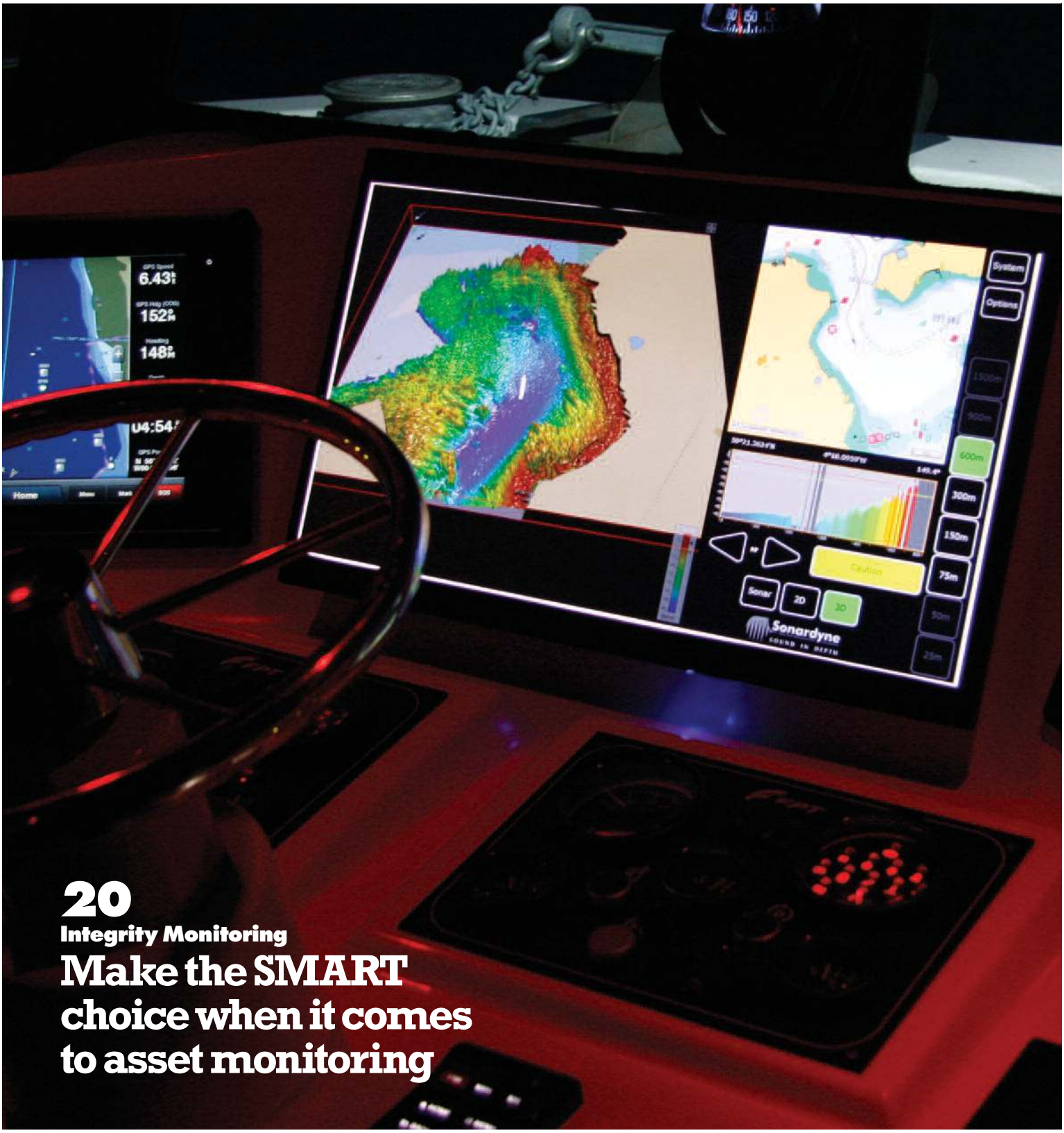
THE CUSTOMER MAGAZINE FROM SONARDYNE
ISSUE 15

Baseline



HELLO AND WELCOME to the first edition of Baseline for 2016.

When we are asked to come up with new solutions to solve our clients' subsea challenges, we do just that. We adapt standard techniques, custom engineer instruments and provide you 'always there' global support. In the current climate of reduced CapEx budgets, we're now going a step further by offering multi-year operational leases on a wide range of our products. You can read more about the scheme on page 7 then get in touch with your local Sonardyne office to see how it could help keep your next subsea project on budget.

Space. It's not a theme we typically cover in Baseline, but in the special news feature on page 12 we transport you to the heart of the US space program – NASA's Neutral Buoyancy Lab in Houston. Just recently, we were privileged to be invited by OneSubsea to demonstrate how our wireless acoustic positioning, optical communications and sonar imaging solutions are ready to bring the reality of a digital, cable-free oilfield a giant step closer. Follow the link in the article to see a video of the action.

On page 20, our focus returns firmly to the subsea domain in an article discussing the importance asset integrity monitoring. If you're involved in drilling, production, platforms, mooring and pipelines, we provide you with some expert advice on the benefits of monitoring and the low risk, field-proven tools at our disposable to help you.

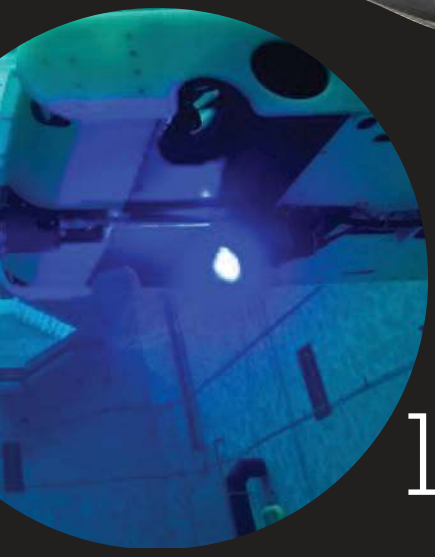
It's another busy issue as you can see with barely enough space left here for me to introduce the other highlights of this issue which include trials reports on our advances in contactless laser metrology (page 14) and plate tectonic monitoring (page 18).

David Brown Editor

Baseline » Issue 15

Front Cover
Installed on our trials vessel *Echo Explorer*, NOAS (Navigation and Obstacle Avoidance Sonar) plots a safe course ahead during demonstrations in Plymouth, south-west England. NOAS works by scanning a wide area in front of a vessel with multiple sonar 'pings' to create a highly detailed, 3D model of the sea floor and water column along a vessel's course.

In this issue...



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The Customer magazine from Sonardyne

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Sonardyne
SOUND IN DEPTH

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»KIT

Our latest subsea technology and services

HEADING AND ATTITUDE, ACOUSTICALLY AIDED INERTIAL NAVIGATION AND DOPPLER VELOCITY SENSORS

Flexible, cost-effective and easy to use subsea navigation

With a track record spanning 10 years in survey, dynamic positioning and vessel applications, our Lodestar Attitude and Heading Reference Sensor and SPRINT Inertial Navigation System range has now evolved into its 3rd generation to meet the needs of any subsea application with a smaller housing, and a new range of performance levels. When combined with our Syrinx Doppler Velocity Log, Lodestar and SPRINT provide unprecedented levels of performance and a single offering for ROV guidance and survey.

WE RECOMMEND THESE FOR ROV GUIDANCE AND BASIC SURVEY TASKS

Lodestar 200 AHRS

A cost-effective north-seeking gyrocompass with class-leading performance (**0.4°** Sec Lat Heading) and settling time. Provides extended outputs (acceleration and rotation rates) for ROV DP. Upgradeable to Lodestar 300 or SPRINT 300.

Lodestar 300 AHRS

Lodestar 300 is a robust and reliable subsea AHRS that provides **0.2°** Sec Lat Heading within 15 minutes of starting and can settle in dynamic conditions. Available with many connector and endcaps options to suit most ROV integration requirements.

SPRINT 300 INS

The lowest cost subsea INS available with **<0.1°** Sec Lat Heading. Supports dual ROV and Survey use and standalone ROV guidance. Also provides mid-water station keeping with vendor independent USBL aiding.

WE RECOMMEND THESE FOR DEMANDING SURVEY TASKS AND ROV GUIDANCE

Lodestar 500 AHRS

A survey grade, proven AHRS with **0.1°** Sec Lat Heading available after 5 minutes of settling time. Common with all Lodestar/ SPRINT units, Lodestar 500 is re-calibration free and has an internal battery allowing continuous operation during loss of power for short periods.

SPRINT 500 INS

Supports tightly integrated sparse LBL range aiding from Sonardyne 6G beacons, which have demonstrated cost savings in field operations since 2012. Perfectly suited to demanding multibeam survey operations with automatic, proven pressure and swell compensation.

SPRINT 700 INS

SPRINT 700 is one of the highest performance INS systems available under dual use export control. With tight integration to Sonardyne acoustics, it supports the most demanding subsea survey tasks such as mobile laser mapping and acoustic inertial metrology.

SPRINT SYRINX

Combined INS and DVL

Syrinx provides tight beam-level aiding to SPRINT INS that allows for unprecedented DVL positioning performance and can continue to operate even if one or two DVL beams are unavailable.

Standalone 3rd generation Lodestar and SPRINT units are engineered to mechanically 'mate' with Syrinx DVL using matching endcap alignment dowels. This provides the performance and space benefits of pre-calibrated and repeatable inertial and DVL but either unit can be swapped out.

For the ultimate integration, Lodestar/SPRINT and Syrinx are also now available as a single combined unit. The result is one of the smallest inertial DVL instruments available on the market. Available with an optional internal intelligent pressure sensor it provides a single unit for almost any ROV and survey task. In the combined unit, each Syrinx transducer has a full depth rated water block to ensure protection of the internal components.

When supplied together, most combinations of Lodestar/SPRINT and Syrinx are unlikely to require a re-export licence, making shipping easier.

Technical File

LODESTAR AHRS AND SPRINT INS

Reasons to Invest

Small Form Factor

The new smaller titanium 4,000 metre housing allows easy fitment to almost any Work-class ROV. A 6,000 metre housing is also available.

Connectivity

High quality titanium connectors can be provided as standard, supporting Serial/Ethernet and power pass through to external aiding sensors, ensuring easy installation.

Dual AHRS and INS Algorithms

SPRINT is unique in providing dual AHRS and INS algorithms, for separate ROV and survey. SPRINT INS starts instantaneously and does not require time consuming alignment.

Onboard Data and Power Backup

All real-time data is logged on internal storage and can be used for remote support and performance verification, negating factory re-testing.

Remote Upgrades

Every Lodestar (except 200) can be upgraded in-field to high performance SPRINT. This provides you with operational and commercial flexibility, only paying for features when needed without the need to fit a different instrument.

Long Life Sensors

Lodestars and SPRINTs use RLGs, inertial sensors with a 400,000hrs MTBF, proven over 15 years of use in almost every commercial airliner (100,000 inertial).

»KIT

Our latest subsea technology and services

RESEARCH AND DEVELOPMENT

Test with us and take the pressure off your development costs

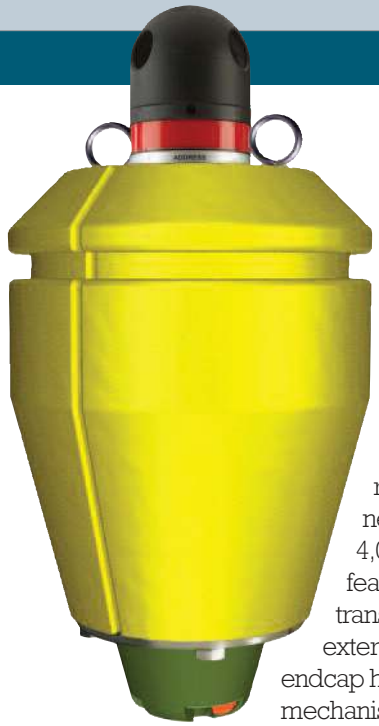
If you are developing subsea technology that needs to be environmentally tested, the facilities at our UK headquarters are now available to hire.

Hydrostatic testing is the most effective way to validate the integrity of subsea equipment before it is deployed. Our new pressure chamber can simulate pressures up to 6,300 metres (20,670 feet) and has an internal diameter of 0.76 metres and internal length of 2 metres. Equipment under test can be interfaced via six breakout ports that can be adapted to suit client specific connectors, allowing communications with the equipment whilst under pressure. A 2.5 tonne overhead crane allows safe handling of equipment. The chamber's advanced control system can be programmed to meet specific standards including pressure cycling, ramping and holding. A dedicated Test Engineer supervises all operational activities and can provide you with a full report which includes applied pressure graphs, test certificates and photographic records. For pricing and availability, please email: **support@sonardyne.com**

ACOUSTIC POSITIONING

New features for Mini-Ranger 2 USBL

With an acoustic update rate of 3x per second and excellent high elevation tracking, it's easy to see why Mini-Ranger 2 Ultra-Short BaseLine (USBL) is proving popular. A year on from its launch, Mini-Ranger 2 now supports more beacons including the high power Wideband Mini-Transponder (WMT) and Wideband Release Transponder (WRT). This confirms the system's suitability for use for near shore surveys and shallow water construction. Chart backdrops allow for dual use as a USBL system and navigation screen. Importantly, we have taken the opportunity to set the default range to 995 metres, easing export control and enabling the system to be used globally. If you need to track further, the export controlled Extended Range Pack gives a typical range performance of 2,000 metres, with up to 4,000 metres potentially achievable depending on your setup. Your local sales office will help you decide which Mini-Ranger 2 is right for you.



