



March 2018

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FEATURE STORY

**The Next Generation in
Persistent Hybrid-Powered
Unmanned Surface and
Subsurface Vessels**

PAGE 10



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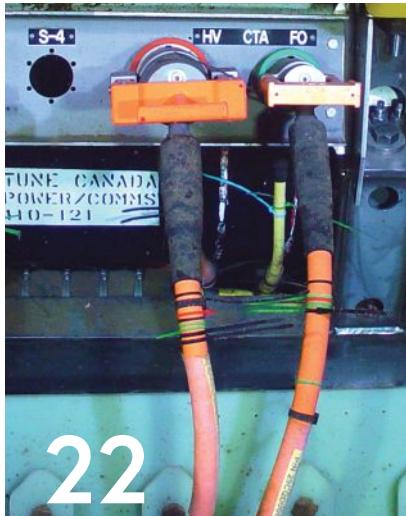


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ON THE COVER:

Innovation: an offshore heavy lift DP2 jack-up vessel from DEME Group. Photo courtesy of DEME Group.

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**EDITORIAL****JOHN MANOCK**
Editor, SubCableWorld

Keeping Up with the Internet: Submarine Telecom and Streaming Video

The submarine telecom market is in the midst of perhaps the biggest boom in its history. Cables are being built at a record pace—and as soon as they enter service, new cable systems are announced to take their place in the project pipeline.

All of this activity is an effort to keep up with skyrocketing demand for Internet bandwidth. More and more each year, the Internet is becoming people's choice for entertainment video. In the developed world, the Internet is replacing cable television. In the developing world, where the availability of television was not widespread, the Internet offers a multitude of video choices to people for whom video entertainment was previously beyond reach. In addition, the Internet of Things (IoT), virtualization, and other high-bandwidth services are poised to explode onto the scene. These technologies and others that are now only being contemplated will drive demand to new heights.

In its 30-plus year history, the submarine telecom industry has been able to keep up with demand for bandwidth. It has done this with a multi-phase approach, including building more cables, increasing the number of optical fibers within the cable, increasing the number of wavelengths that can be used in each fiber and increasing the amount of capacity that each wavelength can carry.

With each new advance, it was believed that supply would quickly outstrip demand. This did happen once in the early days of the 21st century; the result was a collapse of the submarine cable market.

But that was a different world. Once the Internet became fully entwined in the lives of billions and streaming video began to take hold, supply

has been forced to play catch up to demand. New cables are being contracted for annually, while technological advances are driving the bandwidth capacities of these new cables from a few dozen Gigabits (billions) in the early days of the century to well over a hundred Terabits (trillions) today. And still the OTTs (over-the-top providers like Google, Microsoft, and Facebook) are demanding more and more.

Now the submarine telecom cable industry is facing a barrier that was unimaginable only a few years ago—Shannon's Limit. First conceived by MIT's Claude Shannon in 1948, this is a theoretical limit on the amount of capacity that an optical fiber (or any medium) can carry due to the presence of "noise" within the fiber. For most of the era of optical fibers, it was thought that Shannon's Limit would never be a factor, that demand for bandwidth could never be that great. But now, reaching Shannon's Limit is a very real fear.

In the past year, several companies in the submarine telecom industry have announced the results of tests that indicate they are approaching Shannon's Limit. Research is also being conducted to try to find ways around it. And all the while vast amounts of bandwidth are being gobbled up by the Terabits to provide services to Internet users.

It is an interesting question: How will the submarine telecom industry keep up with Internet demand? We really don't know beyond the next few years. Few conceived a decade ago that streaming video would so profoundly change the supply/demand equation. Who can say how the IoT and virtualization will impact it in the future?

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The Next Generation in Persistent Hybrid-Powered Unmanned Surface and Subsurface Vessels

BY

NEIL TRENAMAN

Ocean Aero Inc.

R. MURRAY GERO

Lockheed Martin Corporation





THE SUBMARAN™ is the first wind- and solar-powered hybrid, autonomous, unmanned surface and subsurface vessel designed for extended ocean observation and data collection.

Built for speed, efficiency, and manoeuvrability, it is powered by a unique composite wing sail and state-of-the-art solar panels that recharge batteries quickly. The combination of wind and solar power enables the Submaran™ to travel further and faster—with the navigational agility for lengthy station keeping and prolonged monitoring.

The Submaran™ features a hull length of 4.2 m (13.8 ft), a payload capacity of 23 kg (50 lbs), a top speed of 5.5 kts, and the ability to transition from surface sailing to fully submerged in 2 to 3 minutes. It is ideally suited for autonomous missions that require speed, stealth, long endurance, and persistence under demanding ocean conditions.

In August 2016, Ocean Aero and its Submaran™ Autonomous Unmanned Surface and Subsurface Vessel (AUSSV) teamed with Lockheed Martin's (NYSE: LMT) "Marlin MK2" Autonomous Underwater Vehicle (AUV) and a Lockheed Martin "Vector Hawk" Unmanned Aerial

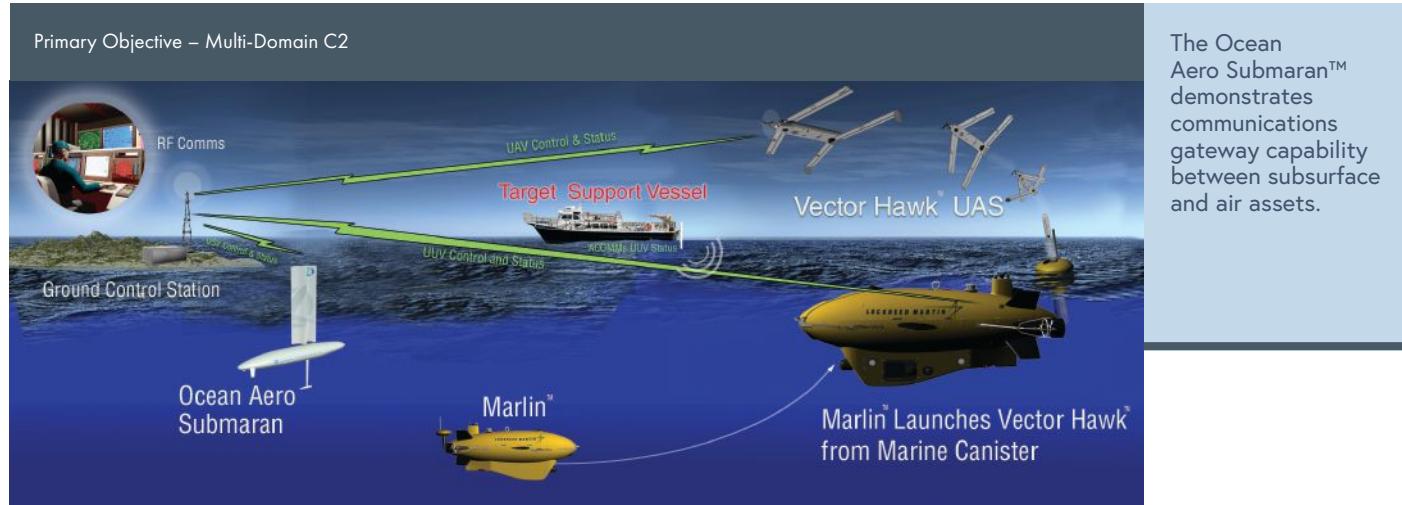
Vehicle (UAV) to showcase the combined capabilities of using autonomous underwater, autonomous surface, and autonomous aerial vehicles for cross-domain communications and command and control via underwater acoustic and aerial radio links.

These efforts were a part of the U.S. Navy's second Advanced Naval Technology Exercise (ANTX), which featured more than 30 participants operating under the theme of "Cross Domain Communications and Command and Control." Ocean Aero and Lockheed Martin demonstrated the versatility and adaptability that unmanned systems bring to complex missions.

At ANTX 2016, Ocean Aero and Lockheed Martin demonstrated the versatility and adaptability that unmanned systems bring to complex missions. Lockheed Martin successfully launched Vector Hawk, a small UAV, on command from the Marlin MK2 AUV during a cross-domain command and control event hosted by the U.S. Navy.

In addition to Marlin and Vector Hawk, the Submaran™, a hybrid autonomous underwater and surface vehicle (AUSV), provided surface reconnaissance and surveillance. The Submaran™ relayed instructions to the Marlin from a ground control station via underwater acoustic communications. Following these instructions, the Marlin launched the Vector Hawk using a specially designed canister from the surface of Narragansett Bay.

Following launch, Vector Hawk successfully assumed a mission flight track. All three autonomous vehicles communicated operational status to the ground control station to maintain situational awareness and provide a means to command and control all assets.



Ccean Aero followed its initial successful collaboration at ANTX 2016 by participating with the U.S. Navy's Space and Naval Warfare Systems Center Pacific (SPAWAR SSC PAC) at ANTX 17 held at Camp Pendleton, California. The goal of the ANTX 2017 exercise was to demonstrate how cooperative AUSV/UAV operations can be coordinated to provide bathymetric survey data for amphibious landings where the Submaran™ filled the AUSV role and the Vapor 55 filled the UAV role.

The Submaran™ and Vapor 55 participated in three (Shield, Spear, Dagger) primary missions.

The missions were to simulate real-world operations where an over-the-horizon force preparing for an amphibious landing gathered intelligence and threat identification information via stealthy deployment of autonomous, unmanned technologies.

The Submaran™, equipped with an acoustic multi-beam sonar, was deployed from a remote location to collect high-definition imagery of the seabed in a designated area of interest in the littoral zone offshore of a potential amphibious landing site. The multi-beam data provided near-real time bathymetric images detailing possible hazards such as mine-like objects and subsurface structures designed to thwart amphibious landing craft gaining access to the beach.

The high-resolution data were then transmitted to the Vapor 55, which was hovering overhead after having flown autonomously from a simulated over-horizon asset.

Upon completion of the data transfer from the Submaran™, the Vapor 55 UAV returned to its point of departure and the dataset recovered and processed to provide acoustic image maps of the seafloor and identify hazards and threats.

These exercises illustrate the cross-domain benefits that autonomous underwater, surface, and aerial technologies bring to operational surveillance and near real-time environmental updates to support field command logistics.

In the future, it is clear that the Submaran™ will be "missionized," likely using a variety of Lockheed Martin payloads and systems integration expertise, to become the cross-domain lynchpin of a "system of systems" performing a diverse assortment of potential missions, including those requiring a covert platform. These potential missions include low-cost, persistent ISR; cross domain communications gateway; critical infrastructure monitoring; special operations support; payload delivery; ocean observation; and law enforcement/drug interdiction.



OCEANALPHA

Celebrates Chinese New Year with Astonishing USV Show



ON 15
FEBRUARY,

an incredible unmanned surface vessel (USV) showcase was staged at the Hong Kong-Zhuhai-Macao Bridge, one of Zhuhai's landmarks. The newly completed bridge, which is the longest sea-crossing bridge in the world, connects Zhuhai to Hong Kong and Macao. For this celebration, however, the bridge became a spectacular background for a show of spectacular proportions.

To kick off the main event, a 7.5-m long lookout USV led eight smaller (1.6-m long) unmanned vessels, forming a brightly lit arrow formation and traveling through the arches of the Hong Kong-Zhuhai-Macao Bridge.

Like a robotic marching band, the brightly lit vessels then formed into the Chinese word "启航" which means "set sail" and headed for the door of "the new era" made up of drones in the sky. The lights and fireworks illuminated the ocean dream of the Chinese nation. The show has foreshadowed the developing unmanned technology strength of China, which is now moving to a new era with determined steps.



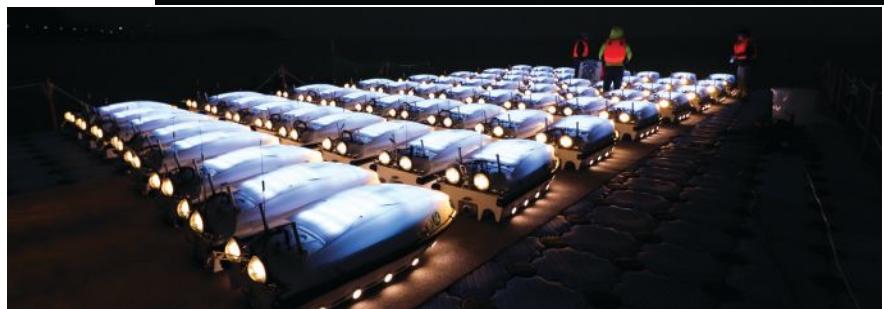
This show was the first such display of multi-vessels collaboration from Oceanalpha. During the two months leading up to the performance, nearly 100 unmanned vessels have been produced and turned into "water dancers" via a collaborative programming effort—simultaneously operating 81 USVs is unprecedented in the industry.

“This is not just a performance, it is a tribute to future marine survey and exploration by mankind...”

Faced with wind and rippled waves, the Oceanalpha team utilized robust and adaptive control technology to ensure smooth control of the fleet. High-precision GNSS and integrated inertial navigation, combined with RTK technology, ensured the precise trajectory of USVs. In addition to controlling and navigating formations, the Oceanalpha team adopted a tracking algorithm based on the virtual leader combined with the path to realize formation-conversion and automatic collision avoidance of a massive number of vessels.

Oceanalpha released a statement that read, "The performance on the CCTV spring festival gala is the first in the world to achieve the massive number of USVs working together and presenting a spectacular show in world-class."

"This is not just a performance, it is a tribute to future marine survey and exploration by mankind, especially the start of new technological methods in geophysical survey. In the near future, unmanned vessels will be more efficient to play its own technical characteristics, and gradually get rid of the existing "ship + mission payload" of the traditional mode of operation, with a new payload, new methods of operation, high-density cluster collaboration in an unprecedented way to change the entire industry, and extending to more industry applications," CEO of Oceanalpha Zhang Yunfei said.



启航

For more information, visit
WWW.OCEANALPHA.COM

SEATOOLS Supplying Remote Offshore Monitoring System

The Ocean Cleanup, the Dutch non-profit developing advanced technologies to rid the world's oceans from floating plastic, has awarded subsea technology company Seatools a contract for the development and delivery of a remote offshore monitoring system. The monitoring system will be used to gain real-time insight into the performance of the first-ever ocean cleanup system, which will be deployed during trials starting later this year on the US west coast.

Jan Frumau, managing director at Seatoools, is very pleased with the contract. "Besides the fact that we thoroughly support this meaningful initiative, the project is compelling from a technological viewpoint as well. It requires a unique combination of technologies and capabilities. We will be able to make a valuable contribution to the project thanks to our extensive background in the development of measurement systems located in the splash zone, combined with our capabilities in monitoring, controls, and software engineering. It will be inspiring to work with such an ambitious team as The Ocean Cleanup."

The remote monitoring system is of critical importance during the upcoming sea trials of the first operational system, which consists of a 600-m long drifting barrier. The main purpose of the trials, which will take place in the Pacific (200+ nmi off the coast of San Francisco), is to gain detailed information about the behavior of The Ocean Cleanup's system under real offshore conditions and validate the extensive computer models the group has been using in their designs. Next to disseminating essential data about the system's base position and general conditions, its behavior will be monitored under all environmental circumstances. In addition, data will be collected that enables the remote offshore monitoring system to assess in real time how efficiently the barrier catches plastic. Based on the results of the trial, the system will be optimized for the scale up to the full cleanup phase in 2019-21.

One of the most pressing design criteria for the monitoring system is that it must be able to operate completely autonomously. During the first year of operation, the system will be constantly monitored, but for future deployment,

there will be no ability to access the floating systems for maintenance or retrieve the measurement data while they are in operation. This will not only pose a challenge from a mechanical point of view—the system will be exposed to harsh, open-ocean conditions—but also requires a solution for the absence of external power sources. Seatoools will perform a thorough analysis on the required solar power configuration, including a study on the expected solar yield. In addition, a smart power system will be developed to activate and de-activate specific functionalities depending on the available power. This will ensure that critical functionalities, including those relating to navigation, will remain active under all circumstances.

For more information, visit
WWW.THEOCEANCLEANUP.COM



"Besides the fact that we thoroughly support this meaningful initiative, the project is compelling from a technological viewpoint as well."



For more information, visit
THEOGTC.COM

New Subsea Technology Could Generate £3 Billion from the North Sea

Wood Mackenzie and the Oil & Gas Technology Centre have announced that developing new subsea technology and approaches to field developments could help unlock 400 million additional barrels of oil and gas and generate £3 billion of additional value.

On the UK Continental Shelf (UKCS), there is 3.4 billion barrels of oil and gas potential discovered in marginal fields, or "small pools." At the current oil price, 1.5 billion barrels in small pools in the basin are potentially economic.

The Technology Centre's "Tie-back of the Future" initiative, which aims to both halve the cost and the time to develop small pools, would make an additional 400 million barrels economic.

The initiative brings together 25 operators, supply chain firms, and technology developers to transform the approach to developing marginal fields. Creating a circular economy, whereby subsea equipment is designed for disassembly and reuse, is at the heart of the initiative.

To date, the Technology Centre has invested £250,000 in engineering activity to develop the initiative, five

technology projects are underway, 13 technology proposals are in the pipeline and six integrated studies have been completed. Industry support from operating and supply chain companies is required to make the Tie-back of the Future a reality.

The UKCS has around 10% of the world's small pools and with 27 billion barrels in small pools globally, there is huge potential to take solutions developed here to other basins with marginal fields, driving international growth and export opportunities.

Chris Pearson, Small Pools Solution Centre Manager for the Oil & Gas Technology Centre, said, "Small pools represent a big prize for the UK economy, but they each have their own challenges. The Tie-back of the Future concept is making significant strides to making more of these fields economically viable...some of the ideas and early-stage technologies out there are really interesting. We are seeing developments in mechanical hot taps, mechanically connected pipelines, multi-use pipelines, the integration of renewable energy systems, and unmanned facilities. These solutions could transform the

development of small pools and extend the economic life of the North Sea."

Mhairidh Evans, principal analyst for Wood Mackenzie, said, "At current exploration rates, it would take 14 years and 500 wells to find the same volumes that have already been discovered in small pools. As a mature basin, these barrels can no longer be ignored. As well as providing much-needed new investment, unlocking small pools is key to extending the life of existing infrastructure. The UK industry, with the Technology Centre's backing, is at the forefront of these new technologies. Approaches taken here will be much-watched and learned from around the globe."

Small Pools

Small pools are classified as unsanctioned discoveries containing less than 50 million barrels of oil equivalent (mmboe) (P50 technically recoverable).

DATABANK Handheld Datalogger

Now Includes Internal GPS

Turner Designs' Databank Handheld Datalogger is upgraded to include an internal GPS chipset, allowing users to log GPS coordinates along with measurement data for location tracking. Using GPS & GLONASS Global Navigation Satellite System, DataBank provides horizontal position accuracy of 2.5 m. DataBank stores up to 9,999 records as well as 16 calibrations and uses an intuitive GUI interface for configuring and calibrating Cyclops sensors; logged data are downloaded via USB. DataBank's internal rechargeable battery provides continuous measurements up to 15 hours or continuous GPS data collection for up to 5 hours.

Turner Designs' DataBank Handheld Datalogger now includes integrated GPS to identify measurement locations.

Databank comes with one factory-installed cable that supplies power to and communicates with Turner Designs' Cyclops sensors. Standard Cyclops sensors are available for detecting *in vivo* chlorophyll, crude oil, refined fuels, CDOM/FDOM (dissolved organic material), blue/green algae, fluorescein dye, rhodamine dye, PTSa dye, optical brighteners, tryptophan, and turbidity. Cyclops sensors can also be configured with custom optics for specialized applications per customer request.

Integrated GPS data are important for field work such as conducting dye trace studies, mapping algal blooms, or looking for the presence of optical brighteners as an indicator of wastewater contamination. Small and lightweight, DataBank is ideal for such remote field work.



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XPRIZE Announces Winners of the Big Ocean Button Challenge

With billions of people depending on the ocean for their livelihoods and a wealth of data collected each day, access to digestible, instant ocean data can help solve some of the world's grand challenges and push the new blue economy forward. However, the vast majority of ocean data remains untouched by app developers. But soon, that may change.

In mid-February, the XPRIZE Ocean Initiative, backed by Wendy Schmidt, announced the seven winners of the Big Ocean Button Challenge—a global crowdsourcing competition awarding \$100,000 for mobile app developments that turn ocean data into ocean services we need. The competition seeks new solutions for organizing and broadcasting ocean data with application innovations in five categories: Fishing, Shipping and Trade, Ocean Acidification, Public Safety, and Exploration.

SEASTATUS MARINE WEATHER & TIDES APP

Seven Winning Mobile Apps

SEASEE

Winner: Exploration, Education

The SeaSee app uses bathymetric (seafloor) data to generate 3D views of the underwater terrain from where the user is pointing their phone and their GPS location.

SEASTATUS

Winner: Public Safety,

Integrating Multiple Data Sets

The SeaStatus app gives simple, personalized, and accurate marine weather reports to anyone with an internet-connected mobile device.

FISHANGER

Winner: Fishing

The FishAngler app is designed to capture, track, and share some of your finest sports fishing experiences.

