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Research Efforts in Wide-Area Ocean Surveillance

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The Defense Systems Information Analysis Center (DSIAC) was asked to identify key contributors to Department of Defense research efforts in the area of wide-area ocean surveillance. DSIAC searched open source documents for relevant information, which was compiled into a report and delivered to the inquirer. Key contributors were organized by government, academia, and industry, followed by a summary of each organization's research.

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The Defense Systems Information Analysis Center (DSIAC) is a DoD IAC sponsored by DTIC to provide expertise in nine technical focus areas: weapons systems; survivability and vulnerability; reliability, maintainability, quality, supportability, and interoperability; advanced materials; military sensing; autonomous systems; energetics; directed energy; and non-lethal weapons. DSIAC is operated by SURVICE Engineering Company under contract FA8075-14-D-0001.

A chief service of the DoD IACs is free technical inquiry (TI) research, limited to 4 research hours per inquiry. This TI response report summarizes the research findings of one such inquiry jointly conducted by DSIAC.

ABSTRACT

The Defense Systems Information Analysis Center (DSIAC) was asked to identify key contributors to Department of Defense research efforts in the area of wide-area ocean surveillance. DSIAC searched open source documents for relevant information, which was compiled into a report and delivered to the inquirer. Key contributors were organized by government, academia, and industry, followed by a summary of each organization's research.

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1.0 TI Request

1.1 INQUIRY

Who are the key contributors to Department of Defense (DoD) research efforts in the area of wide-area ocean surveillance and what are their contributions?

1.2 DESCRIPTION

Key government, academia, and industry contributors to DoD wide-area ocean surveillance research were identified and their efforts were summarized.

2.0 TI Response

The U.S. military has been faced with an increasing demand for wide-area ocean surveillance. Estimates of the positions and identities of high-interest targets and the surrounding area over large ocean areas need to be maintained for effective command and control. Due to the need for complete, persistent, and accurate surveillance in tactical maritime situations, multiple organizations are conducting research relevant to wide-area ocean surveillance.

2.1 GOVERNMENT RESEARCH EFFORTS

2.1.1 Defense Advanced Research Projects Agency (DARPA)

DARPA has participated in a variety of programs and research efforts over the past decade that are relevant to wide-area ocean surveillance.

Distributed Agile Submarine Hunting (DASH)

The DASH program developed prototypes that demonstrated functional sonar, communications, and mobility at great ocean depths. Research efforts were aimed at finding an adversary's quiet submarine using advanced standoff sensing from unmanned underwater vehicles (UUVs). Deep sonar nodes were also used to operate deep in the open ocean with wide fields of view to find overhead submarines [1]. Applied Physical Systems (APS) intended to provide a mobile active sonar platform to track submarines after initial detections were made. The platform was to be used with DARPA's Submarine Hold at Risk (SHARK) prototype, another UUV. DARPA awarded a contract to Leidos in 2014 for a two-year Phase Four of the DASH program with the goal of enabling the U.S. Navy to use the technology to support a broad range of acoustic surveillance missions [2].

Deep Sea Operations Program

In 2010, DARPA participated in the Deep Sea Operations program, which researched surveillance that operates at extreme ocean depths to detect quiet submarines overhead. The system would be developed for antisubmarine warfare to help protect U.S. Navy aircraft carriers and their support vessels from quiet enemy attack submarines [3].

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

DARPA has been developing an unmanned vessel optimized to robustly track quiet diesel electric submarines. This vessel would also allow the U.S. Navy to detect, identify, and attack enemy ships [4].

Ocean of Things Program

In 2017, DARPA launched their Ocean of Things program which seeks to enable persistent, maritime situational awareness over large ocean areas by deploying thousands of small, low-cost floats that could form a distributed sensor network. Each float would contain sensors to collect environmental data such as ocean temperature, sea state, location, and data about vessels, aircraft, and maritime mammals in the area. The floats would transmit data via satellite to a cloud network for storage and real-time analysis [5]. Figure 1 showcases the basics of how the program would operate.

