US planning advanced submarine sensing and hunting technologies for Russian ultra quiet submarines

Russia is seeking to further bolster its sub-surface capabilities, with new generations of conventional and nuclear propulsion submarines, which promise to be significantly more difficult to detect and track for western naval forces. This includes the Yasen, Lada, Borei and Kalina classes of submarines.

Submarines are one of deadliest weapons which are hardest to detect, literally a pile of submerged nuclear weapons ready to unleash widespread destruction with single command. In case of a nuclear war the stealthy submarines have a greater chance of surviving the first strike. Once on high alert the boats can leave their bases stay undetected for months and can carry and fire missiles that could sink even the sturdiest ship and flatten entire cities.

DARPA considers ultra-quiet as well as highly lethal submarines as an asymmetric threat and in response has launched the Distributed Agile Submarine Hunting (DASH) program that intends to reverse the asymmetric advantage of this threat through the development of advanced standoff sensing from unmanned systems.

DARPA has awarded BAE Systems a $4.6 million contract for its Mobile Offboard Clandestine Communications and Approach (MOCCA) program. The MOCCA program's goal is to enable submarines to detect other submerged vessels at greater distances, while minimizing the risk of counter-detection.

"With the resurgence of near-peer competitors and an

increasing number of submarines, MOCCA technology will provide Navy submariners with a vital asymmetrical advantage against a rapidly proliferating undersea threat.” Geoff Edelson, director of Maritime Systems and Technology at BAE Systems, said in a written statement.

DARPA is also developing the ASW Continuous Trail Unmanned Vessel (ACTUV), a 40-meter long state of art unmanned vessel built specifically to track quiet diesel-electric submarines, at a fraction of their size and cost. DARPA believes using large numbers of inexpensive unmanned ACTUVs are a way to counter submarines as an undersea component of anti-access warfare.

DARPA program manager Ellison Urban, quoted by Defense One, explains the rationale behind the U.S. Navy’s push for robot ships: Instead of chasing down these submarines and trying to keep track of them with expensive nuclear powered-submarines, which is the way we do it now, we want to try and build this at significantly reduced cost. It will be able to transit by itself across thousands of kilometers of ocean and it can deploy for months at a time. It can go out, find a diesel-electric submarine, and just ping on it.

Russian Super stealth submarine threat and US Response

Russia has been devloping super quiet submarines like new lada-class diesel electric submarines. “The stealth capabilities of Russia’s new Lada-class diesel-electric submarines far exceed those of their predecessors, Admiraty Shipyard’s CEO Alexander Buzakov told the Russian press.

“According to Buzakov, the new vessels are even stealthier than Russian Kilo-class submarines, thought to be one of the quietest diesel-electric submarine classes in the world and dubbed “black holes” for their ability to “disappear” from sonars. “The new submarines are able to maintain such a low profile thanks to a clever implementation of a next-generation anti-reflective acoustic coating and a new improved hydro-acoustic system, Buzakov said

Russia’s super-quiet “Improved Kilo” class or Varshavyanka class submarines also possesses an extended combat range, and its relatively small size helps it maneuver in shallow waters.

for more information on Russian Submarines: http://idstch.com/home5/international-defence-security-and-technology/military/sea-232/russia-enters-its-first-in-the-series-of-six-varshavyanka-class-diesel-electric-submarines-into-service-under-plan-to-boost-crimea-based-black-sea-fleet/

“The emerging security environment lays bare the urgent need to regenerate maritime patrol capabilities in Europe and more broadly enhance not only antisubmarine warfare but also maritime domain awareness across the maritime domains in and around Europe,” said Magnus Nordenman, Director for the Transatlantic Security Initiative. “Airborne systems to provide MDA, and maritime patrol aircraft (MPAs) in particular, stand out among the most important and urgent of these maritime requirements. Maritime patrol aircraft fulfill a number of roles, from high-end Anti-Submarine Warfare and Anti-Surface Warfare (ASuW) to maritime Intelligence, Surveillance, and Reconnaissance (ISR), and search and rescue at sea.”

U.S. Defense Secretary Ash Carter called for “a continuous arc

of highly capable maritime patrol aircraft” to meet the challenge of increasingly sophisticated and active Russian submarines at the boundary of the North Atlantic. It’s an important call to replace a depleted capability – and it will require a special kind of cooperation to make happen.

US Navy seeking advanced sub-hunting technology

The U.S. Navy wants to upgrade its ability to detect Russian submarines in response to assertive naval moves by President Vladimir Putin.