SOPHIE

Winner: Ocean Acidification

The SOPhIE app delivers daily metrics of ocean acidification, ideal for users working in aquaculture, fisheries, and coastal monitoring.

NAVISEA

Winner: Shipping & Trade

The Navisea app is built for planning and tracking ocean voyages with tons of additional data, including traffic, ports, docks, charts, weather, and more.

CHILE ES MAR

Winner: Judge's Award

The Chile es Mar app is aimed at bridging the information gap between science, fishermen, and seafood consumers in relation to the biology and ecology of exploited species, fishing regulation, market opportunities, and traceability of small-scale fisheries in Chile.

ENDANGERED WAVES

Winner: Conservation

The Endangered Waves app empowers and incentivizes surfers to monitor the health of their own coastlines through crowdsourced data.

Iver3 Autonomous Underwater Vehicles



Rapid Data Collection For

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Researchers Pioneer Observations of HURRICANE WIND SPEEDS FROM SPACE

Researchers at the National Oceanography Centre (NOC) have developed a technique that, for the first time, uses reflected GPS signals from satellites orbiting the Earth to measure very high wind speeds and changes in near-surface ocean conditions during hurricanes. This pioneering research, recently published in the leading science journal *Geophysical Research Letters*, has the potential to improve our understanding of these destructive weather phenomena, including prediction of their behavior before they reach land, offering a potential to improve public safety as well as delivering tangible economic benefits.

The research by Giuseppe Foti, Dr. Christine Gommenginger, and Prof. Meric Srokosz of the NOC demonstrates that useful observations of hurricanes can be obtained from spaceborne Global Navigation Satellite Systems-Reflectometry (GNSS-R) data, using satellites that also support the Global Positioning System (GPS) network. The reflections of navigation signals from the Earth's surface can be used to assess hurricane structure and wind speed; previous studies have used this technique to obtain hurricane wind speed data from aircraft, but this new

research shows that the same technique also works from Earth-orbiting satellites.

To prove that the technique was sensitive enough to be used from space, the team analyzed data from the Surrey Satellite Technology Ltd (SSTL) GNSS-R instrument mounted on the UK-funded TechDemoSat-1 (TDS-1) satellite orbiting 635 km above the Earth. Satellite data were collected between May 2015 and October 2016 and compared against hurricane data derived from three independent sources, including the International Best Track Archive for Climate Stewardship (IBTrACS) that provides information on storm location, radius, and maximum wind speed.

The study presents data from three tropical cyclones in summer-autumn 2015 in the North Atlantic and North Pacific Oceans: Joaquin, Jimena, and Chan-Hom. These data were compared to the three other data sources, revealing that the satellite-based data correctly measured variations in structure across the hurricanes (including the eye and wall of the hurricane) and were able to produce credible estimates of very high wind speeds up to 155 mph (250 km/h).

Greater Understanding

Lead author, Giuseppe Foti of the NOC, said: "This is the first step and proof of concept in an important new area of research. Developing greater understanding of hurricanes will enhance operational agencies' ability to forecast and respond to these extreme phenomena, which will benefit coastal communities around the world. Another benefit of GNSS-R is that the instrument onboard TDS-1 is small, making the cost relatively low. The results are very encouraging, and we look forward to refining this work further. The team here at the NOC is grateful to colleagues at SSTL for their collaboration and to the Centre for Earth Observation Instrumentation (CEOI) and European Space Agency for their support."

TO VIEW THE FULL
RESEARCH PAPER, VISIT
[onlinelibrary.wiley.com/
doi/10.1002/2017GL076166/full](http://onlinelibrary.wiley.com/doi/10.1002/2017GL076166/full)



SUBSEA SOLUTIONS: SMART AND SCALABLE

EVOLOGICS GMBH FROM BERLIN (DE) DESIGNS AND MANUFACTURES UNDERWATER COMMUNICATION AND POSITIONING SYSTEMS AS WELL AS NOVEL ROBOTIC SOLUTIONS. MARITIME AND OFFSHORE INDUSTRIES ARE KEY MARKETS, AND THE COMPANY'S GROWTH STRATEGY IS DEFINED BY RESEARCH AND INNOVATION.

EvoLogics' S2C spread-spectrum communication technology stems from bionic concepts and spans over a whole ecosystem of products. This includes several series of underwater acoustic modems, modular underwater positioning systems (USBL, LBL, SBL), a framework for developers in both networking and hardware design, and a modular autonomous surface vehicle for bathymetry and monitoring.

The keyword is modular: most EvoLogics products are designed to provide the highest degree of customization.

EvoLogics strives to offer highly configurable solutions instead of "bespoke tailoring" for a particular operation. Pre-configured modules allow EvoLogics to build a device that caters to the client's application while maintaining effective price points and delivery lead times.

Of course, because every scenario is unique, EvoLogics also tailor-builds when a client requires such an approach.

Still, the core challenge for any wireless underwater solution remains overcoming both common and site-specific problems of transmitting data in the dynamic subsea environment. EvoLogics' S2C technology is proven to facilitate a highly-reliable bidirectional data link along with acoustic positioning, broadcasting, and networking functionalities.

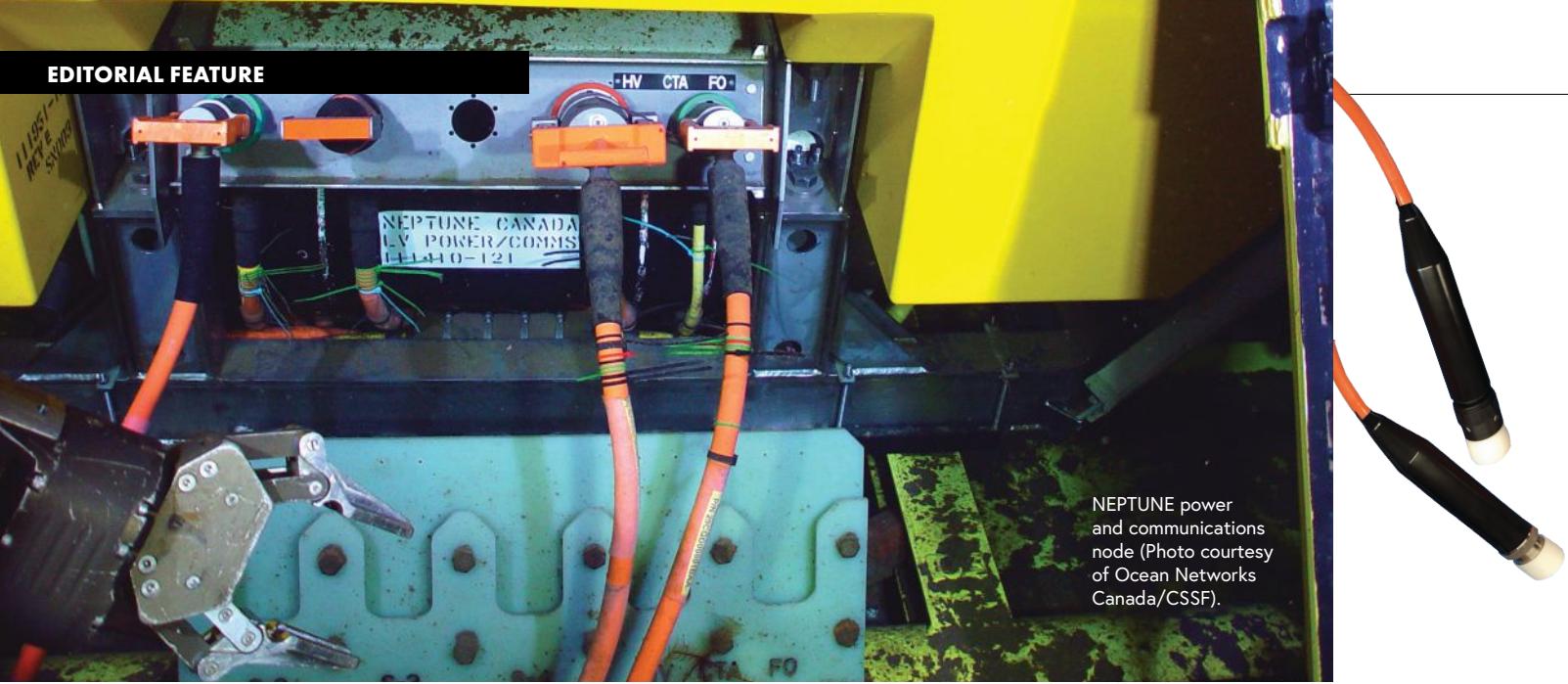
Besides great performance benchmarks, modern applications require scalability and flexibility. Current systems that are bulky, risky, and expensive to acquire, deploy, and maintain for large-scale maritime and offshore operations are slowly pushed out by newer technologies and smarter, more effective solutions.

The days of design and deployment occurring years apart from each other are over. Now, the client can start out in the cloud with a virtual emulator of underwater acoustic modems, proceed to test in the real-world with actual modem hardware, then integrate with existing infrastructure and deploy the system within months. The operation can be scaled by adding multiple acoustic network nodes, both stationary and mobile.

As the challenges of offshore and maritime industries are more and more demanding, underwater "Internet of things" that enables intelligent cooperation between various vehicles and sensors is one of the main vectors of EvoLogics development strategy.



EVOLOGICS SHOWCASE AT OCEANOLOGY INTERNATIONAL 2018 IN LONDON WILL DEMONSTRATE THE RECENT LAUNCHES AND RESEARCH & DEVELOPMENT EFFORTS AT STAND C251.



NEPTUNE power and communications node (Photo courtesy of Ocean Networks Canada/CSSF).

The Subsea Future Arrives

BY DAVE NICHOLSON | General Manager, Teledyne Impulse-PDM

How the demand for reliability and increased capacity is pushing the evolution of subsea optical sensing, imaging, and instrumentation.

Subsea instrumentation such as sensing and monitoring systems, high-definition cameras, and vehicles such as remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs), and gliders are being required to collect and process more and more data as sensor technology continues to advance and allow offshore operations in deeper waters. The subsequent requirement from these sensors is to transmit data in real-time from a single point rather than collecting from multiple sources and processing at a later time. Interconnected systems must, as a result, adapt to the more advanced instrument technology by providing additional contacts, smaller connector footprints, and flexible configurations combining electro/optical capabilities in a single connector. This will allow higher electrical power, higher bandwidth capability, and on-demand data transmission for extreme depth applications.

The existing product range offered by Teledyne Marine consists of electrical, optical, and "hybrid" (or electro-optical) subsea interconnect. These connectors are available in single or multi-mode fibers, provide low data loss, and are rated for 5,000 to 10,000 psi. Dry

mateable connectors rated for shallower water are typically constructed of stainless steel, but connector assemblies rated for deeper water or higher pressure applications can be provided in a variety of materials, including titanium, Hastelloy, Monel, and beryllium-copper. Wet mateable connectors are typically provided in titanium to withstand mating and demating operations by ROVs and survive 25+ year performance life.

Some of the technical challenges of pushing the boundaries of submersible hybrid interconnect technologies will be explored as the industry demands the capabilities to manage the massive amount of data being collected under the ocean's surface in a compact and cost-effective footprint. Feedback from the industry and a deep understanding of the technological advances in sensors and instruments are crucial to understanding what the face of next generation of hybrid technology will look like. Once the optimal level of configurability of electrical and optical combinations for subsea connectors is identified by the industry—or standardized to some extent—connector and cable producers can develop products to meet the needs of these instrumentation systems.

In addition to other configurations, we will explore the importance of reliability in subsea interconnect systems as the requirements for engineered systems become ever more complex. In deepwater environments, the margin and tolerance for error, uncollected data, or connectivity failures is often slim to none, which creates a different set of challenges in engineering interconnect systems that operate in these environments. Managing the two priorities of enhanced technical performance while maintaining or even improving reliability requires input and support from the subsea instrumentation and vehicles community to gain insight to develop these next-generation interconnect technologies.

Introduction

The development of hybrid connectors containing optical and electrical circuits in the late 1990s represented a significant step forward in connector design, joining two enabling technologies into a single package. Hybrid connectors enabled the delivery of electrical power along with high-bandwidth optical communication. Powered temperature, pressure, flow, or erosion sensors on pipelines and trees could now be read topside in virtual real time. Teledyne's Nautilus Rolling



Seal Hybrid (NRH) joined the Rolling Seal optical technology with the already widely used Nautilus electrical pins in order to provide optical connectivity and electrical power up to 30 amps and 1 kV. Though used more frequently for oceanographic/communication programs such as Japan's Dense Oceanfloor Network System for Earthquakes and Tsunamis (DONET) system and the Ocean Networks Canada's NEPTUNE nodal science project located off the west coast of British Columbia, NRH connectors have also enabled cost savings on oil and gas projects, such as Total's ultra-deep flagship field Egina off the coast of Nigeria.

The shift to real-time data collection and long-term deployments has changed the landscape. In addition to more sophisticated sensors, the required connectors need to be more robust, rugged, and durable. Historically, the equipment was deployed over the side of a boat and retrieved hours later. But requirements have changed. Now, there are long-term deployments with skyrocketing amounts of data collected. The subsea interconnect industry needs to help shift the culture of the customers, engineers, and users away from the standard practice of selecting the least expensive connectors available (which were designed for short-term deployments) toward considering the total cost of data collection. The risk to data collection and impact on the projects also needs to be mitigated. Given the advanced engineering, materials, and molding solutions available, risking mission failure due to data loss because of a focus on the low cost of the interconnect should not happen today.

Case Studies

Marine Institute selected a number of Teledyne solutions to comprise a fiber optic cable harness, including the ODI Nautilus connector, PDM's Omega Fiber Optic connectors, and a range of Impulse MHD connectors. The functional requirements were that the connector must be resistant to corrosion and the connection must not fail, even if the cable jacket was damaged. The PDM and Impulse connectors were manufactured in titanium to provide corrosion

resistance, and the termination on both connectors was specifically designed to provide a two-stage sealing arrangement such that a break in the cable jacket would not cause a failure of the harness assembly.

Teledyne Marine has developed a range of molding techniques that extend the life of a molded connector. This is a traditional requirement of defense customers, but the same technology was used in the manufacture of the Marine Institute connector moldings to deliver customer-specified performance life characteristics. The presence of a conductive metal surface at the polyurethane-molded interface can result in cathodic delamination. We have developed a test cell capable of accelerating this effect such that we can comparison test assembly techniques. Our current best practice offering represents an increase in time to failure from the traditional methodology.

For Panoptes, a provider of cameras to monitor aquaculture facilities, the challenge required a ruggedized single fiber optic Omega connector and cable harness to transmit 8,000 images of fish in fish farms back to the laboratory for analysis. The images can be used to monitor the stock rather than sending a fish sample to a laboratory for testing, saving time and costs. Through early engagement with the customer, we identified that the standard stainless steel offering would not provide the anti-fouling properties required within the environment. So we worked with our supply chain to select a cost-effective alternative material called "Cupro-Nickel."

A third challenge within subsea hybrid interconnects involved a Submarine Rescue Vehicle connector system that required a cable harness while attached to the submarine to communicate with the crew of the vehicle. The crew needed to be able to disconnect the cable from the vehicle prior to launching from the submarine to prevent the cable getting caught in the thrusters. A modified version of the standard Omicron connector was developed using a weak link in the engaging nut that would allow for the connector to be pulled away prior to the vehicle launching.

Material Advances in Subsea Interconnection Molding

In the case of molded assemblies intended for use in water or other harsh environments, polyurethane mixing equipment consisted of a set of scales, bucket, and a paddle on the end of an electric drill 30 years ago. Over the years, the industry has moved forward to increasingly sophisticated automatic metering equipment now capable of mixing more material per minute with a dial in range of hardness from 60 shore A to 75 shore D. We can also control the speed of cure to be most appropriate to the style, shape, and size of the part we are molding. Additionally, with increasing environmental regulations, one of the new challenges is moving to a non-mercury catalyst, RoHS-compliant material where the cure time is very linear (RoHS: Restriction of Hazardous Substances). Teledyne utilizes R&D and test facilities in the EU and the US to develop and validate new materials and processes.

Conclusion

Too often, the subsea interconnect within a system is purchased off the shelf without a thorough analysis of the performance requirements, operating conditions, or functional requirements. This can contribute to high failure rates and potential loss of data or equipment. In many cases, the performance expectations of the interconnect assembly are mismatched to connector and assemblies' original design performance characteristics. Now, there is a shift in the mission of the interconnect and evolutionary demands on the technology: RoHS compliance, 30-year life demands on molded assemblies, and higher data transmission requirements. The demand for reliability and the capacities of systems mean that early and thoughtful attention to the mission-critical importance of interconnect systems in today's sensor arrays is paramount to the success of the mission.



EIA Economists Offer Outlook for Deepwater Production

BY VICTORIA ZARETSKAYA, FAOUZI ALOULOU, AND LAURA SINGER

Lead Industry Economist / Industry Economist / Economist

In a recent analysis of decisions to invest in the development of oil and natural gas resources, three economists from the EIA conclude that many large, capital-intensive oil and gas projects will come online after 2025 in order to meet rising demand.

According to the EIA, for deepwater, tight oil, and oil sands development, related investment is expected to be limited before 2025. These resources are typically more costly to develop, take longer to reach full production, and require additional investment in infrastructure because of remote locations. However, most projects currently under development are expected to continue.

Between 2000 and 2014, upstream investment in liquids and natural gas production increased from \$139 billion in 2000 to \$903 billion in 2014. Between 2011 and 2014, growing global demand and sustained crude oil prices of about \$100/b supported investment in large-scale, relatively expensive projects to recover oil from less conventional sources, such as oil sands, offshore deepwater fields, and tight oil formations. Combined production from

these resources increased by 44% over this period and reached 12 million barrels per day (b/d) in 2014, which was 16% of world crude production.

Following a sharp decline in crude oil prices between 2014 and 2015, companies reduced capital expenditures and deferred or canceled many capital-intensive projects. In only two years, global upstream investment declined by about 40%, from \$903 billion in 2014 to \$513 billion in 2016. Total investments in tight oil, oil sands, and offshore deepwater decreased from \$280 billion dollars in 2014 to \$126 billion dollars in 2016.

Between 2017 and 2040, production from tight oil is projected to increase by 3.3 million b/d, offshore deepwater by 2.7 million b/d, and oil sands by 1.4 million b/d. However, the timing associated with the development of these types of resources across regions differs because of rising oil prices and many other factors.

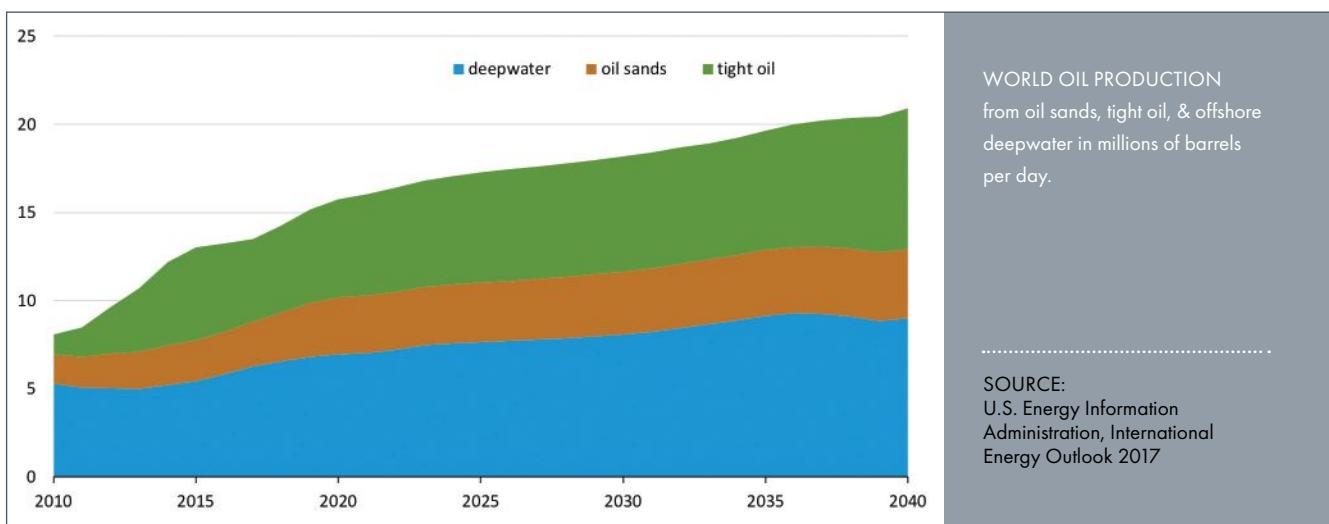
Deepwater Outlook

Although offshore deepwater oil projects have high fixed costs and require long lead times from project conception to first production, they provide large

TO VIEW THE FULL ANALYSIS, VISIT
[www.eia.gov/outlooks/
ieo/uon.php](http://www.eia.gov/outlooks/ieo/uon.php)

production volumes that can achieve relatively low per-barrel operating costs. In 2016, Brazil accounted for the largest share of the global deepwater production (32%), followed by the United States (24%), Angola (19%), and Nigeria (10%). The United States and Brazil together accounted for more than 90% of global ultra-deepwater production in 2016, with ultra-deepwater production expected to increase in 2017 in both countries.

