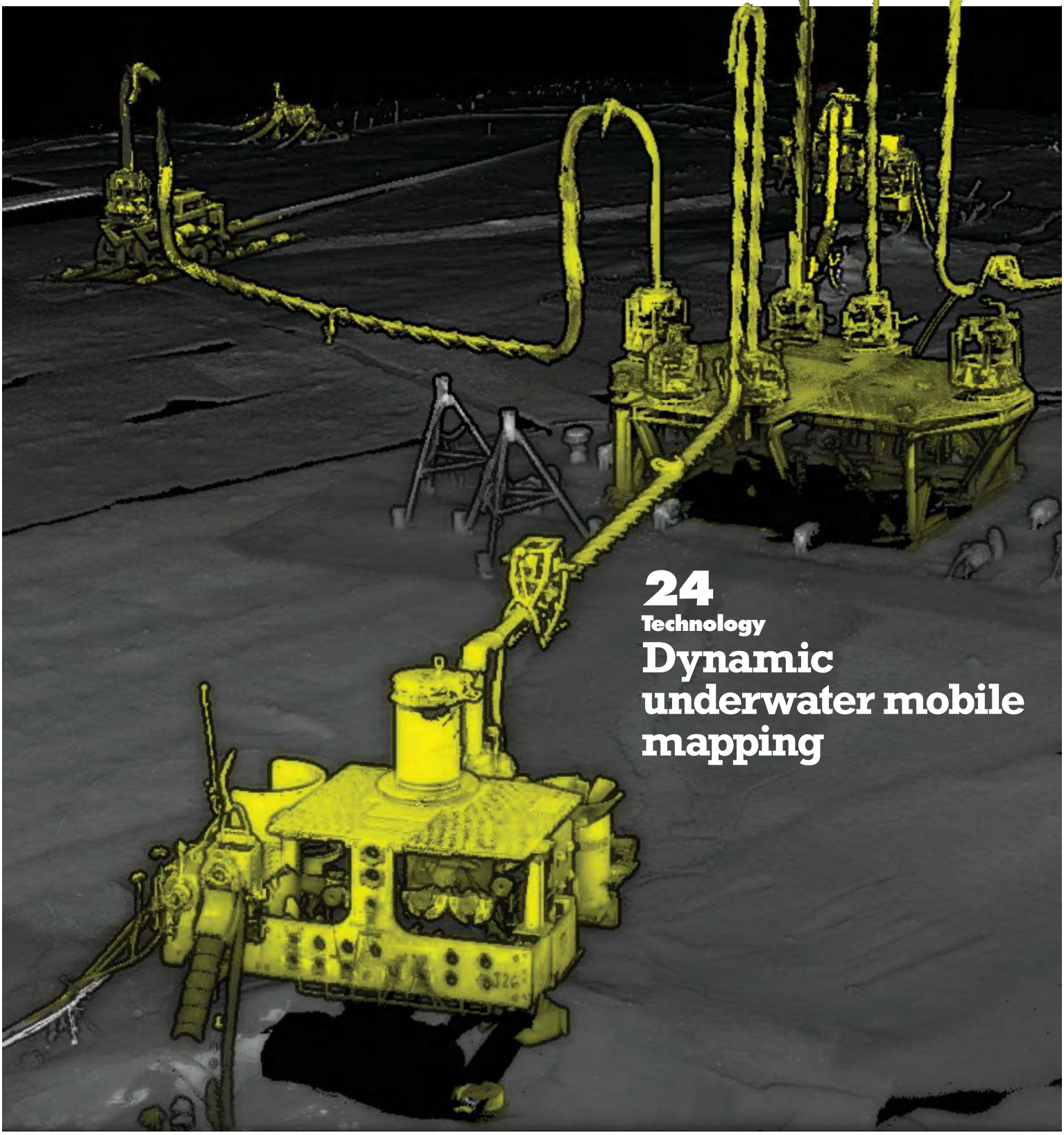
THE CUSTOMER MAGAZINE FROM SONARDYNE
ISSUE 17

Baseline



SIX HUNDRED MILLION. It's hard to imagine what six hundred million of anything would look like but for one client, Shell, it's the number of measurements that were collected by a network of Autonomous Monitoring Transponders in a unique project spanning 10 years. Read the full story on page 20.

Continuing the big numbers theme – this time millions of point cloud data – discover on page 24 how we are once again at the forefront of technology that's improving the efficiency of your surveys. Our integrated INS, DVL and acoustic navigation solution, SPRINT-Mapper, delivers centimetric geo-referenced navigation data meaning you can now quickly and precisely map anything underwater.

With the introduction of our OEM series in Kit on page 4, your marine platforms can now benefit from '6G-inside' even when space is tight. We also take a look at our long-life sensor node, Fetch, which now lasts longer, and BlueComm 200UV for high ambient light environments. With the arrival of our smallest ever Compatt – Micro, 6G continues to provide trusted solutions for your projects, and on page 7 there's the first chance to see our new seabed lander.

You can keep up to date with all our latest news stories from page 8, including our largest ever Sentinel port protection deployment and more success for Ranger 2 DP-INS. See for yourself the scale of our latest bundle tow project with Subsea 7, utilising our 6G technology in the North Sea on page 12, and discover what we can do for your marine robotics platforms in the latest in a series of articles from our expert business team on page 14.

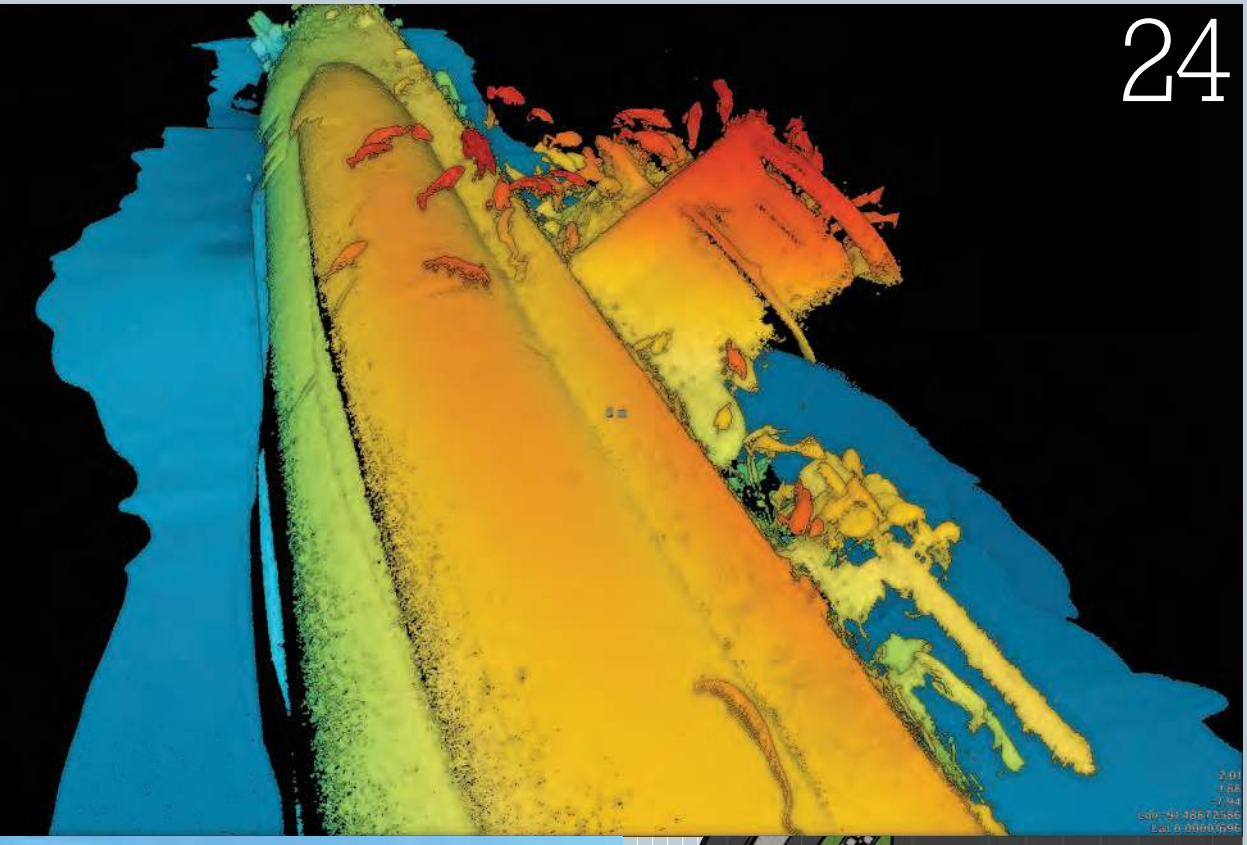
David Brown Editor

Baseline » Issue 17

Front Cover
Jumpers and spool pieces can be seen in great detail in the post-processed point cloud data from a recent mobile mapping project.

Images courtesy of:
DEEPOCEAN

In this issue...



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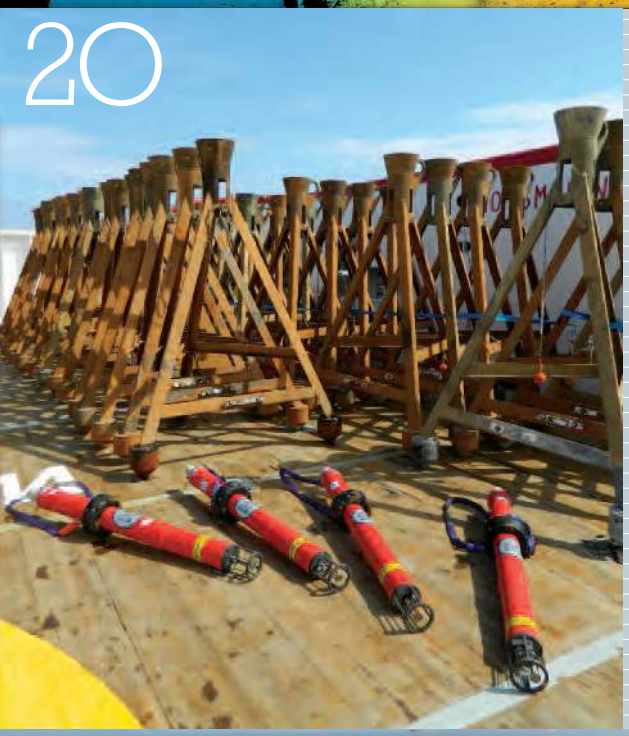

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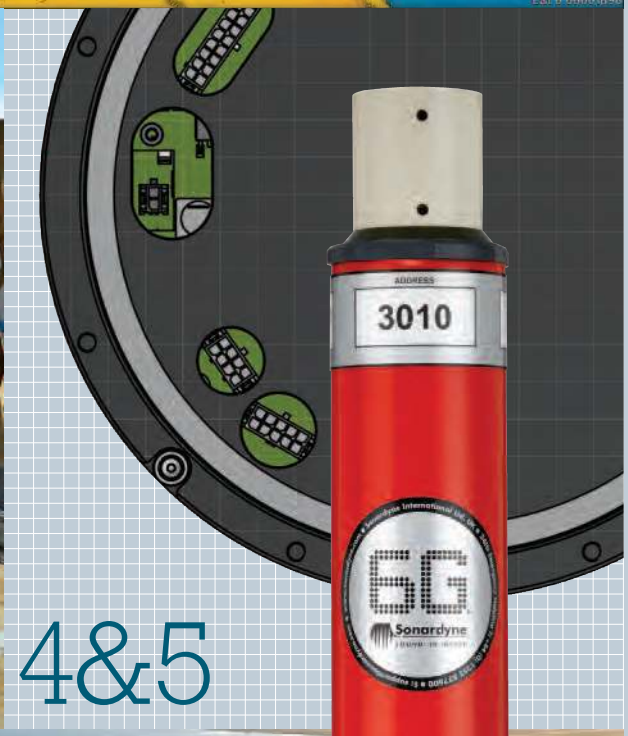

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Baseline Magazine
The Customer magazine from Sonardyne

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Sonardyne
SOUND IN DEPTH

SONARDYNE.COM

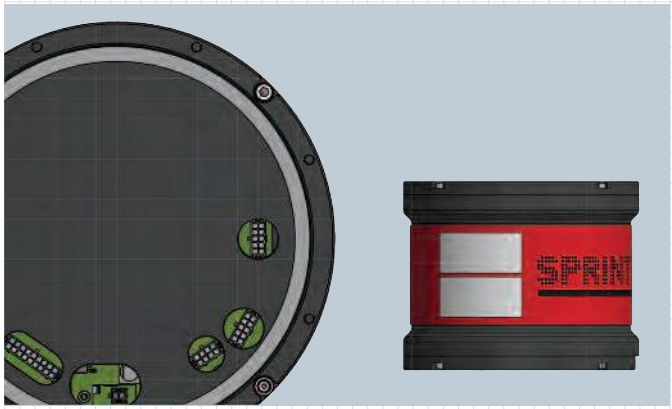
»KIT

Our latest subsea technology and services

OEM EQUIPMENT

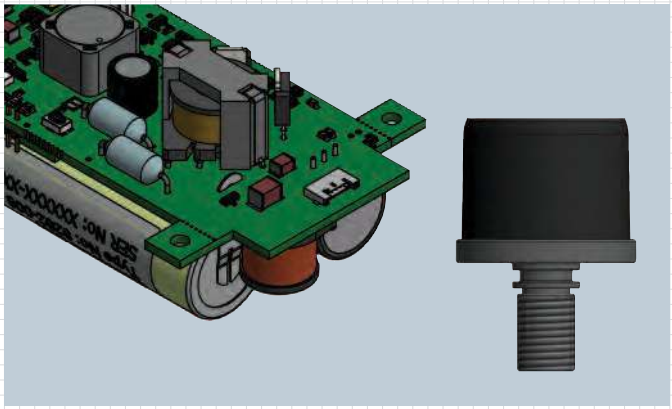
No jacket required

Limited by space, layout or weight? Don't worry; our most popular navigation, tracking and modem products are now available in OEM form meaning you can package them in any way that best suits you.