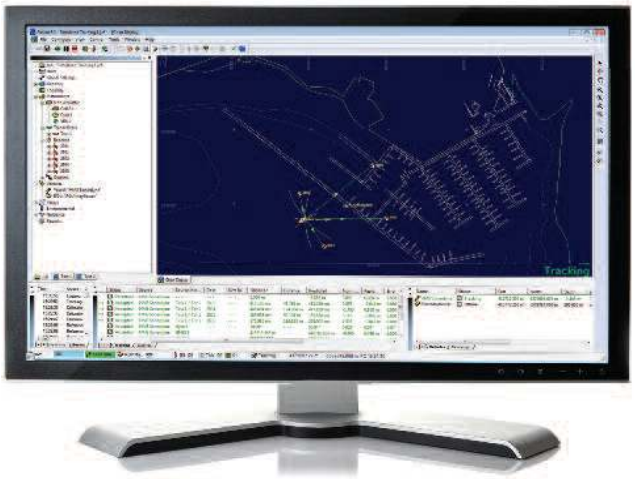
TRANSPONDERS

Wideband Sub-Mini 6 Plus (WSM6+) with acoustic release

If you're looking for a rapidly deployable, small acoustic transponder which can be used as a temporary seabed reference for calibration purposes, or to deploy and recover instrumentation, why not consider the new WSM6+R. Available in 1,000 metre and 4,000 metre depth options, it offers all of the features you get in a standard WSM6+ such as transponder/ responder modes, Wideband 2, external on/off switch and depth sensor. Its bottom endcap however incorporates a 'screw-off' release mechanism with a Working Load Limit of 125 kg and is based around the same field-proven reliable design used in our LRT product range. An easy to fit, two-piece floatation collar provides the buoyancy needed to get it back to the surface, whilst an optional rope canister allows seabed items to be hauled up.

SOFTWARE

More features for Fusion 1.12 software



Following close to the recent release of Fusion Long BaseLine (LBL) 1.12 software in which we introduced support for Windows 7, multi-user and Mini ROVNav 6, the next release looks to introduce some equally valuable features. It will support interfacing instruments through the proven Navigation Sensor Hub (NSH) and a one-project simulator mode based on the LBL training course array we have deployed in Plymouth. This will allow users to refresh themselves on the operation of Fusion and ensures their skills are up-to-date reducing operational risks. Expect this release around mid-2016. Contact your local sales office for details on upgrading to the current version or Plymouth training course availability.

COMMERCIAL

Operational Leases spread the cost

For companies currently operating with reduced CapEx, we are pleased to announce Operational Lease agreements are now available across most of our technology range. Ranging between one and five years, all lease offerings begin with the supply of new* hardware, complete with a life-of-lease warranty. This includes free annual servicing meaning equipment will be at its best for your subsea operations. At the end of lease, equipment is returned and a new lease can be agreed for the most up to date equipment generation.

Unlike rental agreements, consumable items such as manuals and cables don't have to be returned. There are even options to store your leased equipment between projects and during maintenance periods. Contact your local Sonardyne sales office for more information.

*Shorter term lease durations may be supplied with manufacturer re-furbished and warranted equipment.

TRANSPONDERS

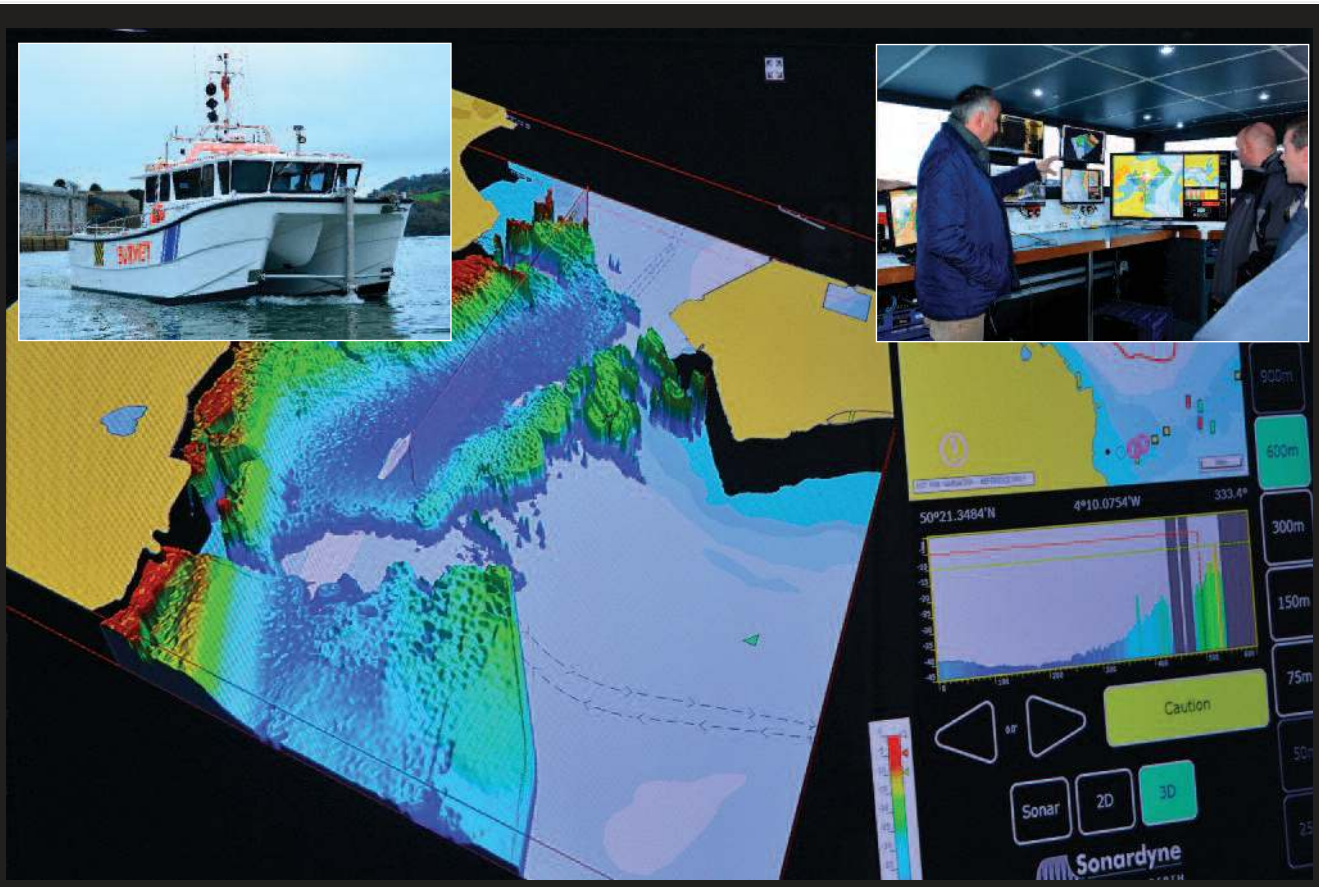
Track with Nano

At only 153 mm long by 55 mm in diameter, Nano is the perfect transponder to use with Mini-Ranger 2 USBL for tracking divers, small AUVs and small ROVs. Its wireless charging and App-based configuration capability means that storing it, turning it on and setting it up is quick and simple. Two models are available; one with a pressure sensor for depth aiding and one without. Both are depth rated to 500 metres.

NEWS

MARITIME SECURITY

NOAS shows the way ahead for vessel navigation



Sonardyne's charter trials vessel, *Echo Explorer*, sets sail with NOAS – an important new aid to navigation and underwater obstacle avoidance.

The capabilities of our Navigation and Obstacle Avoidance Sonar (NOAS) as an important new aid to vessel navigation and underwater obstacle avoidance have been demonstrated to more than 25 equipment specifiers, owners' representatives and vessel operators from the European superyacht industry, commercial shipping and naval community.

When navigating poorly charted or unfamiliar areas, commercial ships, expedition cruise ships and naval vessels remain vulnerable to groundings and collisions with submerged objects. This is where underwater forward-looking sonar technology provides a solution.

NOAS works by scanning a wide area in front of a vessel with multiple sonar 'pings' to create a highly detailed, 3D model of the sea floor and water column along a vessel's course. Water depth, underwater features and potential hazards to a range of up to 600 metres over a 90 degree field of view are displayed.

Uniquely with NOAS, sonar imagery over a wide field of view is temporarily retained, providing the operator with a recent history of the vessel's passage. This feature is expected to be of particular value when manoeuvring large vessels as the depth of the water and potential hazards can be confirmed, even when outside of the sonar's current field of view.

NOAS is designed to be retro-fitted to existing vessels as well as new vessels. For the demonstrations, it was operated from our 12 metre research vessel, *Echo Explorer*.

During each trip around the Tamar estuary and Plymouth Sound, the system's hull-mounted sonar and processor located on the vessel's bridge, generated real-time 3D images. These were overlaid on digital navigation charts, offering those onboard with a highly immersive view of the underwater environment. Alerts based on water depth, distance from the vessel and estimated time to impact were created to demonstrate how NOAS warns operators of potential collision hazards or shallow water.

Speaking on the success of the demonstrations, Nick Swift, Business Manager for Maritime Security at Sonardyne said, "We appreciate the investment in time made by our clients to travel to Plymouth and experience NOAS first-hand. The spring tides and high levels of fresh water run-off from the surrounding farmland and Dartmoor, led to extreme sound velocity profiles which changed on an hourly basis. However, as expected, NOAS performed exceptionally in these difficult environmental conditions, producing consistently high quality navigation sonar imagery."

He added, "The first new-build vessels to be specified with NOAS are close to completion, and we look forward to developing further opportunities for this unique sonar technology with our commercial, private and naval partners."

DYNAMIC POSITIONING

C&C upgrade fleet to Ranger 2 Pro

Survey and mapping specialists C&C Technologies, Inc., a subsidiary of Oceaneering International, Inc. has taken delivery of five Ranger 2 Pro Ultra-Short BaseLine (USBL) tracking systems.

By upgrading to the latest standard of acoustic positioning technology, C&C Technologies will now benefit from Ranger 2 Pro's ability to track multiple subsea targets at greater speeds, over longer ranges, and with the highest level of positioning accuracy.

Ranger 2 Pro is designed for deep water tracking of underwater targets and position referencing for dynamically positioned (DP) vessels. It builds on the simplicity and performance of our original Ranger system by adding support for 6G (Sixth Generation) acoustic instruments and Wideband 2 signal architecture. Both of these unique Sonardyne innovations have been proven to increase the efficiency of

"Using their Ranger 2 Pro systems C&C Technologies can now track multiple targets simultaneously at ranges beyond 6,000 metres."

survey operations with equipment that is quick to set up and easy to use.

Using their Ranger 2 Pro systems, with its fast position update rates, C&C Technologies can now track multiple targets, including ROVs, towfish and AUVs, simultaneously at ranges beyond 6,000 metres. And, thanks to the system also supporting Long and Ultra-Short BaseLine (LUSBL) positioning, carry out complex seafloor operations with the highest levels of precision.

Ralph Gall, Technical Sales Manager for Sonardyne Inc. in Houston who supplied the equipment said, "Previously we have supplied DP-INS systems for the *Ocean Intervention* series of vessels for DP purposes. We're extremely pleased to have been able to meet the requirements of C&C Technologies on this occasion and hope to build upon the relationship for many years to come."

DYNAMIC POSITIONING

DP-INS selected for new *Brandon Bordelon* Stingray-class vessel

Bordelon Marine, providers of vessel services to operators in the Gulf of Mexico and around the world, has selected our acoustically-aided inertial navigation technology for its new Ultra-Light Intervention Vessel (ULIV), *Brandon Bordelon*.

The dual Ranger 2 Pro DP-INS systems will be used to track ROVs during inspection, repair and maintenance (IRM) activities and provide an independent position reference for the vessel's Marine Technologies Class 2 dynamic positioning (DP) system.

Specialised vessels such as the *Brandon Bordelon*, conventionally rely on Ultra-Short BaseLine (USBL) acoustics and the Global Navigation Satellite System (GNSS) as their primary sources of DP reference data. However, a vessel's station-keeping capability can be compromised if the USBL is affected by thruster aeration or noise and the GNSS signal is simultaneously interrupted. The latter is particularly common around equatorial regions and during periods of high solar radiation.

Ranger 2 Pro DP-INS addresses this vulnerability by exploiting the long term accuracy of our Wideband 2 acoustics with high integrity, high update rate inertial measurements. The resulting navigation output has the ability to ride-through short term acoustic disruptions and is completely independent from GNSS.

DP-INS is also proven to deliver valuable operational savings. It does not need a full seabed array of transponders to be installed as most project specifications can be met with only one or two transponders.

"Ranger 2 DP-INS is a mature, field-proven technology that addresses operators' need for a robust, independent DP reference that provides an update rate and accuracy on par with GNSS." Mark Carter, DP Global Business Manager.

The equipment supplied to Bordelon Marine included a ship-mounted inertial navigation sensor and two deep-water optimised HPT 7000 transceivers installed on through-hull deployment poles.

Wes Bordelon, President/CEO Bordelon Marine said, "Equipping the *Brandon Bordelon* with Sonardyne's Ranger 2 DP-INS reflects our commitment to providing hi-tech, hi-spec equipment on our fit-for-purpose Stingray-class vessels and ensuring our fleet is safe, efficient and cost-effective."

The new *Brandon Bordelon* is equipped with a high capacity deep water crane, infrastructure for two Work-class ROVs and a large, reconfigurable back-deck area.

NEWS

CORPORATE

A view from the top with Sonardyne's new Managing Director, Robin Bjorøy

Hello to all our clients and readers. I am delighted to have joined Sonardyne as Managing Director and now several months in, I am more excited than ever about the future of the company. I look forward to meeting as many of you as possible at industry events and during my regional visits.

