THE FUTURE OF SONAR?

All things being equal, the longer wider the receiving antenna in a sonar, the greater the sensitivity, picking up even the smallest acoustic signals and the farther away it can detect a target

Large sonar antennas can be found on submarines (flank arrays, towed arrays) or frigates, even on seismic vessels that are able to tow up to 16 streamers of 10km long. But the infrastructure of the sonar body deployed by these carriers is extremely bulky, expensive, and fragile. What if new ideas for deploying antenna of 1 km2 even 10 km2 were emerging? This could soon become a reality with a visionary development.

John Howes talks to Tamara Brizard, General Manager of Arkeocean about its Proteus Swarm.

Receiving a better signal from a sonar effectively means using a wider antenna. In practical terms, however, there comes a point, where the infrastructure of the sonar body becomes too difficult to manage. French company Arkeocean has been working on a project to remove this restriction essentially by de-constructing the sonar antenna.

The result is Proteus.

Incongruously perhaps, the basic building block of Proteus is an a micro AUV pair, semi-permanently connected with each other. When underwater, these neutrally buoyant bodies drift silently in the water with the current.

The ultimate plan envisages a swarm of individual units are placed in a chosen formation and geometry stretching across a potentially wide area.

The main vehicle, called Inca, acts as the node constantly recording and storing passive acoustic signals. Each node in the swarm, therefore, becomes part of the synthetic receiving antenna

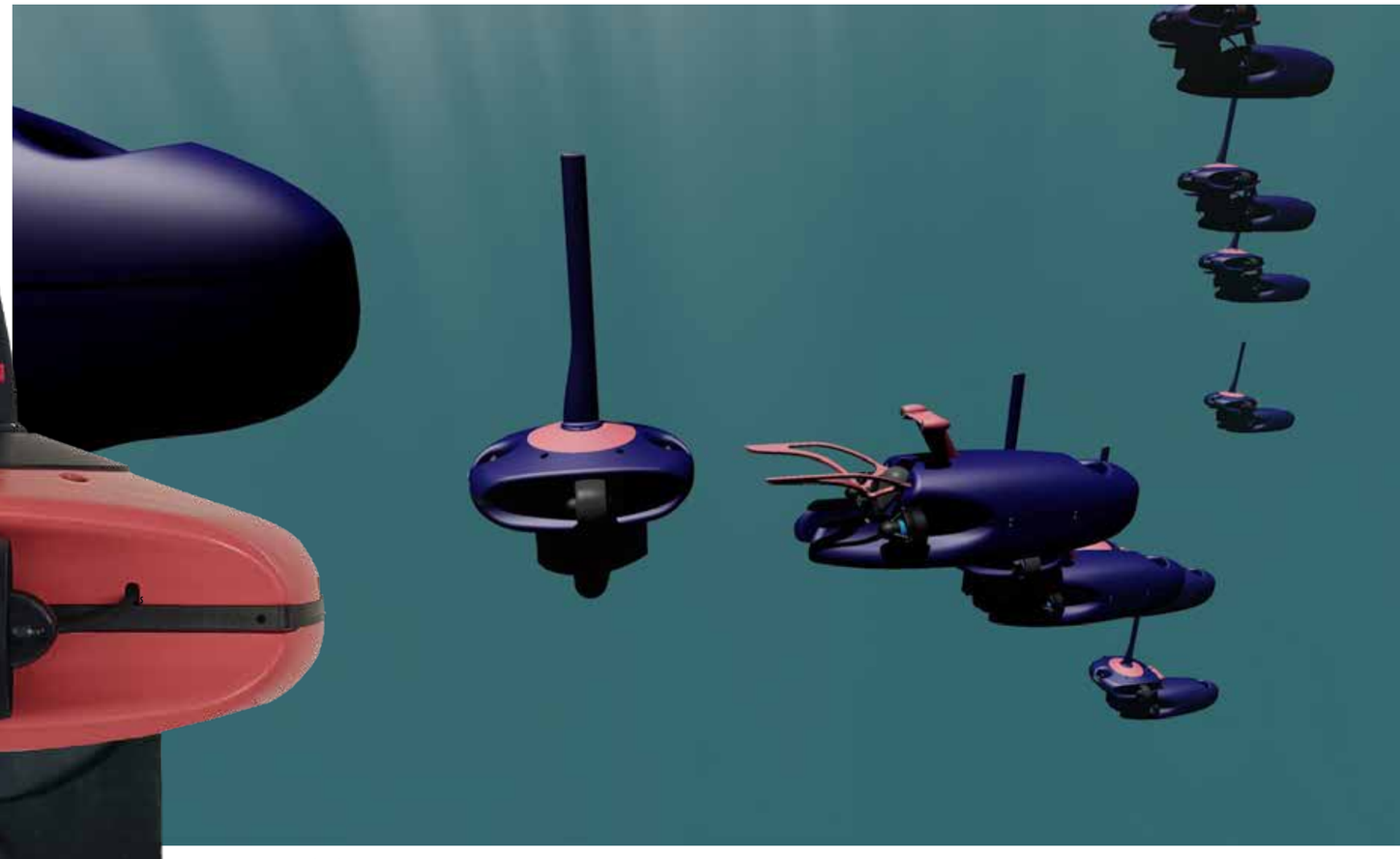
As soon as the Inca has gathered enough acoustic information, it downloads this over a local wi-fi signal to the second attached AUV known as Maya. At this point, this shuttles AUV decouples from the Inca and flies to the surface.