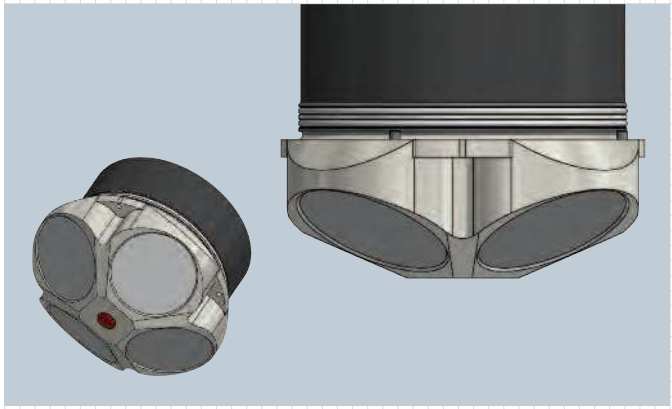
Lodestar AHRS OEM/ SPRINT INS OEM

Our 3rd generation Lodestar and SPRINT mechanics addressed many users' needs for a smaller and lighter form-factor. But sometimes, a vehicle such as a USV or AIV are so restricted on payload capacity, further size and weight savings need to be made. This can now be achieved with an OEM Lodestar or SPRINT. The lightweight aluminium housing of the SPRINT 500 model shown here measures just 202mm in diameter by 162mm tall.



Nano AvTrak 6 OEM

Small AUVs need small instruments and they don't get much smaller than our new Nano AvTrak 6 OEM. It measures just 87.7mm long and 56mm wide but we've managed to pack in many of the features supported by the larger AvTrak 6 transceiver including; USBL tracking and two-way comms. A remote transducer gives you the flexibility to mount it anywhere, whilst the li-ion battery gives you 10 days standby life to help you recover the vehicle if it's lost.

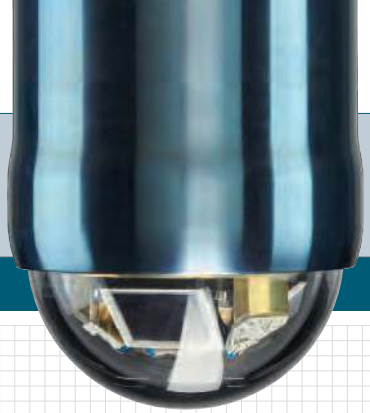


Syrinx DVL OEM

Syrinx is our 600 kHz Doppler Velocity Log (DVL). When fitted to your subsea vehicles and surface platforms, it's capable of high altitude navigation that's comparable to a 300 kHz DVL with the high resolution performance of a 1200 kHz DVL. In OEM form you will get a full depth rated, water blocked array that's connected by cable to a separate electronics module. You can package this into your vehicle's existing main subsea electronics, or re-package it in an entirely custom housing designed to meet your operational setup.

AvTrak 6 OEM

The lightweight rechargeable transceiver design of AvTrak 6 OEM allows for easy integration into autonomous vehicles and provides all of the features supported by the standard AvTrak 6 including; Sparse LBL ranging and Burn Wire. The OEM chassis can be customised to provide mounting points for specific vehicle internals and is supplied with a threaded boss mount MF Omni-directional transducer for easy mounting on a vehicle's hull. The integrated li-ion rechargeable battery provides up to 30 days emergency standby life.



TRANSPONDERS

Compatt 6 family grows – by getting smaller

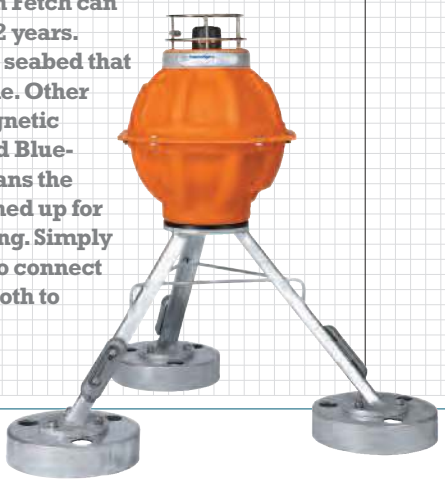
First there was Standard, then along came Mini, Midi, Maxi and Mega. Now there's Micro – our smallest ever Compatt LBL transponder. Designed for short duration missions such as spoolpiece metrology or dynamic mobile mapping (see page 24), Compatt 6 Micro is perfect for installation on Inspection-class ROVs where payload is limited. Its small size also means that a Work-class ROV can deploy multiple units in one trip to the seabed - contributing to those all-important project time savings. Although not as capable as its bigger brothers, Compatt 6 Micro offers you the same accurate and robust positioning that 6G is known for. Plus, its easy handling helps reduce offsetting errors when used with a stab and receptacle for improved metrology results. Also being a re-chargeable unit, it saves you time and money on replacing depleted alkaline batteries. Our website has all the specifications.

TRANSPONDERS

New long-life Fetch goes the extra distance for your surveys

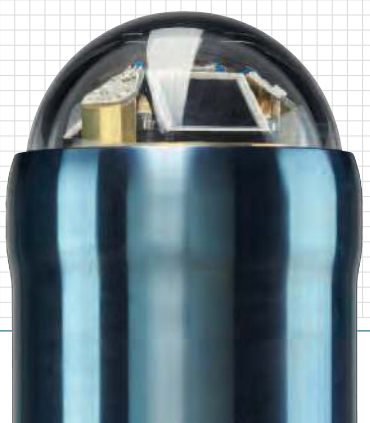
Fetch is our wireless autonomous sensor logging node. It's easy to deploy, easy to recover and is a popular choice for anyone with a remote monitoring application in mind.

At up to five years, Fetch has always had an impressive battery life but thanks to a larger high capacity lithium battery, combined with our low-power Wideband electronics, new generation Fetch can now be deployed for up to 12 years. However, it's not just on the seabed that new Fetch will save you time. Other new features include a magnetic battery disconnect plug and Bluetooth connectivity. This means the unit doesn't need to be opened up for shipping or for programming. Simply pull the magnetic plug off to connect the battery, then use Bluetooth to program the unit before deployment.



BlueComm 200UV for ambient and shallow conditions

Currently in development, BlueComm 200UV is the latest model set to join our family of high-speed optical communication modems. It is optimised for operations in ambient light, such as those encountered in deepwater operations using ROVs or in very shallow water. The standard BlueComm 200 system uses blue light as it has the lowest absorption through water, giving you the maximum possible range. Blue LEDs are also highly efficient giving the most light for the electrical power used and are the perfect choice for low ambient light conditions such as those experienced by AUVs. BlueComm 200 can also come equipped with a white light emitter to illuminate the environment for taking video. The limiting factor with BlueComm 200 is the large amount of blue ambient light from standard ROV lights and the sun which is seen as noise and limits the BlueComm 200's operational range. The UV system has been designed to operate in a portion of the light spectrum with less ambient light and thus less noise. In deep water operations using ROVs, vehicle lighting produces blue light which can limit the maximum range of the standard BlueComm 200 equipment. However a UV-based system is not affected by the ROV's lights as they do not emit UV light thus allowing more consistent operations. Capable of data rates of 20Mb/s at ranges up to 50 metres, expect to see BlueComm 200UV available towards the end of 2017.



»KIT

EXPORT CONTROL

Choose 'Made in the UK' for easy DVL export

It's now two years since we launched our first DVL, Syrinx, and in that time we've seen it rapidly adopted by users around the world. Aside from features such as easy installation, dual outputs, replaceable transducer pucks and high altitude performance, one benefit that has really got users talking is the relative ease with which it can be shipped around the world. Although classed as 'Dual Use' technology (defined as goods, software and technology normally used for civilian purposes but may have military applications), Syrinx is designed and manufactured entirely in the UK. This means it can be exported to countries within the European Union and selected others (including the USA) without the need for a specific export licence. Of course, you still need to apply due-diligence if re-exporting from your own countries. If you need any advice, please contact: **sales@sonardyne.com**

SENSORS

Want to measure it? We can help

Temperature, pressure, salinity and sound velocity; just some of the everyday parameters we're asked to measure. But did you know that we've the capability to measure almost any physical or chemical parameter you can think of, and deliver the data straight to your desktop? We can even build the sensor for you, taking care of all the mechanical integration and testing, saving you time and reducing risk. Why not challenge us to solve your next sensor monitoring project?

Stream your data with our SensorView software.

LEGISLATION

Still using 5G? New rules will affect your operations

It has long been our policy to support one previous generation of technology alongside our current generation platform – in this case 5G and 6G. However, changes in environmental legislation, notably the European Union Restriction of the Use of Certain Hazardous Substances (often called RoHS 2) means this is no longer possible.

Achieving compliance with requirements of RoHS 2 would require a significant re-engineering of 5G products as many of the electronic components in these designs contain trace amounts of certain heavy metals and other chemicals which are now restricted by the legislation.

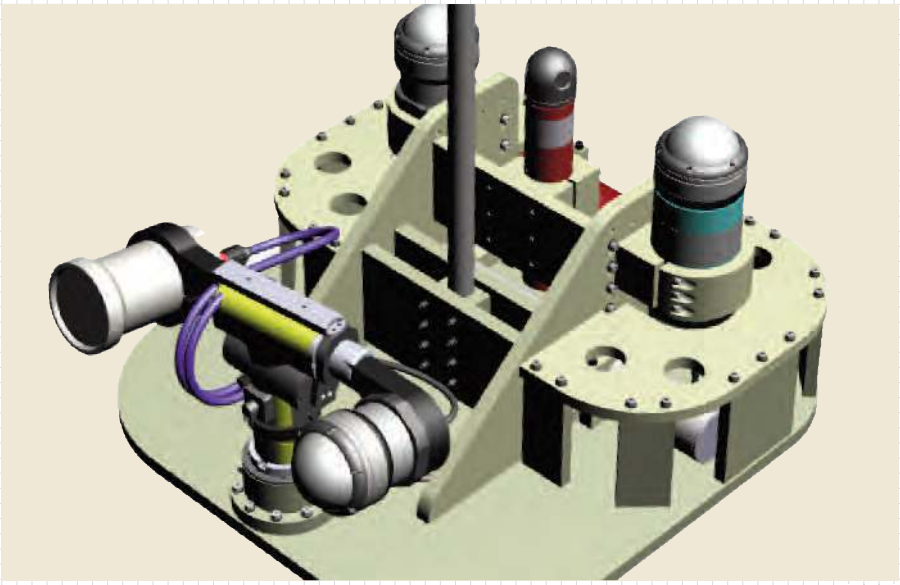
We've therefore reluctantly taken the decision to discontinue the sale of 5G products from this summer. We will of course continue to provide you with technical and operational support for this platform for as long as is reasonably practical.

