboard computer

Figure 1 *The MantaRay Hovering AUV for ocean bottom node seismic operations*

Offshore Operations

A base MantaRay implementation consists of a garage and two AUV’s. One AUV, with a loaded node deployment skid, is deployed in a garage to the seafloor using a heave compensated LARS crane. The garage lands on the seafloor and the AUV departs and starts its mission of deploying or recovering nodes. A waiting AUV is then automatically guided into the garage and returned to the surface where it is resupplied with nodes and the battery is recharged.

For deployment, the AUV follows a mission which is self-designed using the data available to it, which will include node positions, bathymetry information, known hazards etc.. When the unit arrives at the pre-plot location it will assess whether it is acceptable, using the available sensors, and if not move to a more suitable location based on pre-defined rules. The AUV lands deploys the node and then starts the transit to its next location.

For recovery the AUV will move to the locations where it dropped the node and then search for the node using the stereographic camera and graphical recognition application. Once it has the relative location of the node it traverses to that location using the inertial navigation system, lands, recovers the node and continues on its mission.

Operational Modelling against Conventional Technologies

The MantaRay unit is currently undergoing in water staging and as part of this effort the uncertainties in the deployment process are measured. Using these assumptions and assuming a standard MantsRay configuration of one garage and two AUV’s, the deployment rate for square receiver grids from 100m to 1200m were modelled and compared to a dual and single ROV solution (Figure 1). Considering only the receiver side of the productivity equation the MantaRay deploys and recovers at approximately twice the speed of a dual ROV solution and three times the speed of a single ROV solution. You will note that the MantaRay solution is sensitive to water depth when deploying a dense receiver grid (yellow and light blue curves). In deeper water, with dense grids, the non-operational unit can not be replenished before the operational AUV has completed its mission. For these survey types it would be necessary to use an MantaRay configuration of two garages and three AUV’s to ensure a unit is continually in production. The green curve represents the enhanced configuration in 3000m water depth. In all but the densest grids the deployment and recovery operation is continuous, matching the shallower water depth efficiencies.

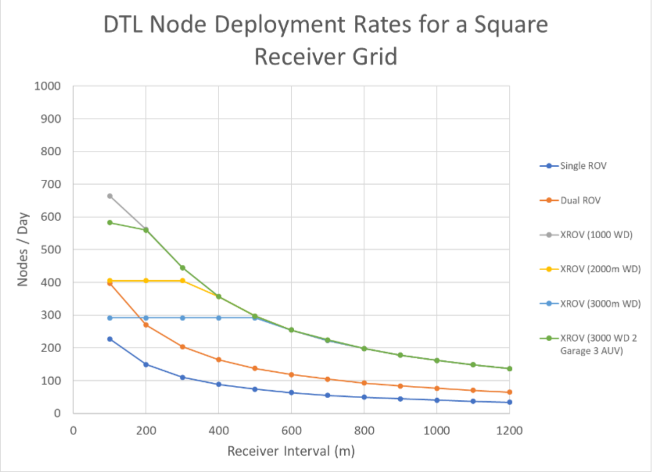

Figure 3 *Comparison of receiver resource efficiency comparing MantaRay to ROV*

Likewise the MantaRay solution has been modelled against a NOAR geometry using the standard MantaRay configuration of one garage and two AUV’s (Figure 2). With the depth limitation of NOAR solutions the standard MantaRay configuration will not be constrained by the cycle time of the garage to the surface. The NOAR deployment method is very efficient but it has some compromises. In addition to the lower quality placement the method dictates a design with very dense inline receiver sampling which

