Unlocking subsea communications

Defence forces the world over know that oceanic capabilities make up an integral role of any military presence. To make an all-encompassing force, aerial, surface and subsea vessels must work together to provide complimentary capabilities. However, while aerial and surface communications systems can be reliably served via satellite, subsea communications options are significantly more complex. A variety of solutions are available today, but with growing unrest in certain world regions, particularly at sea, more and more systems are being rapidly developed.

Subsea communications systems play an important role in a number of sectors, including but not limited to defence forces, governments, oil and gas, scientific research, and the maritime industry. However, subsea communications systems are much more complex than their above-water analogues, since water and unknown obstacles distort wireless transmissions, reducing their effectiveness. Fibre-optic, ocean-bottom cable systems are one widely-adopted option, however, they take a long time to install and are more expensive than wireless options, in addition to having their own technical limitations including noise interference and higher power consumption.

Today’s subsea wireless communications options include:

- Radio frequency (RF);
- Acoustic;
- Free space optical (FSO); and
- Hybrid (iterations of the above three).

Each solution has its own strengths and limitations, including effective range, bandwidth, data rate, immunity from noise, EMI or turbidity, and power requirements. Given the limited options available and the challenges and limitations of each, more effective solutions are still being developed today.

Unmanned underwater vehicles (UUVs)

Unmanned underwater vehicles (UUVs) have been utilised by the military for some time, and are becoming increasingly popular in the commercial and scientific subsea exploration fields.

They have a number of key advantages over manned subsea vehicles, including reduced risk to staff, reduced personnel costs, and providing access to new territories. UUVs fall into two categories:

- Remotely operated underwater vehicles (ROVs): Controlled by a remote human operator.
- Autonomous underwater vehicles (AUVs): Operate independently of direct human input.

Both ROVs and AUVs can be used for search and reconnaissance, to inspect underwater infrastructure, take water samples, assist with oil and gas exploration, create bathymetric maps of the ocean floor, and map marine life.

According to Markets and Markets, AUV development is a heavy focus within the military, while commercial companies and scientific institutions are more interested in ROVs. Indeed, AUVs have been put to excellent use detecting and terminating subsea mines, and in future might be used as weapons platforms.

Irrelevant of their application, all UUVs must be able to relay data to and from a manned headquarter for decision-making. Some underwater vehicles come close to the surface of the ocean, where they deploy long antennas capable of data relay over satellite, however, this is a relatively slow solution. While the unmanned aerial vehicle (UAV) market is booming right now for both military and commercial applications, the lack of effective communications systems is putting a dampener on the UUV market.

This is a significant problem, as UUVs capable of seamless communications with manned and unmanned subsea, surface and aerial vessels could provide a key strategic advantage for military operations.
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Innovative subsea communications solutions
In order to make UUVs a more viable solution for military applications, several companies are developing their own standalone communications systems to bridge the gap between subsea, surface and aerial vehicles.

Liquid Robotics has presented one solution to the UUV communications challenge, which was initially developed in 2007 to listen to whale songs. The Wave Glider, an unmanned surface vehicle (USV) that floats on the surface of the ocean, uses solar and wave power to propel itself for up to one year. Its sensor computer connects a surface radio modem and antenna with an underwater acoustic modem, enabling rapid two-way communications.

In 2014, Liquid Robotics and Boeing partnered to develop a military-grade version called the Sensor Hosting Autonomous Remote Craft (SHARC), which combines the Wave Glider platform with Boeing’s sensor technology. Boeing is working with the Navy’s research lab to develop additional capabilities for SHARC as it sees the platform as a potential communication conduit between UUVs, aircraft, ships and satellites.

“Ultimately, it is a more efficient and effective way to do maritime surveillance, we think, in large ocean areas,” said Egan Greenstein, Senior Director of Autonomous Maritime Systems at Boeing.