The Navy is seeking to deploy a sophisticated surveillance device made by Lockheed Martin Corp. in the Atlantic Ocean. The device, towed by a ship, already is in use in the Pacific. As soon as mid-2016, the service also wants to send to the Atlantic a prototype networked “undersea sensor system” that “addresses emergent real-world threats,” according to a Defense Department budget document.

The prototype sensor network will be best used “in a choke point like Gibraltar” or a stretch of the North Atlantic from Greenland and Iceland to Britain, where Soviet submarines transited during the Cold War, Bryan Clark, a naval analyst for the nonpartisan Center for Strategic and Budgetary Assessments, said in an email.

The Navy proposals are evidence that “the U.S. military views Russian submarine activity in the Atlantic as both an immediate risk and an emerging long-term threat,” said Tom Spahn, a Navy reservist who writes on undersea warfare issues. The projects may be part of a strategy “to replace or upgrade our aging” undersea sensor system of hydrophones – underwater

microphones – “made famous during the Cold War, which again points to Russia as the target,” Spahn said

DARPA’s Distributed Agile Submarine Hunting (DASH)

DARPA’s program Distributed Agile Submarine Hunting, or DASH, effort is to find an adversary’s quiet submarine using advanced standoff sensing from unmanned underwater systems.

Through a scalable number of collaborative sensor platforms that use multiple sensing modalities, the program will demonstrate system solutions to detect and localize submarines over large areas in both shallow and deep water environments.

Two complementary prototype systems – part of DARPA’s Phase 2 development effort in the Distributed Agile Submarine Hunting program – have demonstrated functional sonar, communications and mobility at deep depths in recent tests, it said.

DARPA’s Bistatic Sonar System under Mobile Off board Command and Control and Approach (MOCCA) program.

Most sonar systems are monostatic, in that the transmitter and receiver are in the same place. But DARPA wants a Bistatic sonar describes wherein the transmitter and receiver(s) are separated by a distance large enough to be comparable to the distance to the target. Bistatic sonar system for anti-submarine warfare (ASW) would be able to provide long range of active sonar without compromising the stealth of U.S. attack submarines.

Whereas surface ships conducting anti-submarine warfare can use a combination of active and passive sensors, submarines use passive detection systems to listen to their surroundings

without putting out any pings, to maintain their own stealth. According to a Broad Agency Announcement released last year at the start of DARPA's Mobile Offboard Clandestine Communications and Approach (MOCCA) program, MOCCA would leverage the benefits of active sonar systems while protecting the submarine's location, since the pings would be coming from a UUV at some unknown distance from the submarine.

Under MOCCA program, an attack submarine shall launch a small UUV 21 inches in diameter or smaller, and may operate in littoral waters, the bottom of the ocean and other challenging environments.

The UUV will carry a small but powerful sound projector, which shall transmit sound pings of high volume The sound reflected by enemy submarines shall be received by attack submarine and be used to detect and track enemy submarines at long ranges.

The submarine will need the ability to coordinate the operational functions of the supporting UUV. Thus, the program must also demonstrate the ability to achieve reliable clandestine communications between the host submarine and supporting UUV without sacrificing submarine stealth.

DARPA researchers want an active sonar with an active sonar projector small enough for UUV operations; and bistatic active sonar processing. This will involve developing high-output transducer materials, and a sonar projector that is as energy-efficient as possible.

Researchers want the ability to focus the projected acoustic signal in a direction of interest. The goal is to produce practical and flexible designs for the projector that can scale for several different UUVs and deployment options.

The program is looking for companies to develop compact power-efficient sonar projector bistatic sonar processing advancements in reverberation and clutter rejection as well as precision localization capability and secure undersea

communications technology.

DARPA has awarded BAE Systems a $4.6 million contract for its MOCCA program

The U.S. Defense Advanced Research Projects Agency (DARPA) has awarded BAE Systems a $4.6 million contract for its Mobile Offboard Clandestine Communications and Approach (MOCCA) program. “Advances in maritime technology are critical to the Department of Defense and an area where the U.S. military can continue to strengthen its advantage,” Geoff Edelson, director of Maritime Systems and Technology at BAE Systems, said in a written statement.

To meet the MOCCA program’s ambitious Phase 1 goals, BAE Systems’ researchers will design efficient sonar capabilities to maximize detection range and improve target identification and tracking, BAE developers say.

“An ideal link would have a low probability of intercept and of exploitation and provide high link reliability,” DARPA states.

