Navy Aims at Goal to Improve E-2D Mission-Capable Readiness

The E-2D has 11 major mission systems to be maintained in operating condition for the aircraft to reach full mission capability, according to Capt. Pete Arrobio, the Navy's E-2D program manager. *NORTHROP GRUMMAN*

NATIONAL HARBOR, Md. – The Navy is only weeks away from its goal to achieve a mission-capable rate for its E-2D Advanced Hawkeye carrier-based command and control aircraft of 28 aircraft, a Navy program official said.

The Navy also is aiming for 22 of those 28 E-2Ds hitting and sustaining full mission capability by Sept. 1, said Capt. Pete Arrobio, the Navy's E-2D program manager, speaking Aug. 3 at the Navy League's Sea-Air-Space Expo at National Harbor, Maryland.

Attaining full mission capability is no small task. Arrobio pointed out that the E-2D has 11 major mission systems to be maintained in operating condition for the aircraft to reach full mission capability.

Arrobio said the Navy has a detailed plan to add and improve capability to the E-2D fleet over time. He stressed the need in the future to move faster in upgrading the aircraft software and systems to keep them relevant to high-level warfare. Future needs include cyber hardening; connectivity to the joint all-domain command and control environment; sensor improvement; more space, weight and power capacity; improved reliability of components; and integration of artificial intelligence and machine learning where appropriate.

Northrop Grumman has delivered 48 E-2Ds to the Navy so far,

out of 52 ordered so far. The U.S. Navy's program of record calls for 86 E-2Ds. The aircraft delivered so far equip five airborne command and control (VAW) squadrons and one fleet replacement squadron, with the fleet squadrons deploying with five aircraft each. Two of those VAW squadrons have completed transition to an aerial refueling capability. Four fleet squadrons are still equipped with the E-2C Hawkeye.

Three of nine ordered by Japan have been delivered. France has signed a letter of agreement to procure three E-2Ds to replace its E-2Cs. Taiwan and Egypt, which operate E-2Cs, also are potential customers for the E-2D.

There are 26 E-2Cs remaining in the U.S. Navy's inventory and they are scheduled for phase out by 2026. Japan, France, Taiwan and Egypt operate a total of 28 E-2Cs, which Arrobio's office helps to sustain with program support.

Raytheon Anticipates 5-Year Production Contract for SPY-6 Radar and Variants

The SPY-6 demo array was introduced at Sea-Air-Space 2019. *RAYTHEON*

NATIONAL HARBOR, Md. – Raytheon is expecting a five-year contract from the Naval Sea Systems Command for hardware production and sustainment of all variants of the SPY-6 shipboard radar, a company official said.

Raytheon anticipates the contract award in September 2021 which will cover up to 59 radars, said Scott Spence, director

of Naval Radars for Raytheon, speaking to Seapower Aug. 3 at the Navy League's Sea-Air-Space Expo at National Harbor, Maryland.

Raytheon now is in full-rate production of the SPY-6 family of radars, building at a rate of one per month, Spence said.

The company has been able to sustain a solid rate of production despite the COVID pandemic. Mike Mills, Raytheon's SPY-6 program director, said the company delivered 12 SPY-6 arrays in a 13-month period.

Raytheon has delivered the first two shipsets of the SPY-6(V)1 Air and Missile Defense Radar (AMDR), one for the first Flight III Arleigh Burke-class guided-missile destroyer, the future USS Jack H. Lucas (DDG 125) and the second, DDG 128. Spence said the company is starting deliver of parts for a third DDG.

Delivery of the first production SPY-6(V)2 rotating Enterprise Air-Search Radars (EASR) is planned Nimitz-class aircraft carriers, the future America-class amphibious assault ship USS Bougainville (LHA 8) and the future San Antonio-class amphibious platform dock ship USS Richard M. McCool Jr. (LPD 29). Installation on the latter two ships will be made post-construction, Spence said.

The fixed-face EASR, the SPY-6(V)3, is in the engineering development phase for the future Gerald R. Ford-class aircraft carrier USS John F. Kennedy (CVN 79) and subsequent carriers of that class. It also will be the EASR for the new Constellation-class guided-missile frigate.

Spence also said the expected contract will cover backfit of some Flight IIA Arleigh Burke DDG with the fixed-face SPY-6(V)4 version during the ships' mid-life upgrades. The company already submitted the technical data package for the back-fit to the Navy.

The SPY-6 is scheduled to achieve Initial Operational

Capability on the Jack H. Lucas in 2024, according to Spence.

Navy Decision Approving Production Decision of AARGM-ER Expected Soon

The Advanced Anti-Radiation Guided Missile – Extended Range (AARGM-ER) could soon have low-rate initial production approved. *NORTHROP GRUMMAN*

NATIONAL HARBOR, Md. – The U.S. Navy expects to make a decision soon approving low-rate initial production of the Advanced Anti-Radiation Guided Missile – Extended Range (AARGM-ER), built by Northrop Grumman, expects to make a decision approving low-rate initial production soon, a program official said.

The milestone to approve proceeding to LRIP is "expected within weeks," said Mike Overs, the Navy's deputy program manager for Direct and Time-Sensitive Strike, speaking Aug. 3 at the Navy League's Sea-Air-Space Expo at National Harbor, Maryland.

