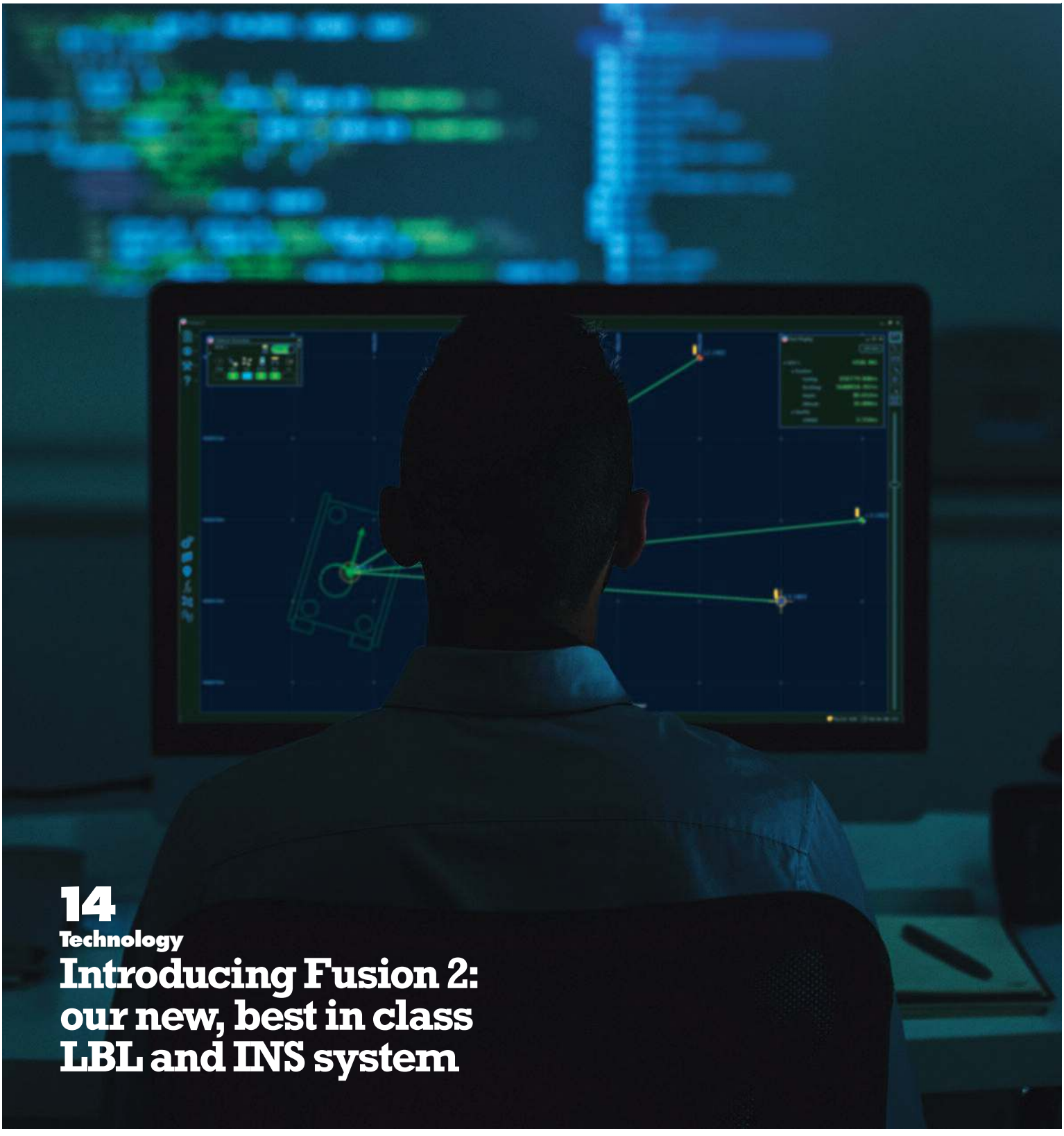
THE CUSTOMER MAGAZINE FROM SONARDYNE
ISSUE 20

Baseline



THESE ARE EXCITING times at Sonardyne. We've been building our team, bringing a step-change in our capability and product offering in LBL and INS operations, developing a new Navigation and Obstacle Avoidance Sonar (NOAS) and taking part in pioneering marine robotics research. And that's just some of what we've been able to cover in this latest issue of Baseline.

The highlight of this issue is a preview of our new Fusion 2. It's a completely new software architecture, built from the ground up, bringing you one simple to use system to run all your LBL, Sparse LBL and SPRINT INS operations. Go to page 14 to find out how Fusion 2 is our fastest and easiest to use LBL system yet, with real-time SLAM calibration capability and, easier, more intuitive tracking, all using less hardware and fewer interfaces than you needed before.

To compliment Fusion 2, we have released Compatt 6+ and ROVNav 6+ instruments, which will take advantage of our new Wideband 3 signal protocol. Find out more on page 8.

In this issue, we're also highlighting the capabilities of our sonar technology, with a look at our latest generation NOAS, from page 20. It gives mariners the ability to see and set alarms for submerged objects and seafloor obstacles, such as reefs, that they might not otherwise spot. What's more, this compact, high-performance, multi-function system is easy to integrate and use.

We also feature an in-depth look at a first for our Sentry integrity monitoring sonar from page 10. By being able to monitor methane gas escaping from the seafloor, the path has been laid for Papua New Guinea's first offshore hydrocarbon development.

David

David Brown Editor

Baseline » Issue 20

Front Cover
There's no denying Long BaseLine and inertial navigation operations can be complex. Now, they don't have to be. We've been working behind the scenes on building, from the ground up, a whole new version of our Fusion software platform. Turn to page 14 to learn more.

In this issue...

Baseline Magazine
The Customer magazine from Sonardyne

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SOUND IN DEPTH

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NEWS

OUR PEOPLE

New business sector appointments strengthen our global team

(Left to right) New appointments: Derek Lynch, Global Business Manager for Marine Vessel Systems; Stephen Auld, Global Business Manager for Subsea Asset Monitoring; Elizabeth Paull, Business Development Manager for Aquaculture and Renewables.

The strength and depth of our international business team means that when making investment decisions or planning your next project, access to expert application advice is always close at hand. And, following the recent promotion and appointment of two new Global Business Managers and a new Business Development Manager, in the areas of subsea asset monitoring, marine vessel systems, and renewables and aquaculture, our team is stronger than ever.

Stephen Auld is our new Global Business Manager for Subsea Asset Monitoring. Stephen, who joined Sonardyne last June (2017), takes over the role from Stephen Fasham, who is staying with the business in a newly created strategic role focussing on growth and investment opportunities.

Before joining Sonardyne last year, Stephen was Business Development Manager at Liquid Robotics Oil and Gas, which was a joint venture between oilfield services company Schlumberger and Liquid Robotics Inc. Before joining Liquid Robotics, Stephen was Managing Director at CodaOctopus Products Ltd.

Like Stephen, Derek Lynch will be another very familiar name to many Baseline readers. He's been appointed as Global Business Manager for Marine Vessel Systems, having gained more than 25 years' experience working within the offshore energy, maritime and naval sectors.

A former serviceman in the RAF and a licenced avionics engineer, Derek has held senior management positions with several leading edge technology companies involved in positioning, navigation and vessel control systems. These include the maritime software developer Sea Information Systems; Nautronix, where he was Vice President of Sales and; Veripos, where he held the position of Global Sales and Marketing Manager. Most recently, Derek was a Director at Positioneering, where he was a founding member. The company was set up to pioneer new approaches to precise GNSS positioning solutions.

> **"Elizabeth will also focus on other developing ocean industry markets, such as subsea mining, for Sonardyne's widening portfolio of products."**

Our latest appointment came at the end of this summer. Elizabeth Paull joins as Business Development Manager to support and grow our business within the aquaculture and renewables industries.

Elizabeth will also focus on other developing ocean industry markets, such as subsea mining, for our widening portfolio of products, as well as supporting customers and developing partnerships and academic research programmes focused on the Blue Growth agenda.

Elizabeth has a Masters in Oceanography, from Southampton University, and joins us from subsea instrumentation and systems company Aquatec Group, where she was Sales and Marketing Director. Elizabeth's previous roles include working as a research scientist for Thames Water.

She also has a Master of Business Administration from the Open University.

CONSTRUCTION SURVEY

Mini-Ranger 2 supports diver and ROV inspection operations offshore Brazil

Brazilian underwater engineering company Belov Engenharia has chosen a Mini-Ranger 2 Ultra-Short BaseLine (USBL) underwater positioning system for its dive support vessel, *Cidade Ouro Preto*, for its operations offshore Brazil.

The system will be used for diver and ROV inspection operations on Brazilian operator Petrobras' facilities offshore Brazil.

Mini-Ranger 2 is a sixth-generation (6G) USBL underwater positioning system. It has a standard operating range of 995 metres (extendable up to 4,000 metres with the Extended Range pack) and an ability to simultaneously track up to 10 subsea targets (e.g. divers, ROVs and structures) at very fast update rates.

Mini-Ranger 2 is ideal for nearshore operations on small, quiet vessels, as well as vessels of opportunity, pipelay vessels and construction barges that need survey grade positioning performance without the cost and complexity of a deep water USBL solution.

Speaking about the contract, Andre Moura, Sales & Applications Manager for Sonardyne in Brazil said, "Our 6G technology, like Mini-Ranger 2, continues to strengthen its reputation as the best available technology to meet the Brazilian offshore industry's specifications for subsea positioning. Although this system will be permanently installed on the *Cidade Ouro Preto*, if the team at Belov Engenharia ever need to move it to another vessel, the process is quick and simple."

"Mini-Ranger 2 is ideal for nearshore operations on small, quiet vessels, as well as vessels of opportunity pipelay and construction barges."

Belov Engenharia provides underwater and port underwater engineering, construction, inspection, survey and recovery services.

***Cidade Ouro Preto* carrying out its inspection operations in Brazil using Mini-Ranger 2 USBL's survey grade positioning performance**

CONSTRUCTION SURVEY

6G helps Isabella meet new specifications

6G continues to strengthen its reputation as the best available technology to meet Brazil's stringent new contracting specifications for subsea positioning, following the sale of USBL and LBL equipment to vessel owner and operator Companhia Brasileira de Offshore (CBO).

The multi-functional Compatt 6 transponders and Ranger 2 USBL (Ultra-Short BaseLine) HPT transceivers ordered will be used alongside existing Sonardyne technology on the dive support vessel *CBO Isabella*, which is on long-term contract to Petrobas, to support subsea operations including structure installation, pipeline metrology and ROV tracking.

CBO opted to have two independent acoustic positioning systems onboard the *CBO Isabella* so that operations can continue in the event of a single system failure. This requirement has been met through a combination of our Fusion LBL, Optimised Ranger 2 USBL and SPRINT INS technologies, which provide the vessel with the flexibility to meet virtually any project requirement in any water depth, including Sparse LBL, full LBL and acoustically aided inertial navigation for the vessel's work class ROV.

CBO's *CBO Isabella* dive support vessel.

Replacing the *CBO Isabella's* GDT through-hull transceivers with fully digital HPT transceivers completes her upgrade path from 5G to 6G. The vessel can now exploit the full benefits of our 6G technology: stable and precise positioning for DP, reliable structure and vehicle tracking and support for simultaneous vessel operations using shared seabed transponder arrays.

The work on the vessel's inventory of Compatt 6 LBL transponders with high specification DigiQuartz pressure sensors was carried out at our Macaé service centre.

NEWS

MARINE ROBOTICS

Sonardyne equipment supports the XPRIZE Ocean Discovery Challenge

This winter, there's going to be an autonomous subsea and surface robotics invasion in one of the world's oceans or seas – supported by Sonardyne technology. More subsea and surface robotics than has possibly ever been deployed over a set period will be going into an area of ocean for the last round of the US$7 million Shell Ocean Discovery XPRIZE competition.

Nine teams made it through to the final, with fleets of unmanned subsea and surface technologies that will be deployed to map, image and identify seabed features across a 500 square kilometre site in 4,000 metres water depth.

As part of the competition, they have to deploy their technologies from shore or air, with restricted human intervention, and complete their surveys within 24 hours, using equipment that fits into a 40 foot container.

