THE CUSTOMER MAGAZINE FROM SONARDYNE
ISSUE 19

Baseline

ALTHOUGH IT'S NOW eight years since the first sixth generation instruments began to appear, the platform continues to growth in strength and depth. If proof's needed, turn to KIT on page 4 to discover our new approach to acoustic modems. Experience tells us one size doesn't fit all, so just as you have always been able to get transponders from us in many different configurations, you can now do the same for an acoustic modem.

Anyone deploying instrument moorings and sensors using an acoustic release is likely to have encountered Sonardyne LRTs, ORTs or DORTs. Meet their 6G replacements on page 6, featuring a battery life of up to four years and for the first time, compatibility with your vessel's Sonardyne USBL tracking system. And talking of USBLs, our latest shallow water model is called Micro-Ranger 2. The transceiver is so small, we've been able to print it full size on page 8.

Last time we reported on trials to assess the Low Medium Frequency band for ultra-long range tracking. We follow up in this issue on page 18 with details of a further trial examining usable data telemetry rates over similarly impressive distances, touching upon why acoustics remains an outstanding method to communicate.

Marine robots are on the rise, but to maximise their operational value it's essential that the instruments you fit to them are well integrated. The lessons we've learnt working with vehicle designers and manufacturers over the years are shared on page 26.

Project case studies on page 14 and 28 highlight why Fusion 6G remains the most popular, low risk Long BaseLine technology for supporting field construction – whether you're working in 1,675 metres or, as one client was, just 14 metres.

David Brown Editor

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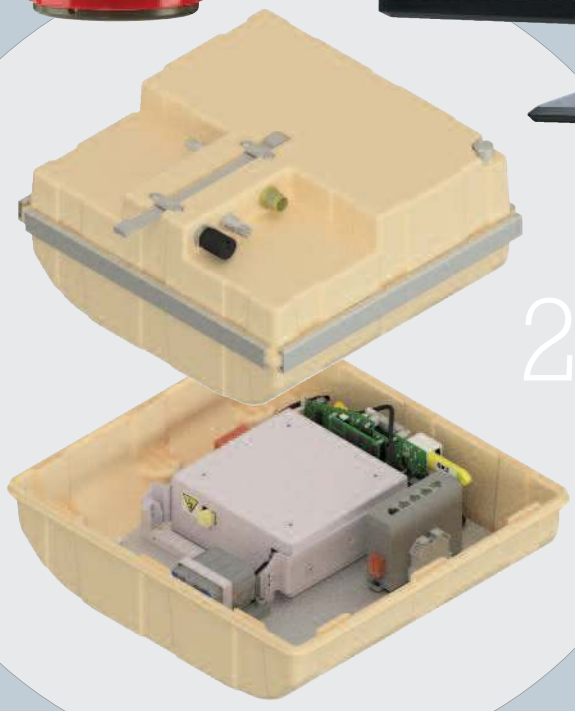
Front Cover
A deep rated Low Medium Frequency Compatt 6 transponder is prepared for deployment from NOC's *RRS Ship James Cook* during trials conducted off the Spanish island of Tenerife. Turn to page 18 for the full story and results which underline the technology's capabilities to meet the challenges of ocean explorers and researchers.

In this issue...



“These results once again under-line the impressive capability of our LMF Ranger 2 USBL to meet the challening requirements of ocean explorers and researchers”

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The Customer magazine from Sonardyne

Editorial Team
David Brown,
Head of Marketing

Anthony Hammond
Marketing Manager – Digital & Events

Tom Acton
Marketing Assistant

Design and Art Direction
TruthStudio Ltd.
www.truthstudio.co.uk

Photography
Astonleigh Studios
www.astonleighstudio.co.uk
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Sonardyne
SOUND IN DEPTH

SONARDYNE.COM

»KIT

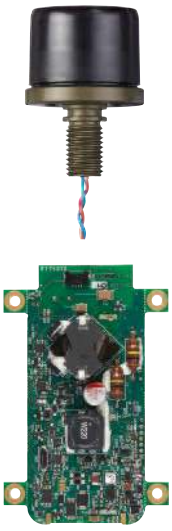
Our latest subsea technology and services

ACOUSTIC COMMUNICATIONS

GET CONNECTED WITH MODEM 6

Modem functionality comes as standard with our range of 6G family of positioning, tracking and autonomous monitoring instruments. They use robust, digital spread spectrum signals to reliably telemeter sensor data from the seafloor to the surface and have collectively transferred many gigabytes of clients' information. But what if sending data underwater is all you ever want to do? Why pay for features you don't need? Introducing Modem 6; a family of inter-compatible acoustic modems built around our trusted 6G platform and configured to connect you to your subsea data at rates between 200 and 9,000 bps. There's one to suit any requirement and all can be upgraded to offer additional capability such as LBL and USBL.

#1



#2

#3

#4

#5

#1 Modem 6 Nano OEM

The size of a credit card for those times when size really does matter. Requires external power and housing within your own instrumentation. Supplied with a remote MF omni-directional transducer.

- 88mm long x 56mm wide
- RS232 interface
- 12/20VDC input
- 995m typical operating range

#2 Modem 6 Sub-Mini

Available in 1,000and 4,000 metre options, offers excellent horizontal, shallow and deep performance. Internal rechargeable battery provides up to 35 days standby.

- MF omni or directional transducers
- On/Off switch for storage
- 24VDC external power input
- Advanced transmitter power control

#3 Modem 6 Mini

Available in 3000/5000/ 7000m depth rated housing, transducer types and serial interfaces. With its integrated Li-ion battery and isolated external power supply, Mini is most suitable for vehicles.

- MF and LMF transducers.
- RS232/485 serial interface
- 24/48VDC isolated external power input
- External IO control

#4 Modem 6 Mini OEM

As #3 but for integration into your subsea housings. Used in long range and/or in high noise applications. Available with remote transducers in both MF and LMF frequency bands.

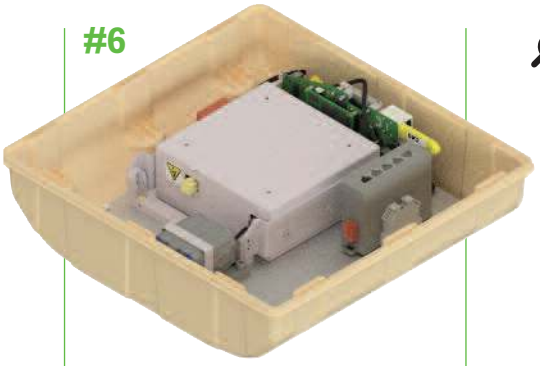
- Omni or directional transducers
- 24/48VDC isolated external power input
- Optional OEM Li-ion battery
- Typical 3,000m/6,000m range

#5 Modem 6 Mini (Surface Kit)

If you're using a pair of Minis, this accessory kit turns one of them into a lightweight dunker with protection from knocks and bumps during deployment and recovery.

- Perfect for small vessels
- RS485 comms interface
- Supplied with cable and drum
- Includes power and interface unit

#6



#6 Modem 6 USV

Boxed and sealed for integration on an Unmanned Surface Vehicle of your choice for remote data harvesting. On-board processor allows scripts to be run on the vehicle reducing the bandwidth of the data link / costs to shore. Read more about the hardware on page 22

- Low power electronics
- Autonomous operation
- Used on leading vehicles platforms
- Custom design service available

#7

Looking for specifications? Our website has all you need to know.

#8

#9

#10

#7 Modem 6 HPT

Offers ultimate performance. Excellent vessel noise rejection and multiple receivers ensure the highest data rates possible. Can be upgraded to a Ranger 2 USBL transceiver.

- Proven 11km+ range capable
- Optimised for noisy environments
- Ideal for permanent vessel fit
- Optional dunking kit

#8 Modem 6 Dunker

A portable very rugged dunker system. Supplied with a 100m cable drum and interface unit, lower it into the water by10 metres to avoid surface or vessel interference.

- Ideal for vessels-of-opportunity
- Shock mounted electronics
- MF/LMF omni or directional transducers
- Buoy and seabed mounting options

#9 Modem 6 Midi

Comes with integrated battery pack and high power acoustic transmitter for maximum range performance. Can take power in and provide acoustically controlled power to external systems. Ultimate long range performance to 11km.

- MF/LMF omni or directional transducers
- 3000/5000/7000m housings
- High capacity primary battery

#10 Modem 6 Standard

Same as #9 but with larger battery pack options enables deployment for years or even decades. Alkaline and lithium battery options. Optional acoustic release for recovery. Wide range of housing materials available.

- High energy 100Ahr battery pack
- MF/LMF omni or directional transducers
- External power input and output
- 3000/5000/7000m housings

»KIT

Our latest subsea technology and services

ACOUSTIC RELEASES

GET RELEASED WITH RT 6

New acoustic releases that you can control with your current 6G topside hardware.

If you deploy and recover instrument moorings and subsea structures, chances are you have probably used one of our acoustic releases to help with the task. However, ORTs, DORTs and LRTs all use different topside equipment to activate them and they're not compatible with the Ranger 2 USBL tracking systems fitted to many research and survey vessels. So we're replacing them with Release Transponder 6 (RT 6).

On the outside, RT 6s are similar to what you know and trust, so they'll be just as rugged and reliable. It's on the inside where you'll notice the difference. Wideband 2 signals for commanding in any environment, vastly extended battery performance for long-life deployment, 1,000, 3,000 and 6,000 metre depth ratings and compatibility with any 6G topside hardware you have available; dunker, iWand or HPT USBL transceiver.

#1
RT 6-6000

Our deepest rated release transponder allows you to deploy moorings in water depths down to 6,000 metres for up to four years. It's also LMF, meaning you can track it from far away using your vessel's Ranger 2 USBL system. 1,275 kg Working Load Limit (WLL).

#2
RT 6-1000

A design that will be familiar to users of our popular LRT, RT 6-1000 is the perfect low-cost option for nearshore applications but with significantly increased depth rating (now 1,000 metres) and battery life (now 18 months). 125 kg WLL.

#3
RT 6-3000

The RT 6-3000 replaces our hugely popular ORT but we've kept the 1,275 kg WLL mechanics the same to ensure they will fit with your existing deployment arrangements. Inside is a 6G, MF frequency USBL transponder for tracking and activating using Ranger 2.

#4
iWand

A handheld device that's used to support your back deck preparations prior to deployment including; programming addresses, in-air acoustic testing, loading the release mechanism and verifying battery status.

#5
Surface Transceiver 6

If your vessel's not equipped with a permanent Sonardyne USBL transceiver, this is the next best way of commanding your deeply deployed releases. Supplied with a cable drum, acoustic interface box and dunking transducer.

Looking for specifications? Our website has all you need to know.

#6
HPT USBL Transceiver

You'll find our HPT USBL transceivers installed on a global fleet of ocean science and commercial survey vessels. This means you have everything you need to deploy, track and recover our new family of 6G acoustic releases.

»KIT

Our latest subsea technology and services

USBL SYSTEMS

Need to know where your divers are? Micro-Ranger 2 has them covered

Portable and quick to mobilise, Micro-Ranger 2 USBL can be used from any waterside location or vessel of opportunity, including RHIBs and small survey vessels, to track divers, underwater vehicles and equipment.

It's built around the same market-leading 6G hardware and Wideband 2 digital acoustic technology you'll find in our family of deep water USBL systems, Mini-Ranger 2 and Ranger 2, but for significantly less cost and complexity.

If you're a first time user of USBL technology, you'll find Micro-Ranger 2 incredibly easy to use. Simply connect your computer, external GPS and transceiver (shown here full size) to the system's 1U-high interface unit, then attach a transponder (Nano or WSM 6+) to each target you want to monitor the position of. With the transceiver lowered into the water, you're ready to start tracking.

