OBJECTIVE: Develop an Artificial Intelligence (AI) Software-based Autonomous Battle-space Monitoring Agent (SABM) with the capability to augment or assist combat systems console operators in maintaining Situational Awareness (SA) of tactically relevant changes occurring within the ship’s Area of Responsibility (AOR).

DESCRIPTION: The current AEGIS Combat System implementation does not include a comprehensive distributed (that is, multi-platform) capability for capturing the complete battle-space operational, environmental, and tactical picture in a coherent integrated manner. Currently available commercial systems and software that might be considered for adaptation to partially address the Navy’s combat systems requirement for advanced situational awareness (e.g., the FAA Air Traffic Control System hardware and software) are dated in their designs. Their ability to integrate, support, or coordinate with stand-alone (i.e., autonomous) DoD-sourced or 3rd-party software applications in a real-time manner is minimal or non-existent. Additionally, the currently available commercial technology mentioned above is limited in that it lacks the capability to track, identify, and manage complex air, surface, and subsurface entities and threats present in a combat environment. Since no viable commercial alternatives exist or can be adapted to address these needs, it becomes necessary for the Navy to pursue a different avenue of exploration.

The Navy needs an AI Software agent intended to function within the AEGIS Combat System (BL10 or later) and a Common Core Combat System (CCCS) prototype combat system implementation and associated Distributed Common Operational Picture (DCOP) subsystem. A new capability needs to be developed within AEGIS to present a Common Operational Picture (COP) to the combat system’s watch stander. The capability will provide the watch stander with complete SA. The technology will include detailed engagement-quality track data, identification data from various sources, estimated platform sensor or weapons capabilities derived from organic and non-organic databases, and observationally-derived behavioral data for each tactically relevant entity within the battlespace. The subsystem must be modular in nature and support the sharing of the COP across all participating platforms within the battlegroup in a manner that insures the data coherence of the COP on every platform. In order for such an AI-based software application to function within AEGIS, a DCOP software subsystem must be integrated within the AEGIS Combat System, or alternately, a suitable set of ancillary data collection algorithms must be developed to acquire the relevant data needed for the AI algorithm from data sources currently available within the AEGIS Combat System.

An AI-based autonomous SABM, when operating within an appropriate CCCS Ecosystem software environment or equivalent, and when given data access to a CCCS DCOP implementation or AEGIS equivalent, will provide the Combat System (CS) watch stander with an autonomous SA monitoring capability focused on augmenting the ability to successfully execute the mission. SABM will perform analytical monitoring tasks utilizing data derived from a combat-system supported accessible DCOP subsystem capable of providing both detailed real-time observable and known historical parameters exhibited by all observable battle-space entities within the AOR. The solution technology must be an architectural model, software framework and Algorithm description, with an outline for a functional SABM implementation.
AI has significantly advanced with the development of “Deep Learning” algorithms [Ref. 4]. These algorithms have led to the commercial development and deployment of several software AI products, such as Siri, Cortana, and Alexa, which endeavor to assist individuals in accomplishing routine daily tasks with a minimum of confusion, reduction in required time, or specifically directed research. Implementing an autonomous software agent battle-space monitor within a CCCS/DCOP (or equivalent AEGIS-based) combat system that leverages currently existing AI algorithms similar to the ones mentioned above [Refs 2, 3] could be extremely advantageous. Such an autonomous agent, utilizing the development of new combat-systems focused AI-based analytical algorithms, will advance the ability of CS watch standers to monitor dynamically changing tactical environments. The autonomous nature of such a software agent will allow it to function without the need for CS watch standers to constantly reconfigure the agent manually to adapt it to dynamically changing battle-space conditions.

