Demonstrating collaborative uncrewed capabilities.

The DriX USV (Uncrewed Surface Vessel) has been deployed with the Teledyne Gavia AUV (Autonomous Underwater Vehicle) to validate the concept of operation of a USV and an AUV operating in tandem to conduct high accuracy subsea operations.

CHALLENGE
Making surface and subsea autonomous vehicles work together in a collaborative way.

SOLUTION
DriX equipped with an iXblue Gaps USBL system, WIFI communication system and Benthos acoustic modem

RESULTS
Collaborative uncrewed surface & subsea vehicles capabilities demonstrated to provide high accuracy survey

Reduced carbon footprint and QHSE risks

DriX performed a project for Total Energies, partnering with Teledyne Gavia and Sulmara. The aim of this project was to assess collaborative capabilities between two autonomous assets in order to conduct missions such as bathymetric, side scan sonar and video survey. Both uncrewed platforms (USV and AUV) were remotely controlled and supervised from iXblue Onshore Control Center, with iXblue DriX USV acting as a communication gateway between the onshore control center and the Gavia AUV performing its survey operation.

▲ Operator working at iXblue's control centre in La Ciotat (France)

Partners

TELEDYNE GAVIA Autonomous Underwater Vehicles

sulmara SUBSEA

TotalEnergies

1. Operational scenario

1.1 Autonomous collaboration

High accuracy surveys such as cable or pipeline inspections usually require sensors to be closer to the seabed to provide enough spatial resolution for detailed structure assessments. Therefore such surveys often make use of underwater vehicles (ROVs or AUVs).

When deploying cost-effective AUVs, which navigation capabilities are more limited than high-grade AUVs, a surface vehicle (either crewed or uncrewed) needs to be on site to track the subsea vehicle. This is done through the use of an Ultra Short Baseline (USBL) system that will feed the position to the AUV's onboard Inertial Navigation System (INS) (in that particular case, an iXblue Phins C3).

The surface vessel will position itself above the AUV and will follow it, mostly by manually adjusting its course during the mission for crewed vessels. During those inspection survey missions the surface vessel usually has to stay several days on site with an associated cost and a fossil fuel consumption far from being negligible for traditional crewed assets. Carbon neutral USVs on the other hand, are safer and more economical to deploy, and present a more efficient and cost-effective alternative to crewed surface vessels.

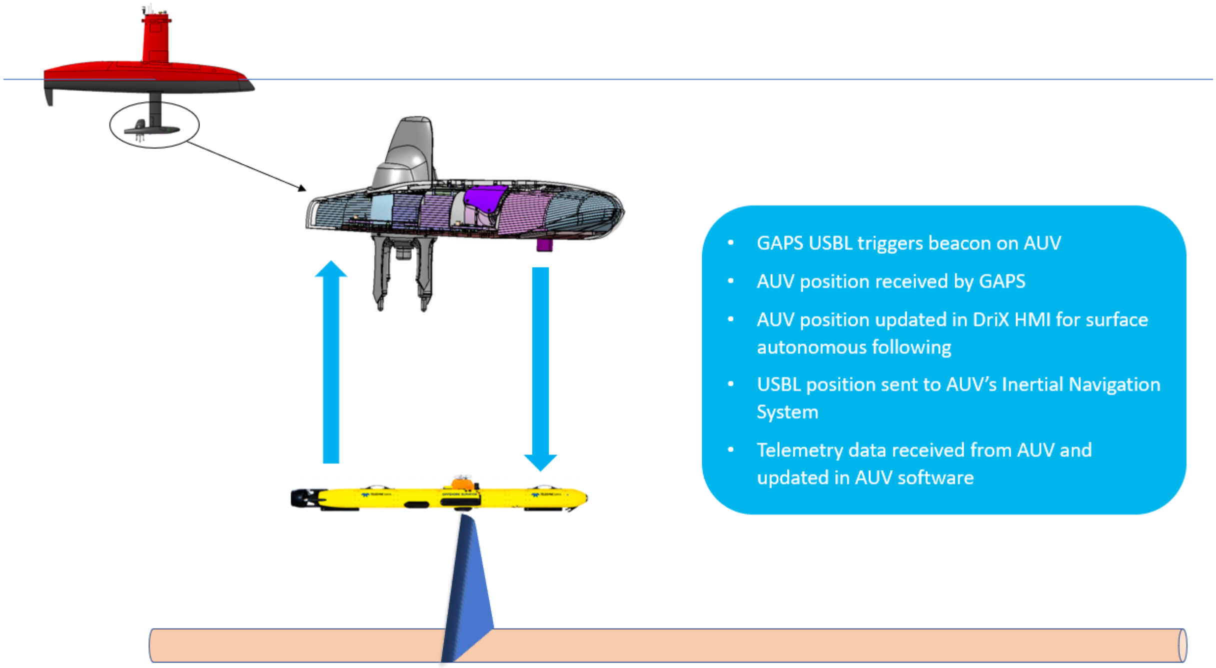
iXblue has thus developed a solution that allows their DriX USV to autonomously follow the AUV by decoding its position and at the same time send it to "feed" the vehicle INS and avoid position drift. The AUV's control software being integrated within DriX architecture, both autonomous vehicles can be supervised and monitored from a remote location.