The Micro-Ranger Transceiver (MRT) is extremely small and light and can be deployed from the side of a vessel, pontoon, or even USV. Its design provides omni-directional acoustic tracking coverage, so is ideal for tracking targets in shallow water all the way to the surface. Contact your local office for price and availability.

MOBILE MAPPING

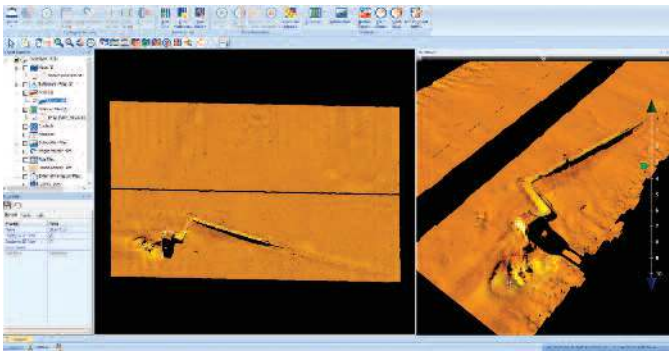
Newton Labs complete SPRINT-Mapper integration

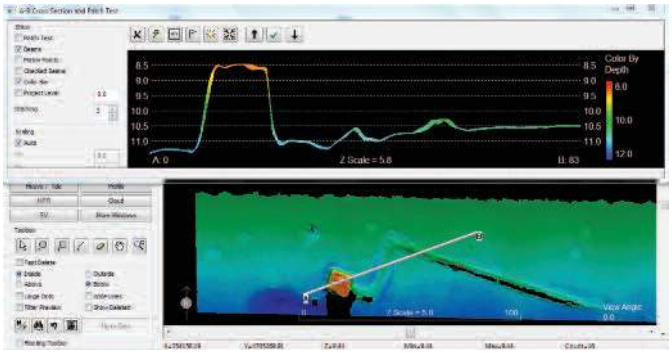
Tests have been completed to integrate Newton Labs' underwater laser scanners with our acoustically-aided inertial navigation system for underwater vehicles, SPRINT-Mapper.

We entered into a formal collaboration agreement with Newton Labs last year to develop and promote dynamic underwater laser mapping, a rapidly emerging survey technique which significantly reduces the time needed to carry out inspections using underwater vehicles, including ROVs and manned submersibles.

The work carried out at Newton's facility in Seattle in January included configuring the inertial and time synchronisation data output from SPRINT-Mapper to pass directly into Newton's underwater laser scanners.

John Bramblet, President and CEO at Newton Labs said, ''Integration of Newton Labs underwater lasers with Sonardyne SPRINT technology allows our high, 0.1 mm, resolution scanners to perform virtually any laser scanning project, whether it is full field scanning, pipeline scanning or high resolution corrosion and crack detection all from a mobile platform.''





TRANSPONDERS

Mark it, leave it, find it

Deep marker transponders allow scientific experiments, archaeological sites and diving bells to be quickly and accurately located by your divers and ROVs months or even years later. Currently in development is our next generation model – upgraded to 6G to deliver to host of new benefits for your operations. It will be compatible with any 6G transceiver, depth rated to 4,000 metres and have an omni-directional beam pattern to make fitting straightforward. A key feature will be the ability to test, configure and store Marker 6 with a NFC enabled smart phone running our Android App. This latest wireless technology allows the battery and inclinometer data to be checked on deck, the address configured, or put into storage mode where the battery is electronically disconnected. The 3S3P AA cell alkaline battery provides a battery life of 18 months.

SOFTWARE

Industry support for Solstice

Hydrographic surveying packages from three leading vendors can now be used to process and display data from our Solstice side scan sonar. Chesapeake Technology Inc's SonarWiz 7, HYPACK's (a Xylem brand) HYPACK® MAX and HYSWEEP® titles, and Seebyte's SeeTrack V4 product can gather Solstice sonar data, process it through their editors and generate final products.

Solstice is a Multi Aperture Sonar (MAS) designed for Search, Classify and Map (SCM) and Hydrographic operations with integrated swath bathymetry. It has been tailored for low-logistic AUVs and gathers high resolution imagery that can be used for automatic target recognition, hydrography and post-mission analysis. With an along-track resolution of 0.15°, the imagery produced by Solstice is considered to be of the highest quality possible from a side scan sonar.

Ioseba Tena, Global Business Manager for Sonardyne added, ''These companies have a long track record in the industry and it's great that our customers can now count on their powerful software suites to manage their projects and generate client deliverables.''

NEWS

Photos: Neptune

Positioned by Mini-Ranger 2 USBL, Neptune's ROV team operated the Swift Work-Class ROV around the wreck in challenging conditions.

SEARCH AND SALVAGE

Neptune uses Mini-Ranger 2 for Singapore Straits salvage

Last February, whilst moored to a barge in the Traffic Scheme Separation of the Straits of Singapore, the tug *Harita Berlian* 18 began taking on water and sank. With the wreck of the vessel lying in just 45 metres of water, it was declared a navigation hazard and a contract was awarded to SMIT Salvage to remove it.

Despite the shallow water, the salvage operation would be made more complicated because of the busy location and the many submarine cables lying nearby. This meant vessels assisting in the wreck removal would need to be held without anchors and ROV technology used wherever possible to minimise the risk to divers.

Neptune, a leading provider of marine inspection, maintenance and repair solutions in the region, was appointed to provide project management and subsea survey services. To assist their work, they selected our Mini-Ranger 2 USBL tracking equipment supplied by our team in Singapore.

Mini-Ranger 2 boasts a number of features that makes it ideal for underwater operations requiring high accuracy positioning without the cost and complexity associated with a deep-water USBL solution. It can position multiple underwater targets simultaneously at very fast update rates, it is quick to install on vessels of opportunity and has a tracking range of up to 4,000 metres.

The 12-day recovery operation began last September. Neptune's seven-man survey team maintained surface positioning of the *SMIT Cyclone* crane barge and utilised their proprietary NepSMART Tug Management System to maintain positioning of the *Pacific Warlock*, *Pacific Viper* and *Pacific Valour* support vessels.

"We were also really impressed with the reliability of the WSM6+ transponders working in what were close to the dictionary definition of challenging acoustic conditions!"

Tracked with Mini-Ranger 2 USBL, Neptune's ROV team piloted their Swift Work-class ROV around the wreck in challenging conditions to complete the required surveys, and using a multi-beam imaging sonar and the ROV's manipulators, conduct the intricate work of securing rigging for the actual lift and recovery.

Neptune Chief Executive Officer, Robin King commented, "This project demonstrates Neptune's ability to transfer skills and techniques from the oil and gas sector to benefit other diverse and complex sectors such as salvage. This project is also a good showcase for how Neptune's Singapore office can react and deliver cost-effective integrated survey and ROV services for time sensitive projects at short notice in the region."

Commenting on the successful utilisation of Mini-Ranger 2, James Hope, Survey Manager at Neptune Survey in Singapore said, "The use of Mini-Ranger 2 proved invaluable in providing precise and reliable positioning of our ROV around the wreck, as well as safe navigation in poor visibility. We were also really impressed with the WSM 6+ transponders working in what were close to the dictionary definition of challenging acoustic conditions!"

MODEMS

BlueComm docks with Cellula Imotus HAUV in tank tests

Vancouver-based Cellula Robotics Ltd has successfully demonstrated the capabilities of its Imotus-1 hovering autonomous underwater vehicle (HAUV) for inspection and data acquisition missions in confined environments.

During a week of testing at a pool facility, Imotus-1 navigated using proprietary Simultaneous Localization and Mapping (SLAM) algorithms to hold station, waypoint track and manoeuvre around obstacles.

An autonomous docking demonstration, sponsored by Ocean Networks Canada, included high bandwidth wireless communications between Imotus and its docking station using a pair of our Bluecomm 100 optical modems. The technology is considered to be a critical risk reduction tool for future open water applications, enabling user monitoring and potential intervention in the docking process.

Scott McLean, Director of Ocean Networks Canada, said, "This was an excellent demonstration of Canadian technology that has broad applications globally for both industry and research. Demonstrating both wireless optical communications and contactless connectors for charging and high speed communications, is an essential step to creating the next generation in hybrid AUV systems."

Head to Cellula's YouTube channel to see Imotus and BlueComm in action.

OCEAN SCIENCE

Ranger 2 deep tracking technology selected for German research vessel upgrade

Our deep water acoustic tracking technology, Ranger 2 USBL, has been installed on one of the most modern vessels in the German research fleet, the *Maria S. Merian*.

Delivered through our agent, Scholz Ingenieur Büro GmbH, the system was chosen as a replacement for the vessel's existing third-party Ultra-Short BaseLine (USBL) acoustic equipment to enable science teams to precisely track the position of deep-water science systems including unmanned robotic platforms and seafloor landers to beyond seven kilometres.

Operated by the German Research Vessels Control Station at the Institute of Geology, University of Hamburg, the *Maria S. Merian* is equipped to conduct sea bottom, water column and atmospheric observations in the Mediterranean, North Atlantic and, thanks to its ice-breaking reinforced hull, the subpolar Norwegian Sea.

A key factor in the institute's decision to select Ranger 2 for the *Maria S. Merian* was the system's extensive track record in delivering fast, accurate and repeatable positioning for science operations in all water depths and operating conditions. Central to this has been German scientists' first-hand experience of the Ranger 2 systems fitted to the UK's research vessels, including the *RRS James Cook*, which has been a long-term user of our USBL technology.

As part of the upgrade, the ship has been fitted with a GyroUSBL which incorporates a USBL transceiver and high-grade inertial navigation sensor in the unit. This combination maximises precision by eliminating common sources of USBL system error such as lever arm offsets, pole bending and ship flexing.

Speaking about the contract, Paul Griffiths, Sonardyne Sales Manager said, "Within the global science community, Ranger 2 is now firmly established as a key enabler for sustained ocean observations."

Jan Wommelsdorff of Scholz Ingenieur Büro GmbH added, "This is the first Ranger 2 GyroUSBL to be fitted to a German research ship and is a key technology for enabling the country's scientists to work in demanding deep sea environments."

Photo: Briese Schiffahrts GmbH & Co. KG, Research | Forschungsschiffahrt

The *Maria S. Merian* will use its Ranger 2 USBL to conduct sea bottom, water column and atmospheric observations.

NEWS

UXO SURVEYS

Deep BV upgrades to 6G

Deep BV, a Dutch survey company specialising in hydrography, marine geophysics and oceanography, has two Mini-Ranger 2 USBL tracking systems and WSM 6+ mini transponders to support its inshore, harbour, coastal and offshore activities. Delivered to Deep BV's headquarters in Amsterdam within days of the order being placed, one of the systems was put straight to work during an operation to search for unexploded ordnance (UXO) from onboard their 15 metre, twin hull research vessel, *Deep Volans*, and configured to track a remotely operated towed vehicle (ROTV) named *Iron Lady*. Accurate positioning is paramount for the *Iron Lady's* control software in order to 'fly' the six metre-wide, gradiometer UXO set-up just two metres above the seabed. Klaas Visser, Chief Technology Expert at Deep BV said, "We've been a user of Sonardyne's previous Scout USBL system for several years and have been pleased with the results it's delivered. However, now was the right time to replace these systems and upgrade to 6G with all of its attractive features and performance gains."

CONSTRUCTION SURVEY

Rental companies increase investment in SPRINT and Syrinx navigation technology

Pictured in our Aberdeen office, left to right – Barry Cairns (Sonardyne) Scott Gray and Phil Middleton (Seatronics) and Paul Griffiths (Sonardyne).

SPRINT inertial and Syrinx Doppler technology continues to strengthen its reputation as the best available guidance technology to support deep water vehicle operations, following recent orders from two leading equipment rental organisations.

