TRIDENT: project, updates, and tech insights for long-term deep-sea monitoring

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TRIDENT is developing a new architecture and technological solutions for long-term deep-sea monitoring. In December 2024, TRIDENT had a set of prototypes ready and undergoing further testing, prototypes that will help ensure these new technological approaches.

These will provide a new tactic to deep-sea EIA since they intend to support the long-term deployment of an autonomous, dynamic, robotic set of assets, reducing cost and ensuring trustworthy, constant data to the surface in real-time /near real-time. That real-time/near-real-time data will feed a database, supporting a Traffic Light System, running models of the impacts and their evolution as the mining operation progresses, and generating alerts when thresholds are approached/surpassed.

In the TRIDENT approach, it is envisaged that every mining machine has embedded a system "independent from the contractor", the Black Box, that will ensure data recording, independent positioning of the mining machine as well as the position of the other assets, recording of data, near-field monitoring, connection to the sensing systems in the mining machine, connection to the underwater communication infrastructure, performing as an access-point to nearby assets in the seabed and bridging the seabed assets to the surface, providing the information in real-time/near real-time.

The Black Box, like all the other autonomous dynamic robotic assets in the seabed, has embedded a Smart Low-power Data Logger and has independent power to prevent any loss of data recording in case of a severed connection to the surface.

The Smart Low-Power data logger will also be used in all the other autonomous assets on the seabed and water column. This low-power, high-capacity system is designed to sustain sensing systems in a low-power working profile. It is equipped with standard interfaces, allowing for the connection of the different market standard sensors to the dynamic underwater wireless communication infrastructure. To perform in an advanced manner, it also has edge-computing

abilities, providing on-board data pre-processing actions. This system is divided into two main elements: a smart interface with the sensors unit and a smart power management unit.

These two main elements of the TRIDENT system would not be able to perform adequately unless there is a Dynamic Underwater wireless communication Infrastructure in place. The DUI ensures navigation, monitoring, positioning, energy transfer, and storage in an advanced manner.

In terms of dynamic underwater navigation infrastructure, the system allows overcoming the present limitations of SoA acoustic underwater positioning systems in an ever-changing deep-sea mining environment. One challenge was to correctly address the communication vs positioning since both share the same medium.

Another crucial element of this infrastructure is the advanced solutions for sensor powering to meet the long-term deployments that are TRIDENT's goal. This is based on an innovative wireless deep-sea power transfer system technology. Different designs are under evaluation for wireless sensor powering and precise energy management, and field testing is to be performed next year.