The United States and Brazil are expected to remain the most attractive countries for upstream deepwater investment because they already host the most experienced major international oil companies in deepwater development and hold the largest deepwater oil reserves. In the IEO2017 Reference case, worldwide production from deepwater fields that are either producing now or under development is expected to reach 7.6 million b/d in 2025, and global deepwater production is projected to reach nearly 9 million b/d by 2040.



What are the Scour Effects on Offshore Substation Jackets?

As the hub of an offshore wind farm's energy export, connecting each individual wind turbine to the grid, the stability and integrity of the substation jacket and its cables is vital to successful windfarm operation. Failure or damage to the substation could mean lost transmission for the entire wind farm, with repair costs and loss of revenue running to tens of millions of euros.

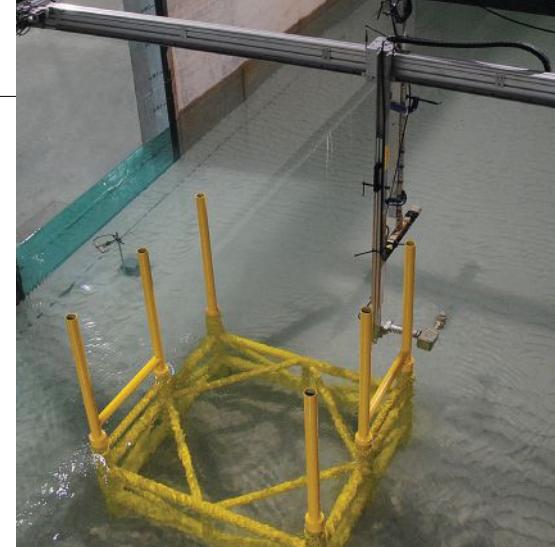
Physical model tests allow for the effects of scour to be accurately assessed under realistic conditions in the laboratory, which can be used to inform and optimise jacket design.

New research being carried out by the University of Rostock and HR Wallingford is assessing the development of scour around substation jacket foundations to

provide new insights for the University of Rostock in research funded by the German government.

Dr. Peter Menzel, from the Sediment Transport Research Group at the Chair for Ocean Engineering at the University of Rostock, said: "The data we are gathering in HR Wallingford's world-leading facilities is deepening our understanding of the effects of scour on offshore substation jackets in the German sector of the North Sea where substantial offshore wind development is both ongoing and being planned."

Results of the research will be published following completion of the program.



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U.S. Offshore Wind Market

Off to a Roaring Start in 2018

BY LIZ BURDOCK

EXECUTIVE DIRECTOR,

BUSINESS NETWORK FOR OFFSHORE WIND



Based on a positive election in New Jersey, offshore wind bids in Massachusetts and the release of the New York State Offshore Wind Master Plan, 2018 expectations for the U.S. offshore wind market were high. The first six weeks of 2018 indicate that the industry may have to raise its sights even higher.

In New York, the New York State Energy Research and Development Authority (NYSERDA) recently outlined its Master Plan, including its goal of 2400 megawatts (MW) by 2030 and a total of 800 MW in offshore solicitations for the years 2018 and 2019. The state is also investing \$15 million in workforce development and infrastructure advancement to ensure that the New York supply chain is ready to supply the components and skilled labor to build these wind farms when they are needed.

As expected, New Jersey's newly elected Governor, Phil Murphy, hit the ground running signing Executive Order Number 8 on 31 January, which directed the NJ Board of Public Utilities (BPU) to set a goal of 3500 MW by 2030, and begin work on a solicitation for 1,100 MW of offshore wind. Murphy has set the larger goal of 100% clean energy by 2050 and legislation was recently introduced calling for 100% clean energy by 2035.

Another state offshore leader, Massachusetts, stepped forward with Massachusetts Ocean Grid, a shared transmission system that would operate off the Massachusetts coast. The state, which is already processing bids for

up to 800 MW of offshore wind from three developers, also plans to work with the U.S. Bureau of Ocean Energy Management (BOEM) to auction off two more wind energy areas later this year.

Maryland, which was the first state to establish pricing for offshore wind energy using Offshore wind Renewable Energy Credits (ORECs) for 368 MW last year, increased its renewable portfolio standard (RPS) by introducing the 100% Clean Renewable Energy Equity Act of 2018, which calls for 100% renewable energy in Maryland by 2035 and a 2.5 GW carve out for offshore wind.

To support its supply chain development, the Maryland Energy Administration awarded three businesses more than \$500,000 combined to participate in the state's two offshore wind projects, Skipjack and U.S. Wind. U.S. Wind also committed to operating an Operations and Maintenance (O&M) facility in Ocean City, Maryland and a laydown and handling facility at Tradepoint Atlantic in Baltimore.

And, some unexpected states declared that they would pursue offshore projects this year. Rhode Island, which was expected to stop at its small but important five-turbine project off of Block Island, stated that they were going for more. Rhode Island Gov. Gina Raimondo directed Rhode Island's utilities to issue a procurement for up to 400 MW of clean energy, including offshore and onshore wind, solar, and hydro resources. Details of the RFP will be released at a later date.

Rhode Island's western neighbor, Connecticut, took its first steps into the offshore marketplace. Connecticut's Department of Energy and Environmental Protection (DEEP) issued an RFP seeking to solicit up to 825,000 MWh of offshore wind-generated power annually. Under the RFP, the minimum nameplate capacity of the projects must be no less than 2 MW, which may include paired and co-located energy storage.

The Business Network for Offshore Wind (the Network) actively follows this activity and held its first "State of the States" webinar for members on 26 January covering offshore wind updates from government officials along the Atlantic Coast from South Carolina to Massachusetts, plus California.



Learn about the most recent developments from the U.S. offshore wind developers and state regulators at the Network's annual International Offshore Wind Partnering Forum (IPF) held in Princeton, New Jersey, 3-6 April.

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Interior Announces Date for Largest Oil and Gas Lease Sale in U.S. History

The U.S. Department of Interior will offer 77.3 million acres offshore Texas, Louisiana, Mississippi, Alabama, and Florida for oil and gas exploration and development.

The region-wide lease sale, which is the largest in U.S. history, is scheduled for 21 March, 2018 and will include all available unleased areas in federal waters of the Gulf of Mexico. In 2017, offshore leases helped the Department raise a billion dollars more in revenue for the year than was made off energy revenues in 2016.

Lease Sale 250, scheduled to be livestreamed from New Orleans, will be the second offshore sale under the National Outer Continental Shelf (OCS) Oil and Gas Leasing Program for 2017-2022. It will include about 14,776 unleased blocks, located from 3 to 231 miles offshore, in the Gulf's Western, Central, and Eastern planning areas in water depths ranging from 9 to more than 11,115 ft (3 to 3,400 m).

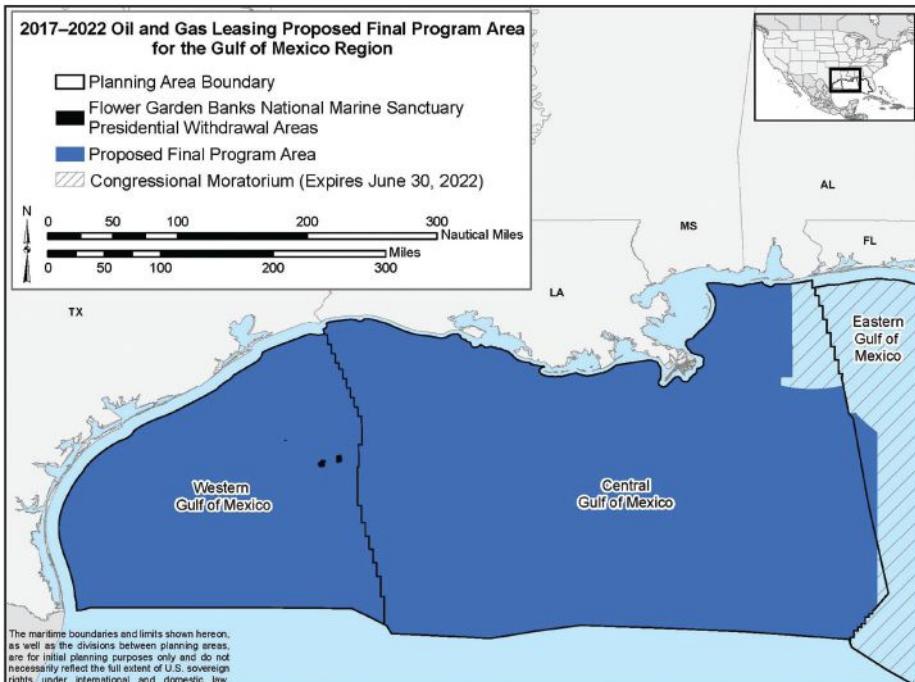
Money received from OCS leases (including high bids, rental payments, and royalty payments) are directed to

the U.S. Treasury, Gulf Coast states, the Land and Water Conservation Fund, and Historic Preservation Fund.

The lease sale terms include stipulations to protect biologically sensitive resources, mitigate potential adverse effects on protected species, and avoid potential conflicts associated with oil and gas development in the region. Additionally, The Bureau of Ocean Energy Management (BOEM) has included appropriate fiscal terms that take into account market conditions and ensure taxpayers receive a fair return for use of the OCS. These terms include a 12.5% royalty rate for leases in less than 200 m of water depth, and a royalty rate of 18.75% for all other leases issued pursuant to the sale in recognition of current hydrocarbon price conditions and the marginal nature of remaining Gulf of Mexico shallow water resources.

BOEM estimates that the OCS contains about 90 billion barrels of undiscovered technically recoverable oil and 327 trillion cubic feet of undiscovered technically recoverable gas. The Gulf of Mexico OCS, covering about 160 million acres, has technically recoverable resources of over 48 billion barrels of oil and 141 trillion cubic feet of gas.

For more information, visit
WWW.BOEM.GOV/SALE-250



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BP's Energy Outlook Examines a Range of Scenarios

The 2018 edition of BP's Energy Outlook has been published and considers the forces shaping the global energy transition out to 2040 and the key uncertainties surrounding that transition. The speed of the energy transition is uncertain and the new Outlook considers a range of scenarios.

Its evolving transition scenario, which assumes that government policies, technologies and societal preferences evolve in a manner and speed similar to the recent past, expects fast growth in developing economies, driving up global energy demand a third higher.

The global energy mix is the most diverse the world has ever seen by 2040, with oil, gas, coal, and non-fossil fuels each contributing around a quarter.

Renewables are by far the fastest-growing fuel source, increasing five-fold and providing around 14% of primary energy. Demand for oil grows over much of the Outlook period before plateauing in the later years. Natural gas demand grows strongly and overtakes coal as the second largest source of energy. Oil and gas together account for over half of the world's energy. Global coal consumption flatlines and it seems increasingly likely that Chinese coal consumption has plateaued.

FOR MORE INFORMATION, VISIT

www.bp.com/en/global/corporate/energy-economics/energy-outlook/energy-outlook-downloads.html

The percentage of cars powered by electricity grows to around 15%, but because of the much higher intensity with which they are used, account for 30% of passenger vehicle kilometers. Carbon emissions continue to rise, signaling the need for a comprehensive set of actions to achieve a decisive break from the past.

The new Outlook was launched in London by Spencer Dale, group chief economist, and Bob Dudley, group chief executive.



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NOBLE CORPORATION Reports 2017 Results

For the 12 months ending 31 December 2017, Noble Corporation plc reported a net loss attributable to the Company of \$517 million, or \$2.11 per diluted share, on revenues of \$1.2 billion. Results for the year included net unfavorable items totaling \$237 million, or \$0.97 per diluted share. Excluding these items, the Company would have reported a net loss attributable to Noble Corporation of \$280 million, or \$1.14 per diluted share.

Julie J. Robertson, chairman, president, and chief executive officer of Noble Corporation plc, stated, "I am proud of our numerous accomplishments in 2017. I believe these noteworthy operational achievements, together with the late-2017 negotiation of a new credit facility and the recent completion of a \$750 million Senior Notes issue and tender offer, reinforce our long history of strong operational execution and

sound financial strategy. They serve to strengthen Noble's competitive posture as we enter 2018."

Ms. Robertson added, "Although the market for offshore rigs remains highly competitive, we are confident that a demonstrated preference by customers for premium, high-specification jackups and floating rigs with highly qualified crews will continue, leading to improving opportunities across our premium fleet in 2018."

2017 highlights for Noble include strong fleet performance and record safety results; contract backlog sustained at approximately \$3 billion; new revolving credit facility extended to 2023; liquidity of \$2.5 billion, including cash of \$663 million; completed issuance of \$750 million of senior unsecured guaranteed notes; and further management of debt maturities following recent tender offer.



LIQUIDITY POSITION & BALANCE SHEET

Noble's total debt at 31 December, 2017 was \$4.0 billion compared to \$4.3 billion at 31 December, 2016. During January 2018, Noble issued \$750 million aggregate principle amount of 7.875% senior unsecured guaranteed notes due 2026. Net proceeds from the offering of approximately \$737 million and existing cash on the balance sheet were used to pay the purchase price and accrued interest, along with fees and expenses, in a concurrent tender offer to purchase \$750 million of Senior Notes due 2018 through 2024.

OPERATING HIGHLIGHTS

Utilization in the fourth quarter of the Company's floating rig fleet, consisting of eight drillships and six semisubmersibles, improved to 41% compared to 39% in the previous quarter of 2017. Utilization in the fourth quarter of the Company's 14 jackups was 76 percent compared to 81% in the preceding quarter.

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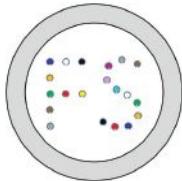
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FIBERSAFE™ TECHNOLOGY SYSTEM



FiberSafe™

AFFORDABLE SUBSEA FIBER OPTIC SYSTEM NEW TECHNOLOGY

Fiber optics has emerged as the preferred communication medium for subsea applications across various industries (oil and gas, ocean science, offshore renewables). Nevertheless, asset owners and operators are hard-pressed to justify it due to heavy CAPEX and prohibitive repair cost potential. Ormond Energy Innovations Inc. has developed a new technology platform called FiberSafe™ to holistically address the inherent drawbacks of existing subsea fiber optic systems and, in conjunction, realize commercial benefits to make subsea fiber optic system hardware CAPEX friendly. This patent, pending technology provides robust and inherently reliable end-to-end fiber optic communication network architecture with affordable subsea fiber optic system hardware.

FiberSafe™ technology is based on a simple premise that optical fibers shall be protectively maintained, similar to within a submarine cable, from topside source to subsea end-instrument without being exposed to

harsh environment. Optical fibers in the entire network are protected by hermetic tubes, protective storage, manifold, and hermetic fiber connector

contact tube string in a gel-filled non-pressurized environment. Furthermore, these fiber-protective boundaries are isolated from seawater by sealed housings containing pressure balancing benign fluid. Submarine cables that evolved since the late 20th century have demonstrated exceptional reliability, primarily due to the fact that fibers are maintained within layers of protection. In contrast, existing industry solution for subsea fiber optic systems commonly offered by various global suppliers involves elimination of the cable-protective layer with fiber break-out, feed-through, and harsh environment loading of optical fibers. Optical fibers in a FiberSafe™ system are maintained in a multi-layer protective environment in a stress-free

state isolated from seawater, chemicals, hydrogen, and other gases under all circumstances.

Typical FiberSafe™ communication system architecture involves submarine fiber optic cable links comprising cable termination, wet-mate connection, flying lead, and penetration subsea hardware. Configurable modular building blocks of this technology enable application-specific, fit-for-purpose, cost-efficient solutions instead of one-size-fits-all industry status quo, cost-prohibitive offerings with inherent drawbacks of exposed fibers. In the FiberSafe™ system, seal type, seal material, housing materials, and joining process options are tiered to cost efficiently address the severity of applications ranging from shallow water to deep and ultra-deep water, including HPHT. Additionally, it offers technical and commercial benefits that are non-existent in current industry solutions, including a) pressure-balanced design, b) fully testable seals prior to deployment, c) smaller footprint, and d) affordable overall system cost.

The fundamentals of the FiberSafe™ technology are applicable to an electro-optic submarine cable to produce a protective electro-optic subsea system. In this embodiment, electrical conductors and their insulation and electronics are also protectively maintained in a gel-filled, non-pressurized insulative medium without exposure to harsh environment. This further enables numerous opto-electronics applications at an affordable system cost that were not previously possible. This principle can also be extended to purely electrical systems without fibers.

Proof of concept test results have validated the technology premise. Qualification prototype development and testing are being carried out to demonstrate the technology and affordable system cost. Interested operators, asset-owners, and umbilical/control system or other equipment suppliers are invited to make enquiries to discuss participation in qualification testing or their system specific application.

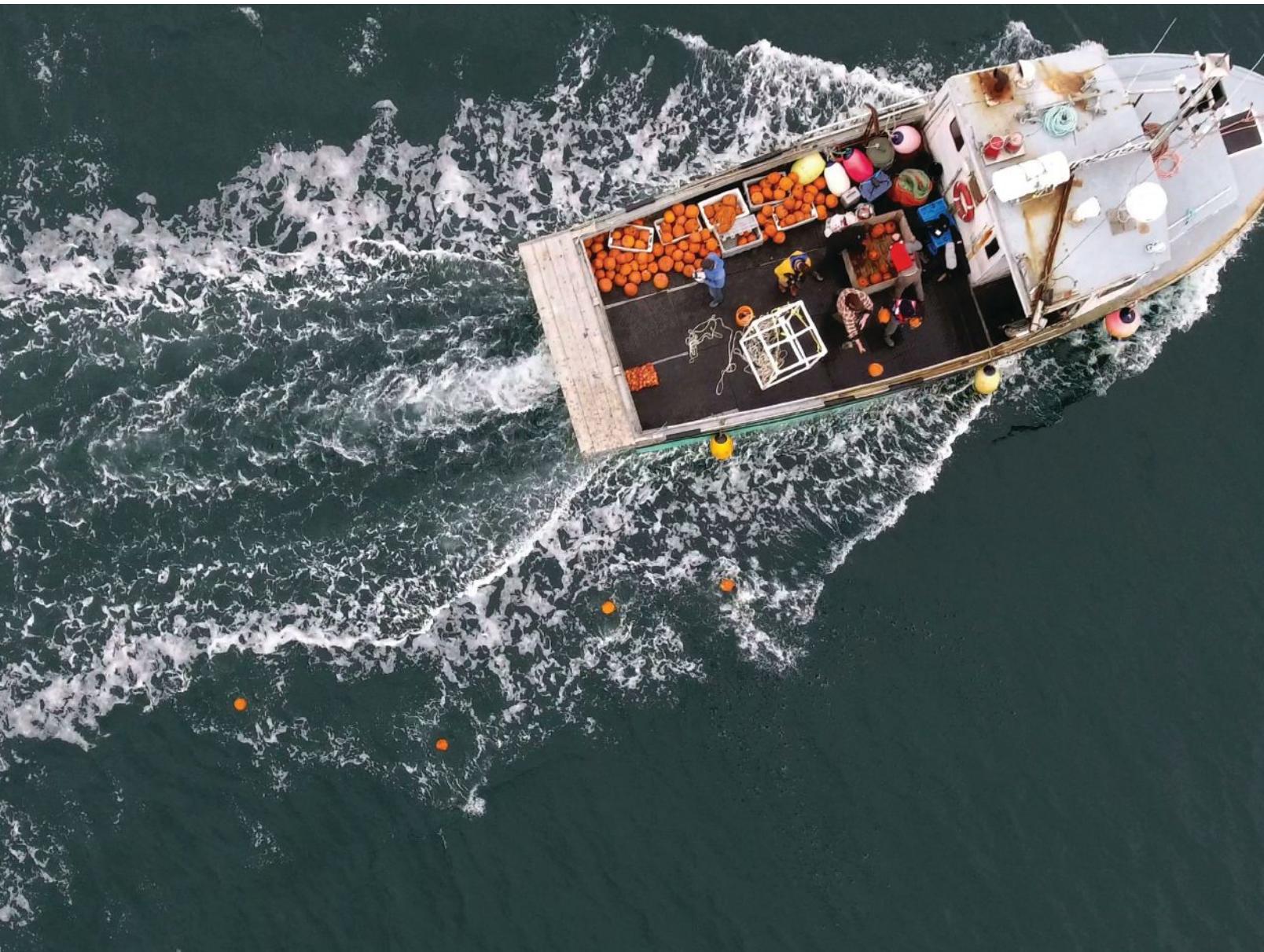
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TRACKING CANADA'S TIDES

BY KIRA COLEY | UK EDITOR



Higher resolution data is complemented by releasing swarms of biodegradable drifters (sometimes pumpkins) that are observed by the UAVs. The team georeferences the HD aerial video and use motion tracking to calculate the speed of the drifters. Photo courtesy of Luna Ocean.



HUMPBACKS BREACH
AS THE SUN SETS
OVER THE OUTER BAY
OF FUNDY, NOVA SCOTIA,
OFTEN WATCHED BY THE TEAM
FROM THE DECK OF THE LUNA
OCEAN OFFICE.

“A LOVE FOR THE SEA NATURALLY BROUGHT ME HOME TO NOVA SCOTIA & TIDAL ENERGY.”