After experiencing rising demand for their existing units, Seatronics, an Acteon company, has purchased multiple SPRINT and Syrinx units to add to its global inventory, whilst Unique Group, has added our combined, pre-calibrated SPRINT and Syrinx instrument, SPRINT-Nav, to complement their existing fleet of Sonardyne technology.

SPRINT makes optimal use of acoustic aiding from data sources including USBL, sparse LBL, DVL and pressure sensors to improve the accuracy, precision and reliability of subsea vehicle navigation. The 4,000 metre depth rated titanium housing is smaller and lighter than previous generations, providing valuable payload savings. Power pass-through helps simplify vehicle integration and wiring.

Syrinx operates at altitudes up to 50 percent higher than conventional 600 kHz DVLs with the high resolution performance of a 1200 kHz unit, all whilst navigating over undulating and challenging terrain of any type. When used with SPRINT, they provide tight beam-level aiding to deliver unprecedented positioning performance, even if one or two DVL beams become unavailable.

SPRINT-Nav combines the features of SPRINT and Syrinx in a single housing that is one of the smallest inertial-DVL instruments on the market. Mechanical alignment of the sensors improves overall navigation performance and ensures rapid and simple mobilisation, making it an ideal choice for rental.

''These purchases reflect the rise in the number of project specifications around the globe calling for our hybrid inertial, acoustic and DVL approach to subsea navigation,'' said Vice President, Barry Cairns. ''With more of this technology now in the rental supply chain, more projects will benefit from it.''

PIPELAY

Allseas touches down with dual GyroUSBLs on Lorelay stinger

Allseas, a global leader in offshore pipeline installation and subsea construction, is to take advantage of the performance and operational benefits available from our GyroUSBL transceiver technology, following an order for two systems for its 236 metre long lay vessel, *Lorelay*.

Used in conjunction with a Ranger 2 USBL topside which also formed part of the order, the GyroUSBLs will be installed on the end of the *Lorelay*'s stinger to acoustically track an ROV deployed to ensure a pipe is accurately touching down in the permitted corridor.

USBL transceivers are routinely deployed through the hull or over-the-side of a vessel, enabling targets to be tracked below, to the side and far behind. However, on a large DP pipelay vessel such as the *Lorelay*, a transceiver cannot reliably 'see' through the thruster wash created at the rear so touchdown monitoring operations are often conducted by an ROV operating from a survey vessel (equipped with its own USBL system) following on behind. With a stinger-mounted GyroUSBL, there is a proven alternative.

The unit combines a 6G HPT transceiver (either 5,000 or 7,000 model) and Lodestar Attitude and Heading Reference System in the same assembly and is supplied pre-calibrated to eliminate the mechanical alignment errors seen in conventional USBL setups. These features allow an acoustic transceiver to be sited well away from noise interference, even on a dynamic structure such as a stinger, and deliver outstanding positioning performance. It also means that a pipelay vessel is able to employ its own ROV to carry out touchdown monitoring, allowing the accompanying survey vessel to get on with another task, or eliminating the need for it altogether.

Mounting a GyroUSBL on a stinger is now a widely adopted practise amongst pipelay vessel operators, with the technique having first appeared on the market in 2013. The *Lorelay* will be the third vessel in the Allseas fleet to be equipped in this way, with systems already in operation on the *Pioneering Spirit* and *Solitaire*.

Alan MacDonald, Sales Manager at Sonardyne in Aberdeen said, ''Locating a transceiver on the stinger is a great solution for ensuring that vessel noise disruption is rejected. The time-saving features of GyroUSBL results in reduced operational costs with the ability for users to move it from vessel to vessel with minimal downtime whilst maintaining the highest levels of positioning performance.''

Photo: Allseas

GyroUSBLs mounted on *Lorelay*'s stinger will track an ROV during touchdown monitoring operations.

CONTRACT

Survey Equipment Services first to invest in Micro-Ranger 2

In February, we chose Underwater Intervention, the annual diving and ROV technology show in New Orleans, as the global launch event for Micro-Ranger 2, the latest (and smallest) addition to our USBL product line-up.

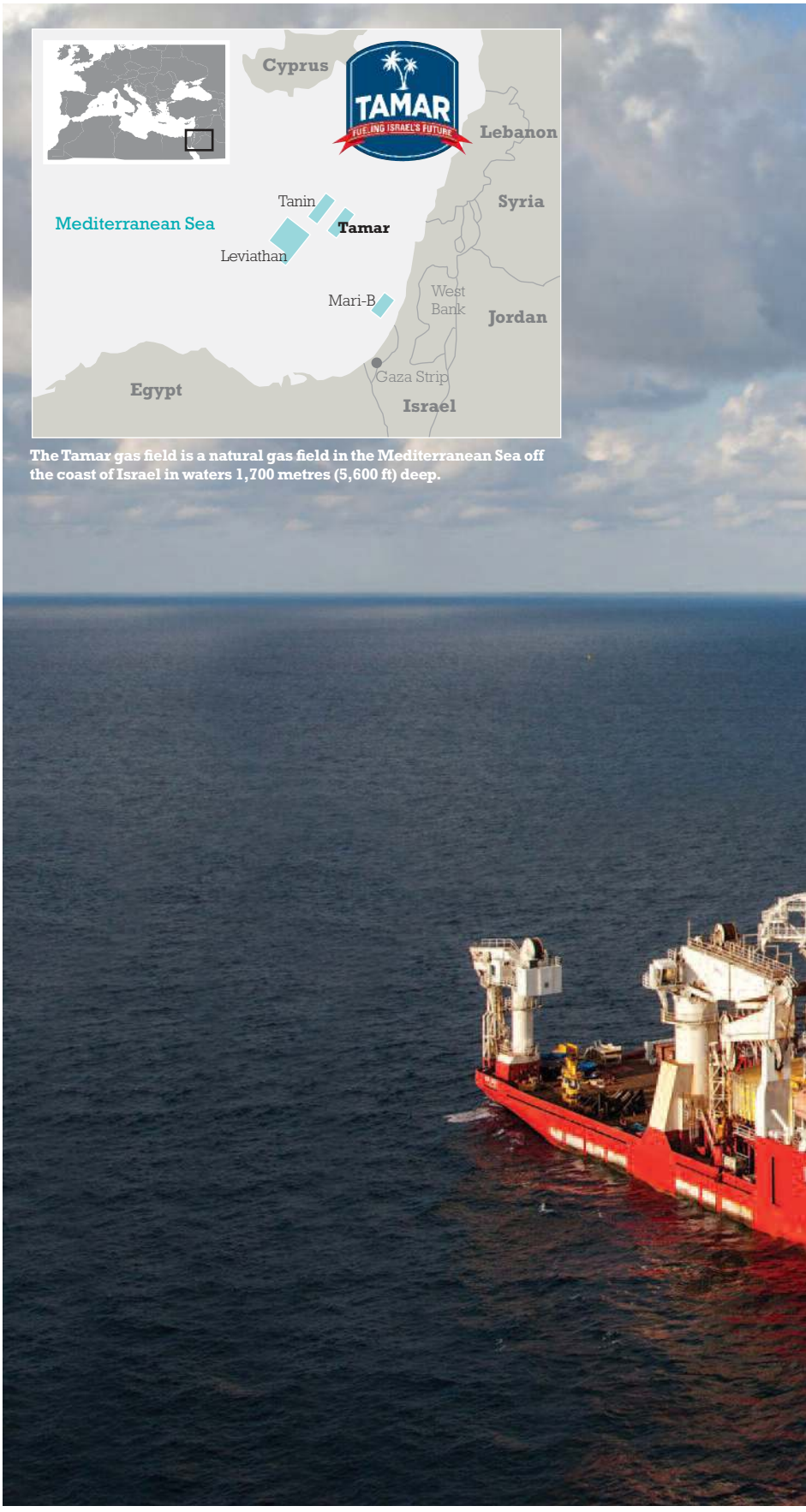
As you'll read on page 8, Micro-Ranger 2's portable design and simple-to-use configuration makes it the ideal choice for shallow water tracking including hydrographic surveys and inland waterway inspections. This is exactly the type of work Houston-based Survey Equipment Services (SES) support through their extensive inventory of rental hardware.

Exhibiting at the show, SES Vice President, Alan Craig, was quick to appreciate the benefits Micro-Ranger 2 would bring to his clients, so an order, including additional Nano transponders, was agreed with Sonardyne Sales Manager, Dan Zatezalo. "Micro-Ranger 2 is a great addition to our shallow water subsea equipment inventory – we don't expect it to be on our shelves for long. We are delighted to be the 1st Sonardyne customer to offer this great product for hire or sale to our clients," said Alan.

Construction Survey

Case Study: High accuracy positioning for structure installation and metrology

Fusion 6G LBL measures up to meet the deep water challenges at Tamar gas field



The Tamar gas field is a natural gas field in the Mediterranean Sea off the coast of Israel in waters 1,700 metres (5,600 ft) deep.

To support the ongoing development of Noble Energy's Tamar gas field in the eastern Mediterranean, Marteam of Israel and Interocean Marine Services of Aberdeen, were contracted to develop the methods, select the equipment and conduct subsea operations to support the positioning of a new wellhead. The campaign included subsea metrology to determine the size of the jumper that would connect the new wellhead to an existing pipeline Flow Line End Termination (FLET) unit. Baseline speaks to **Will Primavesi** (Interocean), **Tamir Frydenrych** (Marteam) and **Drew Nicholson**, (Noble Energy) to get an overview of the challenges that were faced by the survey team, and the solutions that were used to ensure a successful end result. **>>**

The field consists of an offshore processing platform, which is closer to shore in a water depth of approximately 237 metres, and a number of wellheads in the deeper water that are connected to the platform via subsea pipelines.

Photo: Ashernet

Construction Survey

Case Study: High accuracy positioning for structure installation and metrology

The Tamar field is located 50 miles west of Haifa, Israel, in a water depth of approximately 1,675 metres. The field consists of an offshore processing platform connected to a number of wellheads via subsea pipelines.

As a further development of the field, a new well, Tamar #8, was required to be drilled close to an existing wellhead and then connected to the nearby Flowline End Termination (FLET). The rigid steel jumper connecting the new wellhead to the FLET would be fabricated onshore and would be approximately 30 metres in length and approximately 21 tons in weight.

Deepwater Positioning Challenge

Noble Energy required two phases of subsea positioning support for the development and connection of the new well.

Firstly, deployment of seabed markers that would delineate the footprint of the new Tamar #8 wellhead with a positioning accuracy relative to the existing seabed structures of +/-0.5 m. The markers would then be used as visual aids by the drillship *Atwood Advantage* during the start of the drilling process or 'spudding.'

Secondly, determination of the three dimensional spatial relationship between the jumper connector (or hub) on the new wellhead and the jumper hub on the FLET assembly to an accuracy of +/-0.1 m, such that the connecting jumper could be fabricated onshore and later installed subsea.

Fusion 6G LBL. Precision at any depth

To meet these stringent requirements, the project team elected to use our sixth generation (6G) Long BaseLine (LBL) acoustic positioning technology platform, Fusion 6G. Evolved to meet users' requirements for software that is powerful yet simple to use with subsea hardware that can be configured for many different applications, the precision of Fusion 6G far exceeds other surface installed positioning systems such as USBL and is recognised globally as the industry standard.

Offshore Operations

The offshore positioning campaign was conducted in two phases. The seabed markers for Tamar #8 well were installed

(Clockwise from right) A Interocean engineer carries out pre-deployment checks on Compatt 6 transponders. Compatts were placed in flotation collars on three of the existing structures (the FLET, the Tamar #3 well and also an umbilical termination unit), such that the positioning array could be set relative to the structures. A further three Compatts were also placed on the seabed. The use of 'stabs' allows inclinometer-equipped Compatts to be quickly and accurately aligned when mounting them on structure during metrologies. A work class ROV operated by Delta Subsea was used to deploy the Compatts and also the seabed markers. The shape and extent of the array of transponders had to be considered to ensure that there is line of sight between each unit and also to ensure that the required positioning accuracy can be achieved.

in September 2016 and the metrology observations were conducted in February 2017. The well was drilled by the *Atwood Advantage* between October 2016 and January 2017.

