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Sharpened focus: SeaSpider homes in on the torpedo threat

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With increased competition in the underwater domain, anti-torpedo torpedoes provide options for offsetting the submarine threat. *Dr Lee Willett* looks at Atlas Elektronik's SeaSpider system.

The Baltic Sea is home to considerable naval activity; NATO, Russian, and even Chinese forces deploy there. Russian and NATO assets joust for operational space, with US Navy ships being 'buzzed' by Russian aircraft and NATO forces shadowed by Russian vessels. In 2014, a year regarded as a watershed in recent NATO–Russia relations, the Royal Swedish Navy (RSwN) cited "foreign underwater activity" as the focus of a week-long October search of Baltic waters in pursuit of a subsurface transgressor.

The Baltic's shallow, restricted waters provide challenging surface and subsurface operating conditions, and provide an important testing area for new technology.

In April 2019, Atlas Elektronik – a naval and maritime electronics company within the thyssenkrupp Marine Systems (tkMS) technology group – announced the completion of the latest testing phase for its SeaSpider anti-torpedo torpedo (ATT) system. The trials demonstrated a "full 'sensor-to-shooter' functional chain of a hard-kill surface ship torpedo defence [SSTD] system with torpedo detection, classification, and localisation [TDCL]" capability for SeaSpider, Atlas Elektronik said in a statement.

The trials were conducted in the Baltic's Eckernförde Bay, from a research and testing vessel operated by the German Bundeswehr Technical Center for naval ships and weapons technology research (WTD – Wehrtechnische Dienststelle – 71). A prototype SeaSpider was fired from an above-water launcher against threats that included Type DM2A3 torpedoes and a Mk 37 torpedo-derived autonomous underwater vehicle. According to Atlas Elektronik, "the threats … were detected and localised with passive and active TDCL, and the attendant data was used to cue the SeaSpider launch. SeaSpider acquired the threats and homed in into closest point of approach [CPA]. Successful 'intercept'-equivalent CPA was verified by acoustic and optical means," the company said.

The trials, part of a longer testing process, took place at the end of 2017; the results were approved for release by WTD 71 after full evaluation of the outcomes during 2018, Atlas Elektronik added.

Torpedo threat

The long-standing torpedo threat to ships and submarines endures. While only three surface ships have been sunk in combat by torpedoes in nearly 50 years, improving submarine and torpedo capabilities are sharpening the underwater focus for NATO navies.

“At the moment, we are facing the situation [where] the submarine and the torpedo threat are in the ascendancy,” said Thorsten Bochentin, Atlas Elektronik’s underwater warfare business development director. The “standard response … for a torpedo danger area is ‘do not enter’,” Bochentin told *Jane’s*. With the submarine and torpedo threat now covering entire seas such as the Baltic or the Gulf, “not entering actually means not operating at all,” he noted.

Technology has delivered recent step-ups in torpedo performance. “We have two major developments,” said Bochentin. “One is, the digital age has finally hit the torpedo”. This has resulted in digital intelligence, with the torpedo now ‘smart’ enough to maintain its own tactical picture and classify and react to contacts; and, for more straightforward torpedoes, the ability to construct their own time and distance diagram using commercial off-the-shelf (COTS) digital electronics. “Couple that with a simple wake-homing device, and you have an unjammable, unspoofable torpedo,” Bochentin argued.

“Digital has also hit the sonar,” he continued. “If you look at the physics of sonar, being able to conduct digital processing enables full utilisation of [sonar’s] physical potential; with passive sonar you are now in the broadband area, and that means sensor capability has had a major improvement. Sonar capability is now such that [the torpedoes] might be inconvenienced by decoys and jammers but they will still hit the target.”

Digital sonar processing offers benefits for ATT concepts, too. As an enabling technology for SeaSpider, “[it] is a bit of the answer to the question of ‘why didn’t you do this in the 1980s?’” said Bochentin. “Digital technology enables [the use of] more compact processing hardware that can be freely programmed to run advanced algorithms. If you contrast that with analog electronics or even the early hybrid digital-analog systems, it becomes clear that only now, in the digital age, can we build the kind of capabilities needed for an ATT into such a small form factor,” he explained.

Technology paradigms

Bochentin argued that SeaSpider addresses two underwater technology patterns. “One is the operational paradigm, where at the moment the torpedo threat poses an incalculable and therefore intolerable risk,” he said.

