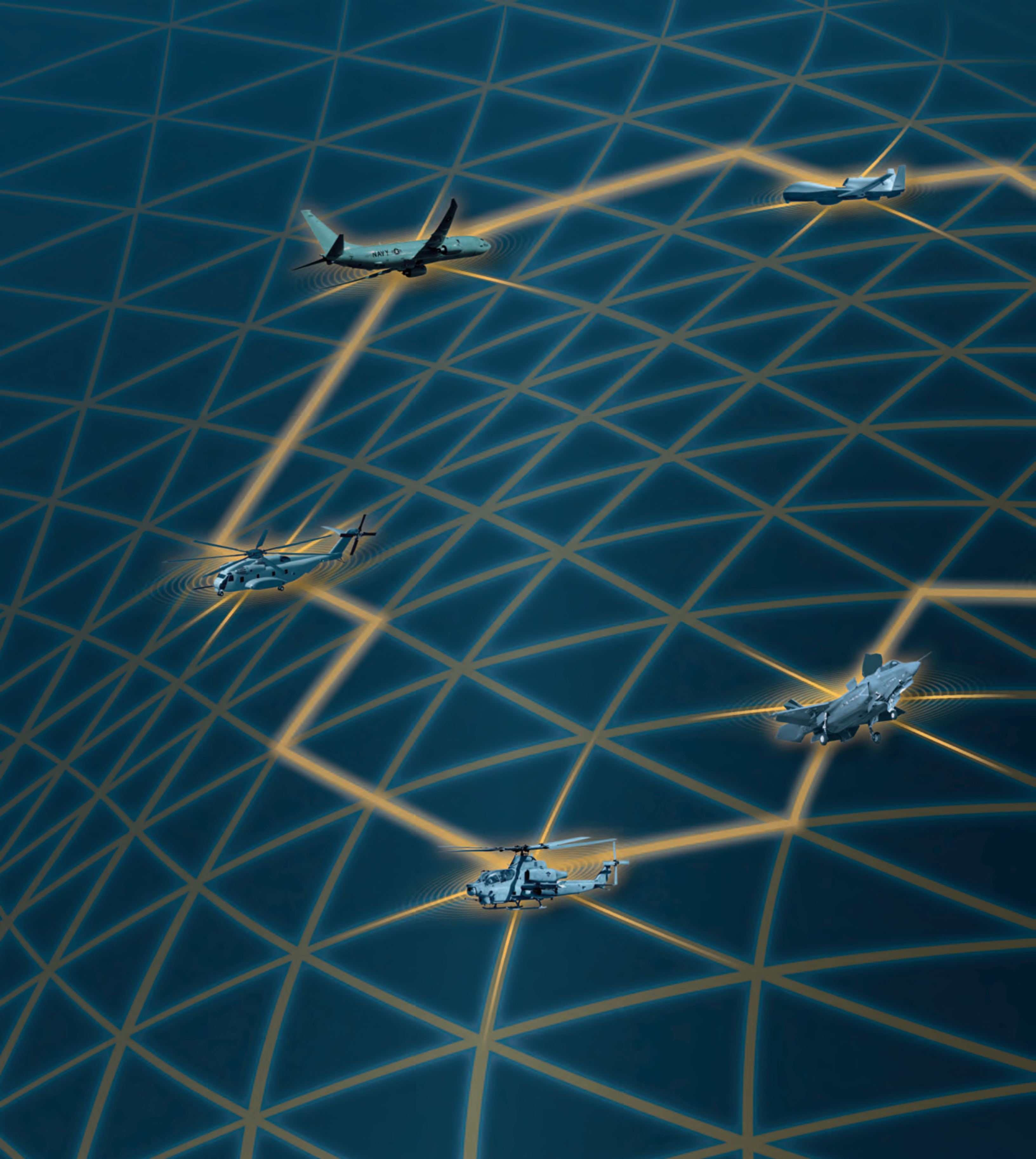

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# NAVAL AVIATION VISION

## 2014 – 2025

# LETTER FROM THE LEADERSHIP OF NAVAL AVIATION

Naval Aviation is a warfighting force. Its capabilities and capacity have been sharply honed and are fundamental to achieving the goals of the Defense Strategic Guidance, *Sustaining U.S. Global Leadership: Priorities for 21st-Century Defense.* The fiscal landscape and emerging security environment are unstable and uncertain; balancing budgetary challenges and the need for national defense demand that Naval Aviation fulfill more global commitments while operating within tighter budget limitations.

This document, guided by and aligned to *The Vision for Naval Aviation 2025* and its pillars of capability superiority, wholeness, and maintaining capacity, provides our unified view of how Naval Aviation intends to meet the challenges ahead. We will do it through revolutionary changes in capabilities, retaining our aggregate and operational capacity, and by safely, effectively, and affordably executing our job of organizing, manning, training, and equipping fleet combat forces.



As the Chief of Naval Operations and the Commandant of the Marine Corps have stated, "Our future naval force will be *where* it matters, *when* it matters, by maintaining a robust forward presence and appropriate readiness. Where our diplomatic interests are threatened or our citizens are at risk, this integrated naval force will provide the ability to intervene. Our Navy-Marine Corps team will continue to provide options for both operational commanders and our national decision-makers. This naval force will be essential for preserving peace, building partner capacity, providing humanitarian relief, and preventing war through the deterrent effect of credible combat power." Naval Aviation is a leading partner in operating and, when necessary, fighting as part of this integrated and interoperable naval force. On any given day, we are forward deployed within steaming and striking distance to influence developing crises, ready to fully execute every one of our missions. Naval Aviation has never been more relevant or more in demand.

***A U.S. Navy F-35C and a U.S. Marine Corps F-35B fly together on functional check flights over Fort Worth, Texas prior to their delivery. (Photo Courtesy of Lockheed Martin)***

Capability is the key to sustaining our warfighting supremacy. Naval Aviation forces will arrive on station with the means–the capability–to prevail in combat. To guarantee this, we must possess a technological edge and embrace an evolutionary approach to improving platforms and payloads. As part of a long-range strategy, the Navy and Marine Corps are transitioning out of legacy aircraft that have served us well and updating nearly every type and model aircraft. In our new vision, a carrier strike group in 2025 would deploy with as few as five models of aircraft with five engine types, significantly reducing life cycle costs. Our next-generation aircraft carrier, the *Ford*-class, provides advanced technologies that drastically reduce maintenance costs, allowing the air wing to fly 25 percent more sorties than the *Nimitz*-class while costing $4 billion less per ship to maintain.

The ability to meet the nation's defense needs in this unpredictable world while continuing to remain relevant in the future hinges on our ability to dramatically change our current processes in order to deliver Integrated Warfighting Capabilities (IWC). The Systems Commands have embraced this responsibility to ensure the technical aspects of warfighting capability work together across platforms, weapons, networks, and sensors from the initial planning stages until delivery to the fleet. IWC will reduce costs, increase efficiencies, and help ensure that our combatant commanders can accomplish their missions.

This is the critical work of all in Naval Aviation. To ensure wholeness, we must reduce operations and support costs while ensuring our forces suffer no losses in readiness. This will be accomplished by implementing "should cost" initiatives that significantly increase total life cycle affordability; leveraging the Naval Aviation Enterprise (NAE) cost-wise readiness initiatives aimed at reducing operations and maintenance costs; and through Navy Aviation using the "Readiness Kill Chain" methodology as a global approach to identify and resolve challenges to sustain the capability, capacity, and wholeness of our forces. Marine Aviation is informed and guided by the USMC Current Readiness Improvement Program and Type/Model/Series Teams within the NAE that maintain future combat readiness within resource efficiency guidelines.

Naval Aviation remains a preeminent warfighting force in the world today. The future vision of Naval Aviation presented here stresses the importance of sustaining our capability superiority, delivering IWC to the fleet, transforming our forces, ensuring wholeness and affordability, and maintaining sufficient capacity. It also acknowledges the fiscal limits facing this nation and the Department of Defense. This vision is shared to inform and guide the actions of those serving Naval Aviation today and those whose support is critical to our continued success as a powerful and affordable naval force.

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**RADM William E. Leigher, USN**
Director of Warfare Integration for Information Dominance

*An Aviation Boatswain's Mate (Fuel) directs the recovery of helicopters on the flight deck as the* San Antonio-*class amphibious transport dock ship Pre-Commissioning Unit (PCU)* Anchorage *(LPD 23) approaches the coast of Alaska. (Photo by MC1 James R. Evans)*

# TABLE OF CONTENTS

# SUSTAINING OUR CAPABILITY SUPERIORITY

Our warfighters operate in an environment where they rely on a multitude of systems to work together to create superior combat capabilities. This imperative is essential in order for combatant commanders to achieve their mission objectives. Recently, discussions about effective and efficient warfighting have increasingly turned from the performance of individual platforms, weapons, networks and sensors; to discussions of how we enable joint operations and mission-level outcomes. Sustaining our capability superiority in that environment today and in the future demands integrated and interoperable capabilities across the spectrum of Naval Aviation roles, missions, and tasks.