The eight currently active finalists include: TeamTao, which comprises a team from SMD and Newcastle University in the UK; the Aggie Ocean Discovery team, from Texas A&M University, in the US; and Team Arggonauts, from the Fraunhofer Institute of Optronics, System Technologies and Image Exploitation, in Germany. While their approaches vary, all three teams are using our technology.

TeamTao will use a swarm of five underwater drones, called Bathypelagic Excursion Modules (BEMs), each of which carries an imaging sonar, lighting, HD camera array and a host of other sensors. They 'swim' vertically through the water column and are deployed from an autonomous surface vessel that's also responsible for processing collected data and then transmitting it to shore.

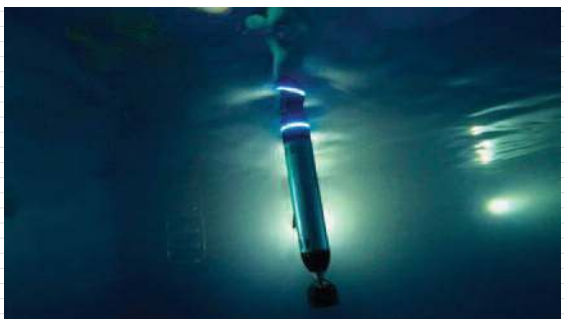
TeamTao has ordered a Sonardyne Ranger 2 GyroUSBL system with Marine Robotics Pack to use with AvTrak 6 OEM Nanos. The Ranger 2 GyroUSBL will be used on the surface vessel to track, while the AvTrak 6 OEM Nanos will enable communication between the BEMs and Ranger 2.

The Aggies will be using an in-house built AUV – either a Marlin or their latest autonomous underwater vehicle (AUV), Dynami – to gather sonar imagery over a 1.2 kilometre swath at 300 metre altitude, as well as at lower altitude in higher definition, in conjunction with a dynamically positioned remote surface vessel. They will also be using a Ranger 2 USBL tracking system and our 5,000 metre rated AvTrak 6 to track, monitor and control the AUVs.

The Arggonauts will deploy a swarm of their Great Diver AUVs from multiple Water Strider unmanned surface vessels. Navigation will be guided by our SPRINT-Nav INS as part of an inverted LBL style setup.

The final competition round takes place this winter. The winner will collect a $4 million prize and the runner up $1 million. There is also $1 million bonus prize from the National Oceanographic and Atmospheric Administration (NOAA) for chemical and biological signal detection technologies.

For more information about XPRIZE: **www.oceandiscovery.xprize.org/teams**



Sonardyne supports XPRIZE finalists: (Clockwise from above) Texas A&M's Aggies; Arggonaut's Great Diver AUV; and a TeamTao BEM AUV.

OUR PEOPLE

Investing in the next generation of UK engineers

Investing in young engineering talent is a core value here at Sonardyne, so we were pleased to see our latest tranche

(Left to right) New apprentices: James Kinsey, Jimmy Page and Josh Hall.

of apprentices graduate with First Class degrees from the University of Portsmouth.

Following three years' studying for a Foundation Degree in engineering at Alton College, Hampshire, then a year studying at the University of Portsmouth, Jimmy Page, Josh Hall and James Kinsey achieved Bachelor degrees (with honours) in Embedded Electronics, a degree recognised by the Institution of Engineering and Technology (IET).

All three have now started their new roles within Sonardyne at our headquarters in Blackbushe, Hampshire; Jimmy has joined the subsea team, Josh has joined the inertial navigation systems team and James has joined the project management office. Jimmy, Josh and James will now work towards becoming IET Incorporated Engineers.

All three graduates had studied for their A-Levels at Alton College before joining Sonardyne's apprenticeship programme. We have a strong relationship with Alton College, via the Sonardyne Foundation, which supported the building of a new Engineering and Technology Centre and supports our ongoing apprenticeship programme.

RESEARCH AND DEVELOPMENT

Leading the way in autonomous navigation systems

We are working with ship technology company Guidance Marine Limited on an industry-leading project that will help vessels, including unmanned autonomous systems, navigate or maintain station, even if they lose access to Global Navigation Satellite System (GNSS) data.

Using our underwater positioning technology and Guidance Marine's relative surface positioning systems, we're creating an integrated solution that will enable vessels to maintain safe passage or maintain station with dynamic positioning, if they lose GNSS access or other sensors fail.

The Innovate UK-backed project, called AutoMINDER (Autonomous Marine Navigation in Denied EnviRonments), will also create a common interface structure to allow the different sensors to be fed into one platform and set out an industry standard.

The system uses our SPRINT-Nav all-in-one subsea navigation instrument, which combines our SPRINT INS solution, Syrinx Doppler Velocity Log (DVL) and a high accuracy pressure sensor into one tightly integrated unit enabling highly accurate acoustic aided positioning. Additionally it takes in position data provided by Guidance Marine's vessel-mounted CyScan laser instrument, which takes range and bearing measurements from targets mounted on buildings or stationary surface structures in the ocean, to calculate the vessel's position and maintain positioning between targets.

During trials earlier this year, a CyScan was mounted on Sonardyne's *Echo Explorer* survey vessel incorporating additional GeoLock functionality. During a transit, between our Plymouth Sea Trials and Training Centre and our classroom facility in nearby Turnchapel, where surface markers were located, the two instruments were used to calculate *Echo Explorer's* position. Less than 0.5 metre positional deviation over a 1 kilometre transit was achieved during the trial, when compared with local, shore-based RTK Global Positioning System (GPS) data.

In trials this Autumn, we're planning to incorporate water track velocity data, to further aid the INS positioning. This will enable estimation of the direction and speed of a vessel in relation to layers in the water column, which means it can be used in deeper waters where DVL bottom lock cannot be achieved.

Guidance Marine will also prove the ability of its CyScan system to laser map unknown surface features or structures, such as navigation markers or even oil platforms, so that they can also be used as navigational aids – a technique known as Simultaneous Localisation and Mapping (SLAM) – further expanding autonomous navigation capability.

Surface and underwater instruments maintained positional accuracy vs RTK data in Plymouth Sound.

»KIT SPECIAL

Compatt 6+ and ROVNav 6+

A BIG + FOR YOUR OPERATIONS

From this November, we're advancing our Compatt 6 transponders and ROVNav 6 vehicle-mounted transceivers to the latest evolution of our 6G platform. Designated as 'plus' variants, you'll instantly spot the difference on the shelf or back deck as they will have a grey sleeve instead of the familiar red one. Other than that, they share the same trusted mechanics that you've become accustomed to. The big difference lies under the hood; differences that only become fully apparent when you set about your first Sparse or Full LBL campaign with the other big product announcement in this issue – Fusion 2 software.

As you'll discover on page 14, Fusion 2 will vastly simplify and reduce the time needed to conduct construction and survey operations, with less hardware, simpler workflows and fewer interfaces. We want to make operations as easy as possible for you, with a more capable and flexible system.

Embedded sensor data

The Wideband 3 signal technology inside Compatt 6+ and ROVNav 6+ is key to unlocking Fusion 2. It allows for the first time, sensor telemetry data (e.g. pressure, depth, temperature) from a Compatt to be embedded within navigation (ranging) telemetry data. This apparently simple change will have a big impact on operations, such as structure installation, as pauses in tracking to get sensor reading updates at vital moments will be a thing of the past.

Compatt 6+ transponders are backwards compatible with your existing Compatt 6 inventories. However, to achieve their full potential you'll need to use exclusively Compatt 6+ arrays and Fusion 2. Compatt 6s can be upgraded by returning them to your local Sonardyne service centre.

Over the next few months, we're hosting events to showcase the 'plus' range of instruments alongside demonstrations of Fusion 2. Contact your local Sonardyne office for more details. However, if you can't make it along to one, our simple guide opposite will answer some of your questions.

Compatt 6+ and RovNav 6+

10 KEY QUESTIONS ANSWERED

Q What is the difference between Compatt 6 and Compatt 6+? Both Compatt 6 and 6+ share the same address range and same Wideband 2 ranging protocols, which are proven to offer accurate ranging to better than +/-7.5mm. They can both operate the Wideband 2 telemetry commands used by Fusion 1 and Ranger 2. This allows backwards compatibility and the ability to be used in shared LBL arrays. The major difference is that Compatt 6+, when used with Fusion 2, will operate using new Wideband 3 commands which combines ranging and telemetry for faster operations.

Q Can Compatt 6+ be used in the same LBL array as standard Compatt 6? Yes, when using Fusion 1. Compatt 6+ will respond to Wideband 2 commands and will operate using Wideband 2 ranging. Therefore it will behave exactly as a standard Compatt 6 when used with Fusion 1 in Wideband 2 mode in a standard Compatt 6 array. Note that Wideband 1 is not supported by default in Compatt 6+. If Wideband 1 is required, you can install legacy Compatt 6 firmware in Compatt6+. Fusion 2 users need to use Compatt 6+ and ROVNav 6+.

Q Do I need to upgrade to Compatt 6+ and ROVNav 6+? If you want to use the benefits of Fusion 2, you will need to upgrade in order to operate using Wideband 3. If you are using Fusion 1 or Ranger 2 / Marksman, you can continue to use Compatt 6 units.

Q I've just purchased Compatt 6 units, what do I do? If you purchased standard Compatt 6s between March and September 2018, we will upgrade those units for free – if you wish. For older Compatt 6 units, there are upgrade and trade-in deals available. Please contact your local Sonardyne office.

Q I want to buy standard red Compatt 6s, are they still available for sale? No. Compatt 6+ supersedes standard Compatt 6. Compatt 6+ is fully backwards compatible and can operate in exactly the same manner as a red Compatt 6.

Q Will my ROVNav 6 work with Compatt 6+? Yes, but only when using Fusion 1. If you want to use Fusion 2, you will need to use ROVNav 6+.

Q Will Compatt 6+ work with Ranger 2 and Marksman? Yes. Compatt 6+ responds to both Wideband 2 and Wideband 3 commands so it will behave the same when used with Ranger 2 or Marksman, which uses Wideband 2 commands.

Q Will my ROVNav 6 work with Fusion 2? No. Fusion 2 operates using our new Wideband 3 telemetry commands which requires ROVNav 6+ and Compatt 6+.

Q If I'm using Fusion 2, can I choose to use Wideband 2 or Wideband 3 telemetry? No. Fusion 2 will only use the Wideband 3 telemetry commands as this is required for the combined ranging and telemetry feature. There is no way in Fusion 2 to drop back to the previous separate ranging and telemetry commands. For background information, Fusion 1 operates by sending Wideband 2 telemetry commands. Fusion 2 operates by sending Wideband 3 telemetry commands.

Q Can ROVNav 6+ be used with standard Compatt 6s? Yes, but only when using Fusion 1. Fusion 2 users need to use Compatt 6+ and ROVNav 6+.

Asset Monitoring

Case Study: Wide area gas seep monitoring

Tracking bubbles on the frontier

Our self-contained Sentry 'B' integrity monitoring sonar has achieved a technical first in a project which could help unlock Papua New Guinea's first offshore hydrocarbon development. >>

Nearly 100 kilometres off the coast of Papua New Guinea, there's a large crater in the seabed, 250 metres in diameter and 44 metres deep. It's what was left behind when, in 1983, an appraisal well on the Pasca A gas-condensate discovery blew out.

Since its discovery in 1968, the Pasca A field had been a challenge to drill. In 1983, the consequences of drilling on Pasca were more dramatic. Well kicks at target depth were followed by leaks from the blowout preventers and the wellhead before near-surface casing in the well gave way, resulting in a massive gas release creating the crater that remains on the seafloor today. The gas release was so large that there were concerns that any ships passing over it would sink instantly in the gaseous water. Finally, after three months, the well collapsed in on itself and the gas leak stopped flowing, apart from some small residual seeps.

Renewed interest in Pasca

Little interest was shown in the field until 2011, when Twinza Oil, an independent oil and gas exploration company, based in Perth, Australia, took on the Pasca A license. Despite some industry scepticism, Twinza saw the potential of the remaining hydrocarbon resources in Pasca A.

