

# TOTAL OCEAN MARKET COVERAGE 2019

## JANUARY

Annual Review & Forecast / Buyers Guide/Directory

**\*\*Oceanology International Americas**, February 25-27, San Diego, CA

## FEBRUARY

Instrumentation: Measurement, Processing & Analysis

**\*\*U.S. HYDRO 2019**, March 19-21, Biloxi, MS

**\*\*Ocean Business**, April 9-11, Southampton, U.K.

## MARCH

Electronic Charting/Vessel Management/Ports & Harbors/Dredging/Homeland Security

**\*\*AUVSI XPONENTIAL 2019**, April 29-May 2, Chicago, IL

## APRIL

Offshore Technology/Alternative Energy & Ocean Engineering

**\*\*Offshore Technology Conference**, May 6-9, Houston, TX

**\*\*UDT 2019**, May 13-15, Stockholm, Sweden

## MAY

Communications, Telemetry, Data Processing

**\*\*BlueTech Expo**, June 4-5, Washington, DC

**\*\*Oceans '19 MTS/IEEE Marseille**, June 17-20, Marseille, France

**\*\*CLEAN PACIFIC 2019**, June 18-20, Vancouver, Canada

## JUNE

Seafloor Mapping/Sonar Systems/Vessels

## JULY

Deck Gear, Cable, Connectors, Power Systems & Salvage

## AUGUST

Geophysical Exploration/Seafloor Engineering

**\*\*SEG 2019**, September 15-20, San Antonio, TX

## SEPTEMBER

Ocean Resources Development & Coastal Zone Management

**\*\*Offshore Energy 2019**, October 7-9, Amsterdam, The Netherlands

**\*\*CLEAN GULF 2019**, October 28-30, New Orleans, LA

**\*\*Oceans '19 MTS/IEEE Seattle**, October 28-31, Seattle, WA

## OCTOBER

Environmental Monitoring, Remote Sensing & Pollution Control

**\*\*International Water Conference**, November 10-14, Orlando, FL

## NOVEMBER

Undersea Defense/Antisubmarine Warfare

## DECEMBER

Diving, Underwater Vehicles & Imaging

**\*\*Underwater Intervention 2020**, January 28-30, New Orleans, LA

**\*\*EXTRA SHOW DISTRIBUTION** (additional shows will be added as information is obtained)

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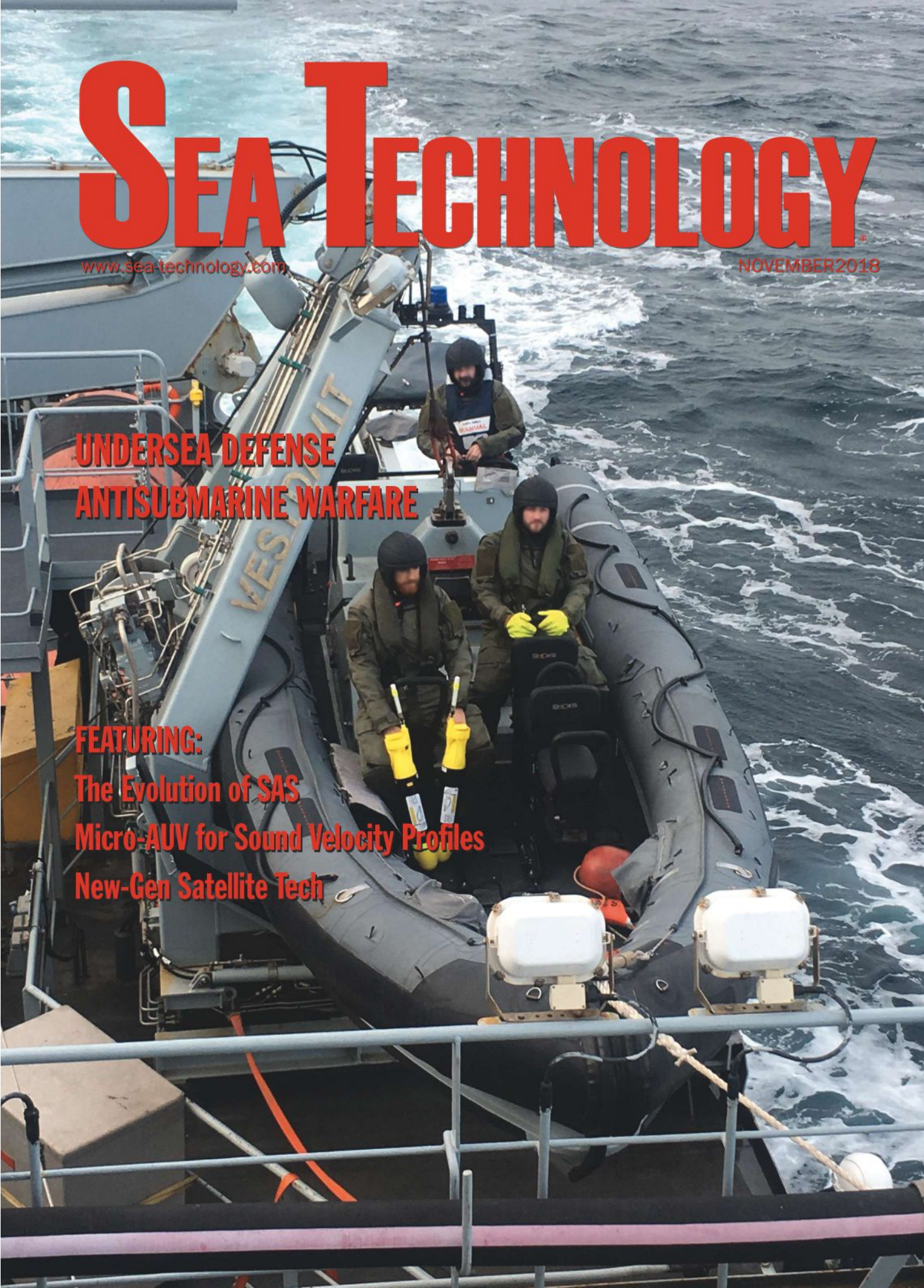
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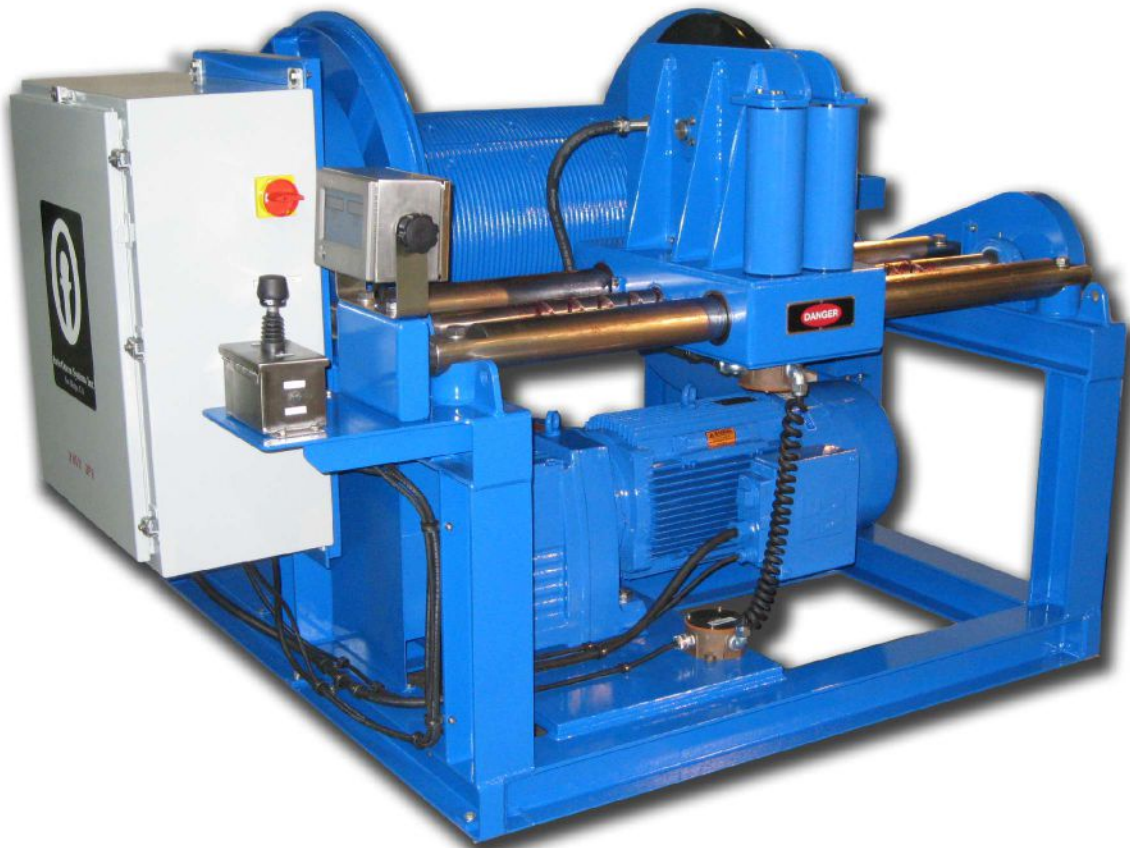
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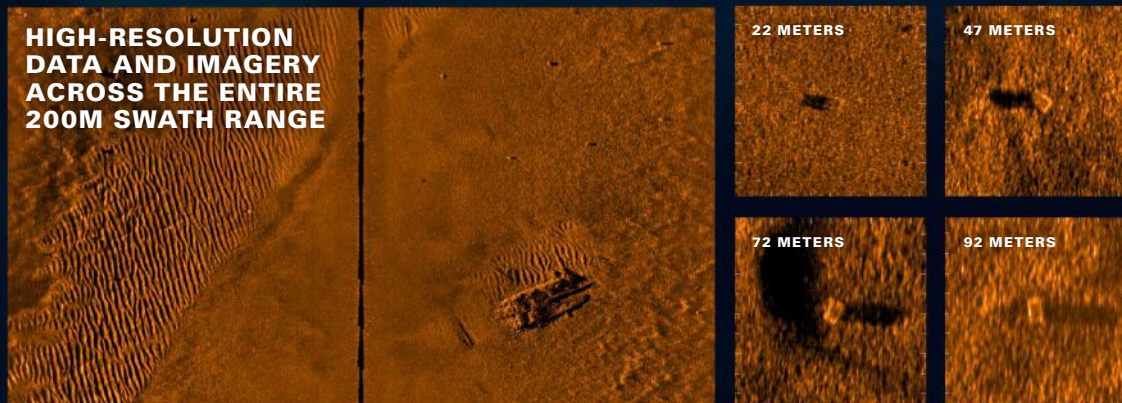
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Two ecoSUB SVP units are deployed from HMS *Enterprise* east of Orkney Islands during a U.K. Royal Navy exercise in October 2018. (Credit: Jeremy Sitbon, ecoSUB Robotics Ltd.)

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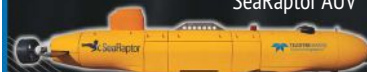


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## Logistics: A Military's Greatest Weapon

From ancient times to today's modern battlefield, it hasn't always been the size of militias or advanced weaponry that has conquered the enemy; it's an often discounted element that plays the leading role in deciding victory—logistics.

A famous example is the Battle of Alesia when Julius Caesar, surrounded and facing defeat, strategically cut off access to his opponent's food and material supply. Caesar understood that interfering with the enemy's resources would ultimately determine the result of the battle.

Today, logistics are just as critical to our military leaders, who face many of the same challenges that warfighters have battled for centuries. It is imperative our military employs clear lines of command to secure the necessary materials to maintain the advantage on the battlefield.

This process is easier said than done. Modern U.S. Navy fleets have distinctive processes and systems on each ship, meaning that each crew has to learn new skills and protocols, which is costly and inefficient. To make matters worse, the military still primarily relies on decades-old systems that heavily utilize paper documentation, which is harder to keep track of and easy to falsify.

More than 430 U.S. Navy ships with 328,267 personnel on board are active at any time. For decades, each ship had different processes for handling food and material logistics, and when reaching port, most transaction receipting was done through outmoded paper documentation. Not only is this system inefficient; it also allows for bad actors to take advantage. The U.S. Navy's recent "Fat Leonard" corruption scandal is a case in point.

To get a handle on fraud, waste and abuse, the National Defense Authorization Act directed the Department of Defense to ensure all financial statements were validated as audit-ready by September 2017 and remain accessible for 10 years. Financial Improvement and Audit Readiness (FIAR) supports implementation and provides instructions for achieving this objective. In a broader sense, FIAR compliance ensures that our forces have the resources they need to execute no-fail missions.

As part of IT modernization in the Navy, the Financial Audit Compliance Enhancement Tool (FACET) is deployed on all Navy ships to help meet FIAR compliance by tracking and storing receipts, letters of authorization and other critical documents. The integrated hardware/software solution employs workflow automation and streamlines approval processes by ensuring that critical logistics are met. These can include quantity and quality control of supplies ordered, proper documentation for item shelf lives, and ensuring defective items are not repurchased.

Designed to deliver a 99.99 percent uptime required of mission-critical systems, FACET ensures audit readiness. Personnel can complete tasks that used to take hours in minutes—creating invaluable efficiencies while allowing the Navy to store and track documents for 10 years. Most importantly, this process impresses accountability at all stages of onboard procurement.

The future of FACET is digital, and the Navy is working on entirely paperless applications that can be used remotely on secure smartphones and tablets. This adoption of an Amazon-like approach with online inventory control systems will provide exponential benefits across its fleets.

Logistical processes still play the same vital role they played in Julius Caesar's historic victory. To ensure the U.S. military remains the strongest in the world, we must continue to streamline logistical operations and close loopholes that allow for fraud, waste and abuse. Technologies like FACET are helping the military modernize decades-old systems and ensure that it has the tools it needs to maintain dominance on land and at sea. **ST**

**)) ABB Guide for Transitioning to New Energy Mix.** In an evolving energy mix environment, ABB makes recommendations for preparing a digital strategy that will help overcome potential hurdles. A robust digital strategy will avoid risks of creating technology silos that lead to fragmented working and poor performance, says ABB in a new guide for oil and gas operators considering the future energy ecosystem. The ABB guide "Innovation to transform the energy future - How digitalization enables oil and gas operators to transition to a new energy ecosystem" suggests that building a digital strategy requires preparing and retraining executives, investing in talent, continually exploring the potential of digital, assessing and benchmarking current data architecture, working the data harder, and greater collaboration throughout the supply chain.

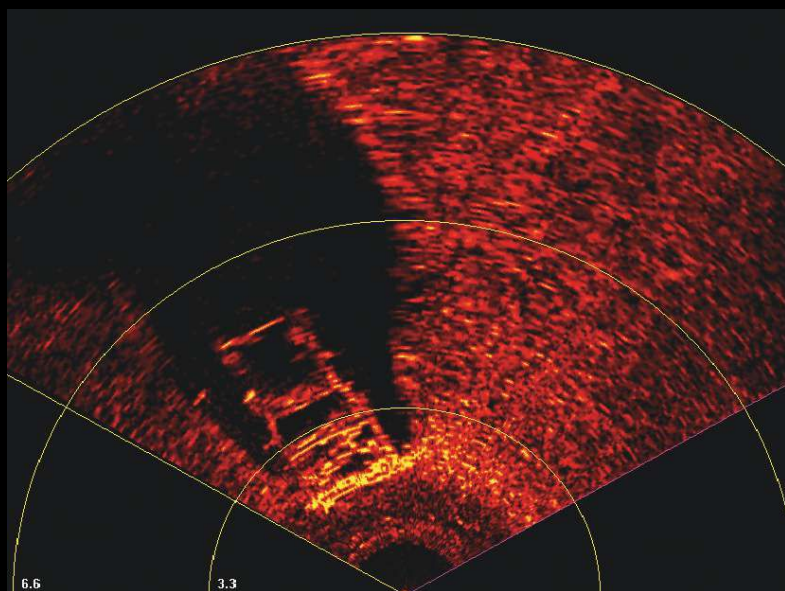
**)) Grant Funding to Build Real-Time 3D Acoustic Telescope.** A first-of-its-kind acoustic telescope is under development at the Woods Hole Oceanographic Institution (WHOI), funded by a \$1 million grant from the W.M. Keck Foundation that will permit researchers to map and study the underwater soundscape. Like an optical telescope, the acoustic telescope will give scientists the ability to focus on individual sounds originating from long distances and direct observation of phenomena including waves, rainfall and earthquakes that produce telltale acoustic signatures. It will be sensitive to a broad range of frequencies to help map the complexity of sounds in the ocean and enable a more nuanced view of both the natural and human-generated underwater soundscape. Once constructed, it will be deployed at the edge of the continental shelf off the northeast coast of the U.S.

**)) Industry Forecast Emphasizes Decarbonization.** DNV GL - Maritime has released its second Maritime Forecast to 2050, part of a suite of Energy Transition Outlook reports. It predicts the maritime energy future and examines how the energy transition will affect the shipping industry. "The energy transition is undeniable," said Remi Eriksen of DNV GL. "Last year, more gigawatts of renewable energy were added than those from fossil fuels, and this is reflected in where lenders are putting their money." The new Maritime Forecast to 2050 focuses on the challenges of decarbonizing the shipping industry. It examines recent changes in shipping activity and fuel consumption, future developments in the types and levels of cargoes transported, and future regulations, fuels and technology drivers.



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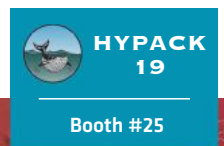
The Maritime Forecast predicts a 32 percent rise in seaborne trade measured in tonne-miles for 2016 to 2030, but only 5 percent growth over the period 2030 to 2050. “Decarbonization will be one of the megatrends that will shape the maritime industry over the next decades, especially in light of the new IMO greenhouse gas strategy,” said Knut Ørbeck-Nilssen of DNV GL - Maritime.