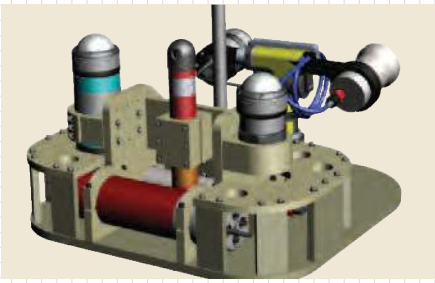
To out find more, including the list of products affected, contact your local Sonardyne office.

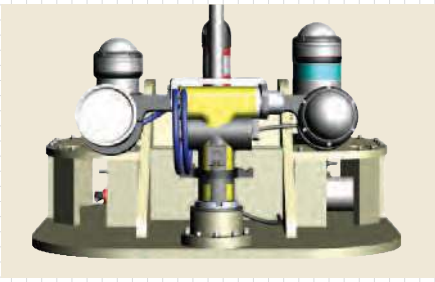
ASSET MONITORING

Lander touches down

Our new lander has been specifically designed to give you a cost-effective wirelessly connected solution to your seabed monitoring activities. Better still, you can get the complete system, sensors and all, from one manufacturer – us! What will you use it for?







Having pioneered the development of high-speed subsea wireless communications with our innovative BlueComm optical modem range, we've now taken the next step of wrapping it into an easy-to-use flexible lander. Options start with the cost-effective BlueComm 100 short range system, capable of 5 Mbps over 15 metres but if this isn't fast enough for you, BlueComm 200 can give you 12.5 Mbps at up to 150 metres.

Integrating a high definition video camera onto the lander, including pan and tilt facility, makes it easy to provide a second perspective for ROV operations. With a matching BlueComm ROV unit, the lander can stream HD video back to your ROV control room along with the ROV video feed. Where your task is to maintain a long endurance vigil on a subsea asset, the camera can be switched to time-lapse mode capturing a series of high definition stills stored on the high capacity solid state drive built into the lander's multiplexer. The BlueComm link can then be used to harvest that data periodically via ROV or passing AUV.

To maximise the productivity of the system, we've also added a 6G acoustic capability which can be used to track the position of your lander or transfer data to or from a surface asset which could be a vessel of opportunity, buoy or USV. The acoustic link can also be used to command the video system, including aiming the pan and tilt mount, as well as controlling the sensors, and receiving data back from the sensor suite at a data rate of 9,000 bps.

The lander has additional inputs for Ethernet and serial devices, enabling you to gather data on metocean parameters such as current profile, salinity, pH etc. Essentially, if you can think of something you need to measure, we're confident we can provide the sensor to do it!

For those who appreciate efficiency, the multiplexer unit also has the capability to provide subsea data processing to compress or analyse data from the camera system or your sensor suite. This enables you to receive critical data including alerts and alarms over the acoustic link; potentially triggering an ROV intervention to collect raw data over the high bandwidth BlueComm connection.

Technical File

Key features and capabilities

- Remote wireless HD camera with up to 150 metres optical modem link
- HD video capture at 1080p resolution
- HD still photography and time lapse recording
- Integrated multiplexer with Ethernet and multiple serial inputs for additional sensors
- Up to 2 TB of onboard storage for camera and sensor data
- Integrated long range acoustic communications for positioning and remote command and control
- Depth rated to 4,000 metres

NEWS

McDermott's *LV108* entered service in 2015 and is currently on contract in the Ichthys field, Western Australia. Designed as a fast-transit, dynamically positioned (DP 2) vessel for subsea construction support across a wide variety of water depths, the *LV108* can accommodate a crew of 129.

DYNAMIC POSITIONING

McDermott International Inc. selects Ranger 2 DP-INS for pipelay vessel *LV 108*

Global engineering, construction and installation services provider McDermott International, Inc., has fitted our Ranger 2 Pro DP-INS system – the highest specification system available – to its Lay Vessel 108 (*LV 108*).

The system is made up of our DP-INS sensor co-located with our sixth generation (6G) HPT, and is being used to support touchdown monitoring surveys of submarine cables, umbilicals and pipelines and as an independent position reference for the *LV 108*'s dynamic positioning (DP) system. The hardware was installed on one of the vessel's two Kongsberg through-hull deployment machines and interfaced directly with the vessel's DP system, also supplied by Kongsberg.

Dynamically positioned construction and installation vessels such as the *LV 108*, conventionally rely on Ultra-Short BaseLine (USBL) acoustics and the Global Navigation Satellite System (GNSS) as their primary sources of position reference data. However, a vessel's station-keeping capability can be compromised in the event the USBL is affected by thruster aeration and noise and the GNSS signal is simultaneously interrupted. The latter is particularly common around equatorial regions and during periods of high solar radiation.

> **"This strategy focuses on ensuring our vessels and acquisitions keep abreast of the industry's growing demand for safe, efficient, cost-effective installation solutions for field developments across all water depths."** Jason Peters, Global Survey Manager, McDermott

Our Ranger 2 Pro DP-INS system addresses this operational vulnerability. It aids vessel positioning by exploiting the long-term accuracy of our Wideband 2 acoustic signal technology 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 has been proven to deliver valuable time and cost savings for vessel owners as it does not need a full seabed array of transponders to be installed and calibrated before subsea operations can commence. For most subsea tasks, positioning specifications can be met with only one or two transponders deployed on the seabed. Additionally, as the system needs only occasional aiding from the acoustics, transponder battery life is substantially increased and the need to task an ROV to deploy and recover transponders for servicing is reduced.

CONTRACTS

SES order Mini-Ranger 2 and Nano on the spot

We exhibit at quite a few trade shows around the world each year. It's a great way to launch new products and speak to our customers about their requirements and identify upcoming trends. And whilst discussions first held at a show regularly lead to a purchase decision, it's often weeks or months later before an order is actually placed.

But that wasn't the case during the recent Underwater Intervention show in New Orleans when Houston based equipment rental company Survey Equipment Services (SES) placed an entirely new order for a Mini-Ranger 2 USBL tracking system and new Nano transponders during show. Sales Manager, Dan Zatezalo, picks up the story.

''We were speaking to the SES guys about the benefits of Mini-Ranger 2 and our new Nano, explaining how the technology is well suited for short-duration work. It's quick to install and is easy to use, and you can begin tracking an underwater target like an AUV or small ROV in just a few steps. It's perfect for any equipment rental pool.''

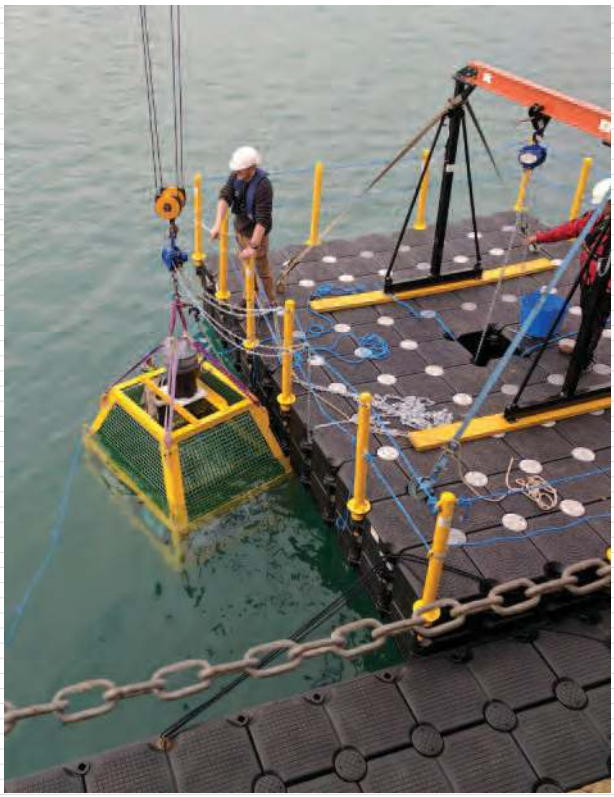
Alan Craig, Vice President of SES and Sonardyne's Dan Zatezalo, seal the deal during UI.

''They seemed particularly impressed with Nano – our smallest ever USBL beacon,'' Dan added. ''SES's clients carry out a large number of inspection projects using divers working from small boats and barges. Measuring 155mm long, and weighing virtually nothing in water, means that a diver barely notices a Nano is attached. From an operational safety aspect, there's of course tremendous benefit knowing exactly where all of your divers are at any point.''

''Unfortunately the kit we had on display were space models, otherwise they would have collected their purchase there and then,'' concluded Dan.

ASSET MONITORING

Carbon Capture and Storage project reaches HAT and SAT phase



A major engineering programme to develop and demonstrate a Carbon Capture and Storage (CCS) monitoring and measurement system, has entered the Harbour Acceptance Testing (HAT) phase. Funded by the Energy Technologies Institute, for the past three years, we've worked alongside project partners Fugro and the NOC to define, model, manufacture, integrate and now test technologies that can reveal if waste carbon dioxide is seeping out of sub-surface storage sites. These include; active and passive sonars, deployment systems, AUV instrumentation and subsea-to-surface-to-shore data links. The HAT is scheduled to last one month, during which time every element of the system will be rigorously evaluated. The project will culminate this summer when Fugro lead Sea Acceptance Trials (SAT) off the north-east coast of England. We'll take an in-depth look at the results in the next issue of Baseline but in the meantime, Issue 12 has all the background on this ground-breaking project.

NEWS

MARITIME SECURITY

Sentinel passes final acceptance tests in foreign military ports

Our most significant maritime security project to date, encompassing the deployment of Sentinel diver detection sonars at multiple military ports, has been fully installed and recently passed all of the client acceptance tests.

Sentinel detects, tracks, and classifies divers and autonomous underwater vehicles (AUVs) approaching a protected asset from any direction and alerts security personnel to the threat. Deployed from a boat, installed in a port or placed along a coastline, it can reliably identify AUVs at ranges of up to 1,200 metres and divers at 900 metres. These performance levels have led it to be used for military, critical national infrastructure, vessel and VIP protection duties around the world.

From the time when equipment for this complex project began to be delivered, our maritime security team has been working closely with in-country partners to install, commission and gain acceptance of the Sentinel sonars. The ports where Sentinel has been deployed offered difficult and challenging acoustic environments; each one different to the next and in many cases, involving networking multiple sonars linked together to protect very large areas.

Sentinel has been specifically designed to cope with conditions such as 'brown' water, shallow water and tidal harbours where vessel activity results in a lot of disturbance in the water column. The system's unique detection, classification and tracking software has been proven to operate in all environmental conditions and is capable of reliably tracking multiple targets in real-time.

Speaking of the success of the project, Gary Male, Operations Manager at Sonardyne said, "The last five sonars deployed at the final port passed their Harbour Acceptance Tests at the start of 2017. Sentinel successfully tracked open and closed divers, as well as the end-client's swimmer delivery vehicle – easily meeting the contracted performance requirements set out." He added, "We now look forward to on-going co-operation with our in-country partner with through-life support, engineering and training."

MARINE ROBOTICS

Innova choose SPRINT-Nav for resident ROVs

Innova AS, a specialist subsea engineering and technology company based in Norway, has selected SPRINT-Nav, our integrated inertial and Doppler navigation technology, for two new in-field resident ROVs (Remotely Operated Vehicles) being built in the country.

Each vehicle will be installed with a co-housed SPRINT Inertial Navigation System (INS) and Syrinx Doppler Velocity Log (DVL) to provide tightly coupled navigation data that will support a wide variety of survey and inspection missions in water depths up to 4,000 metres.

The two ROVs are being built by IKM Technology, this time for delivery to IKM Subsea, who has contracted Innova to supply various on-board sensors, including the navigation system, as part of the vehicle's development programme.

The all-in-one design of SPRINT-Nav makes installation on AUVs and ROVs straightforward, saves payload space and importantly, improves subsea navigation integrity. The design also features a high accuracy pressure sensor which can be removed in the field for re-calibration and still allow SPRINT-Nav to be deployed.

Speaking about the order, Sven Eivind Torkildsen, Sales Manager for Innova AS said, ''Throughout this project, flexibility, cost-effectiveness and performance have been key factors in selecting the technology for our client's new ROVs. SPRINT-Nav meets all these requirements so we had no hesitation in specifying it.''