> ***"An up-front focus on System-of-Systems interoperability, integration, and sustainment at the capability level will reduce overall acquisition costs by eliminating costly post-fielding investments required to properly integrate unique, point-to-point, proprietary, platform-centric solutions."***
>
> ***-VADM David Dunaway, Commander, NAVAIR***



As the Defense Strategic Guidance, *Sustaining U.S. Global Leadership: Priorities for 21st-Century Defense* and defense planners preparing the *Quadrennial Defense Review 2014* have pointed out, achieving these goals while making sound investments in a resource-constrained environment is a tremendous challenge. Naval Aviation is responding with a strategy designed to maintain our effective warfighting capability and readiness at best value to the taxpayers. This strategy will align Naval Aviation leadership, employees, and stakeholders to three top priorities for our future and enable Naval Aviation to continue to fulfill its mission to deliver superior warfighting capability:

- Increase speed of capabilities delivered to the fleet
- Deliver integrated and interoperable warfighting capabilities that produce an immediate and sustainable increase in warfighting effectiveness
- Improve affordability and provide maximum value for every dollar invested

Delivering integrated and interoperable warfighting capabilities will contribute to their speed to the fleet and improve affordability by reducing the time and cost of integrating new systems. To achieve truly Integrated Warfighting Capabilities (IWC), Naval Aviation has broadened its perspective from individual programs to mission areas. Our current acquisition and engineering processes have often resulted in insular, vertically aligned, "stovepiped" programs that focus on optimizing the performance of individual weapons, platforms, or systems instead of the capabilities they provide. As a result, when Naval Aviation attempts to integrate multiple systems after we design, develop, and test them, they do not always "plug and play" as expected. The traditional approach forces fleet operators to often bear the burden of integration and interoperability, which can result in delayed introduction of needed capabilities, reduced readiness, and increased operating costs.

To reduce these barriers, Naval Aviation leadership has embraced a forward-thinking, innovative concept to realign those "stovepiped" programs to a "System-of-Systems" (SoS) perspective. This concept is often referred to as Integration and Interoperability (I&I). This perspective requires us to explicitly link our technical expertise and solutions with operational tactics. If we derive and fund requirements and develop technical solutions with mission outcomes in mind from the start, our platforms, weapons, networks, and sensors will naturally integrate and deliver the intended effects–creating a "warfighting whole" more powerful than the sum of its parts. We call the result an IWC.

This revolutionary effort encompasses the entire Naval Aviation community, where fleet operators work closely with readiness requirements, resource sponsors, and the acquisition community. Naval Aviation leaders are identifying and maturing the processes, skills, infrastructure, and relationships needed to increase teamwork and collaboration across multiple programs and system boundaries from the start. More and more, we'll see the government pursue common standards and take on a role as "lead capability integrator" across a spectrum of efforts–from rapidly inserting new or existing technologies to solve an urgent fleet need (rapid response); to integrating existing programs of record into a SoS to achieve a mission-level outcome; to designing new capabilities from a full SoS context from the beginning of longer-term developmental efforts.

*An MH-60S* **Sea Hawk** *lands on the flight deck aboard USS* **Bataan** *(LHD 5). (Photo by MCSA Michael J. Lieberknecht)*

The need for IWC will continue to grow as mission complexity increases and requirements shift from large-scale acquisition programs to smaller, rapid-response modification/integration efforts. Creating and delivering IWC is the most effective way to achieve the Naval Aviation mission now and for the foreseeable future, and has become one of the Chief of Naval Operation's top priorities.

The required capabilities provided by Naval Aviation to execute our nation's maritime strategy are increasingly interconnected. Because of the significant technological and resource requirements needed to sustain a capability, maintaining our superiority demands Naval Aviation plan and manage an integrated and appropriate portfolio of science and technology investments. Turning the results of those investments into an integrated capability requires extensive planning, engineering, and testing across multiple programs. This is no simple task. Detailed SoS engineering–backed by documented requirements and executed by proficient acquisition professionals–must be matched with accurate and reliable cost estimates. This understanding paves the way to achieve the right mix of payloads supported by the appropriate platforms years into the future.

In the following section we highlight some of the key technologies that sustain and advance Naval Aviation's capabilities, outline the conceptual framework and programs we are using to create and deliver fully IWC and platforms, and discuss the present and planned future for each Naval Aviation capability area.

# INCREASING OUR TECHNOLOGICAL EDGE

Naval Aviation envisions a family of *revolutionary* core capabilities centered around the aircraft carrier and its embarked air wing, supported by long-range maritime patrol platforms that extend surface and subsurface sea control. The integration of technological improvements enable persistent observation of large areas of maritime battlespace with both manned and unmanned Intelligence, Surveillance, and Reconnaissance (ISR) platforms and payloads enabled through robust command, control, and communications. If challenged, aircraft will be capable of countering or defeating any anti-access/area denial (A2/AD) challenges. Aircraft will also be capable of establishing sea control through networked maritime domain awareness, coupled with the lethality of offensive anti-surface warfare weapons. Additionally, Naval Aviation will possess the capability to project scaleable non-kinetic and kinetic effects into all of the surrounding domains (land, air, space, and cyber) with stealth, precision weapons, and electronic and cyber effects.

***An X-47B Unmanned Combat Air System (UCAS) demonstrator launches from USS* George H.W. Bush *(CVN 77).* The Vision for Naval Aviation 2025 *includes unmanned systems that operate from the flight decks of aircraft carriers, providing long-range persistent ISR and aerial refueling capabilities. (Photo courtesy of Northrop Grumman by Alan Radecki)***

The extended service lives for aircraft carriers, amphibious ships, and modern aircraft require adaptability to remain operationally relevant. The extended life cycles of the platforms that enable this concept of operations require rapid technological advancement and the necessity to design platforms that seamlessly integrate multiple generations of payloads (weapons, networks, and sensors) over their life cycle to deliver state-of-the-art lethal warfighting capability. The following technologies are illustrations of how Naval Aviation will remain capable across the spectrum of warfare.

# New Technological Advances

## Unmanned and Undaunted: X-47B and HSM-35

**Lessons learned from the X-47B Demonstrator will be integrated into its follow-on program, the UCLASS system.**

On 10 July 2013, the X-47B Unmanned Combat Air System Demonstrator made history when it trapped successfully aboard USS *George H.W. Bush* (CVN 77). The first landing of a tailless unmanned autonomous aircraft on an aircraft carrier was the climax of six years of steady progress toward the Navy's goal of integrating manned and unmanned carrier aviation. At sea, the X-47B completed 16 precision approaches including nine touch-and-go landings, five planned tests of autonomous wave-off functionality, and two arrested landings. Flight automation in the X-47B proved to be extremely effective during the recent at-sea period. Equipped with three navigation computers that constantly cross-check results and the health of all systems, the aircraft detected a potential problem in one of them while preparing for landing and executed an autonomous wave-off and divert in accordance with predetermined protocol. This is one example of the Navy's pioneering efforts in advanced development of automated algorithms for unmanned systems.

The X-47B is driven autonomously (self-piloted, with human input) using programmed routines and algorithms in autonomous logic that tell the system what to do, as opposed to being driven using a joystick. This avoids compensating for lag and error time on an unforgiving and crowded carrier deck, and it allows for the "waypoint click" navigation that is necessary to cover vast ocean expanses. Precision GPS, relative navigation, carrier deck motion compensation, and high-integrity data links ensured the aircraft made exact landings on pre-designated spots. The aircraft's complementary technologies and positional sensors allow it to share data with other systems such as the F/A-18 *Hornet*, allowing unmanned planes to work safely alongside their human-piloted counterparts. Lessons learned from the X-47B Demonstrator will be integrated into its follow-on program, the Unmanned Carrier-Launched Airborne Surveillance and Strike (UCLASS) system, which the Navy plans to field by 2020.

UCLASS will greatly extend the reach of carrier strike groups, with a planned capability to fly two unrefueled carrier orbits at 600 nautical miles out, or a single unrefueled orbit at 1,200 nautical miles. The aircraft will be able to identify targets for manned aircraft or deliver limited strike capabilities in hostile airspace without putting pilots at risk at ranges exceeding that of manned aircraft. UCLASS is projected to have a small radar footprint and a 3,000-pound payload (including 1,000 pounds of air-to-surface weapons), which should permit improved carrier-based strike capability against anti-ship threats.

## Rebirth of the Magicians

May 2013 marked another first in the move toward integrating manned and unmanned assets: the Navy's establishment of Helicopter Maritime Strike Squadron (HSM) 35 Magicians as the first composite expeditionary operational squadron with unmanned aircraft. HSM-35 will fly eight MH-60R multimission combat helicopters and 10 MQ-8 *Fire Scout* unmanned helicopters. The squadron's first mission will be to train and develop manned and unmanned standards of operation while deployed as detachments assigned to littoral combat ships (LCSs). *Fire Scout*'s multi-mode maritime radar system will provide wide-area search and long-range imaging capabilities that complement the aircraft's current electro-optical/infrared payload. *Fire Scout*'s all-weather sensors will give the squadron unprecedented situational awareness by providing real-time surveillance and target acquisition information to ground or shipboard controllers up to 115 miles away. *Fire Scout* can stay airborne for more than eight hours, which permits the MH-60R to refuel, replenish, and rejoin the fight without losing target contact. Provided with a surface intelligence picture, MH-60Rs can classify targets of interest using high-resolution inverse synthetic aperture radar imagery and direct *Fire Scout* to specific contacts to provide precise identification. Imagery, full-motion video, and other radar data is linked back to the ship for shared tactical awareness, while keeping manned crews at a safe distance. In the future, *Fire Scout* will push data to the MH-60R and other aircraft for more integrated operations. The Magicians are expected to deploy in 2014 aboard USS *Fort Worth* (LCS 3). The ship conducted dynamic interface surface warfare operations with *Fire Scout* on the Point Mugu Test Range in November 2013. During a live-fire event, *Fort Worth* demonstrated the ability to defend herself against several attacking speed boats that were identified as a threat by the ship's helicopter, which passed the information back to the ship. *Fort Worth* successfully engaged all targets with both the 30-mm and the 57-mm gun weapons systems, which reduced the attacking boats to smoking hulks.