The AGM-84G AARGM-ER is a development of the AGM-84E AARGM that has been in service since 2012 with the role of destruction of enemy ground-based air defenses. The ER missile is considerably different in planform and appearance than the basic AARGM. The ER version is slightly shorter – 160 inches versus 14 inches – than the basic AARGM but has a larger diameter (11.5 inches versus 10 inches) and is controlled by its tailfins rather than fins at the mid-body. The ER features a new rocket motor that takes up more of the length of the

missile and is equipped with a new warhead.

The aerodynamic characteristics of the ER plus its larger motor give the missile “twice the tactical range in the same amount of time,” Overs said.

The development of the AARGM-ER was in part in response to the need to accommodate the missile in the weapons bay of the Air Force F-35A and Navy F-35C Lightning II strike fighter. The Marine Corps F-35B, which has a smaller weapons bay, will be able to carry the AARGM-ER on a wing station.

The AARGM-ER completed on July 19 its first developmental test shot, of which Overs said, “met all objectives.”

A total of 15 to 17 developmental test shots are planned.

Initial Operational Capability of the AARGM-ER is planned on the F/A-18E/F Super Hornet strike fighter and EA-18G Growler by the end of fiscal 2023.

Italy, Australia and Germany are equipped with the AARGM and are potential customers for the AARGM-ER, as is any nation operating the F-35.

Over said that there is a Joint Capabilities Technology Demonstration of a surface-launched version of the AARGM-ER planned for 2022, with the idea for use by the Army, Marine Corps or surface Navy.

Navy’s Triton UAV’s IFC-4

Sensors, Systems ‘Performing Better Than Expected’

A MQ-4C Triton taxis at Andersen Air Force Base. U.S. AIR FORCE / Senior Airman Michael S. Murphy

National Harbor, Md. — The mission systems on the first MQ-4C Triton unmanned aerial vehicle (UAV) equipped with a signals intelligence capability functioned well on the first test flight, a Navy official said.

The first MQ-4C equipped with Integrated Functional Capability-Four (IFC-4) made its first flight on July 29, mainly to test the aerodynamic characteristics of the new configuration. The test team, while evaluating such aspects as stability and control, also checked out the performance of the mission systems and sensors. The IFC Triton featured more antennas than the baseline IFC version.

“The sensors and systems are performing better than expected,” said Capt. Dan Mackin, the Navy’s Persistent Maritime Unmanned Aircraft Systems program manager, speaking Aug. 3 at the Navy League’s Sea-Air-Space expo at National Harbor, Maryland.

The IFC-4 hardware and software configuration introduces a signals intelligence capability to the Triton. It will enable the Triton to become an integral part of the Navy’s Maritime Intelligence, Surveillance, Reconnaissance and Targeting (MISR&T) transition plan. As such, it will eventually replace the Navy’s EP-3E Orion electronic reconnaissance aircraft beginning in the fall of 2023 when the first full orbit is established. The IFC-4 upgrade also includes the Minotaur mission system now used on the EP-3E.

Mackin said the Navy expects to introduce artificial intelligence and machine learning capabilities during later upgrades. Other upgrades planned for 2025 include Wideband

Tactical Targeting Network Technology, enhanced radar identification modes, protected satellite communications. M-Code and counter-electronic attack.

Upgrades planned for 2027-2028 include enhancements to enable the Triton to perform without access to the GPS and satellite communications. These include command from afloat units, more robust navigation and communications, increased power, among others.

Mackin said that when the IFC-4 configuration joins the fleet, the mission control centers will be modified with special compartmented intelligence facilities for protection of intelligence and its sources and methods.

The Royal Australian Air Force (RAAF) is partnered with the U.S. Navy on the Triton program and has accelerated its acquisition of three MQ-4Cs to keep the production line going during the U.S. gap in production, said Doug Shaffer, Northrop Grumman's' Triton program manager.

Mackin said the RAAF Tritons will be in the IFC-4 configuration and will be identical to those of the U.S. Navy.

Raytheon's JPALS Proposed for Marine Expeditionary Use

Raytheon's CJ Jaynes discusses the Joint Precision Aircraft Landing System at Sea-Air-Space 2021. *SOLARES PHOTOGRAPHY*
NATIONAL HARBOR, Md. – Raytheon has developed a version of its Joint Precision Aircraft Landing System (JPALS) designed for expeditionary airfields, which it is proposing as ideal for

Marine Corps expeditionary base operations.

JPALS is a landing system based on differential Global Positioning System navigation. It is installed or being installed on the U.S. Navy's aircraft carriers and amphibious assault ships and U.K. and Italian navy aircraft carriers. JPALS was first deployed in 2018.

CJ Jaynes, executive technical adviser, Precision Landing Systems for Raytheon Intelligence, Information and Services, speaking at the Navy League's Sea-Air-Space Expo in National Harbor, Maryland, said the company has developed vehicle-portable JPALS that could be deployed to a forward base for providing precision landing for aircraft fitted with the JPALS avionics.

The expeditionary JPALS consists of a user display, antennas, and for processing racks, and a power generator. It can be carried in a vehicle such as a Humvee or Joint Light Tactical Vehicle. The system can be set up on site in 60-90 minutes by one or two personnel.