1.2 DriX: a versatile platform able to conduct reliable Over The Horizon operations

DriX has already proven, thanks to the various projects it has already conducted, to be a highly versatile asset. The USV can deploy various types of payloads, from USBL (Ultra Short Baseline), single beam or multibeam echosounders, to Acoustic Doppler Current Profilers (ADCP), CTD (Conductivity Temperature Depth) and SBP (Sub bottom Profilers).

DriX is also interfaced with a multi channels communication infrastructure that support reliable LOS (Line of Sight) and OTH (Over The Horizon) operations. For LOS, it includes Wifi modems or Kongsberg Maritime Broadband (MBR) while OTH relies on 4G LTE and Satellite communications.

During this project, an iXblue Gaps USBL subsea positioning system was installed within DriX gondola, together with an acoustic telemetry system. This enabled the DriX USV to position and communicate with the Gavia AUV during the dives. A dedicated Wifi communication system, installed in DriX mast further allowed communication with the Gavia AUV while on the surface.



▲ iXblue **DriX USV collaborating with Teledyne Gavia AUV**

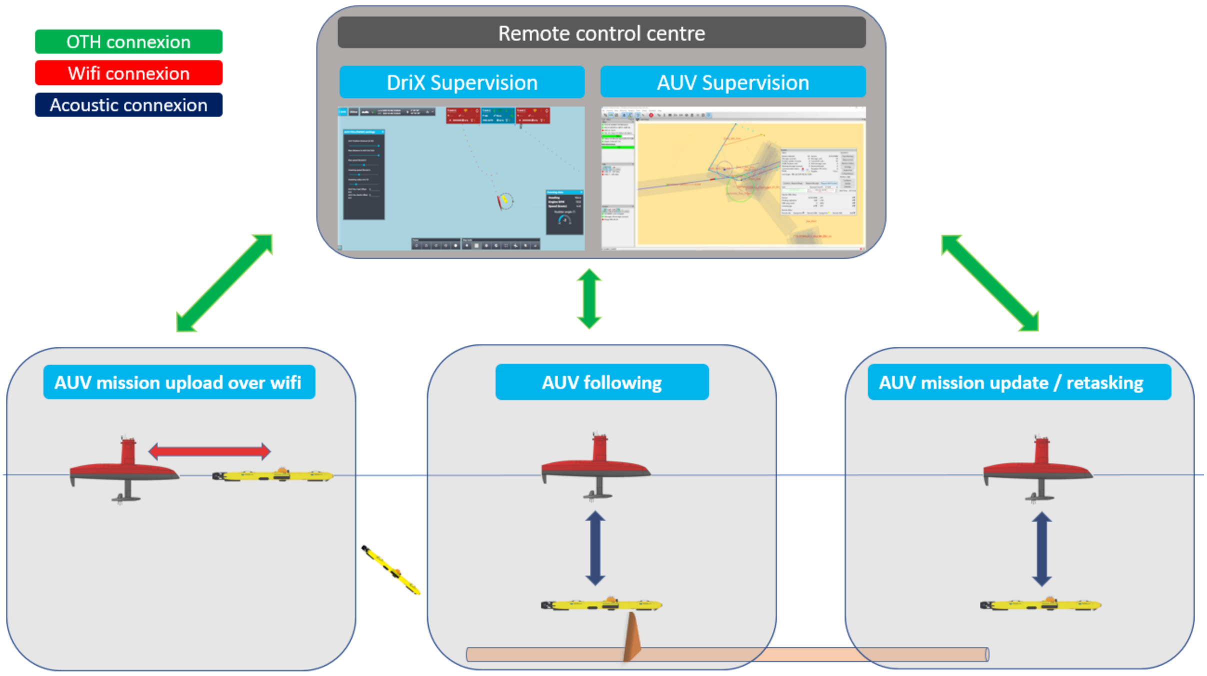
2. Supervised autonomy from a remote location