## Fifth-Generation Fighter: F-35B/C *Lightning*

The F-35B/C *Lightning II* brings strategic agility, operational flexibility, and tactical supremacy to Naval Aviation. The F-35 will lead the way ashore, disabling information nodes and grids, while providing the air-ground task force with unprecedented awareness of opposing challenges and fusing information from MQ-4C, P-8A, E-2D, EA-18G, RQ-21, FA-18E/F, and other sensors into a single-battle picture.

The F-35B/C represents the centerpiece of Marine Corps Aviation transformation. The aircraft will revolutionize tactical air support of ground forces by leveraging unmatched fifth-generation stealth, enhanced precision strike, and multi-spectral, integrated sensors with the expeditionary responsiveness of a Short Takeoff and Vertical Landing (STOVL) fighter-attack platform. The F-35C, flown by the Navy and the Marines as a part of Naval Aviation's Tactical Aviation (TacAir) Integration (TAI), will provide the same fifth-generation stealth, precision weapons, and multi-spectral, integrated sensors, and will provide additional flexibility and persistence operating from aircraft carriers. From the sea and from austere forward bases, the F-35 will support all U.S. forces by providing wide-ranging capabilities ranging from the soft kill of electronic warfare to the precision delivery of kinetic effects in support of troops in contact.

## Redesigned from Keel to Mast: The *Ford*-Class


The Navy's newest aircraft carrier will take Naval Aviation into its second century, incorporating an array of integrated technological improvements and advancements that will enhance the ship's role as the centerpiece of the 21st-century carrier strike group. *Gerald R. Ford* (CVN 78), the lead ship of the class, represents the largest, most powerful, and transformational warship ever built. CVN 78 is expected to be commissioned in 2016, the numerical replacement for the venerable USS *Enterprise* (CVN 65), which was inactivated in December 2012 after more than 50 years of service. The *Ford*-class embodies significant design and technology changes, improved integrated warfighting capabilities originally planned for later ships, and lessons learned from 100 years of aircraft carrier operations. *Gerald R. Ford* is also the first aircraft carrier designed with all-electric utilities that eliminate steam service lines and other

*The 60-foot long, 30-foot wide, 555-metric ton island is lowered onto* **Gerald R. Ford** *(CVN 78) at the Newport News Shipbuilding (NNS) division. (Photo courtesy Huntington Ingalls Industries)*

distributed systems from the ship, improve corrosion-control efforts, and substantially reduce manning and maintenance requirements throughout its 50-year service life.

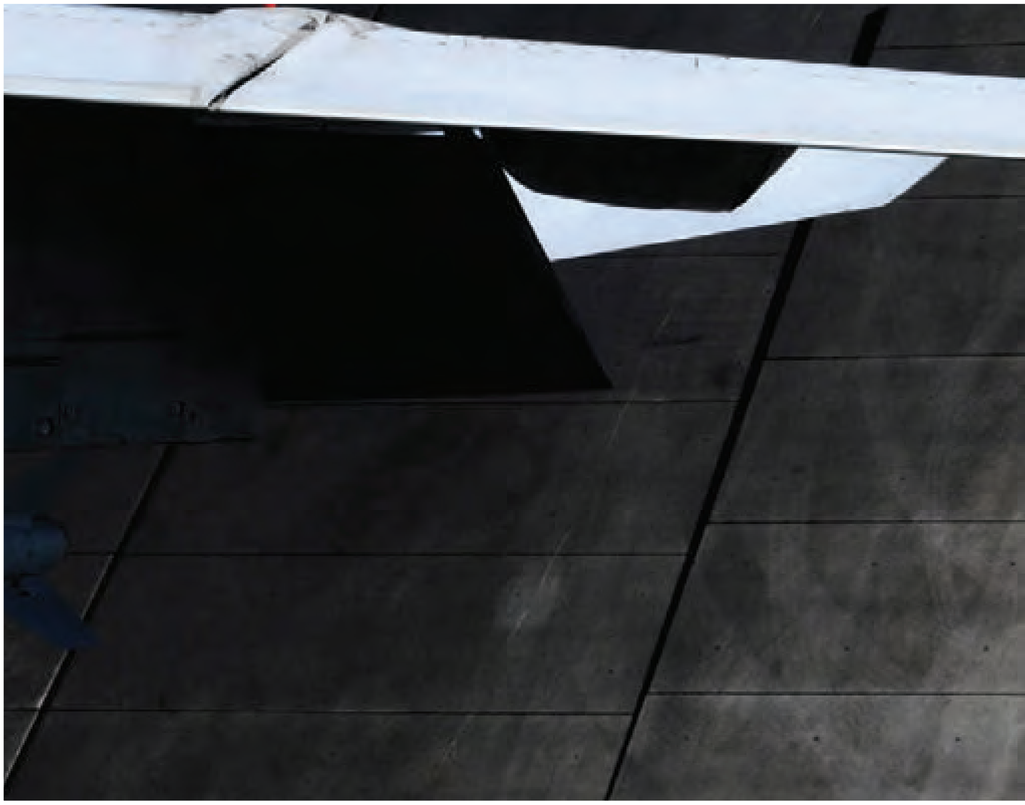
The Electromagnetic Aircraft Launch System (EMALS) replaces the manpower-intensive and aging steam catapult through the use of an electrically-generated moving magnetic field that propels aircraft to launch speed. EMALS expands the launch envelope, allowing launch of both heavier strike fighters and potentially lighter future unmanned aircraft. The system enables the launching and landing of aircraft with less available wind (useful when operating in restricted water space) and it permits a high degree of computer control, monitoring, and automation. The projected capability of EMALS–working in concert with all elements in the redesigned flight deck–to launch more than 160 sorties per day is a significant increase in launch capacity (25 percent) compared to *Nimitz*-class carriers. The ability to launch more than 270 sorties per day is projected during short periods of high-tempo operations.

The Advanced Arresting Gear (AAG) is a highly reliable system consisting of energy absorbers, power conditioning equipment, and digital controls designed to replace the existing MK-7 arresting gear in *Nimitz*-class carriers. EMALS and AAG improve the launch and recovery envelope of the traditional steam catapults and arresting wires, and are expected to produce less stress on airframes, save energy, and result in potentially reduced equipment and aircraft maintenance costs.

EMALS will be capable of launching all conventional and short-takeoff fixed-wing carrier aircraft currently projected for the Navy inventory through 2030, including the F-35C *Lightning II*. Additionally, EMALS and AAG are designed to facilitate integration of unmanned systems, with a goal of launching all future aircraft projected in the inventory through 2050.

***Improved seeker lock-on after launch and reacquisition make the missile harder to evade, and the lofting profile gives the Block II Sidewinder capabilities beyond visual range.***





The increase in sortie generation rates is also enabled by a combination of the redesigned flight deck, which includes more deck space, a smaller island superstructure set further aft on the ship, and a NASCAR-inspired "pit stop" concept that reduces the time required to refuel, conduct maintenance, and launch aircraft. Electromagnetic field-driven weapon elevators, a relocated "bomb farm," and an updated shipboard ordnance arrangement, improve the flow of weapons from magazines to aircraft, further contributing to increased sortie generation. New capabilities have been integrated into the smaller island, which is positioned 140 feet further aft and three feet further outboard to enhance launch and recovery. The island incorporates the advanced Dual Band Radar integrated warfare system that provides full surveillance, weapon targeting, and air traffic control for the carrier and the strike group. *Ford*'s superior command-and-control and "plug and play" capabilities will enable a joint task force commander to efficiently coordinate forces far out at sea.

# An Old Dog with New Tricks: AIM-9X Block II/III *Sidewinder*

First fired successfully in September 1953 at the Naval Ordnance Test Station at China Lake, the AIM-9 is one of the oldest, least expensive, and most successful missiles in the U.S. weapon inventory. The missile is the basic air-to-air missile on all Navy, Marine Corps, and Air Force tactical aircraft, and is used by more than 40 nations throughout the world. The AIM-9X *Sidewinder* Air-to-Air Missile, a significant upgrade to the six-decade-old system, was designated a major defense acquisition program in June 2011.

To maintain the ability of the *Sidewinder* to defeat modern countermeasures, the AIM-9X Block II is designed to detect, acquire, intercept, and destroy a range of airborne threats under all weather conditions. It is a fifth-generation infrared launch-and-leave missile with superior detection and tracking capability, high off-boresight capability, infrared counter-countermeasures, enhanced maneuverability, and growth potential through software improvements. The AIM-9X development leveraged existing AIM-9M components to minimize development risk and cost. Engineering changes, faster processors in the guidance control unit, an upgraded fuze/target detector, and smaller components which accommodate new technologies have resulted in improved performance. These improvements created integrated solutions for today's needs and an opportunity to increase the AIM-9X's capabilities. The new AIM-9X uses a focal plane array to create pictures, which means it's an imaging seeker that uses infrared to create an image, thus making it harder to decoy with infrared countermeasures. With modernization, the *Sidewinder* has become a "beyond visual range" missile, a weapon more akin to an unmanned aircraft with a warhead.


***An aviation ordnanceman assigned to Strike Fighter Squadron (VFA) 22 arms an AIM-9X* Sidewinder *air-to-air missile on an F/A-18C* Hornet *aboard USS* Carl Vinson *(CVN 70). (Photo by MC3 Christopher K. Hwang)***

Both Block II and future Block III increments are integrating the latest technologies. Among the most important enhancements are new data link capabilities and new computer systems that enable the missile to track and find a target, even when challenged with a cluttered background. The two-way data link is the most significant Block II change: it allows the missile to fly toward targets its seeker can't yet see, using target position tracking from its launching platform. Improved seeker lock-on after launch and reacquisition make the missile harder to evade, and the lofting profile gives the Block II *Sidewinder* capabilities beyond visual range. The AIM-9X does not need to be pointed in the direction of its target, and can even locate the adversary behind the firing aircraft by telling the missile to fly to a designated location and search for the identified contact. Block III aims for a 60-percent range boost from a new rocket motor and better flight programming, and a new insensitive munitions warhead for safer use at sea. AIM-9X Block III is projected for Initial Operational Capability by 2022.