Greg Trowse, President of Luna Ocean, 2017-2018 winner of Innovacorp's Blue Solutions Start-Up Challenge

Since 2009, Trowse has been supporting tidal energy developments across Nova Scotia. A decade later, he has been engaged in almost every turbine test conducted in the Bay of Fundy, as well as collaborating on research projects with Dalhousie University, Acadia University, and local companies such as Dynamic Systems Analysis and Huntley's Sub Aqua Construction.

In 2016, he founded Luna Ocean Consulting Ltd. with a continued focus on evaluating the potential for community-scale tidal energy developments to provide coastal communities with a sustainable source of power.

Trowse said, "For tidal energy projects to succeed, we need to better understand how tidal flows vary in time and space. This information is needed to optimize tidal turbine locations and power outputs, reduce turbine failures, improve energy predictions, and reduce operational costs. Success will help reduce our reliance on fossil fuels, while enabling the growth of a new industry, and its supply chain."

The Bay of Fundy has the largest recorded tidal range in the world with 160 billion tonnes of water flowing in and out of its passage twice a day.

In a report commissioned by the Offshore Energy Research Association of Nova Scotia (OERA), the tidal energy industry could generate up to 22,000 full-time jobs and contribute up to C\$1.7 billion to Nova Scotia's gross domestic product (GDP) by 2040.

With offices in Freeport and Shad Bay situated on the water, Luna Ocean is ideally positioned to bolster research and technology innovation in Nova Scotia's blossoming tidal energy industry.

In January 2018, Luna Ocean became one of two Blue Solution winners—a competition that hopes to expand on the increasing ocean technology development, and to ignite the start-up community in the region—receiving C\$60,000 (\$50,000) to support the advancement of tidal energy technology.

Trowse explained, "With tidal energy being in the early stages, success requires development of innovative data collection and processing tools. With respect to energy yield, there can be considerable spatial variation in resource over relatively small areas. Optimization of turbine siting while considering energy density and several other factors has a significant effect on project economics including the ability for projects to share the resource with other users, which is crucial to success."

"Marine operations are also challenging in high-energy tidal environments. The operational windows are short. We often only have 10 to 30 minutes to complete complex operations, so we need to have a very good understanding of the timing of these windows to plan and utilize marine assets in a safe and efficient manner."

In November 2016, Nova Scotia became home to one of the first large-scale grid connected tidal turbines in the world. Located at the Fundy Ocean Research Center for Energy (FORCE), Cape Sharp Tidal deployed a two-megawatt (MW)

Open-Centre Turbine at its berth in the Minas Passage. In the coming years, Nova Scotian deployments are planned by other companies, including Black Rock Tidal Power, DP Energy, Minas Tidal, and Spray Energy.

Canada is not the only country to have at least one eye on the tides. In the UK, the government estimates that wave and tidal in-stream energy combined has the potential to deliver around 20 percent of the UK's current electricity needs, according to RenewableUK.

In January 2017, The Hendry Review—an independent review of UK tidal lagoons—made over thirty recommendations for delivering and supporting innovative tidal projects to harness the vast potential of the UK's tidal range resource. RenewableUK are also looking to launch an Ocean Energy Race Campaign that aims to strengthen political support for developing wave and tidal energy in the country.

"For tidal energy to advance we need to address several uncertainties. In addition to advancements in flow speed analysis that we are currently focused on, we need significant innovation to evaluate and determine the effects on marine life, improvements in outreach and education, and to lower the capital and operational costs of tidal power projects. This is obviously a large challenge. From our perspective, government support for a demonstration project that is not financed based on the sale of energy to grid would help significantly. This would remove barriers associated with the effect of uncertainties on financing a commercial project and enable a focal point for research and innovation."

TRACKING THE TIDES

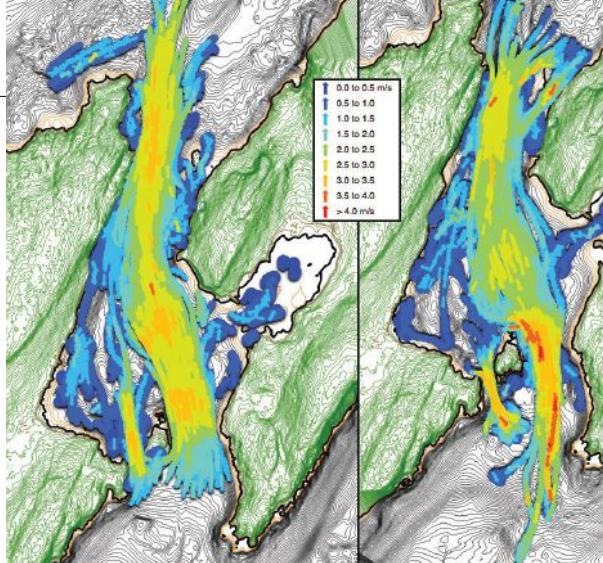
To evaluate how tidal currents change spatially, the Luna Ocean team map flows using hundreds of drifting sensors tracked by GPS and unmanned aerial vehicles (UAVs). Several GPS drifters are deployed upstream of an area of interest, tracked in real-time, and collected downstream. A process which is repeated throughout the tidal cycle.

Trowse said, "We complement this with higher resolution data by releasing swarms of biodegradable drifters (sometime pumpkins) that are observed by the UAVs. We georeference the HD aerial video and use motion tracking to calculate the speed of the drifters. We also have drifters that carry an ADCP [acoustic doppler current profiler] for measuring the vertical flow profile and use standard data collection techniques with vessel- and bottom-mounted ADCPs. The data are all processed using Luna Ocean Data Analysis Software (LODAS)."

For evaluating how tidal currents change in time, Luna Ocean is developing a module for LODAS called LunaTide. By using the strengths of standard harmonic analysis, it produces accurate predictions of water levels, then address weaknesses of standard approaches by evaluating the relationship between water levels and flow speeds.

Their work to date has been accomplished primarily with funding support from the OERA and Natural Resources Canada (NRCan). The Innovacorp funding award will further advance the analysis software and other data collection techniques to better assess water flows for tidal energy projects.

"We currently have existing prototypes, successful proof-of-concept testing, and commercial applications for several customers. Our preliminary results show



significant improvements in accuracy while also requiring less data at new areas of interest. There is potential for increases in accuracy, while also reducing the risk and costs associated with site characterization. The results are quite exciting, and we're fortunate to have ongoing support to create innovative tools that should benefit the industry," explains Trowse.



THROUGHOUT 2018...

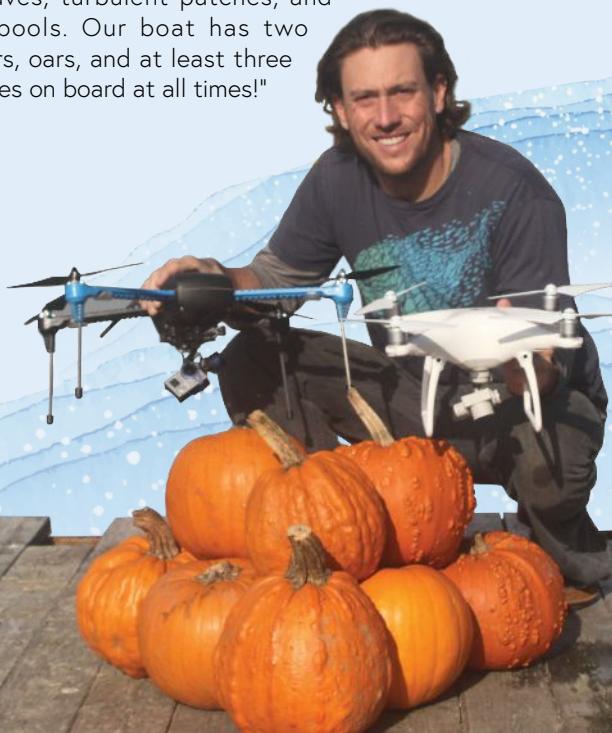
Luna Ocean plans to streamline the software package, making it more user friendly and robust, as well as refine the Drones & Drifters data collection technique and processing software.

With a love for the ocean and sustainable concepts, Trowse is also developing biodegradable drifters and assisting with advancements in tools used for marine life monitoring. He is also taking part in the formation of a not-for-profit to develop and run an ocean research and technology development center.

The Luna Ocean team plans to help evaluate the potential for community-scale tidal projects to be developed at off-grid diesel reliant communities throughout the Canadian north. A big part of this will be to train locals within communities to assist with data collection.

Trowse said, "We're very happy to be part of a long-standing and fast-growing ocean research and technology sector in Atlantic Canada. We're grateful of the financial support from Innovacorp, ACOA, OERA, and NRCan, and to our many friends, colleagues, the moon, and the sea for helping guide, contribute to, and inspire our journey to explore and investigate many beautiful high-energy ocean environments."

"We plan to continue going with the flow, working with world-class researchers and highly knowledgeable locals to evaluate tidal energy as a potential sustainable community-scale energy solution. We know not to fight the tide, but there are lots of challenges along our route in the form of waves, turbulent patches, and whirlpools. Our boat has two motors, oars, and at least three paddles on board at all times!"





OCEANGATE Launches 5-Man Submersible *Titan* to Survey the RMS *Titanic*

OceanGate Inc., a provider of manned-submersible services, announced that it has launched *Titan*, formerly known as Cyclops 2, the world's only privately owned manned-submersible capable of reaching *Titanic* depths of 4,000 m.

Titan is comprised of two major components: a 5-man submersible and an integrated launch and recovery platform. This tandem is scheduled to undergo sea trials in Puget Sound through March 2018, with deep-sea certification in the Bahamas in April. The team will then mobilize to St. John's, Newfoundland in late June for the first manned expedition to the RMS *Titanic* since 2005.

To accomplish this expedition, OceanGate engineered and built *Titan* using some of the most innovative and advanced technology and materials:

- A filament-wound carbon fiber hull—the largest of any manned submersible
- Two titanium hemispheres—the forward dome hinges to serve as the access hatch for easy entry and exit
- The largest viewport of any deep-sea manned submersible
- Electronics and thruster control pods housed outside the pressure hull to increase space available for crew and equipment onboard
- A fiberglass hull insert to prevent condensation from dripping on the crew and eliminate electrical ground faults—two problems that plague metal-hulled submersibles

- A large digital display that streams a live feed from multiple exterior 4K cameras and also acts as a door to the aft equipment bay
- Acoustic modem for text-based communication between sub and surface ship
- A proprietary steering control system using a standard Playstation® controller

One of the most significant innovations is *Titan*'s proprietary real-time hull health monitoring (RTM) system. *Titan* is the only known manned research submersible to employ an integrated real-time hull health monitoring system. Utilizing nine acoustic sensors and 18 strain gauges co-located throughout the pressure vessel boundary, the RTM system makes it possible to analyze the effects of changing pressure on the vessel as the submersible dives deeper and accurately assess the integrity of the structure. This on-board health analysis monitoring system provides early warning detection for the pilot with enough time to arrest the descent and safely return to surface.

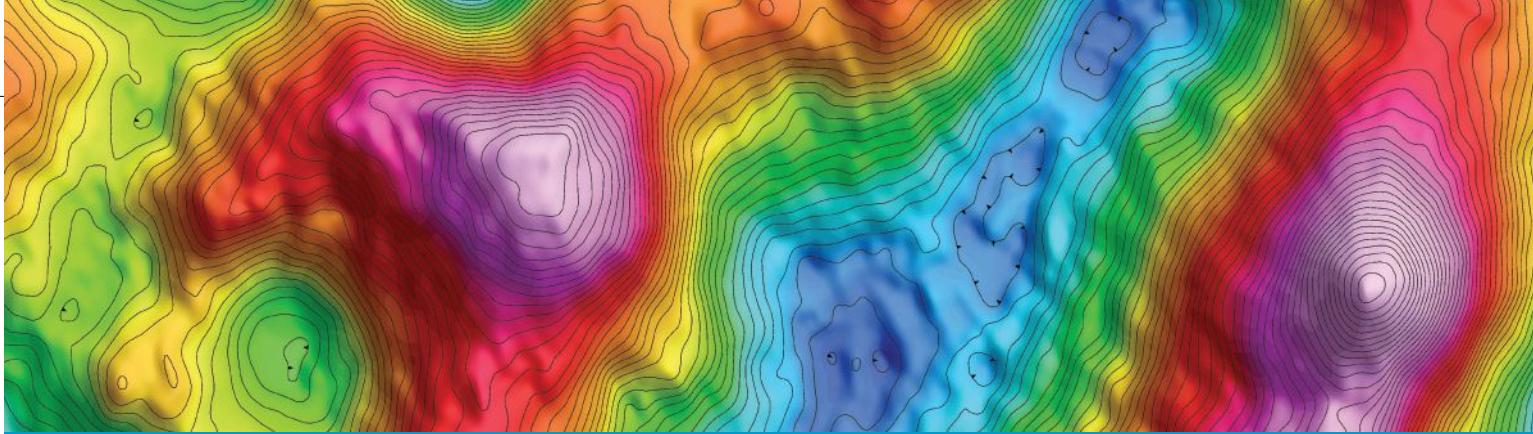
"We believe real-time health monitoring should be standard safety equipment on all manned-submersibles," said Stockton Rush, OceanGate CEO.

The real-time health monitoring system will make it possible for the team to take a methodical approach to live testing. During the deep-sea certification dives in the Bahamas, Stockton Rush will become the second person in history to dive solo to 4,000 m. These dives will validate the design depth, and *Titan*'s maximum depth dive will be certified by an independent certification organization.

Titan will be equipped with multiple 4K cameras, multibeam sonar for navigation, data tablets with a wireless connection to on-board computer systems, 50 thousand lumens of external light, a laser scanner, and four electric thrusters for maximum maneuverability.

Titan is the second in the series of Cyclops-class submersibles. OceanGate has operated Cyclops since 2015 in three oceans to depths of almost 500 m.

For more information, visit
WWW.OCEANGATE.COM



CGG MULTI-PHYSICS Sets Industry Benchmark

CGG's Multi-Physics Marine group achieved a production rate of 99.7% in 2017, including acquisition of gravity and magnetic (GravMag) data totaling nearly 24,000 sail line kilometers during one of the world's largest proprietary 3D marine seismic surveys.

With five years of sustained production rates of over 97%, this year marks the highest. CGG Multi-Physics attributes this year-on-year success to their highly skilled field personnel, responsive support team, and high operational quality standards. For example, data from the vessels are evaluated on a daily basis to ensure the best possible performance, each marine GravMag data acquisition system undergoes a meticulous maintenance routine and rigorous testing before and after deployment, and field personnel at its Houston, Texas facility receive regular training and evaluation.

To match its near-perfect operational productivity, Multi-Physics Marine has received excellent customer satisfaction ratings for its GravMag data acquisition and processing services. Using its suite of industry-leading LCT software, exclusive processing techniques, and state-of-the-art in-house GIS capabilities, its data processing team is acknowledged for providing high-quality client-specific deliverables with a swift turnaround. Upon delivery of the marine GravMag data acquired in conjunction with the recent innovative TopSeis™ project in the Barents Sea, Mats Andersson, external geophysical advisor for Lundin Norway AS, said: "...we have reviewed the processed data on this project. The free air and Bouguer gravity along with the total magnetic intensity looks great! Thank you very much for an excellent delivery from you and your team!"

The value marine GravMag data adds to the bigger geoscience picture for a relatively small investment is demonstrated in CGG's North Viking Graben and Gabon Jumpstart™ packages. The data enhances the overall understanding of an area by providing information that allows for clearer differentiation and more confident modeling of geological formations and structures than with seismic data alone.

Above: Marine gravity data from the Gulf of Mexico showing deep salt feeders (dark blue), salt diapirs (light blue), and the centers of mini-basins (purple).

Image courtesy of CGG Multi-Physics.

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Subsea Line Testing without Disconnects



The V-SUPPLY unit incorporates V-LIM technology and Spread Spectrum Time Domain Reflectometry (SSTDR) for continuous integrity monitoring of electrical conductors.

Maintaining and monitoring subsea electrical networks can be a costly and time-consuming task. Several different topside devices are used to support these networks, including electrical power modules, controller modules, and monitoring devices. Line integrity monitoring (LIM) devices are installed to check the integrity of cable insulation through the measurement of insulation resistance (IR). Using lower voltages than Megohmmeters, measurements have a lower accuracy but offer the advantage of providing a continual picture through which the operator can see any developing trends that may alert them to a potential problem.

If the LIM alarm is tripped, a higher accuracy Megohmmeter test can be scheduled, which traditionally requires a qualified person to be flown to the platform with the appropriate test equipment, cables disconnected, and Megohmmeter tests carried out. This can typically take up to a whole working shift, requires bed space for the technician while they are on site, and is a costly, time-consuming process during which production is stopped.

As cables are disconnected, there is an increased risk to safety and greater chance that faults are introduced to the system through the disconnection/connection process. There is, however, an approach that combines electrical power supply control and LIM technology in a unit that improves data logging capability of system IR, gives a clearer picture of the status of the subsea network, and can reduce the cost of additional line testing.

V-SUPPLY from Viper Innovations is a new type of topside module with in-built over-voltage and over-current protection and advanced, integrated LIM capability. It uses a touchscreen HMI for easier operator interaction, provides greater detail of IR measurements, and has clearer reporting than traditional technology. The design of the module with a patented test procedure also enables Megohmmeter testing without disconnecting or the need to mobilise additional technician resources. The benefits it offers are enormous to offshore operators.

Megohmmeter testing using V-SUPPLY only requires the Megohmmeter test box itself to be shipped to the platform. The intuitive process requires no special training as the operator is guided through the testing process with clear instructions and interlocks on the V-SUPPLY touchscreen HMI.

Once initiated, the coding within the module will not allow the test to proceed unless test procedures are followed exactly. Without the need to disconnect cables, the test simply requires the Megohmmeter test box to be connected to the V-SUPPLY unit and "Go" pressed on the touchscreen. The whole test process is completed in a matter of minutes, reducing testing downtime and providing safer test conditions. V-SUPPLY controls the testing process and will only return to its safe, normal mode of operation once the process is complete.

Additional benefits of the V-SUPPLY unit include the incorporation of V-LIM technology and Spread Spectrum Time Domain Reflectometry (SSTDR) for continuous integrity monitoring of

electrical conductors. Units have remote control and monitoring functionality with even the option for remote restart. Operators can also select to enable either V-LIFE or V-IR technology within the device. V-IR provides a more detailed map of risk areas in the subsea network using V-SLIM (Subsea Line Integrity Monitoring) devices installed at strategic junctions in the network.

These scan for faults upstream and downstream of their installation point and feed the information back to the V-SUPPLY base module. V-SLIM modules are installed around cables and do not require disconnects in the subsea network. V-LIFE actively heals insulation on subsea cables. It has been proven to extend the life of failing cables and offers a way of protecting cables to reduce or even negate water ingress failures caused by the degradation of cable insulation materials.

For more information, visit
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ECA Group and Petrus Partner for Subsea Robotics Services

The A18D AUV is designed and manufactured by ECA Group to dive up to 3,000 m depth and work autonomously for 24 hours. It can carry out inspection and 3D mapping missions, revealing seabed conditions before or after construction/installation of an underwater structure, pipeline, or cable and also before, during, and post decommissioning of subsea installations.

After evaluating the market since June 2017, the ECA Group and Petrus have entered into a partnership agreement to offer the oil & gas sector inspection and survey services using the A18D AUV.

As part of this contract, ECA Group will lease the AUV to Petrus, while also providing operational support. Petrus, with its solid experience in the oil & gas market, will carry out and coordinate missions from preparation to data processing and delivery of results to the customer.

This partnership guarantees to ECA Group a cumulative turnover of €6 million over the next four years, which can increase according to the rate of use of the underwater robot. Depending on the commercial success, additional A18D AUVs could be commissioned as part of this partnership.



The agreement can be extended to other robots in the ECA Group range according to need. The use of autonomous underwater drones is a growing demand within the Oil & Gas industry, first because they significantly reduce the cost of operations compared to traditional processes that require larger and more expensive vessels as well as longer durations for a given operation and second because they provide superior data quality. This agreement is the largest ever signed by ECA Group for its AUVs in the Oil & Gas sector.