For the installation of the markers, an array of six Compatt 6 LBL transponders was deployed by ROV; three on existing structures to provide 'known' coordinates, and three directly on the seabed.

The array was then calibrated, a multi-stage process that includes measuring the local sound speed and determining the relative spatial relationship between the Compatts by measuring the ranges between each unit. The maximum standard deviation of the ranges was 0.004 m, with the standard deviation generally being at the 1 or 2 mm level. The ranges were then used in conjunction with the known coordinates of the Compatts on the existing structures to perform a least squares adjustment of the array network to determine the final station coordinates, with the final array Route Mean Square (RMS) of the adjustment being 0.018 m.

The ultimate conclusion to the overall campaign was provided by Noble Energy when, on April 5, 2017, it reported that the jumper had been installed at the seabed and that it had, "fitted like a glove."

Once the array coordinates were confirmed, an LBL transceiver on the ROV was used to help guide the vehicle to the intended wellhead position and to place the four markers around the intended wellhead position. Once each marker was set down, an average position fix of 60 samples was recorded. The average coordinate standard deviation was less than 3 cm while the average RMS value for the range residuals was less than 2 cm, showing a highly accurate relative position fix.

Metrology campaign

For the second phase of the works, the metrology observations, Compatts equipped with inclinometers were installed on the two hub caps and four standard Compatts were installed in small tripods around the jumper route to provide a geometrically stable network adjustment.

In order to maximize the accuracy of the pitch and roll readings at each hub, the inclinometer Compatts were first set up with the forward line pointing towards structure 'north' on each structure and then rotated through 90° steps with pitch, roll and acoustic range data being recorded at each step.

The process was used to eliminate any residual alignment errors while the recording of five sets of acoustic ranges between all Compatts, established a high confidence level in the horizontal distance between the two hubs. In order to establish the vertical distances between the hubs, a digiquartz depth sensor was used to observe accurate depths at each hub and also at each of the Compatts. The depth surveys were started and stopped at the same station, to allow a 'Bowditch' adjustment to be performed on the depth data similar to that applied to land based level surveys.

Fitted like a glove

The final results of the metrology survey were presented to Noble Energy on completion of the subsea campaign. The surveyors then proceeded to Haifa to assist with the dimensional control of the fabrication of the jumper, ensuring that the as-built shape of the spool matched the configuration dictated by the metrology results.

The positioning and metrology requirements for the Tamar #8 well development presented several challenges for the survey team that included complex logistics, ultra deep water operations, high accuracy subsea spatial measurements and detailed 3-dimensional computations.

The ultimate conclusion to the overall campaign was provided by Noble Energy when, on April 5, 2017, it reported that the jumper had been installed on the seabed and that it had, ''fitted like a glove.''

If you're planning your next LBL campaign, why not get in touch with our Survey Support Group for free advice, including transponder array planning?

Originally published in the Journal of Ocean Technology (2017, V12N3). Reprinted with permission.

Once the array coordinates were confirmed, Fusion was used to navigate the ROV to the intended wellhead position and to position the four markers around the intended wellhead position.

Technology

Trials Report Part 2: Long range LMF acoustic communications

DEEP WATER TRIALS SHOWCASE LMF FOR TELEMETRY

In the last issue of Baseline, we reported on trials performed off California to demonstrate the impressive tracking performance of our Lower Medium Frequency (LMF) Ranger 2 Ultra-Short BaseLine (USBL) system. **Ed Ceurstemont**, Subsea Product Development Team Leader, led the trial in which tracking was reliably maintained at slant ranges beyond 11 kilometres. We pick the story back up last November when Ed journeyed to the Spanish island of Tenerife – this time to characterise the long range data telemetry performance of the same system. **>>**

Technology

Trials Report Part 2: Long range LMF acoustic communications

AS A LOCATION to conduct trials of marine technology and science platforms, Tenerife and California share at least one thing in common; the ability to access to very deep water, very quickly from within a short transit from port. So it's no surprise that the UK's National Oceanography Centre (NOC) regularly choose the island to conduct routine equipment tests from.

RRS James Cook – a model vessel

Hosting us for the latest round of our LMF USBL experiments, was the Royal Research Ship *RRS James Cook*. Although the ship celebrated its 10th birthday in 2016, it is still among the most modern research ships currently in service and has been used as a model for many other ocean-going research ships, including several used by Chinese institutes.

Our Medium Frequency (MF) USBL systems are popular for tracking targets and dynamically positioning a vessel in a few hundred metres down to a few thousand. However, when you need to reach full ocean depth or track a towfish over a very long layback, a common need of the ocean science community, then it's time to consider LMF.

Outwardly, an LMF Ranger 2 USBL is similar to an MF system. But instead of operating in the 19 to 34 kHz frequency range, the vessel-mounted transceiver and transponder hardware is built to work from around 14 to 19.5 kHz. This subtle shift halves absorption by the water path, meaning acoustic signals travel further. It can also mean the system is more susceptible to noise interference from the vessel itself. But, as these trials would go on to show, the gain in received signal as a consequence of less absorption, more than compensates for additional vessel noise in the LMF band.

For maximum operational flexibility, the *RRS James Cook* is permanently fitted with our MF HPT 5000 and HPT 7000 transceivers on her twin USBL spars. This setup presented us with the ideal opportunity to temporarily swap out the HPT 7000 unit with the LMF variant (HPT 7000L) in order to compare it with MF performance in near identical conditions and configuration. The one caveat to this being HPT 5000 has a smaller array giving a wider beamwidth with less noise rejection.

With the HPT 7000L fitted, a calibration procedure to correct for lever arms and installation offsets was conducted using an omni-directional Compatt 6 transponder deployed to a depth of 4,400 metres. This produced a calculated slant range error of 0.14% (1 DRMS) – similar to the 0.12% achieved during our Californian trial.
In practical terms, this means that when tracking a target 11,000 metres away, 66% of position fixes should be within 15.4 metres.

With the system calibrated and noise measurements made, a series of tests were carried out with the ship steaming away from the Compatt on different courses in order to average out the impacts of environmental conditions. Analysis of these runs again echoed previous trials data with consistent tracking achieved out to a slant range in excess of 11,000 metres. Switching to a Compatt with a higher power directional transducer would yield even greater ranges.

> "These results once again underline the impressive capability of our LMF Ranger 2 USBL to meet the challening requirements of ocean explorers and researchers"

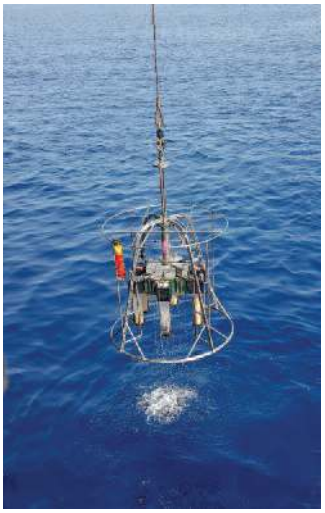
Telemetry schemes

The next test involved putting LMF through its telemetry paces over two slant ranges of 4,300 and 7,200 metres to a LMF Compatt 6 which was fitted with a directional transducer.

Our 6G (Sixth Generation) family of instruments support seven data rate telemetry schemes, ranging from 200 bps up to a nominal maximum of 9,000 bps. All support transmission of the different telemetry schemes however only multi-element platforms, such as our USBL transceivers, support two of the most robust, high-speed telemetry schemes of 3,000 and 6,000 bps due to their enhanced encoding. See sidebar opposite for an in depth explanation.

Actual rates achievable are dependent on configuring the delays

The tests set out to verify the performance of Ranger 2 LMF when uploading data at varying elevations and data rates. (Left) The equipment used included a deep rated Compatt 6 and Wideband Mini-Transponder (WMT). (Centre) Ranger 2 is a key enabler for NOC allowing them to track sensor packages in deep water. (Right) A HPT 7000L attached to one of the vessel's twin through-hull deployment poles.



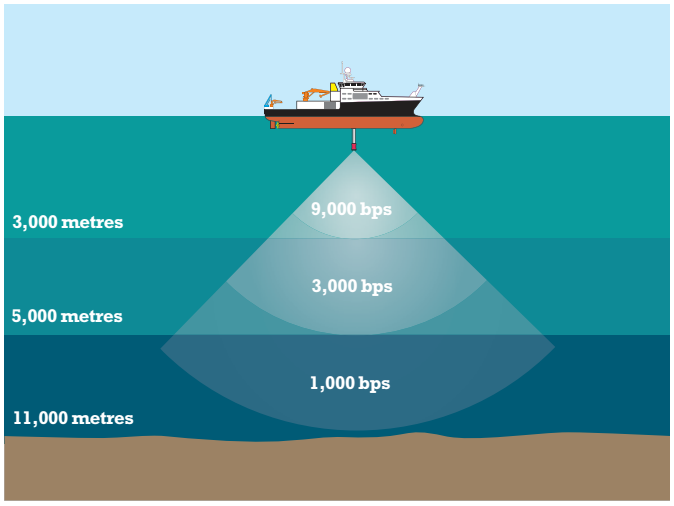
between packets to minimise errors and consequent retries, which in turn reduce real-world data-rates. The tests were carried out with a default set of delays which are normally used to allow the remote modem time to buffer external data using our different schemes. Actual data rates (including re-tries) were observed in excess of 5,000 bps over a slant range of 4,300 metres at 8 millijoules per bit, and in excess of 2,000 bps over a slant range of 7,200 metres at 17 millijoules per bit.

These results serve to underline how Ranger 2's impressive 'out-of-the-box' positioning and telemetry performance in the MF band reaches new levels of capability when switching to LMF. For anyone taking on the challenges of the deep ocean, LMF is a key enabler for their vessels and has the flexibility to meet their precise in-water and near-bottom sustained observation needs.

This is because LMF not only supports control of deep AUVs and long range towfish tracking, but as these trials have shown, is also highly efficient at harvesting data from a wide range of compatible Sonardyne 6G LMF long-life seabed instruments, LMF telemetry therefore unlocks the full potential of these systems by enabling access to the critical data that they are capable of collecting over deployments, which can be several years' long. **BL**

Rate	Theoretical maximum bit rate	Rate achieved during test 1 (4,300 m)	Energy per bit in millijoules (4,300m)	Rate achieved during test 2 (7,200 m)	Energy per bit in millijoules (7,200 m)
200bps	192	154	260	154	260
400bps	352	282	142	256	156
900bps	737	579	69	535	75
3,000bps	3003	2765	14	2259	18
3,500bps	3281	3021	13	2384	17
6,000bps	6007	3686	11	1327	30
9,000bps	9121	5150	8	–	–

Seven different data rates were tested – two of which are only available on multi element receivers such as the HPT 7000L as used in this trial. The actual rate achieved from end to end after the retries excludes travel time of the link.



EXPERT VIEW

Why communicate acoustically?

Communicating reliably at range and at high data rates in all subsea environments is challenging. One only has to look at the diverse range of technologies and methodologies applied to the problem over the last 20 years – from acoustics, to optics to near-field, quasi-field and far-field electromagnetics (EM) – to gain appreciation of the challenge. If you scratch beneath the surface of each of these disparate approaches, several important facts emerge.