Technical Challenges

The MOCCA program has two key technical challenges:

1) Development of an active sonar system, which includes a small form factor active sonar projector suitable for UUV operations and bi-static active sonar processing

A small UUV is disadvantaged as a host for an active sonar projector. The volume available for the projector is highly

constrained which makes high-output transducer materials a necessity. At the same time, the UUV is energy-limited, so the projector must be as energy efficient as possible.

Innovative sonar transducer concepts and designs should consider high-drive materials, efficient power-amplifiers, and compact array projector configurations that will optimize sound output in a UUV volume-and-energy constrained package.

Relatively long-range ensonification is required, so the ability to focus the projected acoustic signal in a direction of interest is needed to provide additional effective source level at the cost of a requirement to scan the sonar to produce the needed coverage. The goal is to produce practical and flexible designs for the projector that can be scaled for multiple vehicles and deployment options.

The acoustic projector should be dynamically steerable to focus acoustic output in directions of interest. This feature will maximize detection performance and minimize the counter-detection risk to the operating host submarine. MOCCA sonar projector frequency bands must be compatible with current US Navy submarine sensors.

Bi-static sonar processing advancements are needed in the area of reverberation and clutter rejection as well as precision localization capability. The system will be operated in bottom limited acoustic environments. Sound that is projected will be scattered, producing reverberation and signal loss. Scattered sound may inadvertently illuminate the host submarine and possibly compromise stealth. For this reason, detailed and accurate predictions of the acoustic environment are important to manage the sonar and potential exposures.

2) Design and implementation of a secure and

reliable communications link to provide positive control of a UUV operating at a significant distance from its host submarine

The communications link between the host submarine and the UUV will be used to control the UUV and its sonar payload, and to communicate information generated on the UUV back to the host platform. The MOCCA system will be used during an engagement, so proper control of the UUV is critical. Link throughput, delay, and reliability trades should consider the need for reliable operation during combat.

The MOCCA communication system designs may include acoustic, optical, and relayed Radio Frequency (RF) signaling modalities that are compatible with existing submarine systems and tactical operations. The fundamental attributes of this link are: (1) Significant communications range (2) Secure and reliable UUV control (3) Ability to preserve the host submarine stealth

MOCCA communications will be evaluated for Low Probability of Intercept and Low Probability of Exploitation (LPI/LPE) characteristics on a continuing basis. The MOCCA communications link cannot degrade submarine stealth.

System Considerations

MOCCA technologies must be compatible with US Navy submarines and submarine-delivered UUVs for future development and demonstration efforts. The MOCCA program will not develop a UUV, but MOCCA sonar and communications payloads should be designed for integration into submarine-launched UUVs with a maximum diameter of 21 inches.

MOCCA sonar and communications data transmission, collection, and processing cannot impact existing submarine operations – the MOCCA submarine processor and display will be adjunct

equipment approved for on-board submarine operation and interface with submarine systems. Digital sonar signal data will be available for MOCCA sonar processing at the output of submarine sensor signal conditioning and analog-to-digital conversion processing.

MOCCA communications will be evaluated for Low Probability of Intercept and Low Probability of Exploitation (LPI/LPE) characteristics on a continuing basis. The MOCCA communications link cannot degrade submarine stealth.

Transformational Reliable Acoustic Path System (TRAPS) Passive Sonar Node

The first prototype is the Transformational Reliable Acoustic Path System (TRAPS) developed by a team led by Science Applications International Corp. It is an expendable, low-size, weight and power (SWaP) fixed passive sonar node for large-area coverage and operates from the deep seafloor.

The significant field of view, along with the advantage of low-noise phenomena at extreme depths will permit a scalable number of collaborative sensor platforms to detect and track submarines over large areas. These nodes will communicate to a stationary surface node via wireless acoustic modems, with further secure RF reach back to the performer’s facilities via satellite.

Under Phase 3 of the contract, SAIC will expand the number of prototype nodes to demonstrate a scalable distributed system prototype system to detect quiet submarines.

SHARC unmanned surface vessel to Monitor ASW Sensors and transmit data to satellites

An unmanned ocean glider developed by Liquid Robotics is destined to be the uplink for antisubmarine warfare acoustic sensors planted on the bottom of the deep ocean.

Liquid Robotics' SHARC (Sensor Hosted in Autonomous Remote Craft) will be part of a battery-operated ASW array of sensors designed to passively monitor submarine movements. SHARC is an unmanned surface vessel that looks like a large raft. It is equipped with solar cells for electrical power for its mission systems and it equipped with a radio for uplink and downlink. A set of wings suspended from the floating raft into the deep provide the propulsion for the SHARC, using the ocean's wave energy. The SHARC's navigation is programmed through waypoints. The SHARC also can tow an acoustic array for submarine detection and tracking.