The JPALS uses triangulation to provide precision landing data to aircraft from a distance of up to 20 nautical miles. It can provide information to a fixed-wing aircraft while at the same time it provides the landing data to a helicopter within range.

The system does not rely on precision approach radar or an instrument landing system, said Brooks Cleveland, Raytheon's senior aviation adviser for Precision Landing Systems.

Aircraft currently configured for JPALS include the F-35A/B/C strike fighters and the CMV-22B Osprey carrier-onboard delivery aircraft and will be installed on the MQ-25A Stingray unmanned aerial vehicle. Installation on the F/A-18E/F Super Hornet is planned for the 2026-2027 time frame.

The JPALS suite for aircraft includes the JPALS waveform, a

reprogrammable radio, and computer power.

Raytheon demonstrated its expeditionary JPALS for three weeks in June at Yuma, Arizona. Marine Corps F-35Bs made 50 approaches.

Jaynes and Cleveland said the land-based system at the outlying field also was praised by Marine Corps F-35B pilots because it gave them practice using the system that would enable them to be more ready for shipboard deployment.

JPALS was first deployed on the amphibious assault ship USS Wasp for use by Marine Corps F-35Bs. The USS Carl Vinson deployed Aug 2 as the Navy's first aircraft carrier to deploy with JPALS. The ship carries the F-35C and CMV-22B on their first deployments.

Raytheon built 12 engineering and manufacturing development versions of JPALS and has delivered 10 of 26 production versions. Raytheon expects to deliver the rest by 2023.

Navy to Stand-Up 2 Fleet MQ-25 Squadrons to Deploy Detachments

The Boeing MQ-25 T1 test asset transfers fuel to a U.S. Navy F/A-18 Super Hornet on June 4, marking the first time in history that an unmanned aircraft has refueled another aircraft. The MQ-25 Stingray will assume the carrier-based tanking role currently performed by F/A-18s, allowing for better use of the combat strike fighters and helping extend the range of the carrier air wing. THE BOEING CO. / Kevin

Flynn

NATIONAL HARBOR, Md. – The U.S. Navy plans to establish two MQ-25 squadrons to deploy detachments of the MQ-25A Stingray unmanned aerial refueling aircraft on board aircraft carriers. Later this year, the MQ-25A fleet replacement squadron will be established to train operators and maintainers for the Stingray.

The fleet replacement squadron, Unmanned Carrier-Launched Multi-Role Squadron 10 (VUQ-10) is slated for establishment on Oct. 1, 2021. It will be based at Naval Air Station Point Mugu, California.

Speaking Aug. 2 at the Navy League's Sea-Air-Space expo in National Harbor, Maryland, Capt. Chad Reed, the Navy's program manager for Unmanned Carrier Aviation, said that the two fleet squadrons will be VUQ-11 and VUQ-12.

The VUQ squadrons will operate under the administrative control of commander, Airborne Command & Control Logistics Wing – also based at Point Mugu – which also controls the Navy's E-2 battle management aircraft.

The two fleet VUQ squadrons will deploy detachments to the E-2 squadrons to operate the Stingrays. Each detachment will deploy with five MQ-25As.

The Navy plans to procure 72 Stingrays. A Boeing-owned prototype, T1, is being test-flown by the company. Boeing is building four Engineering and Manufacturing aircraft, two ground test articles, and three system demonstration aircraft. The Navy is scheduled to receive it first production fleet MQ-25A in 2024.

T1 made its first flight in September 2019, and first flew with an aerial refueling store in December 2020. On June 4, it made history as the first unmanned aircraft to pass fuel to an aircraft in flight.

“T1 has just been tremendous,” Reed said.

The MQ-25A will be the “first unmanned aircraft intended to connect with a manned aircraft,” he said.

Reed said he is looking forward to taking T1 and the ground control station to a carrier deck for the critical trials in handling control on the deck.

The MQ-25A is scheduled to achieve initial operational capability in 2025.

Reed affirmed that there is “no requirement in the current plan for armament [for the MQ-25A], but in the future it certainly could [carry armament].”

Intelligence, surveillance and reconnaissance is a secondary mission for the Stingray.

Four aircraft carriers are being modified with Unmanned Aviation Warfare Centers (UAWC) to control the MQ-25 missions, Reed said, with four more in planning for the modification.

The MQ-25A and the control system are being integrated in the planning for the Joint All-Domain Command and Control concept.

Newport News Shipbuilding Part of 4th Industrial Revolution

Newport News Shipbuilding contractor Andrew Blair, from Birmingham, Alabama, cuts into the deck aboard the aircraft carrier USS John C. Stennis (CVN 74), in Newport News,

Virginia, June 17, 2021. *U.S. NAVY / Mass Communication Specialist Seaman Thomas Willis*
NATIONAL HARBOR, Md. – The advances in shipbuilding technology and investments in facilities, training and tools is helping Newport News Shipbuilding (NNS) – a Huntington Ingalls Industries (Booth 1323) sector – keep up with the demands of the present and prepare for the future, according to its president.