# CREATING AND DELIVERING INTEGRATED WARFIGHTING CAPABILITIES

Our nation benefits significantly from the value of enduring technology and power afforded by the carrier and its embarked air wings, and naval forces will continue to develop and incorporate new technologies into the fleet. However, today's resource-constrained environment requires naval forces to sustain capability superiority, wholeness, and capacity efficiently. Naval Aviation's strategy to create and deliver IWC to the fleet provides the path forward to accomplish these goals both now and in the future.

Central to the solution is changing our engineering process from a traditional point-to-point integration of platforms, weapons, networks, and sensors to a SoS approach where achieving a mission-based warfighting capability becomes part of thinking, planning, and executing across program and system boundaries from the very start.

***The objective of the Integrated Warfighting Capabilities Enterprise Team is to support delivery of verified and validated operationally effective and suitable mission capabilities to the warfighter that not only meet engineering specifications, but also integrate into the battle space such that they interact seamlessly as a SoS to meet engagement, mission, and air campaign objectives.***



### CURRENT (Platform-Focused)

- *In today's acquisition and development process, programs are matured independently*
- *Integration occurs when delivered to the fleet*

### FUTURE (Mission-Focused)

- *Programs are developed to form a System-of-Systems*
- *Intersections are potential nodes in a "Kill Chain"*
- *Single Kill Chain Assessment is a Mission Thread*
- *Assessment of all Mission Threads ensures Integration & Interoperability of Programs*

Naval Aviation engineering needs to become "capabilities-based." The SoS approach has the potential to dramatically improve the capacity of Naval Aviation forces to meet its global demand, while decreasing total life cycle costs.

## *Principles of Integrated Warfighting Capabilities*

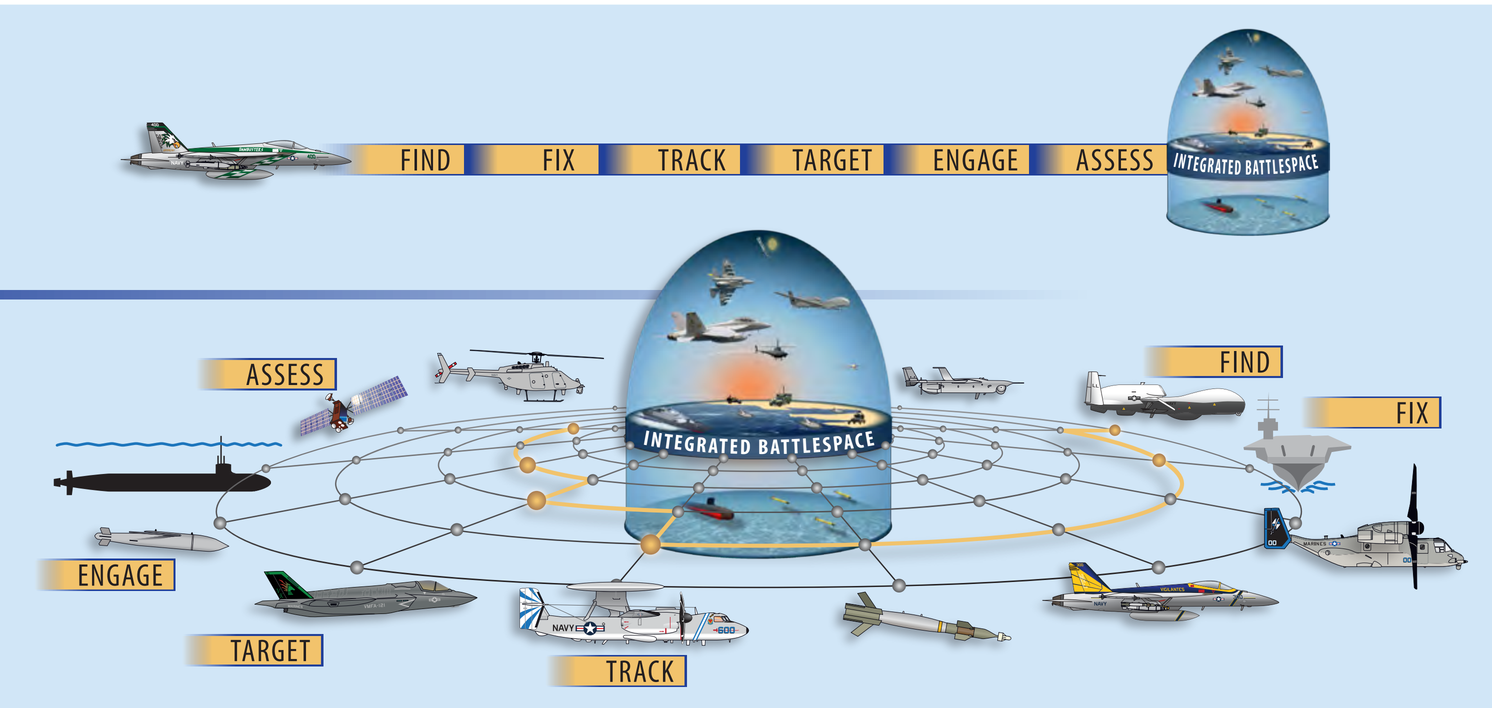
### Kill/Effects Chains

A fundamental principle of IWC is to identify, prioritize, and resolve high-priority gaps in kill and effects chains. Naval Aviation uses the term "kill chains" and "effects chains" to describe the operational sequence of events that must occur to complete a mission thread: Find-Fix-Track-Target-Engage-Assess. The term "kill chain" is often associated with a kinetic mission thread (e.g., delivering a weapon to a target), whereas "effects chain" is used to describe non-kinetic mission threads, such as those associated with the intelligence mission area. However, in practice, the terms are often used interchangeably. Gaps in these chains highlight deficiencies or risk in executing the desired warfighting effect. Kill/effects chain analysis provides valuable insight into where gaps exist and enables focused attention to identify what is needed to close them. The methodology also informs how we should invest our resources to build our capabilities and gain an advantage over our adversaries.

Additionally, when we build a new weapon or improve an existing system, we need to understand how the kill/effects chain will be affected and use that information to design the system to fit seamlessly into the existing and future chains. This approach will reduce the number of new gaps that emerge over time.

# *Fundamental Steps to Implementing IWC*

The immediate focus of IWC is to better integrate our considerable infrastructure to solve capability gaps that exist in the fleet today by developing solutions for kill/effects chain gaps and by addressing urgent and emergent fleet requirements for our deploying carrier strike groups and expeditionary strike groups. Both meet near-term warfighting needs by applying new technologies and leveraging latent capabilities inherent in existing and developing systems.






## I&I Charter: Defining the Way Forward

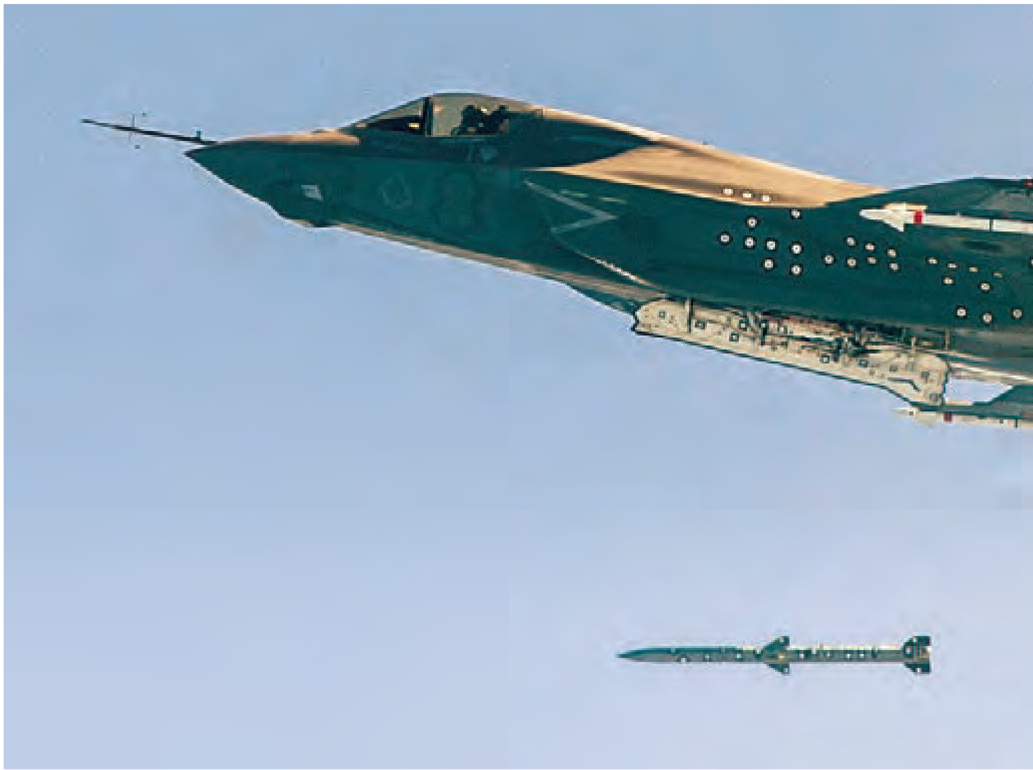
One process to address the fleet's current high-priority warfighting capability gaps is described by the Integration and Interoperability (I&I) Charter signed by the Vice Chief of Naval Operations in December 2012. The Charter establishes the Director of Warfare Integration and Director of Information Dominance as co-chairs of the process to ensure the investments in acquisition portfolios reflect desired warfighting outcomes. The Charter establishes roles, responsibilities, and deliverables associated with executing I&I within Navy processes.