Gary Gysin, president and chief executive officer of Liquid Robotics, told Seapower that the SHARC is part of the rapidly deployable TRAPS system that can be planted in a body of water to create an acoustic surveillance barrier at locations such as a choke point. A SHARC can monitor several bottom acoustic sensors called nodes. As a submarine makes a transit near one of the nodes, the node will record its acoustic signature. The SHARC can interrogate the nodes, collect the recording and uplink the data vie Iridium satellite to an aircraft, ship or ground station.

SHARC is equipped with an Automatic Identification System receiver to enable it to identify shipping and avoid traffic.

Submarine Hold at RisK (SHARK) autonomous unmanned underwater vehicle (UUV)

DARPA, will be testing its latest “submarine drone,” that is, a prototype of SHARK (Submarine Hold at RisK). SHARK is a loitering autonomous unmanned underwater vehicle (UUV) to detect and track submarines in the deepest regions of the ocean. It will provide a mobile active sonar platform to track submarines after initial detections are made.

The SHARK, is designed to exploit long-range acoustic propagation in the deep ocean, an industry spokesperson told IHS Jane’s at the annual DARPA Day at the Pentagon in Washington, DC, on 11 May. SHARK uses long-range active sonar mounted on the front and a receiver array mounted along the side. The UUV can change the steering angle of the sonar and the position of the receiving array so that the array is broadside of the target, he noted.

The UUV is approximately 3,300 lb (1,496.8 kg) dry weight. The 23 ft (7 m) long UUV is designed to dwell at depths of up to 6,000 m until called into action. SHARK is powered by a lithium polymer battery that can provide about 24 hours of endurance, including sonar operations. The vehicle has other features for deep-water operations, he added. “The housing uses aluminum ceramic instead of titanium or aluminum [to achieve the required lower weight] that is much more appropriate for a UUV.

SHARK uses a variable-buoyancy system to enable it to loiter and help with endurance so that the system is not struggling to maintain buoyancy. For safety purposes the UUV has a drop weight that it releases to enable it to quickly rise to the surface.

SHARK was developed by a team led by Applied Physical Systems and the UUV conducted successful deep dive testing in February 2013. DARPA said the prototypes are scheduled to demonstrate

their core sonar functionality together and that subsequent development efforts will follow, including using multiple sonar nodes with TRAP and integrating the SHARK with its sonar.

The program will achieve breakthrough technology for longrange detection and classification, communications, energy management, sensor and platform integration, and robust semiautonomous processing and control for distributed sensing platforms.

For the vast shallow continental shelf areas, the program similarly adopts distributed mobile sensors, but instead leverages insights in non-acoustic sensing from above. Once a wide-area sensor provides an initial indication of a possible target, the forward deployed Anti-Submarine Warfare (ASW) Continuous Trail Unmanned Vessel (ACTUV) will then rapidly "sprint" to the area and use its own sensors to assess the contact.

Anti-Submarine Warfare Continuous Trail Unmanned Vessel (ACTUV) (Unmanned Surface Vessel)

The U.S. Navy is preparing to take full control of the Anti-Submarine Warfare (ASW) Continuous Trail Unmanned Vessel (ACTUV) program and procure a second craft. The ACTUV enemy submarine hunter is expected to be about 130 feet long. Its extremely slender hull form has a composite fiberglass shell and a foam core to provide structural resilience in conditions up to Sea State 7.

The craft is an unmanned surface vehicle (USV) designed to operate and patrol autonomously for 60-90 days straight, being able to track quiet diesel-electric submarines and avoid

surface ships by itself. The ACTUV is designed to out-endure any diesel-electric submarine, even those equipped with Air Independent Propulsion (AIP) at a fraction of their size and cost. Once the enemy sub is spotted it could guide other U.S. naval assets to the vessel's location to destroy it.

In addition to hunting enemy subs, ACTUV will be capable of a wide range of missions, such as reconnaissance and counter-mine deployments. It could also be useful to resupply troops.

A suite of sensors "capable of tracking quiet, modern diesel electric submarines" will be implemented, including very high frequency sonar that will produce an "acoustic image" of the target to identify and classify the specific submarine. ACTUV will be smart, it will not just identify other vessels, but also predict how they will behave.

The vessel was commissioned in April 2016, and in a couple weeks will be sent to San Diego, where DARPA and the Office of Naval Research (ONR) will begin a two-year-long trial period to test the concept and various sensors that can be installed on the 145-ton full load displacement vessel. DARPA will conduct the initial trials and turn the vessel over to ONR later this year. The test phase will run through September 2018.

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