"We are busier than we have been in my 34 years [with NNS], said NNS President Jennifer Boykin, speaking to reporters Aug. 2 at the Navy League's Sea-Air-Space Expo in National Harbor, Maryland.

NNS currently is building or overhauling 34 ships, including 27 at the shipyard in Newport News, Virginia, and 14 elsewhere at other sites.

That capacity is enabled by new technology, including additive manufacturing, laser scanning, augmented reality, 5G shipyard connectivity and data analytics.

Boykin said NNS has the capability to use additive manufacturing to produce components of more than 600 pounds. The capability is awaiting certification from the U.S. Navy to use on its ships.

She also pointed out that the third Gerald R. Ford-class aircraft carrier, the future USS Enterprise (CVN 80), is the first aircraft carrier being built by workers using digital tablets.

With these new technologies, Boykin noted that "many refer to this as the Fourth Industrial Revolution."

NNS has invested $1.9 billion in physical plant infrastructure since 2016. Those funds have been devoted to submarine facility expansion, a joint manufacturing and assembly facility, a new 310-ton crane replacement, machine shops,

foundry and steel fabrication improvements, new automation, and digital infrastructure throughout the shipyard.

NNS builds nuclear-powered ships including Ford-class aircraft carriers and – teamed with General Dynamics Electric Boat (Booth 1023) – Virginia-class attack submarines and Columbia-class ballistic-missile submarines. NNS also conducts refueling and complex overhauls of Nimitz-class aircraft carriers and depot-level maintenance and refueling of some Los Angeles-class attack submarines.

The shipyard is on track to deliver two Virginia-class submarines and re-deliver the Los Angeles-class attack submarine USS Helena to the fleet in 2021.

Asked about what would be needed in terms of shipyard investment to increase capacity to build three Virginia-class submarines per year if so funded, Boykin said significant investment across the submarine construction enterprise – including the supply chain – would be required.

Lockheed Martin Delivers 100th SEWIP 2, Starts Deliveries of SEWIP Lite to Navy

Lockheed Martin is now delivering the Surface Electronic Warfare Improvement Program (SEWIP) Lite as SWEIP Block 2 deliveries reach 100. *LOCKHEED MARTIN*

ARLINGTON, Va. – Lockheed Martin's deliveries of electronic warfare capabilities to U.S. Navy now include Surface Warfare Electronic Warfare Improvement Program (SEWIP) Lite as deliveries of (SEWIP) Block 2 reaches 100, a company official said.

SEWIP Lite is a scaled version of SEWIP Block 2 designed for installation on smaller warships such as the Navy's littoral combat ships (LCSs) and the Coast Guard's new offshore patrol cutters now under construction. SEWIP Lite operates with the same hardware software and same inboard processing as SEWIP Block 2.

"SEWIP Lite now is in production" said Joe Ottaviano, director for Maritime and Air Cyber/Electronic Warfare at Lockheed Martin Rotary and Mission Systems, in an interview with Seapower. "We've delivered several of those already. Some are on the way for installation on LCS."

Ottaviano said that some international customers have expressed an interest in SEWIP Lite, designed for ships smaller than an Arleigh Burke-class destroyer which have size, weight, and space limitations. Block 2 currently is planned for the Constellation-class frigate.

The SLQ-32(V)6 SEWIP Block 2, including SEWIP Lite, is being installed on all active U.S. Navy surface combatants. Block 2 is in its second five-year full-rate production run.

“We’re going through tech refresh now,” Ottaviano said. “A lot of the open-architecture things we had put in place over the years is allowing us to tech refresh SEWIP, our submarine programs, our airborne programs at a pretty rapid pace, every couple of years without causing a huge development cycle.”

Lockheed Martin is continuing to work with the Navy as they integrate the [electronic attack] Block 3 portion into [SEWIP]. Block 3 is a Northrop Grumman program.

“Block 2 brings the foundation of the Navy’s EW battle management – the displays, integration, the sharing of EW information across the fleet, and providing the enterprise protection,” Ottaviano said. “It actually cues Block 3 and helps drive its response.”

He said the SEWIP is now tightly integrated into the Aegis Combat System.

“Now we can do everything we need to do passively,” he said.

Northrop Grumman Preparing

Response to RFP for Navy's Very Light-Weight Torpedo Program

The U.S. Navy is expected to issue a request for proposals soon for the Very Light-Weight Torpedo. *NORTHROP GRUMMAN*

ARLINGTON, Va. – Northrop Grumman expects the U.S. Navy to issue a Request for Proposals in August or September for the Very Light-Weight Torpedo (VWLT) Program, company officials said.

The Navy's VLWT program RFP was delayed from an expected January issuance, now expected to be issued this summer. Northrop Grumman has used the delay to refine its planned manufacturing processes, adapt robotics to the processes, and press for ways to reduce manufacturing cost.

The RFP will be for taking the non-production-designed VLWT prototype – designed by Penn State Applied Physics Lab (APL) – into a production design. and develop it as an All-Up Round it to be suitable for manufacturing. Other Transactional Authority will be used to deploy the torpedo to the fleet.

APL developed the Counter Anti-torpedo Torpedo (CAT), a defensive weapon for use by aircraft carriers to defeat incoming submarine-launched anti-ship torpedoes. Five aircraft carriers were fitted with CAT launchers. The Cat was the first new-design U.S torpedo since the 1980s with the development of the Mk54 Lightweight Torpedo.