**)) ROV Market Forecast Shows Recovery in Demand.** Westwood’s World ROV Operations Market Forecast states that the market for work-class ROVs (WROVs) is fundamentally tied to the offshore oil and gas sector, which is exiting a cyclical downturn and now entering a period of recovery. Cost efficiency remains critical and drives the need for modern systems that can maximize uptime. Demand for both traditional oil and gas applications and new offshore support roles will support a recovery in demand over the 2019 to 2023 forecast. Westwood estimates 2017 global utilization reached a low of 32 percent, down from 55 percent in 2014. Over the forecast, the oversupply situation will ease, with utilization levels expected to return to 50 percent by 2023.

**)) Inaugural Blockchain Bunker Delivery, Transaction.** GoodFuels Marine and Blockchain Labs for Open Collaboration (BLOC) have successfully completed the world’s first bunker delivery and transaction using blockchain technology. Unlike traditional bunker delivery notes (BDN), a paper document still widely used in the industry, blockchain—a decentralized, distributed and public digital ledger—provides end-to-end traceability of marine bunkering transactions from storage to the barge or jetty and on to the vessel’s fuel tank, thereby providing assurance to shipowners, shippers and charterers.

**)) ExxonMobil Participates in Climate Change Risk Mitigation.** ExxonMobil will join the Oil and Gas Climate Initiative, representing 13 of the world’s largest oil and gas producers working collaboratively to mitigate the risks of climate change. The CEO-led organization focuses on areas including carbon capture and storage, methane emissions reductions and energy and transportation efficiency. ExxonMobil has a controversial history of climate change denial but, earlier this year, announced initiatives to lower greenhouse gas emissions related to its operations by 2020. **ST**

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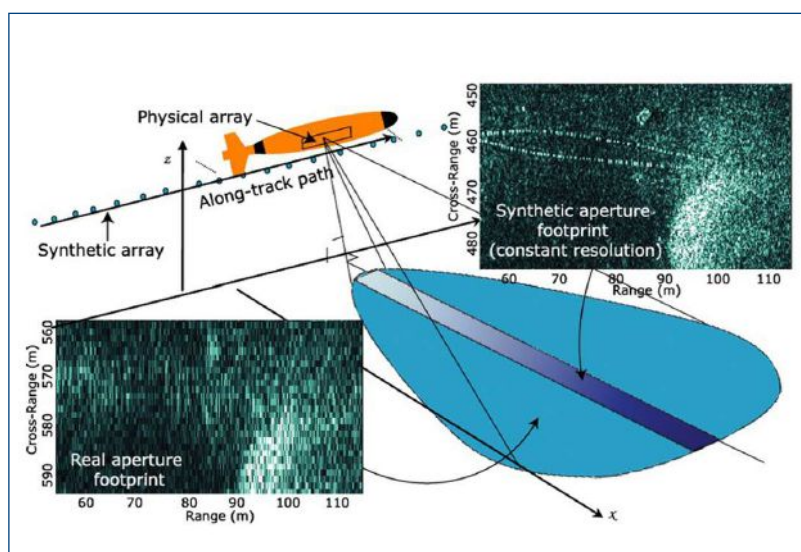
## *The First 50 Years of Synthetic Aperture Sonar Imaging Technology*

By Dr. Daniel D. Sternlicht • Dr. Michael P. Hayes • Dr. Roy E. Hansen

Active synthetic aperture sonar (SAS) is a powerful imaging technique that coherently combines echoes from multiple pings along the trajectory of a towed or robotic platform to construct a long virtual array of hydrophones. When synthetic aperture techniques are applied at sufficiently low acoustic frequencies, where sound absorption in the ocean medium is reduced, a modest-sized side scan sonar can generate seabed imagery with a constant azimuth resolution comparable to that of higher frequency sonar systems, but with longer range.

Synthetic aperture concepts originated in the radar community in the mid-20th century. It was not until the 1970s that the U.S. Naval Surface Warfare Center Panama City Division (NSWC PCD) and others in the sonar community began to show the feasibility of applying these concepts for underwater imaging. With evolutionary advances in enabling technologies, SAS systems are now being fielded on a variety of platforms and over a wide range of commercial and military applications.

The first open publication in side-looking SAS was the 1969 patent awarded to G.M. Walsh of the Raytheon Co., "Acoustic Mapping Apparatus" (U.S. Patent 3484737), stimulating a series of concept studies within the international community. In this time period there was agreement that SAS had tremendous potential; however, the challenges of making a practical system were daunting. These included limitations in coherent multiping processing caused by the perceived severity of medium sound speed fluctuations; the limited area coverage rate (ACR) set by the along-track sampling distance traveled between pings (generally described as half a projector length per ping, or finer); the inability to sufficiently measure random motion of the sonar platform for coher-

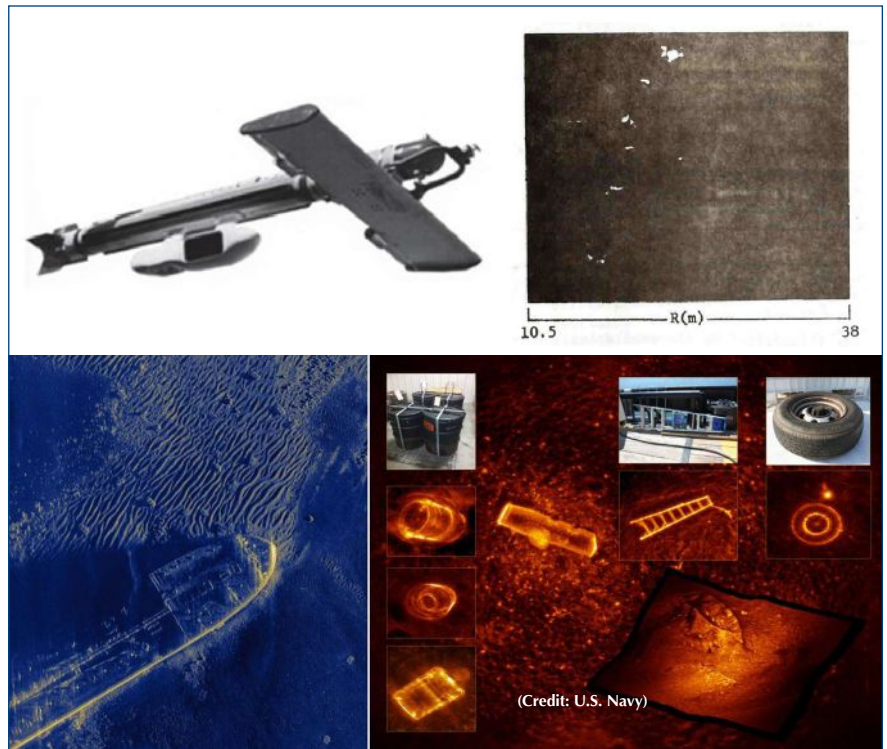


*The synthetic aperture technique combines multiple pings coherently along the path of the sonar trajectory to construct a synthetic array of hydrophones. In the conventional single-ping process, the along-track resolution of the area imaged is dictated by the projection of the sensor's beam pattern onto the seafloor; however, creation of a long synthetic array allows for the creation of fine-, constant-resolution images at long range.*

ent signal processing; multi-path interference; and data processing requirements that were prohibitively complex for the computing platforms of that era.

Experiments conducted during the 1970s and 1980s instilled confidence that sound propagation in the ocean is sufficiently stable over the modest range and time intervals required to create a synthetic aperture. Employment of a multichannel vernier receive array to increase the ACR would be developed by NSWC PCD and others during the 1970s.

*(Top and middle) The image products routinely presented to the SAS user have advanced considerably in 40 years. Note the vintage photograph (1976) of the SHADOWGRAPH SAS and corresponding LF imagery of buried targets compared to recent examples of single-pass and circular SAS images created with the ONR small synthetic aperture minehunter. (Bottom) Fifty years of SAS Development at NSWC PCD. Technologies were developed with partners that include: Northrup Grumman Corp.; Applied Research Laboratory, Penn State University; Bluefin Robotics; EdgeTech Inc.; Applied Research Laboratories, University of Texas; Florida Atlantic University; and Woods Hole Oceanographic Institution.*



In the 1980s and 1990s the evolution of inertial navigation systems (INS) toward smaller, less expensive packages with speed estimates aided by Doppler velocity logs (DVL), combined with techniques to employ the SAS vernier for precise estimates of lateral sonar motion, led to development of the sub-wavelength-scale motion estimation techniques required for SAS image formation.

This was followed by techniques correcting residual phase errors along the synthetic aperture due to unaccounted-for platform motion or medium sound speed fluctuations, developed in the form of data-driven autofocus algorithms.

From the 1990s through the 2000s, the burdensome computational requirements of SAS beamforming were addressed by innovations in SAS algorithms, such as Fourier-based image reconstruction techniques, and large-scale parallel computing architectures for fielded systems—until DSP/FPGA boards and, finally, single-board computers were able to manage the processing loads in the 2000s and 2010s, respectively.

Sea surface multi-path interference continues to be a nuisance; however, mitigation has come in the form of range-dependent beam shading and adaptive beamforming made possible by vertical apodization of the receive array.



## SAS Development by NSWC PCD and Partners

The tradition of pioneering new sensing technologies for maritime reconnaissance dates back to the founding of NSWC PCD at the end of WWII, known also throughout the years as the USN Mine Defense Laboratory (USNMDL) and the Coastal Systems Station (CSS). An example is the 1950s invention of the seabed imaging side scan sonar. This technology transitioned to the Westinghouse C-MK-1 SHADOWGRAPH mine-hunting sonar fielded on minesweepers in the early 1960s, which in turn led to development of the U.S. Navy's AN/AQS-14 (predecessor to the AN/AQS-24) and French DUBM-series mine detection sonars.

In 1969, USNMDL scientist D.H. Brown, a specialist in acoustic lensing and holography, published the paper "Application of the Synthetic Aperture Concept to High Resolution Sonar" for the Mine Advisory Committee of the National Academy of Sciences, National Research Council, wherein he identified the concept's feasibility, usefulness and challenges and described the vernier SAS approach to increase area coverage rate. Under direction by the Naval Ship Systems Command (now NAVSEA), development at the lab commenced in 1973 and would continue through the decade.

Augmented with an inertial measurement unit (IMU), one of the actively navigated SHADOW-GRAPH tow vehicles was used for the first synthetic aperture sonar field experiments. This system had a high-frequency (100 kHz) four-element vernier system on top and a low-frequency (30 kHz) system suspended from the midsection, establishing the multiband mine-hunting approach (high band for high reso-

lution; low band for sediment penetration and buried object detection) that would continue to this day.

On calm days, synthetically formed beams from the high-frequency system processed offline were reported to achieve nearly theoretical resolution at 100-m ranges. Given no corrections for random motion, utility was of course limited. The modest range low-frequency system, with a sole transmit/receive element and less vulnerability to motion, was used to create perhaps the earliest SAS images of targets from a fielded system. These tests, conducted in the Gulf of Mexico, illustrated numerous basic principles, as well as limitations.

By 1980, an SAS testbed and rail facility was constructed and attached to the old Hathaway Bridge, traversing nearby St. Andrew Bay, in order to conduct detailed performance assessments and explore new methods and techniques. This included measurements showing that the ocean medium is sufficiently stable in tidal environments to

form high-frequency synthetic apertures over the range and time intervals required.

These early experiments with fielded systems and controlled rail tests led to more than three decades of innovation, under sponsorship including the Office of Naval Research (ONR), NAVSEA and the Department of Defense Strategic Environmental Research and Development Program (SERDP). With the emergence of smaller, stealthier mines, more emphasis was placed on improving the resolution, as well as range, of these systems. An improved multichannel SAS would be fielded by the end of the 1980s.

In the mid-1990s, NSWC PCD and Northrup Grumman Corp. (formerly Westinghouse) designed and fielded a dual high- and low-frequency SAS payload on a 21-in.-diameter towfish, employing redundant phase center (RPC) motion estimation and real-time processing. In 1998, this system (integrated with magnetic and electro-optic sensors) was rapidly mobilized to locate debris from Swissair Flight 111, which had tragically crashed into the sea off of Nova Scotia. The following year, it performed successfully in the mine-hunting U.S. Navy Fleet Demonstrations of GOMEX 99 (Corpus Christi, Texas) and Kernel Blitz 99 (Camp Pendleton, California), motivating continued refinement of the technology and extension to off-board platforms.

The 2000s and 2010s would see development of the first fielded SAS on board a UUV in 2002; development of a buried object scanning SAS (BOSS); development of the ONR multiband small synthetic aperture minehunter (SSAM) family of systems, deployed on 12.75-in. UUVs for detection/classification of exposed and buried mines; and development and integration of a wide-swath, dual-frequency SAS and high-performance forward-looking sonar (FLS) on a 12.75-in. UUV for combined volume and bottom mine hunting.

#### Other US Initiatives

Northrop Grumman would go on to develop other SAS technolo-

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## U.S. EOD, Airborne & Surface Mine Countermeasures

|                                           |                                |                                           |
|-------------------------------------------|--------------------------------|-------------------------------------------|
| Early Navy<br>Sidescan Sonars<br>(C-MK-1) | NSWC PCD Navy Lab/ARL PSU/ONR  | Small Synthetic Aperture Minehunter (UUV) |
|                                           | Westinghouse->Northrop Grumman | AN/AQS-24 (Towed)                         |
|                                           | Raytheon/DARPA                 | AN/AQS-20 (Towed)                         |

## NATO

|                                                 |                                  |                             |
|-------------------------------------------------|----------------------------------|-----------------------------|
| U.S./France<br>Collaboration<br>NATO Consortium | CMRE (NATO)                      | MUSCLE (UUV)                |
|                                                 | FFI/Kongsberg (Norway)           | HISAS (UUV)                 |
|                                                 | Thomson Marconi->Thales (France) | DUBM Series (Towed & UUV)   |
|                                                 | DERA/QINETIQ->ATLAS (UK/Germany) | Vision Series (UUV)         |
|                                                 | Kraken/DRDC (Canada)             | MINSAS Series (Towed & UUV) |
|                                                 | TNO (Netherlands)                | MUD LF SAS (Ship mounted)   |

Other systems include: KiwiSAS, University of Canterbury, New Zealand; EdgeTech, USA; iXblue, France; Ultra Electronics, United Kingdom; various university and government labs

*Lineage for current seabed mapping SAS systems and product lines, the majority of which rely on the core discoveries and inventions described in this article.*

gies, including synthetic aperture versions of the AN/AQS-24 towed side scan sonars. In the 1990s, Raytheon Co., under Defense Advanced Research Projects Agency (DARPA) sponsorship, built a long-range experimental system, for which Dynamics Technology Inc. (DTI) developed the end-to-end SAS processing (motion compensation through autofocus). These developments led to commercial offerings in real-time SAS processing for wide-swath, high-resolution sonars, as well as the first commercially sold SAS system (with Edge-Tech Inc.).

DTI merged with Applied Signal Technology Inc., expanding its SAS product line, and eventually merged with Raytheon to upgrade the AN/AQS-20 towed mine-hunting sonar for SAS operation. Other U.S. experimental systems that informed the R&D community during the 1990s include multiple-receiver and sub-bottom swath mapping configurations by the University of California, Santa Barbara/Sonatech and the University of Hawaii/Alliant, respectively.

## NATO Collaborative Developments

Beginning with several decades of transatlantic technical exchanges, a rich variety of SAS technologies evolved that include the French DUBM series, the Norwegian HISAS

system, the NATO MUSCLE system, as well as the German Vision and Canadian MINSAS systems.

The U.S. and France had a series of technical exchanges that began with the licensing of the C-MK-1 SHADOWGRAPH to France in the 1960s, continuing with SAS research exchanges between NSWC PCD and the Groupe d'Etudes Sous Marines de l'Atlantique (GESMA) in the 1990s. These and French initiatives in the military, commercial and academic sectors (e.g., ACID/SAMI, IMBAT, ASEMAR, MUSCLE technologies) would contribute to the eventual SAS upgrade of the Thales DUBM series, as well as synthetic aperture developments in buried object imaging.

Expanded technical exchanges between NATO partners led to initiation of the Mine Countermeasures Joint Research Program (MCM JRP), with participation by the U.S., U.K., Germany, France, Netherlands, Norway, Belgium, Canada, Spain and others from the late 1990s to the present. A milestone event for the alliance was the InSAS'00 INS-equipped interferometric SAS rail experiments conducted off Elba Island, Italy, with participation by the NATO STO Centre for Maritime Research and Experimentation (CMRE, then known as SACLANTCEN), the U.K. Defence Evaluation and Research Agency (DERA), and the



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***“If the current trend of innovation is any indication, the number and variety of SAS-based applications will continue to grow, responding to increasing demands for precision, wide-area mapping and greater understanding of the undersea environment.”***

Norwegian Defence Research Establishment (FFI). These and follow-on studies informed the design of a number of SAS systems, including: the CMRE MUSCLE, which was built by Thales Underwater Systems and continues to provide a common research platform for the NATO MCM JRP; the DERA/QINETIQ technologies, which were later acquired by ATLAS ELEKTRONIK and evolved into the Vision family of systems; the Kongsberg/FFI HISAS system, with early developmental emphasis on improved SAS motion estimation by sonar micronavigation aiding of the INS; and the Kraken MINSAS family of systems, developed for broad application across the maritime marketplace. Other European suppliers of SAS systems include the companies Ultra Electronics and iXblue.

### **SAS Development in the Asia-Pacific Region**

Many of the U.S. and NATO systems discussed in this article have been heavily influenced by the studies, innovations and subject matter experts originating from the Acoustics Research Group (ARG) at the University of Canterbury in Christchurch, New Zealand. The ARG, active since the early 1980s, has conducted synthetic aperture research that includes measuring acoustic phase stability in the ocean medium; exploration of continuous transmission frequency modulation (CTFM) for simplified broadband processing; development and evaluation of efficient image reconstruction algorithms and data-driven autofocusing; and methods of SAS interferometry.

Development of experimental synthetic aperture sonar systems has been undertaken by researchers in China and Japan since at least the late 1990s. Low-frequency systems were developed in the early 2000s by the Institute of Acoustics, Chinese Academy of Sciences and partners and, separately, by the NEC Corp. Since 2000, the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) and partners have developed a series of towed SAS systems, which have been used for geologic mapping.