DriX architecture allows third-party software such as the AUV control software to be installed on the onboard computer. During Over The Horizon operations, the DriX USV is used as a communication gateway between the onshore control center and the AUV performing the mission, and the operator can monitor the mission from the safety of the remote control center. At the same time, the USV operator monitors the DriX USV health and safety parameters, and supervises its navigation.

During the first phase of the operation, with DriX and the Gavia AUV both at the surface, the communication with the AUV was established using a dedicated Wifi access point installed on the DriX mast. It allowed the AUV operator to perform AUV checks and mission import before starting the mission.

As soon as the AUV dived, the USBL tracking started. The DriX operated autonomously in "AUV Follow Me" mode. USBL positions were decoded and displayed on the DriX MMI. which allowed the operator to follow both vehicles during the mission. The AUV operator primarily monitored the data coming from the AUV via the acoustic telemetry.

Once the AUV tasks were completed, its mission were either updated using the acoustic modem or a new mission was imported via the Wifi link. If a high bandwidth OTH communication system (4G) is used from the DriX to the control centre, it also offers the possibility to download data, allowing Quality Control from the remote control centre while the AUV is on the surface.

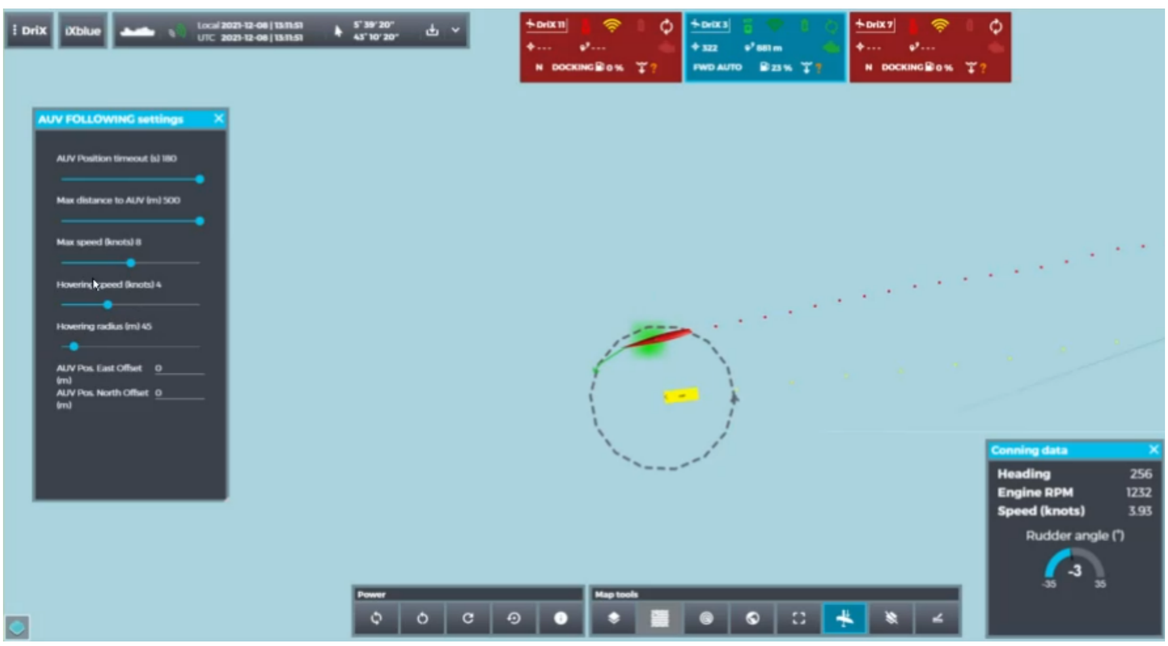


▲ DriX / AUV project phases

3. Results

Once the AUV mission started, DriX autonomously adjusted its navigation to track the AUV, taking into account the updates received from the USBL system. Considering that the AUV navigated at much slower speeds than the DriX USV, the default follow pattern was a circle around the target.