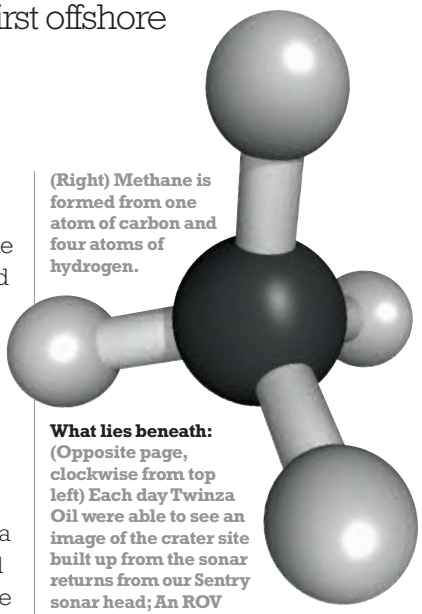
Success at Pasca A would be significant, as it would pave the way for the first offshore hydrocarbon development in Papua New Guinea, a country still seen as an exploration frontier. But, any operations on Pasca A would have to overcome the technical, drilling and engineering challenges posed by the field, without impacting the bridged-off well at the bottom of the crater.

Proof of concept

Twinza was confident it could be done without causing an increase in flow from the crater's residual seeps. But, they had to find a way to monitor the entire site for gas seeps during drilling.

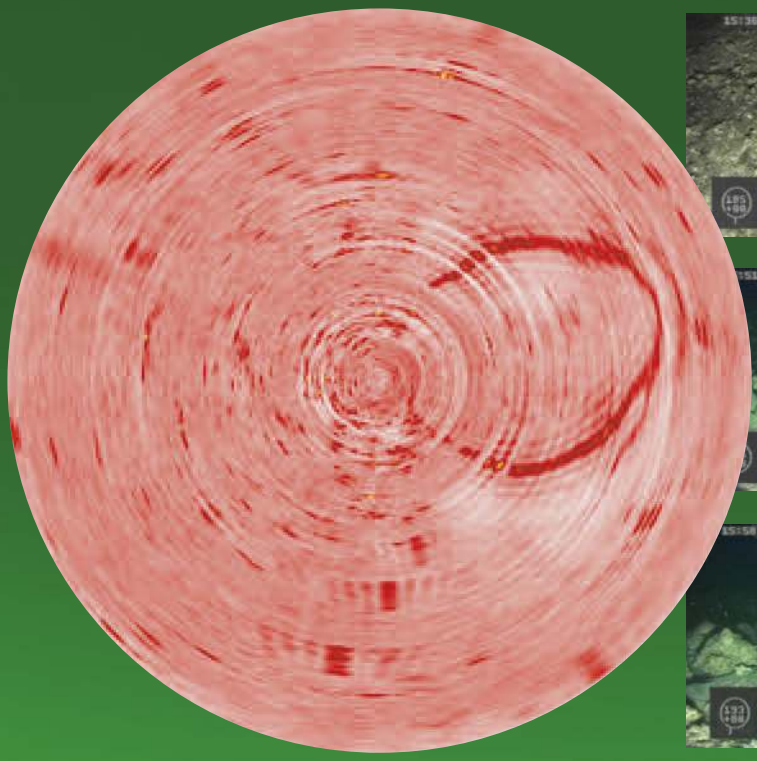
It would not be an easy task. The site is in 100 metres water depth, with little visibility. Even if visibility was good, a considerable number of cameras would be needed to cover the entire 25,000 square meter crater base, which includes a sub-crater. A previous site survey involved a multi-beam sonar survey and gas sample collection, using an ROV, both of which would also be impractical over the full duration of a drilling operation.

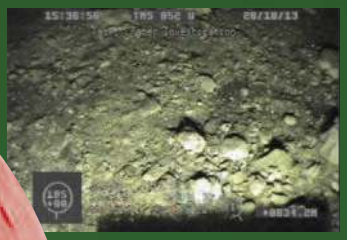
Twinza turned to Singapore-based Resolve Subsea to find a solution. Chris Tapley, Resolve Subsea's managing director, was aware of Sentry, our fixed-location, wide area active integrity monitoring sonar, which provides high sensitivity detection of hydrocarbons.



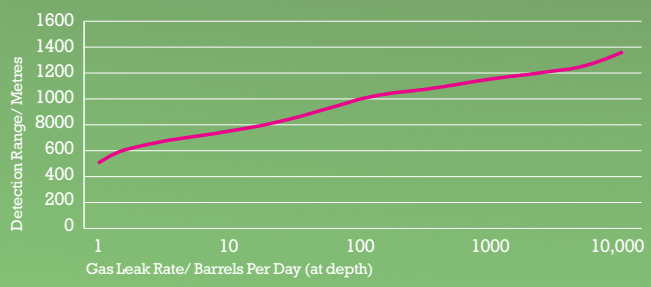
(Right) Methane is formed from one atom of carbon and four atoms of hydrogen.

What lies beneath: (Opposite page, clockwise from top left) Each day Twinza Oil were able to see an image of the crater site built up from the sonar returns from our Sentry sonar head; An ROV survey of the site was able to take photo-graphs showing the small seeps emerging from the site; Our Sentry asset integrity sonar has high range and high capability oil and gas detection; Bathymetry data acquired by Twinza Oil shows the scale of the crater created by early appraisal drilling on Pasca A.

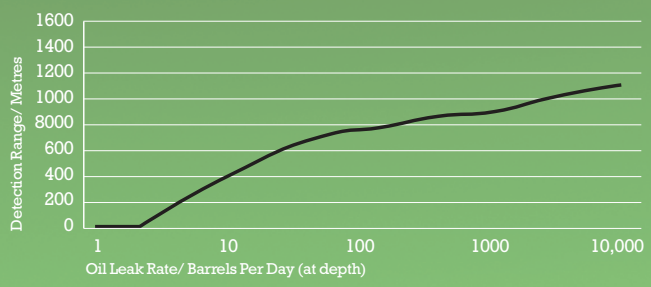


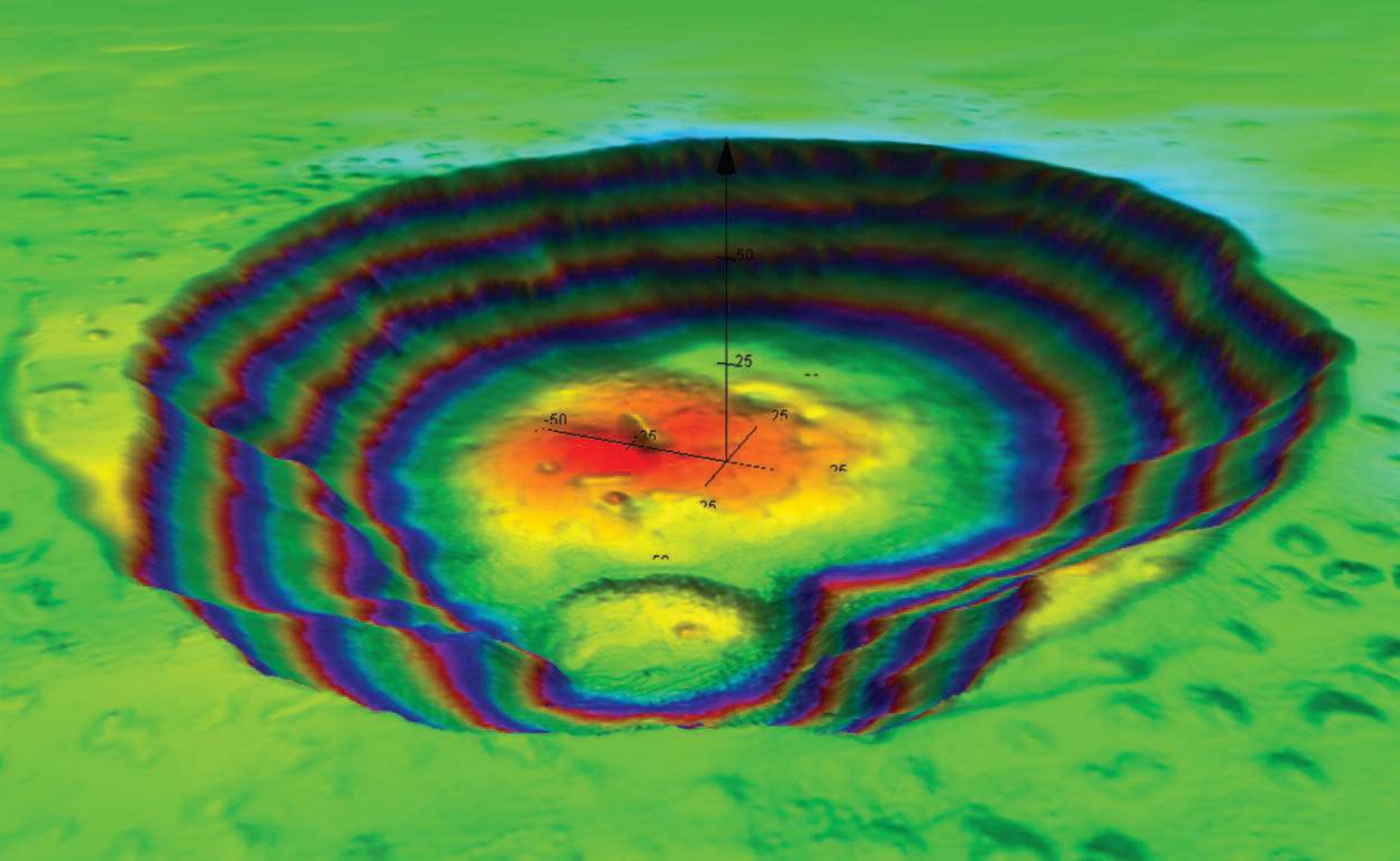


Gas Detection Performance (Predicted detection range vs. gas leak rate)



Oil Detection Performance (Predicted detection range for 'dead' oil)





Asset Monitoring

Case Study: Wide area gas seep monitoring

Standalone Sentry

Sentry was developed from our Sentinel diver detection sonar system. Sentinel was designed for port protection, vessel protection and for any asset where there is a potential for threats to arrive from the sea.

Its sonar head combines a compact 360° piezo-composite transmit and receive array and the electronics needed to transfer the raw data to a Sentinel Sonar Processor.

During system development, it was noticed that the bubble trail from a scuba diver could clearly be seen on the sonar return; this meant Sentinel could be developed to detect gas bubbles in the water column – such as natural gas or CO2 – coming from the seafloor or subsea infrastructure.

Sentry works by projecting a short-duration high-bandwidth ultrasonic pulse into the water and listening for echoes. While the hardware for the Sentry head is very similar to Sentinel, the classification algorithm used to detect the gas bubbles (or oil) is very different to those used for detecting threats by Sentinel. Whereas divers are characterised as moving targets, for example, an oil or gas seep will generally have a stationary source.

Unlike other leak detection systems, which detect the sound of a leak (which means low differential pressure leaks can go unheard), Sentry can detect seeps or leaks quickly and points to where they are, localising the leak location with both range and bearing. The system, which is designed to detect leaks below 1 barrel per day, at ranges in excess of 500 metres, is able to actively monitor a radius of up to 1,500 metres (5,000 feet), with 360° of coverage from a single sensor location.

This capability can be used across the life of a field, from drilling, through production, to decommissioning, when abandoned well heads can be monitored to make sure there are no residual leaks into the environment. Sentry can also be used for long-term monitoring of offshore CO2 storage sites. Indeed, its ability to detect CO2 leaks has already been tested in a project with the UK's Energy Technology Institute (ETI) (see Baseline Issue 18).

Sentry: Need to Know

- **Automatic early warning system for integrity breaches around subsea oil and gas assets.**
- **Capable of monitoring more than one billion cubic feet of seawater, with 360° of coverage from a single sensor location.**
- **Designed to be very sensitive and capable of detecting leaks below 1 barrel per day at ranges in excess of 500 metres.**
- **Configurable detection radius of up to 1,500 metres (5,000 feet).**

Below: The Sentry B lander is fitted with a Compatt 6 for telemetering the data to the surface bouy. Bottom: The *COSL Seeker*, en-route to Pasca A.

(Opposite page, from top) Our Sentry B lander, ready to be deployed offshore Papua New Guinea.

Sentry B and the surface buoy loading for deployment.

"Unlike other leak detection systems, which detect the sound of a leak (which means low differential pressure leaks can go unheard), Sentry can detect seeps or leaks quickly and points to where they are."