Since its formation by John Partridge over 40 years ago, Sonardyne has been, and continues to remain, a proudly independent British company. We've seen significant growth in our solutions and product offering as well as our marketplace and company size. Today, we have both the size and security to be confident of being your valued supplier of leading edge technology well into the future.

We are continuing to invest significantly in new technologies which enhance our existing portfolio and bring new solutions. With one third of our team focused solely on Research and Development, technological innovation will remain a cornerstone of our business.

Customer loyalty and trust is what we continually strive to achieve by offering leading edge innovation and technology backed by a commitment to excellent customer service and an agility that is able to respond to your specific needs.

Robin Bjorøy joined Sonardyne in late 2015

"Customer loyalty and trust is what we continually strive to achieve by offering leading edge innovation and technology backed by a commitment to excellent customer service and an agility that is able to respond to your specific needs."

Clearly the current cycle in the industry is challenging, not only for operators and companies in the offshore sector, but also for the traditional commercial models within the supply chain. As increasing value is being sought within the procurement and delivery processes, the ability to extract ever more value is being tested.

Whether it is in extending the performance, reliability or operating range of our systems, provision of integrated solutions or providing more innovative business models aligned with our customers' drivers, we are investing to meet these challenges and I believe Sonardyne is uniquely positioned to be the valued partner for your subsea operations.

If your team is looking for commercially efficient standard products or customised solutions that work off-the-shelf, combined with excellent customer support and an appetite for challenging business models, we will be delighted to help you achieve your ambition and deliver on your objectives.

OUR PEOPLE

Geraint West joins us in Oceanographic role

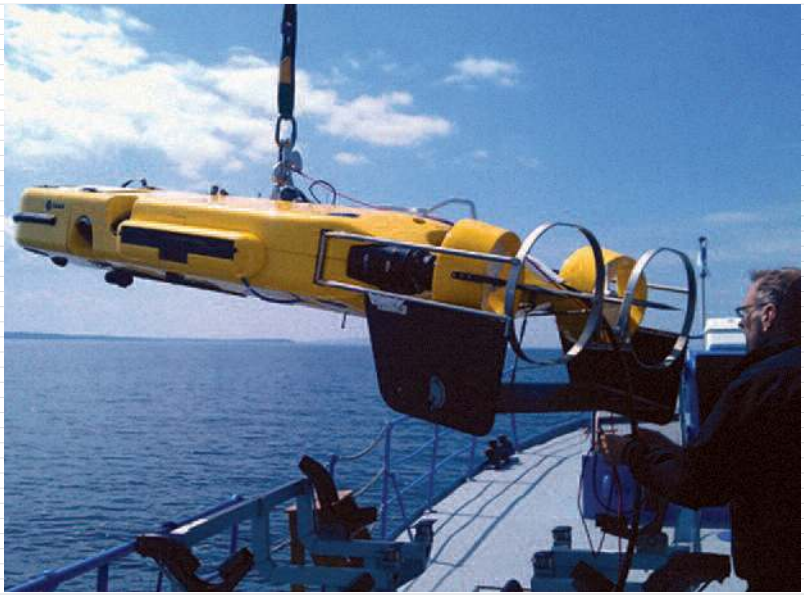
Geraint West has been appointed Global Business Manager for Oceanography bringing with him 32 years of industry experience years gained with the Royal Navy, Fugro and most recently, the National Oceanography Centre (NOC).

During his 14 years with NOC, Geraint held a variety of positions including Director of National Marine Facilities with strategic leadership for the UK marine science community's large research infrastructure, specialist facilities and data centre. He oversaw the introduction of the UK's new multi-purpose oceanographic research ships, RRS *Discovery* and RRS *James Cook*, as well as the establishment of its Marine Autonomous and Robotics Systems group.

Geraint said, "I have been a fan of Sonardyne's products for many years, witnessing first-hand the capabilities of their technology on numerous science cruises. In my new role, I'm looking forward to applying my knowledge of marine science programmes and extensive international contact network to help grow the company's share of the oceanographic market."

MARITIME SECURITY

Solstice sonar purchased for Danish Mine Counter Measure missions



Saab Seaeye's *Double Eagle* SAROV, fitted with Solstice high resolution imaging sonar, being deployed on mission. (Below) Solstice is a low-power, compact side-scan sonar that uses full dynamic focus and multi-ping techniques to gather high fidelity imagery fully corrected for vehicle motion.

The Danish Defence Acquisition and Logistics Organisation (DALO) has procured our Solstice high resolution imaging sonar technology to support its country's Mine Counter Measure (MCM) activities. The equipment has been fitted to Saab Seaeye's *Double Eagle* SAROV and will be used to search for and classify mine-like objects on the seabed.

Denmark's naval forces are internationally recognised for their expertise in the detection, classification, identification and disposal of mines and ammunition at sea. They conduct both domestic and international operations as part of NATO, and have at their disposal specialised ships, containerised command and control facilities, diving equipment, autonomous surface craft and unmanned underwater vehicles.

Designed for use on a variety of under-water platforms, Solstice is a low-power, compact side-scan sonar that uses full dynamic focus and multi-ping integration techniques to gather high fidelity, near SAS (Synthetic Aperture Sonar) quality imagery of the sea floor, fully corrected for motion.

"Using Solstice, operators will now be able to view high definition side-scan imagery and bathymetry in real-time without the need for time-consuming, post-mission data analysis."

Saab Seaeye's *Double Eagle* SAROV enables autonomous mine reconnaissance missions over vast areas to be conducted. Using Solstice, operators will now be able to view high definition side-scan imagery and bathymetry in real-time without the need for time-consuming, post-mission data analysis. If a contact is identified, the vehicle is able to deliver a disposal charge before moving away to a safe distance to allow the mine to be destroyed

Speaking of the contract, Ross Gooding, Business Development Manager for Maritime Security said, ''We are delighted that DALO has selected Solstice to support Danish MCM operations. During evaluation trials led by Saab, we were able to demonstrate how its proprietary technologies are able to increase the operational envelope of underwater vehicles by providing wide swath coverage, long endurance and very high resolution imagery.'' He added, ''We now look forward to supporting DALO during the installation and commissioning phase of project.''

News Feature

Subsea Asset Integrity Monitoring

Sonardyne goes from deep sea to deep space

Wireless integrity monitoring was on the agenda during a recent technical symposium held at NASA's Neutral Buoyancy Lab (NBL) in Houston, Texas.

Hosted by OneSubsea, a Cameron and Schlumberger Company, the event set out to demonstrate how subsea asset monitoring and oil field technologies from companies like Sonardyne, are enabling asset management teams to make more informed decisions regarding planned maintenance, structural integrity and enhanced oil recovery programmes. The event was followed by a further two days of demonstrations organised by underwater vehicle manufacturer, Saab Seaeye, with us as its primary technology partner.

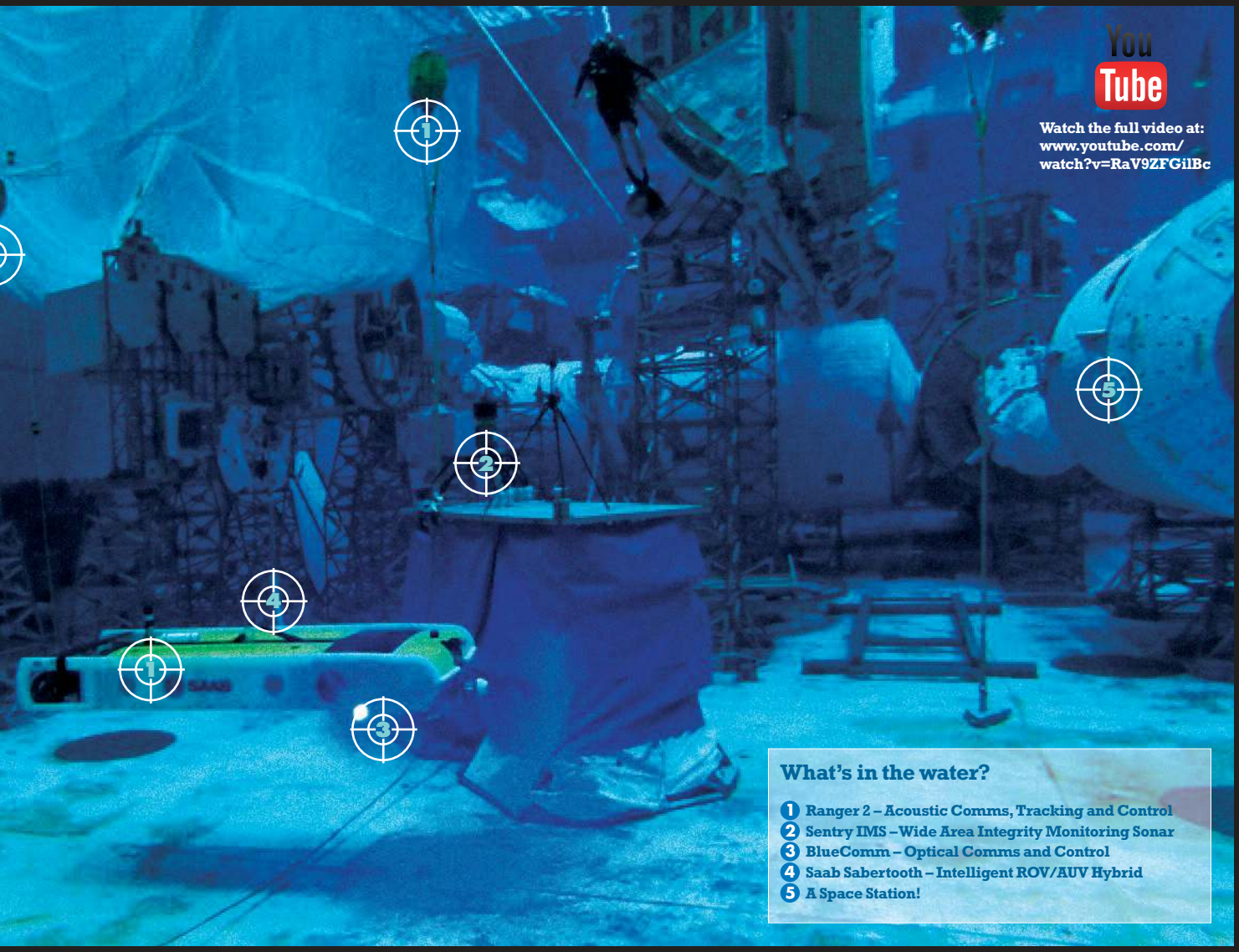
Located near NASA's Johnson Space Centre, the NBL is an underwater training facility used to prepare astronauts for the micro-gravity conditions they will experience in space. At 202 feet long, 101 feet wide and 40 feet deep, and holding 6.2 million gallons of water, the pool is the largest indoor body of water in the world and contains a full size replica of part of the International Space Station (ISS).

Around the pool, we deployed acoustic data telemetry, sonar imaging and optical communications technologies to simulate some of the typical remote inspection and intervention scenarios our technology can be utilised for. 6G sensor nodes suspended mid-water were used to show how critical data from remote assets such as satellite wells can be recovered using robust, long range acoustic communications. On the pool floor was Sentry IMS, a wide area sonar that automatically warns operators of integrity breaches around subsea oil and gas assets. Positioning moving targets in the water was Ranger 2 USBL, a high accuracy system for tracking and commanding ROVs and AUVs as they carry out their work.

Creating significant interest was our high speed optical data modem, BlueComm. Installed on Saab Seaeye's Sabertooth hybrid ROV/AUV, a link was established to a matching BlueComm unit on apparatus designed to replicate a subsea manifold. This enabled through-water wireless control of the vehicle including commanding the actuation of a standard Class 4 subsea valve. A simultaneous video feed provided by BlueComm from the Sabertooth to pool-side allowed the vehicle's pilot, and the gathered audience, to monitor the operation.

After docking in a separate, optically enabled subsea docking station, BlueComm was also used to harvest mission data at very high data rates and to provide the vehicle with details of its next mission. With the exception of an acoustic emergency stop using a WSM6+ mini-beacon, BlueComm was the only means of communication between the Sabertooth ROV/AUV and shore during the entire 30 minute demonstration run.

"Everything we showed at NASA - acoustic positioning, data transfer and wireless monitoring, is commercially available, off-the-shelf technology," said Stephen Fasham, Business Manager for Subsea Asset Monitoring. "Our thanks goes to OneSubsea for hosting the event, in particular Dr Diana Grauer, and their guests for taking the time to travel to the NBL. Also Saab Seaeye for extending the event to enable as many people from the Houston subsea community to experience the capabilities of our technology first-hand."



Watch the full video at:
www.youtube.com/watch?v=RaV9ZFGilBc

What's in the water?

1. Ranger 2 – Acoustic Comms, Tracking and Control
2. Sentry IMS – Wide Area Integrity Monitoring Sonar
3. BlueComm – Optical Comms and Control
4. Saab Sabertooth – Intelligent ROV/AUV Hybrid
5. A Space Station!

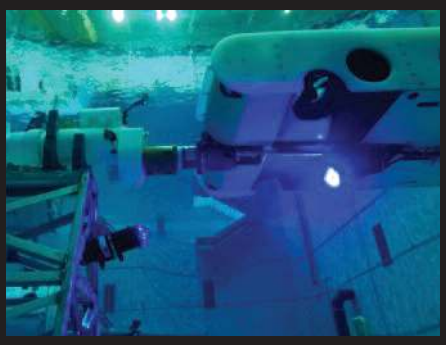
(Above) At 202 feet long, 101 feet wide and 40 feet deep, the NASA NBL in Houston is the world's largest indoor pool.