Early in the CAT design process, its potential as a multi-mission torpedo was noticed, said David Portner, Northrop Grumman's senior program manager for undersea weapons, in a July 28 interview with *Seapower* magazine.

The offensive variant that will be the subject of the RFP, the Compact Rapid Attack Weapon (CRAW), involved a software change to make the CAT into an anti-submarine weapon, Portner said.

The hardware-enabled, software-defined VLWT would be equipped with advanced electronics and processing power, with the software enabling the same weapon to serve in an offensive or defensive role.

The nine-foot-long VWLT is one third of the size of the Mk54 – the Navy's most advanced light-weight torpedo – and weighs just over 200 pounds, compared with the 608-pound Mk54. With this weight advantage, a platform can carry more torpedoes or carry the same number at longer ranges and give the platform more endurance. The VLWT could be carried by surface, airborne, and undersea platforms, manned and unmanned.

The Mk54 is known to carry a 96.8-pound warhead. Portner said he was not at liberty to discuss the size of the VWLT's warhead, but he said its power has everything to do with the warhead's design, which he said will give it lethality against

modern submarines.

Portner said the VLWT could be carried by such anti-submarine aircraft as P-8A maritime patrol aircraft, MH-60R helicopters and MQ-8 Fire Scout unmanned aerial vehicles.

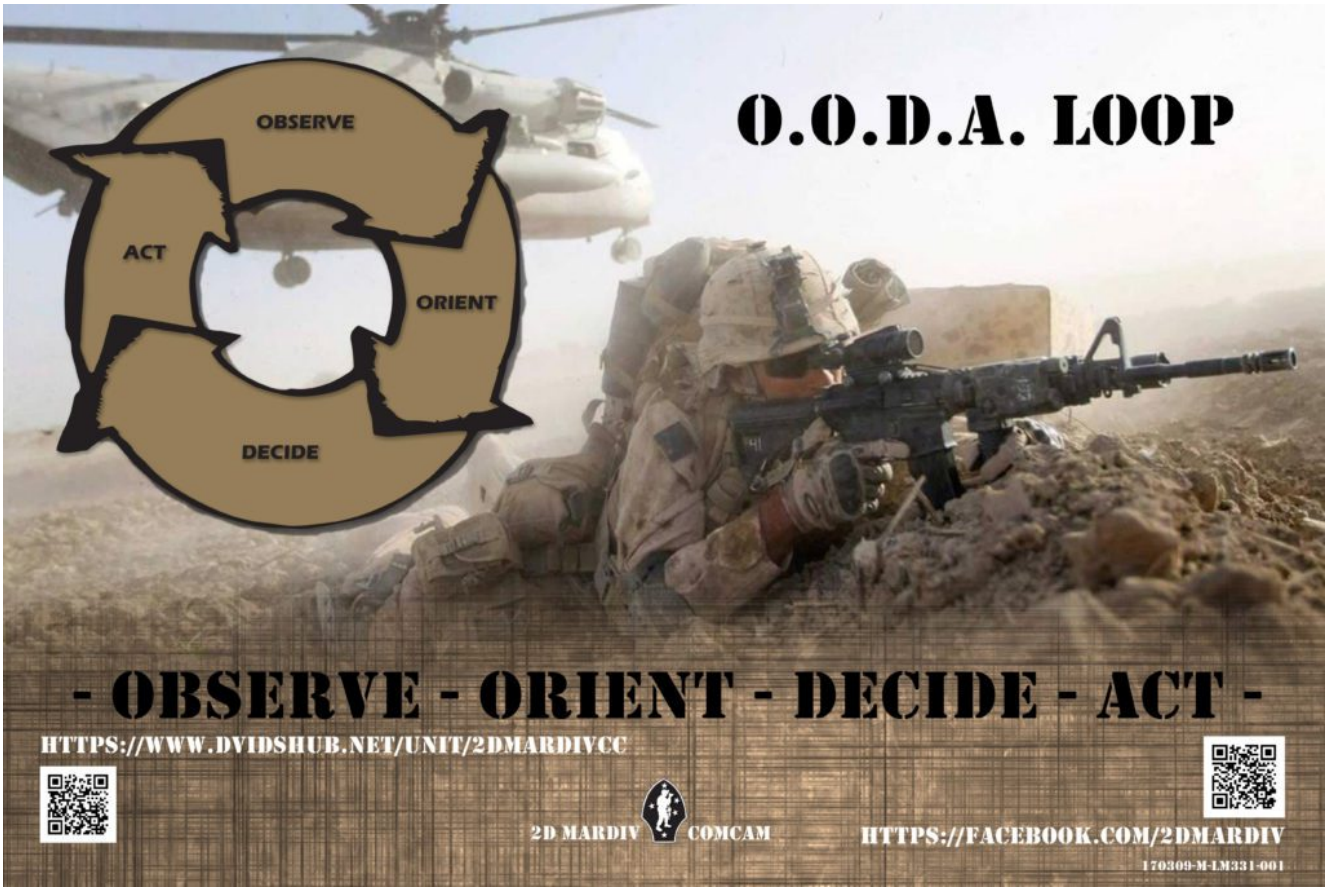
During an Advanced Naval Technology Exercise in 2018, Northrop Grumman demonstrated the deployment of a VLWT from a surrogate helicopter simulating a Fire Scout.

