A new era of digital underwater communications

Satellites and mobile phones, built to international standards, help the world get connected. But the communications technology used on land does not work well underwater. With water covering over 70% of the earth's surface, NATO has sponsored research into establishing the first ever digital underwater communications standard.

Imagine a scuba diver approaching the surface, being made aware of nearby boating activity; or a submarine communicating with a land-based command post; or an underwater robot sending a warning to an oil rig after a leak is detected – the possible applications of underwater communications are many. For example, they could be used in many areas: for harbour protection, maritime surveillance, mine detection, surveying offshore wind farms and pipelines, or even underwater archaeology.

The NATO Science and Technology Organization's Centre for Maritime Research and Experimentation (CMRE) has developed a standard for underwater acoustic communications called JANUS, which has been recognised as a NATO standard by all NATO Allies since 24 March 2017. This marks the first time that a digital underwater communication protocol has been acknowledged at international level and opens the way to develop many exciting underwater communication applications, it has been reported. To this effect NATO issued a *communiqué* on 27 April.

About CMRE
The Centre is working to support effective underwater communication networks to allow undersea robots to work together and report to a base-station (see the nearby pdf showing Digital Underwater Networked Communications).

According to João Alves, Principal Scientist and Project Leader at CMRE: '*Robots can behave intelligently and act as a team. For example, one of the robots could find some interesting feature and call the rest of the team.*'

With effective undersea communication, this can all happen in an autonomous way, without requiring direct human intervention. If needed, the operation can be managed by land-based engineers who monitor all the communications from a command and control room ashore. The connection to land is made through gateway buoys on the surface of the water equipped with radio links to local support platforms or satellites.

John Potter, a scientist at the CMRE Strategic Development Office added: '*This is particularly important for search-and-rescue operations. Autonomous*

vehicles are relatively inexpensive and of course unmanned, so they can be sent to do dirty, dangerous jobs.'

Much of this development work is carried out on the Littoral Ocean Observatory Network, or LOON. This is a test facility, installed in the harbour of La Spezia, Italy. It plays a central role in NATO projects, many of which are developed in partnership with the European Commission.

About LOON
The Littoral Ocean Observatory Network is an underwater test bed, a low-cost permanent and web-based series of devices that enables users such as international institutions, research groups and commercial entities across the world to test underwater communication schemes.

CMRE uses the LOON to develop and test communications systems that contribute to the protection and monitoring of oceans and rivers by underwater robots. Acoustic communications equipment deployed on the seabed forms an underwater acoustic network. Individual nodes of the network connected to shore with cables enable remote control by engineers and scientists. Such method is used extensively in support of the development of JANUS and for CMRE's research in underwater communications.

JANUS, the standard underwater language
To be able to communicate with each other, underwater assets need common standards.

'*In the air we can simply connect our gadgets to any WiFi hotspot without having to worry about the compatibility*,' said João Alves adding: '*Until now, there was not anything even remotely similar for the underwater domain*.'

'*Sound is known to have an impact on marine life,*' concluded João Alves. Aware of this risk, the Centre works with biologists and other scientists to protect the marine environment.

As with the industry standard for WiFi communication, an undersea communication standard has to be defined in order to guarantee the interoperability between equipment from different manufacturers.

For the past ten years, CMRE has been working on the development of the first international digital underwater communication protocol, JANUS, which is now an approved NATO standard.

In Potter's words: '*JANUS was a Roman god of openings and gateways. That is why it is called JANUS, because this language opens the portal between two domains, two different operating paradigms, through which they can talk.*

'*It is a digital underwater signalling system that can be used to contact underwater devices using a common format; announce the presence of a device to reduce conflicts; and enable a group of underwater devices such as robots, submarines, divers or any other equipment operating under the surface, to organise themselves into a network.*'

Adopted globally, JANUS can make military and civilian, NATO and non-NATO devices interoperable, providing them all with a common language with which to communicate and arrange to cooperate.

JANUS has been extensively tested at sea in exercises involving a number of partners (universities, industries and research institutions) covering a range of application scenarios. Close collaboration with NATO Allies has been particularly fruitful in developing JANUS for use in cases that may improve the safety of maritime operations.

For example, the Portuguese Navy has been working with CMRE to develop new concepts to support the exchange of crucial information with submarines (typically only available at the surface via radio) such as the location of nearby ships. Digital data exchanges to support rescue operations in case of a submarine incident are currently also being developed.

NATO Centre for Maritime Research and Experimentation
Located in La Spezia, Italy, CMRE organises and conducts scientific research and technology development, centred on the maritime domain, delivering innovative and field-tested science and technology solutions to address defence and security needs of NATO. It is an executive body of NATO's Science and Technology Organization. The Centre operates NATO's two research vessels that enable science and technology solutions to be explored and developed at sea.

Picture captions
An Ocean Explorer AUV being recovered from the NATO Research Vessel Alliance *during a sea trial.*

Photo:www.nato.int ©.

A network of marine robots.

Photo:www.nato.int ©.