## Establishment of the Integrated Warfighting Capabilities Enterprise Team

As Naval Aviation's primary acquisition provider of platforms, weapons, networks, and sensors, Naval Air Systems Command (NAVAIR) has established an IWC Enterprise Team (ET) to facilitate implementation of IWC goals across Naval Aviation. The IWC ET is composed of representatives from the engineering, test and evaluation, and logistics communities. The team develops and enforces mission-level technical standards, and works closely with leadership to create environments that facilitate the technical interaction required for an integrated SoS approach. The IWC ET works very closely with the other Systems Commands and communicates with resource and requirements sponsors and fleet representatives to maintain proper governance of Mission Technical Baselines and Integrated Capability Technical Baselines.

## Mission-Level Technical Standards

Naval Aviation leaders are collaborating to create mission-level technical standards for current capabilities, programs of record, and future capabilities. Mission Technical Baselines (MTBs) are developed to accurately capture the fleet's desired Concept of Operations (CONOPS) for a given threat and warfare area within each temporal domain. Desired effects for each mission are then mapped to current capability, Program of Record (POR) capability, and anticipated future capability using the best data available. The result is an Integrated Capability Technical Baseline (ICTB) connecting fleet-driven functional Concept of Operations to the technical underpinnings of the platforms, weapons, networks, and sensors to depict end-to-end mission thread execution. The ICTB is then used to identify current capability gaps and guide the new capabilities-based acquisition processes to prevent gaps in programs and future capabilities.



*AIM-120 Weapon Separation test from F-35B. This 5th-generation low-observable strike fighter will leverage networking and distribution capabilities to share battlespace awareness with Naval Aviation and the joint force. (Photo Courtesy of Lockheed Martin)*

## Addressing Gaps: Warfare Capability Baselines and Integrated Capability Packages

Using the ICTB that depicts current threats, missions, and capabilities, the Systems Commands work with Commander, Operational Test and Evaluation Force and the fleet to assess the technical feasibility of executing high-priority warfare effects chains. The Warfare Capability Baseline (WCB) identifies gaps in the effects chains and serves as a feedback loop to the acquisition process by documenting fielded system performance. As of September 2013, the Navy had completed three iterations of the WCB, examining more than 160 high-priority kill/effects chains. Then, materiel and non-materiel solution recommendations to address the gaps identified in the WCB are documented in Integrated Capability Packages (ICPs). ICP development is led by a Warfare Center of Excellence (Naval Strike and Air Warfare Center for Naval Aviation) and delivered to Fleet Forces Command.

## Operationally Realistic Testing and Evaluation

The employment of operationally realistic, world-class modeling and simulation, testing, and training contributes significantly to new systems being able to "plug and play" when deployed to the fleet. Naval Aviation testing and evaluation includes developing Live, Virtual, and Constructed (LVC) test environments for all warfare areas so that systems, weapons, networks, and sensors can be tested against the most realistic environments and concepts of operations-based scenarios. The program below contributes significantly to this goal.

### Naval Infrastructure Capabilities Assessment Initiative

The Naval Infrastructure Capability (NICAP) assessment initiative began as a baseline capture of NAVAIR Research, Development, Test, and Evaluation (RDT&E) assets that defined the "as is" state of NAVAIR's RDT&E environment nationally. The database provided powerful insight into the advanced environment available to support IWC objectives for NAVAIR programs. The baseline also highlighted RDT&E infrastructure gaps and redundancies, thereby informing investment decisions for NAVAIR.


***The employment of operationally realistic, world-class modeling and simulation, testing, and training contributes significantly to new systems being able to "plug and play" when deployed to the fleet.***

The Deputy Assistant Secretary of the Navy for RDT&E has required all Naval Systems Commands to inventory their RDT&E assets similarly and incorporate the results into the NICAP database. When the inventory is complete, we will be able to identify existing gaps/redundancies and avoid costly duplication of effort and investment across Navy labs. By capturing all RDT&E infrastructure assets, the Navy can ensure it has the right mix of representative LVC environments to deliver I&I warfighting outcomes—at a price the Navy can afford.

## Develop Mission-Level Expertise

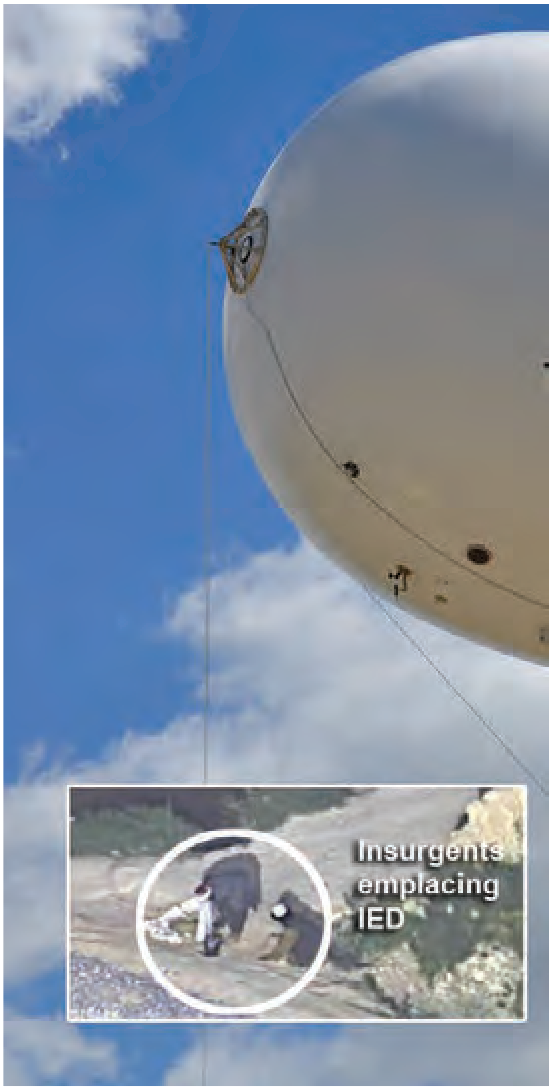
A collaborative culture within Naval Aviation is essential to achieve Integrated and Interoperable Warfighting Capabilities. At the Systems Command level, creating and enforcing mission-level technical standards requires developing a workforce with a SoS perspective and the skills and knowledge needed to perform RDT&E accordingly.

## Rapid Response

Rapid Response initiatives address urgent capability gaps that arise during fleet operations and are largely outside the normal acquisition process. Rapid response projects use mature technology to field a 75-percent solution with spiral upgrades in 2 to 24 months, dramatically improving speed to the fleet. The examples on the following page represent a few Rapid Response successes.

## Persistent Ground Surveillance System (PGSS)

Initiated in October 2009 as a NAVAIR rapid prototype and fielding effort sponsored by the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics and the Army's Intelligence Office, PGSS is a rapid response to a Joint Urgent Operational Need to address critical shortfalls in persistent surveillance required to counter improvised explosive devices and protect Marines and other forces at forward operating bases during Operation Enduring Freedom. PGSS is a ground-tethered aerostat that transmits sensor data and imagery to a ground control station through fiber optics and a back-up wireless link. The system also provides real-time battle assessments and counter-IED support, tracks fleeing insurgents, and provides surveillance of vast numbers of drug-trafficking operations. The first system was fielded in under five months and is the first joint concept technology demonstration program to reach initial operating capability less than one year after initiation. As of June 2013, 59 PGSSs and 20 tower variants had been delivered in-theater and had accumulated more than 880,000 combat surveillance hours.






**The Persistent Ground Surveillance System (PGSS) addresses a critical need to counter improvised explosive devices and protect forces at forward operating bases.**

## Small Unmanned RF Receiver (SURFR)

SURFR is a family of information operations payloads integrated on the *Scan Eagle* unmanned aircraft system that are used in theater to support Special Operations Forces direct-action missions. Before SURFR, no equivalent capability was available to the operating forces and the system has saved numerous lives since its inception. The initial system, SURFR 1, was delivered to the first operational command within 12 months of project initiation, and was undergoing regular operational use just four months later. Follow-on capabilities have been delivered in as little as 10 months and more than 70 systems have been delivered to date. NAVAIR personnel perform the payload integration, which has saved more than $25 million.

# Programs of Record: Delivering Systems that Contribute to Mission Wholeness

The focus of IWC efforts for our programs executed via our traditional acquisition process is to satisfy both program requirements and I&I requirements so that new systems fit seamlessly within the mission-level SoS environment. When IWC efforts are incorporated into the traditional approval processes, they provide the analysis and decision support for cost/schedule/performance trades across program or system boundaries to achieve holistic "mission area" outcomes for the Navy and Marine Corps.

## Gate Reviews and Systems Engineering Technical Review (SETR)

The Office of the Chief of Naval Operations and Assistant Secretary of the Navy (Research, Development, and Acquisition) chaired Gate Reviews and Systems Command SETR events are two of the POR process areas where the savings


***Photo taken in Yuma, Arizona, during PGSS Operations Training of a group of Romanians who later operated as a coalition force at one of the Forward Operating Bases in Afghanistan. Insets are operational images from U.S. Army Forward Operating Bases in Afghanistan. (U.S. Navy photos)***

and benefits of IWC can be factored in to improve decision support. Rather than wait until near the end of a development effort to identify mission-level I&I deficiencies via the Initial Operation and Test and Evaluation report, we will utilize these existing forums to identify and resolve SoS discrepancies during normal program execution. The cost of addressing IWC late in the program is significantly higher than if I&I were incorporated more fully into requirements and system design. Additional mission-level Gate Reviews and SETR event criteria have been proposed that would encourage broader consideration of mission capability, rather than program-specific requirements.