The torpedo is fitted with a parachute to reduce the shock of impact with the water. The VLWT also could be fitted with a glide wing kit similar to the one on Boeing's HAAWC (High-Altitude Anti-submarine Weapon Concept), which is in development to extend the launch range and altitude as well as precision guidance for the Mk54 torpedo.

Portner said the VLWT also could be deployed from a vessel such as a littoral combat ship by way of an unmanned surface vehicle or unmanned underwater vehicle. He said the light weight of the CRAW, compared with the MK54, would enable a platform to carry more weapons the same distance or the same number of weapons to a greater range or endurance.

Portner said in a December interview the Navy already has demonstrated that the legacy Surface Vessel Torpedo Tubes that fire Mk46 and Mk54 light-weight torpedoes could be fitted with internal sleeves to accommodate the smaller-diameter VLWT, but a new launcher could be developed to house a larger number of VLWTs. He also said one or more VLWTs could be fitted to an Anti-Submarine Rocket in place of a MK54 torpedo if the Navy decided to do proceed with that.

Q&A: Charles “C.J.” Johnson-Bey and Jandria Alexander, Booz Allen Hamilton



A poster created using digital illustration software to advertise the “observe, orient, decide, and act” cycle (OODA LOOP) in order to inform Marines and Sailors of the importance of the decision making process. *U.S. MARINE CORPS / Lance Cpl. Alexander N. Sturdivant*

Dr. Charles “C.J.” Johnson-Bey is a leader in electromagnetic technology solutions for Booz Allen Hamilton’s commercial and defense clients. Based out of the company’s Belcamp, Maryland, office, he develops and executes innovative technology strategies that reflect evolving markets and technology dynamics.

Johnson-Bey has more than 25 years of engineering experience spanning cyber resilience, signal processing, system

architecture, advanced prototyping and hardware. In leading Booz Allen's engineering and science community, he inspires leaders and promotes innovation, collaboration and sharing of intellectual capital across the firm.

Prior to joining Booz Allen, he was a research engineer at Motorola Corporate Research Labs and Corning Inc. In *addition, he taught electrical engineering at Morgan State University. He also worked at Lockheed Martin Corp. for 17 years, where he galvanized the company's cyber resources and led research and development activities with organizations including Oak Ridge National Laboratory, Microsoft Research and the GE Global Research Center.*

Johnson-Bey is a co-principal Investigator of the National Science Foundation's Engineering Research Visioning Alliance, which identifies bold and societally impactful engineering research directions that will place the U.S. in a l*eading position to realize a better future for all. He serves on the Whiting School of Engineering Advisory Board at Johns Hopkins University and the Electrical and Computer Engineering Advisory Board at the University of Delaware. He is also on the Cybersecurity Institute Advisory Board for the Community College of Baltimore County.*

Johnson-Bey received both an M.S. and Ph.D. in electrical engineering from the University of Delaware and a B.S. in electrical and computer engineering from Johns Hopkins University.

Charles “C.J.” Johnson-Bey. *BOOZ ALLEN HAMILTON*

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As a cybersecurity leader focused on Navy-Marine Corps clients and cross-market research and development, Jandria Alexander guides the implementation of innovative, technology solutions that drive transformational business growth. She’s a subject matter expert on cybersecurity engineering and assessments, resilient platforms and space systems, infrastructure, and multidomain mission systems.

A nationally recognized cybersecurity expert, Alexander has participated in several National Academy of Sciences studies related to cybersecurity research and new aviation technologies. In 2014, she was appointed by former Virginia Gov. Terry McAuliffe to serve on the bipartisan Virginia Cyber Security Commission to expand the state’s economic footprint in cyber technology and protect critical infrastructure from

cyber threats. She led the effort's unmanned systems cyber-security industry, government and academia consortium.

Over the length of her career, Alexander has provided cybersecurity and digital transformation leadership, market strategy and solution development for the Department of Defense and the intelligence community as well as many civil and commercial organizations. Prior to joining Booz Allen, she was a cybersecurity leader in engineering and technology at a federally funded research and development corporation.

She holds a B.S. in computer science from Brandeis University and an M.S. in information systems from American University.

Johnson-Bey and Alexander discussed unmanned systems' technical and operational challenges with Senior Editor Richard R. Burgess.

Jandria Alexander. *BOOZ ALLEN HAMILTON*

With the Navy's Project Overmatch in progress and having released its Unmanned Campaign Plan, what is the nature of some of the technical challenges the service is trying to overcome?

JOHNSON-BEY: There's always an accelerated trend of technology that catches us by surprise, with technology being used in an unexpected way, creating a new set of problems. In cyber, for one example, when you get things too integrated, you actually introduce some vulnerabilities that you hadn't thought about before. All these things have multi-dimensions to them. I like

being in this space, because there's always a new problem to tackle and it challenges you to think outside the box. And the more we collaborate on these challenges, the smarter we get.