### **Current, Future Trends**

Currently, more than a dozen nations have developed, are developing or have procured synthetic aperture sonar systems, with several North American and European families of systems beginning to see widespread use. An active R&D community, empowered by the maturation of SAS technologies worldwide, has been developing new capabilities that include: SAS interferometry for high-resolution bathymetry, extended ranges, circular SAS tomographic imaging, buried munitions mapping, automated target recognition and change detection, and through-the-sensor characterization of the ocean environment. Improvements in materials, transducers, electronics and processing will lead to new uses that include exploita-

tion of frequency agility and increased bandwidth, calibrated data products (e.g., direct estimation of target or backscatter strength), as well as continued reduction in the size, weight, power and cost of these systems.

Synthetic aperture sonars are currently being fielded in areas that include geological mapping, infrastructure surveys, environmental remediation, marine salvage and archaeology, and mine countermeasures. If the current trend of innovation is any indication, the number and variety of SAS-based applications will continue to grow, responding to increasing demands for precision, wide-area mapping and greater understanding of the undersea environment.

### **Acknowledgments**

We thank Jose Fernandez and Dr. John Lathrop for sharing their vast knowledge and memories of SAS development at NSWC PCD, Tony Waterman for his considerable support locating historical documents in the NSWC PCD Technical Library, and members of the SAS R&D community who kindly shared their insights and reviews of this article.

### **References**

For a list of references, contact Daniel Sternlicht at [daniel.sternlicht@navy.mil](mailto:daniel.sternlicht@navy.mil). **ST**

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*Dr. Roy E. Hansen is a principal scientist in synthetic aperture sonar and AUV development at the Norwegian Defence Research Establishment (FFI). He is also an adjunct professor in acoustic imaging at the Department of Informatics, University of Oslo, Norway. He received a Ph.D. in physics from the University of Tromsø, Norway.*



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# $\mu\text{AUV} + \mu\text{SVP} = \text{ecoSUB } \mu\text{SVP}$

## *Collaboration Produces AUV to Acquire Sound Velocity Profiles*

By Terry Sloane

**e**coSUB is a micro (0.5 m long) AUV jointly developed by Planet Ocean Ltd. and the Marine Autonomous Robotics Systems (MARS) group at the U.K. National Oceanography Centre Southampton (NOCS). Partly funded by Innovate UK and dstl, the U.K. Defence Science and Technology Laboratory, ecoSUB is a disruptive system that aims to democratize the use of autonomous underwater technology in science, commercial and defense applications by using advanced design techniques, materials, sensors, artificial intelligence (AI) and manufacturing methods to produce an affordable and capable AUV.

Just a few short years ago ecoSUB would not have been possible; the ability to manufacture some of the mechanical parts required at this scale, the availability of suitable power supply chemistries, and the availability of small, low-power, accurate sensors together with small, high-capability processors—the lack of these conspired to keep micro-subs firmly at the concept level.

This has all changed in the past three years as potential solutions emerged. Rapid advancements in 3D printing capability, micro-sensors, new battery chemistries and improvements in existing ones, as well as micro-miniature, low-power, high-performance processors provided some of the solutions for the design team to begin the two-year journey in August 2015. Although the task was still extremely challenging, the Planet Ocean and MARS teams set to work to engineer a capable, cost-effective vehicle to meet the demanding specifications identified by Planet Ocean in a detailed and wide-ranging market study.

The result is ecoSUB- $\mu 5$ , which has a 500-m-depth capability and target endurance of 48 hr., with the ability to carry a growing range of highly capable sensors. An important design requirement was that the AUV should, where possible, maintain a “cylinder rule,” i.e., have no projecting control surfaces or antenna that would limit its capability for tube launch from a surface, underwater or sonobuoy tube. This is achieved by using a moving

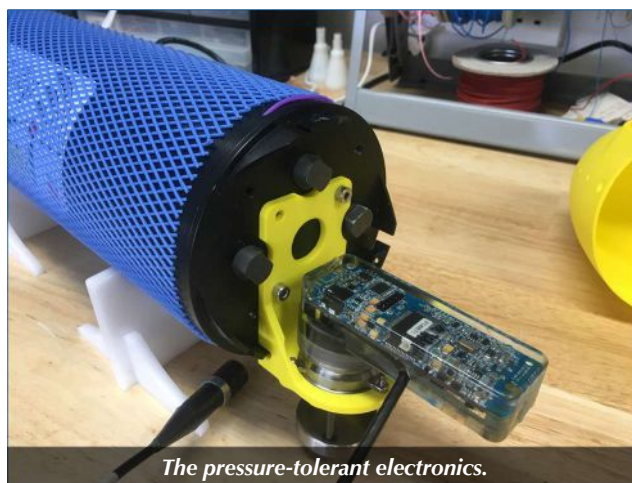


(Top) ecoSUB- $\mu 5$  SVP in communication mode. (Bottom) The sensor and nose cone.

mass within the vehicle to control pitch angle. Using this technique also allows the combined antennas and location beacons, which are coaxial to the main vehicle body, to be adequately exposed for communications and GPS positioning at the surface. When the mass is fully forward, the vehicle can effectively stand on its nose. An added advantage of this is the ability to dive at extremely steep angles, providing a unique profiling capability.

As part of the design process, Planet Ocean sought early engagement with sensor manufacturers to encour-

age them to consider deployment of their sensors on micro-AUV platforms with all that this entails in terms of size, power and weight. An early adopter of this philosophy was Valeport Ltd. Based in southwest England, Valeport has an enviable reputation for producing high-quality sensors designed and manufactured in-house with the inherent ability to adapt quickly to meet the needs of potential end-users such as ecoSUB.



*The pressure-tolerant electronics.*

Two very small wires transmit the temperature data to the ship, where they are post-processed to provide temperature-salinity profiles. The probe is designed to fall at a known rate, so that the depth of the probe can be inferred from the time since it was launched. By plotting temperature as a function of depth, the user can get a picture of the temperature and salinity profile of the water column. Using standard formulas, speed of

sound can be calculated from this information.

### Alternative to XBT

One of the many potential applications of micro-AUV technology identified by the market study was an alternative to the XBT (expendable bathythermograph). The XBT has been used by oceanographers for many years to obtain information on the temperature structure of the water column. It was later adopted by naval forces and others to locate the thermocline. Added conductivity sensors facilitate calculation of speed of sound for sonar calibrations.

The XBT is dropped from a ship and measures the temperature and conductivity as it falls through the water.

Although extremely useful, XBT technology has a number of limitations. First, data are provided only directly below the deploying platform (ship). Second, important data such as depth and salinity are calculated or inferred rather than measured. Third, XBTs are one-shot devices providing a single profile per XBT. These limitations are addressed using ecoSUB technology combined with a time-of-flight sound velocity sensor provided by Valeport.

Using ecoSUB-μ5 combined with a specially adapted Valeport SV (sound velocity) sensor provides a real-time physical measurement of speed of sound, accurate depth

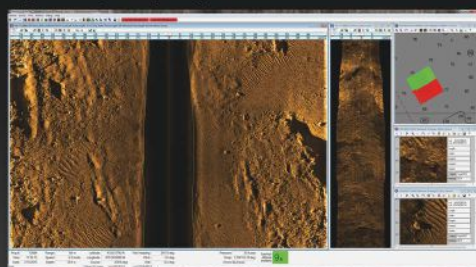



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information and the ability to make multiple SV profiles at several locations autonomously. By clever data compression techniques, ecoSUB can deliver a full sound velocity downcast with speed of sound, depth and latitude/longitude every meter through 290 m in a single Iridium short-burst data (SBD) message before traveling to a new location to repeat the process. This can be extended to 500 m with up- and downcasts using multiple SBD messages or adjusting the interval from less than 1 m to more than 1 m as required in the mission plan. This provides decision makers with a very detailed 3D map of the underwater acoustic environment over a wide area in near real time and in advance of the host vessels arrival at the location. Making an accurate physical measurement of sound velocity reduces errors inherent in calculating sound speed using multiple sensors each with its own error band.

The Valeport time-of-flight SV sensor provides: accuracy of  $\pm 0.02$  m/s (total error budget); precision (peak-to-peak noise) of  $\pm 0.002$  m/s; operating range of 1,375 to 1,900 m/s (covering all environments from freshwater to the Dead Sea and the Marianas Trench); and data rates up to 60 Hz (instrument dependent).

Typically, ecoSUB sensors and electronics are located within the free-flooding nose cone of the vehicle. To accommodate the Valeport sensor, a new ecoSUB nose cone was required. Valeport provided pressure-tolerant electronics that could be fitted within the nose cone and perform at pressures of 50 bar or more.

In addition, Valeport was asked to provide a sensor with the shortest possible path length to minimize the drag experienced by the vehicle while providing the required exposure for the sensor to maintain performance, as well as making the electronics package as close to naturally buoyant as possible.

An advantage of the ecoSUB moving mass system is the steep dive angle. When diving steeply, ecoSUB naturally spirals, keeping the footprint of the dive extremely tight. This can be enhanced further by applying full right or left rudder as part of the profile dive behavior.

## In the Field

The first batch of five vehicles were produced in May 2018 and subjected to extensive sea trials with remarkable results before being supplied to the customer. At the

time of writing, four vehicles are being prepared for deployment on an exercise in the northern North Sea. The subs will be piloted remotely, using the Iridium channel that, with the aid of a specially designed C3 base station, allows over-the-horizon communications with the subs in an internet-denied environment. New missions or alterations to existing missions can be uploaded on the fly when vehicles are on the surface.

Working with stakeholders, particularly in the energy and defense sectors, there is a growing understanding that in some circumstances, information can be more valuable than data. This often means that decision makers need to be provided with preprocessed information rather than complex data sets to allow them to make speedy yet educated decisions. An example of this is in anti-submarine warfare (ASW), where knowledge of the depth of the temperature inversion layer is required. By processing the sound velocity data on board ecoSUB and simply sending a subset of the data located around the inversion depth, or even a concise report along the lines of "thermocline at 40.55 m latitude 0° 00' 0.000" longitude 0° 00' 0.000"," decision makers are not overwhelmed by complex or lengthy data sets requiring interpretation. Raw data are always available and stored locally for use offline as required. Mindful of the value of the data collected, facilities have been incorporated for erasure of the data remotely if necessary.

ecoSUB is currently available in two variants: the micro ( $\mu$ ) 500 m rated and milli (m) 1 m in length and 500 m or 2,500 m rated. Valeport has provided specially commissioned versions of its Hyperion fluorometer system with fast time constant temperature sensor and echosounder for use specifically on ecoSUB vehicles. ecoSUB Robotics is now developing a range of payload configurations and firmware modules suitable for combat hydrography and other defense applications. **ST**

*Terry Sloane began his career in 1975 as an electronics engineer with Marconi Space & Defence Systems working on torpedoes and later became technical director at NBA Environmental Systems. In 1994, he co-founded Hydrosphere UK Ltd., and in 2003 he formed Planet Ocean Ltd. Sloane established ecoSUB Robotics Ltd. in 2016 to develop AUVs, designed in collaboration with the MARS group at the NOC Southampton.*



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# Component Protection on Board

## *Selective Plating Cuts Vessel Downtime for Repairs*

By Derek Vanek

For many years, naval forces around the world have taken advantage of selective plating as an alternative to disassembling components for repair, helping reduce the downtime of critical naval fleet. This technology is already proven for the naval defense industry, and now commercial shipyards are realizing the benefits, too.

Day in, day out, marine and naval equipment are subject to extreme conditions, including saltwater, high temperatures, wear, corrosion and fatigue. The problem that comes with these conditions is the length of downtime needed to repair key marine components and equipment.

In the commercial sector, every second a vessel spends in the shipyard is one when it's not delivering value. In the U.S. alone, investment in shipbuilding has grown steadily, with gross output in 2013 topping \$28 billion. With these figures, it's crucial to minimize downtime.

In the naval defense sector, however, the challenge can be even greater. Despite the presence of onboard machining, welding and plumbing repair facilities, one of the biggest challenges when a naval submarine is at sea is putting metal back onto a part that has been over-machined, worn, corroded or eroded. With no time for sending vital components out for repair, selective brush plating has, for many years, been the method of choice for global naval forces.

### **Traditional Plating**

Typical component problems and issues on a naval or marine vessel can include: fretting or wear on bearings fits and flanges due to continuous vibration; extensive wear



*Extreme marine conditions accelerate corrosion, wear and fatigue.*

on bearing cap faces and saddle areas; corrosion on various components such as compressed air valves and parts exposed to seawater; steam cuts on high-pressure turbine castings; worn Babbitt coatings on bearing shells; and out-of-tolerance or mismachined shafts, housings and bearings.

In some cases, traditional tank plating is a suitable method of re-

pair, which involves the use of large tanks of preparatory and plating solutions and often requires extensive masking. However, the procedure is not portable, meaning the overall process, by nature, is rigid and not suited to components that need plating particularly fast. In naval defense, therefore, this process may not be possible due to the challenges mentioned above. Even where it is possible, every second of downtime counts, as costs can mount up very quickly.

The use of this traditional method can hinder the process and increase downtime further due to the need to disassemble components, the time it takes to transport from shipyard to plating facility and the inevitable reinstallation ahead of re-entering service.

### **Making Protection Portable**

Instead, the naval defense sector has taken advantage of selective plating, a well-established and reliable process that has already been written into shipbuilding specifications. It is a portable method of electroplating localized areas of metal surfaces for OEM components, permanent repairs and salvaging worn or mismachined parts; providing a fast, efficient and targeted solution to



corrosion, wear, galling, solderability and brazing. It is carried out by skilled technicians to repair or maintain critical parts.

The main benefit is portability. Only four elements are required: a power pack, plating tools, plating solutions and a trained operator—all small enough to pass through a submarine hatch.

Unlike tank plating, selective plating can be performed in situ, which is critical in naval defense, of course, as the part or component does not need to be removed and transported to an external site. It can be brought into the shipyard, aboard vessels or anywhere it's needed to enhance or repair components, by any team member—certified technicians and engineers can take on the role after training, while the portable equipment

facilitates use of machine shops at the point of repair. The process not only exceeds the fundamental requirements of shipbuilding manufacturing and repair and maintenance processes, it also provides a full circle of benefits, including quality, durability, cost saving, portability and time saving.

Take the SIFCO Process ([www.sifcoasc.com/marine](http://www.sifcoasc.com/marine)), the leading method of selective electroplating created by SIFCO ASC, in use for more than 35 years. The SIFCO Process is used by, and written into the specifications of, many leading companies servicing the turbomachinery industry. Carrying approvals from the American Bureau of Shipping, Mil-STD 2197(SH) and NAVSEA, the process uses significantly smaller volumes of plating solution than tank plating, using only the required material.



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***“Automation reduces the ergonomic risk to the operator and increases the available capacity by allowing skilled operators to focus on the core business processes.”***

There may be no need for disassembly or transportation, and only minimal need for masking and post-machining; all that’s needed is a quick process that extends maintenance intervals and service life.

The SIFCO Process has been adopted by naval forces of the U.S., U.K. and Japan, used on a wide range of components across the naval defense fleets.

On turbine casings, for example, AeroNikl has been successfully used for interference fits, providing a metal-to-metal seal with less risk for thermal disturbance than the previous repair method, welding.

Elsewhere, copper capped with AeroNikl is used to fill pitting on seal surfaces of components such as main seawater valves and watertight hatches for missile tubes on aircraft carriers and submarines. In these cases, selective plating can prevent the need either for disassembly and transportation to a machine shop (seawater valves), or for in-place machining after TIG welding (watertight hatches).

What’s more, through the ASTM C633-79 Standard Test Method for Adhesion or Cohesive Strength of Flame Sprayed Coatings, the SIFCO Process also established that the cohesive strength of the deposit exceeds that of the bonding cement. For example, the minimum tensile strength value established (at the point of cement failure during testing) for nickel high speed is 22,803 kPa (11,200 psi) on an SAE 4130 steel base material. Additional qualitative tests, as described in AMS-QQ-N-290 were also conducted in which the plated areas were subjected to high stresses and strains. These results also showed excellent adhesion.

#### **Protection in Port**

Remanufacturing is an alternative option to replacing or re-engineering equipment and is worth considering in the naval defense and marine industries with bigger components that can be especially costly.

Sitting at the heart of the remanufacturing decision is the used part that is at the end of its service life. According to the study “Remanufacturing Inspection Models” by a Ph.D. student at Exeter University, U.K., there are four main strategies applied in the decision-making process for remanufacturing, each of which comes down to value and type of component. It states: “If cores [end-of-service-life components] are relatively cheap, disposal is an effective way of increasing the reliability of the population as a whole. If cores are expensive they must be processed almost regardless of cost. In the case of low-value cores there is often a new alternative that can be purchased in its place.” Remanufacturing of a component should be assessed on a case-by-case basis. Different

processes, like selective plating, might be used in the remanufacturing process than were used in manufacturing the original equipment or part.

Due to the high cost of marine equipment combined with the lead time required to purchase new equipment, remanufacturing with selective plating should always remain an option.

#### **Mechanizing, Fully Automating the Process**

When a ship is in port, multiple repairs may be needed. Depending on the application, selective plating can be mechanized or fully automated. Mechanizing the process minimizes the direct contact the operator has with the tooling and chemicals by using a computer program to control the rectifier performing all of the pre-treatment and plating steps, providing consistent control of the process. Fully automating the process removes the operator—and the variability—from the entire operation.

The main benefit of customized, fully automated systems is that they require minimal need for operator intervention. Various pumps, flow systems and cleaning agents work together to change, catch and circulate solution; while a robotic arm holds, oscillates and changes the anodes needed throughout an entire plating operation.