Two efforts have already adopted a SoS approach to ensure they will deliver a fully integrated and interoperable system to the fleet.

**The NIFC-CA effort will provide long-range fire control and projection, the ability to freely operate and control contested battlespace, and coordinated and cooperative situational awareness.**

## Naval Integrated Fire Control-Counter Air (NIFC-CA)

The NIFC-CA operational view extends the battlespace, increases survivability, and provides maximum engagement capability in the air and at sea.

NIFC-CA From the Air (FTA) is an integrated and complex SoS. By 2025, it will consist of F-35B/C *Lightning II*, F/A-18E/F *Super Hornet*, E-2D *Advanced Hawkeye*, EA-18G *Growler*, the Multifunctional Information Distribution System (MIDS), the AIM-120 Advanced Medium Range Air-to-Air Missile, and is designed to enhance offensive and defensive counter-air mission performance through the integration of these programs. The Program Executive Officer for Tactical Aircraft (PEO[T]) established the Air Warfare Mission Area/Air Program Office to provide

programmatic oversight across the FTA portfolio. NIFC-CA From the Sea (FTS) consists of the E-2D *Advanced Hawkeye*, the AEGIS Weapon System in conjunction with Cooperative Engagement Capability (CEC), the AEGIS Combat System, and the SM-6 missile.

All NIFC-CA efforts will provide long-range fire control and projection, the ability to operate in and control contested battlespace, enable coordinated and cooperative situational awareness, and provide spatial and spectral diversity. The associated programs will minimize costs by maximizing component commonality, using high-fidelity modeling and simulation, and leveraging test events associated with its component programs.

## Offensive Anti-Surface Warfare (OASuW)

To meet the challenge of OASuW, Naval Aviation is taking a SoS approach to create operationally viable and technically feasible options for Navy leadership to address current and emergent threats. One option is focused on identifying a weapon system solution that can be air- or surface-launched that will have greater range, survivability, and targeting accuracy than previous surface warfare missiles. It will be a component of the anti-surface warfare capability of the joint force and incorporate integrated warfighting concepts to increase offensive strike capability and close capability gaps.

# *Achieving Full System-of-Systems Integration*

*Aviation Ordnancemen prepare to load an AIM-120 missile onto an F/A-18E* **Super Hornet** *from the Royal Maces of Strike Fighter Squadron (VFA) 27 on the flight deck of USS* **George Washington** *(CVN 73). (Photo by MC3 Ricardo R. Guzman)*

Initiatives are underway to develop the knowledge and standards that will allow future systems to operate in a more flexible and open architecture, dramatically reducing I&I costs, increasing "speed to the fleet," and maximum warfighting capability. These initiatives are part of Naval Aviation's long-range objective to establish government-controlled interface "trade space," which is a concept to tightly manage the interfaces between weapons, networks, sensors, and the platforms on which they reside and/or are required to connect. Control of this space will enable more affordable and flexible weapon systems.

## Increasing Role of Government as Lead Capability Integrator

Naval Aviation leaders recognize that nonstandard proprietary (closed) interfaces are significant barriers to delivering IWC. The government is required by law to gradually assume the role as Lead Systems Integrator (commonly referred to as Lead Capability Integrator). Government control of open architectures will enable more flexible system designs capable of being more readily adapted to changing warfighting needs. Significant life-cycle cost savings will be achieved through increased competition and less time and money spent on unique and redundant integrations.

- Government-controlled interface reference designs allow Naval Aviation to move away from today's proprietary integration schemes that require costly re-engineering and increased flight testing each time weapons, networks, and sensors are married to a platform.
- A number of new programs are helping to move toward government-developed and controlled interface standards and reference designs.
- Government-defined and managed standards expand opportunities for both small and large companies to compete, ensuring best value and the most innovative solutions for the government.

## Network-Enabled Weapon Controller Interface Module

The Network-Enabled Weapon Controller Interface Module (NEWCIM) is an engineering reference model that provides specific design guidance to the weapon system development community and provides the capability to test the interaction between all three Network-Enabled Weapon (NEW) roles. NEWCIM is an integral component of the Link 16 communications developed to support weapons. Link 16 is a military tactical data exchange network used by US, North Atlantic Treaty Organization (NATO), and others, and is part of the family of Tactical Data Links. NEWCIM enables weapon and platform developers to simply code their NEW messages, then test their implementation with and against the reference model. If compatible with NEWCIM, there is likely no need for them to re-engineer their design to achieve enterprise

interoperability. NEWCIM is a working example of I&I that catches interoperability issues at earlier stages, helping developers save time and money. The module was successfully tested several times in 2012 with the F/A-18 and the Joint Standoff Weapon (JSOW), and in a LVC environment using NAVAIR's Manned Flight Simulator at Patuxent River, the Weapon System Center for Integration at China Lake, and the Range at Point Mugu. This test event validated the system engineering approach behind the NEWCIM model and supports Naval Aviation's efforts to have government control of the trade space for integrating network-enabled weapons, controlling platforms, and non-organic sensors. The module saves the government time and money by avoiding the use of multiple interfaces to accommodate multiple proprietary industry designs.

***The NEWCIM reference design prevents the government from having to pay multiple times for multiple interfaces to accommodate proprietary industry designs.***

## Common Standards and Interoperability

Established by the Program Executive Office for Unmanned Aviation and Strike Weapons, the Common Standards and Interoperability (CSI) team ensures the integration of Unmanned Aircraft Systems (UASs) and applicable external systems while identifying innovative contracting and programmatic initiatives to reduce total ownership costs and delivery timelines. Much of the team's effort has been focused on:

- Developing command-and-control and imagery-intelligence interfaces
- Aligning naval unmanned aircraft systems' architecture frameworks for interoperability across systems and consistently depicting the interoperability attributes of each system
- Documenting the government-developed interfaces in architectures to clearly inform industry of the specific interface definitions required for the system

## Common Control System

*RQ-21A* **Blackjack** *is launched at Marine Corps Air Ground Combat Center in Twentynine Palms, Calif.* **Blackjack** *provides battlefield commanders with an organic capability 24/7 for real-time, actionable intelligence, surveillance and reconnaissance. (Photo courtesy of Insitu)*

The UAS Common Control System (CCS), managed by the Strike Planning and Execution Systems Program Office within the Program Executive Office for Unmanned Systems and Strike Weapons, is utilizing the work of the Office of the Secretary of Defense's UAS Control Segment (UCS) Working Group to develop a scalable, modular control system that will be used initially by the UCLASS program and then leveraged by existing and future UAS. CCS will provide a more cost-effective control system from development to sustainment, and enables rapid technology insertion for new capabilities. The UCS open business model leveraged by the CCS effort incentivizes industry to supply cost-competitive services, applications, and interfaces that can be shared across all UAS programs with potential extension to other unmanned systems.

## Future Airborne Capability Environment

The Future Airborne Capability Environment (FACE) is a multiservice open architecture software initiative. The goal of FACE is to develop a common operating environment and technical standard for embedded avionics systems such as flight management systems, the Joint Precision Approach and Landing System, and Identification Friend or Foe. The FACE technical standard, published in March 2013, defines the framework for the acquisition of portable and reusable software products and uses a modular approach to software design and development. Platforms hosting the FACE software infrastructure will be able to:

- Leverage applications acquired by other services and acquisition programs. This reuse will reduce duplicative development costs and speed the integration of software-based capabilities
- Anticipate industry and the government cost reductions of up to 50 percent and a substantial life-cycle cost payoff
- Implement the FACE technical standard across all services in an effort to achieve significant improvements in interoperability, cost reduction, quality, reliability, and readiness

# Data Fusion Vision

Air and surface kill chains today are reliant on individual sensor (radar, electronic support, electronic warfare, electro-optic, infrared) system tracking correlated across one or multiple platforms to support aviation IWC.