- **There is presently no subsea technology concurrently capable of through water, high data rate and long range**
- **Each technology has a finite, overlapping, range-data rate performance envelope, limited by the respective physics of each bearer**
- **Acoustics naturally complements other technologies, notably optics and near-field EM, in providing broadest range-data rate coverage**
- **Hybrid acoustic-optic and acoustic-EM systems provide widest 'coverage' of the range-data rate space**
- **All technologies have a range-data rate trade-off**
- **Care needs to be taken when interpreting range-data rate performance figures to ensure system configuration and environmental conditions are comparable**
- **Looking beyond overlapping technologies, acoustics emerges as the only currently viable technology to perform beyond a few hundred metres range**

Acoustic Range-Data Rate Envelope

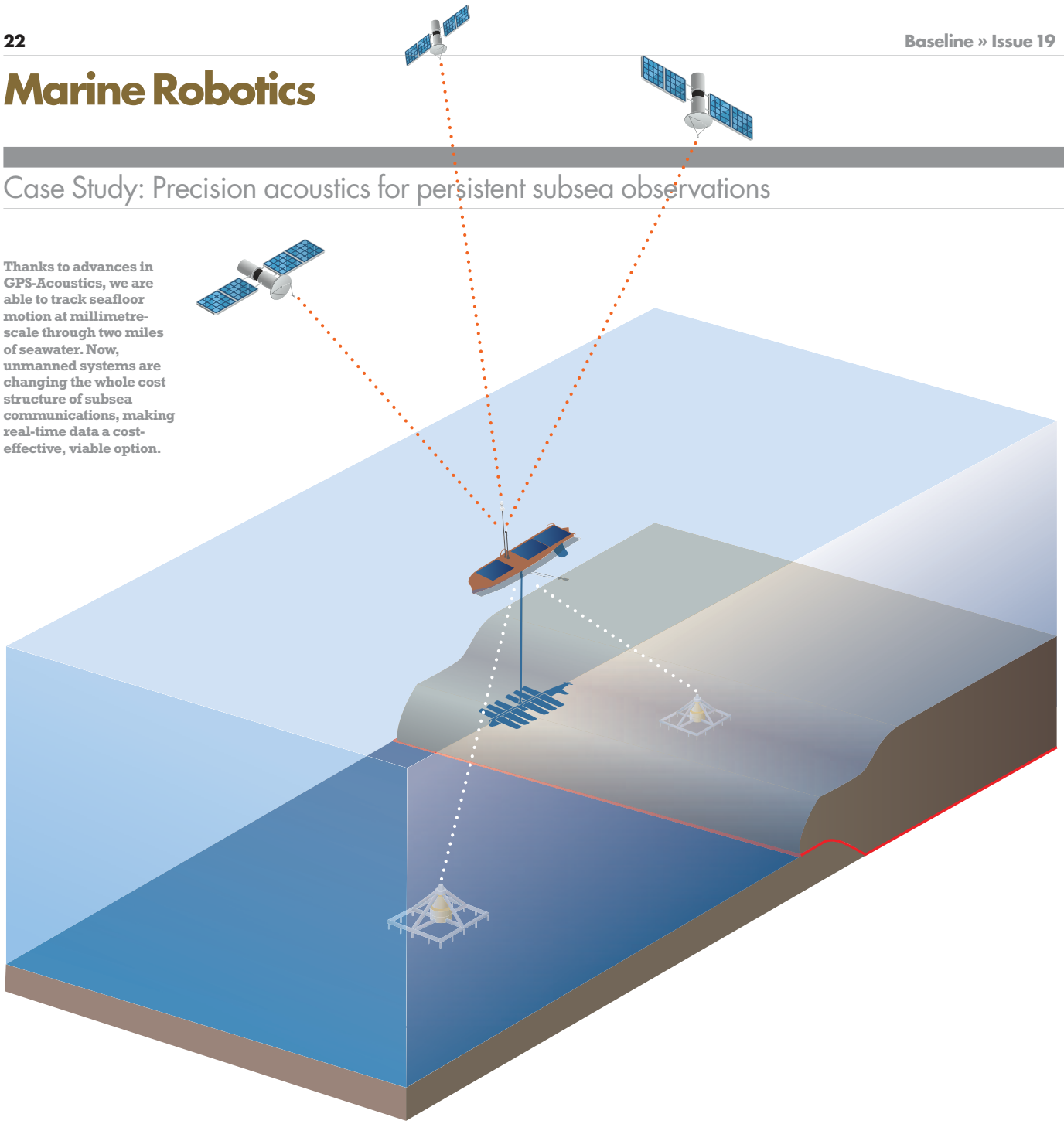
Communicating reliably over a subset of the acoustic range-data rate envelope is challenging by virtue of the complex nature of the acoustic communications channel. Consequently a wide range of techniques have been adopted to try to maximise range-data rate product in acoustic communication systems, involving different array designs and configurations, different modulation/ equalisation schemes, and various channel coding schemes.

Our LMF band extends from 14-19.5 kHz and provides a range-data rate capability of between 200 bps – 9,000 bps up to ranges well in excess of 11 kilometres under favourable conditions using a variety of methods to balance performance against robustness. Whilst the technology can generally be scaled to lower or higher frequency to increase range or increase data rate respectively, the current LMF and MF bands adopted meet the majority of users' requirements.

In the next issue of Baseline, we'll be looking more at this subject, including a comparison of acoustic vs. optical vs. electromagnetic and what the future may hold.

Marine Robotics

Case Study: Precision acoustics for persistent subsea observations



Thanks to advances in GPS-Acoustics, we are able to track seafloor motion at millimetre-scale through two miles of seawater. Now, unmanned systems are changing the whole cost structure of subsea communications, making real-time data a cost-effective, viable option.

GPS-Acoustics unlock a new approach to seabed geodetics

Autonomous and unmanned marine platforms are transforming the way in which we acquire and analyse data from our oceans. **Sean Halpin**, Senior Director, Global Business Development and **Leigh Martin**, Senior Marketing Programs Manager with Liquid Robotics, a Boeing company, take a closer look at seafloor geodesy, an emerging scientific field that is making the real-time study of continental plate tectonics a cost-effective and viable option. **>>**

Seafloor geodesy projects are underway across the globe, all in pursuit of scientific advances that will help us crack the code on earthquake and tsunami risk.

What is the shared goal? To better understand earthquakes, tectonic processes and tsunami hazards, and ultimately save lives. In addition, the technology is being applied within the offshore oil and gas industry to mitigate risk through better ongoing surveillance during the producing life of a field.

But how can you track seafloor and oilfield infrastructure movement at minute scale resolution through two miles of seawater and deliver the results straight to an analyst's desk anywhere in the world?

The satellite-based GPS and laser methods used on land don't work in the ocean, so researchers are turning to a technique that's referred to as GPS-Acoustics (GPS-A). While it's possible to do these surveys using a vessel, to make GPS-A measurements cost-effective, unmanned surface vehicles like the Liquid Robotics Wave Glider and long endurance Sonardyne surveillance technology offer a solution.

GPS-A

Instruments such as Sonardyne's Autonomous Monitoring Transponder (AMT) are designed to autonomously and precisely measure horizontal and vertical displacement using thousands of range (distance between pairs of transponders), pressure (depth), sound velocity, and inclination measurements. Each unit runs a fully automatic data gathering and logging regime and can remain continuously deployed for up to10 years.

Operating at the surface, the wave and solar powered Wave Glider can be used to precisely position each AMT in depths exceeding 5,000 metres. By returning to the location on a regular basis, the absolute change in position of each AMT can be measured with millimetric accuracy to reveal their movement due to plate tectonic action. When required, it also serves as a robust communications gateway – acoustically harvesting the data logged inside each unit and transmitting it to shore in real-time.

Seafloor geodesy projects are underway across the globe, all in pursuit of scientific advances that will help us crack the code on earthquake and tsunami risk. (Top) The Cascadia Subduction Zone in the Pacific Northwest; (middle) monitoring seafloor deformation off the shore of Sumatra; (bottom) off the coast of northern Chile, where some of the most powerful earthquakes on the planet originate.

"In the future, as we think about other seafloor geodesy projects in remote places, these would not be possible without the Wave Glider."

Wave Glider payload

Sonardyne's GPS-A module, carried in the hull of the Wave Glider, takes advantage of developments within low power electronics to provide a data acquisition, processing and seafloor-to-surface-to-shore link.

Inside is a dual core processor mounted onto a custom designed interface board which brings together survey-grade accuracy GPS, MEMS-based pitch, roll and heading in addition to GPS-derived heading. The tight coupling of these sensors, combined with Sonardyne's 6G wideband acoustics and the ability to feed in additional external inputs, delivers the capability – after post-processing – to detect the smallest of movements in a fault line or structure.

Orbital path correction

To be able to accurately position a subsea transponder, you must first be able to accurately position the unmanned surface vessel. So during a mission, the Wave Glider GPS-A payload records GPS logs in Receiver Independent Exchange (RINEX) format; a data interchange format for raw satellite navigation system data. This is a critical and unique part of the system's ability to achieve millimetric precision.

By taking the GPS RINEX files and post processing this data with the corrected orbital paths of the GPS satellites themselves, it is possible to reduce the RMS (Root Mean Square) of the positioning by up to 30 times compared to typical GPS receiver accuracy.

Figure 1, overleaf, shows an Easting and Northing position scatter plot for an unmanned surface platform before (blue) and after (red) GPS-A post processing. The data was captured during a trial at Sonardyne's research facility in Plymouth.

Similarly in Figure 2, the plot shows a surface height comparison over a complete tidal cycle. Once again, the data in blue is the raw observations, whilst the data in red is the RINEX post processed results.

With these advances in technology, seafloor geodesy projects have sprung up around the world, in particular around the Ring of Fire in the Pacific basin where some of the most powerful earthquakes originate.

The Cascadia Subduction Zone

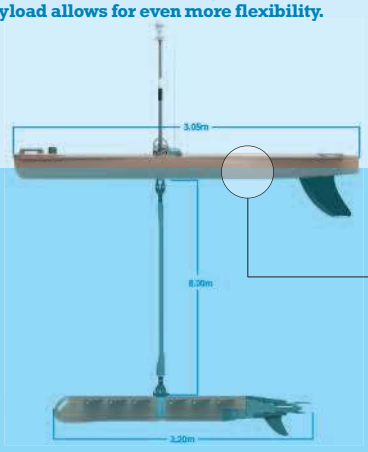
Dr. David Chadwell of Scripps Institute of Oceanography is working with the United

Marine Robotics

Case Study: Precision acoustics for persistent subsea observations

Autonomous future

The Wave Glider platform has been well proven over the last 11 years. Sonardyne has been integrated with their systems since 2010 for acoustic data harvesting. The new GPS-A payload allows for even more flexibility.



Know where you are

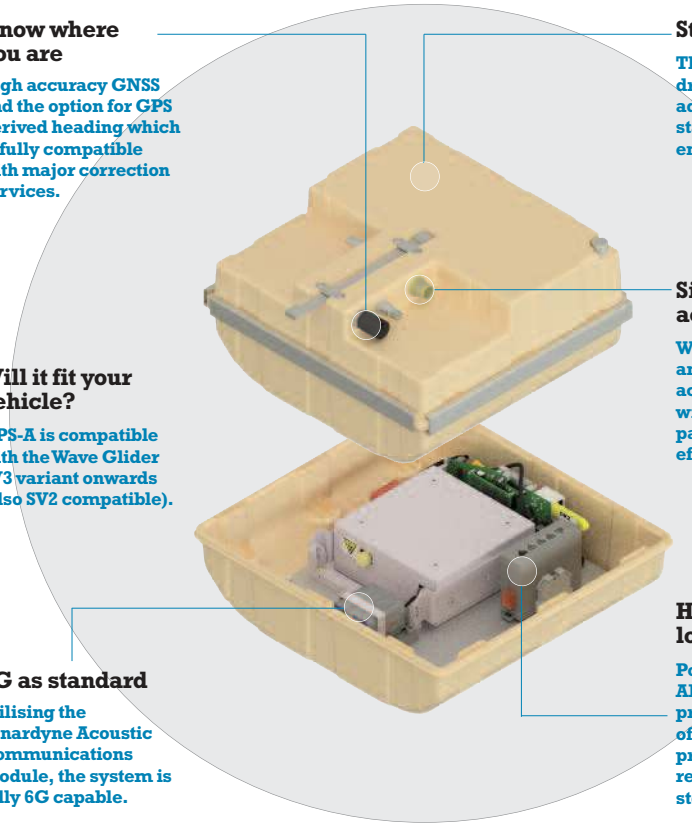
High accuracy GNSS and the option for GPS derived heading which is fully compatible with major correction services.