By automating the selective plating process using a programmable logic controller, operators can review data captured through the human-machine interface to determine if the operation was completed correctly. If any errors do occur, or quality standards are not met, operators can review the data and trace the error to its source and assign the appropriate corrective action, preventing the errors from being repeated—effectively improving traceability and repeatability within the process. Additionally, automation reduces the ergonomic risk to the operator and increases the available capacity by allowing skilled operators to focus on the core business processes. **ST**

Derek Vanek is the technical manager for SIFCO Applied Surface Concepts and has been with the company for about 31 years. Prior to that, he served as a machinery repairman in the United States Navy repairing worn or damaged parts, as well as machining replacement parts that were beyond repair for shipboard equipment, including propulsion systems, compressors, pumps, motors and valves. Vanek’s role within SIFCO ASC includes application development and understanding customer needs and specification



and engineering requirements to determine the suitability of selective plating for the component. For applications beyond traditional selective plating, Vanek works with the SIFCO ASC team to develop specialized processes.

# Unparalleled Connectivity at Sea

## *Thales VesseLINK: New-Gen Satellite Technology, Maritime Comms*

By Robert Squire

In December 2017, in what an observer called a “holiday light show for Southern California and much of the desert southwest,” a SpaceX Falcon 9 rocket launched from the U.S. Pacific coastline carrying satellites for a new communications network.

Stephen Clark described the launch in *Spaceflight Now*: “The Falcon 9 left a brilliant white plume of exhaust in its wake, catching rays of sunshine as it soared above the stratosphere. The ever-expanding plume left a tear-drop-shaped mark in the sky, prompting countless social media posts from rush-hour drivers and others who happened to catch an unexpected glimpse of the rocket’s trip to space.

“The Falcon 9 turned south from Vandenberg on 1.7 million pounds of thrust from its nine Merlin 1D engines, and surpassed the speed of sound about one minute after liftoff. The first stage’s nine engines switched off, and the booster separated from the Falcon 9’s second stage about two-and-a-half minutes into the mission,” he wrote. “The upper stage’s single Merlin engine ignited right on time to drive the rocket’s 10 Iridium satellite passengers into orbit, and the first stage began a controlled propulsive descent back to Earth.”

Shortly thereafter, the Falcon 9’s payload of satellites successfully deployed into a new constellation that is revolutionizing ship-to-ship and ship-to-shore voice and data links. These Iridium NEXT satellites and Thales Ves-



*Thales VesseLINK utilizes Iridium Certus broadband services with a network of 66 satellites covering 100 percent of the globe, including deep oceans and the poles. This robust network provides reliable, mobile and essential voice, text and web communications.*



*The VesseLINK antenna is a high-gain, electronic phased-array antenna that enables fast upload and download speeds to cover any vessel communications need—from safety services to operational reporting and logging. To meet the challenges of maritime environments, VesseLINK hardware is ruggedized. The modem resides inside the terminal, which is constructed of full die-cast aluminum and is IP67 rated for protection against the elements.*

seLINK—a new, state-of-the-art connectivity solution for vessels in commercial shipping, fishing, yachting and a variety of maritime operations—are helping captains and crews overcome the challenges of weather, mobility and remoteness that for decades have thwarted reliable communications at sea.

### A New Constellation for a New Era Of Satellite Connectivity

Today, satellites are handling ever-increasing amounts of the world's commercial and military communications data, and Thales and Iridium are providing the technology for a new generation of innovative, space-based, broadband connectivity platforms.

Whether it's for an Antarctic expedition, on board a ship in polar seas or on a plane flying over remote regions, one thing is an absolute must-have in the Digital Age: satellite communications. Four suppliers have established themselves in this market segment, and one of the leading companies is Iridium Communications Inc. First launched in 1998 as Motorola subsidiary Iridium SSC, the Iridium network was envisioned exclusively as a telephony enterprise.

However, as circumstances changed and technology evolved, Iridium—now an independent company—recognized an opportunity to reboot its network into a unique voice and data satellite services provider. Today, Iridium boasts hundreds of thousands of subscribers supporting maritime, aviation, machine-to-machine and terrestrial activities. With the experience of industry veterans, Iridium has established itself as a major player in the mobile satellite services arena.

As exemplified by the Iridium NEXT initiative, the future of space-based communications technology resides with high-throughput satellites. Iridium NEXT will maintain a uniquely sophisticated architecture of 66 cross-linked satellites, delivering high-quality, truly mobile voice and data coverage over the planet's entire

surface—including oceans, airways and polar regions. On Iridium NEXT, communications routing is not via a ground network but rather through cross-linked satellites, according to a “smart” mesh architecture.

A meshed constellation of interconnected, cross-linked satellites work in a way that each satellite “talks” with the other nearby satellites in front, behind and adjacent orbits. In space, each Iridium satellite is linked to up to four others, creating a dynamic network that routes traffic among satellites to ensure global coverage, even when traditional local systems are unavailable.

In addition, its L-band availability allows customers to take advantage of reduced interference from weather and provides a more reliable network.

The mesh ensures global coverage, while doing away with the need for ground telecom networks. This “smart” in-orbit routing is enabled thanks to the use of computers having the most advanced embedded software technologies. This independence from any ground network allows the Iridium system to be highly resistant to disruptions. Iridium NEXT offers higher data speeds, flexible bandwidth allocation and IP-based routing, making Iridium NEXT a significant space resource for maritime operations.

Adding to the constellation's reliability, the large number of fast-moving low-Earth orbit (LEO) satellites, with multiple overlapping spot beams, minimizes missed connections and dropped calls. The LEO orbit also provides a shorter transmission path with less signal attenuation. Six in-orbit spares can also be quickly repositioned and activated, as needed. At only 476 (780 km) from the Earth, the proximity of Iridium's LEO network means pole-to-pole coverage, a shorter transmission path, stronger signals, lower latency and shorter registration time than with GEO satellites.

Combined with redundancies across the network and secure, dedicated ground infrastructure, this unique configuration will allow services like Thales VesseLINK to continue to remain unaffected by natural disasters, including hurricanes, tsunamis and earthquakes that can cripple terrestrial infrastructure.

### New Network: Iridium Certus

Delivering global, reliable and enterprise-grade services while redefining the capabilities of satellite communications, Iridium Certus is the new service platform to be powered by the Iridium NEXT constellation. Iridium Certus will offer more than just connectivity—it is a portfolio of ever-expanding service offerings that will feature more coverage than any other satellite operator.

With a range of speeds eventually up to 1.4 megabits per second, Iridium Certus supports an innovative portfolio of partner products and satisfies a wide-ranging set of maritime communications solutions. From merchant vessels to the coast guard, Iridium is a preferred, trusted provider for maritime satellite communications for operational and safety services. Thales VesseLINK on Irid-

ium Certus will set a new standard with small, robust, all solid-state equipment providing the highest L-band throughput to any seas. It is the technology maritime has waited decades for—all of the benefits of resilient L-band frequencies combined with high bandwidth and truly global coverage.

Thales's partnership with Iridium for the solution could be said to have started in 2010, when it was announced that Thales would provide for the construction of 81 communication satellites in the Iridium NEXT low-orbit constellation.

In addition to enabling a new network and new communications devices, Iridium NEXT was also required to offer complete backward compatibility with current devices and services. Thales Alenia Space developed a sophisticated, yet flexible solution to meet this requirement. Based on its LEO platform product line, specifically developed for constellations, each Iridium NEXT satellite carries a sophisticated active transmit/receive L-band antenna, Ka-band crosslink and feeder link antennas, two-axis solar arrays and advanced onboard processing hardware and software needed to manage and route voice and data traffic through the Iridium network.

Writ large, the Iridium NEXT initiative reflects the growing reality that in the commercial and government space, the future of space-based communications technology resides with high-throughput satellites (HTS). Last year, the total world commercial satellite market was 53 percent non-HTS, 35 percent partial and 12 percent full

HTS. The HTS proportion of the market will likely double in the next few years, driven by government and consumer demand for data.

#### **Thales Innovation: Enabling Certus Broadband Connectivity**

Thales has long been a provider of mobile communications solutions and space-based technologies. "For decades, Thales customers have been changing the way we travel, communicate and connect," says Thales Sat-Com Solutions Director Brian Aziz. "Along the way, they are changing how we perceive the world around us, and how we connect with people, systems, content and data."

With 3.4 billion internet users, 2 billion people on social networks and 2 billion smartphone users making up 70 percent of the global population, industry and customer expectations for ease of use and access to the world's digital infrastructure are evolving rapidly. When Thales began development of VesselINK on the Iridium Certus network last year, the aim was to provide yet another critical industry with a vital communications life-line and access to the digital tools and online networks familiar to any land-based customer or enterprise.

Carried over Iridium's network of satellites, VesselINK offers coverage of 100 percent of the globe, including the poles. The solution provides highly reliable, mobile voice, text and internet communications, and allows users to simultaneously communicate using IP data ses-

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***“The initial trials have revealed that the voice quality is excellent, beyond our expectations, and data transmission is working optimally, ready for partner platform integration.”***

sions, streaming data—with guaranteed speeds up to 256 kbps—and location tracking for multiple devices. Additional features include 4G LTE pairing, embedded Wi-Fi access and smartphone compatibility, including Android and iOS functionality. The solution’s Wi-Fi component is capable of generating a hotspot for multiple users.

The system features easy installation—including single-cable connectivity from antenna to terminal—a 3.5-kg antenna and a powerful, intuitive user interface. The system is API accessible externally, features a simple command structure—accessed through a built-in management portal for configuration and monitoring—that is password protected.

Features include least-cost routing through VSAT and 4G networks, traffic management (including a built-in traffic limiter) and a radio-over-IP interface. Data speeds run at up to 352 kbps for uplink and downlink, and the system’s software is upgradeable to 700 kbps downlink. For voice communications, the system supports up to three dedicated, high-quality voice lines and PBX-like features on board providing advanced voice configuration and calling options.

To meet the challenges of maritime environments, VesseLINK hardware is ruggedized to IP67 for the antenna rated for protection against the extreme maritime elements. The modem resides inside the below-deck terminal, which is constructed of full die-cast aluminum.

VesseLINK has six times the throughput of existing Iridium services while being convenient to use and deploy. It is lightweight, easy to install and has only one cable between the antenna and the below-deck unit.

### **Approved Technology Through Trusted Partners**

Thales received Iridium Certus certification in August 2018. The initial trials have revealed that the voice quality is excellent, beyond our expectations, and data transmission is working optimally, ready for partner platform integration. Beta testing sea trials for VesseLINK installations should be complete by the end of October 2018.

Today, VesseLINK is available through a certified reseller network. At time of writing, these include MVS USA, MetOcean Telematics, Network Innovations, Pivotel, SpaceNet, Globalsat Group, Trace and the AST Group.

VesseLINK resellers offer the solution for a broad range of maritime markets. As an affordable, enterprise-grade solution designed to meet the unique challenges of maritime environments, VesseLINK’s lightweight hardware affords a simple, adaptable and robust design and easy-to-use interface for ship captains and crews. It can be installed as a stand-alone solution or used as a VSAT companion.

The solution will deliver essential communications for enhanced safety features and critical operations, ensuring that customers have the most reliable capabilities for their individual vessel or fleet-wide needs. It can be equipped on all marine platforms, including commercial shipping, workboats, fishing vessels, leisure and luxury boats, and cruise ships. It will also be available to military customers as a commercial off-the-shelf solution or be adapted to meet the needs of diverse naval warfare operations.

“Thales is pleased to be entering the commercial maritime market with a stand out satellite communications solution,” said Mike Sheehan, president and CEO of Thales Defense and Security Inc. “Thales VesseLINK gives your critical maritime operation global communications coverage. It is the communications solution you can depend on at sea, anytime, anywhere. Whether you operate a large fleet or a single vessel, this solution is designed to meet your needs for safety and connectivity through highly reliable, mobile and essential voice, text and web communications.” **ST**

*Robert Squire is Certus director at Thales Group.*

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# Satcom on Research Vessel

## *Implementing Global Satellite Communication System on Spanish RV*

By Alberto Hernandez • Raul Bardaji • Juan Luis Ruiz

**R**esearch vessels double as sampling platforms and laboratories. These vessels can remain for long periods at sea, during which access to information must be available to researchers whenever required, e.g., to communicate with other members of a project, acquire updated and near-real-time data, etc. Therefore, a global communications system is a capital expense for a research vessel. This article summarizes the communications system implemented in the Spanish RV *García del Cid*.

The RV *García del Cid* is a multipurpose research vessel with a regional capacity that is part of the EuroFLEETS project aiming toward an alliance of European research fleets. It is managed by the Marine Technology Unit of the Spanish National Research Council (UTM-CSIC). The ship was built in 1979, and its characteristics are: a deadweight of 183 t, a length of 37.2 m, a breadth of 8.4 m, a draught of 3.50 m and a capacity for 26 people (14 crew and 12 scientists or technicians).

The vessel's objective is to support national and international scientific research of different disciplines in the Mediterranean Sea, the Iberian zone of the Atlantic

Ocean and the Canary Islands. Hence, a global communication system is needed.

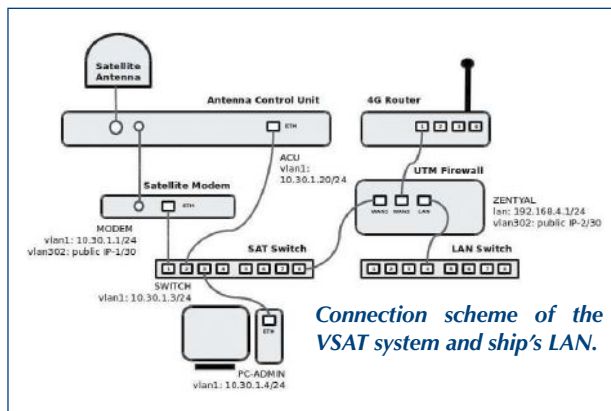
A very small aperture terminal (VSAT) communications system was acquired to ensure the necessary coverage. This type of system is often used to communicate via satellite and provide services such as internet access, telephony, fax and high-speed data communication. A new network management system, based on free software, was also implemented; it is a unified threat management (UTM) firewall that is an approach to information security whereby a single hardware installation provides all security functions. This provides internet access to computers filtering by MAC; quality of service to distribute the bandwidth by services or users; VPN service to access the equipment on the ship; DNS service to obtain the domain names of the network; and DHCP service to provide the automatic configuration of network parameters.

### Network Basics

The VSAT system is connected to the server where the UTM firewall is installed and uses the Intellian v80G

*The RV García del Cid.*





model. It comprises an external part and an internal part. The former contains an antenna and two frequency converters inside the dome, i.e., one for transmission, the block up-converter (BUC), and another for reception, the low-noise block (LNB). Internally, it contains the antenna control unit (ACU) and the modem, both placed at the bridge.

Regarding the UTM firewall, free and open-source software solutions for network management with similar characteristics were considered: Endian, OPNsense, ClearOS and Zentyal.

Zentyal, a project led by a Spanish company, was chosen, providing the firewall, quality of service, VPN, DNS server and DHCP server.

## VSAT Design

The VSAT system, integrated into a satellite internet service provider (ISP) network, has two virtual local area networks (VLAN) configured by a managed switch, namely the VLAN1 and the VLAN302.

The VLAN1 controls the VSAT system through the satellite ISP. This network has the IP address 10.30.1.0/24, and its devices have the following IP addresses: 10.30.1.1/24 (the modem), 10.30.1.3/24 (the switch), 10.30.1.4/24 (the PC administrator) and the 10.30.1.20/24 (ACU).

The devices on the VLAN302 are a gateway, i.e., the modem is a gateway to the UTM firewall and, later, to the rest of the devices on the ship's LAN. This network has four public IP addresses. The modem has the IP "Public IP-1/30," and the UTM Firewall has the IP "Public IP-2/30."

## LAN Design

The local area network connects the machines within the ship. The UTM firewall is part of this system and works as the gateway for the rest of the devices. For the EuroFLEETS project, all research vessels use the IP address 192.168.4.0/24.

The three network interfaces of the UTM firewall are configured as follows: eth0 (192.168.4.1/24) is plugged into the ship's LAN and is the gateway for the computers that have internet access; eth1 (Public IP-2/30) is plugged into the WAN1, which connects to the internet via the VSAT modem (Public IP-1/30) when the vessel is

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at sea; and eth2 (192.168.40.1/24) is plugged into the WAN2, which connects to the internet via 4G router (192.168.40.2/24) when the vessel is in port or near the coast within coverage of a mobile network.

The UTM firewall must be configured to cover all network management needs. Satellite internet is expensive, and the bandwidth is small. The firewall's primary job is to allow only a few computers to connect to the internet; otherwise, navigation would be extremely slow or impossible.

The RV *García del Cid* has a bandwidth of 128 to 256 kbps, limiting internet access to five computers. To communicate via text, the WhatsApp application can be used on smartphones; this requires minimal bandwidth. The smartphones are connected to the access point "ap-whatsapp" (192.168.4.47/32). The access point has an activated DHCP that gives each smartphone an IP address in another range. To ensure that only text messages are transmitted (no images or videos), a service is configured that permits only traffic from 192.168.4.47 via TCP/UDP port 5222, which is used by the application to send text messages.

To establish a VPN between the vessel and UTM-CSIC headquarters, it is necessary to have a Zentyal at each site. The UTM-CSIC manages several research vessels, and a star structure was designed for their VPN. Each ship's Zentyal is connected to the headquarters' Zentyal. In this way, people obtain access from the vessel (range 192.168.4.0/24) to the headquarters (range Public IP-UTM/25) and vice versa all within the same network. The ship's Zentyal (192.168.4.1) is the gateway.

The DNS server resolves the names of all fixed machines connected to the ship's LAN. The DHCP server gives the machines an IP address between 192.168.4.100 and 192.168.4.199.

### Satcom at Work

In May 2018, the RV *García del Cid* was involved in the data validation project of the Surface Water Ocean Topography (SWOT) sat-

ellite in the Balearic Sea. SWOT is a NASA project that aims to accomplish the first global survey of Earth's surface water. The work that the Spanish RV participated in was called PRE-SWOT, during which the in-situ data collected by the vessel was compared with data from NASA airplanes.