Therefore, if the subsea vehicle is travelling at a really low speed (i.e Remotely Operated Vehicle), the DriX will circle around the asset. If the speed of the two vehicles is similar, DriX will navigate on the side of the vehicle at a distance corresponding to the radius of the circle. In the figure below, the DriX in red is navigating on the side of the AUV (in yellow). Every time an USBL update is displayed on the DriX MMI screen, the circle repositions itself above the asset.

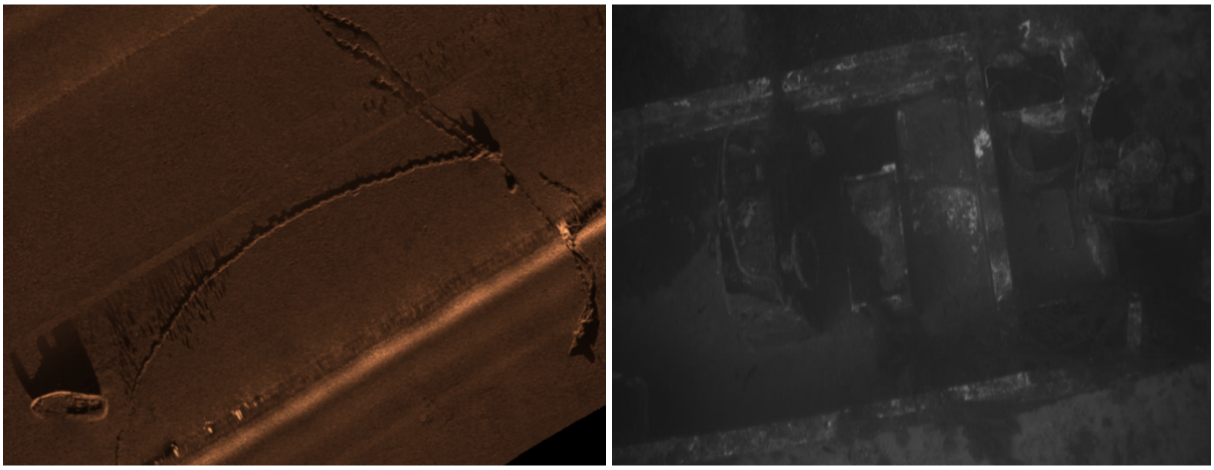


As the minimum speed of DriX was slightly exceeding the maximum speed of the AUV (4knts / 3.5knts), the final following pattern describes a combination of side navigation and circles that allowed DriX to always stay in the vicinity of the AUV. The figure below shows trackplots performed during the project for both the AUV and the USV.

▲ DriX / AUV trajectories

Conclusion

With the development of this concept, iXblue and its partners are now able to deliver a cost effective and carbon reduced solution, providing a new way to perform subsea inspection. Replacing the use of conventional large, crewed inspection and survey vessels with uncrewed solutions such as the DriX USV will indeed allow to reduce offshore risk for personnel, decrease operational costs and lower the carbon footprint of offshore operations.



▲ Wreck and anchor chains on Side Scan data (left) / Wreck seen on the bottom looking camera (right)

Results show an optimised trajectory from the surface vehicle with respect to the AUV position evolution. The USV providing critical external information to the AUV’s inertial navigation system allowing the AUV to perform with high accuracy.