Proven capability

Sentry has already been tested for asset monitoring. It was successfully trialled over eight weeks in the US Gulf of Mexico, from BP's Thunder Horse facility. Because it was trialled from a facility, it was a wired system, with a direct power supply and topside data processing.

For Twinza, however, a standalone system was needed, based on a battery-powered lander deployment with subsea sonar processing, wireless through-water communications to the surface and satellite communications onwards to a control room.

The system for Twinza also had to be different in that it would need to detect a change in the volume of bubbles.

A standalone Sentry B (B for battery powered) system was produced and airfreighted to Papua New Guinea to be used for Twinza's Pasca A appraisal drilling campaign. The deployment comprises a Sentry sonar head mounted on the lander, with processing, battery packs and a Compatt 6 acoustic transponder. A rented surface buoy housed the surface acoustic connection – an AvTrak 6 transceiver – topside processing unit and satellite communications equipment.

Following an initial calibration, to create a reference map of the site, the system works by sending out a series of pings, called a ''look'', around a 360° radius and over an 11° vertical beam spread every hour. It then detects the returns, which are analysed using the advanced software on board to, in this case, detect leaks and increases in leak rates.

The Pasca A4 (AD-1) appraisal well campaign started in August 2017 and ran through into January 2018. Initially, up to 24 situation reports were harvested via the data buoy and the Iridium link every three hours. But, with the system working well, this was reduced to every six hours. Because up to 24 reports are sent back each time, if any are missed, a harvest every six hours is enough to cover any losses and means battery use can be minimised, enabling longer deployment. As with many other system parameters, the look-rate and data harvest period can be configured on the fly via the wireless (satellite and acoustic) link.

A Saab Seaeye Lynx ROV was used to make intermittent surveys of the gas seeps to support the Sentry B results.

Near the end of the drilling campaign, there was an outage in data being sent from the buoy – believed to be the result of cable damage, but, when the sonar head was retrieved, it was found that it had continued to monitor the site and the recorded data was able to show the status of the crater seeps right up until when the lander was removed.

While Sentry is not strictly an image-based system, an image showing detections over 24 hours laid over a Google map can be generated, and these were supplied to Twinza, which gave the company comfort as to the status of the seeps in the crater.

Crucially, the data provided evidence that none of the seeps had been affected by the Pasca A4 (AD-1) drilling operation, supporting Twinza's operational integrity and reassuring the regulators in Papua New Guinea. Videos showing the data over time, built up from the hourly images as a time-lapse movie, were also produced, providing a dynamic and compelling means of visualising the crater activity.

Future plans

Twinza is planning to return to Pasca A in 2019 for production well drilling operations, as part of their Pasca A development project, for which they are keen to have the support of the Sentry system again.

Sonardyne is also due to deploy another system, this time wired, with fibre optics for subsea to surface communication, to cover a drill centre in the US Gulf of Mexico over a six month period. With a wired system, there's no power limitation, so more sonar data can be gathered and greater processing power brought to bear on it.

There can also be hybrid systems, mixing aspects of the two, depending on available infrastructure. However, for surveys in areas without infrastructure, Sentry B offers an effective and robust solution.

Construction Survey

Fusion 2, a new chapter in LBL and INS

Get more data during your operations, using less hardware and software

Fastest, easiest LBL system yet

Run your Sparse LBL survey operations using real-time SLAM calibration, less equipment and less hardware

New software, built from scratch

FUSION 2
MORE WITH LESS

Precise. Scalable. Trusted. Best in field. These are just some of the attributes that for the past 18 years have been associated with our Long BaseLine acoustic positioning software platform, Fusion. This November will see the next chapter in the story written with the first release of our Fusion 2 software. Built entirely from the ground up, it will positively change your entire experience with one simple to use system to run all your LBL and SPRINT INS operations. >>

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Fusion 2 unleashes the potential created by our SPRINT-Nav combined SPRINT INS and Syrinx DVL instrument for Sparse LBL

TIME SPENT OFFSHORE is time on the meter. So, if you could reduce the time it takes you to do your operations, with a simple to use, easy to set up and easy to get right system, with just one software interface, it would be beneficial, right? That's just what we thought.

Long BaseLine (LBL) and Inertial Navigation Systems (INS) can be complex, especially when you want to merge them to conduct Sparse LBL aided INS. There are a lot of variables in what can be a challenging and stressful environment. Sparse LBL operations have helped to reduce how many beacons you need in a positioning array, and how long it takes to set it up, but, two different sets of software, that need to talk to each other, are needed.

From this November, we're taking the first step in taking away all of those problems and bringing you additional benefits, with the first release of our new Fusion 2 acoustic and inertial positioning software. This marks the culmination of years of engineering development work that builds on the achievements of our original Fusion platform by creating a package that's less complicated, more capable, more productive and more intuitive to use.

Huge benefits of this release come through the elimination of the complex interfacing currently required for LBL INS operations and the addition of the capability to do real-time SLAM calibration for Sparse LBL operations.

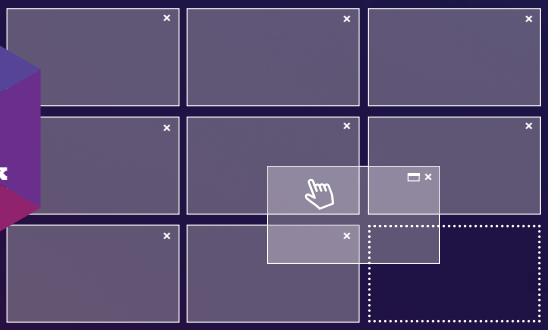
So, your set up is easier and faster, whilst the simplified user interface (UI) provides more intuitive workflows as well as powerful customisation >

Construction Survey

Fusion 2, a new chapter in LBL and INS

THE FUTURE OF LB

#1 Docking Framework

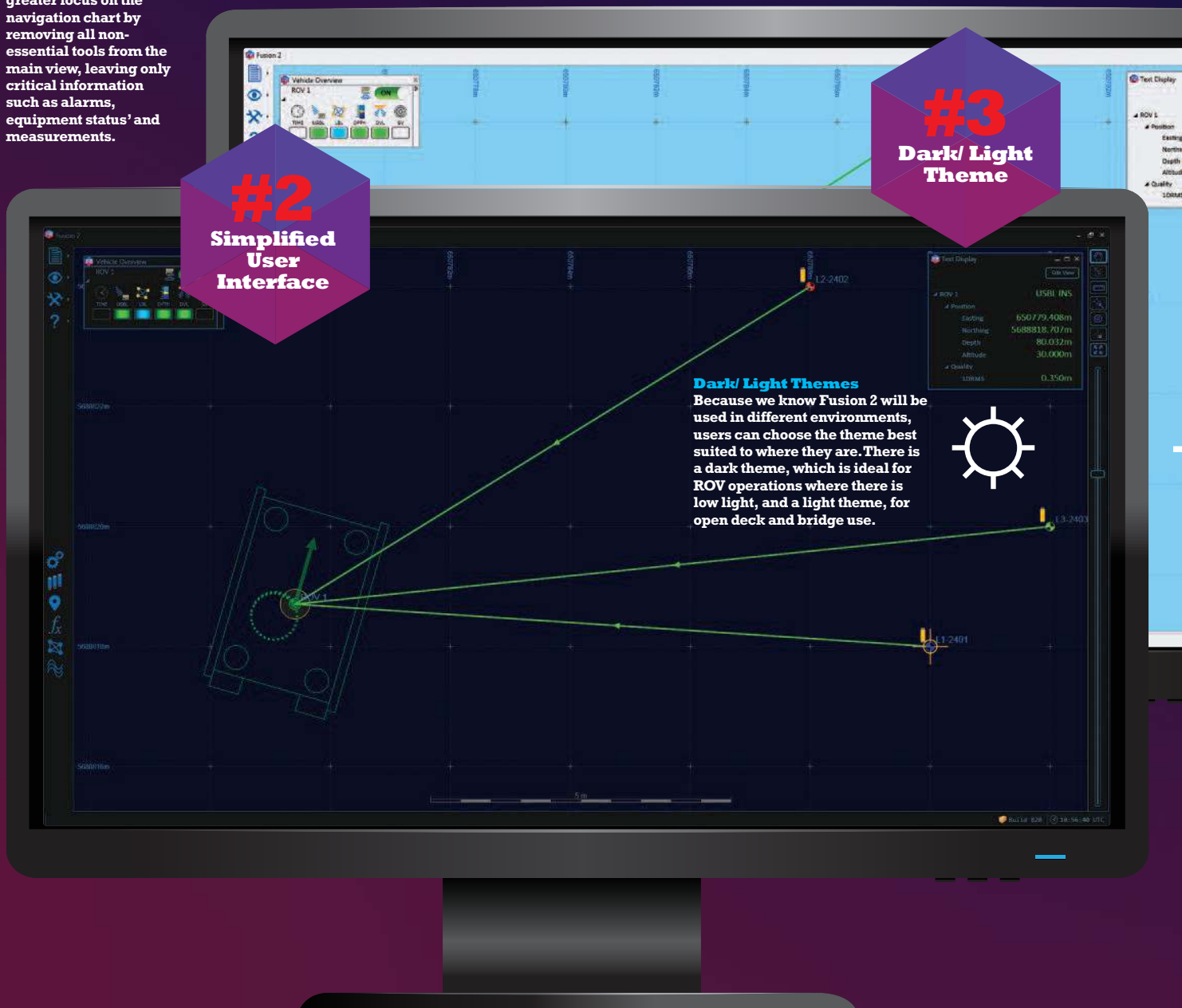


Docking Framework
Users can customise the look and feel of their Fusion 2 software to their specific needs using the 'drag and drop' windows. Windows can then be independently placed and adjusted to the size required. It also works over multiple monitor setups.

Simple UI
Fusion 2's UI has been streamlined, giving greater focus on the navigation chart by removing all non-essential tools from the main view, leaving only critical information such as alarms, equipment status' and measurements.

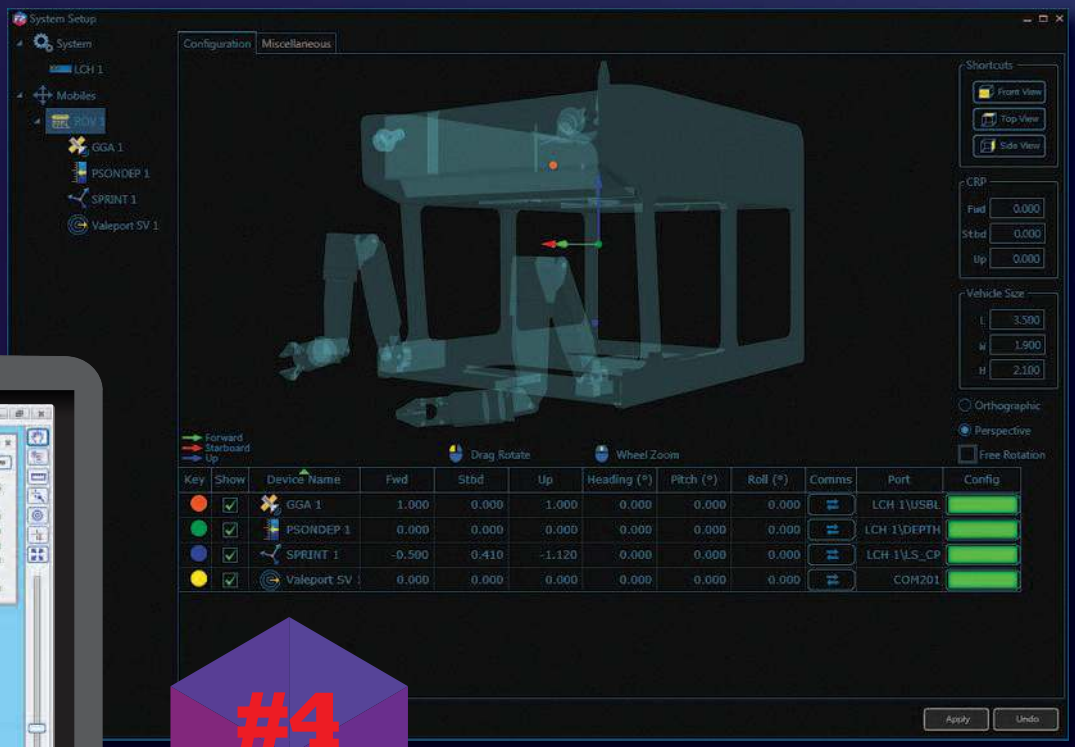
#2 Simplified User Interface

#3 Dark/ Light Theme



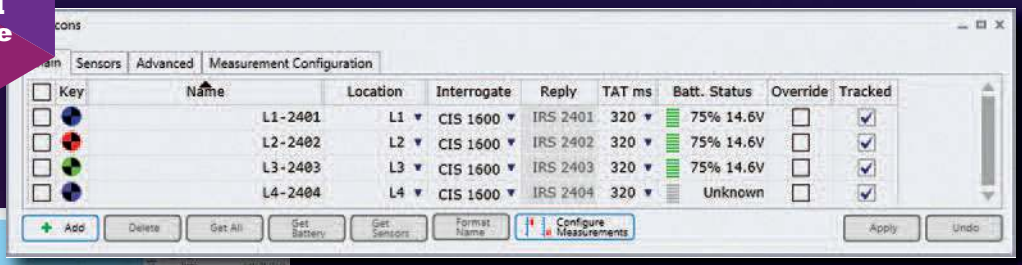
Dark/ Light Themes
Because we know Fusion 2 will be used in different environments, users can choose the theme best suited to where they are. There is a dark theme, which is ideal for ROV operations where there is low light, and a light theme, for open deck and bridge use.