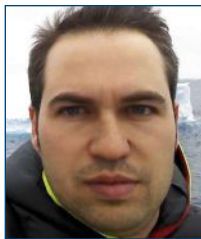
Satcom was used to provide internet access and telephone services to those involved in PRE-SWOT; to coordinate the operations with the UTM-CSIC headquarters; and to send the data in real time. This field work proved that the new vessel satcom system enables and manages communications at sea.

### Acknowledgments

This work was performed in support of the European Union, co-financed by the European Regional Development Fund.

The authors would like to thank UTM Director Jordi Sorribas and the captain of RV *García del Cid*, Alejandro Muro, for their help. **ST**

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*Raul Bardaji is involved in international projects related to developing and innovating autonomous observation platforms. He has specialized in DIY technology and data analysis tools. He holds a B.S. and M.S. in telecommunications engineering from La Salle, Ramon Llull University.*

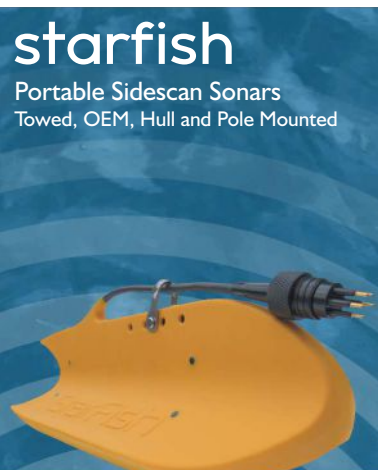


*Juan Luis Ruiz is a data manager at UTM-CSIC and is involved in international projects related to distributed marine data infrastructure. He holds a B.S. in electronics engineering from Barcelona University.*



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# Compact Underwater Slip Ring Swivel

## *Minimizing Effect of CTD Package Rotation on Data Quality*

By Dr. Hiroshi Uchida • Yosaku Maeda • Soichi Kawamata

**R**ecent hydrographic observations have revealed warming of bottom water around the world ocean, caused by warming of the Earth's climate system. These observations involve thousands of conductivity, temperature and depth (CTD) casts, in which research vessels lower a CTD instrument package from the sea surface to the ocean floor on a cable. Researchers must conduct as many CTD casts as possible within their limited ship-board time while ensuring safety and productivity. Measurements for climate studies also must be of the highest possible quality in the deep sea, where the signal-to-noise ratio is generally low.

A persistent problem affecting the quality of CTD data is rotation and related motions of the CTD package. In this article, we describe the use of a compact underwater slip ring swivel to ensure high efficiency, safety and quality for CTD data in the deep ocean.

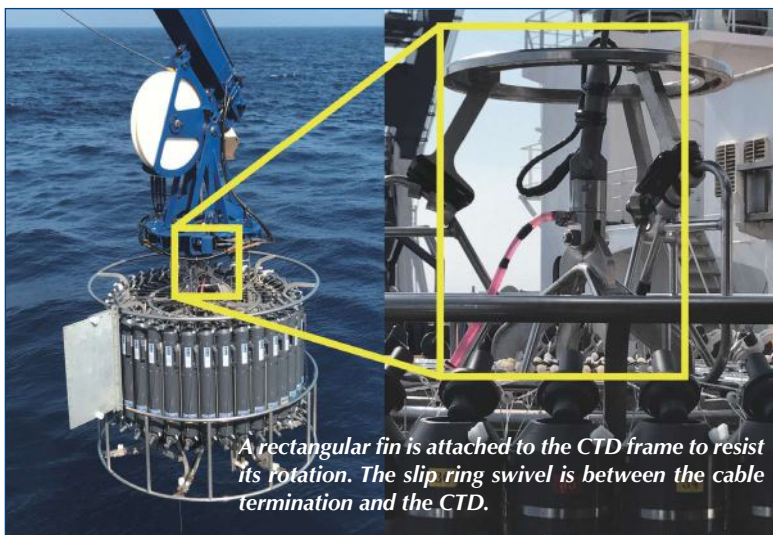
### **The Problem of Rotation**

Most cables are prone to some degree of rotation due to imperfectly balanced torque, thus a CTD package lowered on a cable will also be forced to rotate. But even a perfect cable risks being deformed when the rotation of an imperfectly balanced CTD package forces it to twist. CTD packages rotate as a result of several factors: the location of the center of buoyancy and center of gravity, the righting moment, the package's dynamic stability during free fall, and hydrodynamic resistance. Rotation and related motions (pitch and roll) of the CTD package are common in practice. Attaching a stabilizing fin to the package helps reduce rotation, but the risk remains of the cable developing hockles and other damage.

CTD observations can be compromised by kinking, bird-caging or crushing of cables, which may in turn cause insulation ruptures, broken conductors, poor winding and corrosion. During cruise 73 of RV *Knorr*,

for example, several instances of severe kinking, deformation and loss of signal in the armored cable occurred, even though the damage was limited to the 10 m at the end of the cable.

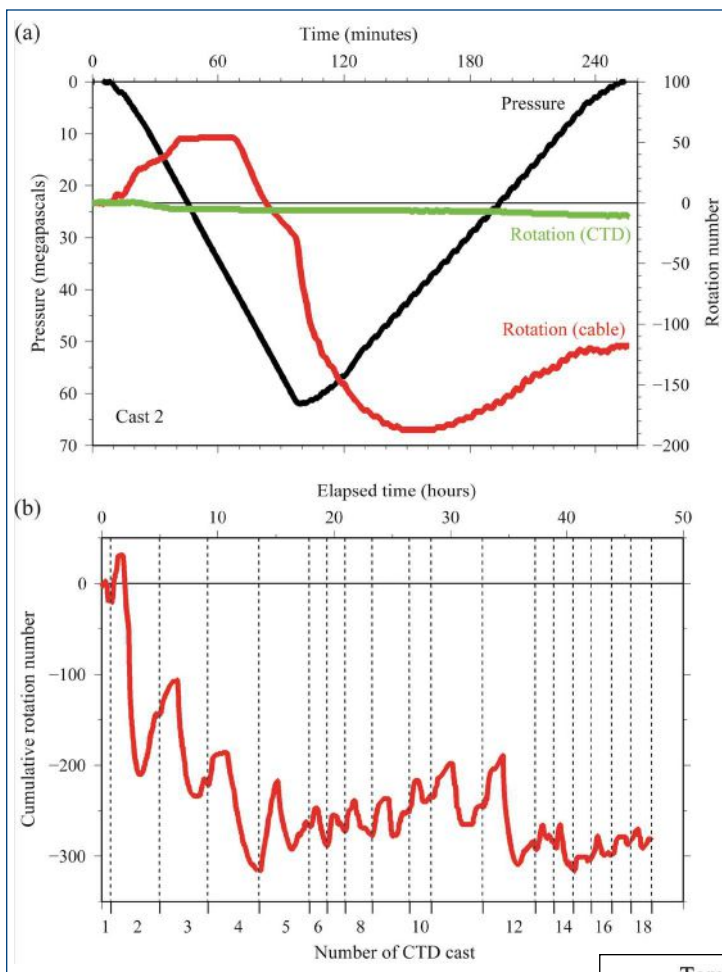
These mishaps are commonly treated during cruises by detaching the cable from the CTD package and untwisting it on the ship's deck to remove hockles and loops, or forestalled by attaching a weight to the cable and em-



ploying a swivel above the weight, which allows the cable to rotate freely and avoid hockles or kinks. However, for CTD measurements, the need to supply power to and transmit data from the CTD package through the cable rules out the use of a simple swivel.

### **Underwater Slip Ring Swivel**

A combination slip ring and swivel enables power supply and signal transmission for underwater CTD sensors while preventing problems arising from cable torque. One such apparatus, by Hanayuu Co. Ltd., has been in use since 2017 to support CTD observations during cruises of RV *Mirai*. Its compact size (21 cm long



(Top) Cumulative rotation numbers (counterclockwise) of the armored cable and the CTD package during cruise MR17-07C of RV *Mirai*. (Right) Typical temperature differences between two CTD thermometers and their relation to the rotation and motions of the CTD package.

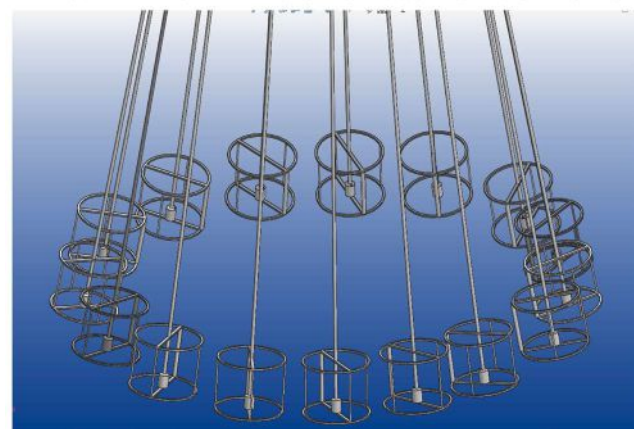
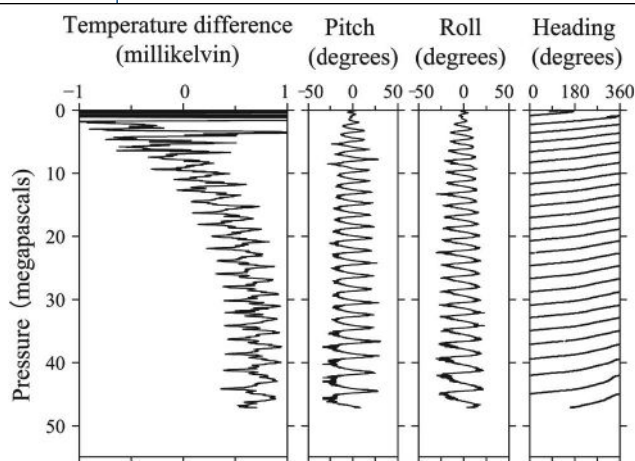
and 8 cm in diameter) and light weight (6 kg in air) are well suited to CTD deployments, and with its pressure rating of 120 megapascals and ultimate tensile load of 8 metric tons, it can be used in the deepest locations. Its body is made of stainless steel, and the slip ring inside it is immersed in oil. An electrical connector attached to the end of a 2-m-long resin tube filled with about 200 mL of oil is connected to the slip ring. At depth, the tube is compressed so that the oil pressure inside the slip ring matches the seawater pressure outside it. In a test cruise of RV *Kaimei* in 2017, a slip ring swivel performed well in CTD measurements at pressures up to 100.53 megapascals in ocean trenches.

Since 2017, a total of 443 CTD casts were conducted from RV *Mirai* without the slip ring swivel needing any maintenance. During an Arctic Ocean cruise, a small amount of seawater invaded the oil-filled tube but was trapped at the bottom of the U-shaped tube. This allowed the slip ring swivel to remain in use with-

out causing a short in the electrical circuit. During cruise MR17-07C of RV *Mirai* in October and November 2017, we investigated the effectiveness of the slip ring swivel by attaching a simple azimuth meter to the termination of an armored cable that was deployed and retrieved by a traction winch and motion-compensated crane. We attached an azimuth/inclination meter to the CTD package to monitor its rotation. The CTD package had a large stabilizing fin (90 cm long and 50 cm wide) attached to its frame to resist its rotation.

In a typical deep CTD cast, up to 61.9 megapascals (in which the cable was unreeled out to 6,040 m), the CTD package rotated six times clockwise during the down cast and four times clockwise during the up cast for a cumulative rotation of 10 times clockwise. On the same deployment, the armored cable rotated 54 times counterclockwise and then 94 times clockwise during the down cast, and rotated 147 more times clockwise and then 69 times counterclockwise during the up cast. During the 18 CTD casts in this cruise, the cable underwent as many as 281 clockwise rotations.

Each time the CTD package was on the deck of the ship and the armored cable was free of tension, the cable was completely free of hockles and loops. Despite the rotations of the cable during casts, there was minimal rotation of the CTD package thanks to the slip ring swivel, which



helped us to conduct safe and efficient CTD operations at 443 casts during seven cruises, free of any of the problems typically associated with armored cables.

#### Effects on Scientific Data

Rotation and related motions of the CTD package may cause errors in the data. Consider the SBE 9plus CTD system by Sea-Bird Scientific, widely used for high-quality hydro-

graphic measurements. This system measures seawater temperature and conductivity in a duct, using a pump to regulate the speed of the water and ensure that the two measurements are made on the same parcel of seawater. The regulated flow causes predictable viscous heating around the temperature probe, but, in our experience, motions of the CTD package may cause temperature fluctuations of about

0.6 millikelvin. Because salinity is calculated from temperature, conductivity and pressure data, such temperature fluctuations may have an effect in the deep ocean where the signal-to-noise ratio is low.

A recent innovation uses fast-response thermistors attached to the CTD package to estimate turbulence. Because variability in the fall rate of the CTD package influences that estimation, rotation and other motions of the CTD package should be minimized as much as possible.

Together, the underwater slip ring swivel, a stabilizing fin and a traction winch that compensates for the ship's motion create a combination that helps ensure high-quality CTD and related measurements in the deep ocean.

#### Acknowledgments

We thank Katsuhisa Maeno (JAMSTEC) for support in the use of the slip ring swivel and the azimuth/inclination meter during the RV *Mirai* and RV *Kaimei* cruises. We also thank Rei Ito (Marine Works Japan Ltd.) for collecting data with the simple azimuth meter in cruise MR17-07C of RV *Mirai*.

#### References

For a list of references, contact Hiroshi Uchida at [huchida@jamstec.go.jp](mailto:huchida@jamstec.go.jp). **ST**

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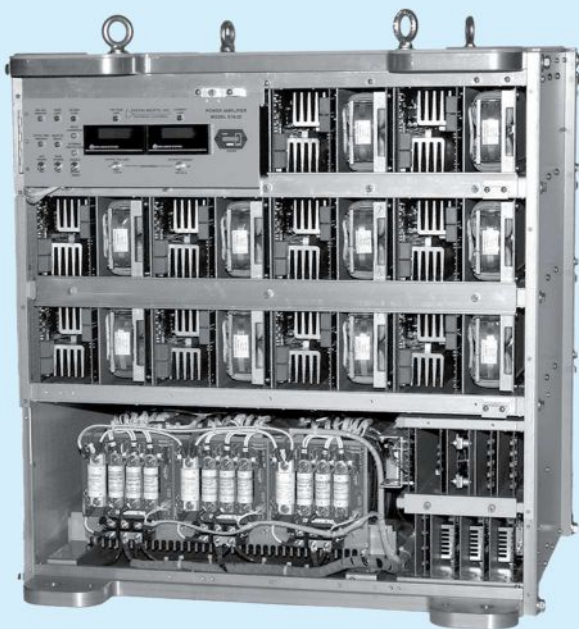
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## Bipartisan Bill to Address Ocean Acidification

U.S. House Oceans Caucus Co-Chair Suzanne Bonamici (D-Ore.) and Estuary Caucus Co-Chair Bill Posey (R-Fla.) have introduced the bipartisan Coastal and Ocean Acidification Stressors and Threats (COAST) Research Act. The legislation will: increase understanding of the socioeconomic effects of ocean acidification and coastal acidification; engage stakeholders, the commercial fishing industry, researchers and community leaders through the creation of an advisory board to inform federal response efforts; provide for the long-term stewardship and standardization of data on ocean acidification and coastal acidification using existing assets from the National Centers for Environmental Information and the Integrated Ocean Observing System; recognize the effects of ocean acidification and coastal acidification on estuaries, other waterways and oceans; and designate NOAA as the lead federal agency responsible for implementing the federal response to ocean acidification and coastal acidification.

## House Approves Legislation to Address Maritime Safety, Coast Guard Tech, Marine Debris

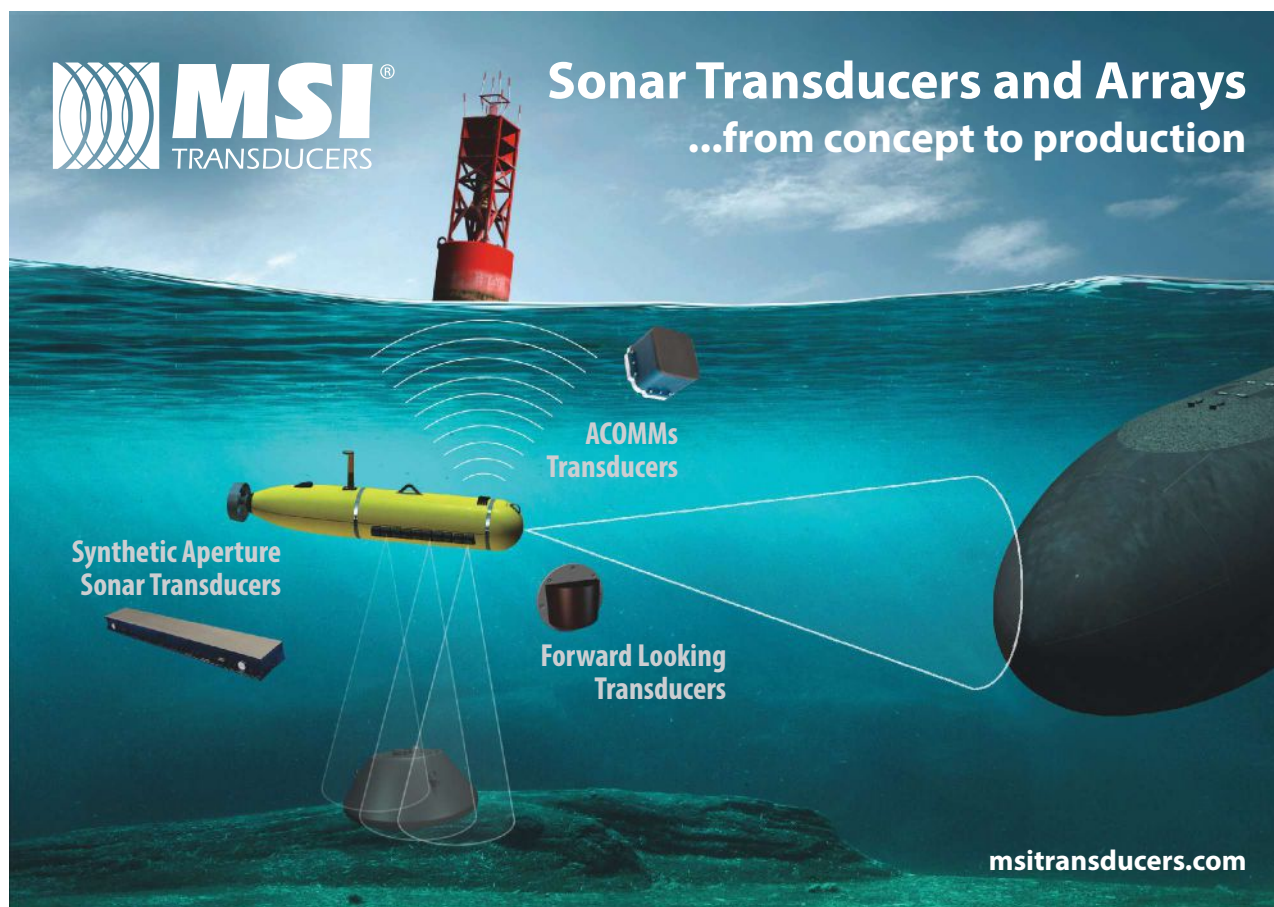
The U.S. House of Representatives approved legislation to address maritime transportation safety issues

raised by the *El Faro* sinking, promote the Coast Guard's awareness of technologies that could help improve mission performance, and reduce marine debris.