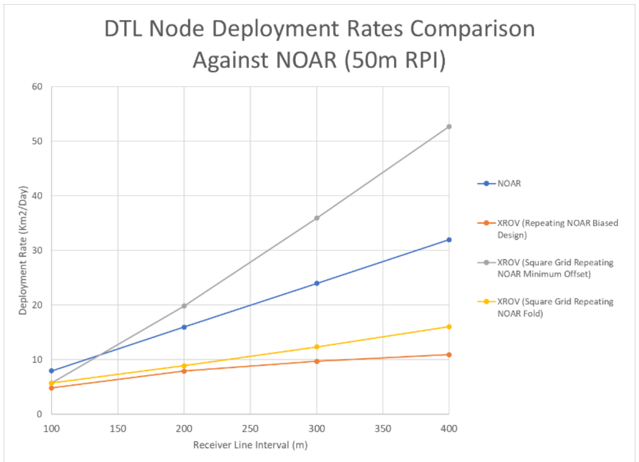

Figure 2 *Comparison or receiver resource efficiency comparing MantaRay to NOAR*

from a purist perspective is a non-optimal way to build fold. A MantaRay solution repeating this dense inline geometry will be 50-60% less efficient that the NOAR method. It is possible to scale up the MantaRay solution by deploying two MantaRay configurations off the same vessel and meet or exceed the efficiency of a NOAR solution. However, with a new technology we should not constrain the designs to the limitations of the existing technology. It is possible to get some improvement in deployment efficiency with a square receiver grid, which matches the dense inline grid fold and significant improvement in deployment efficiency with a square receiver grid, which matches the dense inline grid offset distribution.

Survey Design for MantaRay

Ocean Bottom Seismic surveys use different resources to deploy the sources and receivers. A project will only be as efficient as the least efficient of these two resources. The challenge for survey design geophysicists is how to modify the current templates to benefit from a more efficient receiver resource. The author considers that there will be three options available:

1) **Improved sampling and Image Quality for the same cost -** No change on the source solution but a denser receiver grid, ensuring balanced source and receiver operations
2) **Identical Sampling at Lower Cost -** More aggressive source blending to match the faster node resource
3) **Equivalent Sampling at Lower Cost -** Re-balance the source and receiver sampling – More receivers / less sources

Figure 3 compares the efficiency of the source and receiver solutions for different technology and source/receiver sampling options. In order to maintain source and receiver balance, with a more efficient receiver resource, it is necessary to consider denser receivers, a more efficient source solution or a re-balancing of the source and receiver grid.

Environmental and Operational Considerations

Any known seafloor obstructions, including environmentally sensitive seafloor biological communities will be included in the mission planning and avoided by both the garage and the MantaRay unit. While it is theoretically possible to transmit a low resolution image of the seafloor conditions at the node location, realistically the location where the node is planted will not be reviewed until the unit returns to the surface vessel to be replenished with nodes and recharged. Realtime assessment of the node location seafloor conditions will be achieved using seabed classification on the AUV computer using the stereographic images and a downward facing SONAR. On identification of an unsuitable deployment location the MantaRay unit will search for a suitable deployment location.

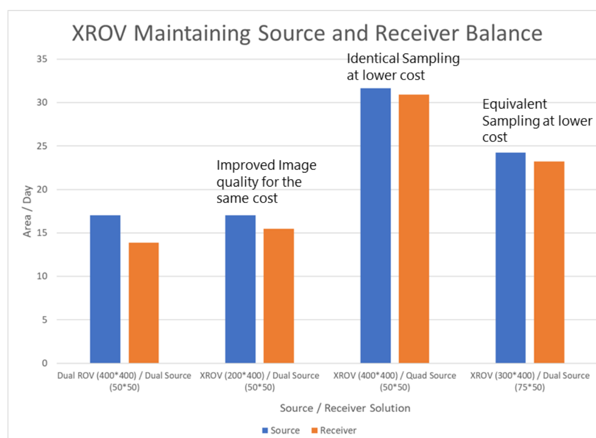

Figure 4 *Comparing the relative productivity of the source and receiver resource for different technology and design solutions*

Conclusions

In this paper we have presented a emerging technology that will accommodate faster deployment speeds while maintaining the benefits of the ROV node deployment solution. This step change in node deployment productivity challenges the normal approach to OBN survey design and survey design geophysicists will need to consider how best to use this more efficient receiver resource. Even with the limited exposure to date we have identified other operational models that will enhance the solution.