“The second paradigm is the usual way of operating underwater weapons, with very high effort at the logistical level, with very sophisticated workshop infrastructure and lots of highly trained personnel needed to maintain, transport, configure, and utilise the weapon system. That’s really something we want to change as well,” he added. The company aims to do this by reducing design, maintenance, and logistics costs – total cost of ownership – for example through designing SeaSpider using rocket propulsion and firing SeaSpider from a canister that acts as both its transport and launching mechanism. The ‘canisterisation’ as an ‘all-up-round’ (AUR) approach is designed “to provide the customer with something that is easy to handle, which does not come with a lot of second- and third-order costs”, Bochentin said.

While ATT concepts and technologies have existed for some time, Bochentin argued that the torpedo threat’s enduring nature mandates a dedicated ATT capability. “The real challenge for [an] ATT is the wake-homing torpedo, and only by prior, dedicated design will you be able to surmount it,” he continued. Atlas “[has] been focusing from the ‘get-go’ with our dedicated design to combat the wake-homing torpedo”.

SeaSpider measures approximately 2 m in length and 0.21 m in diameter. It consists of four sections: a rear section; a rocket motor section; a warhead section, containing the unitary warhead (replaced with the exercise payload when required); and a guidance section, including the sonar-based homing system. The use of solid propellant means the rocket motor has no moving parts, with the overpressure generated in the burning chamber converted into thrust by gas emission through the rocket nozzle.

The homing system offers active and passive sensing modes, complemented with intercept functionality for submarine torpedo defence (STD). While SeaSpider’s sensing frequencies are undisclosed, a company factsheet noted that “the active sonar frequency has been specifically chosen for optimal detection capability against wake-homing torpedoes and to ensure no interference from shipboard sensors.” With the wake-homing torpedo as the benchmark, the ATT’s active and passive functionality is “specifically designed to be capable against torpedoes in the attenuation zone of a wake", Bochentin said. "Generally speaking," he explained, "higher frequencies provide for more robust performance of the ATT mission."

The fully digitised control and guidance capability is based around an advanced solid-state microprocessor incorporating an inertial measurement unit, and is designed specifically to provide performance against wake-homing torpedoes and, for STD, intercept capability. SeaSpider operation is also supported by a TDCL sonar fitted to the launch platform.

The unitary effector provides the capability for SSTD and is pre-planned for STD use, although SeaSpider development is focused on surface ship application. Using both a unitary effector and a canisterised launcher means that, when STD is implemented after market introduction on surface ships, "ideally the customer will be able to reconfigure for submarine [or] surface ship torpedo defence", said Bochentin.

As regards the effector, "We are using a proximity fuse with impact backup," said Bochentin. "The trials showed that a direct hit is a distinct possibility, especially out of the wake, against non-wake homing torpedo threats. We don't require a direct hit but we definitely need the impact capability as a backup."

Littoral trials

A surface ship operating in littoral regions will require capabilities optimised to deal with the littoral underwater operating environment, including shallow waters, restricted access, uneven topography, and the impact of surface and sea bed proximity on sonar performance.

"The Baltic is the littoral benchmark in underwater warfare," Bochentin argued. "To be capable in the littorals, you have to benchmark for littoral conditions; if you don't benchmark for littoral conditions, [the system] will not work there." While classification issues meant he would not be drawn on how SeaSpider's active and passive sensors tackle littoral operational challenges, Bochentin said "Any Atlas Elektronik underwater weapon…for the first time sees a real life environment in Eckernförde Bay, and that's 20 m of water depth."

A surface ship operating in littoral regions also will require a close-in, rapid-reaction capability for torpedo defence. While previous SeaSpider designs had included a booster capability to transport the ATT from its launcher to a splash point further away from the ship, trials in the Baltic's confined spaces underlined the need "to reinforce the close-in and rapid-reaction capability," said Bochentin. This had two design implications. First, it "meant getting [SeaSpider] into the water as quickly as possible close to the defended unit…[using] a downward-angled launcher", he explained. Second, it required "a very, very quick reaction of our propulsion system so that we can have instant dynamic buoyancy and therefore launch the ATT in even the shallowest of operational areas".

The incoming threat torpedo is cued for SeaSpider by the ship-fitted TDCL sonar. The TDCL's closed-loop communications links to SeaSpider were a central focus of the recent trials, as part of the emphasis on platform/ATT integration. The TDCL system – a developmental Atlas active towed array sonar with TDCL functionality – detects, classifies, and localises the threat before handing over the data to SeaSpider's ship-based control unit, which provides the ATT with a set of mission parameters based on this input and launches the weapon. "Then we are in the game," said Bochentin. "That's what we successfully did in the now-concluded trials campaign."

There are three options for firing SeaSpider from the launch platform: using a local firing panel control unit (known also as the effector system computer) close to or fitted onto a launching frame; or, in the operations room, using a standalone console or adding software to an existing multifunction console. As regards the 'ops room' console concept, "It's more likely that [any] standalone console would not be a standalone console for SeaSpider but for torpedo defence writ large," said Bochentin. This console could also include TDCL system control.