Unmanned maritime systems seem to bring more challenges, from preventing boarding to cyber intrusion and keeping communications, navigation and targeting networks open. How can command and control be sustained in a communications-denied environment?

JOHNSON-BEY: A new book that came out in mid-March — "2034: A Novel of the Next World War," [by Elliot Ackerman and U.S. Navy Adm. James Stavridis] — talks about the future, 2034, and war in the South China Sea. It talks about cyber and how we handle it. The Chinese have a capability that we did not expect and that wipes out our comms. How do we deal with that? The reason why I bring that up is because it forces you to think about how we're pushing ahead with new technology, but what if something just comes out of the blue and we have no comms? The new technology we've become reliant upon to carry out missions is suddenly not available. For example, the F-35 [strike fighters] are taken over [by cyber intrusion], the ships at sea are taken over, no comms; so, it's really interesting.

The U.S. Navy has been thinking about the challenges of operating in a communications- or GPS-denied environment. What do you think of these challenges?

JOHNSON-BEY: A lot of old technology is pretty doggone robust, and it had to be. So, we can't get too far ahead of ourselves. I'm a technologist through and through with a Ph.D. in electrical engineering. I've been doing this a long time. But the thing I will say is that we don't want to become too reliant on our technology or the latest technology, and I think that's where innovation comes in. You get innovative when you have constraints. If I don't have any constraints, then I don't need to be innovative. I can just do what I want

to do when I want to do it. But the U.S. and its allies have long been used to using the electromagnetic spectrum to communicate when they want, wherever they want and for however long they want. That's no longer going to be the case. So, we really do need to think about how we complete the mission in a denied or congested environment. The solutions might not be brand new technology but might be an innovative use of some technology that we've had in the past.

Security [of electronic systems] is always an issue and we really look at it from that OODA [observe, orient, decide, act] loop. How do we increase the speed of decision-making for U.S. forces and our allies and decrease if for our adversaries? Part of that is to address it from the OODA loop in the constrained or denied or congested environment. The speed of decision-making saves lives. So, we're developing and investing in technologies that are looking at the security in that space. We're also looking at swarms in that space, distributed platforms, AI [artificial intelligence], distributed processing and processing at the edge. So, we are investing in those areas. Jandria [Alexander] actually has led one of our projects in there last year.

ALEXANDER: The key point to your question is what happens in war. We can leverage alternate communication systems, but our goal is the communications at the tactical edge, from platform system to platform system.

As mentioned, complexity and threats increase with mission operations and communications across multiple UAVs groups, as well as unmanned and autonomous systems across domains. Platform systems in air, ground or undersea are critical part of force operations. As such, rapid data processing or sensor and RF data become differentiators. We've focused on increasing autonomous processing in a secure manner at the tactical edge and secure cross platform communications, whether they be large or small. If we can provide edge processing in a fashion that's secure, design against a common

architecture that’s driving our solutions, and be able to add advanced artificial intelligence and machine learning algorithms to process different data sets, in an extensible and modular fashion, we are able to efficiently increase capabilities without having to rebuild complete systems from scratch.

From an operational perspective, we’re able to respond quickly based on the algorithmic results processed on the platform. In a world of increased connectivity, cybersecurity needs to be addressed as an integral part of all architectures and built into the systems, including edge systems. Integrated security provides functionality and assurance that we can detect anomalies in parameters and processing that could throw off the compute cycle and exhaust the local resources degrading or disabling necessary platform functionality. And all of a sudden, we get into a situation where we can’t operate. So, we want to be able to make sure we monitor those inputs, and we look for anomalies in the different types of data input. Once we do that, we can be a little more confident about the processing that’s occurring at the platforms.

For each area in platform systems – communications, processing, algorithms and cybersecurity – there are technologies and best practices that support optimal and modular system development. Booz Allen has taken that problem set and divided it into the various functions bringing subject matter experts together into cross-functional project teams. The resulting systems are then able to incorporate integrating our solutions, third-party solutions and government solutions.

What is edge processing?

ALEXANDER: Platform systems range from manned to unmanned systems, including very large airborne to undersea platforms of various sizes. The platform systems have various sensors and functionality to support the mission. As data is collected on the platforms, edge processing allows for rapid analysis,

decision support and specific maneuvering locally without having to transmit the data to a data center for central processing. During contested operations, the tactical asset is the edge. We want to be able to make computing decisions and react to those computing decisions based on what occurs at the edge for onboard sensors on the unmanned system as opposed to sending all the data back to a ground system. The local processing enables autonomous operations at the edge.

JOHNSON-BEY: Getting into denied environments, you've got to get innovative, so if you cannot get back to the [data] cloud or if you cannot get [the platform] back or time won't allow, how do we do that computing right where you need it with information that you need to get the mission completed?

Does this create a weapons release authority problem for the man in the loop if you don't have the central command there to some degree?

ALEXANDER: That's right. So, we have to be flexible. We have to recognize that there's a combination of manned and unmanned systems and decision points. As we become more comfortable and have more results and training our confidence and ability to trust the behaviors [of the unmanned systems] will increase. During situations where the volume of data and the need for rapid decisions are critical, edge processing and autonomy provide options that were not previously available. Systems have matured little by little. It's not going from totally manned to totally unmanned, but it's that combination, human in/on the loop, where there's a recommendation and acknowledgment and recommended course of action.