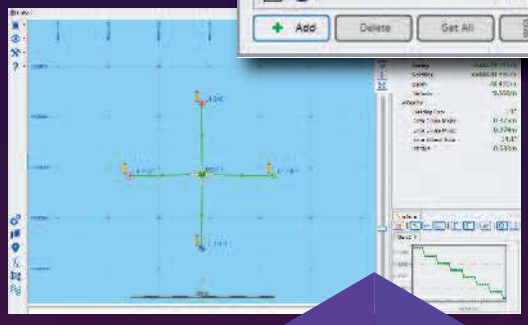
L AND INS IS HERE

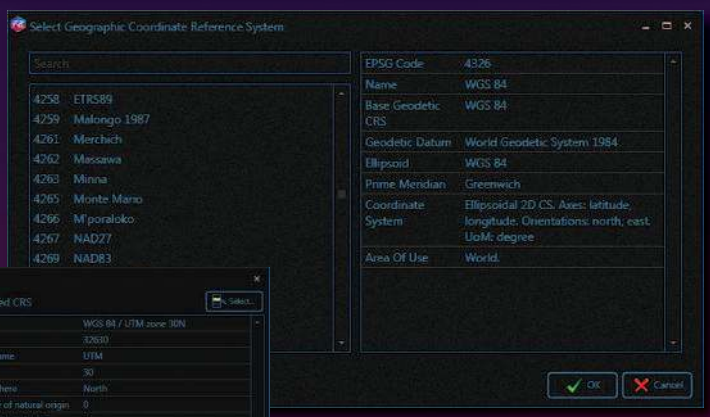


#4 Reduced Hardware

Reduced Hardware
Fusion 2 uses our Navigation Sensor Hub (NSH), which is a one-box solution for all our acoustic systems. As well as reducing the on-board hardware, Fusion 2 reduces the subsea hardware thanks to its support of Sparse LBL. Meaning deploying fewer transponders.







#5 Geodesy

Geodesy
Fusion 2 includes a searchable EPSG geodetic database supporting flexible CRS conversions and projections. The software also includes a Test Point tool.

Construction Survey

Fusion 2, a new chapter in LBL and INS

options for more complex operations.

Further benefits will come when we release our full acoustic LBL functionality early next year, so that all you need is one software system for acoustic LBL and acoustically aided INS, reducing setup complexity and greatly reducing your operational monitoring burden.

What's more, to reduce your hardware requirements, we have developed Fusion 2 so that it works through our Navigation Sensor Hub (NSH) – the same hub we use for our Ranger 2 USBL system – so you not only need fewer systems on deck (just one PC, one sensor hub and one cable between them), you need fewer systems in your inventory, giving you greater utilisation through wider compatibility. Plus, Fusion 2 supports use of our SPRINT 300 for LBL INS, giving you lower start-up costs for practical, reliable LBL INS.

And, to further increase operational efficiency, we have developed a new digital signal processing protocol, Wideband 3, that you'll find inside the latest evolution of our trusted 6G platforms, Compatt 6+ and ROVNav 6+. The good news is that this functionality is available to existing Compatt 6 and ROVNav 6 users, with a firmware upgrade (turn back to page 8 for more details).

Wideband 3 delivers a major step-up in your positioning update rates; we're talking 1Hz LBL tracking of structures as they are lowered and moved in the water column. Wideband 3 allows you to get sensor data at the same time as navigation ranging data, which means operators can get real-time positions and sensor data simultaneously By combining ranging and telemetry data, Wideband 3 will accelerate update rates by a factor of 10, eliminating issues operators face with latency.

Contact our survey support team to work out which release will best suit your needs, for more information about each release and what it can offer you.

Baseline: So why now?

Edward Moller, Global Business Manager, Construction Survey: "It's time to make the software simpler. If you were designing this system from scratch, for LBL INS, you would not design two sets of software. We have listened to customers and built a new Fusion, written from the ground up, which does the work of two systems.

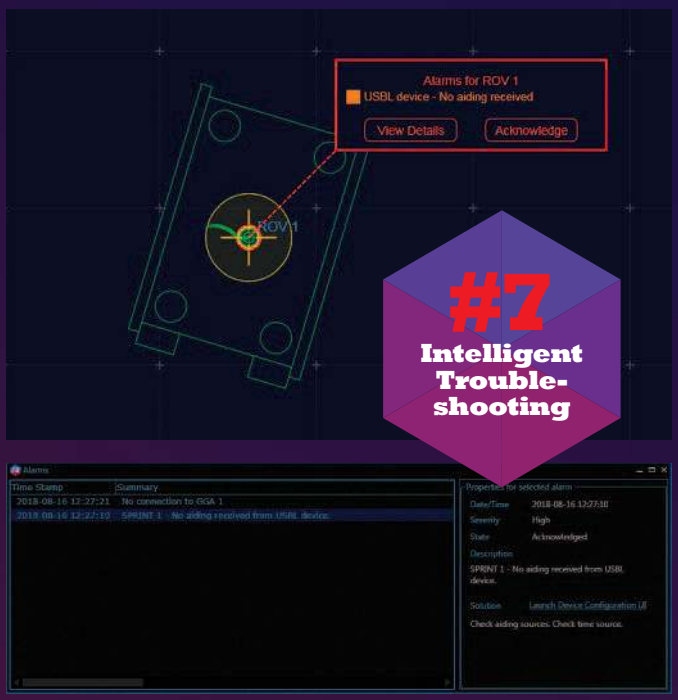
"This approach offers a world of benefits, not least time saving. Set up is easier and faster, it allows real-time SLAM calibration, 1Hz Wideband 3 LBL update rates, including your sensor readings, and you need less hardware. Fusion 2 has also been designed so that it's flexible for the future. It's designed for today's needs, but also so that future needs can also be incorporated more easily."

BL: What are the main benefits from an operational perspective?

Simon Waterfield, Survey Support Group Manager: "One of the main benefits of the first release will be around making Sparse LBL operations faster and easier. Fusion 2 also lets you do your SLAM calibration while you survey, significantly reducing survey time."

Liz Van Rossum, Software Solutions Manager: "To do real-time SLAM, a new set of algorithms has been developed to run in the SPRINT INS, using the raw ranges from the beacons (Compatt 6+ transponders). Fusion 2 manages the whole process in real-time."

SLAM Capability **Fusion 2 can run real-time SLAM calibrations, thanks to a new set of algorithms which have been designed to run in SPRINT INS, using raw ranges from transponders.**



Intelligent troubleshooting **Fusion 2 helps get to the bottom of problems in the system. When an alarm is triggered, the software will suggest options to fix the problem getting the job back on track quickly and efficiently.**

Automatic Bookmarking **Bookmarks are automatically created in the software at the beginning and end of significant operations, such as a calibration. Users can also define bookmarks to add extra details where needed.**

Malik Chibah, Engineering Manager: "Fusion 2 also allows configuration of acoustic and INS survey jobs 'in the office' prior to on-vessel mobilisation, reducing mobilisation time and helping you to be more sure of your operations. Once offshore, using Fusion 2, SPRINT can initialise with ranges from just a single seabed reference beacon, making operation start-up quicker and simpler. During your operation, it then allows you to dynamically select and change seabed acoustic references during navigation, so there is no need to stop and reconfigure references, supporting uninterrupted survey operations, which is particularly useful for pipeline corridor arrays.

"Also, Fusion 2 introduces the concept of having separate beacons and seabed stands/locations tables. This feature better matches the reality of most offshore survey operations and allows an array of seabed stands/locations to be calibrated and stored and/or acoustic reference beacons can be changed out, without the need to reconfigure positions, greatly reducing the complexity for the operator."

BL: Tell us more about the benefits for full LBL?

SW: "LBL operations will benefit from the new level of speed in ranging and telemetry updates created by Wideband 3. The software is able to react faster, using every bit of data it gets as soon as it gets it, and updates the position estimate continuously. Because we can embed telemetry data, such as sound velocity or depth, onto the end of range signals, we also do not interrupt the tracking updates."

LVR: "Before, if you wanted a pressure reading, while lowering a structure subsea, you had to stop ranging, get the depth or pressure sensor reading, then start ranging again. Now, on the end of a range reply we can embed a telemetry reading with that sensor data using Wideband 3. You can even ask it to send you that sensor data every time you get a range. The information you get will be continuous."

SW: "For full LBL operations, this means you de-stress and de-risk mobile Compatt tracking, because you can get an accurate position of your 300 tonne structure, which could be hanging off a crane close to the seabed, in real-time. There's no longer a 10 second wait for your next position, it's one-second updates, with your depth reading at the same time. Also, positioning and calibrations are done using Earth-centred Earth-fixed (ECEF) coordinates, which means grid scale factors are not an issue. Using ECEF means we are taking into account the curvature of the earth, which results in the positioning calculations and calibrations being real-world."

BL: Are there other benefits to Fusion 2 and Wideband 3?

MC: "Fusion 2 allows you to get your sound velocity and pressure updates regularly, without a separate measurement cycle, which means you are less likely to see problems your sound velocity, helping you to improve reliability."

SW: "Multi-user functionality will come as standard with Fusion 2, when we complete the full release next year, so it will be able to support five different users at a time."

EM: "The full Fusion 2 release will enable you to manage your inventory of beacons and locations in one place, enabling quick and easy review and audit. Compatt configuration can be uploaded from Fusion 2 direct from your iWand, which can then be used to transfer the setup straight into the Compatts before they are deployed so you know the status of Compatts as soon as they get wet. Therefore it all becomes a simpler, faster and easier operation."

MC: "A key part of the continuing Fusion 2 development is making the monitoring displays intuitive and flexible so that during LBL and LBL INS operations it prioritises the critical information that the surveyor needs to see in order to ensure that navigation quality is within limits or to quickly identify likely causes, if it is outside the limits. This is particularly important for LBL INS operations, where it has historically been challenging to understand the effect of individual aiding inputs on the INS solution."

BL: What's the bigger picture – why the need to make everything so easy?

LVR: "Offshore operations are stressful and if something goes wrong, it can be costly. We have listened and learned from our experience with Fusion 1 and have developed a software application that is user friendly and intuitive, with increased troubleshooting ability to make your operations simpler. The industry expects software to be easy to use with a reliable operating system and these have been key goals for us."

EM: "For those who want to tailor their operations, that's possible too. In fact, you can do multiple computations, compare different set-ups, and pick the one you want. Sparse LBL might suit one operation more than LBL and vice versa. It's easy to check, on-site, which works best for you. You can also quickly and easily tailor the user interface to suit your operations – the background theme (for working on deck or inside a cabin) can be changed and you can configure the screen, depending on what operation you are carrying out or what tools you want to use, with a simple drag and drop ability. Fusion 2 also has a remote interface for monitoring position data.

"There is also more to come. In future releases, we're looking to automate more processes and workflows and enable smarter integration with survey systems."