The Maritime Safety Act of 2018 would ensure timely weather forecasts, emergency safety gear with locator beacons, float-free voyage data recorders with integrated emergency position-indicating beacons, and other safety improvements. The Coast Guard Blue Technology Center of Expertise Act establishes a Blue Technology Center of Expertise to help promote awareness in the Coast Guard of the range and diversity of blue technologies and enable the sharing and dissemination of blue tech information between the private sector, academia, nonprofits and the Coast Guard. The Save Our Seas Act promotes continued national and international efforts to address the growing amount of marine debris.

## Olmsted Locks and Dam Replaces Outdated Infrastructure

The Olmsted Locks and Dam project is the largest civil works project in the history of the U.S. Army Corps of Engineers. The site opened in Olmsted, Illinois, this summer. Working with the Corps since 2010, Global Diving & Salvage has safely and successfully supported all dive-related services for in-water construction. The Olmsted Locks and Dam lies on the busiest stretch of river in the U.S. Each year, nearly 100 million tons of freight will pass through these locks. The Olmsted Locks and Dam replaces two outdated systems on the Ohio River. **ST**



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# international

## **IOSTIA Launches Healthcare Program**

The International Ocean Science & Technology Industry Association (IOSTIA) launched a program for its U.S.-based members to provide a viable, cost-effective and accessible healthcare program. Entitled the IOSTIA Healthcare Program, the new program couples two ACA-compliant preventative-care options with a medical cost-sharing program to cover significant and catastrophic medical events, as well as covering telemedicine.

## **SeaAhead Joins World Ocean Council**

SeaAhead has joined the World Ocean Council international multi-industry alliance on industry and investment action in support of ocean sustainable development. SeaAhead is a benefit corporation whose mission is to catalyze the intersection of sustainability, oceans and innovation. The team comes from a maritime, clean tech and tech sector background with corporate business development, VC fund, start-up and operational experience. The team is now also seeking to raise SeaAhead Ventures, a Bluetech Sustainability fund.

## **Cargotec Joins Start-up Accelerator Program**

Cargotec has joined the Trade & Transport Impact program, which connects start-ups with corporations for the purpose of addressing big challenges in maritime cargo transport and logistics. This is the first program of its kind in terms of its scale and global scope within maritime and logistics. The program is initiated by the London-based start-up partnership organization, Rainmaking Ltd. The program is scheduled to last three years, with its main venue housed in Hamburg, Germany.

## **FPSO Vessel Offshore Malaysia Receives Specialized Swivel**

MacArtney will supply a Moog Focal LVEOS swivel to a Norwegian turret and loading systems provider. The low-voltage electrical-optical swivel (LVEOS) is intended for inclusion in a swivel stack for an FPSO vessel. Installed at the top of a swivel stack, it allows functionality of a multichannel fiber-optic rotary joint. The swivel will be supplied to an FPSO operating in block SK10 of the Helang gas field located off the coast of Sarawak, Malaysia.

## **London-South Korean Connection Forged As Companies Work to Develop Offshore Wind**

AgileTek has formed a collaborative agreement with Blue Wind Engineering, and the companies plan expansion within the South Korean offshore wind industry.

Headquartered in South Korea, Blue Wind Engineering was established to contribute to the development of the wind power industry in the country, offering services ranging from the design of offshore wind farms to the design and certification support of wind power components, production and construction.

## **French Vessels to Include Dual-Fuel Systems**

Socarenam shipyard hired Barillec Marine to produce the LNG/diesel-electric propulsion system and the water-injection dredging system of a dredger ordered by Dragages Ports and Bordeaux Port Atlantique. It will be the first new dual-fuel construction in France (excluding LNG tankers). The contract involves the main panel for hybrid energy production, the main and auxiliary dual-fuel/electric propulsion and an innovative energy conversion system. The new dredger, *Ostréa*, will be primarily propelled by LNG and secondarily by diesel.

## **Survey Offshore Dominica Helps Update Nautical Charts and Planning**

The UK Hydrographic Office (UKHO) has deployed a motorboat to survey the waters off Dominica as part of the Commonwealth Marine Economies (CME) Programme. The survey focuses on areas including Roseau, Portsmouth and Soufriere Bay, and the data will be used to update navigation charts of the region, as well as helping Dominica to meet its international maritime obligations, including respective elements of the Implementation of IMO Instruments Code (IIIC).

## **Ballast Systems Integrations Analyzed Ahead of BWMS Convention Deadline**

ClassNK has analyzed the retrofit status of ballast water management systems (BWMS) on its registered ships and confirmed that installation deadlines based on the Ballast Water Management Convention for many of them are concentrated in the year 2022. As difficulties are expected in the installation of BWMS if everyone around the world waits until 2022, ClassNK recommends installing early. As of the end of August 2018, 1,915 ships have completed the installation, leaving 5,400 ships that still require attention.

## **New Norwegian Company Aims to Improve Marine Rig Services Offerings**

The newly formed Global Ocean Technology Group will supply vessels ranging from high-speed passenger ferries to fishing and search-and-rescue craft, while its rig service division will offer inspection, maintenance and commissioning to rigs from its base in Mandal and around the world. Its products division will provide leading-edge electro-engineering, naval design, and hydrogen, fuel cell, LNG and battery solutions.

## **Scottish-Japanese R&D Program Award**

Coda Octopus Products Ltd. has been selected as one of eight Scottish companies to develop subsea systems as part of the Scottish-Japanese Joint Ocean Innovation collaborative R&D program, with matched funding by The Nippon Foundation and Scottish Enterprise. It is expected that the funding over three years for the joint program will total approximately \$32 million.

## **New Subsea Testing Center Opens in Aberdeen**

Balmoral Offshore Engineering's subsea test facility opened in Aberdeen last month, a two-year, £20 mil-

lion investment project. Under construction since January 2016, the new building rises 18 m in height and has crane capacity of up to 40 t. The company had to blast through 15 m of granite substrata to accommodate the new underground pressure test vessels.

### Hydrogen Injection Project Secures Funding

Innovate UK granted £430,332 in funding to design and integrate a hydrogen diesel dual-fuel injection system on board a commercial ferry. The hydrogen to be used in the project will be produced by the European Marine Energy Centre (EMEC) from renewable energy sources, and it will power a ferry operating between the main town of Kirkwall and the island of Shapinsay. The 12-month HyDIME (Hydrogen Diesel Injection in a Marine Environment) project was launched in August.

### New Supply Vessel to Service UK Terminals

World Fuel Services (WFS) has welcomed a new supply vessel to its offering: a 75-m LOA, 3,100-dwt product tanker. *Whitstar*, owned by Whitaker Tankers, was built in 2004 and is fitted with deep-well pumps capable of delivering fuel in volumes of up to 450 m<sup>3</sup>/hr. The vessel has epoxy-coated cargo tanks, closed loading and has tank level radars fitted. Its hull is strengthened to enable access to NAABSA berths.

### New Report Details Maritime Cabotage

Seafarers' Rights International (SRI) published a report that explores the nature and extent of cabotage laws around the world and identified 91 member states of the United Nations that have cabotage laws restricting foreign activity in their domestic coastal trades.

The report describes the history of maritime cabotage and traces early rudimentary legal principles. It sets out examples of different definitions of cabotage that exist today at the national, regional and international levels.

### Korean Grant Supports Development of Autonomous Ship Control Center

eMARINE Global Inc. received a grant from the Korea Institute for Advancement of Technology (KIAT) to develop Smart Station, a smart ship control center designed to be the brain of autonomous unmanned ships. The \$760,000 KIAT grant covers a one-year program in which eMARINE Global will lead a team, including the Korea Marine Equipment Research Institute (KOMERI), Orion Co. Ltd, Samwoo Imersion Co. Ltd and Hyundai Mipo Dock Yard, in developing the Smart Station.

### CO<sub>2</sub> Challenge Aims To Reduce Emissions

FUELSAVE, the manufacturer of the fuel-saving additive FS Marine+, applied to the CO<sub>2</sub> Challenge, which aims to partner with technology companies that have systems capable of reducing a vessel's CO<sub>2</sub> emissions in line with international climate strategies and targets. Technical applications include submissions for wind propulsion technologies, engine optimization systems, digital solutions and hull optimization concepts. **ST**



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**Vehicle Batteries**

**Battery Systems**

## **Multi-Vehicle System Combines Technologies for Mine Countermeasures**

Teledyne Marine and its industry partners showcased an autonomous, system-of-systems approach to expeditionary mine-countermeasures (MCM) using multi-domain unmanned assets. The demonstration took place at the Naval Undersea Warfare Center (NUWC) Division Newport during the 2018 Advanced Naval Technology Exercise (ANTX). It involved at least eight different types of software, vehicles and technologies in the pipeline, from powering the vehicles to neutralizing a target.

## **Companies Pledge to Support Women in Maritime Jobs**

KVH pledged its support for Women in Maritime, an initiative of Maritime UK that aims to promote fairness, equality and inclusion within the maritime sector, bringing together leaders from across the industry to identify practical steps to increase the number of women in maritime and, crucially, within senior roles across shipping, ports, marine and business services industries.

## **Local History Mapping Application Helps Students Learn Ocean Mapping in Real Time**

The Center for Coastal and Ocean Mapping (CCOM) at the Joint Hydrographic Center at the University of New Hampshire has added FarSounder as a partner in their industrial associates program. FarSounder technology provides students the benefit of identifying obstacles ahead of the ship with local history mapping (LHM). This application draws a virtual 3D image of the ocean floor as a ship sails over. This bathymetric image is updated with every ping and displayed as an overlay on top of a chart.

## **New Company Forms to Sell Seaview Products**

Long-time Seaview managers Jason Romesburg, Ian Smith and Jason Abrahamsen have formed a new company to manufacture and distribute Seaview products. They say dealers and end-users can expect the same quality products and customer service that they received at PYI, since the new owners have been with Seaview for 16 years. The team has a combined 50-plus years in the marine industry and plans to expand the Seaview line and increase production in a new, larger facility in eastern Washington.

## **Explorer AUV for Chinese Mineral R&D**

International Submarine Engineering (ISE) sold its latest ISE Explorer AUV to China Ocean Mineral Resource R&D Association (COMRA). The ISE Explorer AUV is rated for operations at 6,000-m depth. Its modular design enables it to carry multiple payloads including multi-beam echosounders, side scan sonars, sub-bottom profilers, synthetic aperture sonars, high-definition cameras and laser systems, CTDs and chemical sensors, or any combination of AUV payloads.

## **Toronto Group Acquires Ops Software Company**

Helm Operations was acquired by Toronto-based Volaris Group. Founded in 1999, Helm Operations is a developer of marine operations software for the workboat market. Following an acquisition by ClassNK in 2014, the company released its newest platform, Helm CONNECT, in 2016. Today, Helm CONNECT is a fast-growing software platform in the marine industry, used by 150 companies and 3,000 vessels worldwide.

## **Phoenix is Certified to Perform Underwater Welding**

Phoenix International Holdings received American Bureau of Shipping (ABS) approval of a Class A wet underwater fillet welding procedure specification for ASTM A 131 and Group II steels of the American Welding Society D1.1 structural welding code. With this approval, Phoenix can now perform permanent underwater weld repairs to classed vessels and structures.

## **Former Microsoft Software Architects Join Olis**

Olis Robotics, formerly BluHaptics, acquired White Marsh Forests (WMF), a machine learning start-up based in Seattle. WMF was launched by former Microsoft software architect Steve White, along with Don Marsh, who was a principal software architect at Microsoft. Olis created a software platform that allows pilot-controlled service robots to recognize objects such as valves, tools and dangerous objects in the field. The Olis operating system (OlisOS) also allows for new levels of precision control, progressive levels of autonomy and advanced situational awareness for remotely operated robots.

## **Briggs Acquires Three Canadian Companies**

The Briggs Group acquired three marine companies in Canada: Foreshore Technologies, Balanced Environmental and Ocean Tech. Foreshore Technologies Inc. is an underwater survey and inspection company that specializes in diving, environmental survey, structural survey and marine operations. Balanced Environmental Services is an expert in permitting, licensing, consultation, applications, planning and project delivery. Ocean Tech Constructors is a harbor support company that specializes in the design, manufacture, installation and maintenance of floats, gangways, pontoons and breakwaters.

## **Montrose Port to Host Simulated Emergency Training**

Ethos Empowerment invested six figures in a new facility at Montrose Port to deliver interactive emergency response training sessions. The company also launched its latest oil and gas process simulator, which is used for both emergency response and control room operator coaching.

The simulator is designed to play a fundamental role in offshore emergency response training and increasing safety for personnel involved in demanding offshore operations. The technology positions individuals on a virtual offshore platform to interact with realistic emergency situations.

### Panamá Maritime Authority Installs Beacons

Panamá Maritime Authority installed three new sector lights and towers to improve the navigation safety of ships coming into the Bays of Manzanillo and Las Minas on Panama's Atlantic coast. The beacons consist of sector lights on 15- to 40-m towers. The tender issued by Panamá Maritime Authority was awarded to Delta 9, a local contractor, and Spanish company Almarin was subcontracted for the design and supply of AtoN, specifically the lights, towers and solar energy supply systems.

### Ships Plan to Run on Hydrogen Extracted from Seawater

Joi Scientific signed a license agreement for its Hydrogen 2.0 production technology with boat retailer MarineMax. The license agreement grants MarineMax the exclusive rights to develop, manufacture and sell propulsion and auxiliary boat power systems capable of running on hydrogen extracted from seawater using Joi Scientific's Hydrogen 2.0 technology. Hydrogen 2.0 is a hydrogen production process based on the extraction of hydrogen directly from untreated seawater on demand at the point of use.

### Seabin to Collect Trash from Chesapeake

The first Seabin will be installed on the U.S. East Coast at Nauticus, a maritime science center in Norfolk, Virginia. The Seabin was donated by Wärtsilä Defense Inc. It will be maintained by Nauticus's Junior Scientists' Club, a STEM after-school program for students from local junior high schools. The Seabin will clean as much as 1 t of litter from the river each year.

### Falmouth Scientific to Integrate Seismic Technology into ExxonMobil Design

Falmouth Scientific (FSI) received a patent immunity from ExxonMobil for its cable head marine seismic source (CHS) patent and will incorporate its seismic source with HawkEye Clear Signature technology into ExxonMobil's CHS concept for near-zero offset data acquisition in 3D marine seismic surveys.

### New Company Offers ASV Technology And Autonomous Control Systems

L3 Technologies acquired ASV Global, a USV and autonomous vessel control systems company. The new company will be known as L3 ASV. Based in Louisiana and the U.K., L3 ASV will deliver surface vessels in a range of sizes, currently from 10 to 42 ft., with proprietary software and control systems and unmanned system autonomy architectures.

### New Facility Offers Expanded Subsea Services

C-Innovation opened a dock facility in Port Fourchon, Louisiana, to expand its subsea services group. With more than 550 ft. of open quayside, the facility is supplied with a Manitowoc 777 crane and forklifts for rapid mobilization of subsea construction and inspection, maintenance and repair vessels, including the 525-ft.-long *Island Venture* offshore construction vessel. **ST**

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## Portable Vibration Calibrator

Model 699A07, a compact, battery-

powered vibration reference source, can be used to calibrate sensors, as well as to validate the entire measurement channel of a machinery protection system. It calculates and displays test sensor sensitivity in real time. IMI Sensors.

## Towed Profiling System

The Hammerhead accommodates third-party instruments, including side scan sonar, SV units, CTDs and multiparameter sensors. It allows data collection from a single depth or performs an undulating profile between two set depths. Data can be read in real-time output on the touchscreen topside control box or into an independent software. Ocean Scientific International Ltd.

## Autonomous Vessel Technologies

SM300 integrates with vessel systems to manage missions through

pilot-by-wire propulsion and steering control, condition monitoring of hull and machinery and remote payload control. The SM200 provides remote vessel control. Sea Machines Robotics Inc.

## Biocide-Free Anti-Fouling Coating



The biocide-free, low-friction self-polishing copolymer (SPC) anti-fouling technology, Aquaterras, uses neither biocide materials nor silicone. Its anti-fouling mechanism is based around anti-thrombogenic polymers used in the medical sector. It exposes active micro-domain structures to seawater for long-term performance. Nippon Paint Marine.

## Compatible Cylinder Lubricants

Taro Ultra lubricants are compatible with almost all engines, marine bunker fuels and abatement technologies and are compatible with low-sulphur fuel, distillates and many alternative fuels. They work in applications using high-sulphur bunker fuels that require scrubber emission abatement technology. Chevron Marine Lubricants.

## Data Handling on the Cloud

Mapping Cloud provides storage of data within the cloud for uploading and distributing real-time data. It enables existing PC applications to run in a virtual machine environment and allows users to manage data processing, archiving and sharing through web browsers. Kongsberg Maritime AS.