OCEAN SCIENCE

Partnering with NOC at the MRIC

A year after becoming an Associate Member of the National Oceanography Centre's (NOC) Marine Robotic Innovation Centre (MRIC), we have upgraded our membership to become a Full Partner.

Our relationship with NOC extends back over two decades when we first started to equip their research ships with USBL tracking systems. For the past three years, we have worked together on the Energy Technology Institute's (ETI) Carbon Capture and Storage technology demonstrator project, as well as the Autonomous Surface Sub-Surface Survey System (ASSSS) – funded by InnovateUK. Most recently, NOC, fellow MRIC Partner company ASV Ltd and ourselves have been awarded further InnovateUK funding to undertake feasibility trials of ASSSS as an Autonomous Pipeline Survey System (APSS).

NOC's MRIC provides a unique environment for us to work with academia and other commercial parties to cooperate and develop advanced robotic systems for the underwater environment. As such, MRIC is a hub for the ETI, ASSSS and APSS projects, which are all underpinned by our Ranger 2 acoustic positioning and communications and Solstice multi-aperture side-scan sonar. Solstice not only provides unrivalled imagery and co-registered bathymetry, but also comprises an integral processor that supports automatic target recognition onboard NOC's Autosub Long Range AUV. In the case of ETI, this provides leak detection capability, while APSS will utilise this for pipeline tracking and anomaly identification. In addition, our BlueComm optical communications provides data transfer capability between the autonomous underwater and surface vehicles.

The MRIC opened in 2016 and is a centre of excellence for subsea innovation. Images courtesy of NOC.

OUR PEOPLE

Ioseba Tena strengthens our expertise in marine robotics

Ioseba Tena, known to many as Joe, has joined us as Global Business Manager for Marine Robotic Systems – bringing with him over 20 years experience in the sector, most recently, at SeeByte.

Early in his career, Joe worked with marine robots as a Research Associate at Heriot-Watt University. His PhD was completed in 2001 and focused on navigating Autonomous Underwater Vehicles using imaging sonars. The following year, Joe became part of the original team of SeeByte founders working as part of the management team.

Joe said, ''Over the last ten years, the industry's witnessed how Sonardyne has expanded its product portfolio far beyond acoustic positioning to include inertial navigation, Doppler and high speed optical communications. With everything now available from one source, it's no surprise that manufacturers of unmanned platforms are looking to integrate these solutions at the factory, and in doing so, engineer greater value and efficiency into their robotic systems. I'm really excited to have been given the opportunity to help drive forward Sonardyne's offering for this rapidly evolving cross-market sector.''

Turn to page 14 to read Joe's first article for Baseline and head to our website to follow his new blog.

News Feature

Construction Survey

Subsea 7 bundle tows l

Since 1993, we've worked with seabed-to-surface engineering, construction and services contractor, Subsea 7, supplying them with acoustic monitoring and positioning technology to support the tow-out and installation of pre-fabricated pipelines for the North Sea.

The start of this year was no different and in the last few weeks, one 3.8 kilometre bundle for a field 300 kilometres north-east of Aberdeen and two 2.47 kilometre bundles for a UK-based operator have been delivered.

Pipeline bundles integrate all the components (valve work, pipeline and control systems) required to operate a field within one single steel carrier pipe. Incorporating everything within one structure offers substantial cost savings as offshore operations are minimised.

Each pipeline bundle is assembled at Subsea 7's unique onshore fabrication facility at Wick, Scotland where rail tracks run from almost eight kilometres inland straight into the sea.

Once assembled, each bundle is pulled off the beach and transported to its offshore location suspended between two tow vessels. All stages of launch, tow and laydown on the seabed require continuous real-time monitoring of the bundle assembly to prevent unnecessary strain and stress being placed upon it. Depth, heading, internal pressure and tow wire angle all need to be checked.

To achieve this, specially configured Compatt 6 transponders are installed at regular intervals down the entire length of each bundle. Each one is fitted with a Data Highway Module (DHM) which interfaces with the bundle's own internal data highway. This allows each Compatt to measure depth at its location and then communicate the data, via the data highway, to a designated 'master' Compatt mounted on the bundle.

Heading data for each bundle is collected by three pipe-mounted subsea Lodestar AHRS units – each interfaced to a Compatt. Additionally, two pressure sensors provide carrier pressure at each end of the bundle and one sensor provides tow wire angle; all are interfaced to the bundle's highway – again via the Compatts' DHM.

During a tow, the master Compatt 6 acoustically transmits data every 20-40 seconds to a towfish deployed from the survey vessel. Software developed by Subsea 7 provides the Tow Masters with a graphical representation of the bundle's catenary, together with a histogram of its depth. This enables the actual in-flight profile and shape of the bundle to be regularly updated, and allows the Tow Masters to make operational adjustments during transportation to the field. It also ensures it 'flys' at the required depth to avoid submerged objects.

Upon arriving on-site, the bundle is correctly oriented using acoustics, before the bundle is vented to allow it to settle on the seabed.

Commenting on another successful season with Subsea 7, Nick Street, Senior Projects Manager at Sonardyne said, "We've now clocked up our 20th project using 6G; a great track record and one we hope keep building upon in the future."

Main image: © Subsea 7

nead out again with 6G

Despite the challenging weather conditions, our 6G Compatts were successfully installed on each bundle. (Top right) Lodestar AHRS collects heading data for each bundle, interfaced with its own Compatt.

Marine Robotics

Capability

Image: © National Oceanography Centre

No matter whether you're using an AUV, ROV or USV, we have a solution for your robotic platform that will allow you to track, communicate and control your vehicle.

WE TRACK, WE NAVIGATE, WE IMAGE, WE CONTROL.

The performance of marine robotic systems is directly linked to how well they are able to sense their environment and process the sensed data. Can they find their way? Can they make sense of their surrounding? It's all down to the payload instruments. Sonardyne's integrated, highly accurate instruments add both value and capability. In this article for Baseline, **Ioseba Tena**, Global Business Manager for Marine Robotic Systems, tells us how. **>>**

Navigation instruments

Subsea inertial navigation instruments and capability have evolved a lot over the last two decades. Once typically the reserve of high-end government contracts, the technology has become more readily available and resulted in the production of a new generation of cost-effective instruments that are transforming the way in which marine robots interface with the subsea environment.

It has been far from easy. The building blocks required to achieve the accuracy needed to satisfy survey-grade operations has taken us a decade to realise.

One of our major navigation building blocks is a Honeywell Ring Laser Gyro (RLG). This instrument is capable of measuring changes in rotation along its axis with incredible accuracy. It has become the standard navigation gyroscope in almost all commercial aircraft and a wide range of land, air and sea applications. It's reliable also – demonstrating Mean Times Between Failures (MTBF) in excess of 400,000 hours. With over 100,000 gyros in circulation, it is the world's leading go-to technology.

Marine Robotics

Capability

(Clockwise from left) We teamed with Liquid Robotics to market the Wave Glider Transceiver to harvest data, monitor assets and control from the surface to subsea.

The Solstice side-scan sonar fitted to Saab Seaeye's *Double Eagle* SAROV is used to search for and classify mine-like objects.

MMT's ROV *Survey Interceptor* uses SPRINT to make optimal use of acoustic aiding data including USBL, LBL and DVL and other sensors to improve accuracy, precision, reliability and integrity in any water depth.

BlueComm mounted on Saab Seaeye's *Sabretooth* resident AUV provides wireless comms, data off-load and intervention.

AvTrak is the first choice for many as it combines transponder, transceiver, and telemetry link in one low power unit to meet the requirements of a wide variety of AUV mission scenarios and vehicle types.

An RLG by itself is great, but not sufficient to navigate by. We need to be able to estimate our position and heading and there's three distinct steps to this. Step one – develop an Inertial Motion Unit (IMU) capable of providing true North heading measurements. In other words an Attitude Heading Reference System. Step two – develop onboard processing which turns raw IMU data into an Inertial Navigation System (INS) capable of generating position and heading estimates. Finally step 3 – aid the INS with complimentary instruments such as a Doppler Velocity Log (DVL). The result of these steps? Lodestar, SPRINT and Syrinx.

Lodestar – Attitude Heading Reference System

By mounting three gyros orthogonally together with three accelerometers, in a strap-down gyro configuration, our Lodestar is able to find true North. The maths is simple to understand; input the Latitude from a GPS signal and we know what the rotation of the Earth is at any one point in the globe. The strap-down gyro measures gravity. The rotation of the Earth is perpendicular to that. North in turn is also perpendicular to that rotation. The beauty of an RLG is that it is accurate enough to measure the Earth's rotation, the vital ingredient to solve the equation.

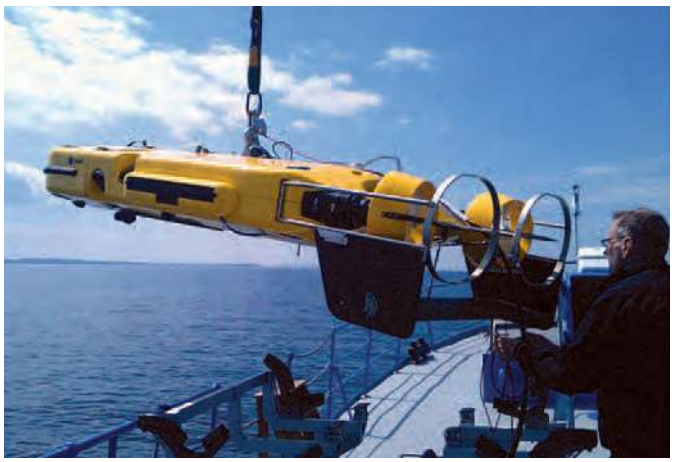
However, alignment of the AHRS is a difficult challenge requiring generous amounts of number crunching. Lodestar does that number crunching in the background when the system is started and finds North in under 10 minutes once the system is configured. It won't lose North either as long as it is switched on.

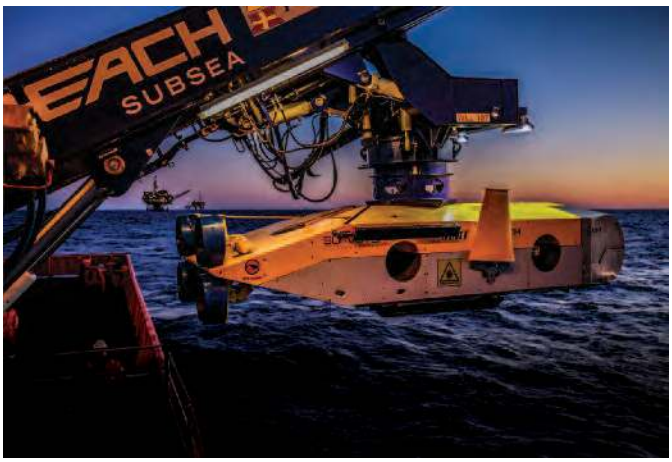
SPRINT – Inertial Navigation System

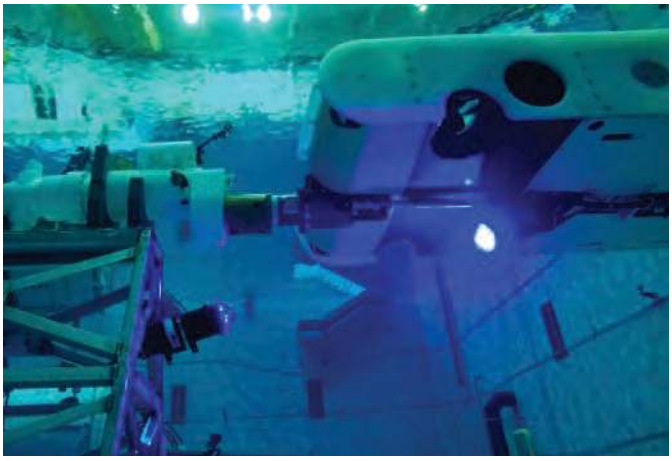
The algorithms for INS are capable of taking the outputs from the IMU and estimating a position and heading. This is done by keeping accurate estimates of the errors inherent on the sensors and using these error calculations to correct the position and heading estimate calculated by integrating the accelerometer and gyro measurements. Every Lodestar can be turned into a SPRINT with a simple firmware update - the hardware is common to both platforms. The trick with INS is to use aiding sensors to accurately estimate the errors in the instruments. This is a very complex challenge and one that we have focussed heavily on solving. In 2015, we introduced our Syrinx DVL and it changed the game.