Multiple independent SABM Agent instances, executing both within the organic ship CCCS Ecosystem as well as within non-organic CCCS Ecosystems (for example those hosted on other battle-group CCCS compliant surface platforms), should be capable of exchanging data and coordinating their analytical processes. Such analytical coordination and data exchange efforts should be capable of crossing surface platform computational boundaries (such as organic and non-organic coordination between surface platforms within the battlegroup) when necessary. The CS watch stader should have the ability to configure each SABM agent instance by identifying appropriate tasks and goals, configuring customized alerts, and defining behavioral traits and patterns which, when associated with existing battle-space entities, will help to identify potential ship threats. Each SABM agent instance should be capable of autonomously prioritizing ship tactical threats and, when coordinating with other organic and non-organic SABM instances, identifying and prioritizing threats and other battle-space AOR situational and environmental issues tactically relevant to the task group and mission.

The SABM architectural model, software framework, and AI Algorithm set will function within a software environment modeled on the CCCS/DCOP architecture and software framework.

Any architecture, software framework, or AI Algorithm set developed in response to this topic will be modular in nature and utilize open systems-based design principles and standards [Ref. 5], and well-defined and documented software interfaces. Architectural implementation attributes will include scalability and the ability to run within the computing resources available within the AEGIS Combat System BL10 or later hardware-computing environment.

The requisite algorithms, as well as any hosting system requirements, should be architected around modular principles with eventual utilization of the CCCS Ecosystem CS Application environment and DCOP battlespace situational awareness subsystem, and eventual implementation and integration within the AEGIS Combat System (BL10 or later). It should be noted that any potential Phase II and Phase III extensions would potentially require such implementation constraints.

The software implementation of the prototype SABM agent shall be capable of installation and integration within a prototype CCCS Ecosystem with access to a prototype DCOP battle-space situational awareness subsystem (or AEGIS equivalent). The target execution environment will be hosted on a Linux (Redhat RHEL 7.5/Fedora 29/Ubuntu 18.4.1 or later) processing environment as a standalone application (that is, no critical dependencies on network-based remotely hosted resources, save for sensor data emulators and network-based connections to other running CCS instances). The prototype SABM agent implementation will demonstrate the following: First, it must demonstrate the ability to successfully monitor the battlespace DCOP and successfully perform DCOP data/potential threat analyses. Second, it must develop ship and battle-group-prioritized tactical threat lists and identify tactically relevant battle-space issues. Third, it must generate associated watch stader alerts. Lastly, it must demonstrate agent coordination across 2 or more independently executing SABM instances, one of which will be hosted on a separate computing platform hosting an independent (but network accessible) CCCS Ecosystem instance.

Any prototype must demonstrate that it meets the capabilities described above during a functional test to be held at an AEGIS or Future Surface Combatant (FSC) prime integrator supported Land Based Test Site (LBTS) identified by the Government, and capable of simulating an AEGIS BL9 compatible or newer combat system hardware test environment.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.
PHASE I: Design a concept outlining the architectural model, software framework and AI-based algorithms needed to implement an Autonomous SABM. Establish feasibility through modeling and analysis commensurate with the design requirements outlined in the Description. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Design, develop, and deliver a prototype software implementation of a SABM agent. Demonstrate the prototype meets the parameters of the Description during a functional test to be held at an AEGIS or Future Surface Combatant (FSC) prime integrator-supported Land Based Test Site (LBTS) provided by the Government, representing an AEGIS BL9 compatible or newer combat system environment. It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL-USE APPLICATIONS: Support the Navy in transitioning the SABM agent software to Navy use. Integrate the SABM agent into a prototype combat system implementation, consisting of one or more of the following: AEGIS BL9 or greater; CCCS experimental prototype, implemented on a virtualized hardware environment within an AEGIS hardware compliant land-based testbed.

This capability has potential for dual-use capability within the commercial Air Traffic Control system in the future development of an air traffic “common operational picture” monitor, capable of predicting and preventing collision events in complex traffic control patterns.

REFERENCES:


KEYWORDS: Maintain Situational Awareness; Autonomous Situational Awareness Monitoring Capability; Combat-systems Focused AI-based Analytical Algorithms; Autonomously Prioritizing Ship Tactical Threats; Software Framework; AI-based Software Application