While an individual SeaSpider is a 'fire and forget' weapon, Atlas is interested in developing the TDCL system to enable it to maintain engagement monitoring so that, when the TDCL sonar delivers a reliable cue assessment, "we might be able to follow a 'shoot, look, shoot' philosophy if the [initial] engagement offers a negative kill assessment," Bochentin explained.

For launch, air pressure in the canister pushes SeaSpider out at a downward angle. The canister itself sits in the launching frame – intended, ideally, to be permanently fitted to the host platform – that provides data and power interfaces.

Canisterisation is central to SeaSpider's development. Presenting SeaSpider as a canisterised AUR capability enables rapid deployment and reduces logistics. "The aim is to certify the entire product with the canister", said Bochentin. The canisters are designed for shipping container transport.

Developing an AUR approach using a canister and launching frame also means numbers fitted to a ship are scalable according to requirement. For larger platforms "like certain high-value units, you will need to distribute the launchers across the length of the ship, port, and starboard", Bochentin said. Smaller ships with shorter sea endurance need fewer launchers. However, ship size, manoeuvrability, and at-sea endurance requirements may mandate a minimum number. Operational endurance can be augmented by an at-sea reload capability.

ATT trials

In the sea trials and R&D campaign concluded in 2018, SeaSpider was launched from a static platform but tackled what Bochentin said was a "fully dynamic" threat for the ATT and the TDCL sonar, with the threat torpedoes "actually [simulating] a dynamic scenario".

The next sets of trials, which are contracted and will take place over the next few years as the programme builds towards planned initial operating availability of 2023–24, are intended to include wake-homing trials where SeaSpider is fired from a moving platform against a torpedo operating in the platform's wake. This, said Bochentin, will be "the major milestone" for the programme. For this next trials phase, he continued, "The end point is being 'on the market'."

Launching SeaSpider

A key step in building towards intended availability in 2023–24 will be securing a launch customer or customers by the right point in that timeframe. While several NATO navies, as well as the NATO Industrial Advisory Group, are assessing SSTD requirements, capabilities, and options, Bochentin did not comment on any potential customers the company is engaged with. The German armed forces have been supporting development and trials to date.

A critical role for a launch customer would be to enable weapons system introduction. "There are some things industry can't do by itself," said Bochentin. "We need a navy as a customer with a capable defence and research establishment to finalise weapons system introduction."

To reach the point of partnering with a potential launch customer, Atlas Elektronik decided – with the support of parent company tkMS – to proceed with company-funded product development. Atlas has teamed with Canada's Magellan Aerospace through a company-to-company contract for the development, certification, and qualification of the explosives for serial production, and also to integrate Magellan's extensive experience in rocket propulsion technology, Bochentin explained.

"The critical path here is qualification and certification of the explosive," said Bochentin. While technology development and testing has taken place with the explosive to date, the production version of the standard blast explosive charge requires full certification under NATO Standardization Agreements (STANAGs) for insensitive munitions, with the entire production of this version being part of the certification process. The lengthened effort and time required to achieve such certification means developing the explosive is a 'critical path' item for SeaSpider's capability, Bochentin added. A key part of the development process for 2019 will be to work with Magellan to begin testing components of the explosive element.

The tie-up between the two companies was confirmed in a press release published on 12 April 2019. According to the statement, "Magellan will lead the design and development of the SeaSpider ATT rocket motor and warhead sections … [including] design, build, test, and product qualification."

More broadly, Bochentin noted that the technologies brought together for SeaSpider have mostly reached Technology Readiness Level (TRL) 6, with some elements close to TRL 7. Here, the company is focusing on maturation of particular elements, such as sonar algorithms. It also is using this well-developed TRL position as "the take-off point for our own investment", Bochentin said.

Another element essential to delivering initial capability – and, thus, another focus area for 2019 – is preparing for simulation of SeaSpider performance. "You can't just literally shoot every variable using the ATT so there is basically a two-pronged process," said Bochentin. "On the one hand, you want to have sea trial data that validates simulation; on the other hand, you want to have a capability with that simulation to go beyond what you have explicitly trialled at sea."

Comment

To give context to the torpedo defence issue, NATO navies are facing underwater threats from the North Atlantic to the Baltic and to the Eastern Mediterranean regions. NATO commanders have pointed publicly to Russia's greater levels of submarine activity and capability. Arguably, the risks are not just theoretical: in April 2018, for example, UK and Russian media reported a Russian Kilo-class diesel-electric submarine presence in the vicinity of US, UK, and French forces preparing to conduct strikes in Syria.