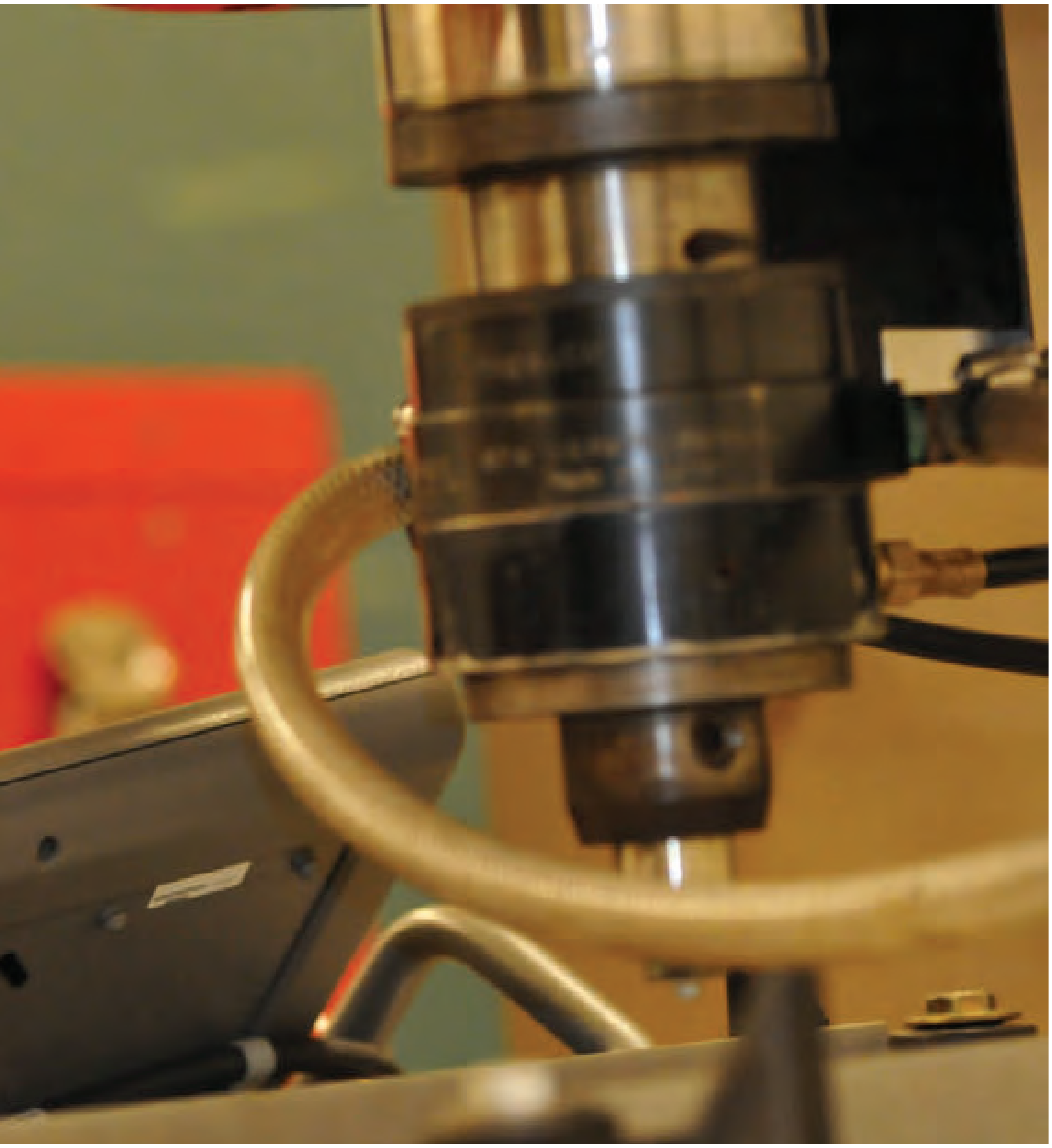
Emerging sensor systems improvements and advanced networks are enabling current and future weapons systems to share, correlate, and fuse high-quality data, tracks and

***Data fusion systems that integrate sensor data are important because obtaining the correct information in a timely manner is often critical to mission success.***

information for the entire force to see and act on the best picture. Fusion of sensor capabilities will enable 1) improved situational awareness, resource allocation, and decision making; 2) integrated fire control with targeting quality track and ID data for improved engagements and weapon/target pairing; and 3) integration of tactical data with theater assets and national data in near-real time (NRT) for improved threat awareness and cueing. NAVAIR Fusion Team and Data Fusion Initiatives are focused on development of these fusion enabled warfare capabilities and products and application of common solutions to improve I&I.

## Additive Manufacturing

Additive Manufacturing (AM), more commonly known as 3D Printing, is a process of joining materials to make objects from 3D model data, usually layer upon layer. The "ink" in this process includes metals, ceramics, polymers, composites, and a biological system. AM is expected to have a disruptive influence on the Navy and the nation as a whole. The ability to produce "parts on demand when and where they are needed" is likely to impact every aspect of the acquisition life cycle including the design, engineering, manufacturing, repair, and maintenance of our weapon systems. Furthermore, current business models, product delivery methods, and logistic support system will need to adapt in order to take advantage of the benefits of AM.



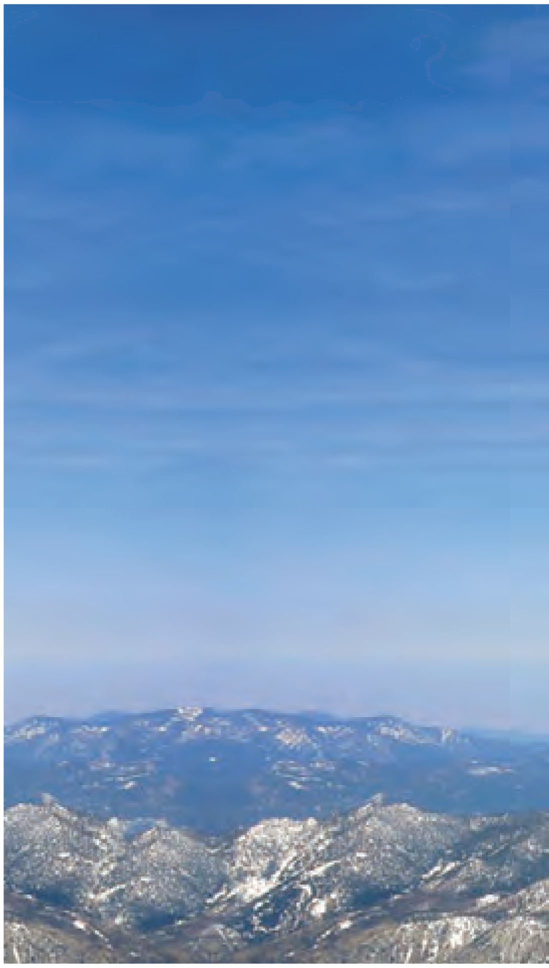
***Dr. Jennifer Wolk, a materials engineer at Naval Surface Warfare Center Carderock Division (NSWCCD), is researching nonferrous naval materials such as aluminum and titanium. She also works in advanced manufacturing processes, such as friction stir welding, cold spray and additive manufacturing. (U.S. Navy Photo)***

Presently, AM is being implemented at NAVAIR to facilitate design and for the production of tools, dies, and fixtures. These applications have already reduced the time and the cost associated with maintenance. The true value of AM, however, will be in the fabrication of flight-worthy aircraft components, where AM is projected to contribute significantly to speed to the fleet, improved operational readiness, and decreased life cycle costs of Naval Aviation weapon systems.

It is important to understand what the implications are to the warfighter, and to facilitate the transformation of our current policies, processes, procedures to fully support necessary research and development for Naval Aviation.

# THE STRATEGIC IMPERATIVE OF INTEGRATED WARFARE

Integrated warfare is not a new idea. It is embodied in the concept of jointness that has been at the heart of the American way of war for decades, and it is the guiding principle of combatant commanders who use combined Navy, Marine Corps, Air Force, Army, and other forces to fight and win this nation's wars. While integration has been the letter and the law at the highest level of command, making integration a reality farther down the warfighting continuum has been more challenging. As outlined below, Naval Aviation's more traditional missions are all moving toward greater integration—not only from an operational perspective, but from the earliest stages of the acquisition process. Today's Air-Sea Battle Concept–which foresees deep integration of joint air, sea, and land forces in anti-access, area-denial battlespaces of the future–is one example of bringing together and integrating capabilities in new and innovative ways across services.





***The integration of the* E-2D Advanced Hawkeye, EA-18G Growler, *and the* MQ-4C Triton *maritime ISR platforms greatly expands the area of control exerted by a smaller fighter force.***

## *Air Warfare: Achieving Dominance in the Skies*

**Present Day:** A few minutes past midnight on 1 November 2011, after radioing a "thank you" to the Malta air-traffic controller, a NATO E-3 Airborne Warning and Control System aircraft began its descent to Trapani Air Base in Sicily, effectively ending Operation *Unified Protector* and heralding Libya's liberation. Since the beginning of the operation on 31 March, NATO conducted more than 26,500 sorties, including more than 9,700 strike sorties. Opening operations were spearheaded by Navy EA-18G *Growlers*, equipped with the ALQ-99 radar jamming pod, AGM-88 High-Speed Anti-Radiation Missiles, and APG-79 phased-array radar, which devastated the Qadhafi regime's air defenses and communications networks. These operations allowed fighters and bombers free reign to strike armored vehicles, communication depots, and other strategic targets. American aircraft supplied all of the electronic warfare missions over Libya, more than 75 percent of the air-to-air refueling, and more than 70 percent of the aerial surveillance during Operations *Odyssey Dawn* and *Unified Protector*. The *Growlers*' integrated communications and networking capability with other NATO aircraft, as well as *Growler* 90-percent commonality with the *Super Hornet* (shared airframe, radar, weapon systems, and stores management), created enhanced readiness and efficiency on the carrier to support operations between the F/A-18E/Fs and EA-18Gs, reducing maintenance man hours per flight hours. The *Super Hornets*' strike capability includes an internal 20-mm gun, the capacity to carry air-to-air missiles, air-to-surface weapons, and the ability to serve as an airborne refueling tanker with the addition of extra fuel in up to five external fuel tanks.

**Tomorrow:** Air warfare capabilities have traditionally been achieved through dominating the battlespace with friendly air forces capable of clearing a path, defending an area, or interdicting an adversary's flight profiles. Improvements in adversary capabilities, however, are increasing the volume of airspace that we must monitor and potentially control. The integration of other naval aircraft such as the E-2D *Advanced Hawkeye*, EA-18G *Growler*, and maritime ISR platforms such as the MQ-4C *Triton* greatly expand the area of control exerted by a smaller fighter force. Further integration with Navy surface assets through CEC and eventually NIFC-CA not only increases the area that can be controlled, but also expands the magazine depth of the aggregate platforms. Cooperation with Air Force and Army partners through cross-domain integration described by the Air-Sea-Battle Concept increases resilience in our effects chains eliminating single points of vulnerability. Networked incorporation of information sharing within the global information grid further expands the area of awareness. Many of these capabilities are expanding to our partner nations; examples are the international Joint Strike Fighter program and the Australian purchase of the EA-18G.