For more information, visit
WWW.ECAGROUP.COM



For more information, visit
WWW.ENPRO-SUBSEA.COM

ENPRO SUBSEA Wins Frame Agreement Contract with Tullow Oil

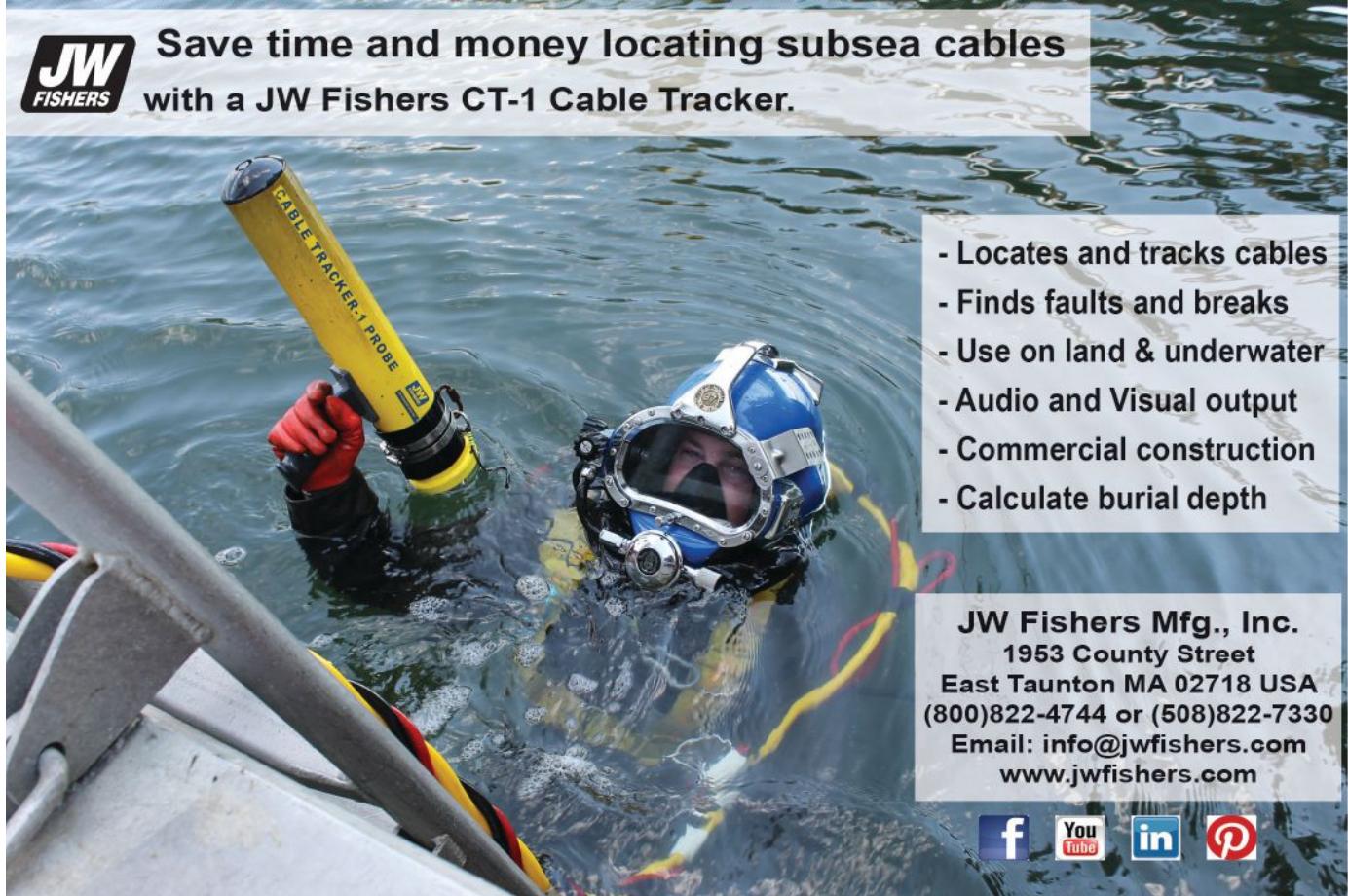
Production optimization specialist company Enpro Subsea has been awarded a frame agreement contract to support leading multinational exploration and production (E&P) company Tullow Oil as part of the operator's strategic activities in Ghana.

The contract will see the Aberdeen-headquartered firm delivering its innovative subsea intervention technologies to support Tullow's plans with new and existing wells in the Jubilee & TEN fields.

The campaign will see a consignment of up to 15 of its patented flow access modules (FAMs) being deployed in phases during 2018 and 2019 to facilitate a range of immediate applications, including multiphase metering, scale squeeze, and acid stimulation in addition to potential future applications like fluid sampling and water cut metering. The FAM system provides capital efficient, fast-track field development using standard subsea hardware. The work will continue to be delivered by Enpro Subsea personnel as they work towards establishing a permanent presence in the region.

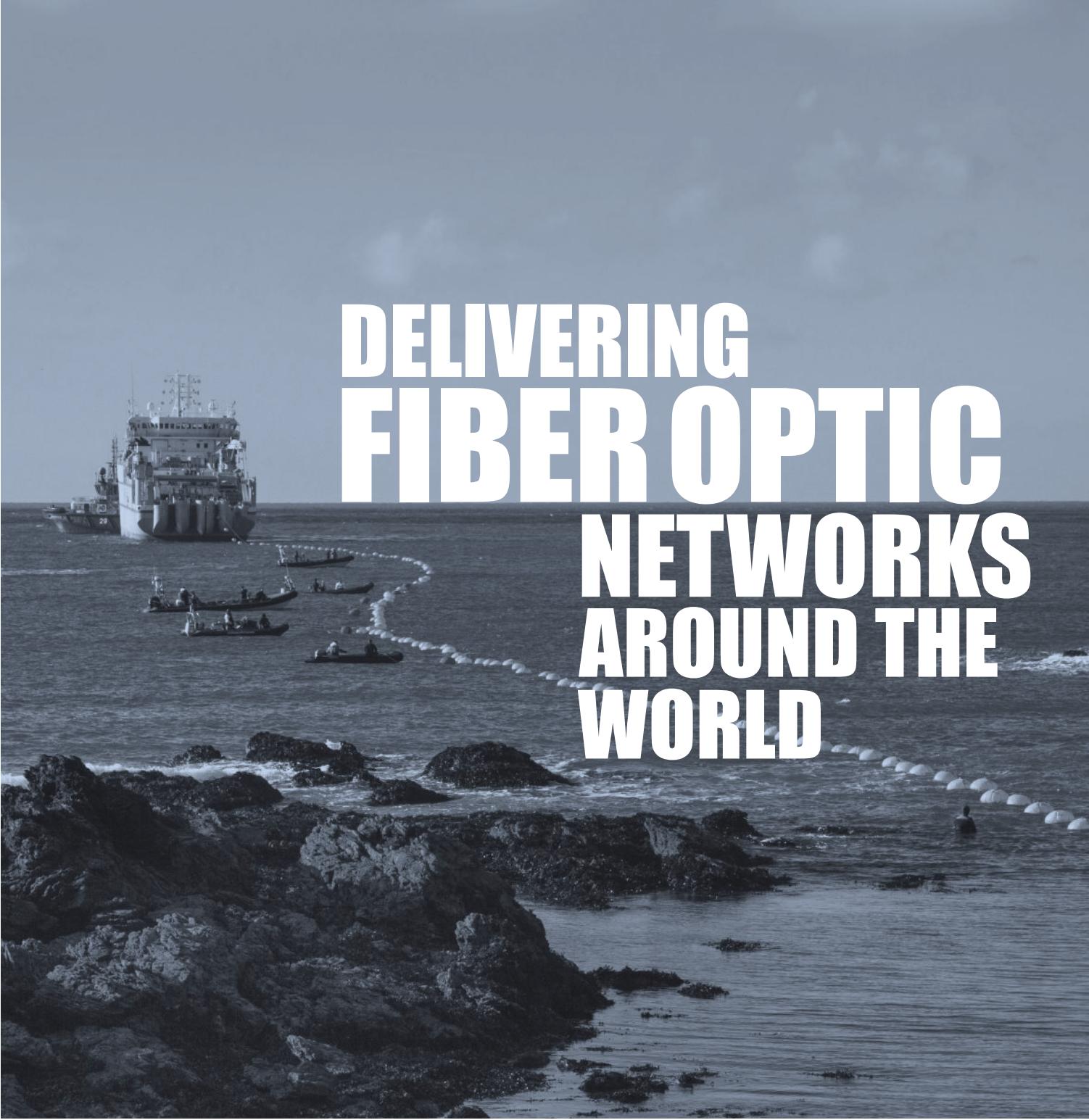
The first award in 2016 saw Enpro supplying five FAMs to the E&P business, which also marked its first export of its unique modular systems to a major international region. Last year, Enpro's FAM technology was a contributing factor to a major operator in the Gulf of Mexico achieving first oil in just 11 months—a record time for the operating company and one month ahead of schedule.

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Can We Secure Undersea Cables?

More must be done to protect the Internet infrastructure provided by undersea cables, urged Rishi Sunak MP in a December 2017 report published by Policy Exchange, "Undersea Cables: Indispensable, insecure."

The report was endorsed by Admiral James Stavridis, U.S. Navy (Ret), former NATO Supreme Allied Commander; Robert Hannigan, former Security Adviser to the Prime Minister and Director of GCHQ until earlier this year; and General Lord Houghton, former UK Chief of Defence Staff. The following is a summary of that report, as compiled by ON&T staff.

Indispensable Infrastructure

Approximately 97% of global communications and \$10 trillion in daily financial transactions are transmitted not by satellites in the skies, but by cables lying deep beneath the ocean. This submarine network, comprising an estimated 213 independent cable systems and 545,018 miles of fibre, is one of the world's most indispensable pieces of infrastructure, yet it is inadequately protected and highly vulnerable to attack at sea and on land, from both hostile states and terrorists.

Inadequate Protections

Since the first trans-Atlantic cable was laid in 1858, undersea cables have generally been owned and installed by private companies. Although this is good for taxpayers, it also means that most governments have not given undersea cables enough attention. Unlike ships, cables that pass under the sea fly no flag and are, therefore, not registered as being legally associated with any particular nationality. This raises complications for the status of cables under international law that the international community has attempted to address with a number of multilateral agreements.

Current international law—largely the 1982 United Nations Convention on the Law of the Sea (UNCLOS)—does not give states adequate jurisdiction over offenders, the ability to board suspect vessels, protect cables on land, and is not consistently enacted domestically

by all nation states. Moreover, much damage can be done without even violating the law. For example, UNCLOS in no way prohibits states from treating undersea cables as legitimate military targets during wartime.

Credible Threats, Easy Targets, and Catastrophic Impacts

Short of nuclear or biological warfare, it is difficult to think of a threat that could be more justifiably described as existential than that posed by the catastrophic failure of undersea cable networks as a result of hostile action.

While the diversity of cable connections to economies like the UK and United States offer enough resilience to ensure that accidental damage does not pose a realistic threat of a catastrophic outage, coordinated sabotage on multiple cables has the potential to pose a major threat to the UK. The threat this poses is illustrated by the submarine cable connections between Europe and India. If one or two cables were damaged accidentally, functionality would be unlikely to be significantly impaired thanks to spare capacity. Cut three cables, however, and India would lose 70% of its data traffic with Europe.

Describing the potential impact of hostile actions, Robert C. Fonnow (then a senior advisor to U.S. State Department on telecommunications), wrote this in a 2006 article for the Armed Forces Communications and Electronics Association (AFCEA): "Cascading failures could immobilize much of the international telecommunications system and Internet...The effect on international finance, military logistics, medicine, commerce and agriculture in a global economy would be profound...Electronic funds transfers, credit card transactions and international bank reconciliations would slow to a crawl...such an event would cause a global depression."

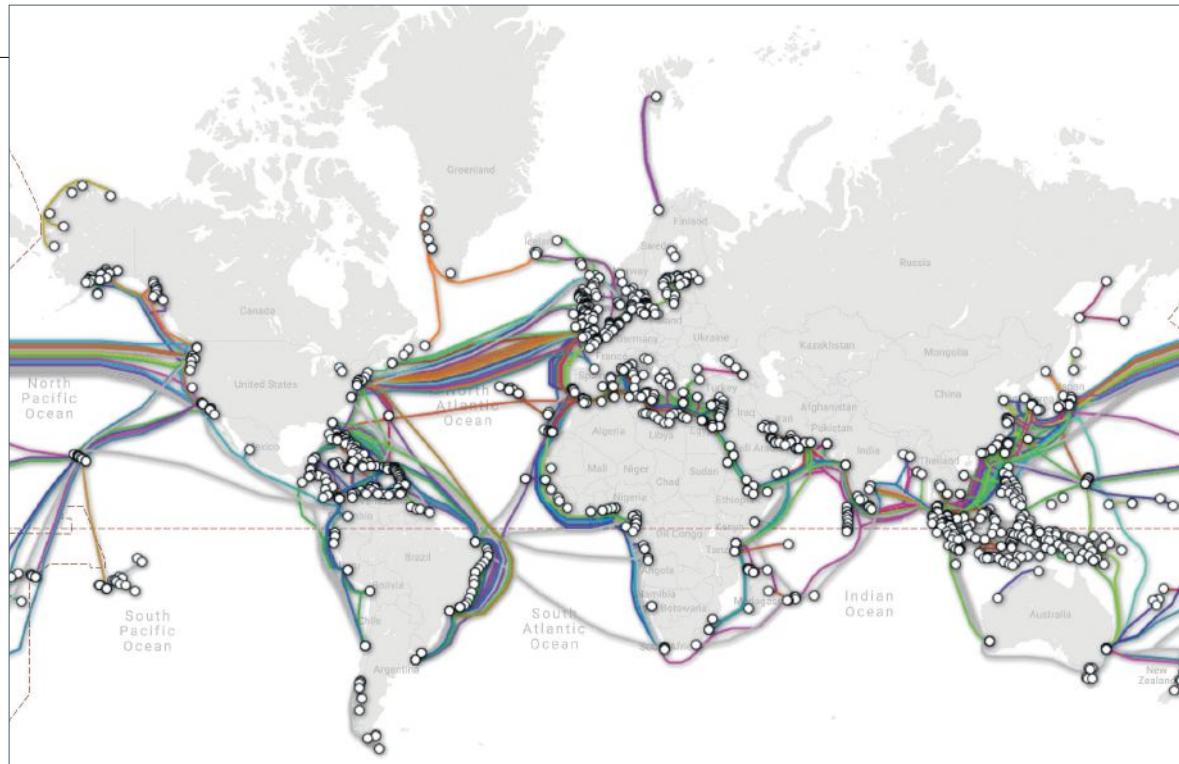
Cables are vulnerable because their location is generally publicly available, they tend to be concentrated geographically, and it requires limited technical expertise and resources to damage them. Cables at sea are located hundreds if not thousands of miles from anywhere or anything that can detect and monitor the presence of a hostile maritime actor. Also, damage done at these depths is hard to locate and repair.

Undersea cables come ashore in just a few remote, coastal locations. These landing sites are critical national infrastructure but often have minimal protection. A foiled Al-Qaeda plot to destroy a key London Internet exchange in 2007 illustrates the credibility of the threat.

U.S. intelligence officials have spoken of Russian submarines "aggressively operating" near Atlantic cables as part of its broader interest in unconventional methods of warfare. When Russia annexed Crimea, one of its first moves was to sever the main cable connection to the outside world.

Accidental Damage Also a Threat

The most straightforward threat to undersea cables is posed by unintended error. The United Nations estimates that between 100-150 cables are damaged annually with the most frequent culprit being fishing activity. In July 2017, for instance, Somalia suffered a near total Internet outage for three weeks as a result of offshore cable damage—an incident that is estimated to have cost the economy in the region of \$10 million a day, about half of Somalia's daily national output.



Submarine Cable Map courtesy of TeleGeography.

Another incident occurred in December 2008, when three of the world's largest undersea cables, connecting Italy with Egypt, were severed by shipping traffic in the Mediterranean. In a matter of hours, disruptions to regional connectivity had knocked out 80% of the connectivity between Europe and the Middle East. Given that the U.S. military relies upon commercial cable networks for 95% of its strategic communications, this posed serious operational problems for the nearly 200,000 British and American troops stationed in Iraq at that time.

An Existing Model for Protections

As remote island nations with highly developed economies, Australia and New Zealand have more reason than most to be alert to the dangers of cable damage. These vulnerabilities have led the two countries to implement Cable Protection Zones (CPZs), a series of restricted areas within the two nations' sovereign waters in which all anchoring, bottom trawling, and most types of fishing are banned in order to prevent cable damage. The bans are enforced by substantial fines. A number of organizations, including the International Cable Protection Committee, have argued for more widespread use of CPZs in order to reduce the frequency of cable faults.

RECOMMENDATIONS

- NATO nations should undertake naval exercises and war games to hone potential responses to an attack on undersea cable infrastructure. These exercises would work with the submarine cable industry to test protocols and defense strategies in an international setting. Furthermore, it may be necessary to increase NATO maritime capabilities to protect freedom of the seas and our sea lanes of communication.
- Individual nations should specifically consider risks from attacks on undersea cable infrastructure and ensure steps are being taken to mitigate this risk and that their maritime assets are sufficient.
- Review and improve security at landing sites where cables come ashore.
- Governments should work with private communications companies to install more backup "dark cables" and improve monitoring at sea.
- Follow the example of Australia and New Zealand and establish Cable Protection Zones around the highest value communications corridors.
- Develop a new international treaty to protect undersea cables.
- Deploy better monitoring equipment on cables, such as requiring cable laying companies to place relatively cheap sensors that detect sonar frequencies near key undersea infrastructure and along cable routes. If the sensors were tripped, they could alert nearby coast guard or navy asset.

FROM BRAZIL TO AFRICA in the Blink of an Eye

The First Subsea Cable Link Between the Americas and Africa Makes Landfall

Angola Cables, a telecommunications multinational, has reported that the South Atlantic Cable System (SACS) has made landfall at Fortaleza on the Brazilian coast, making it the first fiber line connecting Africa and South America. The installation of SACS was made on 23 February in the city of Fortaleza. The cable now enters its final

phase of completion and is expected to go live by September.

SACS will have an initial capacity of 40 Tbps and will provide direct internet connectivity between the two continents and onwards to the US. There will then be significant improvement in communications and content sharing

between Angola, African countries and the Americas. Latency will be reduced fivefold from the current 350 thousandths of a second to just over 60 thousandths of a second. Angola Cables CEO, António Nunes said, "Once SACS has been fully commissioned, we will see a significant improvement in communications and content sharing between Angola, African countries and the Americas."

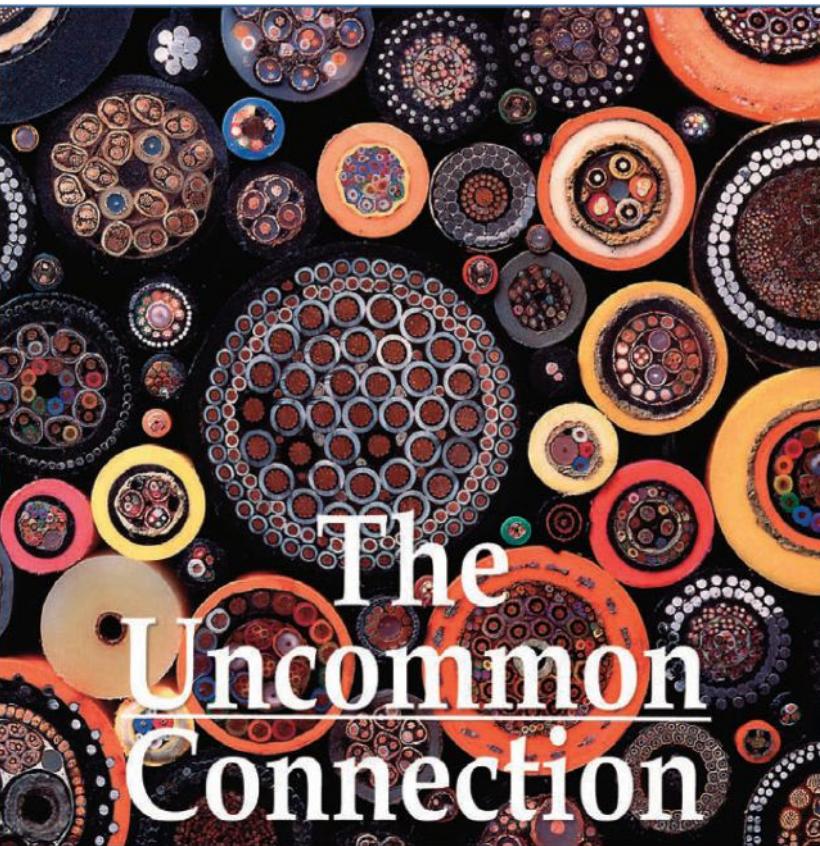
OSI LEADS NETWORK DEVELOPMENT OF SACS

Developing onward high capacity connectivity for SACS has been crucially important. Ocean Specialists, Inc. (OSI) has been imbedded with the Angola Cables network development and executive teams. After successfully identifying and developing key strategic partnerships, OSI led the partner working committees, network and technology assessments, and landing station vetting and selection. OSI oversees all construction, installation, commissioning and initial operations and management processes on behalf of Angola Cables. They did the same for the MONET project. Meanwhile, the fiber-optic cable was supplied by Japan's NEC, with France's Orange Marine laying it on the ocean bed.

MONET is being developed alongside SACS, providing much needed Transatlantic capacity capable of linking Africa, India and Asia to North America via the Southern Hemisphere.

"Investments made by Angola Cables and its partners in underwater cable systems, such as the West African Cable System (WACS) and MONET—connecting North and South America—combined with other investments in terrestrial infrastructure such as data centers, are opening up global communications networks. It is also reorienting worldwide internet traffic and is effectively positioning Angola as a telecommunications hub in sub-Saharan Africa." concluded Nunes.