(Far left) SAAB's Sabertooth hybrid AUV/ROV prepares to submerge on a demonstration run.

(Left) Astronaut training ran alongside the demonstrations.

(Right) The BlueComm communications link enabled through-water wireless control of the vehicle including commanding the actuation of a standard Class 4 subsea valve. This is believed to be the first time an operation like this has been conducted.

(Below) Many of Houston's subsea community attended.



Construction Survey

Fast 3D Subsea Mobile Mapping and Contactless Metrology

CAUTION
ACOUSTICALLY AIDED LASER METROLOGY IN PROGRESS

Aerial mobile mapping using Lidar and GNSS aided inertial navigation has revolutionised the efficiency of land and shallow water bathymetric surveying. Now, fast ultra-high resolution subsea mobile mapping is approaching, reports Principal INS Engineer, **Dr. Mikael Larsen**. Millimetre resolution subsea laser sensors have emerged in parallel with major advances in tightly integrated subsea inertial navigation. Wideband Doppler Velocity Log (DVL) navigation, Long BaseLine (LBL) observations, Simultaneous Localisation And Mapping (SLAM), automatic calibration and forwards-backwards post-processing, join with Acoustically Aided INS (AAINS) to provide robust dynamic sub-millimetre relative accuracy and centimetric level accuracy over wide areas. **>>**

THE COMBINATION OF multi-beam echosounders (MBES) and (loosely coupled) AAINS on ROVs/AUVs has been successful for demanding subsea applications such as pipeline Out Of Straightness (OOS) surveys. Since the advent of Sonardyne Wideband acoustics and 6G, LBL acoustic positioning has provided centimetric level static accuracy over wide areas and is the long-standing trusted reference for subsea metrology.

Commercial subsea Lidar and laser mapping sensors with millimetre level precision are available from several vendors including; 2G Robotics, 3D at Depth, Cathx Ocean and Fugro (Netherlands).

(Top) Sonardyne 6G LBL based acoustic metrology provides the best level of accuracy and QC and is the reference against which all other methods are compared.

(Above) Subsea metrology requires accurate, precise and robust measurements which are critical for successful fabrication and installation of spools and jumpers.

Static scanning

Laser sensors are used in two different modes of operation; static scanning and mobile mapping. In static scanning, the sensor is placed on the seafloor (e.g. on a tripod) and mechanically rotated to scan the local area. Use in a confined area is relatively simple since no navigation is required. However, variable turbidity introduces risk that planned coverage is not achieved. Wide area use becomes impractical due to the need for complex and time consuming scanning and merging of data from multiple locations. Scanning of horizontal and elevated features is difficult since the sensor is tied to the seafloor.

Mobile mapping

Laser mobile mapping is similar to well known MBES surveying but provides dramatically higher resolution. Mobile mapping is inherently faster than static scanning and can cover wide areas. Risk from turbidity is reduced since the sensor can be moved along the optimal path for mapping e.g. close to and directly above a structure. This can be a critical advantage when measuring hub/flange orientations for metrology.

Tight INS integration of raw wideband acoustics

Full utilisation of laser sensor resolution in mobile mapping has, to date, been constrained by navigation accuracy. Developed with these sensors in mind, this will dramatically change with the next generation of higher performance tighter integrated AAINS.

Direct INS integration of raw two-way travel time measurements allow dynamic vehicle positioning over wide areas to the centimetric level of accuracy known previously only from static wideband LBL. Similarly, direct integration of the raw measurements from the individual beams of a state-of-the-art wideband Doppler Velocity Log (Syrinx DVL) robustly achieves millimetric level relative accuracy. Time efficiency, accuracy and robustness are further enhanced by a host of techniques; Sparse SLAM LBL array calibration, forward-backwards post-processing, miniature wideband transponders, mechanically integrated sensors and auto-calibration. The boost in relative dynamic accuracy enables fast contactless measurement of target orientation to tiny fractions of a degree.

Mobile mapping and 'contactless' metrology

Subsea metrology is the post-installation measurement of relative position and orientation differences between the hubs/flanges of two or more

Construction Survey

Fast 3D Subsea Mobile Mapping and Contactless Metrology

subsea structures. Results are used for on land manufacturing of rigid interconnecting sections of pipe and both accuracy (5 cm, <<0.5 deg) and quality control (QC) requirements are therefore stringent. Metrology based on modern LBL acoustics provides the best level of accuracy and QC and is the reference against which all other methods are compared.

'Contactless' AAINS mobile mapping inherits the fundamental accuracy of LBL acoustics but by-passes any need for precision ROV handling of equipment on the structures and is therefore potentially extremely fast. LBL transponders are deployed at flexible locations on the seafloor and provide bounded accuracy and strong QC. Transponder count and calibration time is reduced via SLAM sparse LBL techniques incorporating accurate reliable transponder-to-transponder baseline measurements where possible.

Monterey Canyon trials, November 2015

Deep water ROV mobile mapping trials were first performed in 2014 and then again in November 2015 onboard the R/V *Western Flyer* through co-operation with the Monterey Bay Aquarium Research Institute (MBARI). Figure 1a depicts a 'subsea elevator' prepared with flanges of varying diameters to simulate a metrology target. The red Sonardyne Compatt 6 (C6) transponder was used as both scanning target and LBL position reference.

MBARI's ROV *Doc Ricketts* was equipped and navigated using state-of-the-art SPRINT 700 AAINS, 6G Wideband Syrinx DVL (600 kHz), ROVNav 6 LBL transceiver and a precision pressure sensor. The calibrated and trusted LBL reference array included four additional rapidly deployable miniature Wideband Mini Transponders (WMT), see Figure 2.

Array baseline calibration residuals ('C-O') were 2.7 cm RMS (root of mean square). The Compatt 6 had pressure and sound speed sensors for automatic tidal compensation, processing redundancy and QC via periodic acoustic telemetry. The LBL array layout and two ROV metrology baselines performed in opposite directions are shown in Figure 3. The two transponders constituting each metrology baseline were excluded from use in navigation.

> "All six metrology baselines were mapped by the ROV within a single 1 hour 45 minute time frame."

2G Robotics ULS-500 and Eiva NaviSuite

The ULS-500 works by emitting a line of laser light onto the target surface where it is observed from an offset camera. Through image processing, the offset camera determines the angle to 1,400 points along the laser line and then calculates the location of intersection between the laser line and the target surface. By then passing the ROV over the target of interest, adjacent profiles are captured to build a complete 3D point cloud model of the environment.

Dependent on altitude and ROV speed (0.1-0.5 m/s), resolution was as good as a few millimetres. Eiva's NaviSuite supports the ULS-500 and was used for 3D real-time visualisation, data recording and offline for merging with post-processed navigation to generate accurately geo-referenced 3D point clouds from which metrology results were derived.

Operation was optimised for metrology speed rather than image clarity. Figure 1b is the result of a single ~20 second overhead pass by the ROV and yet resolution and quality is sufficient for metrology.

Results and conclusion

Results from six metrology baselines are shown in Table 1. The RMS of all baselines is just over 3 cm with a single baseline error marginally above 5 cm. It is likely that the calibrated LBL reference contributed slightly to the observed differences. Flange/hub orientations are determined via point cloud matching to the known geometry. Accuracy is robustly below metrology tolerances (<<0.5 deg) – see Figure 4.

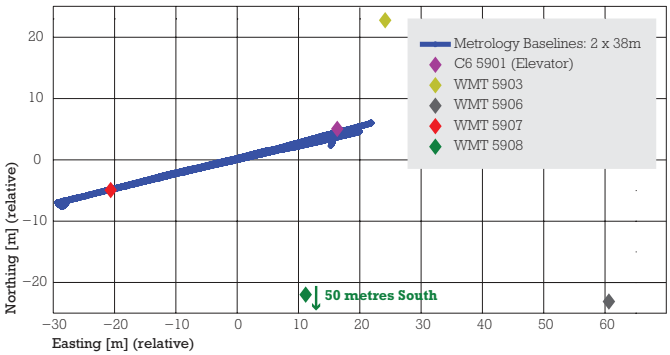


Figure 3. LBL transponder (1 x Compatt 6 and 4 x WMTs array layout. Blue lines are two ROV metrology baselines mapping transponders 5901 and 5903 from opposite directions. 5908 was 50 metres south of the shown location.

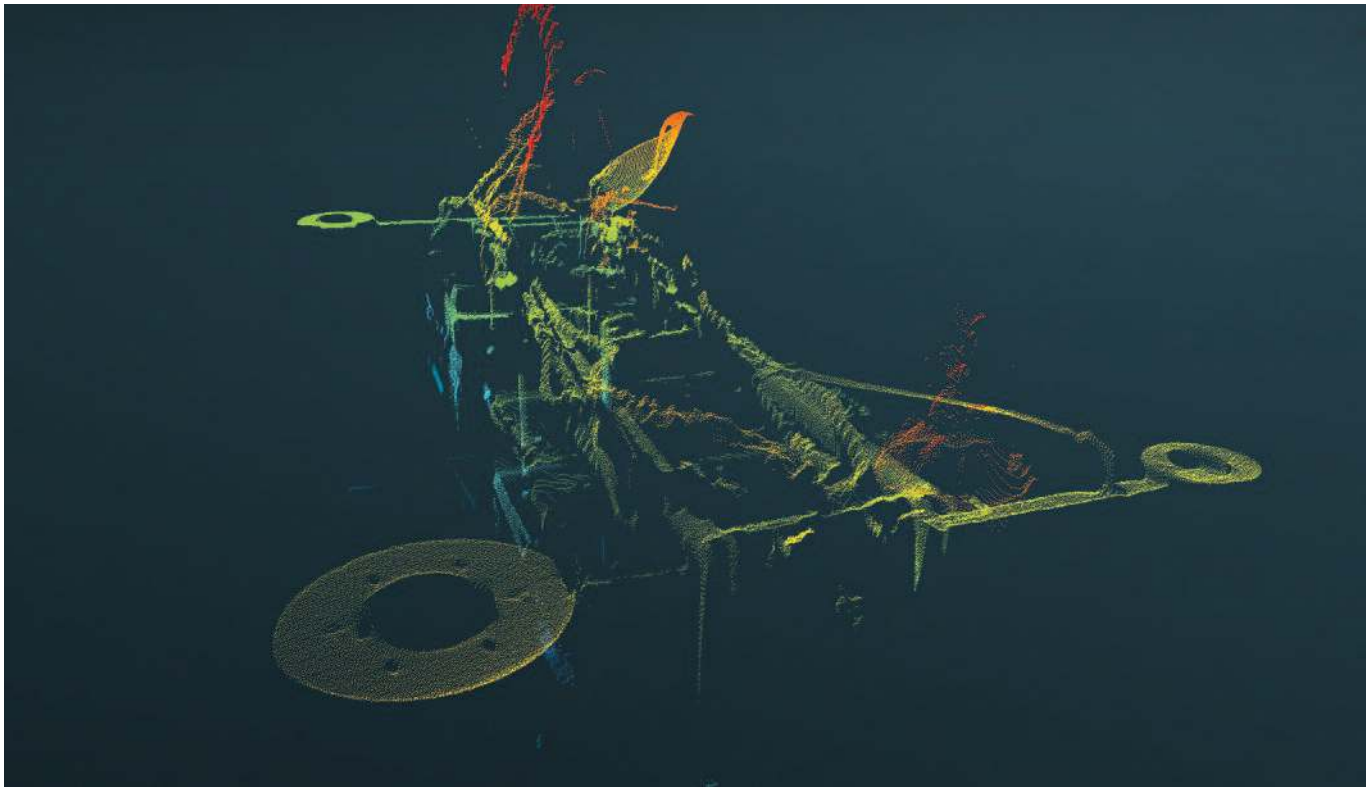
Metrology From	To	AAINS/Laser Derived Baseline [m]	Reference Acoustic Baseline [m]	Difference [m] 'C-O'
5907	5901 (Elevator)	38.472	38.466	0.006
5903	5906	58.634	58.610	0.024
5906	5901	52.543	52.499	0.044
5901	5907	38.453	38.467	-0.013
5907	5903	52.695	52.694	0.001
5903	5901	19.459	19.403	0.056
RMS			**45.28m**	**3.11cm**

Table 1. Measured baselines: AAINS/laser mobile mapping vs calibrated LBL acoustic reference. Baselines were measured from the generated 3D point cloud and compared to the calibrated LBL acoustic baseline reference.

This is due to the combination of AAINS dynamic relative accuracy and the sub-millimetre precision of the laser scanner (2G Robotics ULS-500).

All six metrology baselines were mapped by the ROV within a single 1 hour 45 minute time frame. Prior deployment of the four miniature wideband transponders took less than 30 minutes and fewer transponders would be used in an operational scenario. With realistic streamlining for commercial operations, AAINS mobile mapping technology will support single dive, contactless metrology in considerably less time than any other known method. Moderate turbidity is required which will not always be present subsea so more traditional forms of metrology will still be important.

Highly time efficient mobile mapping with reliability, accuracy and resolution proven to metrology standards is generically valuable for a host of other subsea survey, inspection and construction applications. **BL**



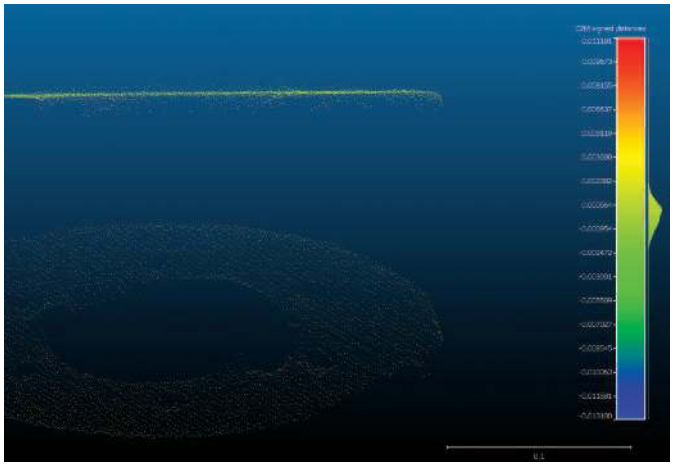
(Clockwise from top) Figure 1b. SPRINT mobile mapping derived 3D point cloud in 1,850 metres water depth (Eiva NaviSuite and 2G Robotics ULS-500).

