

## **Tutorial 1: JANUS: The first (and so far only) international digital underwater communications standard for manned and unmanned maritime systems – bootstrapping underwater networks and UIoT.**

### **Abstract**

For over 70 years, the only Underwater Communications (UComms) standard was 'Gertrude', the analogue underwater telephone. Gertrude was dreadful. Low bandwidth, garbled, analogue spoken phonetic data only, but in the land of the blind, the one-eyed man is king. With the rapid rise of Maritime Unmanned Systems (MUS), particularly Autonomous Underwater Vehicles (AUV), a pressing need has developed for a generic digital wireless UComms standard that can be used to convey any type of data and that supports communication between any mix of unmanned and manned systems, bootstrapping the creation of an Underwater Internet of Things (UIoT).

JANUS answers this need and its adoption as the first digital UComms standard by the 29 countries of NATO is the result of over 10 years of effort, for which the JANUS team at NATO STO CMRE was awarded the NATO Scientific Achievement Award in 2018. Applications are just beginning to take hold, with JANUS already successfully deployed in submarine rescue exercises and to transmit meteorology and AIS pictures of surface traffic to submerged submarines at rates some 16 times that of Gertrude, with error correction and CRC to guarantee information integrity.

But JANUS is not restricted to NATO, indeed not even restricted to military use, but open and available to both military and civilian use worldwide. The adoption by NATO is just the start. As users demand more flexible UComms options to create networks of MUS, modem providers are beginning to offer JANUS as a protocol option, and we now see its use spread to offshore wind farms, oil and gas operations, oceanographic surveying, diver support and many other applications. JANUS not only provides an interoperable UComms protocol for point-to-point communications, but offers a bootstrapping method for node discovery and the construction of dynamic ad-hoc networks. JANUS also offers the potential to dynamically negotiate and de-conflict operations that may not have been co-ordinated in prior planning, but which discover each other during operation.

This tutorial will offer material to support signal processors, modem designers, users and industry to understand what JANUS offers, how it has been designed and how to implement it in communication systems. The intended audience are offshore oil and gas operators and service providers, signal processing and electronic design engineers in the UComms industry, ocean researchers and anyone who has an interest in MUS, UComms and networking. The baseline level skills required are a basic familiarity with signal processing principles such as sampling theory and time-frequency domain properties. The core learning objectives are to understand why JANUS is designed as it is, what potential it offers in maritime operations and the basics of how to implement the JANUS protocol in a practical system. 10-30 participants are anticipated.

The presentation will include multimedia materials and open discussion, with the intention to include hands-on real-time encoding, transmission, reception and decoding of JANUS messages and access to the JANUS Wiki online.