Syrinx – Doppler Velocity Log

Syrinx calculates the Doppler shift generated by four beams of sound as they reflect from the seafloor to calculate the robot's velocity relative to it. This velocity estimate can be integrated over time to generate an







estimate of the robot's position. Syrinx by itself can be used as an input to a control system enabling automatic station keeping, but as an aiding sensor to SPRINT, it is used to generate accurate error estimates for the instruments used to compute the navigation solution. SPRINT actually uses each of the DVL beams as individual aiding sources which helps improve the overall accuracy and integrity of the system and improves results in challenging seafloor environments.

SPRINT-Nav – Combined INS and DVL

SPRINT-Nav is a single instrument, housing an IMU, an AHRS computer, an INS navigation computer, a DVL and a high-accuracy pressure sensor. It's the easiest way to integrate survey ready navigation into your robotic platform. Multiple connectors enable multiple outputs. This means your robot can feed inputs directly to its control system and your payload can also be served through a different output. It is also capable of receiving aiding from other sensors.

A combined instrument reduces your power requirements, simplifies integration and provides class-leading performance as good as a fraction of a metre over many kilometres travelled. As the SPRINT and Syrinx are permanently aligned, there's no need to constantly align the DVL. Operating SPRINT-Nav is simple. Switch the unit on, wait 10 minutes to find North and that's it. The INS navigation computer is initialised with the AHRS estimates automatically.

SPRINT-Nav, aided with updates from Ultra-Short BaseLine (USBL) instruments, can be used to map the seabed to a level of accuracy suitable for most survey jobs. In combination with our AvTrak 6 family (see next page), your AUVs can navigate and communicate with the mothership regularly and reliably.

Payload Instruments

Once you know where your robot is, the next challenge is to understand its environment. We offer two ways to help; sonar imaging to let your vehicle see what's around it and wireless modems to let it communicate.

Solstice – High resolution sonar

Solstice is a Multi Aperture Sonar (MAS) where the multi-beam input from 32 elements is dynamically focussed to ensure pixel perfect imaging across the 200 metre swath. Its compact design is suitable for low logistic platforms. By using multiple apertures, the data is massively enhanced and the Signal-to-Noise Ratio (SNR) is improved. The process generates narrow along-track beams and at 18 watts, it places very little drain on your power budget. This means that Solstice users can

Marine Robotics

Capability

generate ultra-high resolution pictures of the environment suitable for Hydrography and Mine Counter-Measures (MCM) persistently.

BlueComm – Optical modem

Robust, low bandwidth communications over long distances using acoustics is available through our 6G family of products. But what happens when you need to share large volumes of data?

Historically, you've extracted on the surface and sent it back to base to analyse, but BlueComm changes all that. Using the power of the EM spectrum, BlueComm modems can pass incredible volumes of data over hundreds of metres to one another. This means that an AUV or an ROV flies through a field full of data logging instruments and harvests their data quickly and efficiently

BlueComm is now being used by AUV manufacturers to mount onto docking stations. It is also being used to enable communications with sensors permanently deployed on subsea fields. It's transforming the way we think about the subsea environment. Now every subsea asset can be made a 'connected' subsea asset all the way back to your office.

Under pressure and out of sight

If you're in the marine robotics domain then you already know how challenging the subsea environment is. Your robots face a constant onslaught from waves and currents. Marine growth can accumulate on actuators and sensors. Tremendous pressure with depth of water

> "The OEM range enables manufacturers the flexibility to integrate our class-leading solutions and make most effective use of the space. And our engineering services, testing, trialling and training services are here to assist you every step of the way."

requires robust housings and water-tight seals. Simple tasks that we carry out on land when carried out subsea become true engineering feats.

We have engineered solutions to meet your every need. 45 years of experience has taught us which materials to use, how to house the sensors and actuators and how to use the environment to our advantage. Our integrated instruments reduce your risk, save you time and let you get on with the job in hand.

One size doesn't fit all

Marine robotic systems have evolved to meet the challenging ocean conditions and this has resulted in the development of systems that range from the small one-man portable vehicles to the very large platforms intended to replace ships. By engaging with leading manufacturers, we've now developed a range of Original Equipment Manufacturer (OEM) solutions that can be easily integrated to your robot's own pressure housing. The OEM range enables manufacturers the flexibility to integrate our class-leading solutions and make the most effective use of the space. And our engineering services, testing, trialling and training services are here to assist you every step of the way. **BL**

8 Reasons you should fit AvTrak 6

#1 Communicate

AvTrak 6 is an advanced, acoustic bi-directional communication system or 'modem' utilising spread-spectrum digital signal processing supporting user data rates from 100 to 9000bps. It has been proven world-wide from thousands of deployments from shallow to deep, quiet to noisy. Built-in diagnostics provides the quality of the acoustic link at each end.

#2 Be compatible

It is compatible with all the Sonardyne 6G systems fitted to many vehicles and ships across the oceans. Change missions parameters, get vehicle status information, send large volumes of sensor data, this is all done with fast, efficient, low-latency robust communications.

#3 Position it

It as an Ultra-Short BaseLine (USBL) transponder so any vehicle fitted with it can be accurately positioned from any Sonardyne Ranger2 USBL system on a vessel – or even from other USBL systems operating in a compatible mode. The AUV's position calculated on the ship can then automatically and efficiently be sent down to the vehicle in one short cycle, so aiding any on-board INS system. Vehicle position and status data is sent back up.

#4 Navigate

AvTrak 6 can be used to communicate position and status and range to hundreds of other AUVs fitted with one. It can also range to seabed references (LBL transponders) to enable very high accuracy aiding of the INS. Interrogate one at a time or interrogate a whole swarm.

#5 In an emergency

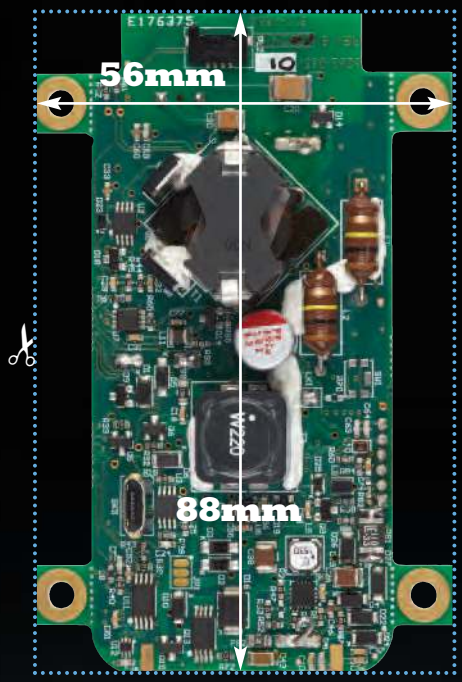
AvTrak 6 contains a small battery that supports its high power transmissions so if vehicle power is dead, you can still find it and communicate with it. Integrated outputs enable control of a release, burn-wire, or drop weight functions.

#6 It comes with support

An Interface Control Document (ICD) enables your engineers to quickly talk the language and integrate it into any vehicle. Sonardyne is flexible and will often adapt functions to your particular needs; our engineers are available to help.

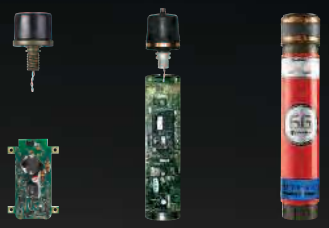
#7 Smaller than you might think

Unsure if AvTrak Nano OEM is small enough for your vehicle? Why not cut out this image and see for yourself – the PCB shown here is actual size!



#8 Choice

There's three models of AvTrak 6 – which one will work best for your vehicle?



	AvTrak 6 Nano OEM	AvTrak 6 OEM	AvTrak 6
6G	✔	✔	✔
USBL	✔	✔	✔
LBL Ranging		✔	✔
Sparse LBL Ranging		✔	✔
Data Exchange	✔	✔	✔
Burn Wire		✔	✔
On/Off Switch		✔	✔
ICD	✔	✔	✔
Battery Life	10 days	30 days	30 days
Subsea Housing			✔
Depth Rating	500 m	3,000 m 5,000 m 7,000 m	3,000 m 5,000 m 7,000 m
Frequency Band	MF (19/34 KHz)	MF (19/34 KHz)	MF (19/34 KHz)

Exploration and Reservoir Surveillance

Seafloor subsidence monitoring

During the summer of 2016, all the AMTs were recovered from the seabed at Ormen Lange after six years service. The transponders and frames were in great condition, even after such a long deployment.

10 YEARS at Ormen Lange

In 2007, a unique chapter in Sonardyne's history began to be written – a chapter that would span the next 10 years and lead to the development of a completely autonomous and long endurance seafloor monitoring capability. Reporting for Baseline, **Shaun Dunn**, Global Business Manager, and **Tom Bennetts**, Project Manager at Sonardyne look back at a unique subsea engineering challenge, how it was overcome and supporting a reservoir surveillance campaign that saw over 600 million measurements collected.


Left to their own devices:

We've been following this story ever since its inception back in 2007. We reported on the first developments of the project in Issue #5 of Baseline. See our website to catch up.

It began with a challenge set by Shell geophysicists, Stephen Bourne and Paul Hatchell. They were looking for a method of precisely measuring potential movement of the seabed caused by reservoir depletion in the newly commissioned Ormen Lange deep water gas field, located hundreds of metres beneath the surface off the coast of Norway.

Subsidence measurement on land is comparatively easy because satellite positioning systems such as GPS provide highly accurate and repeatable measurements over long timescales. In the ocean it's much harder, since electromagnetic waves are attenuated by salt water so GPS and optical survey techniques are not possible.

Therefore, a totally new solution was required and as we reported at the time in Baseline Issue 5, Stephen and Paul set us a very demanding brief. They were looking for subsea technology that could be deployed for many years without intervention, make hundreds of millions of stable highly precise measurements from a number of sensors, safely log the data and on command, wirelessly transmit the data to the surface.

Understanding the problem

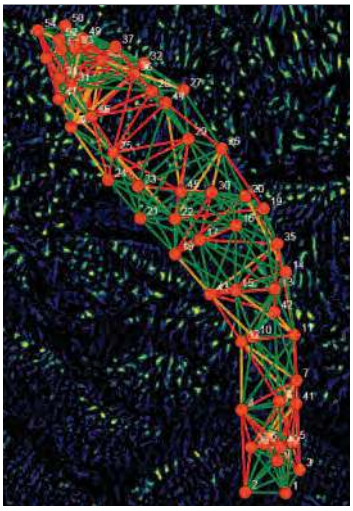
Extracting hydrocarbons from a reservoir lowers the pore-pressure of the formation that contains the oil or gas, weakening it to a point where it might not be able to adequately support the rock layers above it. In earth sciences, this layer is known as 'the overburden'. If measured accurately enough, the small, but detectable, changes to the surface of the overburden can be used by geophysicists to provide valuable insight into the rate of subsidence and other dynamic properties of the reservoir.

Because deformation manifests itself as both vertical and horizontal seabed displacements, it quickly became apparent that these movements could be measured using a network of our acoustic transponders acting as 'seabed monuments' placed both within and outside of the expected subsidence region.

Acoustic signals can be used for the purpose of measuring horizontal displacement by transmitting signals between pairs of transponders separated by several hundred metres and then

Exploration and Reservoir Surveillance

Seafloor subsidence monitoring



(Left to right) AMTs in frames deployed easily and quickly from a vessel's moon pool; Section of transponder locations including lines of sight between each unit; Spiked AMT frame allows transponders to be deployed on small ridges without fear of movement whilst collecting data; Transceiver deployed on an over the side deployment pole from a vessel of opportunity to collect data.

accurately measuring the two-way round trip time. Since we can also measure the acoustic wave speed using sound velocity (SV) sensors built into each transponder, we can convert time and speed into distance and therefore continuously monitor for changes to the separation, known as strain rate, between many pairs of transponders.

Vertical displacement can be measured using integral pressure sensors and the results from multiple transponders can be compared and therefore the effects of tide, water column density and barometric pressure changes which are largely common to all instruments over long timescales can be removed from the data, leaving only the seabed depth changes remaining.