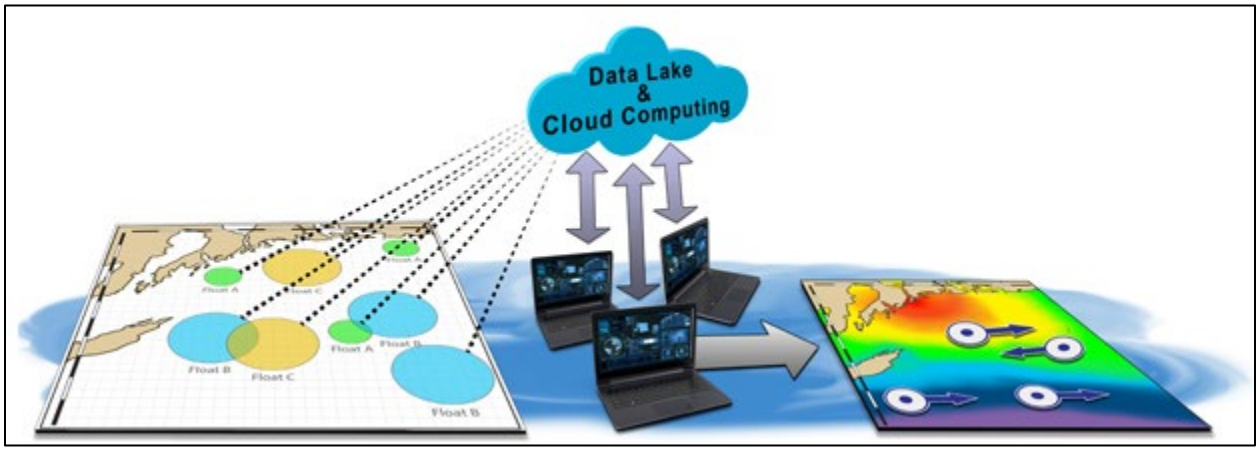

Figure 1: Basic Operation of DARPA's Ocean of Things Program *(Source: [5])*.

Sensors would float along the surface for at least one year, transmitting short messages via the iridium satellite constellation back to a central location for analysis. A goal of the program is for the data analytics portion to develop algorithms to automatically detect, track, and identify nearby vessels [6].

2.1.2 Office of Naval Research (ONR)

ONR's Ocean Engineering and Marine Systems program invests in applied research and advanced technology development to support development of new capabilities for ocean engineering and Naval Special Warfare (NSW), among other areas. The program seeks to accelerate the transition of basic research into advanced maritime platform systems with applications to unmanned surveillance and monitoring systems for the naval forces and at-sea experimental capabilities for the ocean sciences community. NSW is a component of the U.S. Special Operations Force and focuses on two core missions: special reconnaissance and direct action. Topics of interest to NSW include intelligence, surveillance, and reconnaissance sensors, among many others [7].

Another relevant research effort ONR undertook in 2016 is the Unmanned Warrior 2016 Mission Theme: Intelligence, Surveillance, Targeting and Reconnaissance. Part of this effort included the Airborne Computer Vision (ACV) computer, which can be hosted onboard multiple unmanned systems (UxSs). The ACV computer can mimic aspects of human-level analysis of imagery collected by UxSs and can autonomously detect, classify, identify, and geolocate maritime vessels at sea and in port. Vessels are classified by size, 3-D shape, and color, followed by pattern matching to compare detected vessels against a library for positive identification. Measurements are collected to determine the position of the vessel, and if the vessel meets predefined criteria, the Fleet is provided with an alert [8].

2.2 ACADEMIA RESEARCH EFFORTS

Research at academic institutions can often result in useful prototypes and knowledge for the DoD. The universities discussed in the following sections are conducting research that may be applicable now or in the future throughout the DoD.