Will it fit your vehicle?

GPS-A is compatible with the Wave Glider SV3 variant onwards (also SV2 compatible).

6G as standard

Utilising the Sonardyne Acoustic Communications Module, the system is fully 6G capable.



Standard fitting

The GPS-A module drybox takes advantage of the standard 3MPU LRI enclosure.

Simple data access

With both Ethernet and Wi-Fi onboard, accessing system data without opening the payload is both efficient and simple.

High performance, low power computing

Powered by a dual core ARM A7 + single core M4 processor provides plenty of grunt for onboard processing with dual redundant 128GB of data storage.

States Geological Survey (USGS) to better understand the Cascadia Subduction Zone in order to better predict when a major event is more likely to occur.

After selecting Sonardyne's Fetch instrument (functionally equivalent to the AMT, but with a much bigger battery that enables deployments of up to 10 years) for the seabed component of the study and validating their abilities using a research vessel, Dr. Chadwell was looking for a more cost-effective platform to collect their data. His original plan was to use a diesel-powered buoy but he soon recognised the mobility and longevity advantages the Wave Gliders could offer. Dr. Chadwell has also been recognised by further funding to extend this seafloor geodesy research north to the Aleutian Islands.

The Mentawai Seismic Gap

At the Earth Observatory of Singapore, Dr. Sylvain Barbot, Dr. Emma Hill, and Dr. Sharadha Sathiakumar are working to better understand seismic hazards in Indonesia.

The 2004 Sumatra earthquake and tsunami triggered a series of earthquakes along the Sunda subduction zone. The Mentawai seismic gap is one of the remaining regions that did not experience a large earthquake in the last decade.

An extensive land-based network for geodetic measurements has been installed on islands along the fault line, but there are gaps offshore that prevent understanding tsunami generation dynamics. Seafloor geodesy can fill that observation gap.

Here, researchers are also equipping Wave Gliders with GPS-A technology to monitor seafloor deformation off the coast of Sumatra. An unmanned platform is essential, as regular surveys using research vessels are just too expensive. The ultimate goal is to move towards persistent ocean laboratories (or towards extensive offshore geodetic networks) that can cover a large spatial footprint and build a multi-decade time-series of data on seafloor deformation

Nazca-South American Plate Boundary

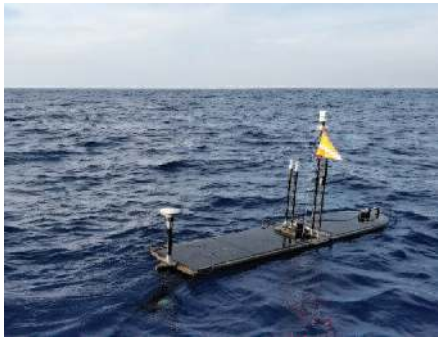
Off the coast of northern Chile, where some of the most powerful earthquakes on the planet originate, scientists from GEOMAR Helmholtz Centre for Ocean Research Kiel have installed a seafloor geodetic network called GeoSEA (Geodetic Earthquake Observatory on the SEAfloor) at depths ranging from 2,600 – 6,000 metres. In this case, rather than using absolute GPS-A measurements, the relative movement of the AMTs to each other is measured using the on-board pressure sensors and acoustic ranging between the AMTs. Once installed, the next challenge was how to retrieve the seafloor data frequently and cost-effectively.

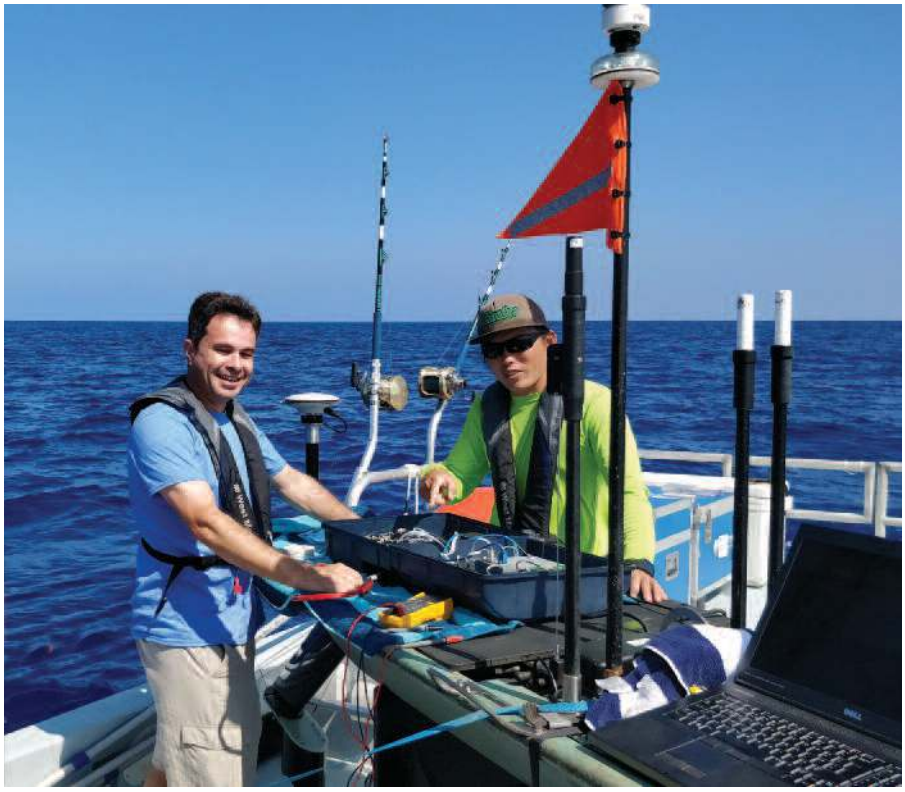
As reported in Issue 18 of Baseline, the GeoSEA network consists of AMTs installed in three areas along the Nazca-South American plate boundary, an area identified to be in the latest stage of the seismic cycle. The other key component of the network is a GPS-A equipped Wave Glider.

Operating autonomously at the surface, the vehicle holds position above the seafloor stations, monitors system health, uploads data from the seafloor node, and transfers it back to shore via satellite - allowing the research vessel to focus on other more valuable tasks.

Dr. Heidrun Kopp, Chief Scientist at GEOMAR, said retrieving data with a Wave Glider was an important first step to proving the capability of the network. ''In the future, as we think about other seafloor geodesy projects in remote places, these would not be possible without the Wave Glider.''

Integration trials were conducted at Liquid Robotics' research facility in Hawaii. Water depths quickly reach several thousand feet, providing a real test for seafloor technology.





Creeping pipelines

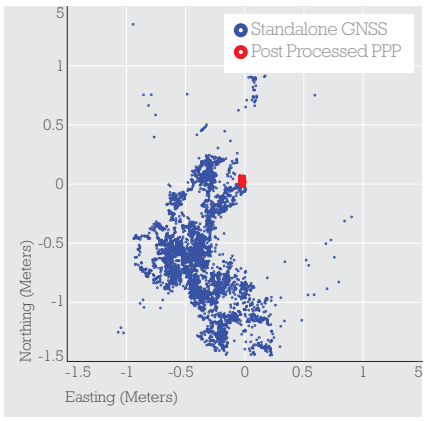
GPS-A is also being applied to oilfield asset monitoring. For example, if a pipeline is suspected of creeping due to axial strain, the survey choices are somewhat limited. You can send out a vessel of opportunity then launch an ROV to visually observe and measure the creep. However, it's not cost-effective or practical to do this very often because it can cost $1-$2 million alone just to get to the location. Alternatively, it can be monitored with data loggers, but until the data is downloaded, it's impossible to know what is really going on.

Instead, imagine using AMTs deployed on and near the pipe communicating with a GPS-A Wave Glider patrolling above, enabling asset teams thousands of miles away to be alerted to movement in real-time.

Reimagining ocean monitoring

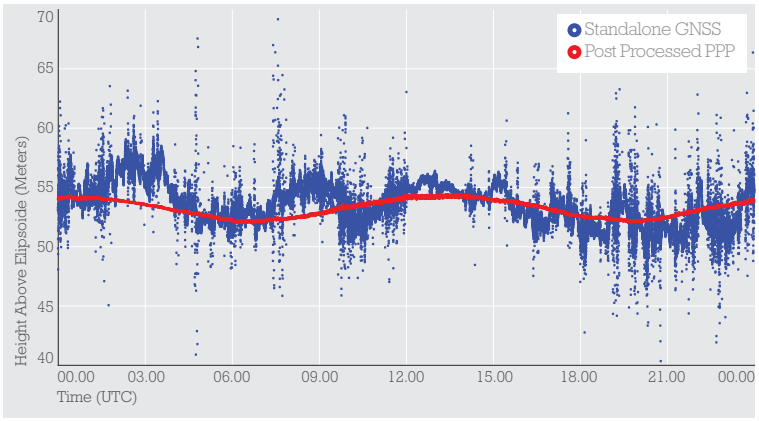
Gathering seabed geodetic data is difficult, slow, expensive and not without risk to the people sent out to get the job done. With long endurance instruments, such as Sonardyne's Ambient-Zero-Ambiuent (AZA), which overcomes the inherent problem of pressure sensor drift, and a Wave Glider at the surface to position the transponders and transmit the data, there is now a viable alternative that provides near real-time awareness of plate tectonic activity.

The impact of the technologies developed by Sonardyne and Liquid Robotics goes far beyond simply providing a cost-effective alternative to crewed vessels, as researchers pursue breakthroughs in earthquake and tsunami early warning systems that may ultimately save lives. These solutions are proven and ready for deployment today, so if you're working on a seafloor geodesy, asset monitoring or subsea communications gateway project, get in touch with our organisation at: **www.liquid-robotics.com**



(Left) Figure 1 Easting and Northing position scatter plot for an unmanned surface platform before (blue) and after (red) GPS-A post processing.

(Right) Figure 2 Surface height comparison over a complete tidal cycle. Data in blue are the raw observations, data in red is the RINEX post



Marine Robotics

Technology: Engineering Integration Service

JOINED-UP THINKING HELPS YOUR ROBOTS TO GET TO WORK FASTER

Remote, resident, autonomous or hybrid. Whichever type of marine robotic system you operate, its value can be enhanced by using our instruments to track, navigate, control and retrieve data from it. Step one is configuring the instrument work with your platform – a task that's fully supported by the teams delivering our Engineering Integration Service. **Ioseba Tena**, Global Business Manager at Sonardyne, explains more and takes a closer look at a recent project involving the leading manufacturer of electrical ROVs Saab Seaeye. **>>**

There are many questions that need answering when integrating technology on robots.

ANYBODY INVOLVED IN this industry knows that, if not done with care, integrating a subsea instrument into a robot can be time consuming, frustrating and error prone. There are so many questions that need answering. How much space is available? What's the weight budget? What connectors are used? What about power? What command and interfaces are needed? And these are just the basics. Almost every decision you make has the potential to prolong the time spent with the robot in the workshop and not in the ocean where it's supposed to be.

Lessons learnt

Over the many years we've been helping organisations integrate our instruments into their ocean robots, we've learnt many lessons and constantly strive to make the process of integration as easy as possible. The common takeaway message from these projects is simple; view the process as a vital undertaking and don't wait until you start to unpack your new equipment.

As a technology developer, we fully recognise we have to start the conversation with you about integration as early as possible. That's why we've introduced our Engineering Integration Service – a tiered support process to ensure you are up and running in double quick time.