MC: "We have been working with leading suppliers of survey navigation systems to provide slicker integration. This is something that's been planned from the start. An additional benefit here is that as well as position data, associated position quality information will also be transferred to survey navigation packages. We will also be adding simulation and planning support that is carried through into configuration."

BL: When will users be able to get their hands on Fusion 2 and Wideband 3?

EM: "Throughout the rest of 2018 and into 2019, we're running a road show to demonstrate what we have done. Get in touch if you want to find out if there is one near you. In terms of getting hold of the technology, we're launching our Fusion 2 INS pack, to operate SPRINT INS later this year, followed by our full Fusion 2 LBL software in Spring 2019.

"Our full Fusion 2 software will replace Fusion for LBL operations and negate the need for a separate SPRINT system for LBL INS. You also have the option to use the system for more basic USBL INS operations, so a single system could address all your operational requirements.

"We recognise that our SPRINT software remains a popular system amongst our customers for a number of operations, therefore we will continue to sell and support it, whilst providing flexible upgrade options should you wish to update to Fusion 2 at a later date." **BL**

Marine Vessel Systems

Technology: Navigation, obstacle and collision avoidance

SEEING IS BELIEVING

The risk of a collision or a grounding can be dramatically reduced with our Navigation and Obstacle Avoidance Sonar (NOAS) – and now we have built a new version which is substantially smaller and lighter, but with the same high performance plus new features. Mariners can benefit from early and automated hazard warnings of everything from uncharted reefs and sandbanks to submerged objects such as shipping containers. **>>**

Photo: Courtesy of RNLI/ Lewis Davidson

Marine Vessel Systems

Technology: Navigation, obstacle and collision avoidance

WHILE MORE PEOPLE are using our oceans, there are still hidden risks that established navigational tools don't always detect.

There are still areas of the oceans that are uncharted. When areas are charted, the nautical charts are not always accurate; sand banks can shift dramatically and natural disasters can create new but hidden features.

Global Navigation Satellite Systems (GNSS), which are widely accepted as a ship's primary source of position information, can fail or be subjected to spoofing or jamming, which can mean you are not where you think you are.

And then there are submerged and semi-submerged objects that pose collision risks, from icebergs to shipping containers and even large marine mammals, such as whales. Meanwhile, weather, such as fog can also make navigation fraught with uncertainty.

"These are some of the tangible risks to mariners," says Derek Lynch, our Global Business Manager for Marine Vessel Systems, "from tankers to the growing fleet of new expedition cruise ships, which also go to unique places, like Antarctica, as well as close to shore lines.

"In the past four years alone, there have been more than 1,250 ship groundings, according to published data," he says. "It's a daily occurrence. Many of these were oil and chemical tankers, but vessels across the spectrum, from cruise liners to submarines are on the list."

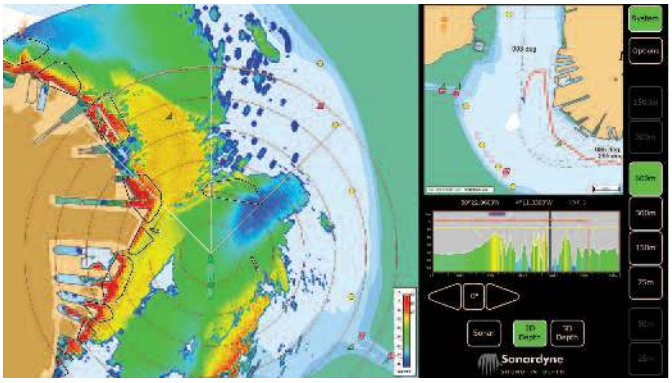
In addition to the obvious concerns about catastrophic damage to the environment, when a ship grounds there are the costs of recovery, repairs or even scrapping, disruption to operations, third party liabilities, fines and reputational damage. For example, after the *USS Guardian* ran aground in 2014 on a reef off the Philippines, due to an error on its chart, the vessel had to be scrapped and a US$1.97 million fine was issued, due to damage to a large area of reef.

Early warning system

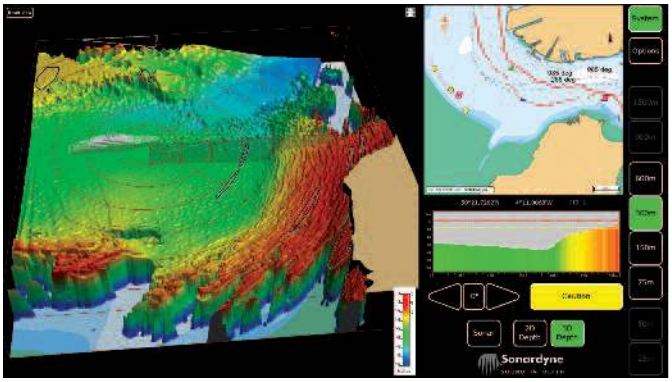
"Having a system like NOAS on board could have prevented these incidents," says Derek. NOAS is a low-power forward looking active sonar system, designed to warn mariners of potential hazards in the water, such as wrecks, rocks, reefs and sandbanks, or submerged or semi-submerged floating objects, such as icebergs or shipping containers. NOAS is based on similar sonar technology employed in our Sentinel intruder detection sonar; acclaimed for its exceptional detection and object classification capabilities, it is the most widely deployed system of its type in the world.

Our new variant NOAS transmits acoustic energy into the water, through a 90 degree azimuth, and through a vertical plane down to 50 metre water depth, and listens for the echoes, which it then uses to build up a picture of what is in the water – out to 1,500 metres – and the shape and depth of the seabed – out to 600 metres – depending on what mode you are using.

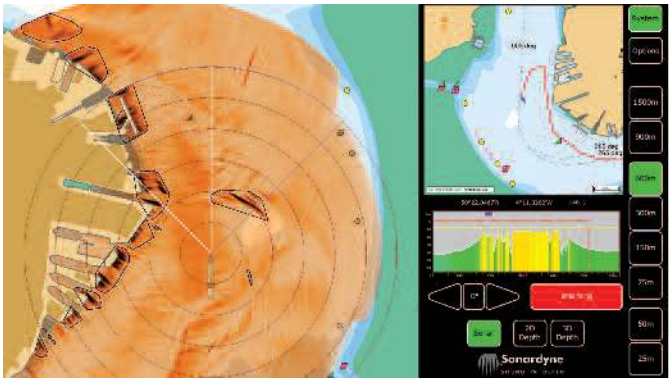
"It's like an underwater radar system, detecting hazards you are at risk of hitting, even in poor underwater environments where the water is murky," says Derek. "It's not a calculated or estimated position – it's your position absolutely relative to what's beneath and in front of you. It is the best available system for collision or grounding avoidance for large vessels and, in the event of a mechanical or engine failure, it could help you manoeuvre into safe waters by giving you a clear view of the seascape around you. It's the one thing you can be certain of."



In 2D Mode, NOAS shows water depth colour coded on a bow up display. Good for confined waters where you want a detailed image around you.



In 3D Mode, NOAS shows the water depth in a fully rotatable, interactive 3D display. Good for a complete perspective on situational awareness.



In Sonar mode, NOAS shows long range sonar echo intensities. Good for open water navigation to detect any objects in the water.

NOAS has been successfully installed on very large private yachts and navy swimmer delivery vehicles, but, now even more vessels will be able to use this system because we have been able to redesign the system so that it offers the same capability, but in a smaller form factor that's easier to install and comes with a smaller price tag. This makes it an attractive option for almost any vessel type, from smaller luxury pleasure boats to mega yachts, cruise liners, oil and chemical tankers and even autonomous surface and underwater vehicles.

Adding autonomy

We have also added more tools and automation, in addition to depth

alarms, so that the system can do more for you. "In Sonar mode, both variants of NOAS are able to detect submerged objects, down to something like a one cubic metre iceberg, out to 1,500 metres in open water, giving you long-range detection capability of anything from another ship to marine life, uncharted rocks, or indeed an iceberg," says Pete Tomlinson, Engineering Manager – Maritime Security at Sonardyne. "Now we have added computer aided detection (CAD), which automatically analyses the sonar returns and tells you where there are large objects in the water ahead of you.

"What's more, when working in Sonar mode, if you get a CAD alarm telling you that there is an object ahead, you can then seamlessly switch between Sonar, 2D or 3D modes, instantly giving you more detail including a clear visualisation of the water depth and seabed topography out to 600 metres in front of you, all without the system having to rebuild the image on your graphical user interface (GUI).

"Adding automation is really important for collision avoidance at cruising speed," adds Pete. "When a radar is saying there is nothing out there and no one is looking at a navigation screen, NOAS now gives you an automated warning that there is something out there." What's more, all the data that NOAS gathers can be exported and used by

> "Adding automation is really important for collision avoidance at cruising speed. When a radar is saying there is nothing out there and no one is looking at a navigation screen, NOAS now gives you an automated warning that there is something out there."

third party interfaces, for autopilot and or marine autonomous systems. "Users can select the data they want to bring into their system and use it how they want to," says Pete. This will be useful for aiding autopilot systems and unmanned vessel navigation, giving the intelligence systems on board more information that they can use to navigate.

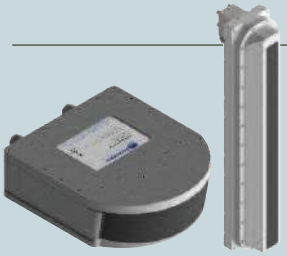
Unique processing

"We've also developed some very clever and unique processing, including our ACF, or Altitude Confidence Filter, which means you get exceptional image clarity, in 3D, as well as image stability and high image update rates," adds Derek. "The image you get doesn't jump around; it's impressive, quick, clear and precise, showing you the underwater situation around you, in real-time, and it can be overlaid on digital navigation charts."

Vessel crew can also view a history of where their vessel has been, which is useful if you have to back up or make tight manoeuvres.

"In fact, it's pretty much like a subsea radar," says Derek. "It will see an embankment under the water surface and gives you a range and bearing to it. Radar is used for collision avoidance on the surface and for validating position fixes by plotting ranges to visible targets. NOAS could do this for you, subsea."

Our new variant NOAS is tested and ready and we'll be bringing the first units on to the market in the Spring of 2019. Get in touch with us if you would like more information. **BL**



NOAS: Need to Know

- **NOAS is a low-power forward looking active sonar system able to detect hazards out to 1,500 metres.**
- **It can operate as an independent system or feed fully-processed sonar images into, and be controlled by, the vessel's integrated navigation system.**
- **NOAS works in three modes, Sonar, 2D and 3D, which you can switch between seamlessly.**
- **In Sonar mode, computer aided detection markers alert you to potential subsea hazards up to 1,500 metres ahead of the vessel.**
- **In 2D mode, NOAS shows water depth colour coded on a bow up display. In 3D mode, water depth is shown in a fully rotatable, interactive 3D display.**
- **Live data processing using our unique filters means accurate depth data is modelled and displayed as stable, real-time 3D images of the subsea environment up to 600 metres ahead of the vessel.**
- **In all three modes, the range of the displays can be selected by the user, and sensitivity to surface clutter or noise can be adjusted.**
- **Multiple alerts can be set, which trigger an alarm if water depth drops below a user defined level ahead of the vessel.**
- **If you plan to make a manoeuvre, you can steer the view of the sonar head to look where you plan to go first.**
- **NOAS stores the sonar imagery for the terrain it has recently passed over, enabling users to re-trace their steps if needed.**
- **Our market-leading diver detection sonar, Sentinel, can complement a NOAS installation.**
- **Sentinel enables the detection of underwater intruders approaching a vessel when it's stationary through a full 360 degrees.**

Marine Robotics

Technology: Enabling autonomous platforms to go further, for longer

EXTENDING THE LIMITS OF OCEAN SYSTEMS

Improving the endurance and navigational accuracy of underwater autonomous systems, while also reducing costs, could provide disruptive capability in the subsea monitoring and inspection space. All three are goals for a new three-year collaborative project we have launched with partners ASV Global and the National Oceanography Centre. **>>**

In trials on Loch Ness our SPRINT-Nav, Solstice side scan sonar and BlueComm underwater optical modem were all deployed together.

SENDING AUTONOMOUS AND unmanned underwater vehicles (AUV/UUV) out on missions unaided by vessels or any other supporting offshore infrastructure is a major goal for the ocean science, offshore energy and defence sectors.