AeroVironment has also developed a standalone subsea communications system called Blackwing. The Blackwing system is a small, tube-launched unmanned aircraft that can be deployed from underwater vehicles, as well as surface and land vehicles. It uses an advanced, miniature electro-optical and infrared (EO/IR) payload, Selective Availability Anti-Spoofing Module (SASSM) GPS and AeroVironment’s Secure Digital Data Link (DDL). It was developed as part of a 2013 Navy and US Special Operations Command (USSOCOM) joint capability demonstration known as ‘Advanced Weapons Enhanced by Submarine against Mobile Targets (AWESUM),’ and was completed late in 2015.

“AeroVironment’s new Blackwing unmanned aircraft system is a valuable new capability that resulted from our team’s close collaboration with, and responsiveness to, the US Navy’s undersea warfare community and the Special Operations community,” said Kirk Flittie, AeroVironment’s Vice President and General manager of its Unmanned Aircraft Systems business segment. “In addition to operating from undersea vehicles, Blackwing can also be integrated with and deployed from a wide variety of surface vessels and mobile ground vehicles to provide rapid response reconnaissance capabilities that help our customers operate more safely and effectively.”

In August 2016 at the Annual Naval Technology Exercise (ANTX), the US Navy successfully demonstrated the submarine launch of the Blackwing system and its link with a swarm of UUVs and communication with the submarine combat control system. As well as providing intelligence, surveillance and reconnaissance to submarine commanders, Blackwing also provided a high-speed data and communication relay for Command and Control between geographically separated subsea vessels and surface ships. During the exercise, the DDL relayed real-time information from a manned submarine via Blackwing to and from multiple UUVs.

Military groups are also investing in new designs and innovations under development by small companies and start-ups. In October 2016, the US Navy announced plans to award a three-phase small business innovative research (SBIR) deal to Hydronalix. The deal would see Hydronalix upgrade its micro USV technology and integrate it with existing subsea acoustic communications technology, enabling situational awareness and data relay capabilities.

A small USV would be adapted to function as a mobile gateway buoy to support Fifth Fleet operations, acting as a communications node in a subsea network to help protect manned Navy rigid-hull inflatable boats operating in the Persian Gulf. These boats monitor port operations and perform vehicle inspections, among other tasks. The solution is expected to reduce the need for other Navy boats and aircraft to protect the ships, while enabling more missions to be carried out during bad weather or engagement limitations.

Ultimately, Navy researchers plan to create a field-deployable system to enable Fifth Fleet explosive ordnance disposal forces to communicate remotely and track UUVs involved in locating and destroying enemy mines.

Hybrid UUV solutions
In an alternative route to the standalone systems discussed above, new subsea manned and unmanned vehicles are being developed with integrated systems capable of communicating with surface and aerial assets.

In March 2016, Boeing unveiled the Boeing Echo Voyager, a 51 foot, 50t hybrid UUV, designed to undertake surveillance and reconnaissance missions for defence, commercial and scientific customers for days, weeks or even months. The UUV was expected to begin trials off the coast of California in the summer, although no updates have been posted.

Unlike other UUVs, the Echo Voyager runs off of batteries that it recharges with a diesel generator just below the surface of the ocean, instead of recharging at a nearby ship. While near the surface, it can connect with satellites for data relays without the need for a companion vessel. The Echo Voyager can also communicate with nearby ships while still submerged, offering a more functional solution than typical UUVs that surface for the sole purpose of data relays.

“What we came up with Echo Voyager, was a way to do those same missions without the requirement of a surface ship for the launch and recovery,” said Lance Towers, Director of the Boeing Phantom Works’ Sea & Land Division, which built the UUV. “Any of those missions can now be conducted at a significantly lower cost with the advent of Echo Voyager.”

The Unmanned Warrior exercise
One of the most efficient ways to advance technical capabilities like subsea communications systems is to invite commercial entities to demonstrate their capabilities at specifically-designed exercise events. Additionally, by encouraging commercial groups to invest in research and development, military groups, often constrained by financial budgets, can avoid some of the initial
“This deployment will showcase the capabilities of marine robots the Royal Navy, and other defence and industry partners,” said the NOC’s Russell Wynn, Chief Scientist for the mission. “The results will also inform the wider scientific community of these new technologies as an alternative to manned vessels, which are relatively expensive to operate and have a larger environmental impact.”