Precise ranging, acquisition of sensor data and telemetry is a common element of many subsea applications, so much of the engineering effort for the Ormen Lange project focussed on delivering the required endurance - which at that time was much longer than users typically required - and transponders that were capable of running a fully automatic data gathering and logging regime without intervention.

These requirements were met with the development of the Autonomous Monitoring Transponder (AMT) – a 3,000 metre depth rated instrument fitted with a range of sensors, wireless communications and a five year battery life.

Trial deployment

Keen to witness its capabilities, including ranging precision and long term pressure sensor performance, a small scale field trial of 10 AMTs was commissioned at Ormen Lange later that year. The AMTs were mounted in three metre tall tripod frames and deployed to the seabed by ROV . Conscious that any horizontal movement could affect the quality of the results, the AMT tripod was designed to be 'heavy' with the option of spiked feet for mounting on rocky terrain or a 'mud skirt' to reduce settlement into a soft seabed.

An initial 250 days of acoustic travel-time, pressure, sound velocity, temperature and inclination data was wirelessly recovered to the surface and handed to Shell for processing. Analysis of around 500,000 travel time, 60,000 sound velocity and around 10,000 pressure measurements demonstrated a range repeatability of around 5mm/km and drift in depth data in the order of 20mm/year. Results from this trial deployment were considered to be sufficiently encouraging to justify a longer-term field-wide subsidence monitoring campaign at Ormen Lange.

Full scale deployment

As the northern field was both the least developed area in 2010, and was also perceived to have the highest risk of deformation, it was decided to focus a field-wide network in this area such that the data would have the highest potential business impact to Shell and its asset partners. A narrow strip of sensors was also added to provide insight into the reservoir connectivity, pressure baffles and compartmentalisation over the saddle area between the southern and northern part of the field.

The next task was to perform a terrain assessment across the region to identify suitable deployment locations for each AMT that would avoid line of sight obstructions

Project highlights and achievements

The Ormen Lange seafloor monitoring campaign is a great example of how we work closely with clients to understand all aspects of their projects, balancing performance, costs, vessel operations and risk. Here's what we achieved:

- **Large scale project delivered successfully to an oil major**
- **Inclusive design, prototyping, manufacture and delivery in a short timescale**
- **Supported contractor with complex subsea installation**
- **Instruments proved highly reliable and operated for six years without intervention**
- **Multi-year support of data acquisition and processing provided**
- **Lessons learnt and improvements captured and integrated into new generation of instruments now deployed**

Get in touch and find out how we can help you.

and therefore ensure successful range measurement. This work was carried out by our Survey Support Group and their resulting deployment plan proposed 138 AMT units for the main northern subsidence region, 34 units for the trussed stripe going from north to south, and four stationary controls placed well outside the main array.

Having determined the AMT array plan, all the instruments were manufactured and deployed within the very short Norwegian summer weather window. Using a vessel-of-opportunity, each AMT was lowered by crane to the seabed and moved into its final position using an ROV.

Data harvesting and recovery

The Ormen Lange AMT array was programmed to gather range, pressure, SV and temperature and tilt data at three-hourly intervals. Each AMT wakes up and acoustically interrogates several neighbouring AMTs in order to precisely measure the distance between each unit. These ranges, along with the environmental readings from the on-board sensors, were then stored to the AMT's memory.

The time-stamped data logged within each AMT was available for recovery at the surface via the integrated high-speed acoustic telemetry modem. On eight separate occasions, a vessel-of-opportunity was tasked with visiting the site and recovering data from where it was immediately sent to Shell whilst the vessel continued to move around the site.

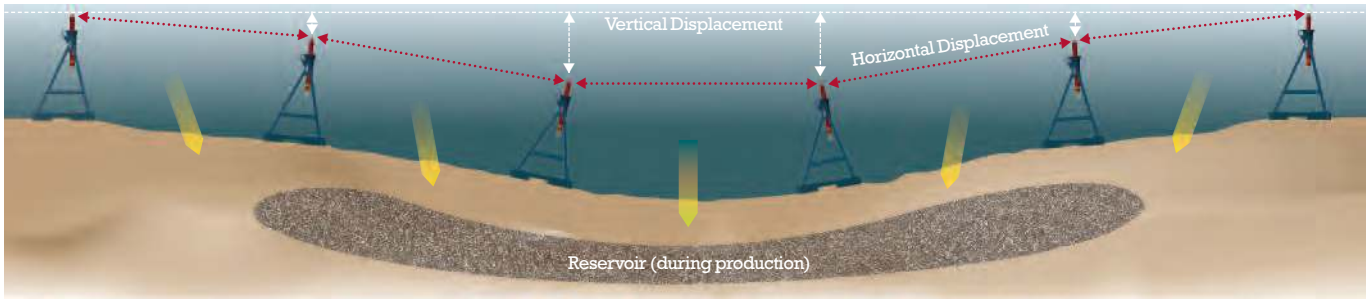
In June 2016, after five and a half years of continuous operation, a final visit to the Ormen Lange AMT array was made – this time to recover all the transponders and bring the project to an end. This involved using an ROV to attach a crane hook to each AMT tripod from where they could be lifted from the seabed and on to the vessel.

Survey findings and looking ahead

The acoustic network data has been analysed in great detail by Shell geophysicists and used to obtain average deformation values over the period from October 2010 to May 2016. The data indicates the network is contracting at a maximum rate of around 10ppm/year in the centre of the field – equating to around 1cm of contraction per kilometre of seabed per year.

The pressure data has been used to obtain subsidence estimates averaged over a period of one year. Individual AMT stations subside by up to 3.5cm/ year although there is some uncertainty in this result since drifts in the older generation pressure sensors used and residual noise on this data was observed to be quite close in magnitude to the measured subsidence signal.

When comparing the seafloor deformation data, a consistent picture of low subsidence rates was found to be in agreement with modelled predictions for Ormen Lange. The measured strain and subsidence rates of 5ppm/year and 2cm/year on average, were close to the sensitivity limits of this generation of equipment, but several promising improvements have been made to the sensors used and the AMT design since it was first developed in 2007, and it is expected to reach an overall sensitivity to horizontal strain and vertical subsidence of better than 5ppm/year and 1cm/ year in future deployments.

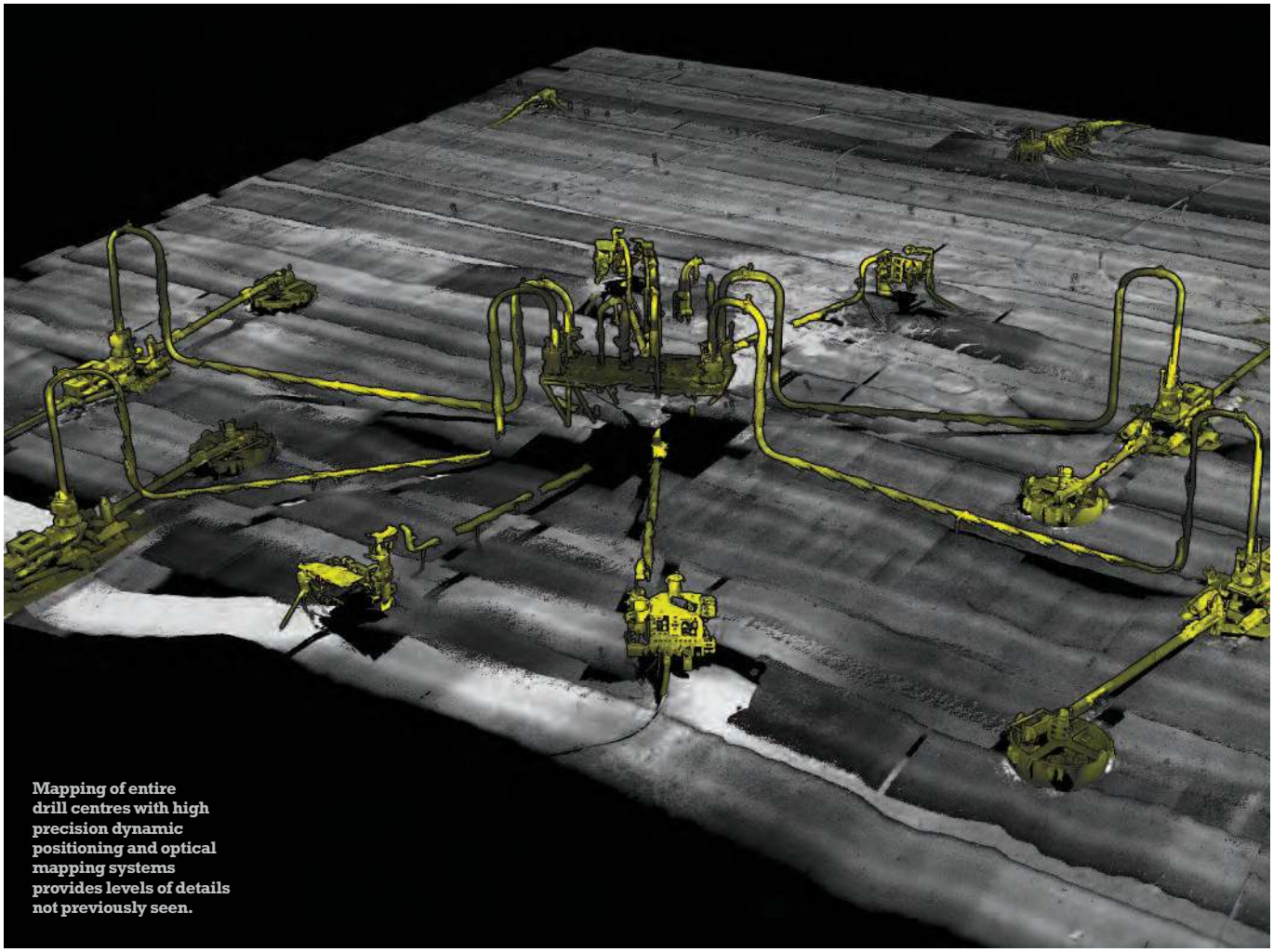


Technology

Dynamic underwater mobile mapping

Terrestrial mapping was revolutionised by aerial LiDAR. Using high-accuracy, post-processed GNSS-aided inertial navigation for geo-referencing sensor frame point measurements into 'real world' coordinates has enabled reliable mapping of large areas to high accuracy extremely quickly and cost effectively. Our SPRINT-Mapper technology now provides users with a similar subsea capability and set of advantages. **Simon Waterfield**, Survey Support Group Manager and **Dr Mikael Larsen**, Principal Engineer – INS, explain how the system's concept, features and exhaustive testing regime now has the capability to deliver subsea mapping to centimetre – level accuracy and resolution from a dynamic vehicle. >>

MAP OUT THE FUTUR



Mapping of entire drill centres with high precision dynamic positioning and optical mapping systems provides levels of details not previously seen.

Image courtesy of DeepOcean

SPRINT-Mapper hardware comprises INS and DVL sensors (combined SPRINT-Nav shown), as well as positioning beacons such as our new Compatt 6 Micro LBL transponder and Mini-ROVNav 6. Perfect for when ROV space and weight is limited and time is short.

RE OF YOUR SURVEYS

UNDERWATER MAPPING SURVEYS can be broadly divided into two disciplines; mobile and static.

Up until now, mobile mapping efforts largely involved multi-beam sonars being fitted to ROVs and AUVs alongside a spread of INS, DVL, acoustics (e.g. USBL) and depth instrumentation. Being dynamic, large areas can be quickly imaged but at best, this approach can only achieve up to ~10cm relative accuracy – ruling out any applications that require centimetre or better accuracy.

Over the last few years, subsea LiDAR and laser/camera optical mapping sensors have emerged with resolution and accuracy at the millimetric to centimetric level. These sensors have most commonly been used to scan from a static location (e.g. a tripod or ROV resting on the seabed). Due to the relatively short and variable optical range (limited by turbidity), multiple scans are often required. This involves relocating the scanner and eventual artificial targets needed for stitching individual scans together in - a process called 'point cloud registration.'

However, static scanning from the seabed inherently limits the perspective to a horizontal view only whilst relocating the scanner, waiting for sediment to clear and lengthy processing time, adds considerable time to any survey – and offshore time is money.

Mobile mapping – the wide area navigation challenge

But what if you could combine the operational efficiency of wide area mobile mapping with the precision of static mapping?

