Tutorial topic proposal – Oceans Anchorage 2017

Title: **JANUS; understanding, implementing and using the first digital underwater communications standard**

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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 is a pressing need for a wireless digital UW communications standard that can be used to convey not only analogue voice, but any type of data. We desperately need to transition, underwater, from the analogue telephone technology of 1946 to the equivalent of the smartphone. This is a key technology underpinning both interoperability and the creation of the Internet of Underwater Things.

JANUS 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 28 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 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. 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 there with the presenter.

JANUS Tutorial Content Details

Content	Duration
Introduction to UnderWater (UW) 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
Questions and Requests on material so far	20 min
Break	20 min
JANUS Media Access Protocol and interference issues	20 min
Overview of the JANUS protocol data flow	15 min
Specific flexibility aspects of JANUS	15 min
Example templates and message types	20 min
Matlab, C and Octave baseline implementations	15 min
JANUS wiki and resources	15 min
Questions and wrap-up	10 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.

Potter, J., "Underwater Communications; The Tower of Babel and Cocktail Party", Defence Global Magazine, 2011.

Potter, J., Berni, A., Alves, J., Merani, G., Zappa, G. and Been, R. "Underwater communications protocols and architecture developments at NURC", Oceans Europe, 2011.

Alves, J., Vermeij, A., Zappa, G. and Hughes, D. "JANUS-based tactical paging system for AUVs", Proceedings of the Underwater Acoustic Measurements conference, 2011.

Zappa, G., Nissen, I., and Potter, J., "Doppler compensation for JANUS applied to data collected in the Baltic Sea", Proceedings of the Underwater Acoustic Measurements conference, 2011.

Potter, J., Alves, J., Green, D., Zappa, G., Nissen, I., and McCoy, K., "The JANUS underwater communications standard" Underwater Communications and Networking conference, 2014.

Anon., "Digital Underwater Signalling Standard for Network Node Discovery and Interoperability: NATO STANDARD ANEP-87", NATO Standardization Office, March 2017. https://nso.nato.int/nso/zPublic/ap/PROM/ANEP-87 EDA V1 E.pdf