The Unmanned Warrior event took place in Scotland in October 2016 to demonstrate how unmanned systems and sensors might integrate into current and future military operations. Approximately 50 aerial, surface and subsea autonomous systems were deployed for surveillance, intelligence gathering and mine warfare roles. Surface vessels were used as communications links between subsea and aerial systems, the aerial vessels acted as communications nodes to connect robots with humans on the shore, while subsea vehicles hunted for mines.

Boeing’s advanced platform technology and sensors were used with Insitu’s ScanEagle UAS, Schiebel’s CAMCOPTER S-100 UAS and Liquid Robotics’ SHARC USV in order to detect, classify and track potentially hostile surface and subsea targets and to expand tactical intelligence available to decision-makers. In addition, Inmarsat, Cobham and Boeing provided high throughput satellite (HTS) services to the Royal Navy to enable full-motion video sharing and large file transfers around the ‘battlefield’ quickly and efficiently.

“These systems can help protect our sailors and marines from some of the Navy’s dull, dirty and dangerous missions, like mine countermeasures. Additionally, these systems can increase our capabilities at a more affordable cost of the conventional systems we currently employ,” said Chief of Naval Research, Rear Adm. Mat Winter. “Autonomy will enable our naval forces to stay longer, see farther, understand more, decide faster, do more, adapt more quickly and, when necessary, be more lethal.”

BAE Systems rolls out first armored multi-purpose vehicle

BAE Systems has rolled out the first prototype Armored Multi-Purpose Vehicle (AMPV) to the US Army during a ceremony at the company’s York, Pennsylvania facility. The AMPV provides the Army with enhanced mobility, survivability, force protection, and combat superiority.

“The AMPV prototype vehicles are the result of a highly collaborative relationship between the Army and our industry team,” said Beach Day, Program Director for AMPV at BAE Systems Combat Vehicles. “Through this relationship, we have been able to design a vehicle that provides a modern, robust solution that meets the needs of today’s soldier and of the future force.”

The AMPV is a fully modern, highly flexible vehicle that includes five variants and is designed to replace the Vietnam War-era M113 family of vehicles. It is a mature, cost-effective solution that leverages proven Bradley Infantry Fighting Vehicle and M109A7 Self-Propelled Howitzer designs. It meets the Army’s force protection and all-terrain mobility requirements that enable the AMPV to maneuver with the rest of the Armored Brigade Combat Team (ABCT). Maximizing commonality within the ABCT reduces developmental risk and provides significant cost savings to the Army. In December 2014, BAE Systems was awarded a contract worth up to $1.2 billion from the Army for the Engineering, Manufacturing, and Development (EMD) and Low-Rate Initial Production (LRIP) phases of the AMPV program. The initial award of $383 million, under the EMD phase, is for development and production of 29 vehicles across all of the variants: general purpose, mission command, mortar carrier, medical evacuation, and medical treatment.

The ceremony commemorated the rollout of the first of the general purpose variant. Deliveries of the prototype vehicles will continue into 2017, and developmental testing will run through 2018.

armasuisse renews its trust in Thales

Thales has been selected by armasuisse for the standardisation of the Full Flight Mission Simulator (FFMS) for the AS532 Super-Puma transport helicopter. Functional upgrades will also be made to the multi-purpose twin-engined EC635 military helicopter.

The standardisation of the AS532 Super-Puma Full Flight Mission Simulator includes the upgrading of the primary flight avionics, radio communications, the digital map, the forward-looking infrared imagery and the helmet-mounted display. Functional improvements will also be made to both simulators, in particular on the instructor station. All of these updates will be delivered to the Swiss Air Force in September 2017. These Thales flight simulators, used by the Swiss Air Force since 2012, meet the Swiss Air Force’s specific pilot instruction and training requirements, improve operational effectiveness, raise levels of crew and operator safety and reduce environmental impacts. The interconnection between these two simulators provides pilots with unlimited scope for training exercises involving formation flying and tactical operations.