For more information, visit
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For nearly 20 years, Ocean Specialists, Inc. (OSI) has developed international fiber optic networks for the telecom, energy, government, and science industries. OSI offers a full range of commercial and technical services that investors, developers, and operators of subsea networks use to manage risk and move a project through its life cycle.

A subsea cable is typically developed via a phased approach for Planning, Design, Procurement, and Installation processes. Each phase has schedule, financial, and technical risks that can significantly impact the project. The OSI team couples a "been there, managed that" awareness of the network development risks with a disciplined cross-team approach to identify, plan for, and mitigate those risks.

Our commitment to protect our clients' interests is built into our corporate culture and begins with our commitment to our employees. OSI has built our team with the most skilled and experienced submarine telecom professionals in the industry, and unlike many consulting companies, we employ most of our staff on a full-time basis. Our customers benefit from our in-house mix of commercial and technical experts and their wide range of experiences; our employees benefit from a culture that promotes shared knowledge, experiences, and new ideas.

Over the past decade, OSI has made a significant investment to expand our global footprint and capabilities. Today, our global capability is evident in our projects either recently completed or in development: SACS and MONET in the Atlantic and the Americas, ATISA and Tonga in Asia Pacific, SAPL which will link Chile to Florida, and Quintillion, the first subsea cable in northern Alaska. We have also invested in addressing industry needs by developing new products where there is a technology or capability shortfall.

Specifically, the following products are new in our portfolio, and all have been developed to meet customer demand:

- **Subsea Node** – As one of the few subsea network groups that has worked extensively with seafloor network technologies, OSI developed a subsea node based upon specifications and design requirements from our customers in the Energy, Science, and Government markets. The request from these industries is for a node that is designed and built to a common spec, replicable in form and functionality, and that can be supplied at a significantly lower unit cost once in production. Branded OceanHub™, OSI's subsea node consolidates proven power and communications components with common sensor packages, facilitating a rapid delivery and installation cycle.
- **Cable Portal (C-Portal)** – OSI has completed design and delivery of the C-Portal™, our premiere geospatial information platform that provides cable owners and operators the ability to warehouse and access network and operational data in a cloud-based environment. Our network development customers as well as our Cable Maintenance Authority customers utilize the geospatial information functionality during critical incidents, for routine O&M and also for streaming live data feeds such as for AIS Asset Protection.
- **Power Feed Equipment** – In 2013, OSI designed, built, and deployed a constant voltage power feed system (CV PFE) on a private submarine cable network. The units have operated on the system since deployment without failure. OSI is working with suppliers and technology customers on enhancements to the existing specifications and capabilities in order to meet a wider industry need. We see the provision of these units going forward as a critical component of subsea network development.



The global subsea network industry is continuously evolving. New technologies, emerging geographies, and the expanding service footprints of global industries drive the need for new network capacity. OSI will continue to address the evolving needs of our customers, employees, and the submarine cable industry in the coming years. We are always amazed at the pace of change and will continue our efforts to help lead the way forward.

Make the Most Out of Subsea Cable Investment

BY CHAD LAMB | CHIEF SYSTEMS ARCHITECT FOR XKL

Today, networks are able to handle the load required by the expanding user base by deploying more and more fiber optic cable and adding additional wireless sites. This is oftentimes a typical solution to the expanse of usage, however it may not be the most economical. The answer often lies with efficiency gains in the technologies that transport data around the world.

In the face of demand and growth, bandwidth management is essential for network operators. The process of controlling traffic passing through routers to ensure there is enough room for a traffic surge has been a critical aspect in the network operator's toolbox. No network operator wants to accept packet loss or high latency as today's end-users consider such inconveniences unacceptable. There are many complex approaches to bandwidth management, but one of the most effective conveniently takes place at the simplest network layer.

The Open Systems Interconnection (OSI) model is used to abstract the various layers of a network in terms of their fundamental structure and technology. Each layer performs a role in a network, and each higher layer relies on the layer

below it. The conceptual model spans from Layer 1, where data are transmitted through physical mediums, all the way up to Layer 7, where users receive information via computing applications.

Channel Utilization

Manipulating router port utilization is a key tool for many network operators. A 10 Gigabit (10G) router port, for example, does not transmit and receive 10G of packet data; 10G is the maximum line rate of the port, not the actual throughput. The amount of data packets constantly passing through the router port will be something less than 10G. Typically, network operators dial back the utilization of their router ports anywhere from 15% to 50%. This means from 50% to 85% of the time, the router port is not transmitting data and, rather, is idle or sending empty packets. Under heavy load conditions this reduction of throughput works to the network operator's advantage when peaks in traffic are experienced. Network operators do not design their networks to support the maximum possible bandwidth; the typical usage is the design target. This is where statistical multiplexing can help. By taking advantage of inconsistent Internet traffic and port utilization targets of network operators, statistical

multiplexing significantly improves network throughput, allowing operators to efficiently transport data through their networks.

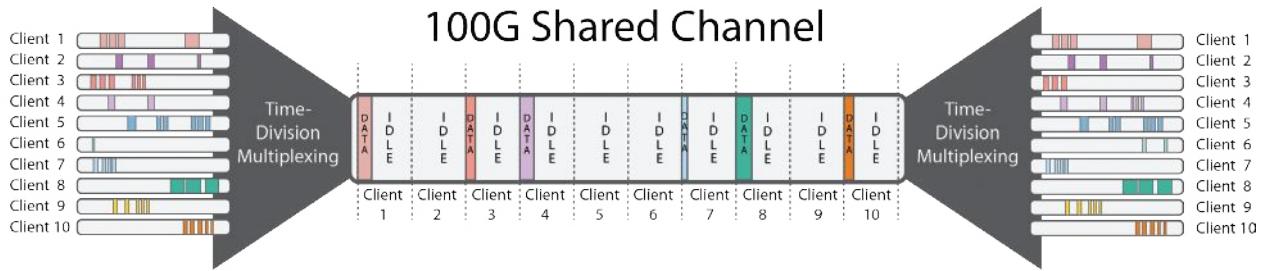
Maximize Your Assets, Get the Most Capacity Out of Subsea Cables

Based on network operator channel utilization and the statistics of Internet traffic, inefficiencies in network bandwidth utilization are very common. How can network operators make better use of idle router ports and maximize their investments? In 2016, XKL, a Seattle-based company that engineers and manufactures optical networking equipment, introduced a 100G optical transport solution called eVelocity leveraging statistical multiplexing for Layer 1, the optical transport layer. Statistical multiplexing is not a new concept in the world of computer networking; in fact, it had its beginnings at Bell Labs in the 1960s and became popular in the 1990s when network providers were concerned with Quality of Service in the early days of broadband.

Why Statistical Multiplexing for Layer 1

Statistical multiplexing is defined as the sharing of a communication channel using the statistics of demand; this





is generally referred to as dynamic bandwidth allocation. Internet traffic is wave-like, and peak usage is much greater than average usage. Static partitioning schemes, like time-division multiplexing, are not well suited for data communication like the Internet. By applying statistical multiplexing algorithms to Internet equipment, networks can be built for significantly less.

How Does the Algorithm Work?

An example of a typical use case would be 10 users sharing a communication channel. If each of the 10 users was running a 10G link, and the shared communication channel was 100G, then a static aggregation scheme such as time-division multiplexing can support all 10 users sharing the 100G channel. This is illustrated in the graphic above. Since the shared channel has the capacity to support $10 \times 10\text{G}$ users, there is no problem with this method.

There are two drawbacks to this approach. First, an 11th user cannot share the channel. The time-division multiplexing technique cannot aggregate 11 users of 10G down a 100G shared channel. Second, if each user is operating at 50% line utilization, for example, then the aggregate bandwidth on the shared channel will be approximately 50% of 100G. So, about half of the available shared channel bandwidth is wasted and goes unused.

By taking advantage of the statistics of demand, a statistical multiplexing algorithm to this same scenario enables many more users to share the channel. In this example, there are 24 users of 10G sharing a 100G channel.

The shared communication channel is the same as previous, 100G. Each user is active 40% of the time (utilization). Under these conditions, the shared communication channel can transport all user data without any dropped packets or collisions. In the time-division multiplexing scheme, two additional 100G channels are needed in order to support 24 users.

Priority Classification

An integral part of the statistical multiplexing feature in the XKL eVelocity solution is client classification. Client classification refers to a soft configurable property applied to each client port for bandwidth allocation. The classification feature allows a network operator to control the bandwidth offered to the shared channel from each client port. For an ISP (Internet Service Provider), for example, their customer may pay based on bandwidth. By assigning a port classification to a port/customer, the ISP can control this. A customer can be charged for 2.5G, 5G, 7.5G, or the full 10G.

Make the Most Out of Subsea Cable Investment

According to the website Telegeography, there are approximately 428 subsea cables successfully in service around the world, most of which carry fiber-optic technology across vast expanses of ocean to digitally tether the Earth's landmasses. Most of the existing infrastructure is aging, with legacy cables containing far less fiber capacity than new builds.

Even though the new cables are receiving the spotlight, it is possible to get better performance out of legacy cables, thereby extending the subsea cable life. eVelocity uses physical ports with soft-assigned priorities along with statistical multiplexing to provide Quality of Service control, flexible bandwidth allocation, and maximized line utilization. Spectral efficiency is only part of the optical transport equation. Networks also need to fully utilize their line-side capacity, and statistical multiplexing allows for that much-needed and more efficient line utilization.



UNCOMPROMISED RELIABILITY

in Harsh Marine Environments

Empowering Underwater Technology Since 1978

Ever since MacArtney's foundation in 1978, connectivity has had a special place at the core of the increasingly system-oriented MacArtney Group. Even today, connectors, cables, umbilicals, terminations, junction boxes, and anything beyond and in between are involved in pretty much every project managed by the Group. In many ways, connectivity and integration have paved—and still pave—the way for most other innovative MacArtney products and systems.

Rugged Reliability and Excellent Performance

MacArtney designs and manufactures state-of-the-art connectivity for any application within all maritime industries, including subsea, offshore oil and gas, renewable energy, ocean science, civil engineering, defence, fisheries, and diving. Key technologies include wet- and dry-mateable power, signal and optical connector solutions, terminations and penetrators under the renowned SubConn®, TrustLink and OptoLink brands, GreenLink termination solutions, and subsea cables from leading manufacturers. In addition, MacArtney supplies an endless list of custom connectivity solutions, including specially moulded or machined cable assemblies, bespoke interconnect solutions and junction boxes.

CONNECTIVITY CASE

An example of a purpose-designed subsea connectivity solution is reflected by one of MacArtney's latest orders.

Giant-sized Connectors for Railway Tunnel

MacArtney has supplied a set of 4-pin power connectors based on MacArtney's SubConn® 1-pin power connector.

Four SubConn® 1-pin power connectors have been installed in a connector body designed and manufactured by MacArtney and subsequently moulded to a MacArtney supplied power cable in MacArtney's moulding and cable assembly work-shop, representing state-of-the art moulding technology.

The connector has a rating of 1000V/250A per pin. A standard 3-pin SubConn® circular connector for signal transfer is included in the connector as well. The total order consists of nine sets of male and female connectors and includes POM dust caps, too.

Railway Tunnel Use

The specific connectors are intended for use in railway tunnels. In these tunnels, water, and spills (oil, fuel, etc.) inevitably accumulate at the lowest point of the tunnel. High power pumps are therefore usually installed at this point in order to pump liquids out of the tunnel, often over a distance of several kilometres.

Minimising Downtime

In the event of servicing or replacement of the pumps, it is essential for the safe operation of the tunnel that the downtime is minimised. The 4-pin custom connector selected allows the operator to quickly connect and disconnect the pumps and is thus a critical part of the tunnel safety infrastructure.



OPTIONS

The connector can easily be modified to a configuration having three or five 1-pin power connectors, if needed.

Other potential applications for this jumbo connector:

- Shore power supply for (naval) vessels
- Underwater high power battery applications
- Other high power pump applications

For more information, visit
MACARTNEY.COM

JIP Develops Guidelines for Assessing Subsea Cables Stability on Rocky Seabeds

A joint industry project (JIP), led by Wood, has developed a new set of industry guidelines related to submarine cables behavior on the marine environment and rocky seabed.

The new methodology, based on numerical models calibrated with laboratory tests performed in the wave and current basin of the Oceanide test facility in the South of France, provides advice on assessing subsea cables on-bottom stability on rocky and non-smooth seabed.

The parametric description of the physical mechanisms driving cables stability resulted in the implementation of an advanced methodology for on-bottom stability analysis with a significant gain in conservatism compared with previous standards, according to Wood.

The project, called CABILITY: Cable On-bottom Stability, gathered key industry players to produce a new, more appropriate set of guidelines as the ones currently in place originally derived

from the oil & gas industry and more suited towards assessing the stability of pipelines.

Aside from Wood, other companies that participated in the project were EDF Energies Nouvelles, RTE, Naval Energies, VBMS, LDTravocean, Bardot Group, Silec Cable (General Cable), and DNV GL.

Bob MacDonald, CEO of Wood's Specialist Technical Solutions business, said: "The CABILITY: Cable On-bottom Stability JIP has really demonstrated the importance of industry collaboration. Our findings have acknowledged that there were over-conservatism issues but by working together we have developed a new set of guidelines, which will ultimately deliver significant improvement of costs for both OPEX and CAPEX."

Submarine cables are required to connect renewable energy sources such as offshore wind, wave, and tidal power projects with the grid. The new guide is expected to reduce the need for overly

conservative designs with onerous recommendations and the expensive stabilization systems that could, in turn, jeopardize the financial viability of new projects, according to Wood.

Oceanide, where the tests were completed, operates a unique combination of tests facilities in France including the BGO deep water basin, a wave flume, and a shallow water wave tank. Tests on scale models constitute a significant activity recognized internationally of Oceanide with more than 200 test campaigns conducted in BGO FIRST and more than 100 campaigns in wave flume or shallow water wave tank. They are performed on behalf of public or private customers or through collaborative research projects, such as the CABILITY JIP.

FOR MORE INFORMATION, VISIT
[www.woodgroup.com/what-we-do/
view-by-products-and-services/subsea/
subsea-power-cables](http://www.woodgroup.com/what-we-do/view-by-products-and-services/subsea/subsea-power-cables)

Intellian and Inmarsat to Enhance Inmarsat's FleetBroadband Service

Inmarsat and Intellian have signed an outline agreement that supports enhancements to Inmarsat's FleetBroadband service for the next decade and beyond. The agreement will see Intellian design and manufacture a new generation of FleetBroadband terminals that support the existing I-4 network and Inmarsat's sixth generation satellite constellation, the first of which is scheduled for launch in 2020.

<http://ont.news/2EMoydh>

Iridium Certus Announces Global Launch Partners

Marlink, Speedcast, Applied Satellite Technologies Ltd (AST) and Satcom Global are the initial global maritime launch partners for Iridium Certus. The first regional maritime launch partner, Arion, will focus on delivering Iridium Certus to the Asian market. The partners represent the global nature of Iridium and will deliver business critical broadband solutions to all key maritime markets.

<http://ont.news/2ot0m4y>

Global Ship Manager E.R. Schiffahrt Chooses KVH for Connectivity

KVH Industries, Inc., announced that global ship manager E.R. Schiffahrt has chosen KVH's new advanced TracPhone® V7-HTS antenna equipment and the AgilePlans™ subscription-based Connectivity as a Service (CaaS) program to bring fast, global connectivity to its container and dry bulk vessels. Installations for the first 11 vessels have begun, with plans for a total of up to 60 vessels throughout 2018.

<http://ont.news/2Cf3R7U>

e-BO Enterprises Chooses EdgeCentrix Technology for Offshore Networks

Quortus has announced a collaboration with e-BO Enterprises, a Belgian provider of smart content distribution platforms, network operation services, secure cloud computing solutions, and network infrastructure, to enable LTE voice and data solutions for offshore wind farms.

<http://ont.news/2BKPZRS>

NEW ZEALAND NAVY

Turns to Vestdavit for Hands-On Experience



Boat handling technology from Vestdavit is playing a central role in The Royal New Zealand Navy's drive to operate Realistic Working Environments (RWE) at its new Devonport Naval Base training facility, Auckland, set to open in March 2018.

RWE uses "like for like" equipment to that installed on board RNZ Navy ships, working within a controlled training environment. The new center includes a purpose-built landside facility housing a replica Inshore Patrol Vessel, plus an innovative Seamanship Training Aids Facility Pontoon (STA). The STA is kitted out with a range of equipment designed to allow new trainees to develop their seamanship skills in boat handling, rope work, anchoring, berthing, and towing through repetition before they need to perform in an operational environment.

A PLAR-4000 davit from Vestdavit is a major feature of the pontoon, where it is mounted on the starboard side to allow personnel to practice boat approaches and launch and recovery of RHIBs. For obvious reasons, however, the RWE approach envisages operational training that equips seafarers to operate davits on both sides of a ship.

"Unlike a ship, the pontoon could only take one davit, but the requirement to train both port and starboard approaches remained," explains

Lieutenant Commander Angela Barker, RNZN Deputy Maritime Lead, Capability Branch. "In order to achieve this, we have had a dual receive cradle put in place and this will allow both approaches to be used."

In addition, a sea-water cooling system has been installed to lengthen the training time of the equipment as the trainees will be repeating the activity at a much higher rate than would be the case at sea.

"The PLAR davit has been especially adapted to replicate the keel supports and boarding arrangements for port and starboard handling," says Alasdair Morrison, New Zealand Manager for Vestdavit representative agency and partner Antelope Engineering. "Load testing was completed successfully at the end of October in Ruakaka, before the davit was transported to Devonport."

Since 2000, Vestdavit has supplied 14 davits for seven NZ Navy vessels. The new NZ Navy fleet replenishment tanker Aotearoa, under construction at

Hyundai Heavy Industries, South Korea and due delivery in 2019, will also feature twin davits from Vestdavit.

Naval architect Worley Parsons designed the STA project, with South Pacific Industrial acting as ship builder working with contractor H-Infrastructure Limited. The pontoon is fixed to two piles using an articulated truss. Other features include an accommodation ladder, Pilot and Boarding Assault ladder positions, a life raft launcher, a HIAB Crane and a Swimmer of the Watch Gantry.

For more information, visit
WWW.VESTDAVIT.NO



BOLLINGER Delivers the USCGC RICHARD SNYDER

Bollinger Shipyards has delivered the USCGC *Richard Snyder*, the 27th Fast Response Cutter (FRC) to the U.S. Coast Guard. The Coast Guard took delivery on the 8 February 2018 in Key West, Florida. The vessel's commissioning is scheduled for April 2018 in Atlantic Beach, North Carolina.

"This FRC built by Bollinger Shipyards will be the first FRC to be stationed in Atlantic Beach, North Carolina," said Ben Bordelon, Bollinger President & CEO. "Previous cutters have been stationed in Florida, San Juan, Puerto Rico, Cape May, New Jersey, Ketchikan, Alaska, and Pascagoula, Missouri and Honolulu, Hawaii. FRCs already in commission have seized multiple tons of narcotics, interdicted thousands of illegal aliens, and saved many lives. The FRC program is a model program for government acquisition and has surpassed all historical quality benchmarks for vessels of this type and complexity. The results are the delivery of truly extraordinary Coast Guard cutters that will serve our nation for decades to come. We are extremely proud that the Fast Response Cutters built by Louisiana

craftsmen here at Bollinger Shipyards are having such a major impact on our country's safety and security."

The 154-ft patrol craft USCGC *Richard Snyder* is the 27th vessel in the Coast Guard's Sentinel-class FRC program. The FRC has been described as an operational "game changer," by senior Coast Guard officials. To build the FRC, Bollinger used a proven, in-service parent craft design based on the Damen Stan Patrol Boat 4708. It has a flank speed of 28 knots, state-of-the-art command, control, communications, and computer technology, and a stern launch system for the vessel's 26-ft cutter boat.

Each FRC is named for an enlisted Coast Guard hero who distinguished him or herself in the line of duty. This vessel is named after Coast Guard Hero Richard Snyder. On 27 May 1944 as U.S. forces attacked Biak Island, at the western end of Papua, New Guinea, Snyder was serving as a member of Navy Beach Party Number Six when members of a landing party were subject to severe hand grenade bombardment from Japanese troops.

By his initiative and resourceful fighting qualities under fire, he defeated the enemy resistance and made possible the expeditious landing of vital material without casualty. For gallantry in action during the amphibious assault, Snyder was awarded the Silver Star.

For more information, visit
BOLLINGERSHIPYARDS.COM

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Marine Organisms to Help Monitor Strategic Waters



The world's vast oceans and seas offer seemingly endless spaces in which adversaries of the United States can maneuver undetected. The U.S. military deploys networks of manned and unmanned platforms and sensors to monitor adversary activity, but the scale of the task is daunting and hardware alone cannot meet every need in the dynamic marine environment. Sea life, however, offers a potential new advantage. Marine organisms are highly attuned to their surroundings—their survival depends on it—and a new program out of DARPA's Biological Technologies Office aims to tap into their natural sensing capabilities to detect and signal when activities of interest occur in strategic waters such as straits and littoral regions.