So what does the service include? In simple terms, time and knowledge. The more complex the product, the more time and knowledge we offer. The process starts with a detailed view of the technology you've just invested in - covering everything from communications protocols to available interfaces and suggesting the most suitable development tools such as simulators and sample code. This is often presented as part of a technical workshop with our engineers sat face-to-face with yours to work out the best way to install and commission the instrument, whether it's separate instruments such sonar, INS, DVL, modem - or a combined acoustic inertial hybrid navigation system.

To make sure you get the answers you need, when you need them, you'll be assigned a lead engineer who will guide you through extracting the best possible performance. And after the initial integration and testing is carried out, they'll be available for any support or trouble-shooting that may be required.

Let's take a closer look at one recent case study with vehicle manufacturer Saab Seaeye.

NASA's Neutral Buoyance Lab

Our two organisations have a long track record of working together. In November 2015, for example, we were both invited to NASA's Neutral Buoyance Lab (NBL) in Houston, for two days of live in-water marine robotics demonstrations.

The Seaeye Sabretooth used our 6G acoustics and BlueComm optical model to wirelessly navigate, harvest data and communicate with the surface. Many of the technical achievements were world firsts. Baseline Issue 15 has the full story.

What that event showed was the value of teams working closely to develop a good understanding for a mutually beneficial outcome. Recently we were approached by Saab Seaeye again, this time to work with their Leopard Work-class ROV.

Leopard ROV

Although very compact, the Leopard is an exceptionally powerful electric ROV. It produces an impressive half tonne of forward thrust and can carry over 200 kilogrammes of payload down to 3,000 metres. Fit it with heavy duty manipulators, and it's ready to face tasks normally associated with hydraulic Work-Class ROVs like drill support, pipeline survey, salvage and deep water Inspection, Repair and Maintenance (IRM).

So how can you get more value from the Leopard? By integrating an instrument that enhances its existing capabilities – SPRINT-Nav, our hybrid acoustic and inertial navigation platform.

Hybrid navigation for a hybrid vehicle

SPRINT-Nav combines our SPRINT inertial sensor, Syrinx 600 kHz Doppler Velocity Log (DVL) and high accuracy intelligent pressure sensor in a single housing. Like the Seaeye Leopard, it's also compact, and clever. It can output raw data direct to the ROV control unit or it can output survey quality INS data to a survey team or it can do both at the same time. This means that vehicles like the Leopard can get position,

> "Sonardyne were attentive, provided great advice and were on call to support us with post-integration questions."

depth, orientation, velocity and associated rates in real-time and use that information to enable advanced control techniques like station-keeping, waypoint following or cruise modes.

So having decided to equip the Leopard with SPRINT-Nav, earlier this year Saab Seaeye took advantage of our integration service. Sonardyne Engineering Manager, Malik Chibah, recalls that two project teams quickly made progress thanks to the SPRINT-Nav integration development kit and Leopard's digital architecture. "The iCON™ intelligent control system fitted to the vehicle is known for its enhanced user interface and it provides a simple network architecture. The combination of SPRINT-Nav's vehicle optimised interfaces and our engineers on-site, made the process of integration with iCON uncomplicated and fast."

And Saab Seaeye's take on it? "It was great working with the Sonardyne team on this project. They were able to provide the right level of expertise at the right time. We worked with them to ensure that the integration service worked with our schedule," Stephen Wells project manager at Saab Seaeye explains. "This was an important project to us. We wanted to show the industry that Leopard can behave like a conventional AUV without all the navigation complexity associated with a conventional AUV. SPRINT-Nav delivered. Sonardyne were attentive, provided great advice and were on call to support us with post-integration questions. This is great when you are dealing with ring laser gyros, Doppler effects and other complex physics. Subsea engineering may not be rocket science, but we are very close." **BL**

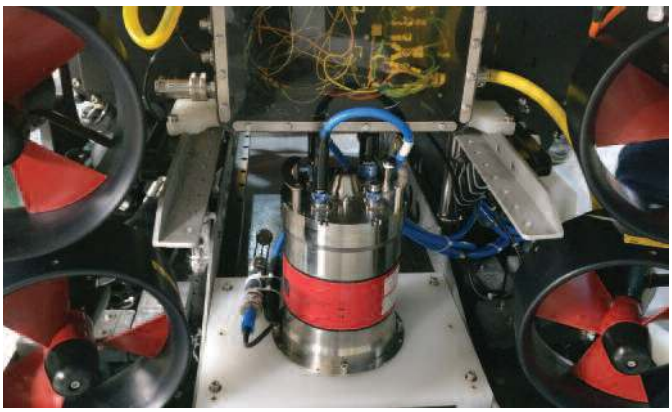
Interested in finding out more? Contact your local Sonardyne sales office or drop me an email: ioseba.tena@sonardyne.com and let's get your Sonardyne-enabled robot into the water and working.

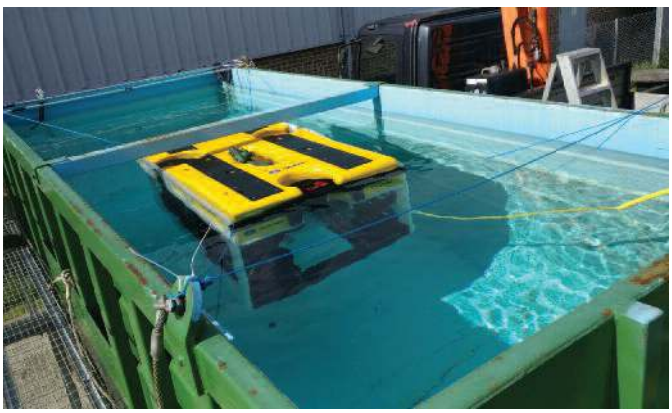
The level of support we provide varies with the sophistication of instrument we're helping you to integrate. Here's a few examples for standard products. And remember, you should only need the service to support your first installation. Thereafter, your team will have the knowledge they need to go solo.

Product	Integration Service Level	No of Days Included
Nano AvTrak 6*	Band A	2
AvTrak 6*	Band A	2
Syrinx DVL*	Band A	2
iHPT	Band B	3
Ranger 2 for a USV	Band B	3
SPRINT*	Band C	5

*Standard or OEM

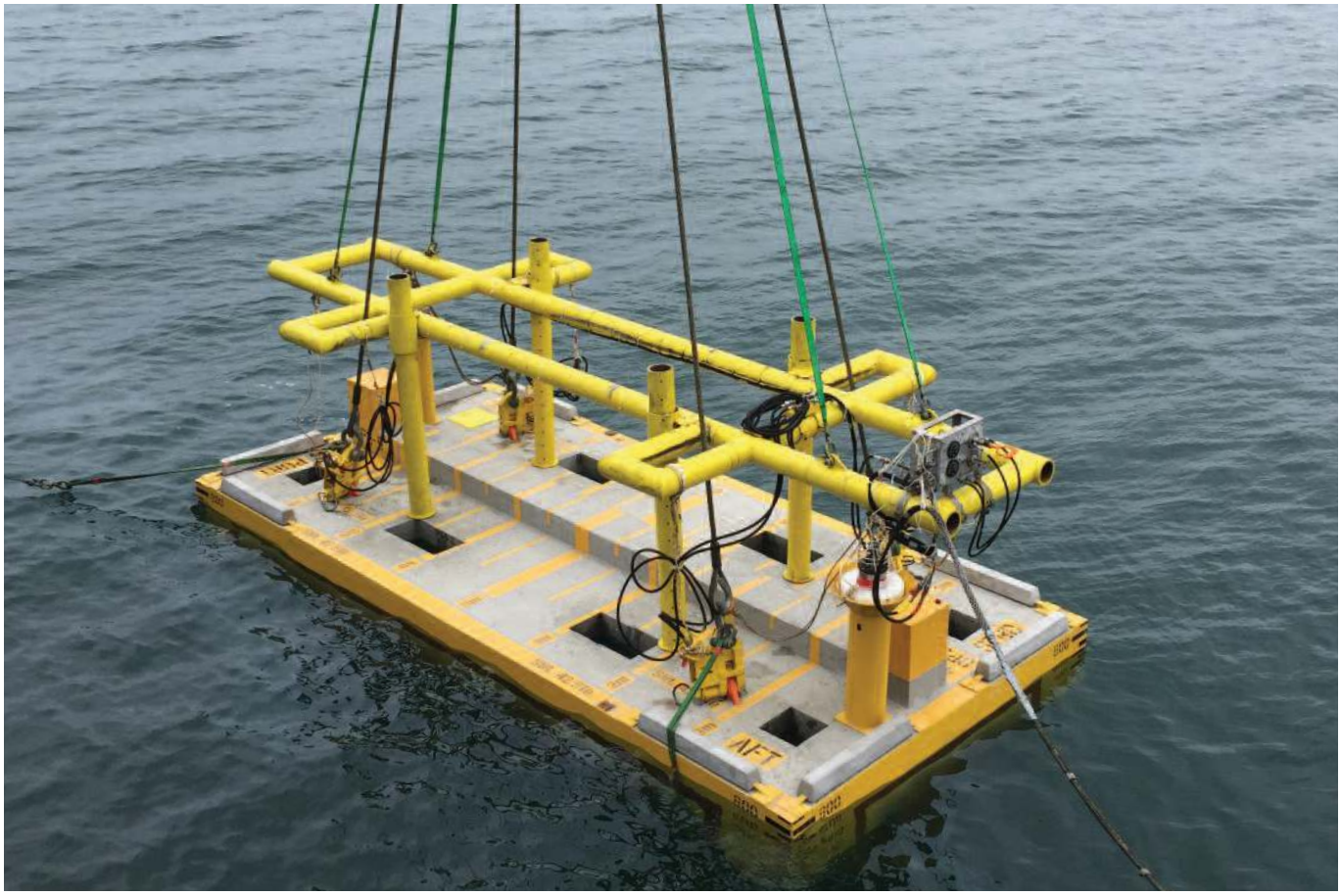
Dynamic tests were carried out in a 270 metre long towing tank, the largest in the UK and is one of the most capable in the world.





Construction Survey

Case Study: Shallow water structure installation



One of 75 Crossing Support Structures is lowered into position. Each of the 11 metre long, 5 metre wide, 2.2 metre tall structures weighed over 65 tonnes, was equipped with two GyroCompatt transponders to provide high update high update rate attitude, heading, heave, surge, sway and positioning.

Wideband technology shines for LIGHTHOUSE in the Caspian Sea

Recently, geophysical and construction support company, LIGHTHOUSE, was contracted to provide underwater positioning for the installation of pipeline crossing support structures (CSS) in the southern Caspian Sea. The project posed a few challenges such as shallow water turbidity causing poor visibility for ROV operation, and 'acoustic congestion' in the water column created by multiple vessels working close to each other. To overcome these challenges, the experienced team at LIGHTHOUSE turned to 6G and Wideband 2. **>>**

In large scale offshore field developments, it is somewhat inevitable that, at some point, the need will arise to lay production pipelines or control umbilicals over the top of existing seabed infrastructure.

Crossing Support Structures

To prevent the new pipeline or umbilical damaging the existing pipeline at the point the two cross, either from weight or lateral strain, project specifications routinely call for the installation of Crossing Support Structures – CSS. Usually constructed from cast concrete, CSSs are laid on the seabed parallel to the existing pipeline to enable the new pipeline to be 'draped' over the top without ever coming into direct contact with the existing asset underneath. Additional structural integrity can be offered by laying multiple CSSs either side of a pipeline at staggered heights so that the new pipeline is evenly supported as it rises off the seabed, free spans the existing pipeline, and touches back down on the other side.

Challenging acoustic environment

When LIGHTHOUSE was granted its first project in 2012 to reinforce offshore projects in the Caspian Sea, the company realised the problems it would face when providing underwater positioning due to the complex acoustic environment and shallow water.