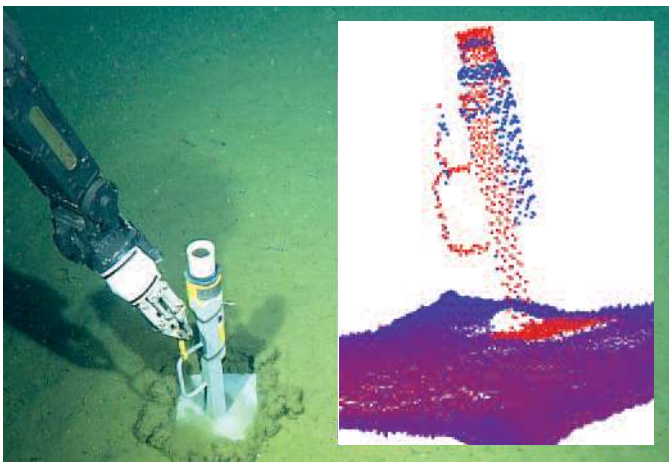
Figure 1a. 'Subsea elevator' onboard MBARI's R/V *Western Flyer.*

Figure 2. AAINS/Lidar mobile mapping trials Dec. 2014. Touchdown of a miniature wideband transponder in 2,850 metre water depth and associated point cloud using a 3D at Depth SL1 subsea-Lidar, Sonardyne SPRINT 700 and Janus post-processing navigation software.

Figure 4. Flange (ø30 cm) orientation determined to << 0.5 deg. The 3D point cloud to plane mismatch ('Cloud 2 Mesh – C2M') RMS is just 1.7 mm with the majority being due to edge effects and flange machining precision (syntactic foam).

Acknowledgements
Our sincere gratitude to MBARI for their cooperation, their highly professional employees for an enjoyable time, friendliness, hard work and invaluable support. Their knowledge, passion and contribution to deep ocean science and technology is impressive and inspiring.





Oceanographic

Case Study: Precise acoustic positioning for seafloor geodesy

Scientists deploy 6G LBL to help study plate tectonic movement

The precision offered by the Wideband 2 digital signal architecture found in Sonardyne's sixth generation (6G) positioning equipment, is widely recognised. Structures can be installed on the seabed and mobile targets tracked with millimetric accuracy. A recent trial conducted in the Mediterranean set out to show how this standard, off-the-shelf technology could be applied to the science of plate tectonic monitoring.

Earth's gigantic interlocking, tectonic plates float on molten rock and although we think of them as static, they move continuously – albeit very slowly – at typically just a few centimetres a year. Large events such as earthquakes cause much larger movements of metres, or even tens of metres, and as we know, these can result in underwater landslides triggering Tsunamis causing enormous damage and tragic loss of life. On land, these tiny movements can be tracked with GNSS stations, but tracking oceanic plate boundaries deep subsea to aid understanding of the fundamentals is much more challenging.

One method used to measure subsea displacement involves using permanent geodetic references consisting of long-life acoustic positioning transponders on the seabed. A GNSS positioned survey vessel measures many ranges to the transponders to accurately establish a position. Over subsequent visits to the site (after many months), the acoustic measurements are re-observed and processed to determine the movement of the seabed relative to the GNSS spheroid.

First conceived in the 1980s, the technique is highly dependent upon the precision of the measurements. Variations in the ionosphere, a constantly changing water velocity, a dynamic vessel and instrument errors can all mask these small movements in the seabed references.

Key to success therefore is the precision and repeatability of both the GNSS and the acoustic positioning component of the survey system – the acoustic part of this having improved significantly with the advent of Sonardyne 6G and Wideband 2 acoustic positioning technologies.

Establishing the exact level of improvement was one of the aims of a recent trial conducted by a team of researchers from the University Institute European De La Mer (IUEM).

For the test, the research vessel *Tethys II*, operated by the Centre national de la recherche scientifique (CNRS), was mobilised to sail from Nice to a location where the water depth reached 2,400 metres. The vessel sailed with four Compatt 6 transponders, a Pressure Inverted Echo Sounder (PIES) and a deep water optimised GyroUSBL transceiver installed on a temporary over-the-side deployment pole.

Chris Hammersley, Project Engineer at Sonardyne who joined the trial said, "Inside GyroUSBL, we've integrated our high grade attitude and heading reference/ INS sensor, Lodestar, with a 6G (Sixth Generation) HPT transceiver. This combination eliminates the alignment errors seen in conventional USBL systems and is proven to deliver unrivalled levels of accuracy and precision – even when installed on *Tethys II* using a side mount temporary deployment pole."

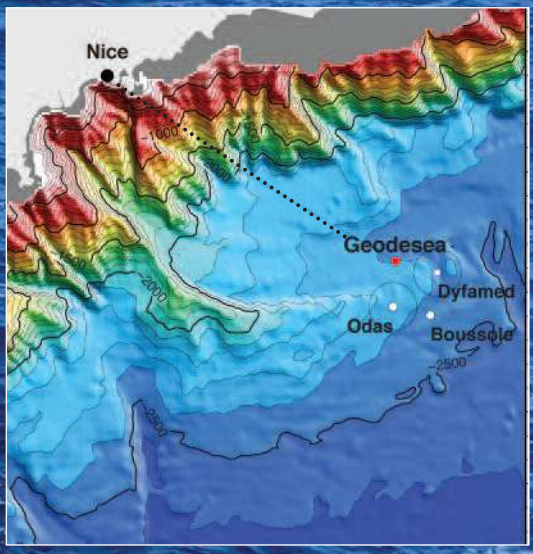
At the test site, the Compatts were lowered to the seabed, three forming an equilateral triangle with 2,600 metre baselines and the fourth placed in the triangle's centre. Each Compatt was mounted in rigid tripods to minimise movement in the current.

The PIES unit was freefall-deployed in the immediate working area to observe change in sound speed through the water column. It was set to log temperature, pressure and inclination every 10 minutes. The data collected by the PIES was used to independently validate the calculated sound speed along with multiple dips using a CTD.

The network of transponders was 'boxed-in' using Sonardyne's calibration software to determine their absolute positions and over the course of 36 hours, range observations were logged. At the end of the cruise, all acoustic transponders were recovered using their integrated acoustic release mechanism which allows the unit, with tripod, to float back up to the surface.

Analysis of the GPS-acoustic data set (including GPS positions, acoustic ranges and Lodestar attitude data) indicated that the seafloor could be positioned with centimetre-level precision commensurate with the measurement of tectonic plate movements.

Seafloor positioning performance is significantly impacted by the acoustic range precision and GPS accuracy. From the GPS-acoustic data set, the precision of the acoustic range measurement was estimated to be 5mm one-sigma. Whilst the trial focused on the estimation of tectonic plate movements, the high levels of precision and reliability of the acoustic ranges could support more general seafloor positioning applications. Sonardyne's equipment has already been deployed subsea for years to monitor fault zones in the Mediterranean, and off the West coast of North and South America. Hopefully one day, our improved understanding of tectonic plate motion may help computer models better predict earthquake and tsunami risks, so saving lives.



(Top) The selected site, off the French Riviera, was located in a relatively flat area, 2,400 metres deep, in the vicinity of permanently deployed oceanographic and meteorological moorings to benefit from observations of the water column and atmospheric physical properties.

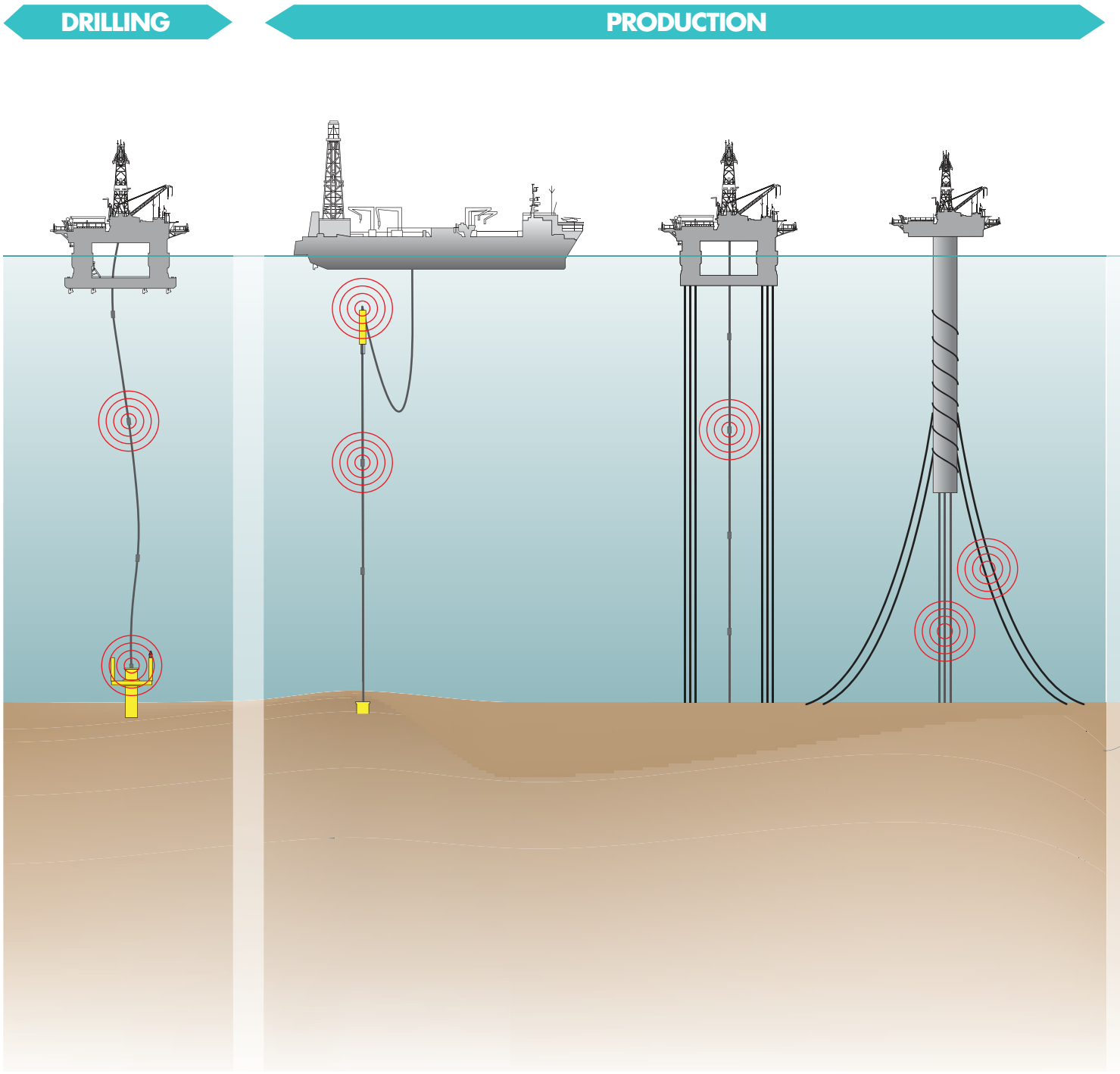
(Middle images) For the trial, four Compatt 6 LBL transponders, a Pressure Inverted Echo Sounder (PIES) and a GyroUSBL transceiver were mobilised. Seen left, is the PIES transponder fitted with a floatation collar being lowered to the seabed.

(Right) Three Compatts formed an equilateral triangle with 2,600 metre baselines and the fourth placed in the triangle's centre.