Well, with the arrival of our SPRINT-Mapper now you can. It provides tightly integrated acoustically-aided inertial navigation matching the resolution of state-of-the-art optical mapping sensors, and is the latest major technology milestone in an INS research and development program that spans more than a decade.

The level of practical positioning accuracy is unprecedented and a true enabler for wide spread use of high tempo subsea mobile mapping projects. It provides enough redundancy and QC to both reliably satisfy accuracy requirement and support high-integrity applications such as spool-piece and jumper metrology.

By adopting a dynamic platform, such as an ROV navigated fitted with our SPRINT INS, Syrinx DVL and Fusion 6G (sixth generation) LBL acoustics, a site can be mapped much quicker with much less issues from reduced visibility as the ROV does not have to come into contact with the seabed at the survey site and can move to scan any target of interest. For metrology operations, the ability to dynamically position a laser in close proximity to the structures allows operations to be conducted in reduced visibility, reducing delays, and allowing a greater point density over targets. High resolution point cloud data can contain a wealth of information which can be utilised for various applications.

Whilst contactless subsea metrology is one of the obvious applications, the ability to generate geo-referenced 3D maps at the centimetric accuracy level supports a wide spread of applications also including; structure mapping, pipeline inspections, mooring chain surveys, inland waterway inspections, scour surveys, seabed coral / fauna mapping, wreck and drilling mud surveys to name a few.

What makes up the system?

A typical 3D mobile mapping campaign involves equipping a subsea vehicle – be it ROV, AUV or manned-submersible – with a pre-calibrated SPRINT INS co-located with a Syrinx DVL (or our new combined SPRINT-Nav), ROVNav 6 transceiver, high-precision depth sensor, sound velocity sensor and your choice of high resolution laser/camera, LiDAR or multi-beam.

Compatt 6 transponders such as the new Micro model (see KIT, page 05), are deployed on the seabed around the survey area with

Technology

Dynamic underwater mobile mapping

their approximate relative positions to each other reliably and time efficiently determined by DVL/INS dead reckoning. The vehicle then carries out the required survey of the structure, while the INS, DVL, LBL ranges, depth and sound velocity are gathered by the SPRINT and Fusion software. The process does not require transponder-transponder acoustic line of sight, but can utilise these acoustic baseline measurements when available.

On completion of the survey, the raw sensor data is post-processed using our powerful software tool, Janus. Post-processing concurrently calibrates transponder positions using a SLAM (Simultaneous Localisation and Mapping) technique and optimises absolute and relative navigation accuracy. The finished navigation data is then merged with the laser/camera, LiDAR or multi-beam data to produce a geo-referenced 3D point cloud.

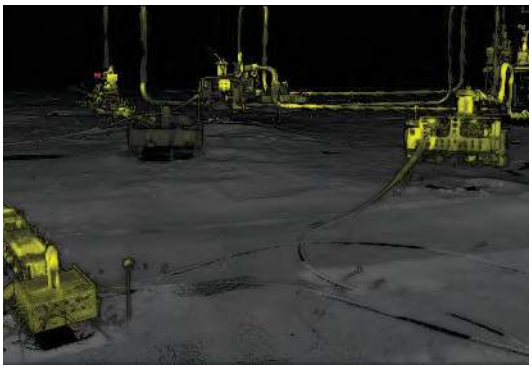
> "We're the only subsea equipment vendor who designs and manufactures its own INS, DVL and acoustic sensors. Therefore we're uniquely placed to provide you with a tightly integrated, acoustically-aided navigation solution for mobile mapping at centimetre level accuracy."

Our factory-supplied equipment is the latest specification and pre-configured to ensure your operation can be mobilised as quickly as possible. In the planning phase of a project, the expert knowledge of our Survey Support Group (SSG) is available to help you plan every aspect of the operation including reviewing procedures and tasks to identify and reduce risk ahead of mobilisation. Highly experienced Sonardyne personnel will then join your offshore survey team to operate the acoustic and inertial system, gather the required navigation data and post-process it offline.

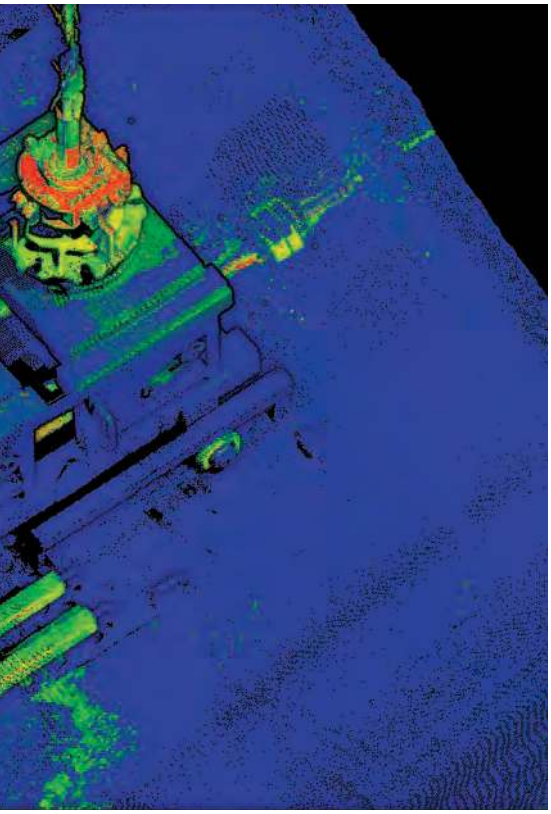
Here's some of the technical benefits of SPRINT-Mapper for dynamic mobile mapping.

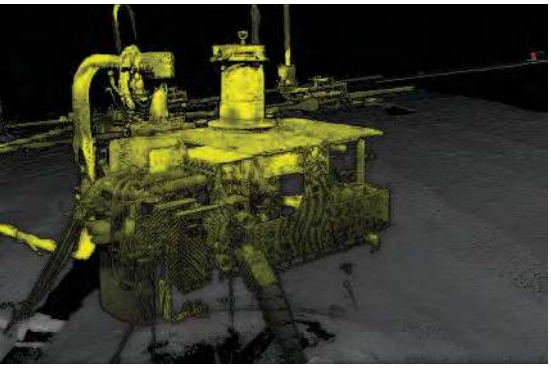
- The ability to aid SPRINT with tightly coupled Fusion 6G two-way travel times, with each range received individually.
- The ability to combine individual Syrinx DVL beam velocities rather than generic DVL instrument frame velocity and thereby operate robustly over structures and where DVL beam slant ranges dramatically differ.
- All 6G acoustic aiding (LBL and DVL) uses rich proprietary quality metrics, and timing is guaranteed to the micro-second level.
- System architecture has been designed to remove the risk of issues with latency or timing jitter on ROV MUX communications to topside, which could affect time synchronisation between instruments when receiving 1PPS from topside, as per established methods.
- Janus post-processing software is an extremely powerful tool for ensuring the very highest quality post-processed navigation with full QC of data. It performs forwards and backwards post-processing of the INS data and utilises a host of other proprietary techniques to optimise system performance in every operational scenario and condition.

Image courtesy of DeepOcean



Images courtesy of DeepOcean





(Clockwise from top left) By using a dynamic vehicle seabed structures can be mapped to a high precision from all sides. The intensity value from the laser system can be used to colour the images, or produce bathymetric style colour contour charts.

All the positioning and laser sensors can be installed on to a compact frame which can be pre-calibrated and dimensionally controlled to reduce mobilisation time.

Spool pieces can be mapped to monitor movement. The level of detail available is the same quality as video imagery, with the added benefit that precise measurements can be taken from the point cloud.

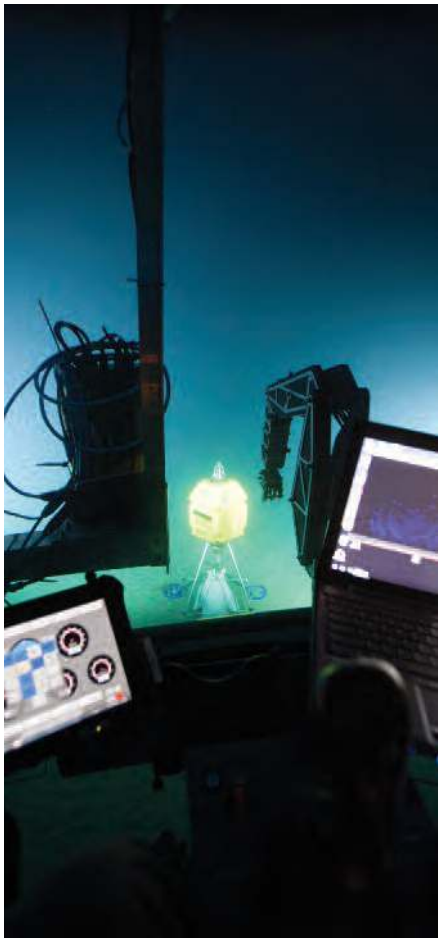
Our experienced offshore personnel are on hand to set-up and operate the SPRINT-Mapper system, obtain the data and post-process it offline.

Entire drill centre sites can be mapped in short time scales to obtain full as-built point clouds of the entire infrastructure. This provides unparalleled levels of detail for operators to plan their asset monitoring, maintenance and intervention work.

Image courtesy of DeepOcean

Technology

Dynamic underwater mobile mapping



(Left) View from the mini-sub during the NOAA mobile mapping project of U-576. A Compatt providing LBL baselines to the system can be clearly seen on the seafloor, whilst SPRINT and DVL seen to the left gather navigation data.

(Below left) Dummy flange/ hub assembly readied for deployment during the DOF demos. The Compatt 6 Midi was used as part of the LBL array.

(Below right) Post-processed laser scan image of the dummy hub/ flange unit. Features in the flanges such as bolt holes are clearly visible.

So what performance can you expect to see? Well, our approach delivers the following 3D point cloud tolerances;

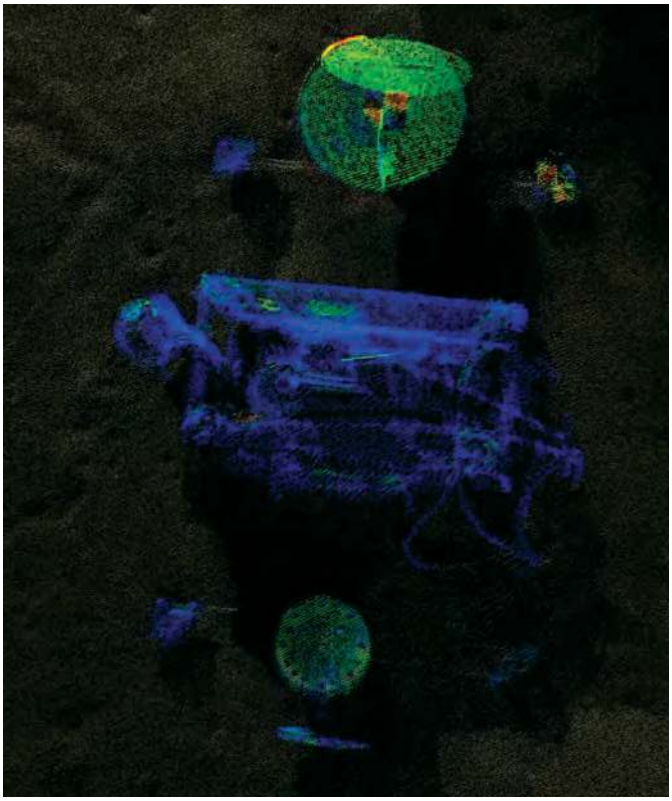
- 1cm level typical accuracy (vertical and horizontal baseline RMS) for single run-line distances of ~20m (typical metrology) and not much worse over longer distances.
- 5-10 cm level typical area (e.g. 50-200m square) mapping accuracy when merging multiple run-lines at arbitrary headings.

Track record

For the past three years, we've been working behind the scenes supporting clients with their mobile mapping projects, witnessing first-hand how this game-changing capability can re-write the operational rule book.

MBARI 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). A conventional Compatt 6G array was deployed and calibrated to act as reference for the mobile mapping trials. The reference acoustic baselines were compared to the 3D point cloud derived baselines. The difference 'C-O' RMS between the baselines was just over 3cm with a single baseline error marginally above 5cm. Additionally, simulated flange/hub assemblies were mapped and demonstrated angular accuracy robustly below 0.5 degrees. Baseline Issue 15 has the full article.