The Persistent Aquatic Living Sensors (PALS) program, led by program manager Lori Adornato, will study natural and modified organisms to determine which ones could best support sensor systems that detect the movement of manned and unmanned underwater vehicles. PALS will investigate marine organisms' responses to the presence of such vehicles and characterize the resulting signals or behaviors so they can be captured, interpreted, and relayed by a network of hardware devices.

"The U.S. Navy's current approach to detecting and monitoring underwater vehicles is hardware-centric and resource intensive. As a result, the capability

is mostly used at the tactical level to protect high-value assets like aircraft carriers, and less so at the broader strategic level," Adornato said. "If we can tap into the innate sensing capabilities of living organisms that are ubiquitous in the oceans, we can extend our ability to track adversary activity and do so discreetly, on a persistent basis, and with enough precision to characterize the size and type of adversary vehicles."

Beyond sheer ubiquity, sensor systems built around living organisms would offer a number of advantages over hardware alone. Sea life adapts and responds to its environment, and it self-replicates and self-sustains. Evolution has given marine organisms the ability to sense stimuli across domains—tactile, electrical, acoustic, magnetic, chemical, and optical. Even extreme low light is not an obstacle to organisms that have evolved to hunt and evade in the dark.

However, evaluating the sensing capabilities of sea life is only one of the challenges for PALS researchers. Performer teams supporting DARPA will also have to develop hardware, software, and algorithms to translate organism behavior into actionable information and then communicate it to end users. Deployed hardware systems operating at a standoff distance of up to 500 m must collect signals of interest from relevant species, process and distill them, and then relay them to remote end users. The complete sensing systems must also

discriminate between target vehicles and other sources of stimuli, such as debris and other marine organisms, to limit the number of false positives.

Adornato is aiming to demonstrate the approach and its advantages in realistic environments to convey military utility.

"Our ideal scenario for PALS is to leverage a wide range of native marine organisms, with no need to train, house, or modify them in any way, which would open up this type of sensing to many locations," Adornato said.

DARPA favors proposals that employ natural organisms, but proposers are able to suggest modifications. To the extent researchers do propose solutions that would tune organisms' reporting mechanisms, the proposers will be responsible for developing appropriate environmental safeguards to support future deployment. However, at no point in the PALS program will DARPA test modified organisms outside of contained, biosecure facilities.

DARPA anticipates that PALS will be a four-year, fundamental research program requiring contributions in the areas of biology, chemistry, physics, machine learning, analytics, oceanography, mechanical and electrical engineering, and weak signals detection.

A detailed Broad Agency Announcement will be made available on www.fbo.gov.

JFD'S 3RD GENERATION SUBMARINE Rescue System Delivered

JFD, part of James Fisher and Sons plc, has completed the first stage of harbor acceptance trials of its first deep search and rescue vehicle (DSRV) for the Indian Navy's 3rd Generation Submarine Rescue System, the company has announced.

The initial harbor acceptance trials of the first DSRV, which were undertaken at Glasgow's King George V dock, are now complete. As part of this process, the system has been comprehensively tested in a variety of conditions.

The DSRV hull previously underwent factory acceptance tests in December 2017 at the JFD-owned National Hyperbaric Centre in Aberdeen. These tests included thorough pressurized testing on the system's pressure hulls and command module—all of which were completed successfully.

Upon completion of the harbor acceptance trials, the DSRV will be fully integrated with the rest of the rescue system at a site in Glasgow, including the offshore handling system, intervention suite, and 90-person decompression facilities.

Speaking on the development, Ben Sharples, India DSRV Project Director at JFD said: "JFD's 3rd Generation DSRV marks a significant and pioneering step-change in real-world submarine rescue capability. It is one of the deepest submarine rescue vehicles available

and is weight optimized for maximum payload and optimum transportability. It has high levels of in-water performance, including speed and maneuverability, and can mate with submarines that might be subject to inclination on the seabed."

The 3rd Generation Submarine Rescue System has been developed by JFD to maximize the chances of successfully rescuing the crew of a distressed submarine (DISSUB). Using its 30 years of experience and knowledge, it has challenged the convention and brought to market an innovative new system that ensures the highest standards in safety, quality, flexibility, and speed thereby better protecting the lives of submariners.

Under the £193 million contract, awarded in March 2016, JFD is providing two complete flyaway submarine rescue systems to the Indian Navy, including DSRVs, Launch and Recovery Systems (LARS) equipment, Transfer Under Pressure (TUP) systems, and all logistics and support equipment required to operate the service. The equipment has been designed, manufactured, integrated, and tested by JFD prior to shipping in March 2018 for final commissioning and trials. The full, certified systems are due to be delivered to the customer in June 2018.



For more information, visit WWW.JFDGLOBAL.COM



MONTH IN REVIEW

1. Polish Navy Upgrades Rescue Vessel with Teledyne RESON Sonar

Teledyne RESON has been selected as provider of a high-resolution multibeam system to the Polish Navy. Teledyne RESON has delivered the SeaBat T50-R multibeam sonar system. The system is currently being installed in the hull of the rescue vessel *ORP Piast* at the Nauta Shipyard in Gdynia, Poland.
<http://ont.news/2BGgmZ3>

2. BAE Systems Selected to Help SPAWAR Identify and Track Threats

The U.S. Navy has selected BAE Systems to provide equipment and support services for Space and Naval Warfare Systems Center Atlantic (SPAWAR). As one of several companies involved, BAE Systems will pursue future orders as part of this five-year indefinite delivery, indefinite quantity (IDIQ) contract with a total value is estimated at \$180 million.
<http://ont.news/2GyUPR8>

3. USS Mississippi Visits Yokosuka

The Virginia-class attack submarine *USS Mississippi* (SSN 782) arrived at Fleet Activities Yokosuka 12 February, for a routine visit as part of its deployment to the Indo-Pacific region.
<http://ont.news/2CA4y7t>

4. Navy Names Two Littoral Combat Ships

On 13 February, Secretary of the Navy Richard V. Spencer announced the next Freedom and Independence variant Littoral Combat Ships will be named *USS Nantucket* (LCS 27) and *USS Savannah* (LCS 28).
<http://ont.news/2CbpDto>



TAKE TWO ASPIRIN & Call Me in the Morning

BY G. ALLEN BROOKS | Author, *Musings From the Oil Patch* | www.energymusings.com

The infamous doctor's directive to ill patients has universal applicability to today's commodity markets. Traders and analysts need these aspirin to ease the headaches and painful neck muscles caused by trying to keep up with the whipsawing of crude oil and natural gas prices.

Much like the recent volatility that has overwhelmed global stocks markets in recent weeks, expectations about oil and natural gas market conditions are seesawing, creating volatility. In this case, the volatility is being caused by wildly different views of the future for each market.

The crude oil market has been experiencing a steady recovery in prices since mid-summer 2017, but it has suddenly hit a wall. The wall reflects the fear traders have that higher oil prices will bring a flood of new U.S. shale oil supply into the market. Even the International Energy Agency and Organization of the Petroleum Exporting Countries (OPEC) are cautioning about this possibility given the accelerating oil price recovery.

The U.S. Energy Information Administration (EIA) issued its latest monthly Short-Term Energy Outlook (STEO) report, setting forth its monthly expectations through the end of 2019 for a host of energy industry data series. One of those series is oil production. Since the EIA officially declared that domestic oil output in January set a new all-time record of 10.2 million barrels a day, speculation has been keen about just how high output can rise. The STEO suggests output may reach 11.3 million barrels a day by November 2019. This forecast has many in disbelief, primarily because they believe the quality of shale formations left to be drilled is declining

and so will future well output. Shale wells have rapid production decline rates, thus skeptics believe the industry will soon be on a treadmill to nowhere before production eventually starts to decline.

On the other hand, optimists point to the various technological improvements that have boosted output and ultimate economic recovery rates as a signal that production has substantial growth ahead. But, one aspect of the EIA's forecast is troubling: if oil prices set the stage for the industry's drilling activity—they produce the revenues that fund capital expenditures—then one needs to consider the price action of the past two years. Between April 2016 and August 2017, oil prices traded in a relatively narrow range, averaging approximately \$48 a barrel. That price resulted in the 1.1 million barrels a day production growth witnessed between November 2016 and November 2017. Clearly, one must be impressed by what the industry was able to do in boosting well output and reducing well costs.

Since August 2017, oil prices have moved steadily higher, exceeding \$66 for a barrel of West Texas Intermediate (WTI) by late January 2018. Although recently falling under \$60 a barrel as fears of a stronger U.S. dollar and surging shale output have depressed prices, for the first month and a half of 2018 the oil price has averaged nearly \$5.50 a barrel higher than in the early period (April 2016 to August 2017).

If oil prices only average 10% more than the 2016-2017 average, given the industry's technological improvements, one can see output surging. However, the EIA is projecting a slowing in the rate of increase in oil output, seemingly reaching peak production by late 2019. If oil prices settle out around \$60 a barrel for 2018, there is no reason not to believe that the EIA's output forecast for 2019 will prove conservative.

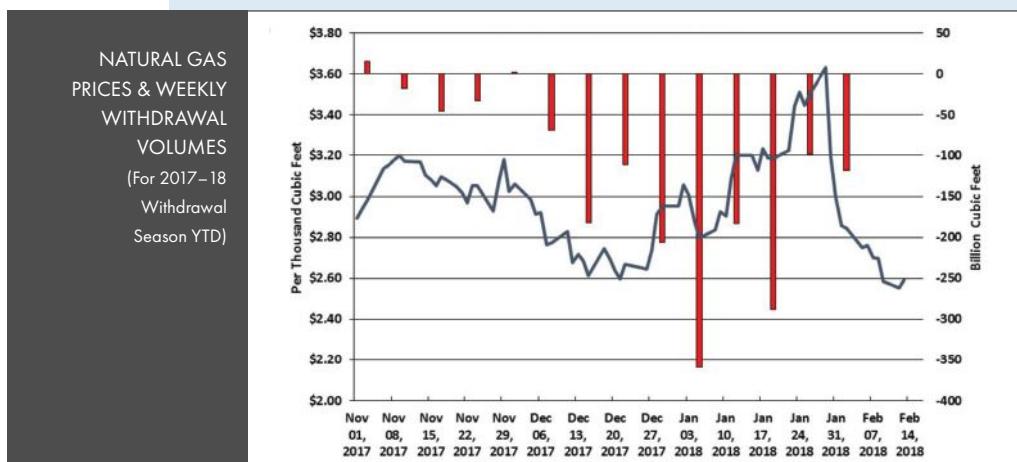
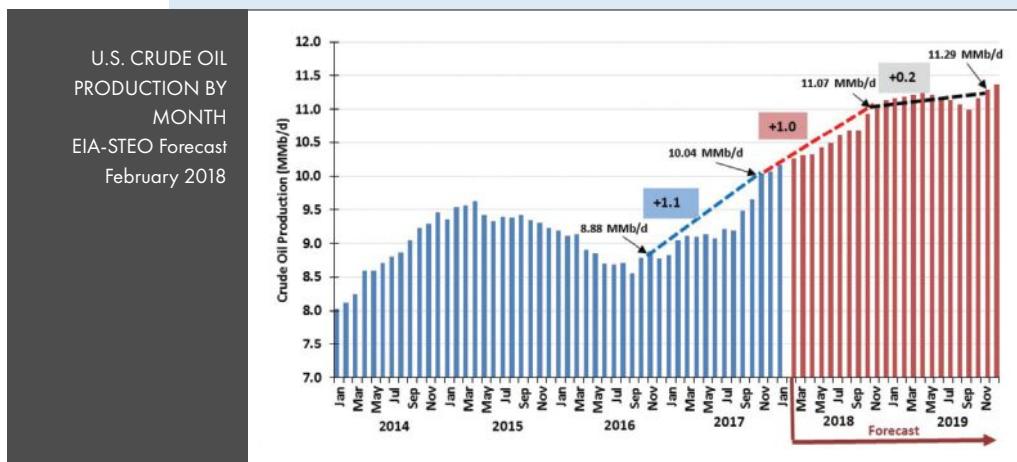
In the natural gas trading pits, something similar has happened, but in a swifter and more dramatic fashion. In mid-December, as bitter cold weather arrived in the Midwest and Northeast regions of the country, gas prices (trading around \$2.60 per thousand cubic feet) began rising. As weekly gas volumes withdrawn from storage surged, ultimately setting a record one-week withdrawal in early January, gas prices roared ahead, exceeding \$3.60 per thousand cubic feet. In a span of 30 days, gas prices had jumped by 40%!

The gas price increase was predicated on the fear among traders that the volume of gas needed to be injected into storage caverns this summer would prove difficult to secure without sharply higher prices, which would encourage exploration and production companies to drill and produce more gas. Recently, however, gas traders shifted their focus to the weather forecasts showing the return of more typical winter temperatures for the balance of the winter. Moderating temperatures will ease gas demand

and likely reduce volumes needing to be withdrawn from storage. Less withdrawals means less gas will be needed for storage refill this summer. As a result, gas prices slumped, falling below where they were when the first polar vortex arrived in mid-December.

The oil and gas price volatility demonstrated during the last 30 days has shaken many energy traders and investors. The reality is that nothing moves in a straight line for long. Expect more volatility in the future. However, the underlying fundamentals of both the oil

and natural gas markets are improving, meaning the odds of debilitating low commodity prices in the near future are low. The energy industry recovery continues.

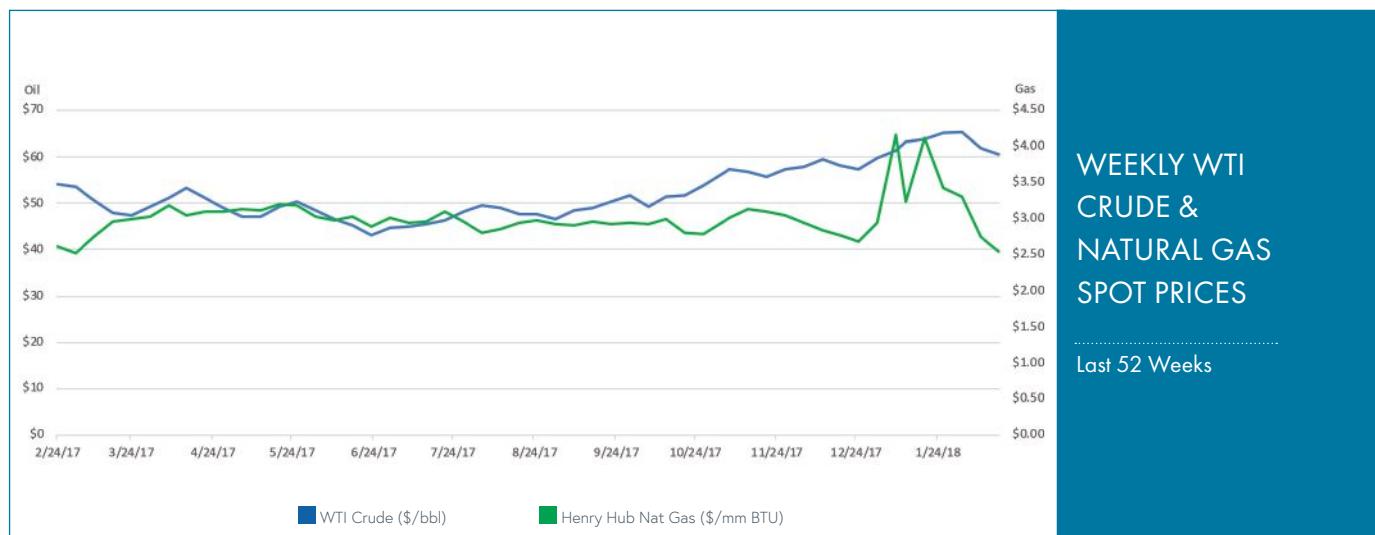


CRUDE & NATURAL GAS Spot Prices

PRICES IN US DOLLARS AS OF FEBRUARY 16, 2018

Following a frigid January that saw oil prices surged, record mild temperatures in the Northeast United States in February caused demand and prices to drop back somewhat. The WTI spot prices jumped to over \$65.00/million BTU in January, before settling back to just over \$60. That is still above the December levels that never reached the \$60 mark.

A similar pattern was seen in the Henry Hub natural gas spot prices as the January cold caused prices to spike passed the \$4.00/million BTU mark, only to fall back to levels just above \$2.50/million BTU during the warm February.



KEY EQUITY Indexes

PRICES IN US DOLLARS AS OF FEBRUARY 16, 2018

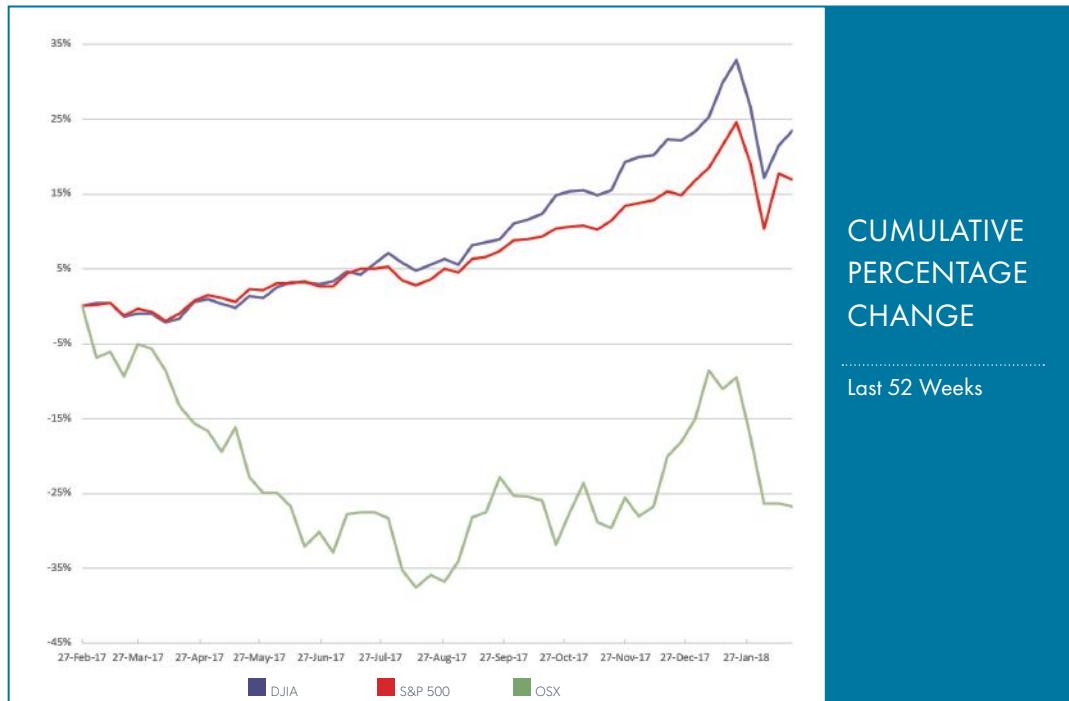
U.S. EQUITY MARKETS

experienced one of the most turbulent periods in its history from late January through most of February.

The **Dow Jones (DJIA)** saw two weeks with losses exceeding 1,000 points, before a rally made up some of those losses. The turbulence was experienced in both the Dow and the **S&P 500** and was attributed by most observers to a long-awaited market correction. Both indexes ended the period since our last report well off their January record highs.

The **Philadelphia Oilfield Services Index (OSX)** saw similar turbulence, dropping from highs over 160 points in January back to levels its December in the 130-point range.