As it travels up the water column the Maya takes temperature and salinity data to improve the local sound gradient knowledge.

“Upon reaching the surface, the Maya performs multiple jobs- the first being to communicate the acoustic information to the control centre,” said Tamara Brizard. “This base control centre could be anywhere on the planet; for the current project we are using a centre just 2km away but equally, this could be on a boat or for some operations, at static or mobile terrestrial location."

A synthetic sonar antenna only works if the position of each node is known relative to others within the swarm. A second function of

The Maya. Named with reference to the Maya foraging Bee Melipona beecheii



Maya docking into an Inca AUV

the Maya is that it becomes with the other Mayas on the surface, a classic long baseline (LBL), using accurate satellite and underwater acoustic positioning to accurately fix the position the Inca below.

Once If needed, the underwater vehicle repositions itself if the control center finds it too far from the position it should hold in the chosen geometry.The Maya then flies down and latches on to one of the larger Maya Inca.

Once the vehicles reach the end of their battery life, they fly into a catching crate basket and are retrieved by a ship.

"Logistically it's going to be so much easier and cheaper to operate one boat with less than 10 people to launch and retrieve them as they all go back into this catching crate and we just picked them up out of the water like crabs’

One byproduct is that the difference between the original and updated position can give an indication underwater currents, possibly at different horizons depending the geometry of the swarm.

Importantly, the AUVs don't communicate with each other underwater. The principal reason is they never need to. If they communicate, they will be generating noise while it is more important that they remain silent and just listen.

A more important reason, however, is that they need to be capable of stretching over miles if required.

"We didn't want to restrain the size of the antenna by the range of the acoustics," said Tamara Brizard, "so the only limiting factor is not the distance between the Incas but the distance between the Inca and the Maya on the surface.

"At the moment, we have a 1.5km acoustic range between the two. As for the maximum depth, it is currently 300m but in the next stage, we are pushing this to 1000m and beyond.

POSITION
“The precise knowledge of the node's position in three dimensions is a prerequisite for efficient post processing by the control centre," continued Tamara Brizard. "It effectively determines the quality of the postprocessing of the acoustic data recorded by each AUV node,

"We calculated that if can maintain a high accuracy of position of each element to within 1.5 m, underwater we could have a huge detection range and localisation accuracy from this antenna.

"We carried out an experiment to prove this hypothesis last summer. Results came out and they are already looking very good.

Being able to reposition the antenna gives us a great advantage. We can move all the AUVs en masse, straighten lines and return them to the original relative position, but we can also move specific nodes within the antenna depending on the configuration we need.

High accuracy positioning is the focus of what we are currently working at Arkeocean on with a team of experts,” said Tamara Brizard. “For optimum antenna design, the positions of the AUVs form a lacunar structure.”

There are a number of applications. Historically, the military and the oil industry have underwritten the funding of key projects such as these. The prospect of a silent, highly accurate sonar is understandably appealing for the military but that is not the only application. The company is currently in talks for scientific applications for mapping, water quality control, and monitoring protected zones.

"In France, we have protected marine spaces where people are not supposed to have any sort of commercial activity. But how do you protect them? How do you know people aren't fishing there?

"We don't have any tools for that because we have nothing scalable to the size of the ocean and that's where swarms of small cheap AUVs with affordable sensors come in. "AUVS are minimally invasive and there don't have to be hundreds. A swarm of AUVs starts with two but gives us a way of observing the ocean and its scale.

The Inca AUV

AUV Swarm

"Arkeocean was formed in 2009 to monitor archaeological sites.," said Tamara Brizzard, "My father had a patent on an antenna-based homing that allowed divers would always know the way back to a boat and realised that he could apply the technology to numerous fields of interest.

"We carried out work for Seabed Geosolutions and realised we held the technology for swarms of vehicles.

One of the reasons that we proposed this system as that we were lucky enough to participate in the largest seismic acquisition programme that coordinated 200 AUVs in the water just off the coast of Sète.

“People used to say swarms of a AUVs were the stuff of the future. The costs are very high and scaling up this technology is very expensive which means that it is not a feasible solution for most applications.

"That is just not true any more.

"Proteus is enabling people to recognise swarm may be solutions for their projects They are more affordable than ever. Our base acoustic sensors range between €3500 and € 4500.

USBL

The equipment that underpins Arkeocean's vision is its agile acoustic USBL system designed to fit on dives, AUVs and ROVs.

It comes in two versions.
The SEAKER is equipped with a receiving (Rx) phased array that gives the relative bearing of incident acoustic signals.

SEAKER+, however, combines the SEAKER Rx array with a transmitter (Tx) used for the emission of acoustic signals.

Both work with narrow or large band pulses on eight frequency channels. They are equipped with a nine-axis Inertial Management Unit and GPS.

These systems are used for positioning, creating a complex network of over 200 synchronised units, docking mobile vehicles together, directing autonomous or remotely operated vehicles back to a recovery device, or guiding divers back to their boat

It can also be used as a communication tool, enabling simple and robust data exchanges between two or more equipped vehicles.