Structural Asset Integrity Monitoring

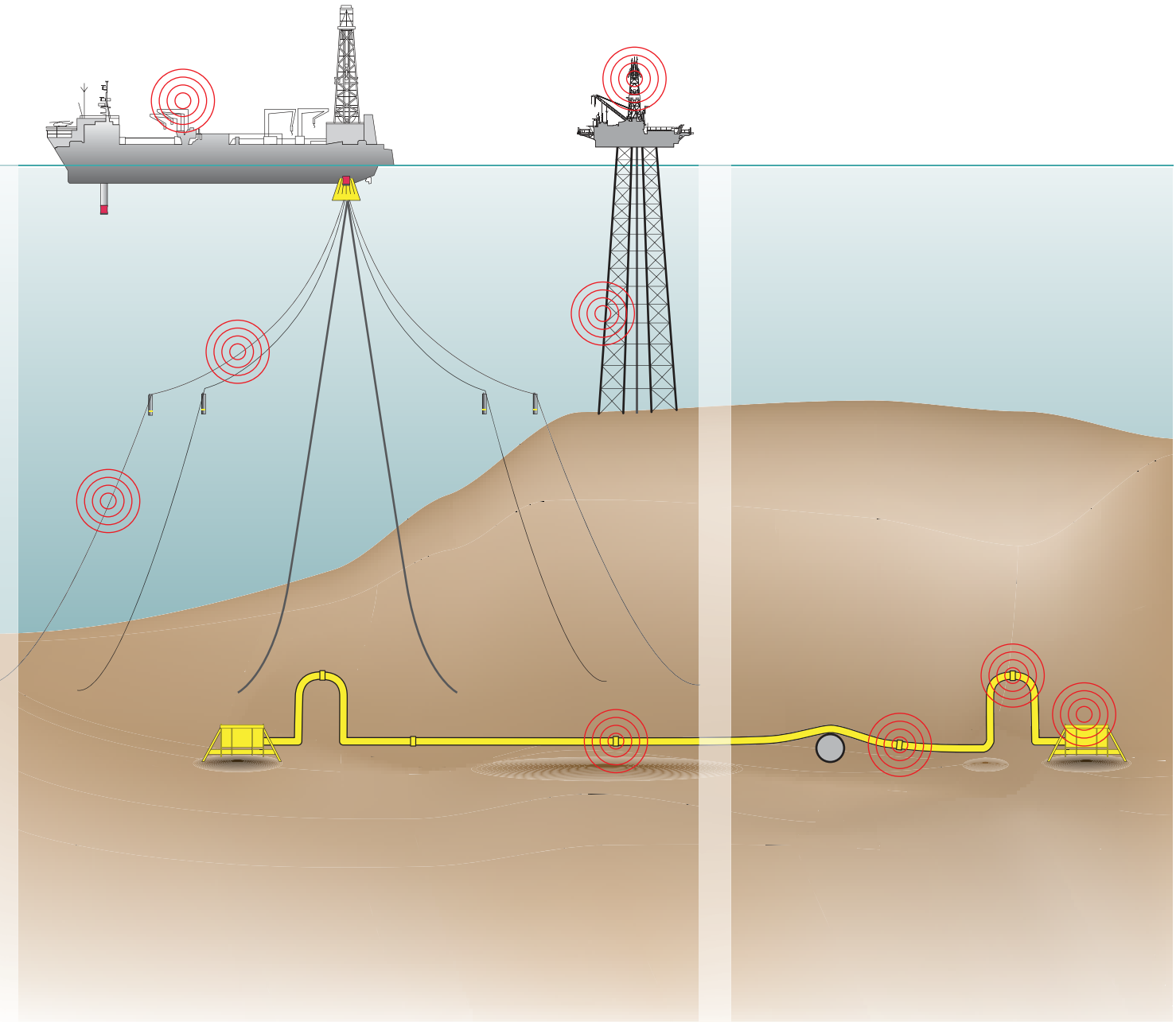
SMART - Subsea Monitoring, Analysis and Reporting Transponder

WHEN IT COMES TO ASSET MONITORING, MAKE THE SMART CHOICE



It is of paramount importance to ensure the structural integrity of offshore facilities. Unfortunately, this does not come easily. Deep water offshore developments are hugely complex and are often exposed to extreme environmental forces. Existing structures are subjected to ever-changing loading as well as severe ocean and environmental conditions. These pose engineering challenges and together with an intense focus on health, safety and environmental performance are putting ever greater pressure on operators to improve their structural integrity management capabilities. Dr Pei An, Consultant for Structural Monitoring, reports for Baseline. **>>**

PLATFORM AND MOORING **PIPELINE & INFRASTRUCTURE**



Structural Asset Integrity Monitoring

SMART - Subsea Monitoring, Analysis and Reporting Transponder

ALTHOUGH THE OIL and gas industry has long appreciated the critical nature of their structural assets, it has been slow to embrace the concept of continuous structural monitoring subsea. In the last few years, structural condition monitoring has increasingly been recognised as a vital ingredient in integrity management, providing vital real-time in-situ data about the behaviour and performance of the structures from which their integrity can be inferred. The take up of condition monitoring has accelerated following several notable incidents, driving operators and contractors to seek a better understanding of risk.

Structural integrity monitoring has become increasingly accepted after years of technology innovations in the field and successful real world deployments which have demonstrated benefits to end users.

What needs monitoring?

This article will address four broad categories of subsea structural assets with integrity concerns:

- Drilling risers and conductors
- Production risers
- Mooring lines and platforms
- Subsea pipelines and infrastructure

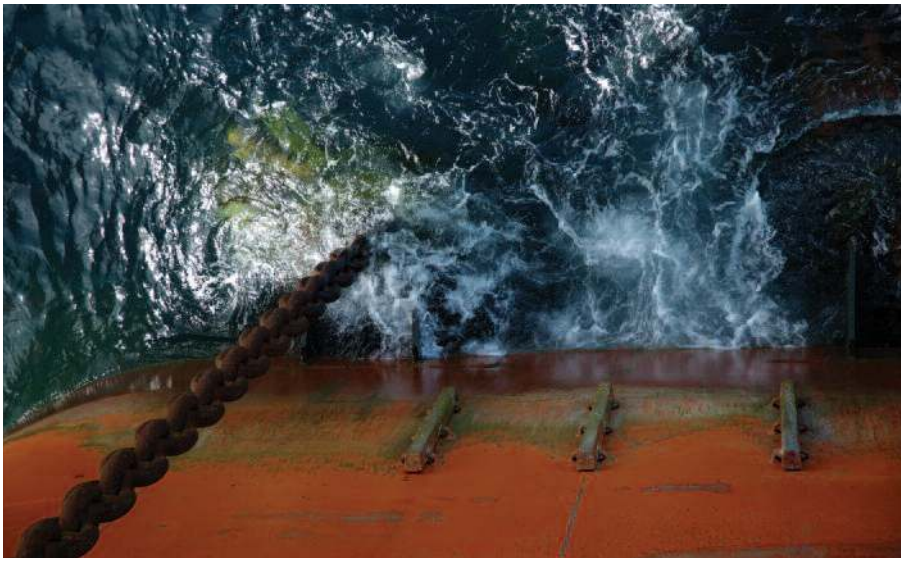
Drilling risers can be subjected to accelerated fatigue damage when strong ocean currents are present, the current can cause a riser to vibrate laterally at its own natural frequency due to vortex shedding, an effect known as Vortex Induced Vibration (VIV). Once VIV has locked-in for a riser, the amplitude of vibration can increase dramatically and rate of fatigue damage accumulation increases substantially. Hence, the probability of a riser failure is increased and needs to be understood. Risers are connected to wellheads and conductors via the BOP and LMRP, and the vibration of risers will transfer to conductors so that they also bend from side to side experiencing accelerated fatigue damage. To compound this, the latest generation of BOPs and LMRPs are significantly larger in mass and size compared with their earlier counterparts. As such, the induced motion from the riser to the conductor may be amplified. It is obvious that the risk of fatigue damage to the conductor must be evaluated and carefully managed.

Production risers have a typical design life of 30+ years and are subjected to similar loadings to drilling risers. Given the long service life, it is once again important to understand the accumulation of fatigue damage. One example is the hang-off and touch-down regions of Steel Catenary Risers (SCR) which experience the highest cyclic stresses due to dynamic bending of the riser. Another example is free standing hybrid risers. An air-filled and submerged buoyancy tank generates up-thrust tension to pull the riser upright. As a key indicator, this tension should be monitored continuously to detect any decrease in the tension due to buoyancy tank leakage. Tension monitoring inferring the integrity of buoyancy tanks.

Clockwise from top: Phenomenon such as Vortex Induced Vibration can lead to accelerated fatigue damage in drilling risers. The risk of a riser failure must be evaluated and understood.

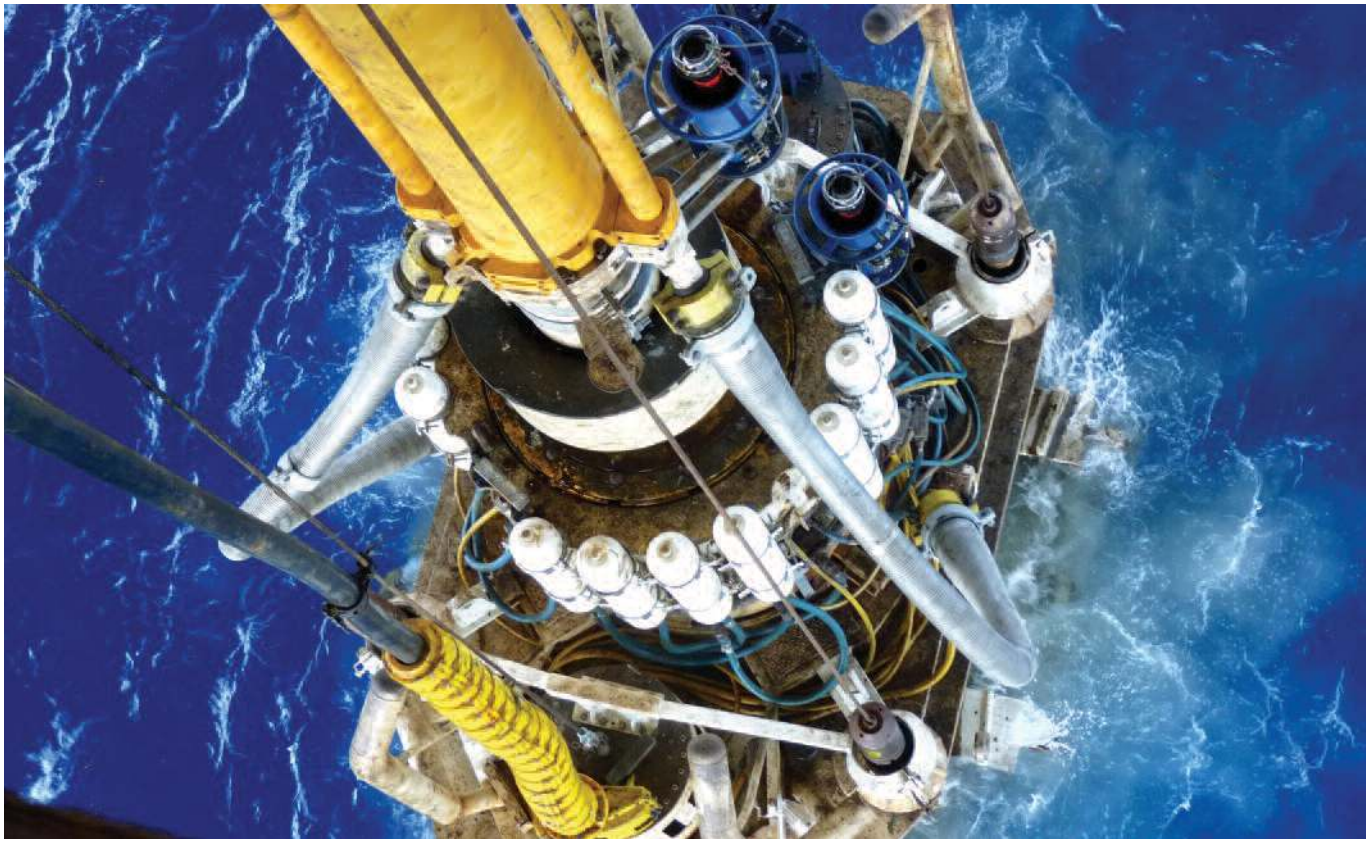
In recent years, there has been a notable rise in the reporting of mooring line failures on moored production platforms such as FPSOs. Continual subsea monitoring can be used to analyse inclination and line tension and also immediately alert an operator should a failure occur.

Throughout their typical design life of 30+ years, production risers must be monitored for signs of fatigue damage. Hang-off and touch-down regions of Steel Catenary Risers (SCR) experience high levels of cyclic stress so are both particularly susceptible. This enables damaging operating conditions to be detected at an early stage and preventative action swiftly taken.



Structural Asset Integrity Monitoring

SMART - Subsea Monitoring, Analysis and Reporting Transponder



For FPSOs, mooring line integrity is an area of increasing concern as more and more failures have been reported in the last few years. Subsea systems can monitor mooring lines continuously, detecting and reporting failures promptly to the operator, thereby allowing safe management of the asset. Such systems can also present mooring line inclination and the line tension in real-time in the marine control room.

There are many causes of concerns for operators of subsea pipelines, such as vibration at spans, spools, jumpers and sleeper regions due to VIV, Flow Induced Vibration (FIV), and slugging in multi-phase flow all of which can cause accelerated damage. The sideways 'walking' of a subsea pipe due to slugging or thermal cycling and movement of subsea PipeLine End Terminations (PLET) also indicate pipeline integrity concerns. Pipeline wall thickness reduction due to corrosion and erosion is also of concern. In-situ monitoring can provide the data required for evaluating and mitigating these integrity issues.

Benefits of monitoring

The purpose of monitoring is to ensure the safe operation of subsea assets. This is based on developing an understanding of how subsea structures and assets are responding to loadings and enabling faults to be detected at an early stage. In-situ real-time data measured by the monitoring systems allows structures to be analysed so as to determine if their integrity is jeopardised. This in turn helps to decide on the potential interventions which could be performed. Structural monitoring can also allow optimisation of production efficiency, savings on periodic inspection and facilitate proactive maintenance regimes, whilst extending service life safely. Major benefits of structure monitoring include:

- Enhanced operational safety
- Proactive integrity management
- Enhanced operational efficiency
- Asset life extension
- Real-world design verification
- Future improvements of structural designs

Get SMART

Sonardyne can provide the industry with a best-in-class structural monitoring tool. This is enabled by its portfolio of technologies including subsea communications, positioning and extensive experience in marine instrumentation. We have in excess of three decades of experience in supporting our customers to implement offshore structural monitoring systems providing reliable, field-proven, practical and useful structural monitoring solutions.

The Subsea Monitoring, Analysis and Reporting Transponder (SMART) is the latest product development from Sonardyne. The core of the system is a new Advanced Data Acquisition and Processing System (ADAPS) which is built around a highly capable micro-processor with the latest peripheral electronics. This battery-powered device brings together powerful subsea data processing capability, low power electronics, long duration logging, versatile sensor input, and acoustic/

(Opposite page) Having access to qualified and regularly updated knowledge about the integrity of your subsea assets is of utmost importance for making the right decisions at the right time. The solution is continuous subsea surveillance and monitoring.

