# Tutorial topic proposal – IEEE/MTS Oceans Kobe 2018

**Title: Hands-on with JANUS: understanding, implementing and using the first digital underwater communications standard**

**Presenter:**

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**Duration: ½ day (4 hours with 20-minute break)**

For over 70 years, the only underwater (UW) communications standard has been the analogue UW telephone, known as 'Gertrude'. With the rapid rise in the availability and use of autonomous UW assets, there has been a pressing need for a wireless digital UW communications standard that can be used to convey any type of data and support machine-to-machine exchanges.

JANUS answers this need and is the result of over 10 years of effort, led by NATO STO Centre for Maritime Research and Experimentation (CMRE), funded by NATO ACT and involving contributions from many international research centres, modem designers, producers and users. During this process, consensus and alignment was continuously sought through inclusive consultancy that included staging three workshops. The standard known as JANUS has now been approved by NATO and is to be implemented across the naval assets of all 29 NATO nations.

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 navies is just the start. Driven initially by naval demand, we soon expect many UW modems to be offering JANUS as a communication protocol option, and to see its use spread to offshore oil and gas operations, oceanographic surveying, diver support and many other applications. JANUS not only provides an interoperable UW communications 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 present material to help signal processors, modem designers, users and industry to understand what JANUS offers, how it has been designed and critically 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 UW communication industry, ocean researchers and anyone who has an interest in UW communication 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 be made using computer-generated media, projected through a high-resolution colour projector onto a white screen, with audio, to be played through a good-quality audio system of sufficient power for the room chosen, with a frequency response of 50 Hz-16 kHz. A white board or flip chart, loaded with white paper, is also requested. Wi-Fi internet is also required, so the audience may log on to the JANUS wiki website and explore the materials with the presenter.

A similar tutorial was delivered by John Potter in Oceans Anchorage 2017 and was enthusiastically received by 11 attendees. We believe the topic is of crucial relevance and should also be offered to the Asia edition of Oceans. We are taking advantage of the experience from the previous presentation in Oceans Anchorage 2017 to deliver a high quality, compelling and relevant tutorial that can attract a wide audience.

## JANUS Tutorial Content Details

| Content | Duration |
|---|---|
| Introduction to underwater communications; challenges and solutions | 20 min |
| The need for a digital UW communications standard | 15 min |
| The objectives of JANUS | 15 min |
| The design principles of JANUS | 20 min |
| JANUS physical layer design outline | 20 min |
| JANUS Media Access Protocol and interference issues | 20 min |
| Break | 20 min |
| Overview of the JANUS protocol data flow | 15 min |
| JANUS wiki and resources | 10 min |
| Matlab, C and Octave baseline implementations | 15 min |
| JANUS use cases and application scenarios | 20 min |
| Hands-on with JANUS: transmitting and receiving data using the baseline implementations. | 30 min |
| Questions and wrap-up | 20 min |

Total time 4 hours, with one 20-minute break.

# Bibliography

McCoy, K., Tomasi, B. and Zappa, G., “JANUS: genesis propagation and use of an underwater standard”, European Conference on Underwater Acoustics, 2010.

Potter, J. and Been, R. “Underwater automated identification systems for deconfliction for submarine and surface asset situational awareness”, Defence Technology Asia, 2010.

Tomasi, B., Casari, P., Finesso, L., Zappa, G., McCoy, K. and Zorzi, M., “On modelling JANUS Packet Errors over a Shallow Water Acoustic Channel using Markov and Hidden Markov Models” Military Communications conference, January 2011, pp 24-26.

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