2.2.1 Johns Hopkins University Applied Physics Laboratory (JHU APL)

JHU APL has a Sea Control Mission Area that focuses on integrated undersea surveillance systems. They focus on solving critical challenges for the Navy's undersea surveillance community, while making contributions including active and passive sonar processing algorithms for inclusion in the Advanced Surveillance Build tactical sonar modernization program. JHU APL has also been given direction to complete testing and evaluation for the Surveillance Towed Array System (SURTASS) and to develop modular, quick-reaction, mobile surveillance system capabilities to extend the SURTASS presence world-wide [9].

2.2.2 Naval War College

The Naval War College has researched ideas and concepts to avoid an enemy's ocean surveillance in times of war. Techniques include, but are not limited to, dispersion, electronic warfare, force-level maneuver, and jamming [10].

2.2.3 Naval Postgraduate School

Research at the Naval Postgraduate School has examined the integration of ocean glider unmanned surface vehicles (USVs) and UUVs in support of wide-area oceanographic and acoustic sampling. These collaborative systems could enable the Navy to conduct multimonth maritime surveillance. An experiment in Monterey Bay evaluated the underwater gliders as mobile, passive, acoustic sensing platforms. Acoustic propagation modeling was used to plan experiment geometry, predict transmission loss, and estimate acoustic communications performance with a USV. Results demonstrated that gliders are effective mobile platforms to support persistent acoustic sensing [11].

2.3 INDUSTRY RESEARCH EFFORTS

There are multiple key contributors in industry that follow current research and market demands, including wide-area ocean surveillance. Companies are developing products to meet the demands expressed by the military and the DoD.

2.3.1 Northrop Grumman

Northrop Grumman has built the MQ-4C Triton, also called the Broad Area Maritime Surveillance (BAMS) unmanned aerial vehicle (UAV), to fly maritime surveillance missions as long as 24 hours at altitudes of more than 10 miles high to enable coverage out to 2,000 nautical miles. The UAV's suite of sensors can detect and classify different types of surface ships automatically. The Triton is part of the Navy's strategy for conducting surveillance of surface ship and submarine traffic in the Pacific and other oceans. It's able to work with the Navy's P-8A Poseidon manned maritime patrol aircraft. The Triton's search radar is called the Multi-Function Active Sensor (MFAS) and provides a 360° view of a large maritime area while providing all-weather coverage for detecting, classifying, tracking, and identifying surface ships and other targets of interest [12].

2.3.2 Raytheon

The Naval Surface Warfare Center Crane Division announced a $7.2 million contract to the Raytheon Co. Space and Airborne Segment, for three AN/DAS-3 Multispectral Targeting System (MTS) sensors for low-rate initial production versions of the Triton UAV. The AN/DAS-4 is the latest version of the Raytheon MTS family of electro-optical sensors and incorporates greater fire control and target location accuracy for precise targeting coordinates [13].

Raytheon also developed the SeaVue XMC (eXpanded Mission Capability) radar, a next-generation maritime situational awareness package developed during the Ocean Surveillance Initiative (OSI) program sponsored by the U.S. Navy. This radar can automatically detect, track, and sort thousands of maritime targets simultaneously and then correlate the radar tracks with Automatic Identification System (AIS) contact. The system geographically registers radar

detections to AIS data and digital nautical chart features for more precise tracking, threat location, and accurate cross-sensor cueing to the electro-optic system [14].

2.3.3 BAE Systems

BAE Systems provides high-resolution, airborne, persistent surveillance; identification systems; and signals intelligence. The Airborne Wide-Area Persistent Surveillance System (AWAPSS) is an eye in the sky that provides decision makers with useful and focused information. AWAPSS simultaneously collects registered, 100-megapixel visible and infrared images at one or two frames per second across an 8-km diameter radius. It can be installed on a fixed-wing, lighter-than-air or rotary aircraft and is monitored by a staff member [15].

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