SELECTED EQUITY INDEXES



24,964.75

-1,106.97 from previous month



TRENDING DOWN

DJIA

2,716.26

-94.04 from previous month



TRENDING DOWN

S&P 500

136.06

-24.34 from previous month



TRENDING DOWN

OSX



UTC

Bergen, Norway
June 12-14
www.utc.no

Offshore Northern Seas

Stavanger, Norway
August 27-30
www.ons.no/2018

Hybrid Marine Power & Propulsion

Southampton, UK
April 18-19
www.hybridmarine-power.com

MAST Advanced Workshop

Portsmouth, UK
May 15-17
mastconfex.com/future

Unmanned Maritime Systems

London, UK
May 16-17
www.smi-online.co.uk/defence/uk/Unmanned-Maritime-Systems

SMM

Hamburg, Germany
September 4-7
www.smm-hamburg.com/en

WindEnergy Hamburg

Hamburg, Germany
September 25-28
www.windenergyhamburg.com/en

ICCOE

Shanghai, China
April 27-29
www.iccoe.org

OTO'18

Kobe, Japan
May 28-31
www.oceans18mtsieekobe.org

TOWES

Taipei, Taiwan
May 15-16
www.neoventurecorp.com/events/taiwanoffshore

AWTEC

Taipei, Taiwan
September 9-13
www.awtec2018.com

Submarine Networks World

Singapore
September 24-26
www.terrapinn.com/conference/submarine-networks-world/index.stm

ICPC Plenary Meeting

Cape Town, South Africa
April 10-12
iscpc.org/events

2018 EDITORIAL CALENDAR

CALENDAR

JANUARY

- EDITORIAL: Underwater Navigation; Manned Submersibles; Deepwater Pipeline/Repair/Maintenance
- FOCUS: Multibeam and Side Scan Sonar; Oil Spill Prevention and Clean-Up Services

FEBRUARY

- EDITORIAL: Oceanology; Maritime Security
- FOCUS: Buoys and Monitoring Instrumentation; Diver Detection Systems; Training & Safety

MARCH

- EDITORIAL: Offshore Technology; Subsea Fiber Optic Networks
- FOCUS: Connectors, Cables & Umbilicals; Environmental Monitoring/Testing Services

APRIL

- EDITORIAL: Meteorology; Ocean Mapping & Survey; Decommissioning & Abandonment
- FOCUS: Subsea Tools & Manipulators; Data Acquisition Products; Seismic Imaging

MAY

- EDITORIAL: Ocean and Coastal Engineering, Infrastructure, and Construction; Bathymetric Mapping
- FOCUS: Cranes, Winches & Control Systems; Water Dredges and Airlifts

JUNE

- EDITORIAL: UW Imaging and Processing; UW Archaeology
- FOCUS: UW Imaging and Processing; Tracking and Positioning Systems; Magnetometers

JULY

BUYER'S GUIDE

AUGUST

- EDITORIAL: ROV and AUV Technology
- FOCUS: Cameras, Lights and Imaging Sonars; Vehicle Sensor Suites

SEPTEMBER

- EDITORIAL: Offshore Wind Installation and Maintenance; Offshore Supply & Emergency Vehicles
- FOCUS: Offshore Support; Turbines; Offshore Wind Inspection Services

OCTOBER

- EDITORIAL: Offshore Communications; Subsea Telecom; Subsea Inspection, Monitoring, Repair & Maintenance
- FOCUS: Marine Communications; Cable Installation Services

NOVEMBER/DECEMBER

- EDITORIAL: Year in Review; Commercial Diving and Salvage; Ocean Observing Systems; Ocean Science & Exploration
- FOCUS: Acoustic Modems, Releases and Transponders; Diving Equipment and Services; Salvage; Buoyancy Materials

SHOW DISTRIBUTION

JANUARY

- GoM Oil Spill & Ecosystem - February 5-8
- Underwater Intervention - February 6-8
- Subsea Expo - February 7-9
- Decomm & Abandonment Summit - February 20-21

FEBRUARY

- Oceanology International - March 13-15
- Asia Pacific Maritime - March 14-16 *
- CUCEx - March 25-27 *

MARCH

- Int'l Offshore Wind Forum - April 3-6
- OTC - April 30 - May 3

APRIL

TBD

MAY

- Int'l Conf on Ocean Energy - June 12-14 ^
- Clean Pacific - June 19-21
- Int'l Conf on Coastal Engineering - July 30-Aug 3 ^

JUNE

- UDT - June 26-28 ^

JULY

TBD

AUGUST

- SMM - September 4-7 ^*
- Submarine Networks World - September 24-26 ^*
- MTS Dynamic Positioning - October 9-10 ^
- OCEANS '18 - October 22-25 ^

SEPTEMBER

- Wind Energy Hamburg - September 25-28 ^
- AWEA Offshore Wind - October 16-17 ^
- Offshore Energy - October 22-24 ^
- Pacific Marine Expo - TBD

OCTOBER

- Clean Gulf - November 13-15 ^
- Offshore Well Intervention - TBD

NOVEMBER/DECEMBER

TBD

* Digital Distribution

^ Pending



Add Energy Celebrates New Projects

Add Energy has increased its workforce by 103% in 12 months. New contracts totalling over £4,089,000 see the energy consultancy firm expand into power generation and mining as well as continuing its work providing solutions to drilling contractors, FPSOs, and oil and gas operators.

<http://ont.news/2FqxgL1>



Teledyne Marine Welcomes Lockhart as New VP

Teledyne Marine has added Doug Lockhart in the role of Vice President and General Manager of Teledyne SeaBotix and Teledyne Oceanscience. Mr. Lockhart will report to Dr. Thomas Altshuler, Vice President and Group General Manager for Teledyne Marine Vehicles, the unmanned systems business group for Teledyne Marine.

<http://ont.news/2EQuIOE>



CSA Strengthens HSSE and Dive Safety Management

CSA Ocean Sciences Inc. (CSA) has added Eirik Kydland, who will serve a dual position of Diving Safety Officer (DSO) and Health, Safety, Security, and Environment (HSSE) Manager. Kydland brings substantial expertise to enhance CSA's scientific diving program, global health and safety programs, and extensive operational activities in the U.S. and internationally.

<http://ont.news/2or957c>

AgileTek Wins the Small Company of the Year Award at Subsea UK Awards

Subsea engineering analysis consultancy, AgileTek, has won the Small Company of the Year Award at this year's Subsea UK awards. Winners were announced at an awards ceremony 8 February in Aberdeen.

<http://ont.news/2ouxWaf>



Ecosse Focus on Global Expansion

Subsea technology specialist Ecosse Subsea Systems (ESS) has charged Andy Readyhough with global business development for the ambitious Aberdeenshire based company that specializes in seabed clearance and trenching operations in the renewable energy, oil and gas, and interconnector sectors. The appointment follows Mark Brown joining as Engineering Manager.

<http://ont.news/2HE66Bc>



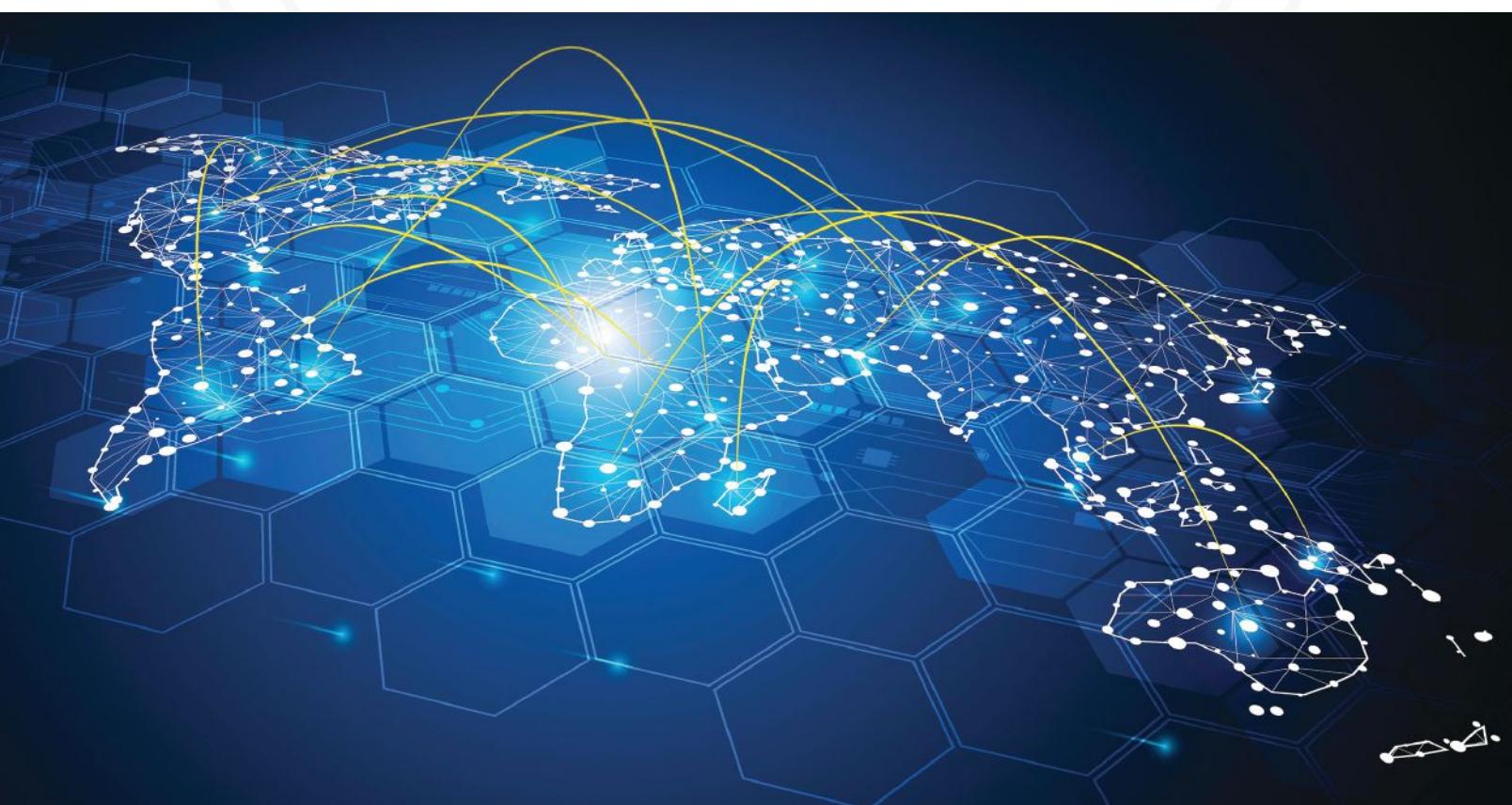
Scotland to Strengthen Offshore Innovation Ties with China

Organized by the Royal Society of Edinburgh (RSE), in partnership with the Oil and Gas Innovation Centre (OGIC) and DataLab, a selection of Scotland's leading oil and gas R&D institutions head to China to strengthen ties, share knowledge, and increase business opportunities with leading innovation houses in Beijing.

<http://ont.news/2CENHQX>



SubCableWorld



Analyzing the cable industry.

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Website: www.oceansonics.com



Ocean Sonics designs and manufactures the icListen, a compact self-contained easy to deploy digital hydrophone. As the world leader in gathering ocean sound, Ocean Sonics combines very high signal performance with innovative ease of use, to give customers the best digital hydrophone technology available. It's a compact, all-in-one instrument capable of processing data while collecting in real-time.

Creating Acoustic Arrays is now simple. Connect two or more icListen hydrophones together and they self-synchronize, operating as one. Ocean Sonics offers a wide range of geometries, including vertical, horizontal, autonomous, very small geometrical arrays, or spread out over many kilometres.

RTSYS

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E-mail: info@rtsys.eu
Website: www.rtsys.eu



- Acoustic Monitoring: EASDA14, Embedded Multichannel Passive Acoustic Recorders
- WiFi remote Buoy: BASDA14, Multi-sensor & Rechargeable Acoustic Buoy accessible in Real-time
- Sediment Characterization: INSEA, Acoustic Velocimeter for Sediment Characterization

We provide advanced embedded acoustic products in the environmental research, surveying and monitoring areas. With Synchronized Multichannel Acquisition and accepting a broad range of Acoustic Transducers and Hydrophones from 3Hz to more than 1MHz, our solutions allow the user a new range of applications.

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Website: www.nortekgroup.com



Nortek excels in the development and manufacture of acoustic Doppler instrumentation. Doppler Velocity Logs (DVLs) are used for seafloor navigation. Acoustic Doppler Current Profilers (ADCPs) are used to understand physical processes in the ocean, rivers, lakes and laboratories. We pride ourselves on being innovative in product development and production processes. Nortek provides solutions to engineers and scientists by offering real-time data collection and support from our responsive technical team.

ROWE TECHNOLOGIES, INC.

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Website: www.rowetechinc.com
Contact: Chris Arends, Global Sales Director



Rowe Technologies designs and manufactures state-of-the-art Acoustic Doppler Current Profilers (ADCPs) and Doppler Velocity Logs (DVLs), applicable to an array of current measuring and navigational deployments for world-wide use, in oceans, lakes, and rivers. Rowe Technologies 7,100 ft² facility is headquartered in San Diego California and was founded in 2009 by Dan and Steve Rowe, the sons of Fran Rowe who is the originator of the Acoustic Doppler Current Profiler (ADCP) and co-founder of Teledyne RDI. Rowe Technologies highly experienced, innovative staff has over 250+ years of Doppler system development experience and is on the preponderance of ADCP patents.

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Website: www.metocean.com
Contact: Emily MacPherson



MetOcean Telematics designs and manufactures drifting buoys, environmental platforms, and the world renowned NOVATECH locator beacon product line. In addition to providing complete end-to-end telematics services, and one of the few manufacturers in the world to achieve ISO 9001 certification. MetOcean Telematics' drifting buoy family consists of environmental and weather monitoring, oil spill response, and search and rescue drifters: NOVA profiling float, Iridium SVP (iSVP), iSPHERE, Argosphere, SLDB, and iSLDB.

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Contact: Dan Cote, Sales Manager



DeepWater Buoyancy creates subsea buoyancy products for leading companies in the oceanographic, seismic, survey, military and offshore oil & gas markets. Thousands of customers have relied on our products for over thirty-five years, from the ocean surface to depths exceeding six thousand meters.

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Cortland has more than 30 years of manufacturing experience supplying custom-designed electro-optical-mechanical cables. We provide solutions that meet the challenges posed by harsh environments, hydrostatic pressures, and high mechanical stresses.

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For over 50 years, Falmat Cable has been a key supplier and a solution provider to many global OEMs and end users supporting a wide range of marine applications. We design and manufacture high performance cables for use in harsh and demanding environments. Our rugged Xtreme cables are known and preferred worldwide for superior reliability and durability in commercial and military projects. We offer XtremeMarine cables with precision coaxial components for use with SD/HD video requirements, wet rated submersible pump cables, miniature fiber optic cables, a comprehensive range of highly engineered ROV Tethers plus our well recognized Xtreme Ethernet cables. Falmat is a Certified ISO9001/AS9100 organization. Visit our web site: www.falmat.com

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Website: www.southbaycable.com
Contact: Gary Brown, Sales Manager



Since 1957, South Bay Cable Corp has designed and manufactured specialized electrical, electro-mechanical and electro-optical-mechanical cables for use in demanding marine environments. Cables are designed to meet customer requirements and include tether and umbilical cables for ROVs, tow cables, video inspection, faired cables and a host of other customer specific applications.

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Website: www.birns.com
Contact: Eric Birns



BIRNS, Inc. has been serving the subsea industry since 1954, and is an ISO 9001:2008 certified global leader in the design and manufacturing of high performance connectors, custom cable assemblies and lighting systems. With a NAVSEA PRO-020 certified molding facility, the company leads the industry with sophisticated connector lines, including exceptional 6km-rated electrical, electromechanical, coaxial, electro-coax, optical, electro-optical and electro-opto-mechanical hybrid options. BIRNS provides the industry's highest volume of cost-effective hydrostatic and helium pressure testing, and has a wide range of ABS Product Design Assessment (PDA) certified fiber optic and electrical penetrators. BIRNS also delivers brilliant LED and tungsten-halogen marine, chamber, security and commercial diving lights trusted in the world's most extreme environments.

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Website: www.birnsaquamate.com
Contact: Eli Bar-Hai



Birns Aquamate design and manufacture underwater electrical connectors, cable assemblies, and cable terminations. The company produces a wide range of standard industry connectors such as the 5500 Series, SC, MC, LP, FAWL/FAWM, Rubber Molded, etc. BIRNS Aquamate is the only underwater connector producer that guarantees compatibility with other manufacturers. Birns also specializes in fast turn-around for custom design of special connector solutions. Stocking dealers in the UK, South Africa and Holland as well as dealers in Canada, Germany, Belgium, Norway, China, and Brazil.

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The SEACON Group are world leaders in underwater connector technology and provide an extensive and diverse range of electrical, optical and hybrid connector assemblies, submersible switches and cable system solutions for many applications within the Oceanographic, Defense, Oil and Gas and Environmental markets. With locations in California and Texas, USA, Mexico, Brazil, the United Kingdom and Norway and a worldwide network of agencies and representatives, SEACON is able to supply very quick solutions to any requirements across the globe.



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Teledyne Marine Interconnect Solutions integrates the resources of ODI, DGO, Impulse, and Cable Solutions into a single organization that supplies innovative, high-performance solutions for harsh environment interconnect. Solutions for these harsh environments include wet-mate, splash-mate and dry-mate connectors, pressure boundary penetrators, cable assemblies, cable terminations, and custom-engineered encapsulation and molding. TMIS contains a broad portfolio of field-proven, time-tested electrical, optical, and hybrid interconnect capabilities optimized for applications where performance and reliability are imperative. Products are available as stand-alone items, or as complex solutions that integrate technologies into advanced, value-added systems.

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Ocean Specialists, Inc. (OSI) is a developer of undersea cable projects and technology with global project capabilities. OSI works with clients during all project phases of subsea network development, from planning and design to procurement and implementation. Our customers, primarily representing Oil and Gas, Telecommunications and Ocean Observing, recognize the value of fiber optic networks to their field and services solutions, and look to OSI to deliver the skills and experience that developing these networks require.

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- Oceanographic Products:** Acoustic Zooplankton Fish Profiler (AZFP), Ice Profiler IPS5 & shallow water SWIP, Wave Profiler, Acoustic Scintillation Flow Meter (ASFM), Imagenex scanning sonar logger (IRIS), instrument cages, bottom frames. Custom acoustic system integration.
- Consulting:** Field work, data collection, analyses, numerical modelling, acoustics, remote sensing, oceanographic mooring design and system integration.
- Manufacturer's Representative:** Teledyne RD Instruments, Teledyne Oceanscience, Teledyne Benthos, Deep Water Buoyancy, WERA Northern Radar.

NKE INSTRUMENTATION

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- Provor and Arvor profiling subsurface floats (ARGO project): CTD, dissolved oxygen, BGC, deep; Argos and Iridium transmission.
- Drifting surface buoys with temperature and GPS receiver for Surface velocity project. Contact: Nathalie Le Bris, nlebris@nke.fr or Jérôme Sagot, jsagot@nke.fr

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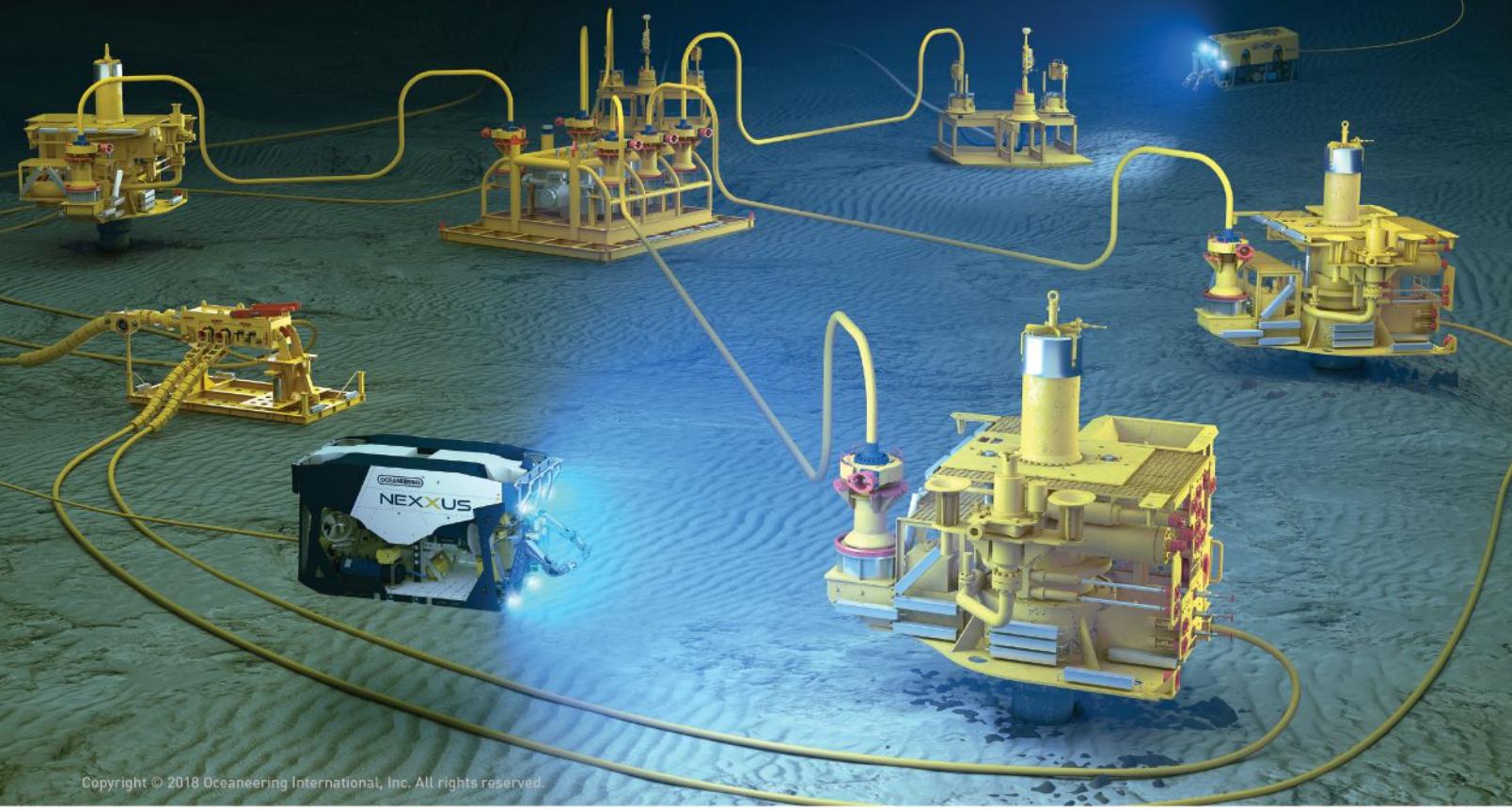
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