If you remove the need for a surface vessel, you reduce costs and risks to personnel. You could survey more seabed for longer and with fewer or even no people offshore.

Survey, inspection, monitoring and surveillance requirements are growing, globally. We're using the oceans more and we need to know more about them. In the offshore energy industries, pipelines and power cables need inspecting and wells need monitoring, at ever lower costs. In ocean science, researchers need to learn ever more about our oceans, in more detail and over longer periods of time and often in remote locations, to help understand a variety of physical, chemical and biological processes.

Defence players want unmanned vehicles they can use to extend their reach, often in covert deployment scenarios.

But, current constraints on AUV or UUV operations, such as limited power budgets and navigational accuracy degradation over time, means that the capabilities of these systems are not being fully tapped.


SIMRAD
CW79
ASV
ALR 3

Marine Robotics

Technology: Enabling autonomous platforms to go further, for longer

We're looking to change that. Working with partners ASV Global (ASV) and the National Oceanography Centre (NOC), we have already proven the ability for multiple unmanned subsea and surface systems to work together on joint survey missions, controlled from shore, through the three-year Autonomous Surface and Sub-surface Survey System (ASSSS) collaborative project, led by ASV.

Now, we've launched a new two year £1.4 million project. Working again with the NOC and ASV, we will develop new positioning technologies to extend the limits of AUVs. The project, led by Sonardyne,

> "We're planning to demonstrate autonomous USV deployment of seafloor positioning transponders, with onboard data processing, making LBL operations faster and easier."

is called Precise Positioning for Persistent AUVs – or P3AUV for short – and is supported by funding through Innovate UK's research and development competition for Robotics and Artificial Intelligence in extreme and challenging environments.

"We're going to be developing ways to provide greater positioning accuracy for long-endurance operations in deep water, while also reducing power requirements," says Geraint West, Global Business Manager for Oceanography, Sonardyne. "We'll also be increasing the use of autonomy to make Long BaseLine (LBL) positioning system deployment faster and easier, by proving autonomous transponder deployment from an unmanned vessel, with onboard data processing and calibration.

"This will all be done through work in three key and complimentary areas: improved lower power navigational accuracy over long distances for AUV/UUVs, autonomous transponder deployment from an unmanned vessel and improved positioning accuracy during vehicle descent/ascent in the water column."

Balancing power and accuracy needs

Long duration missions dictate low power navigation sensors, but these provide relatively poor self-contained navigation accuracy and so vehicles will need to surface regularly to reinitialise with a GPS fix. However, by including high performance, high power navigation instruments and integrating them using novel techniques to dramatically reduce power consumption, vehicle operators will get the best of both worlds.

"The NOC's Autosub Long Range (ALR) for example, currently uses a low-power microelectronic mechanical system (MEMS) Inertial Navigation Systems (INS) to calculate how far it has travelled on missions which can be several months long," says Geraint. "To increase its accuracy over longer distances, we will integrate a derivative of our SPRINT-Nav INS-DVL instrument. The two navigation instruments are combined into a single payload that will automatically manage the operation of the hardware as well as integrating the navigation solutions. The result will be a navigation system that dramatically improves the self-contained navigation accuracy of ALR without increasing the power consumption to the levels typically required for high performance INS.

"For the P3AUV project, combining the instruments into a single payload means we're saving space as well as power. This means you get higher accuracy and precision, using less power, so that you can go on longer duration deployments."

Better accuracy, during ascent and descent

The project will also involve improving positioning accuracy while subsea vehicles transition through the water column. "This is a notoriously difficult area for AUV deployments, because it relies on the Doppler Velocity Log (DVL) being able to 'lock' on to the seafloor (bottom lock), so that vehicle XYZ velocities can be calculated, supported by pressure data," says Geraint.

"However, extending the capability of SPRINT-Nav will reduce the navigation error in this scenario. The internal Syrinx DVL can measure water current as well as velocity relative to the seabed. SPRINT-Nav will be able to use the water current velocity to reduce the dead reckoning mid water navigation error, but we'll be putting this to the test throughout the P3AUV project."

As mentioned, at the heart of this capability is our class-leading SPRINT-Nav instrument, which combines our SPRINT INS sensor, Syrinx DVL and a high-accuracy pressure sensor in a single housing.

Proving integrated autonomy

The aim of the Autonomous Surface and Sub-surface Survey System (ASSSS) project was to deliver an integrated system to perform low cost, full water column marine surveys using multiple unmanned systems.

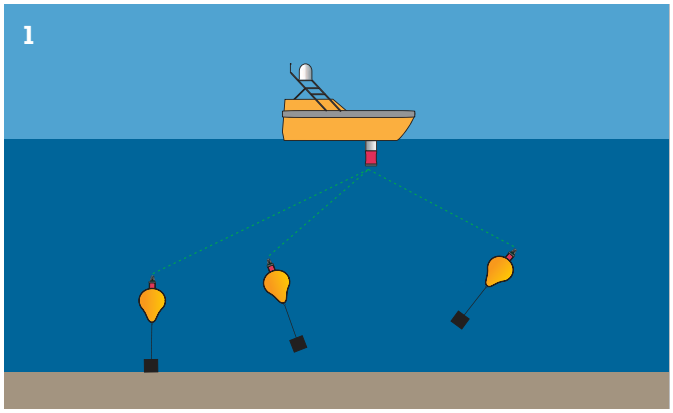
Proving acoustic-enabled multi-vehicle tracking and command and control with optical data transfer through the water column lays the ground work for long-range, over-the-horizon autonomous underwater vehicle survey operations.

During trials in and on Loch Ness, our USBL acoustic positioning and AvTrak 6 telemetry systems enabled one of project leader ASV Global's C-Worker 5 unmanned surface vessels (USV) to locate, track and command and control the NOC's Autosub Long Range (ALR) AUV. Position and mission status updates were transmitted to shore via wireless surface communications.

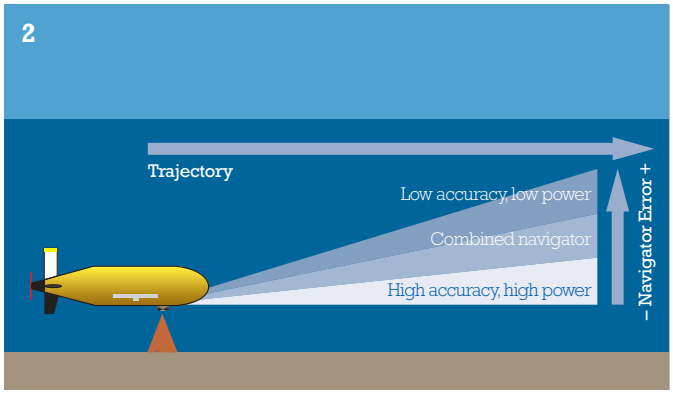
The mission also included, for the first time, through-water transfer of data collected by a our Solstice multi-aperture sonar on the AUV to the USV, using our BlueComm high-speed optical modem.

Our USBL and AvTrak 6 technologies are also able to track and communicate with multiple subsea platforms, so a single USV would be able to manage swarms of AUVs, further extending unmanned operational capabilities.

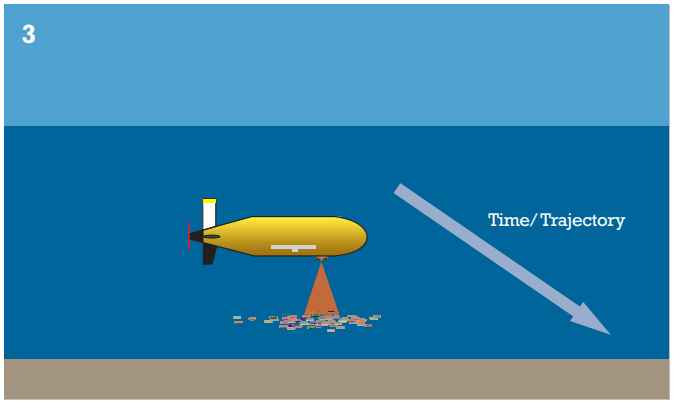
The ASSSS project, led by ASV Global with partners Sonardyne, the NOC and SeeByte Ltd., was supported with funding from Innovate UK and the Defence Science and Technology Laboratory.



1. Automated beacon deployment
A USV deploys seafloor positioning transponders autonomously, making operations faster and easier.



2. Combined Dead Reckoning Navigation
High and low power navigation sensors will be combined to provide high accuracy with low power requirements.



3. INS-DVL aided descent and ascent
SPRINT-Nav will use tight beam level aiding from it's internal Syrinx DVL to provide high accuracy mid water navigation.

Furthermore, these instruments are tightly integrated, which means SPRINT-Nav can use individual beam level measurements from our Syrinx DVL, making it a much more robust and reliable system than a separate DVL, which needs all the beams to calculate velocity.

Automating beacon deployment

We're also planning to demonstrate autonomous USV deployment of seafloor positioning transponders, with onboard data processing, making LBL operations faster and easier.

"The goal is to enable full ocean depth, 1 metre accuracy wide-area seabed mapping in a single operation, using an ASV USV to both autonomously deploy a number of our Compatt transponders and then precisely position (box-in) them," says Geraint. "These Compatts can then be utilised in combination with the AUV's SPRINT-Nav INS to calculate a Sparse Long BaseLine (Sparse LBL) solution. Sparse LBL is

(Above, from top)
Our BlueComm through-water wireless optical communication system; Syrinx is our Doppler Velocity Log (DVL) navigation instrument for subsea and surface vehicles; SPRINT-Nav is our all-in-one subsea navigation instrument for underwater vehicles, combining SPRINT INS, DVL and high accuracy pressure sensor.

Marine Robotics

Technology: Making autonomous go further, for longer

able to use just one or two Compatts to provide positioning that is comparable to a full LBL array, but using fewer Compatts.

"Autonomous low-cost deployment of seabed transponders is attractive to the offshore energy industry for AUV operation, as well as a wide range of scenarios throughout the whole life of a field, including exploration", says Geraint. "Currently, all seabed navigation transponders are deployed by manned vessels, which make it a costly and time-consuming activity. Using autonomous deployment and calibration techniques will remove the need for manned vessel support, providing a dramatic cost saving over current 'state-of-the-art' AUV operations, as well as any other operations where an LBL positioning system is needed."

Typically, an offshore support or research vessel will burn some 3,000 tonnes of fuel annually and generate about 10,000 tonnes (equivalent) of greenhouse gases. The environmental footprint of an independent AUV is, by comparison, negligible.

"The reduction of manned vessel operations, as well as reducing deployment/recovery of vehicles over-the-side of such vessels, will reduce risk in offshore survey operations. Furthermore, the ability to mobilise this capability at short notice, without the high cost of mobilising a ship, could generate a new service industry model."

Game-changing

Combining all of these capabilities will bring a step-change in AUV operations, providing a disruptive capability in the subsea monitoring and inspection space. Indeed, reducing the cost and improving the navigation precision of autonomous ocean research in remote areas could bring a disruptive capability to a wide variety of applications.

"Sustained ocean observation without the need for ship support is coming under increasing focus from the research community, especially in ice-covered polar areas," says Geraint. "Long-duration navigational

> "Autonomous low-cost deployment of seabed transponders is attractive to the offshore energy industry for AUV operation, as well as a wide range of scenarios throughout the whole life of a field, including exploration. Currently, all seabed navigation transponders are deployed by manned vessels, which make it a costly and time-consuming activity."

capability is also a key enabler for persistent covert surveillance operations in the defence sector, as well as emerging applications, including resident seabed-based systems, deep sea mining, aquaculture, platform decommissioning and UXO surveys for renewable installations.

"There are also emerging requirements to monitor decommissioned offshore infrastructure 'in perpetuity', all of which will generate a market for this rapid and efficient mode of seabed navigation. As the only company that produces a complete Doppler, INS and acoustic navigation suite for AUVs, we are uniquely placed to work with our partners ASV and NOC to produce a game-changing capability through the P3AUV project." **BL**

Demonstrating our capability
Right: During our Marine Robotics Week at our facilities in Mayflower Marina: partners and clients were welcomed aboard our floating classroom, *Val B*, to see BlueComm and unmanned surface vessel demonstrations; onboard our *Sound Surveyer* catamaran, we demonstrated our Ranger 2 USBL system, used with our Marine Robotics Pack software, alongside AvTrak 6 multi-function transceivers; and our *Echo Explorer* training and research vessel, which we took out into Plymouth Sound to demonstrate our Solstice side scan sonar and SPRINT-Nav.