## Extended-Range DVL Tracking

A proprietary extended-range tracking (XRT) option is capable of extending the bottom tracking range of its Pathfinder and Pioneer Doppler velocity logs (DVL) by 60%. It is included with new DVLs or as a firmware upgrade. Teledyne RD Instruments.

## Pop-Up Buoy Recovery System

The pop-up buoy recovery system (PUB) for the EdgeTech PORT LF SD

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acoustic release allows retrieval of seabed packages such as anchors, anchor lines and bottom-mounted frames and instruments. It is made from solid syntactic foam with a polyurethane elastomer coating. Deep Water Buoyancy Inc.

### Qimera Software Update

Qimera version 1.7.2 now available for download rectifies a bug that affects the unloading of edits to certain processed points file formats. The bug affects files that require file offset values to unload, most notably FAU and LAS, and causes the first 500 footprints not to be unloaded. QPS BV.

### Holographic Lighthouse

The Hololightkeeper is a concept for a modern lighthouse that uses holographic technology to project an 82-ft. lighthouse in the sea. The concept includes living space inside the lighthouse and a projection lens on the side of the building. Studio NAB.

### Two-Way Satellite Messenger

The SPOT X messaging device combines emergency notification technology with text messaging functionality, regardless of cellular network availability, using satellite messaging. It has 10 days' battery life, connection to the GEOS International Emergency Response Coordination Center and programmable waypoints. Globalstar.

### Mooring Analysis Tool

SHIPMOOR is an internet-based application that facilitates mooring analysis, matching data on LNG vessels and terminals to support ship-to-shore compatibility assessments. HR Wallingford.

### Replacement Pumps & Impellers



Replacement engine cooling pumps and flexible impellers are available for 41 of the Northern Lights 4.5- to 32-kW generator sets. Direct replacements for OEM pump models 25-11202, 25-12007, 25-12057 and 25-15405 are available. JMP Marine LLC.

### Next-Gen Survey System

The SuperSting Marine Resistivity System has applications in dredging, time-lapse studies, dam/levee diagnostics, subsurface pollution location and marine construction and includes resistivity, track correction and route optimization tools. Advanced Geosciences Inc.

### Motion-Compensated Gangway

The Safeway Albatross for shipping lines and operators has a lift integrated in the mast of the installation

that can be extended to the below-deck storage hold of a platform supply vessel. Its 30-m boom can be rotated 360°. Safeway BV.

### Marine Navigation App

The TZ iBoat iOS app offers coastal satellite imaging to fuse charts with the coastline. It displays the position on vector or raster charts, while displaying incoming boats via radar and AIS. TIMEZERO.

### Improved Dual-Antenna RTK INS

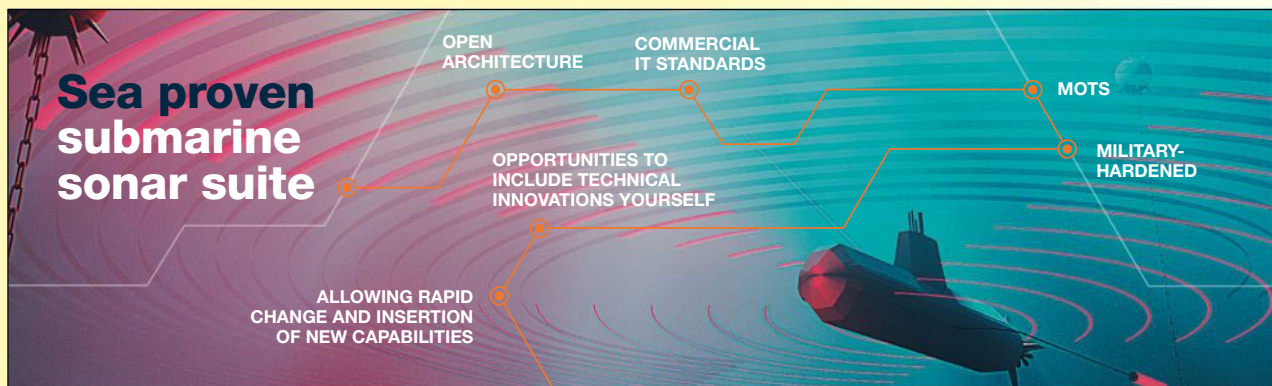
The Ellipse2-D inertial navigation system has an integrated RTK GNSS receiver. It provides roll, pitch, heading, heave, velocity and position in real time. The new version has lower power, full constellations and raw data for post-processing. SBG Systems SAS.

### Ultrasonic Flow Meter

The Portasonic 2.FLO uses two transducers as ultrasonic transmitters and receivers and offers three modes of operation for transducer positioning. It has digital set up, +/- 1% accuracy and no moving parts. Coltraco Ultrasonics.

### Inertial Measurement Unit

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# offshore oil & ocean engineering

## Jack-Up for German North Sea Wind Farm

Attollo Offshore has mobilized a jack-up accommodation unit to Ørsted's Borkum Riffgrund 2 offshore wind farm.

Borkum Riffgrund 2 comprises the largest wind turbines in the German North Sea and is expected to produce electricity to power nearly half a million homes per annum.

Attollo will provide accommodation and construction support for the hookup and commissioning of the 450-MW substation.

## GOM Jack-Up Market Doing Well

At first glance, it would be difficult to view a region with just 27 jack-ups and only 12 of those contracted as warranting special attention. However, a deeper dive into the numbers shows that the U.S. Gulf of Mexico (GOM) jack-up market has quietly become one of

the best in the world, according to Westwood. Utilization of the 12-rig marketed fleet is 100 percent and contract backlog is increasing. Day rates have risen, and evidence suggests that further increases for some segments of the fleet are not far off.

However, this market is nowhere near what it once was. Supply reached 157 in March 2001, while the peak number of working rigs hit 144 a month later. But by the end of 2001, the number of contracted units was under 100 and demand was well on its way to the historic low levels it ultimately reached. Supply was initially slower to react, but continued mobilization out of the region and retirements ultimately brought that number down, too.

The end-result has been an 83 percent supply decrease and a 92 percent fall in demand between June 2000 and August 2018.

However, also notable is the sharp upward spike in the utiliza-

tion line in 2018. Since January, fleet supply decreased by 10 while demand rose by four, resulting in utilization more than doubling from 21 to 44 percent in August.

## Kongsberg Power, Control Solution for Awilco Drilling Rig

Kongsberg Maritime has been selected by Keppel Offshore & Marine to provide an extensive and integrated technology delivery for a new semi-submersible drilling rig ordered by U.K.-based drilling contractor Awilco Drilling PLC.

Awilco Drilling's new rig will be equipped and certified for drilling on the Norwegian Continental Shelf, including the Barents Sea, in water depths up to 5,000 ft. The improved drilling efficiency and reliability will result in lower OPEX with per day cost savings compared to existing semi-submersible rigs. This is aided by a complete Kongsberg electro package, including a hybrid power system with advanced battery technology, MV switchboards, thruster and drilling drives



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and energy management systems, contributing significantly to reducing fuel oil consumption and minimizing CO<sub>2</sub> and NOx emissions.

### Digital Compliance Framework for Industry

LR has developed the first ever data-driven compliance framework for the marine and offshore industry: "Digital Compliance." The increasing use and advancement of digital twins presents a significant opportunity to marine and offshore operators to improve operational performance and maintenance regimes, as well as allowing for greater transparency and repeatability in demonstrating compliance with internal and external requirements.

LR has developed this framework in collaboration with leading industry partners and to respond to growing industry interest. The framework is applied through a series of defined levels with the system provider and the operator. This builds confidence in a digital twin that is used within a digital health management (DHM) system. LR will assess and give recognition to the capabilities of a system provider to create an asset-specific twin.

LR will build the confidence level in the DHM system from the commissioning stage to awarding of the descriptive note "Digital Twin LIVE," which will grant credit for survey activity through demonstrated functioning of the twin over time.

### Fugro E&P Contracts In Trinidad and Tobago

Fugro has won three contracts with BHP Petroleum (Deepwater) Inc. to deliver specialist services to support exploration and production (E&P) operations in Trinidad and Tobago and the Gulf of Mexico.

Within Trinidad's Block 3(a), Fugro is providing geophysical and geotechnical services from dedicated vessels to support the development of the Ruby field.

Fugro will conduct 3DHR seismic surveys, seabed clearance and shallow hazards surveys, a flowline corridor survey and a shallow geotechnical survey.

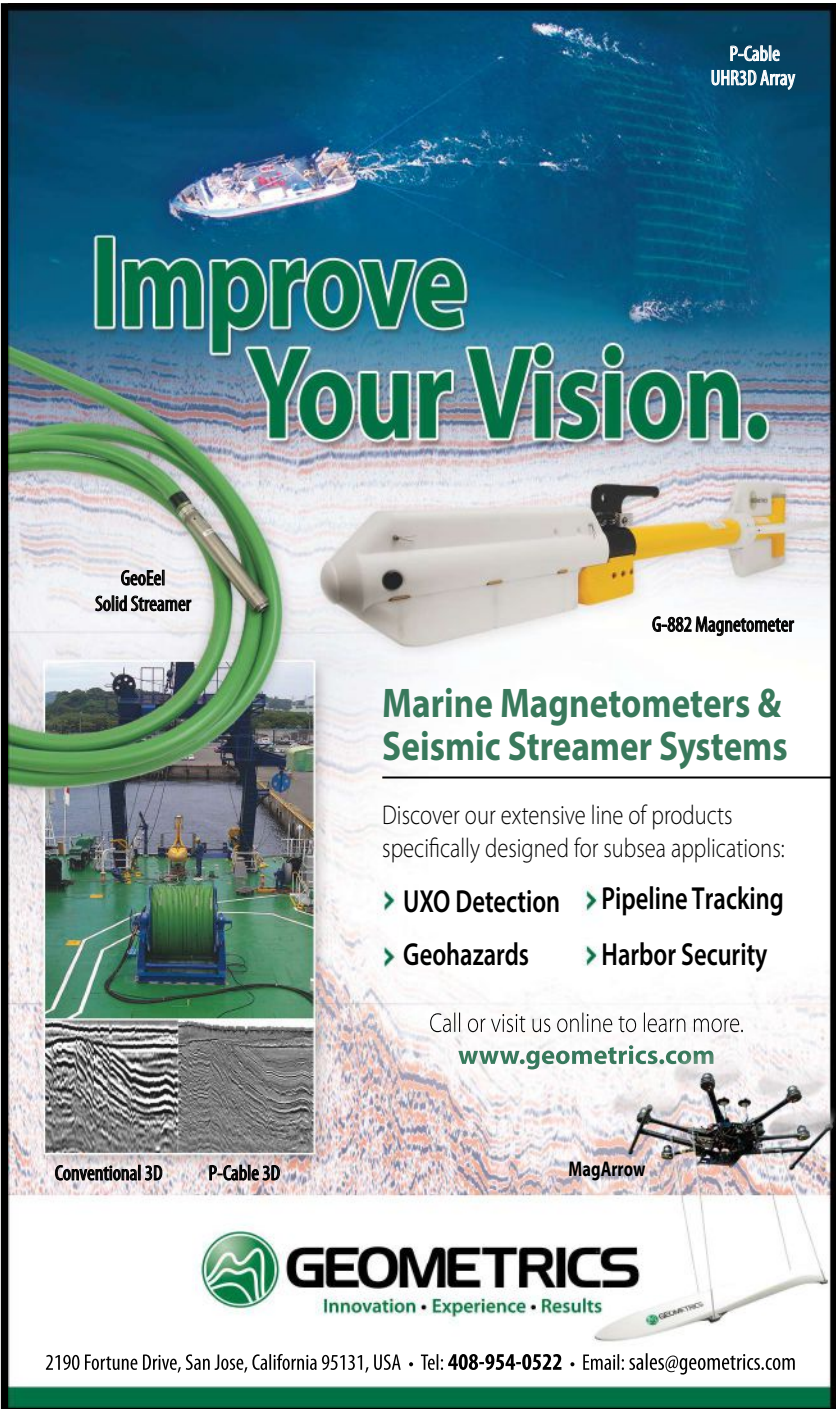
### Tiger Acquisition In Middle East

Tiger Offshore Rentals has acquired Rigzone Mechanical Equipment LLC, including its manufacturing facility and fleet of DNV-certified offshore cargo carrying units in the United Arab Emirates.

The acquisition expands Tiger's position as a provider of offshore rental equipment in the Middle East region.

### England Offshore Services Base

DeepOcean has opened a new offshore services base at Blyth in England, which will be of strategic importance to DeepOcean's increasing presence in global cable lay and trenching markets. This facility supports the planning, preparation, mobilization and maintenance of DeepOcean's subsea trenching assets and vessel fleet. It has year-round access for large vessels. **ST**



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## Ocean Infinity Signs Agreement with US Naval Meteorology and Oceanography Command

Ocean Infinity has signed a cooperative research and development agreement with the U.S. Naval Meteorology and Oceanography Command (NMOC), based at the Space Center in Stennis, Mississippi. During the next five years, the collaboration will focus on combining and expanding technologies relating to a broad range of deep-water platforms and sensors focused on undersea data gathering and analysis.

## Damen Marine Components to Supply Chilean Navy Polar Vessel

Damen Marine Components has won a contract to supply steering gear, rudders and stern tube parts for an Antarctic research vessel of the Chilean Navy, under LRS-Polar 5 class notation. The contract was awarded by AS-MAR Talcahuano Shipyard, Chile.

Design of the vessel was done in collaboration with VARD Canada.

Damen Marine Components will supply twin COM-MANDER Ram-Type electrohydraulic steering gear units, twin ATLANTIC semi-spade rudders and twin stern tube casting parts. The equipment will be delivered in 2020. The vessel is scheduled to set sail on its maiden voyage to the Antarctic Polar Circle in 2023.



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## Students Demonstrate Skills In Autonomous Subs and Presentation

The International RoboSub Competition took place in San Diego at the Space and Naval Warfare Systems Center Pacific Transducer Evaluation Center. The week-long autonomous submarine competition is co-sponsored by the U.S. Office of Naval Research (ONR) and the Association of Unmanned Vehicles International Foundation. All submarines must demonstrate autonomous capability by completing a series of visual- and acoustic-based tasks that simulate duties required of underwater vehicles.

To meet this year's mission requirements, the submarines—without human or computer interaction—had to complete “casino-themed” tasks including: touching dice buoys; dropping chips into a roulette bin; pulling a slots lever to fire mock torpedoes through small cutout holes; and cashing in by grabbing a chip, then surfacing the vehicle and dropping the chip into a cashier's register. Teams also had to create a website, write a paper that outlined their work and give a presentation.

Harbin Engineering University (China) took this year's top prize, while National University of Singapore and École de Technologie Supérieure (Canada) placed second and third, respectively.

## DVL for US Navy Micro-UUV

Teledyne RD Instruments' (TRDI) new ultracompact 600-kHz Pathfinder DVL has been selected by Riptide to provide precision navigation capability for its micro-UUV for the U.S. Navy. The DVL, coupled with an iXblue INS, will deliver a 200 percent increase in navigation performance with minimal impact on vehicle endurance.

## eMARINE to Continue Servicing Korean Navy

eMARINE Global Inc. announced the extension and expansion of its maintenance contract with the Republic of Korea (ROK) Navy for work through 2019. eMARINE Global has been servicing the ROK Navy continuously for nine years, providing routine, preventive and emergency maintenance, as well as chart updates for the electronic charts display and information systems (ECDIS) onboard Korean naval vessels. The latest contract extends this relationship and expands it to more than 213 vessels.

## Combat Diver Navigation System For Poor-Visibility Environment

JFD, part of James Fisher and Sons plc, has partnered with the U.S. Navy's Naval Surface Warfare Centre – Panama City Division (NSWC PCD) to develop an advanced combat diver navigation module, Shadow NAV, bringing a hands-free underwater navigation capability to the military market for the first time.

Military combat divers frequently conduct underwater navigation missions in hazardous conditions with extremely poor visibility. Accurate underwater navigation is critical, as well as staying within closed-circuit oxygen rebreather depth limits to prevent oxygen toxicity.

The Shadow NAV ensures combat divers have continuous visibility of accurate information with a mask-mounted head-up display. **ST**

## More Falcons for Salmon Farming

Huon Aquaculture has doubled its fleet of Saab Seaeye Falcons to four vehicles. The two new Falcons will join the fleet to inspect nets, rigging and moorings at Huon's aquaculture pens. The pens are positioned in areas of strong current and rough water favored for salmon farming because it mimics the salmon's natural habitat.

Huon produces more than 24,000 tonnes of farmed salmon a year.

## Collaboration to Provide Satellite Service

Singtel and KVH Industries Inc. have partnered to provide shipping companies a seamless broadband satellite service with KVH's miniVSAT broadband satellite connectivity across Asia-Pacific.

This satellite service will facilitate the use of digital solutions to improve operational efficiency, crew welfare and onboard safety. Vessels can harness real-time data on engine performance gleaned from onboard sensors to facilitate preventive maintenance and reduce maintenance costs; obtain information on weather patterns and sea currents to determine the ship's most fuel-efficient route; and provide onshore operations staff regular updates on cargo status.

Singtel will provide its maritime customers with KVH's product and service offerings, including AgilePlans, a subscription-based connectivity solution for commercial fleets.

## New Digital Ship Notation for Efficient Use of Digital Tech

RINA has launched the Digital Ship Notation, the first additional class notation available for shipowners willing to demonstrate the added value of their ship or fleet through the efficient use of digital technology. GNV is the first company to receive the new notation, certifying 11 ships of its fleet, all equipped with a data collection system.

RINA invested in the development of its own RINACube platform, launched in December 2017. It is cloud-based and can gather and integrate data and digital assets from various sources, interacting seamlessly with most common technologies on board.

## Students Developing AUV To Target Invasive Lionfish

Undergraduate students at Worcester Polytechnic Institute (WPI) are building an autonomous underwater robot that could help reduce the threat posed by an invasive species of fish that, unchecked by natural predators, threatens the well-being of coral reefs and other marine ecosystems in the coastal U.S., including commercially and recreationally important native fish.