The salt content of the Caspian Sea varies considerably with the northern part having less salt than the southern part of the sea. The average salinity is 13g/ litre, one third of the world's oceans salinity. These factors make the Caspian Sea a challenging environment to conduct underwater installation for the offshore oil industry.

Drawing on the company's experience, LIGHTHOUSE chose to invest in Fusion 6G; our sixth generation Long BaseLine (LBL) technology platform. Fusion 6G is the net result of nearly four decades of LBL experience. Over this time, the development of 'best practice' techniques and proven computations deliver exceptional subsea positioning performance no matter how deep, how shallow or how complex the task is.

The precision of Fusion 6G far exceeds other surface installed positioning systems such as USBL. Field developments can be planned to the same specification in deep and shallow water, safe in the knowledge that the highly accurate Wideband 2 acoustic signals found inside 6G hardware such as Compatt 6 allow for the precise installation of subsea structures, ROV tracking and accurate acoustic metrologies.

For the CSS installation project, this precision would be put to the test as LIGHTHOUSE was required to install a total of 75 concrete structures within a few centimetres of three active pipelines, and all whilst working in just 14 metres of water.

Array planning

Planning for the operation began onshore with LIGHTHOUSE's in-house survey department using 3D simulation software to determine the location for each Compatt that would make up the seabed positioning network. This ensured that the geometry of the 16 Compatt array maximised the acoustic range redundancy. The array covered an area of 900 by 200 metres.

Line of sight alone cannot guarantee good LBL data. Sound velocity (SV) profiles should be acquired continuously to check the effect of the thermocline on the data so for this reason LIGHTHOUSE chose to equip each Compatt with integral SV sensors.

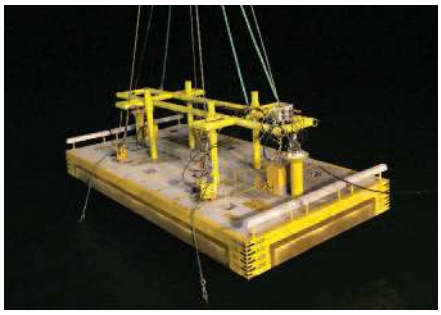
Offshore operations were scheduled to last one month and would be conducted from a moored crane barge. This was mobilised with the topside hardware needed to control and monitor the LBL campaign; a Data Fusion Engine, software and dunking transducer lowered over the side. Two Work-class ROVs fitted with ROVNav 6 LBL transceivers, provided visual touchdown monitoring.

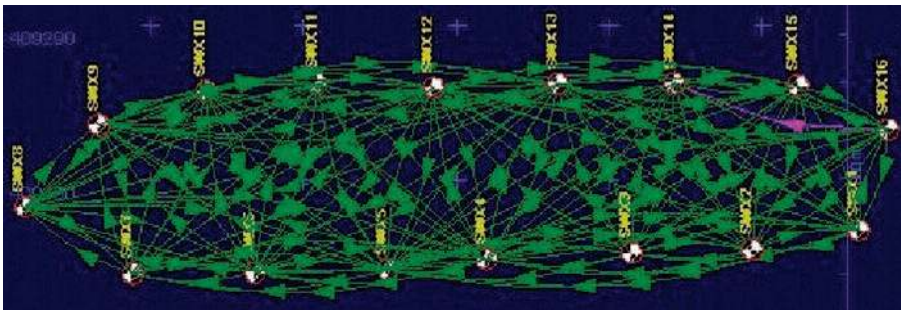
Each of the 11 metre long, 5 metre wide and 2.2 metre tall Crossing Support Structures needed to be landed within a few centimetres of each target location, and on a precise heading. To achieve this, two top specification GyroCompatt 6 transponders were installed on each CSS. These highly versatile instruments integrate an LBL transponder and ring laser gyro in the same subsea housing for structure heading, pitch and roll measurements.

As each CCS was lowered to the seabed, surveyors onboard the barge were able to track in real-time its position, heading and orientation; determining the exact moment to signal the lift team to land it. As-laid measurements were recorded prior to each GyroCompatt 6 being recovered by the ROV and returned to the surface for use on the next CSS. All structures were installed within the project specification of less than 0.5 metres.

Reflecting on the project, Enrico Sassi, General Manager at LIGHTHOUSE, said, ''None of the difficulties we expected to see on this job, such as signal multi-path from the salty, shallow water, materialised. This meant positioning operations were largely uninterrupted and the installation of all 75 pipeline crossing structures could proceed at such a pace, that we were able to move to the next project phase ahead of schedule. Our client was naturally pleased with the impact this had on the project's budget.

The LBL array was used for tracking the CSS during positioning, and proved to be a stable in a highly multipath environment.





International

News from our Regions Around the World

Europe, Africa, S. America

Barry Cairns Vice President

Pre-salt reservoirs

With the potential for foreign investment in the pre-salt reservoirs, expectations are raised for a large increase in activity in Brazil. Our permanent presence has allowed us to build some very strong relationships with our client base, and through these relationships we are assisting in plans for the next generation of field development.

6G technology has been field proven with clients around the globe. Now these same clients are working with major oil companies here to provide cost effective positioning and telemetry solutions to the country's deep water challenges. The Libra field licence round would be the first in Brazil for 15 years so is being met with much anticipation.

From our HQ in Macaé, we provide services from life-of-field planning down to instrument re-calibration. Gillyane Lobo has rejoined the team to provide direct support to the sales and operations team and enhance our customers' experience.

Aberdeen

2018 has begun positively with investment appearing in key markets. In Exploration, the new SST 6 transponder is being used for ocean bottom cable positioning; in Construction Survey, there's been a rush to equip ROVs with SPRINT and SPRINT-Nav systems and in DP – a market that's been quiet for a while - integrators are spec'ing Ranger 2 as their preferred acoustic reference. In Marine Robotics, the story's been all about OEM and how easy it is now for vehicle manufacturers to integrate our acoustics, modems, INS and DVLs. Turn back to page 26 to read about the work we've undertaken with Saab Seaeye.

Our technology workshops are a great way to enhance your team's understanding of what's possible with Sonardyne technology. They run regularly and are free – get in touch for upcoming dates.

North America

Simon Reeves Senior Vice President

2018 marks a significant anniversary for Sonardyne in North America as it's 30 years since we set up shop in Houston. A lot has happened in that time and we're hoping to share some of those memories with old friends and new ones throughout the year – with the highlight event being our annual open house and BBQ in October. We hope to see as many of you there as possible.

As Barry has also reported, over the last few months we've also seen an increase in SPRINT and SPRINT-Nav being specified by end users for their projects in the Gulf. Customers and clients are impressed by the cost benefit and improvements in efficiency from this leading inertial technology.

Lightning strikes twice

And proving that lighting does strike twice, Dan Zatezalo, was able to land another 'real'purchase order during an exhibition. It was from SES here in Houston for Micro-Ranger 2. Read more on page 13.

Ranger 2 Gyro USBL

The University of Washington recently purchased Ranger 2 GyroUSBL for the *RV Thomas G. Thompson*. The installation is an important upgrade for the ship which has just completed her 18-month mid-life refit. Adding the capability offered by GyroUSBL will further enhance the vessel's ability to support embarked science teams including major ROV systems like *Jason*.

Middle East, SE Asia

Anthony Gleeson Vice President

A Sentry Integrity Monitoring Sonar has just returned to base following a three month deployment in the region. The system has been developed to automatically warn of containment issues around subsea oil and gas assets. It's battery powered and can be deployed into a field for up to 12 months. It's available now for trials and demonstrations.

SPRINT-Nav and LBL

Simultaneous Location And Mapping training gets underway soon for a client who's looking to ensure their team have the know how to deliver the best solution in the quickest time possible to their end clients. Baseline 15 and Baseline 17 have articles worth reading on these techniques.

Our recent marine robotics capability webinar was well received with key partners from Australia, China, Indonesia, India, Singapore, South Korea, Thailand, and Japan dialling in. If you have a topic or technology you wish to know more about, let us know and we will work with our Global Business Managers and Survey Support team to put something together. It's a great way to get up to speed with developments without leaving your office.

As the Chinese New Year celebrations come to an end, over 50 clients and industry leaders attended our annual CNY Curry Night. It was particularly encouraging to see a level of optimism in the room, with everyone talking about current and future projects. Let's hope it continues this way.

THE KNOW HOW

Tips and advice from our product specialists.
Have a question for them?
Email **training@sonardyne.com**

Here's how to configure unusual GyroUSBL mounting angles in Ranger 2 and Marksman software

When a Gyro USBL transceiver is deployed in an unconventional arrangement, in this example, on the end of a stinger to support pipe lay operations, the orientation offsets need to be carefully determined by the software. It is particularly important to manually zero the 'Ship to Lodestar' corrections before applying the 'Tcvr to Ship' corrections – calculated by undertaking a CASIUS. The correct values then are automatically pushed into the 'Lodestar to Tcvr' boxes. Notice that the signs from the CASIUS reports change as one offset is going from 'Tcvr to Ship', whereas the other is going from 'Lodestar to Tcvr.'

Once the 'Lodestar to Tcvr' boxes are populated, and the stinger is deployed, it is important to run an AHRS calibration with the vessel AHRS sensors set as the reference, to compute the approximate alignment of the 'Ship to Lodestar'. This will then cause the 'Tcvr to Ship' values to update for the current mounting angle of the GyroUSBL. Notice that the 'Lodestar toTcvr' offsets remain unchanged.

Testing integrity of double O-ring seals using inter O-ring test ports on Type 8195 Data Loggers

Our data loggers gather potentially campaign-changing information about wells so as part of your pre-deployment checks, we recommend checking their integrity. Here's how. Using a flat-bladed screwdriver, unscrew the sealing plug, taking care not to damage the small O-ring seal as it is removed. Prevent the vent from turning using the dedicated opening tool. Fit the adaptor supplied in place of the plug; this is ready-assembled to one half of a quick-detach fitting. Check the O-ring seal is clean and undamaged before screwing in the adaptor to hand-tightness. Connect a pressure source to the adaptor via the other half of the quick-detach fitting. Pump up the pressure source to a pressure just exceeding 75 psi. Allow the pressure to settle for a few seconds then leave untouched for one minute. Check that the pressure does not drop by more than 1 psi. Carefully release the pressure, disconnect the pressure source and unscrew the adaptor. Check that the O-seal on the port plug is clean, lightly grease with silicone grease or petroleum jelly. Replace the plug, tightening to hand tight.

Forgotten the IP Address of your BlueComm modem? Here's how to change it back

Power and plug in the BlueComm to your PC. Make sure your PC is on the same IP subnet as your BlueComm. Start the BlueComm OM Monitor software and head to the configuration page. At the bottom of the configuration box, type the BlueComm's current IP in the 'Target IP' box and press 'Connect'.

The window will now populate with your BlueComm's information. The top box in the network tab is the current IP address. Change the text in that box to the new IP address, press 'Save' and then reboot. Your BlueComm will then boot back up onto that IP address.

If changing subnets, don't forget to change your computer's IP address to now be on that subnet or you won't be able to reconnect!

Sonardyne
SOUND IN DEPTH

SUBSEA TECHNOLOGY

Total Choice

Introducing Micro. The biggest small thing to happen to our Ranger 2 USBL acoustic positioning family.

It maybe our smallest ever USBL system, but the technology that's inside Micro-Ranger 2 will have a big impact upon your diver, small vehicle and target tracking operations. It's built using the same 6G and Wideband 2 architecture you'll find in our nearshore and deep ocean systems; Mini-Ranger 2 and Ranger 2. So you can expect precision, ease of use and versatility as standard – but with a price that will change your opinion on what a low-cost USBL system should be capable of. Search **Micro-Ranger 2.**

POSITIONING
NAVIGATION
COMMUNICATION
MONITORING
IMAGING