UTEC/McDermott Following these successful trials, Sonardyne and laser manufacturer 2G Robotics were invited to perform a contactless



dynamic metrology trial by UTEC and McDermott in a deep-water operational environment. The operational elapsed time and results were compared to a static laser metrology and delivered on the requirements of meeting typical metrology tolerances whilst delivering operational efficiency and cost savings.

Further operational projects followed in collaboration with 2G Robotics last year, including with DeepOcean and with the National Oceanographic and Atmospheric Administration (NOAA).

NOAA The project with NOAA demonstrated the versatility of the system; in this case it was installed and operated on a manned submersible to map two key archaeological wreck sites, the *U-576* submarine and the freighter *SS Bluefields*. Even in challenging dynamic and environmental conditions, SPRINT-Mapper provided outstanding accuracy, with the condition of both wrecks, their fittings and features easily distinguished and identifiable for analysis.

DeepOcean DeepOcean's dynamic survey operation covered 12 drill centre locations and a total of 27 metrologies, setting new bench marks for high resolution contextual 3D survey while proving an alternative and rapid 'contactless' solution to conventional metrology surveys

DOF Late last year, we supported DOF at The Underwater Centre in Fort William, Scotland, to demonstrate mobile mapping to invited industry representatives. The 'truth' reference for this trial was traditional Sonardyne 6G LBL acoustic metrologies and third-party gyro packages.

Laser results were an average of inferred metrology from two runs (in same direction). Despite the extreme weather conditions, our full program results are within metrology tolerance of the truth reference.

Tested. Trialled. Proven

The benefits of underwater mobile mapping have now been proven with ultra-fast wide area surveying, inspection and metrology. Turbidity affecting visibility can be reduced by moving the dynamic vehicle closer to the target. The use of tightly coupled Sonardyne 6G acoustics provides trusted quality control alongside optimal aiding to the INS. Mobile mapping does require a complex system integration of INS, DVL, acoustic ranges and mapping sensor to achieve centimetric results. But this is overcome with our unique, 'under-one-roof' capability.

> "The level of practical positioning accuracy is unprecedented and a true enabler for widespread use of high tempo subsea mobile mapping projects. It provides enough redundancy and QC to both reliably satisfy accuracy requirement and support high integrity applications such a spool-piece and jumper metrology."

We have ability to merge and post-process all sensors at the raw data level. We have a deep understanding of subsea operations and your commercial pressure. And we have experienced offshore personnel ready to support you every step of the way, de-risking your projects. This proven capability has the potential to revolutionise many subsea operations. Contact us to discuss how it could revolutionise yours. **BL**

Not all applications require the same level of performance. That's why SPRINT-Mapper now supports a range of off-the-shelf configurations to support any operation; from wide area absolute positioning to confined area relative mapping projects.

SPRINT-Mapper

Use it for basic underwater mapping applications such as archaeology and ocean science

Capability, Complexity and Precison

- Works with Multi-beam, Laser or LiDAR
- You'll need a SPRINT INS, Syrinx DVL, a USBL and a depth sensor
- Accuracy is scenario dependent; absolute accuracy determined by chosen USBL system
- Integrity is limited
- There's no INS Post-Processing
- It's supported by your personnel

SPRINT-Mapper Plus

Perfect for mapping tasks such as Pipeline Out-Of-Straightness and civil engineering

Capability, Complexity and Precison

- Works with Multi-beam, Laser or LiDAR
- You'll need a SPRINT INS, Syrinx DVL, a USBL and a depth sensor
- Expect~10 cm accuracy (relative) over 50m distance. Absolute accuracy dependent upon USBL
- Limited integrity
- INS Post-Processing using Janus
- It's supported by your personnel

SPRINT-Mapper Pro

Pro lets you map areas up to 500 metres and is suitable for asset inspection and monitoring activities

Capability, Complexity and Precison

- Works with Laser or LiDAR only
- You'll need a SPRINT INS, Syrinx DVL, 6G LBL spread and a depth sensor
- <5cm level typical accuracy for single run-line distances of ~20m. 10cm level typical area (e.g. 50-500m square) mapping accuracy
- Trusted QC with 6G acoustic range aiding
- INS Post-Processing using Janus
- Pre-planning services included and support for your personnel

SPRINT-Mapper Elite

Suitable for confined area mapping, anchor chain, riser monitoring and metrology in areas between 100 and 200 metres

Capability, Complexity and Precison

- Works with Laser or LiDAR only
- You'll need a SPRINT INS, Syrinx DVL, 6G LBL spread and a depth sensor
- 1cm level typical accuracy for single run-line distances of ~20m. 5-10 cm level typical area (e.g. 50-200m square) mapping accuracy
- Trusted QC with 6G acoustic range aiding
- INS Post-Processing using Janus
- Pre-planning services and expert offshore personnel supplied by us

International

News from our Regions Around the World

Middle East, SE Asia

Anthony Gleeson Vice President

We recently had some subsea asset monitoring equipment returned to our workshop for service and refurbishment. To the delight of both our customer and service engineers, the system was still recording and storing data after nearly seven years subsea. We're able to do this due to our very efficient low power 6G electronics and long-life battery packs, meaning longer service intervals and lower operational costs for you.

And speaking of subsea asset monitoring projects, we're currently working on a number of new ones, including the first deployment in the region of our Sentry integrity monitoring system which is planned to take place in the coming months.

Elsewhere, we've been delivering a significant number of Ranger 2 GyroUSBL systems – further cementing its reputation locally as the system of choice for USBL operations on vessels-of-opportunity. Due to its ease of use and rugged build quality, it's able to be mobilised quickly and offers impressive tracking performance straight out of the box.

If operator training is on your mind, we've got LBL, SPRINT, DVL and USBL courses coming up soon. Senior instructors from the UK will be running them at our Singapore Training Centre, supported by our local team. Head to our website for dates or get in touch to book your place.

Europe, Africa, S. America

Barry Cairns Vice President

The wave of new short-term contracts available from Petrobras, has meant a busy start to 2017 for our Brazil team. The specifications for these construction survey operations demand high accuracy and versatile systems which is a perfect fit for our 6G technology. That's resulted in customers returning their previous-generation systems for upgrade.

Our workshops are a great way for you to get an understanding of new technologies and techniques. They're free to attend and over the next six months, we'll be hosting sessions on SPRINT, DVL Marksman and Ranger 2. You'll learn how these products meet the need of any subsea positioning, telemetry, command and control requirement – and save you time and money at the same time. Come along and learn how 6G can help you. Email us for dates.

An air of optimism

As in Brazil, market conditions in Europe and Africa remain overall challenging. However, recent subsea networking events have had an air of optimism about them with many feeling we've reached a point where certain market areas are ready to move forward.

That's been reflected in some good orders in Q1. Notable amongst these are sales of our combined SPRINT INS and Syrinx DVL which we now call SPRINT-Nav. These will be used by an ROV operator and a European research institute. We also handled a significant LBL sale to a Tier One SURF contractor that included nine GyroCompatts! Other orders include BlueComm 200 to be used for remote wireless video transmission and there is lots of interest in our tightly integrated navigation solution for mobile mapping.

We're also running workshops in the local area and around Europe. Contact us to find out when we will be near you.

North America

Simon Reeves Senior Vice President

As you might have read on page 9, Dan Zatezalo had the perfect start to his new role in sales when he received a purchase order during a recent trade event. Locally based rental company Survey Equipment Services were so impressed with what Dan had to tell them about Mini-Ranger 2 and Nano beacon, they ordered one on the spot! And as I write, a second PO's landed for another Mini-Ranger 2 from a company we spoke to at the same show.

Last year we made significant inroads within the domestic and Canadian ocean science community when our DVL and INS technologies were chosen for some of the world's most capable marine robotic platforms. We're seeing this trend continue in 2017, with vessel and ROV upgrade programmes designed to enable scientists to explore new depths. It's worth mentioning, that if you'd like to compare our Syrinx DVL against your current unit, we have demo units available. Just get in touch.

Condition monitoring with SMART

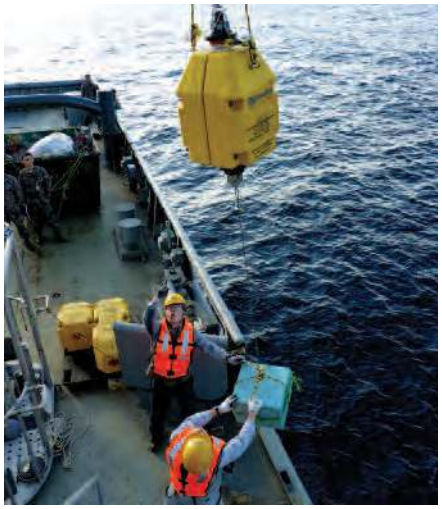
Although talk of new projects in the Gulf region remains quiet, when it comes to assessing the integrity of fields in production, there's plenty of buzz around our SMART solution. Interface SMART with sensors including strain, corrosion and vibration, and it will carry out the analysis onboard for you - allowing you to make more informed decisions. We can run a dedicated workshop if your asset team would like to learn more.

Help & Advice

THE KNOW HOW

In this issue, our highly experienced product specialists share their tips on setting up and deploying Compatts. Get in touch with them at: support@sonardyne.com

When to use a float, when to use a stand?



First consider your error budget; how precise does your position information need to be for this job? For example, Metrology requires millimetric precision so rigid stands are your only option. But this requires planning in order to ensure stand heights are suitable to provide good line of sight between transponders, and will most likely require ROV resources to deploy and recover them. If however, you have more flexibility in your tracking solution, you may decide to go with the simpler float collar option. Deployed by freefall or ROV, tethered releasable weights keep the Compatt on the seabed as it floats upright. But be aware of currents; they'll cause the Compatt to sway – the amount depends on the length of tether and design of float. In uneven topography, longer tethers may be needed to ensure line of sight. Our teardrop float is worth considering as it reduces drag, and minimises deflection. Our SSG team are here to help. Email them at: **survey.support@sonardyne.com**

Get, Set, Deploy with iWand

Place the iWand's antenna against the Compatt's transducer, then select 'Get Configuration.' After a quick ID and comms handshake, the unit's settings are uploaded to the iWand's memory. Move to the next Compatt and repeat the process. Now connect iWand to your PC using RS232, USB or Bluetooth. Open the 6G Configurator software and click 'Refresh' to see all the details for each of your recently added Compatts. Select each one in turn and make any configuration changes you need for your job including; addresses, power and gain levels. Once all changes are made, select Set Configuration and download the settings back to your Compatts. Now test the sensors and release before generating a report for each unit. Head to our YouTube channel to see iWand in action.

How to correctly set a Compatt release mechanism

If set incorrectly, your Compatt's release mechanism can become damaged; it might fail to open or sinker weights may fail prematurely when lifted off the back deck. Use the following method to ensure the release is set correctly and safely.

There is a hole in the lever arm of the release and another in the side plate. Insert a 4mm Allen key into the lever arm hole. Make sure the supplied stainless steel shackle is situated and push the Allen key towards the body of the Compatt to move the lever arm into place. We only use the best quality shackles; cheaper alternatives are available, but using these can put your equipment at risk.

Keeping pressure on the Allen key, insert a screwdriver in the side plate hole, across the top of the lever arm and out of the other side plate. You can now relax and remove the Allen key as the screwdriver will keep the lever arm in place.

Using 6G Terminal Lite software or an iWand, 'Arm' and then 'Close' the release. The motorised cam will close, locking the lever arm in place. Once this is complete, remove the screwdriver, attach the weights to the shackle and your release is set.

Sonardyne
SOUND IN DEPTH

SUBSEA TECHNOLOGY

Total Navigation

Lodestar AHRS, SPRINT INS and Syrinx DVL. All-in-one, class-leading subsea navigation for ROVs and AUVs

With a track record spanning more than 10 years, our Lodestar AHRS and SPRINT INS range has evolved into its 3rd generation, with smaller titanium housings, different performance levels and in-field upgrades to meet the needs of any subsea vehicle guidance and survey application. When combined with our Syrinx DVL, Lodestar and SPRINT provide unprecedented levels of performance in a single offering for ROV and AUV guidance and survey. Discover more; search **Sonardyne SPRINT-Nav**

POSITIONING
NAVIGATION
COMMUNICATION
MONITORING
IMAGING