In a multiyear effort launched last fall, WPI student teams are developing an untethered robot designed to autonomously hunt and harvest lionfish. The project's goal is to reduce the invasive species' impact on marine ecosystems from the Caribbean up to the coasts of Florida and Georgia. Since the fish is a pricey delicacy, the robot also could provide a new source of income for local fishermen.

## Autonomous Navigation Without GNSS

Sonardyne International Ltd. and Guidance Marine Ltd. are working together on a project that will help unmanned autonomous vessels navigate, even when they lose access to global navigation satellite systems (GNSS). The project will combine Sonardyne's underwater positioning systems and Guidance Marine's relative surface positioning systems to enable vessels to maintain safe passage in GNSS-denied environments, or for dynamic positioning systems to maintain their position if they lose GNSS access or other sensors fail.

The Innovate UK-backed AutoMINDER (Autonomous Marine Navigation in Denied Environments) project will also create a

common interface structure to allow the different sensors to be fed into one platform and develop an industry standard.

## Digitalization Research To Aid Oil, Gas Industry

The Oil & Gas Innovation Centre (OGIC) is supporting three new research projects centered on how digitalization can improve efficiency and cost savings for the oil and gas industry. Three companies have teamed up with Robert Gordon University's (RGU) School of Computing Science and Digital Media to carry out research into the digital transformation of the oilfield.

DNV GL is developing an interactive program extracting and processing information from images of piping and instrumentation diagrams and other types of engineering drawings. This will speed up the collection of data for use in technical applications. ComplyAnts is developing an automated system to manage the compliance process, aiming to deliver a fully functional prototype within 12 months. IDS is developing a data-driven tool to predict task durations, associated risk and NPT.

## Space Project to Refine Ocean Color Measurements

Led by the European Space Agency with support from the Committee on Earth Observation Satellites, the FRM4SOC (Fiducial Reference Measurements for Satellite Ocean Colour) project aims to catalog the quality and uncertainty of various commercial radiometers to increase confidence in satellite measurements of ocean color.

Sea-Bird Scientific participated with 13 organizations from eight countries. For stage one, Sea-Bird sent OCR-200s to several calibration labs for comparison data. Stage two involved sending HyperOCRs and members of Sea-Bird's science team to the Estonian Space Research Centre for field measurements and analysis of sensor uncertainty. Among the participating scientists, researchers from Sea-Bird Scientific were the sole ones from an instrument manufacturer. **ST**



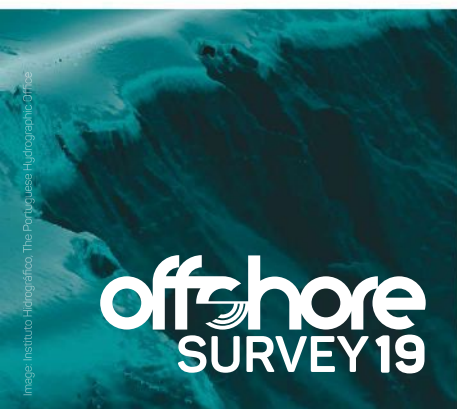
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# environmental monitoring

## Bacteria Levels Rise After Hurricane Flooding

Hurricane Harvey brought more than 50 in. of rain and extreme flooding to the city of Houston in 2017. Floodwaters harbor bacteria that can cause disease. Now, researchers have surveyed the microbes in Houston floodwaters. They reported their results in *Environmental Science & Technology Letters*.

The researchers found that *E. coli* levels in two of Houston's major bayous were significantly elevated in the immediate aftermath of Harvey but gradually decreased over two months after the storm to pre-storm levels. Similarly, antibiotic-resistance gene levels were highest three days after the storm.

The highest levels of fecal bacteria, human pathogens and antibiotic-resistance genes occurred in homes with stagnant floodwater inside.

The study indicates that residents and relief workers should exercise caution to prevent coming into contact with harmful microbes in the aftermath of extreme floods, especially in stagnant indoor waters.

## Belgium Gets Systems To Assess Algae Levels

The Flanders Environment Agency (VMM) has taken delivery of CTG ALGAE-Wader Pro systems to assist in assessing algae levels of the water environments in Belgium.

The systems supplied to VMM are configured for measurements of Chl-a, phycocyanin and phycoerythrin and come with a handheld unit that provides graphical and digital real-time data to the operator, with red, amber, green thresholding, and logs the data for post-mission extraction.

The three channels provided by the CTG TriLux fluorometer within the system will also help inform on the group type of the algae present.

## APT Recorders for THEMO

A new Mediterranean observatory is using Soundnine's inductive

telemetry and temperature/pressure recorders. THEMO (Texas A&M - University of Haifa Eastern Mediterranean Observatory) comprises a shallow mooring (125 m) on the continental shelf near the edge of the Levant Basin, 25 km from Haifa, and a deep mooring (1,500 m) located 50 km from Haifa.

Soundnine's Enduro APT recorders (acceleration, pressure, temperature) with inductive telemetry are clamped to the jacketed wire rope mooring line at 11 depths between 5 and 85 m. They communicate through the wire rope with a Soundnine Ulti-modem connected to the buoy controller.

The two moorings have real-time RF communication with a shore station linked to the University of Haifa.

## AZFP to Examine Onset of Hypoxia Using Cyanobacteria

Urban freshwater environments are often exposed to nutrient loading via groundwater movement and fertilizer runoff that can cause algal blooms and widespread fluctuations in oxygen levels.

Through an ongoing monitoring program, Rob Bowen of Diversified Scientific Solutions has been conducting surveys of dissolved oxygen, pH, oxidation-reduction potential, temperature, nitrogen and phosphorous at Swan Lake, in Victoria, BC, Canada.

An ASL Environmental Sciences' acoustic zooplankton fish profiler (AZFP) was deployed late summer to collect data.

Because *Aphanizomenon flos-aquae* are relatively large acoustic targets, it is hopeful that this new application of the AZFP will provide valuable insights into the dynamics of this freshwater system.

## Coastal Erosion in Arctic Intensifies Global Warming

The loss of Arctic permafrost deposits by coastal erosion could amplify climate warming via the greenhouse effect. A study using sediment samples from the Sea of Okhotsk in

eastern Russia revealed the loss of Arctic permafrost at the end of the last glacial period led to repeated sudden increases in atmospheric carbon dioxide concentration.

Researchers from the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI) together with colleagues from Copenhagen and Zurich have found evidence of this phenomenon for the Arctic permafrost regions showing that several thousand years ago large quantities of carbon dioxide were released from Arctic permafrost due to a rapid rise of sea level.

Today, the Arctic's permafrost coast is eroding severely because the region is warming rapidly. In some places, the coast is receding at a rate of 20 m per year.

Coastal erosion is a key process that must be included in climate models.

## Climate Patterns Affect Greenland Ice Sheet Melt

Scientists know that warming global climate is melting the Greenland Ice Sheet, the second largest ice sheet in the world. A new study from Woods Hole Oceanographic Institution shows the melting rate might temporarily increase or decrease via two climate patterns: the North Atlantic Oscillation (NAO) and the Atlantic Multidecadal Oscillation (AMO).

The study found that when the NAO stays in its negative phase (meaning air pressure is high over Greenland) it can trigger extreme ice melt in Greenland during the summer season.

Likewise, the AMO, which alters sea surface temperatures in the North Atlantic, can cause major melting events when it is in its warm phase, raising the temperature of the region as a whole.

If global climate change continues at its current rate, the Greenland Ice Sheet may melt entirely. Depending on how the AMO and NAO interact, excess melting could happen two decades earlier than expected or two decades later this century. This melting will affect climate predictions and resource management. **ST**

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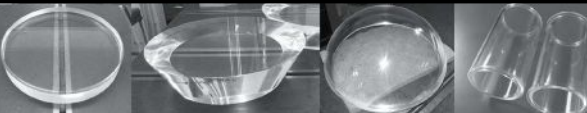
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# contracts

**SubC, Aberdeen, Scotland**, has been awarded a contract to provide underwater Ethernet digital cameras and related services to support the objectives of the National Science Foundations' Ocean Observatories Initiative (OOI) Cabled Array. University of Washington.

**Woods Hole Oceanographic Institution, Woods Hole, Massachusetts**, will lead a coalition of academic and oceanographic research organizations in a five-year National Science Foundation contract to operate and maintain the Ocean Observatories Initiative (OOI). University of Washington, Oregon State University, Rutgers.

**Kongsberg Digital, Horten, Norway**, will deliver a comprehensive LNG simulator package designed to enable new levels of safety and operational training for professional crews on 27 existing LNG vessels and seven more vessels currently on order. GasLog.

**GeoSpectrum Technologies, Dartmouth, Canada**, will supply two "C-BASS" low-frequency sources for conducting continuous acoustic experiments, along with control systems and amplifiers for autonomous moorings and manual deployment. Scripps Institution of Oceanography.

**Sonardyne International Ltd., Yateley, England**, signed a joint agreement to provide advanced integrated monitoring solutions for managing critical subsea assets, including drilling and production risers, moorings and wellheads. BMT.

**Unique Group, Sharjah, United Arab Emirates**, will provide a turn-key package for hydrographic survey vessels and hydrographic office setup, including providing multiple newbuild vessels with dynamic positioning systems and navigational equipment. Southern African Shipyards.

**Equinor ASA, Stavanger, Norway**, submitted an award of NOK 1 billion for engineering, procurement, fabrication, installation and testing of two high-voltage cables to supply power from shore for the second phase of the Johan Sverdrup development. NKT.

**Great Lakes Dredge & Dock Co. LLC, Oak Brook, Illinois**, received a \$113 million base contract award on the Jacksonville Harbor Construction Dredging Contract 'B' 47-Foot Project. It expects additional option work items on the contract by mid-2019 with a value of \$97 million, resulting in a total contract award of \$210 million. U.S. Army Corps of Engineers.

**Teledyne Marine, Slangerup, Denmark**, received an order for several Teledyne Odom Hydrographic Echotrac E20 single-beam echosounders, which are constructed at the company's Sonar Technology Center of Excellence. Survey Equipment Services.

**BIO-UV Group, Lunel, France**, will supply its BIO-SEA ballast water treatment system for retrofit installation to the 3,500 dwt Ro-Ro vessel *Ciudad de Cadiz*, a vessel that transports large sections and parts for the Airbus A380. Louis Dreyfus Armateurs SAS. **ST**

# meetings

## DECEMBER

**December 4-7—World Maritime Technology Conference, Shanghai, China.** +86 21 6473 2729, [ssnaoe@ssnaoe.org](mailto:ssnaoe@ssnaoe.org) or <http://wmtc18.ssnname.com.cn>.

**December 5—ASTM International Workshop on Autonomous Shipping, Vessel Automation and Maritime Cyber Security, Washington, D.C.** 610-832-9677, [symposia@astm.org](mailto:symposia@astm.org) or [www.astm.org/F25Workshop2018](http://www.astm.org/F25Workshop2018).

**December 5-6—ASNE Combat Systems Symposium, Washington,**

**D.C.** [www.navalengineers.org/Symposia/Combat-Systems-Symposium-2018](http://www.navalengineers.org/Symposia/Combat-Systems-Symposium-2018).

**December 6—Congress on Ocean Policy, Washington, D.C.** <https://nrf.org/2018cong>.

**December 10-11—MarTech, Porto, Portugal.** [info@martech-workshop.org](mailto:info@martech-workshop.org) or <http://martech-workshop.org>.

**December 8-13—National Summit on Coastal and Estuarine Restoration and Management, Long Beach, California.** [clewis@estuaries.org](mailto:clewis@estuaries.org) or <https://estuaries.org/Summit>.

## 2019

### JANUARY

**January 15-17—SNA Annual National Symposium, Arlington, Virginia.** 703-960-6800, [navysna@aol.com](mailto:navysna@aol.com) or <http://navysnaevents.org/national-symposium>.

**January 16-18—The Unmanned Systems Expo, Rotterdam, Netherlands.** [info@tusexpo.com](mailto:info@tusexpo.com) or [www.tusexpo.com](http://www.tusexpo.com).

**January 23-24—Coastal Futures, London, England.** [bob.earll@coastms.co.uk](mailto:bob.earll@coastms.co.uk) or <http://coastal-futures.net>.

**January 28-30—International LiDAR Mapping Forum, Denver, Colorado.** [wemison@divcom.com](mailto:wemison@divcom.com) or [www.lidarmap.org](http://www.lidarmap.org).

**January 29-30—ADECS, Marina Bay Sands, Singapore.** [www.asia-decs.com](http://www.asia-decs.com).

### FEBRUARY

**February 4-6—EUROMARITIME, Marseille, France.** [anne-charlotte.micca@gican.asso.fr](mailto:anne-charlotte.micca@gican.asso.fr) or [www.euro-maritime.fr](http://www.euro-maritime.fr).

**February 4-7—Gulf of Mexico Oil Spill & Ecosystem Science Conference, New Orleans, Louisiana.** <https://tinyurl.com/y998tjr6>.

For more industry meetings, visit [sea-technology.com/meetings](http://sea-technology.com/meetings). **ST**

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*J. A. (Jack) Runfola is president of R&R System Solutions. He has managed internal operations, business development, projects, contract negotiations and manufacturing operations for domestic and international companies. His ongoing industry experience includes submarine cable systems for global telecommunication companies, the offshore petrochemical industry and the U.S. Department of Defense.*



According to the Public-Private Analytic Exchange Program, “Creating economic havoc, political discourse and other geopolitical instability can occur with the simple cut of a subsea cable. Coordinated cuts of multiple cables executed in a strategic manner could bring a country or region to a standstill.”

In 2017, the Public-Private Analytic Exchange Program published a collaborative effort titled “Threats to Undersea Cable Communications.” As someone whose career has been involved with the submarine cable industry on both the military and commercial side, I consider this a pertinent and timely study.

What is the medium that carries the internet, financial transactions, international communications, social media, news, etc. from continent to continent? It is submarine communication cables. Most people do not think about the importance of these cable systems, but ignoring them is a potential security threat.

In 2005, R&R System Solutions was asked to address a U.S. Homeland Security Conference on submarine cable security. We discussed the vulnerability of cables and landing stations. Since that time, there have been multiple articles and studies focused on the vulnerability of submarine telecommunication cables. These communication links are critical. Since the 1980s, there

have been well over 400 international and domestic submarine cables installed.

Locations of commercial subsea cables and landing stations are public information. As technology and demand have increased, many of these systems are now, or will be, deactivated, upgraded or replaced with new systems with higher capacity.

Will damaging one cable cause a national or international communication shutdown? The answer is no. Telecommunication system operators have multiple agreements in place for the rerouting of their traffic or spreading the traffic over other systems. Will disrupting multiple cables at once cause such a shutdown? No, but the impact in terms of revenue, security and internet traffic could be severe.

As a means of commercial protection, international cables are buried on the continental shelf. Nominal cable burial is 1 m, and deeper burial is possible. Non-sabotage causes for submarine cable damage are most often fishing, ship anchors and natural hazards. Often the cable is only damaged, not completely severed, and an electric fault occurs. When a fault occurs, it is instantly recognized at the network operating center. This triggers multiple events, including notification to the maintenance operator, who then leaves port to initiate recovery and repair.

The deliberate damaging of one or a couple of submarine cables represents harassment.

Vulnerable industries include offshore renewable energy and offshore petrochemical when multiple platforms are tied into a single communication system.

If one wished to cause substantial damage to submarine cables, how would one go about it? Sailing down the Atlantic dragging an anchor, for example, would damage a cable but the distance between

cables is significant. Attempting to damage cables in this manner would take too much time, and the culprit would be readily detected. Additionally, system operators have multiple tools to track a suspicious vessel and, as needed, pursue legal recourse within national waters.

Transoceanic cables carry deadly high voltage, so sending down a diver to cut a cable is unlikely because of danger to a diver's life.

Explosives are also not practical to use on a single cable.

The most likely potential security threat is at the landing sites. Commercial operators land multiple cables in one location, and multiple landing sites are typically not far apart.

Island nations are the most vulnerable because their coastlines are relatively small, with landing stations close to each other. If a bottleneck occurs, this could create failure in multiple cables that could affect domestic and international communication.

These commercial systems are national assets and require protection. Right now, in the U.S., there is no certainty as to whether they are viewed as warranting military protection or government surveillance.

Commercial companies have limitations as to the level of security they provide, as does the government. However, the government has more sophisticated tools. For instance, when a ship lingers in an area over a cable system, a warning vessel can be used to monitor the lingering ship's activities. Air reconnaissance and undersea surveillance systems are other methods.

We need to know that undersea cable vulnerability is not being ignored by governments or by the systems' owners.

The United States has a large defense budget. It seems reasonable for some of this funding to be allocated to address this critical vulnerability. **ST**

# november advertiser index

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\*For more information, consult the 2018 Sea Technology Buyers Guide/Directory: <http://stbuyersguide.epubxp.com>

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## USBL POSITIONING SYSTEMS

**simultaneous** positioning and communication - no need to switch between positioning mode and modem mode

- flexible SiNAPS positioning software
- reliable data transmissions
- range: up to 8000 m
- accuracy: up to 0.04 degrees

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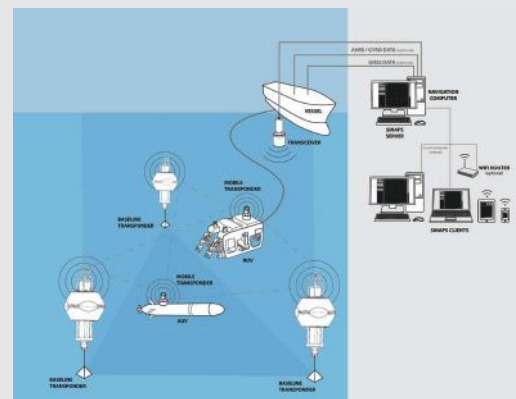
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- depth: up to 6000 m
- data rate: up to 62.5 kbps

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