JOHNSON-BEY: I've heard the term "human on the loop" instead of "in the loop." [Humans] are "on the loop," where they're helping to make the decisions as needed. But the way things are moving, we need to be able to, in some instances, operate at the speed of computation because – particularly with things like hypersonics or getting so much data – when you look again

at that OODA loop, it could just be that you can't make a decision fast enough, so you're going to need some AI and autonomy. You're going to have some overall decision-making, but you are going to have to have some trust or some delegation of the ability to complete a mission done at the edge or where communication is congested or denied.

ALEXANDER: The other point is, it's not only the speed but it's also the volume. We have much better sensors right now. We're collecting so much data that the time to process has to rely on automation. We have to figure out ways to streamline and synthesize the data to make decisions. Credibility of data also is an aspect. We want to be able to weigh the sources and understand which inputs are most trusted to rate and weigh the results. We need AI/ML [machine learning] algorithms that have been trained on actual and synthetic data sets. In an ideal case, the data processing is based on rich data sets, where we have full information; in the worst case, we have limited and lower quality information. The challenge is to develop an edge processing capability that can optimize operations.

JOHNSON-BEY: One of the things we're investing in is, for example, the project that Jandria's been working: platform agnostics, so a system can go on an unmanned aerial system, an unmanned underwater system, an unmanned surface system or an unmanned ground system. That unmanned piece is going to grow if the Navy wants to reach 355 ships or that next-generation Navy capability. So, what we're looking at is how do we help a naval system grow into the unmanned space so that we can advance our capability, ability to make decisions and our ability to complete the mission with the unmanned aspect.

ALEXANDER: That brings up another good point. Large aerospace satellite systems, for example, used to take 20 years to build and deploy. We are transitioning to building constellations with disaggregated functionality. The key is to build smaller satellites – with more specialized function – that collectively perform complex missions. As we break up

functionality, we build systems faster. They can be simpler and more secure. We can then integrate those data outputs from the various functional systems to support advanced decisions and assorted missions. Every platform doesn't have to be all or nothing across every domain. Edge processing can also help with collecting additional or specialized data sources. Specialized platform systems can collect the unique data source provide it to the processing platform and then as the data gets synthesized, the mission advances.

Are micro-satellites part of the solution?

ALEXANDER: Absolutely. We have many examples in communication systems, with platforms that perform certain functions but may be perishable in the long term and don't persist beyond short-term operations. As disposable assets, we don't need them to be as rigorous.

How is your company supporting Project Overmatch and other programs?

JOHNSON-BEY: Project Overmatch is something that the Navy is focused in on and that goes everywhere from networks like the tactical grid to the infrastructure that deals with computer storage and tech stacks to the data architecture and then the tools and analytics like AI and ML and those different applications. So, what we're focusing in on and investing in are these specific areas so that we can get some minimum viable products out. As the Navy grows its capabilities, we're going to be able to provide some of these solutions to them. And then, as we all get smarter, we will continue to improve. It's about speed, getting something useful out quickly, something I really do believe saves lives. So, we're focused on being able to make decisions quickly, to field things quickly, to be very nimble in order to get from idea to deployment efficiently. We're looking at how do we do things in a very quick way and demonstrate it in the marine environment and in the environment in which it will be used.

We're also looking at the challenge in a multi-domain aspect and how to create products to help the Navy complete its missions.

ALEXANDER: So, we're tracking Project Overmatch very closely. This includes solutions for the enterprise as well as the tactical edge. The tactical edge is exactly the piece we've been talking about – the edge processor – that is one piece of the overall architecture and mission. Beyond the technology, is how the technology is integrated into legacy as well as future systems, as well as the training and the governance around it. Those are other parts that will drive adoption ultimately resulting in more successful mission capabilities.

Where is your company's support to the Navy directed?

ALEXANDER: We support all the Navy echelons. We support the warfare centers focused on technical solutions and prototypes. We support program offices across Navy System Commands, the Echelon II systems commands – Naval Information Warfare Systems Command [NAVWAR], Naval Air Systems Command, Naval Sea Systems Command. Overmatch is certainly one of those programs that is occurring at all of the levels.

JOHNSON-BEY: One other thing to drive home is that we also are working with the Office of Naval Research [ONR]. We have multiple programs there and we are looking to increase our collaboration with them. We think that is certainly important. That's where you start getting in with the new ideas, new capabilities, the innovation, and we think that's a perfect place for us to be. We do a significant amount of work with ONR today, and we're looking to increase that as well as with the warfare centers but particularly with ONR. Fun fact: Our relationship with the Navy goes back 80 years continuously.

ALEXANDER: We are engaged with our clients to provide thought leadership and diligent execution. Critical initiatives have many aspects. There's often a policy piece, an acquisition

piece and a solution piece. We want to make sure that our solutions align with the missions and provide enhanced operations and that the policies consider all of the various stakeholders and the overall strategic intent. We collaborate across our program and functional teams to address mission requirements. This allows us to leverage the perspectives that are needed, collect lessons learned and bring our innovation leads to solve the emerging problems of our clients.