SMART brings together low power electronics, long duration data logging, subsea data processing and acoustic telemetry into a single, easily deployed instrument. It has the flexibility to interface with a wide range of internal and external sensors and other data sources to provide operators with key data. This can be wirelessly transmitted at regular intervals to a topside system giving near real-time information about the condition of whatever the SMART unit is monitoring.

optical telemetry into a single easy-to-deploy subsea instrument.

The SMART unit works seamlessly with existing Sonardyne technologies, including 6G acoustic telemetry systems, making use of associated subsea housings, batteries, low power electronics and sensors. In doing so, SMART leverages existing field-proven Sonardyne designs and technologies allowing low risk operational deployment.

> "We have in excess of three decades of experience in supporting our customers to implement offshore structural monitoring systems providing reliable, field-proven, and practical structural monitoring solutions."

SMART is built as a versatile instrumentation platform. It has the flexibility to interface with a wide range of internal and external sensors and other data sources to provide operators with required data. The data processing unit can apply any user-specified mathematic and data processing algorithms. Providing answers to problems, not just data, is a key part of the SMART ethos.

The SMART unit shares its acoustic telemetry module and transducer technology with the award-winning Compatt 6 using Wideband 2 digital signal protocols. This enables SMART to transmit at up to 9000 bps to Sonardyne's existing range of topside transceivers in ultra deep water.

Where higher data transfer rates are required, SMART can be connected with other wireless communication devices such as Sonardyne's high speed optical modem, BlueComm. Here, data transfer rates from 5 to 500 Mbps can be achieved over distances up to 100 metres.

SMART has multiple digital and analogue inputs which can be configured to connect a variety of sensors. Internal sensors are available for motion measurements including accelerometers, angular rate sensors and inclinometers, along with standard and high precision pressure and temperature sensors. The standard internal accelerometers and angular rate sensors exhibit a typical RMS noise level of 0.2 mg and 0.005 deg/s at a sampling frequency of 10 Hz, respectively. External sensor options include external force sensors such as strain sensors and shackle pins. Any external sensors are connected to the SMART unit via highly reliable external subsea connectors.

The unit is fully programmable to set data logging frequencies, sample periods and sleep periods. During sleep, SMART has ultra-low power consumption to preserve battery power. Logged data acquired from the sensors is saved into two independent memory stores, fulfilling user requirements for redundancy. The on-board data processor can run sophisticated user specified algorithms such as spectrum analysis as well as simple data analyses such as Min/Max/Mean statistics, thresholding for alarms and critical event reporting. This allows data reduction subsea, creating information whilst retaining the raw data. This information can then be reliably transferred acoustically to the topside in a near real-time to enable true structural monitoring applications. **BL**

Ocean Science

Case Study: Shallow water performance characterisation of BlueComm 200

BlueComm shines at Toulon trials

In November 2015 off the coast of Toulon, Total, together with the French research institute, Ifremer, conducted a performance trial of Sonardyne's Free Space Optical Communications technology, BlueComm. The objective was to characterise the performance of the BlueComm 200 variant collecting data on beam shape, maximum range and data transfer rate. The secondary objective was to control an ROV using only BlueComm confirming link stability and demonstrating real world practicality. Communications Application Engineer, **Matt Kingsland**, was aboard for Baseline.

Ifremer scientists deployed one BlueComm 200 from a temporary over-the-side pole mounted to the stern of *L'Europe*, the institute's 29 metre coastal research catamaran. A second BlueComm 200 unit was installed on Ifremer's hybrid ROV *Vortex*.

BlueComm is Sonardyne's innovative through-water wireless optical communication system that's capable of transmitting data at very high speed. Unlike our traditional range of navigation and positioning technologies, BlueComm uses the electromagnetic spectrum rather than acoustic pressure waves to transmit high volumes of data.

Typically operating in the 450 nano-metre Blue Light region of the spectrum, BlueComm can achieve data rates of greater than 500 Mbps. Optical data transmission is highly efficient, enabling 1 Gb of data to be transmitted with the energy contained within a single lithium 'D' sized cell over distances greater than 150 metres.

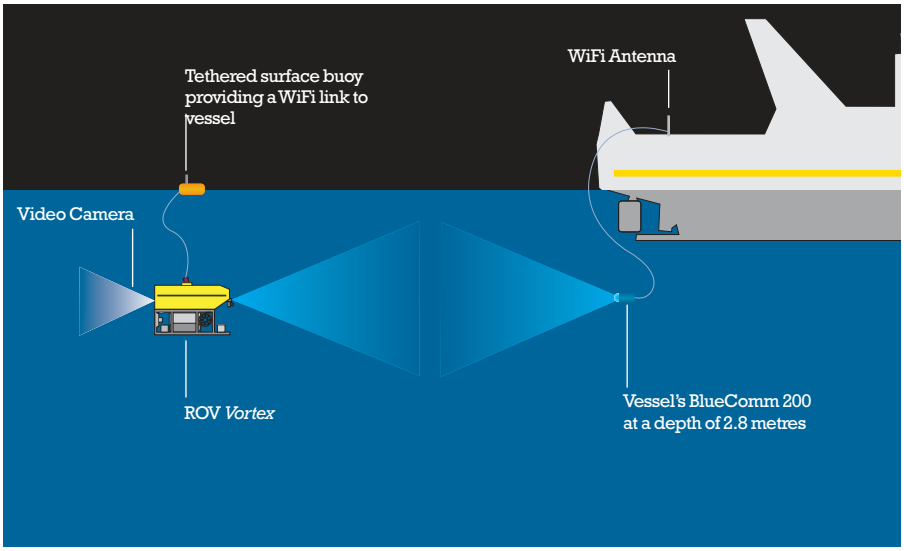
If you think of it in the context of 'underwater broadband,' then the myriad of potential applications for the technology soon becomes apparent; tether-less vehicle control, real-time video streaming and well intervention using resident AUVs (see the special news feature on page 12 of this issue for more on this particular application).

BlueComm 100, 200 and 5000

The BlueComm product family is now made up of three variants. BlueComm 100 is optimised for shallow water 'high ambient light' operating environments and offers a good balance between data rate and range. At the other end of the model line-up is BlueComm 5000. Its dual laser configuration supports data transfer rates at an impressive 500 Mbps at ranges of up to seven metres – enough distance for passing AUVs to safely and efficiently harvest logged data from oil field infrastructure.

Under the spotlight at Ifremer was BlueComm 200, the 4,000 metre depth rated, long range (200 metre) model. It uses an array of high powered blue light emitting diodes (LEDs) that are rapidly modulated to transmit data. Its receiver uses photo multiplier tubes (PMT) that are sensitive to just a few photons. The unit is bi-directional with three data speeds selectable by the user.

BlueComm200 System Setup at Ifremer Trial



For the trial, Ifremer scientists mounted one BlueComm 200 to a temporary over-the-side pole deployed from the stern of *L'Europe*, the institute's 29 metre coastal research catamaran. A second BlueComm 200 unit was installed on Ifremer's hybrid ROV *Vortex*. Initial tests used *Vortex*'s on-board camera to constantly stream video via BlueComm while later tests would also include command and control data for *Vortex*.

BlueComm 200 can be configured to operate using one of three data bandwidths depending on the user's requirements; 2.5 Mbps, 6 Mbps or 12.5 Mbps.

Using a time division communication scheme, proportions of the bandwidth can be allocated to either the uplink or the downlink. For example, initial testing was spent streaming a 1.1 Mb/s video stream from *Vortex* to the ship as this was decided as the minimum data rate for usable video. To accommodate the video, the BlueComm was set to the 2.5 Mbps bandwidth with a 50:50 distribution uplink to downlink. Meaning 50% of the bandwidth 1.25 Mbps was dedicated to the uplink and 1.25 Mbps was allocated to the downlink.

The trial was conducted at night time to simulate as far as practically possible the darkness of deep water. Environmental conditions were considered 'good' between 98%-99% irradiance transmittance per metre. However, the shallow depth that the trial was conducted at (just 2.8 metres), light

Ocean Science

Case Study: Shallow water performance characterisation of BlueComm 200

pollution from the full Moon and Toulon just a few miles away, were observable factors that affected range performance.

Testing began by manoeuvring *Vortex* to the limits of BlueComm's ability to characterise the working beam shape. This can be seen in Figure 1 (right). A video range of 88 metres was achieved while the connection was capable of lower data rates up to 99 metres. The beam shape shows excellent omni-directional coverage with the maximum inline video range only reducing by 20% to 70 metres at the 90 degree point. Further testing showed the pair of BlueComms could reliably communicate with each other well beyond 90 degrees.

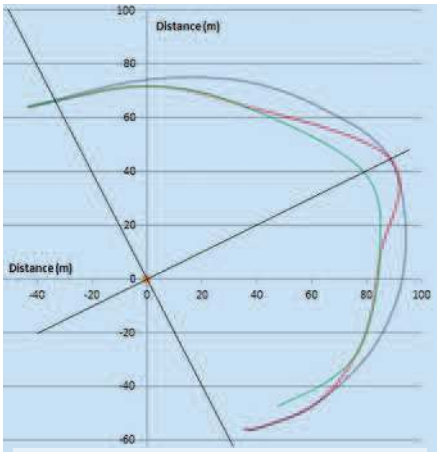
ROV command and control

The second phase of testing moved *Vortex*'s command and control over to the BlueComm link. For this testing, *Vortex* was fitted with an additional BlueComm white light emitter. This emitter is designed to provide lighting for the camera as conventional vehicle lighting can interfere with BlueComm's sensitive receivers. The white emitter pulses in synchronisation with the transmissions so as not to cause any interference.

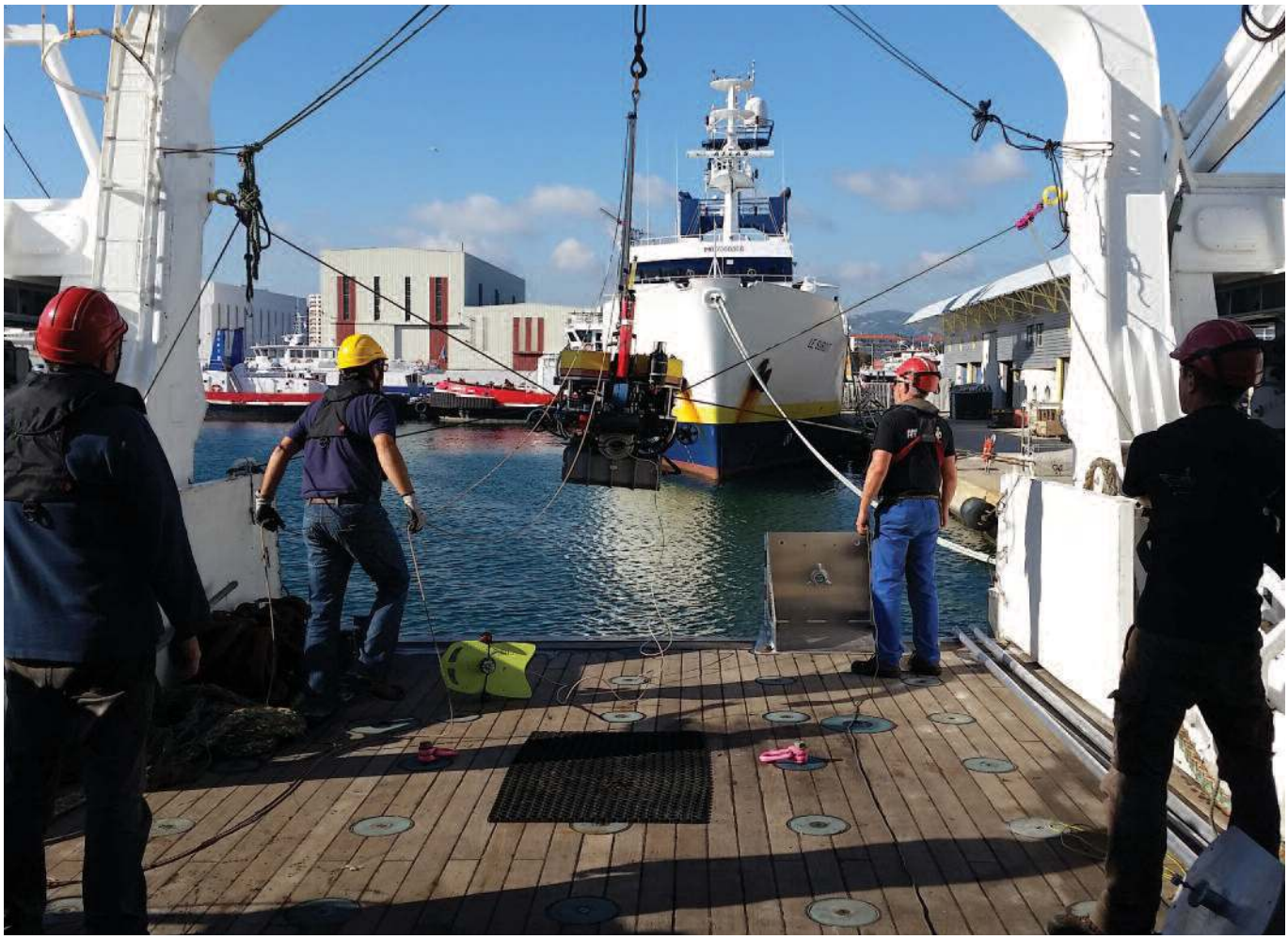
Vortex was successfully piloted remotely using the BlueComm for over 45 minutes. Meanwhile increasingly strenuous data transfer tests took place including HD video at 12.5 Mbps transfer speed. The 12.5 Mbps link showed a reduced maximum range of only 4% over the 2.5 Mbps link.