MARINE ROBOTICS SHOWCASE

Shining a light on marine autonomous systems

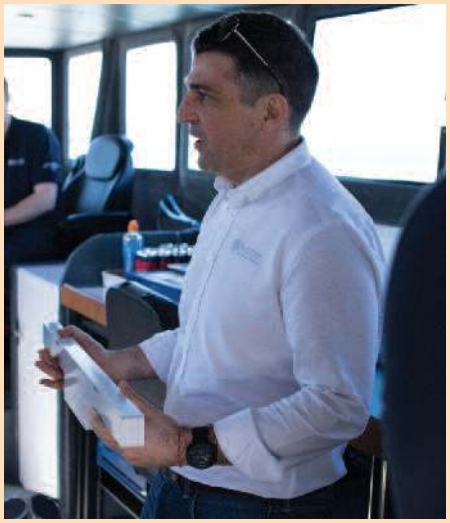
Marine robotics is a fast-growing segment of the marine industry, featuring unmanned surface vessels (USVs), autonomous or unmanned underwater vehicles (AUV/ UUV) and, where we specialise, the systems that connect and control them.

Earlier this year, over three days, we "opened the doors" to our training and testing vessels at Mayflower Marina, Plymouth, to give industry partners and clients an in-depth and hands-on look at our marine robotics technology capabilities.

Mayflower Marina opens out on to Plymouth Sound, which is a challenging environment to operate and demonstrate these systems in, with aggressive tides and different thermal as well as seawater and freshwater layers, all of which make for a tough proving ground for underwater technologies. However, this means that those working in the military, oil and gas and ocean science sectors got to see our technologies performing in real and challenging conditions – from the comfort and warmth of our vessels.

"It's about the opportunity to have time to talk to our customers, understand their requirements and see how we can adapt our solutions to meet their requirements," says Ioseba Tena, Global Business Manager for Marine Robotic Systems, who led the event.

Our research vessel *Echo Explorer* took visitors out into the Sound to demonstrate our Solstice side scan multi-aperture sonar. Solstice, which boasts an impressive 200 metre swath, using only 18 watts, is designed to work on small AUVs operating in stable conditions at a constant depth from the



seafloor. For this demonstration, however, it was deployed from *Echo Explorer*, in fairly rough conditions. Despite this environment, it was still able to highlight details on the seafloor that you would not normally expect to see with a multi-aperture sonar.

Echo Explorer was also used in the same conditions to demonstrate our combined SPRINT-Nav, which houses an INS, DVL and a high precision pressure sensor, in one compact and easy to integrate unit.

Meanwhile, onboard *Sound Surveyor*, our second 12 metre catamaran based at Mayflower Marina, we demonstrated the latest software bolt-on for our Ranger 2 USBL tracking system, the Marine Robotics Pack. Used with AvTrak 6 multi-function transceivers, the Marine Robotics Pack enables tracking and communication with and between multiple subsea targets, such as AUV swarms, at the same time.

In our static floating classroom, *Val B*, we demonstrated our BlueComm high-speed optical modem. BlueComm can enable high-speed and high-volume data transfer between underwater objects or between underwater and surface based systems, such as an AUV and USV, enabling subsea survey data to be transmitted to shore far faster than is otherwise possible.

USV supplier and operator ASV Global also joined us to give an on-water demonstration of its C-Cat 3 USV platform, equipped with our Syrinx DVL. As well as providing bottom-lock navigation aiding, Syrinx's ADCP mode was used to show how a water column can be profiled "on the go."

Marine Robotics Week was our third marine robotics demonstration event. Scan the QR code to watch the video highlights on our YouTube channel, and let us know if you would like to take part in future.

Our vessels and crew in Plymouth are available to hire, supported by our permanently installed LBL and USBL equipment on site.

International

News from our Regions Around the World

Europe, Africa, S. America

Barry Cairns Vice President

Brazil bidding excitement

The recent successful bidding rounds on Brazilian oil fields has sparked a real feeling of excitement while operations through Sonardyne's Brazil office continue to steadily increase. Vessel tenders from our Brazilian clients are demanding concurrent themes: easy to install, fully integrated, high-specification navigation systems. The challenge is to move away from separate systems and create a tightly integrated, all-in-one solution to help companies deliver more efficient ROV deployments.

SPRINT-Nav

One such development from us is SPRINT-Nav, our all-in-one navigational instrument which combines INS, DVL, AHRS and depth sensor in one single unit. We have just delivered multiple SPRINT-Nav systems into the region because it meets these challenging requirements.

In Europe, companies are also looking to reduce the need for support vessels and ROV teams. This is driving interest in our navigation and communication products for autonomous field resident vehicles. SPRINT-Nav and BlueComm, our optical modem, are the ideal products to meet the challenging requirements.

Drilling

New tenders are now going live for drilling vessels to be used on the huge Libra development, pointing to an increase in activity over the next year. Our Marksman system has been selected with the upgraded option of DP-INS to help improve operational performance and efficiency. This is achieved through a combination of a tightly integrated INS and 6G acoustic solution.

In oil well and reservoir monitoring, we have also seen an unprecedented upturn in customer requests for downhole logging capabilities, using instruments that are capable of remaining in-situ for years.

North America

Simon Reeves Senior Vice President

Some momentum is returning to the North American oil and gas market, with an upturn in the seismic and survey construction markets.

SMART

We're also seeing operators putting an increasing focus on monitoring their subsea assets. We've seen several new orders for our SMART solutions in the Gulf of Mexico. SMART (Subsea Monitoring, Analysis and Reporting Technology) brings together low-power electronics, long duration data logging, subsea data processing and acoustic telemetry into a single, easily deployed instrument.

Operators see the benefits of this wireless subsea monitoring platform, which lets them log and process data from a range of sensors, including the standard internal six-degrees of freedom sensors.

Navy applications

It's not just about oil and gas. We're seeing increased interest in our proven commercial, off-the-shelf products from the US Navy, resulting in some recent sales, which we look forward to telling you more about. This continues our diversification into the US Defense Market and, alongside it being the 30th anniversary of our move into Houston this year, gives us yet more to celebrate at our annual open house and BBQ in October. Be sure to join us in the celebration.

Middle East, SE Asia

Anthony Gleeson Vice President

We have been seeing an increase in exploration activity across the region and this is translating into new sales in the Middle East, China, Indonesia and Africa.

USBL and marine robotics

In China, seismic companies are preparing for upcoming work, which again will lead to further drilling activity. China is also very active in ocean research. We're

continuing to support their work with our long-range tracking and telemetry USBLs. Our marine robotics systems are in high demand for civil engineering works, like underwater road tunnels, as contractors look to de-risk these challenging projects.

Our recent networking curry night in Singapore was well attended. Thank you all for attending and continuing to make this a successful social event.

LBL and INS demos

As you'll read elsewhere in Baseline, there's significant improvements coming for our LBL and INS clients and we're playing our part in their market release. In November, Perth will be the location for in-water demonstrations and a few weeks later during OSEA, we have the honour of hosting a client reception on the day Fusion 2 is released. Get in touch if you would like to attend.

Finally on a personal note, I'm looking forward to my year as chairman of the Society of Underwater Technology (SUT) Singapore chapter.

THE KNOW HOW

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

Optimised USBL – The important role of vessel-mounted attitude sensors

The positioning accuracy obtainable from a Ranger 2 USBL can be further improved by mounting our premium quality Attitude and Heading Reference System (AHRS), Lodestar, on the top of your vessel's transceiver deployment pole. Known as Optimised USBL, raw range and bearing data is processed with the Lodestar's attitude data, achieving a tightly compensated solution that enables a system accuracy of 0.1% of slant range.

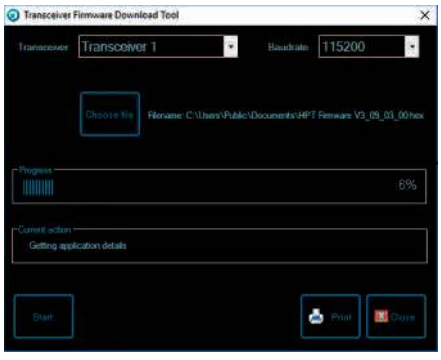
But how does the optimised system relate to vessel frame? For example, if the pole was tilting by 1 degree, how does Ranger 2 know if the vessel itself is tilting that amount, and not just the pole?

In order to normalise the Lodestar's angular mounting to the vessel-frame, separate vessel-mounted attitude sensors must be used. Typically a gyro and VRU, these devices are assumed to have been accurately surveyed by a qualified Surveyor in order to truly report the vessel's pitch, roll and heading.

Ranger 2 has a tool to calibrate the attitude differences, their values are then stored in the software, aligning the Lodestar to the vessel reference frame.

Once the calibration has been performed, data from the vessel-mounted attitude sensors is no longer required, and the optimised system is then able to position transponders relative to the vessel – rather than just to the face of the transceiver. Note that at this point, a CASIUS system verification check should be performed.

Keeping your Ranger 2 and Marksman solutions up to date



If you're a Ranger 2 or Marksman customer, you can perform the software and firmware upgrades yourself. New features are added to the software at regular intervals, making it easier to use and increasing its functionality. So, it's well worth making use of vessel downtime to keep up with the current versions.

The latest versions of Ranger 2 and Marksman now have the required applications to upgrade the Navigation Sensor Hub and Transceiver built in to the software. This allows the upgrades to be performed with the equipment in-situ, making the process relatively simple for the user. All the required firmware is included on the software installation disk with the new version of software. The entire process should only take a couple of hours and, once complete, the system should be ready for work immediately. It is not necessary to change any of the job configuration or installation offsets as these will be carried over from the previous software installation.

It is important that all the hardware and software is kept to the same upgrade level, as new features in the software require certain versions of firmware to operate correctly. If you do undertake the upgrade, be sure to upgrade any spares units at the same time so that they are ready to go, should they be required.

The entire process is covered in your manuals, so you can have a look at the steps required and make sure you are comfortable with the process before starting. For more information, contact our customer support team. Make sure to have your system serial numbers to hand, so they can then provide more details based on the versions you are upgrading from.

Version 6 built for 6G

As a result of 5G equipment being withdrawn from sale last year due to changes in environmental legislation, it is no longer technically or commercially viable to develop and test the code required to support legacy 5G hardware. Therefore, the upcoming major release of Ranger 2 USBL and Marksman LUSBL software, Version 6, will only contain codebase to support 6G hardware such as Compatt 6, HPT, and DPT 6. Version 6 software will also only be compatible with Windows 7 and higher operating systems.

If you wish to continue using your current inventory of 5G equipment, it is essential that you do not upgrade to any release of Ranger 2 or Marksman LUSBL software beyond Version 4.06. We will of course continue to provide your business with technical and operational support for your 5G systems for as long as is reasonably practical. This includes testing and releasing Version 4 software patches if any future 5G-related operational issues are identified. Please contact **support@sonardyne.com** for more details.

Sonardyne
SOUND IN DEPTH

SUBSEA TECHNOLOGY

Total Simplicity

Photo: Ashernet

More capable. More productive. Less complicated

Fusion LBL, Sprint INS, 6G and Wideband. For more than a decade, these core software, hardware and communication technologies have positively shaped offshore survey and construction operations; lowering your risk, saving you time and reducing your costs. This autumn, a new industry standard arrives. Fusion 2 software will streamline your everyday workflows, making the complex simple and removing the need for separate software and topside hardware if your projects involve Sparse LBL. Compatt 6 transponders and ROVNav transceiver also take a step forward. The 'plus' variants look reassuringly similar to the current generation - and are backwardly-compatible with them – but new Wideband 3 signal protocols on the inside open new possibilities. Navigation and telemetry signals are now embedded together, keeping you more informed and in control during critical phases of your operations. Discover more by attending our live events and in-water demonstrations. **Contact your local office for dates and locations**

F2 6G Sonardyne Wideband 3

POSITIONING
NAVIGATION
COMMUNICATION
MONITORING
IMAGING