The remote control of *Vortex* showed as the link speed decreased with range, a way to prioritise data such as positioning command and control over less important data is needed. However, there are already Ethernet based standards in place such as QoS (Quality of Service) which can be

BlueComm200 Range Performance
Clear Shallow water (2.8 metres)



Absolute Max Measured Range (IP Ping drops out)
Predicted Maximum IP Ping Range
Edge of Maximum Data Rate IP Camera Streaming 1 Mbps
Ship



Deploying *Vortex* and its surface WiFi link (yellow float on deck) from the stern of *L'Europe* for an initial daylight test run.

implemented. This would allow an ROV to use the full range of BlueComm without risking a loss of connection.

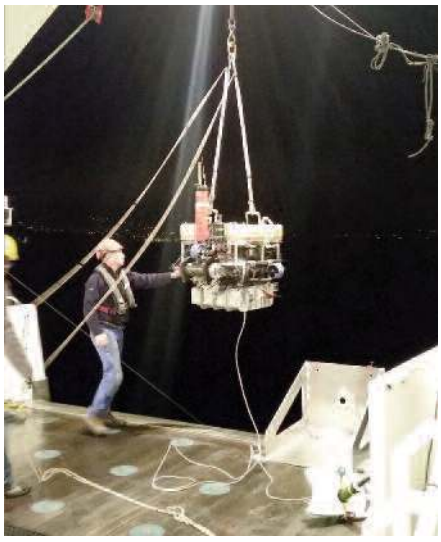
Conclusions

In summary, the testing showed a representative maximum operational range of the BlueComm 200 for shallow water applications. The range, however, is still less than seen in deep water testing due to ambient light levels near the surface. The system did however cope with these conditions and provided a robust network link up to 12.5 Mbps between the ship and *Vortex*.

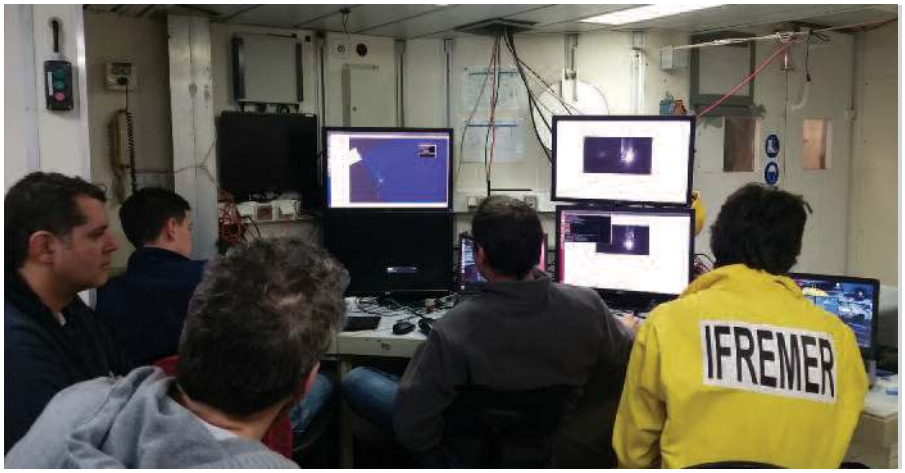
Efficient use of bandwidth such as a good video compression algorithm would allow the system to operate at lower speeds thus achieving greater range and lower power consumption. While a QoS system or reserving bandwidth would allow the ROV to operate without risk of losing comms.

ROV *Vortex*

***Vortex* is Ifremer's demonstration and test bed Hybrid ROV which BlueComm was fitted to for the trial. Equipped with a 3800 Wh battery *Vortex* could operate remotely via a WiFi link for over 4 hours. The WiFi link is provided by a tethered buoy which floats on the surface as *Vortex* dives to depth. A configurable on board camera provides high bandwidth data to test the BlueComm link.**



The trial was conducted at night time to simulate as far as practically possible the darkness of deep water. Light pollution from the nearby city of Toulon, the full Moon and shallow water were all observable factors in the trial's results.



International

News from our Regions Around the World

UK – Aberdeen

Barry Cairns VP Europe and Africa

News of our new form-factor SPRINT operating with Syrinx DVL has had a very positive response from our ROV customers. Having the concurrent Ethernet connectivity to the DVL is proving to be a real winner, helping ROV teams and Survey teams operate together with one set of equipment. Further to this, we have an industry-first combined INS and DVL (see page 5). Limited connectivity and stringent export rules are always a concern for clients; both have been addressed with these new products.

Thank you to all those who visited us at Subsea Expo. We received great feedback on our new 3rd generation Lodestar AHRS and SPRINT INS. We're looking forward to seeing them fitted to your ROVs and AUVs in the near future.

2016 is set to be just as busy for us on the USBL, DVL and INS front. We've made significant advances so why not attend one of our free workshops and get the full story. Email: **kaite.wade@sonardyne.com** to register your interest. ■

Brazil – Rio das Ostras

Joao Ramos General Manager

Sonardyne Brasil is today facing tough local market challenges but we're taking the necessary steps to adjust our business and maintain the high level of support that you have come to expect.

With ISO 9001 accreditation achieved last year, our repair response time and procedures are now more competitive than ever. Taking full advantage of our in-house facilities, our added-value services now include full tank testing, source level testing and endcap sensor calibrations. For example, we recently completed the full upgrade, tank testing and endcap calibrations of a large batch of Compatt 6's for a construction client.

Invest in training

Given the present economic scenario, we are currently offering discounted training rates. These include Ranger 2, Marksman and Fusion. Invest now to ensure your operators have the skills and confidence to operate and maintain our systems to their full potential.

You'll read elsewhere in Baseline (page 7) about operational leases. This new scheme is available in Brasil so if you need to acquire subsea technology for your next project, talk to us about this attractive financing arrangement. ■

SE Asia – Singapore

Anthony Gleeson Vice President

In recent weeks we have been running regular Mini-Ranger 2 USBL demonstrations in our test tank. Those attending have witnessed the ease with which you can set the system up and begin tracking. The high update rates (3 per second) achieved while tracking the WSM6+ transponder we had deployed certainly grabbed the attention of those looking on.

If you're currently specifying shallow water survey and construction projects in the region, I suggest you look no further than Mini-Ranger 2.

In-house demonstrations of BlueComm modems are next on the schedule for us, so if you'd like to come along and understand more about this unique, high speed modem technology, do please get in touch.

Our track record with the region's ocean science community continues to build. Three new-build research vessels and an ice breaker have all selected our acoustics for DP reference and vehicle positioning. We'll be announcing more details of these prestigious contracts in the coming weeks.

The start of the year is the perfect time to service equipment. We offer pre-deployment, post-deployment and sensor calibration checks. Book a service today by emailing: **asia.repair@sonardyne.com** ■

USA – Houston

Simon Reeves Senior Vice President

Wellhead Monitoring

Despite the slow down, new projects and new opportunities are keeping us focused. One of these is SMART(see page 20). We're set to deliver our first units configured for wellhead monitoring. As well as reading a suite of user defined sensors at a fast update rate, these intelligent units analyse sensor data subsea, ready for efficient acoustic upload to the surface.

We currently have two telemetry projects for capping stacks here in the GOM. These capping stacks are for use on HPHT (High Pressure High Temperature) wells and will provide the necessary safeguards for operators drilling in ever more challenging environments.

Lodestar and SPRINT in the US

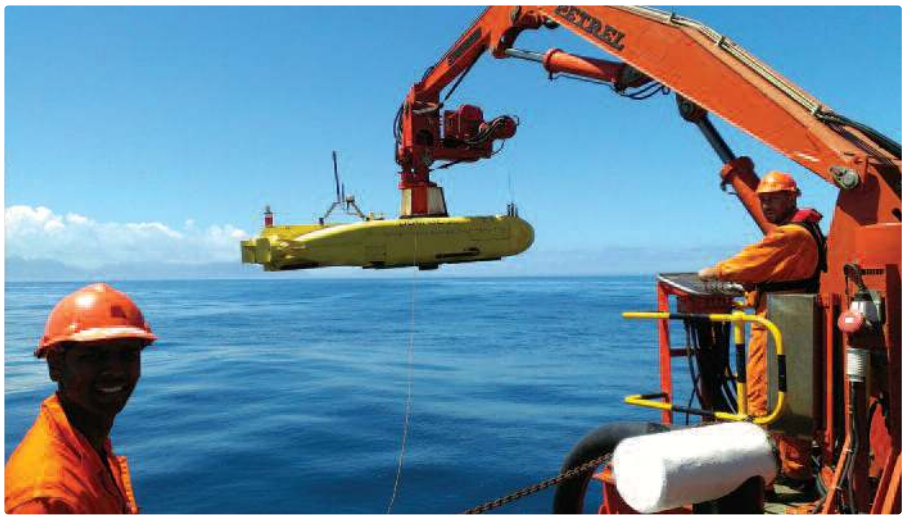
Our new line up of Lodestars and SPRINTs (page 4) mean that US ROV manufacturers have greater choice when spec'ing subsea navigation. Fit one bottle and upgrade from AHRS to INS as your needs grow.

Away from oil and gas, the capabilities offered by our LRT acoustic releases continue to prove popular with academic and oceanographic institutions – with many qualifying for special discounts. ■

Help & Advice

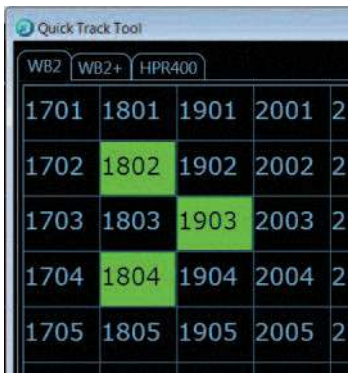
THE KNOW HOW

Our highly experienced product specialists are available to help you maximise the performance from your Sonardyne technology. Get in touch: support@sonardyne.com



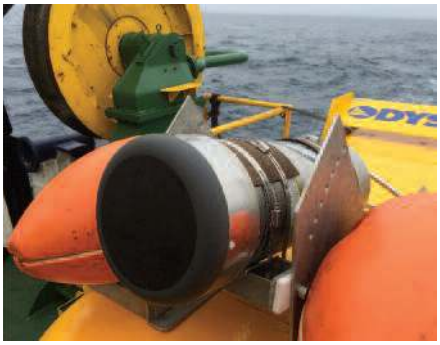
AUV telemetry position updates

A new feature in the latest release of Ranger 2 software allows an AUV fitted with an AvTrak 6 transceiver to receive USBL position updates on every navigation cycle. This can be used to provide high update rate USBL aiding to a navigation system - something that's particularly important during descent when the vehicle's navigation system has no Doppler Velocity bottom lock aiding, i.e. operating on free-inertial. In addition to receiving high update USBL position observation, the feature allows the AUV to pass status information into the AvTrak 6's data buffer which is then retrieved automatically on the next navigation cycle and forwarded to the user's topside mission control software. It is also possible for the mission control software to substitute bespoke commands such as requesting the AUV status, emergency abort, navigation status and snippets of observed data for QC. For details on how to update your software, email: support@sonardyne.com



Keep an eye out for Quick Track

One of the many new features that will be available in the upcoming release of Ranger 2 Version 4.04 software is Quick Track. This tool allows you to instantly start tracking a beacon with no other information required other than the unit's address. You'll no longer have to manually add the beacon to your job and go through the process of acoustically acquiring the beacon's configuration. Ranger 2 takes care of everything, leaving you to get on with your subsea operations. Quick Track is particularly useful for checking system performance.



Long layback tracking – tips for success

Here are some things to consider when planning a long layback towfish USBL tracking job. If extreme range is required, our LMF (Low Medium Frequency) HPT transceiver system reduces absorption and therefore may be better suited to the task. However performance will depend on the noise signature of your vessel so make sure you have a good understanding of this. Next, choose a transponder with a high acoustic output such as a directional 5,000 or 7,000 metre rated WMT. If space on your vehicle allows, use a Compatt 6 as it has twice the Tx power. In either case, always use WB2+ signals to get double the energy into the water. Angle your beacon to point towards your vessel and set it to Responder mode for the fastest possible position update rates. Tilting the transceiver can open the face to vessel noise and reduce effective range so if your vessel is noisy, inverted USBL (iUSBL) could be the answer. It's important to discuss your exact requirements so get in touch with us by emailing: **survey.support@sonardyne.com** for free expert advice.

Got a Compatt 6? Then you've got a modem

Did you know that all Compatt 6 transponders come with a robust, underwater telemetry capability built-in as standard? The transponder supports user transfer rates from 100 bps to 9,000 bps and is equipped with an internal 512 kB data buffer. Unlike many acoustic modems, it's highly customisable and can support a number of different applications such as auto forwarding of ADCP data.


Sonardyne
SOUND IN DEPTH
SUBSEA TECHNOLOGY
Total ROV
With acoustic positioning, aided inertial and now DVL, Sonardyne is your total ROV navigation supplier
Whether you're operating an Inspection-class ROV in shallow water, or tracking a 6,000 metre rated Work-class vehicle to support deep water drilling and field development programmes, our acoustic, inertial and optical technologies are designed to keep you operational at all times. 6G USBL and LBL acoustic hardware is low-risk and field-proven. Lodestar AHRS and tightly integrated SPRINT INS sensors extend capability and improve vehicle control. And if you hadn't already heard, we now manufacture DVLs, so you can now get more of your ROV's technology from one trusted manufacturer.
POSITIONING
NAVIGATION
COMMUNICATION
MONITORING
IMAGING