***The Navy conducts initial flight integration test for Advanced Anti-Radiation Guided Missile (AARGM) on the EA-18G* Growler *in China Lake, Calif. (U.S. Navy photo)***

# Anti-submarine Warfare: Nowhere to Run, Nowhere to Hide

**Present Day:** The P-8A *Poseidon* began its debut deployment to Kadena Air Base in Okinawa in December 2013, with detachments throughout the western Pacific. Highly reliable and supportable, the *Poseidon* is a long-range anti-submarine warfare, anti-surface warfare, ISR aircraft capable of broad-area, maritime, and littoral operations. The aircraft's advanced mission system of integrated sensors ensures maximum interoperability in the future battle space. Onboard P-8A, all sensors contribute to a single-fused tactical situation display, which is then shared over both military standard and internet protocol data links, allowing seamless, precise information sharing among U.S. and coalition forces. As an armed platform, the *Poseidon* independently closes the kill chain, while simultaneously providing data to everyone on the network: satellite communications; the carrier strike group; RC-135 Air Force Reconnaissance aircraft; and the *Triton* maritime patrol and surveillance unmanned aircraft system. The P-8 is also equiped with air-launched sonobuoys that are networked to relay underwater sounds associated with ships and submarines to remote processors.

***An armed platform, the Poseidon independently closes the kill chain, while simultaneously providing data to everyone on the network.***




*A P-8A* **Poseidon** *assigned to Patrol Squadron (VP) 16 in flight over Jacksonville, Fla. (Photo by PS1 Anthony Petry)*

**Tomorrow:** Designed for future growth and adaptability, future *Poseidon* upgrades will bring multi-static active coherent acoustics, automated information systems, and High Altitude Anti-Submarine Warfare System (HAASW) capability to the fight. HAASW integrates modified sonobuoy sensors to enhance the P-8A's capability to conduct its mission at higher than traditional altitudes, enabling greater communications range with larger buoy fields and greater coverage from other onboard non-acoustic sensors.

Dominance of the undersea domain requires the ability to cover vast swaths of open ocean while simultaneously executing a complex effects chain with many variables. The modern anti-submarine warfare environment is characterized by high-traffic density, poor sound propagation, high-technology enemies, and asymmetric challenges. The integration of naval aircraft, such as the P-8A *Poseidon* and MH-60R *Seahawk*, into a coherent anti-submarine warfare mission area mitigates the limitations of individual platforms in this difficult and demanding domain. Key sensor improvements are being deployed, including HAASW upgrades aboard the P-8A, advanced air radar periscope detection upgrades for the MH-60R, and data link coordination between Link-16 and Naval Tactical Data Links. The combined efforts allow fewer platforms to cover much larger areas, while increasing coordination between platforms to allow multiple platforms, including ships and ground stations, to perform the individual detect-to-engage functions or to form communications relay nodes in an integrated warfighting construct. The ability to connect to the current Navy and national information grid that supports maritime domain awareness is critical. Future systems integration will focus on maintaining a flexible host platform for improved weapon systems and open and application-based architectures for improved sensors. The benefits of integrated anti-submarine warfare will be realized in the larger area of the battle space that can be controlled by a smaller force, more cost-effective upgrades through open architectures, and increased effectiveness in training and prosecution. Further, the *Poseidon* has the capability to refuel at commercial airfields practically anywhere, and will also have an aerial refueling capability. Starting in 2015, P-8A aircrews will begin air-to-air refueling training, and all 12 squadrons will be capable by 2020.



***An MH-53E* Sea Dragon *helicopter assigned to (HM) 14 lands at Naval Surface Warfare Center Panama City Division after conducting airborne mine countermeasure training in the Joint Gulf Test Range in the Gulf of Mexico. (Photo by Ron Newsome)***

## Mine Warfare: Up from the Depths-Airborne Countermeasures

**Present Day:** The MH-53E *Sea Dragon* is the Navy's sole current Airborne Mine Countermeasures (AMCM) asset and is capable of towing a variety of mine-sweeping countermeasures systems, including the Mk 105 minesweeping sled, the ASQ-14 side-scan sonar, and the Mk 103 mechanical minesweeping system that operates inside the minefield. In 2012, in response to a Central Command urgent request for mine warfare countermeasures in the Arabian Gulf, the Navy rapidly outfitted the 43-year-old amphibious ship USS *Ponce* (AFSB [I] 15) and transformed it into the first afloat forward-staging base. Home ported in Bahrain, this is the first time the Navy has had a platform permanently based in 5$^{th}$ Fleet capable of such a wide variety of missions. *Ponce* participated in major international naval exercises, such as International Mine Countermeasures Exercise (IMCMEX) in 2012 and 2013 to test these new capabilities alongside 34 international navies. IMCMEX focuses on surface mine countermeasures, mine hunting, and airborne countermeasures. *Ponce* also flies the *Scan Eagle* Unmanned Aerial Vehicle (UAV), and the ship has been selected as the test platform for the Navy's sea-based laser weapon capable of disabling small enemy vessels or shooting down surveillance drones.

**Tomorrow:** Effective mine warfare is a key tenet of the Navy's A2/AD strategy. AMCM plays an important role in the strategy's execution. Beginning in 2015, AMCM will become an integrated mission area when the LCS mine countermeasures mission package reaches initial operational capability in response to an ever-changing threat environment and identification of warfighting gaps in the littorals. The mission package comprises the MH-60S employing two on-board systems: the Airborne Laser Mine Detection System and the Airborne Mine Neutralization System. The mission package also uses the Remote Multimission Vehicle, which deploys from the LCS to provide additional mine-hunting and neutralization capability. The key to integration in AMCM is the maturation of data

link, full-motion video, and stream telemetry. These technologies will enable near-real-time, post-mission analysis to reduce the AMCM kill chain, while enabling information sharing with other airborne platform such as the P-8A. Investments continue in key initiatives such as the MK-18 mod 2 unmanned underwater vehicle, which are changing AMCM concepts. The mine countermeasures modular packages are tailored for individual missions, integrating rotating crews, interchangeable mission systems (vehicles, sensors, weapons), and support equipment. The new integrated mine warfare force will allow the Navy to retire obsolescent mine countermeasures and ensure mine threats are neutralized, while keeping Sailors and Marines out of the minefield.

## Strike Warfare: Integrated Lethality

**Present Day:** When Marines in Operation *Enduring Freedom* issued an Urgent Operational Need, the office responsible for direct- and time-sensitive weapons responded to create a capability for a precise rapid-fire missile system that would minimize collateral damage. Employed on AH-1W *Super Cobra* attack and UH-1Y *Venom* utility helicopters, Advanced Precision Kill Weapon System (APKWS) II allows for volume precision attacks and is used in counter-insurgency operations against soft and lightly armored/hardened targets, as well as moving targets that may only be exposed for a few seconds. The missile's value is its ability to hit ground troops hiding behind walls and berms in ambush sites, clusters of fighters placing bombs in roads and other locations, or manning emplacements for mortars and heavy machine guns. APKWS II bridges a weapons gap between machine guns and large ordnance, and unguided rockets and laser-guided *Hellfire* missiles. APKWS II also enhances air crew and launch platform survivability from ground fire. The weapon's cost-effective technology integrates the standard 2.75-inch *Hydra* unguided rocket with a semi-active laser-guided precision munition that is easily assembled by Marines in the field. The Navy has also tested APKWS by firing the missile from MH-60S as a flexible, fast-response defense against maritime targets—in particular, small, high-speed boats used as remotely controlled or suicide weapons against U.S. ships.

*F-35B Aircraft BF-1 and BF-5 perform STOVL operations aboard the USS* Wasp *(LHD 1). (Photo Courtesy of Lockheed Martin)*

**Tomorrow:** Key Naval Aviation strike warfare capabilities are embodied in the F-35B/C *Lightning II*, F/A-18E/F *Super Hornet*, and EA-18G *Growler*, as well as battle management and intelligence support from the E-2D *Advanced Hawkeye*. The F-35B/C will deliver needed stealth, sensing, and command-and-control capabilities to the future air wing. The F-35B/C is also designed to share its operational picture with other aircraft–particularly the F/A-18E/F–to enable *Super Hornet*s to conduct strike and anti-air attacks with stand-off weapons. The F-35B/C will integrate various active and passive sensors from multiple aircraft into the F-35's operational picture. This process automatically formulates weapons-quality tracks for each target that can then be shared with other aircraft and ships, enabling them to engage the target.

# Expeditionary Warfare: From the Sea, Ready to Fight

**PRESENT DAY:** As a prelude to more amphibious forces deploying to the Western Pacific region, in June 2013, about 5,000 ground and naval troops from the U.S., Canada, Japan, and New Zealand participated in the Amphibious Exercise *Dawn Blitz* 13. The exercise took place ashore at Camp Pendleton and Twenty-nine Palms, California, and aboard ships off the coast of San Diego. Members of the 11th Marine Expeditionary Unit, 1st Marine Division, 1st Marine Logistics Group, 3rd Marine Aircraft Wing, and Marine Forces Reserve participated in various live-firing events, such as a beach assault, anti-mine and logistics exercises, and command, control, and communications scenarios. *Dawn Blitz* simulated an amphibious landing assault to retake an island with 70 amphibious assault vehicles

> ***"The important landing of an MV-22 Osprey on a Japanese ship is a great demonstration of the interoperability of our armed forces."***
> ***-BGen John Broadmeadow Commanding General 1st Marine Expeditionary Brigade***

and six landing craft air cushion vehicles landing on the beach and moving inland for additional training ashore. Expeditionary-marked Japanese ground, naval, and air forces participated in a U.S. exercise, and a Marine Corps MV-22 *Osprey* tilt-rotor aircraft landed aboard one of the Japan Maritime Self-Defense Force's helicopter destroyers, *Hyuga* (DDH 181). After landing, the *Osprey* and *Hyuga* crews worked together to demonstrate the utility of the MV-22 through towing procedures, lowering and raising the aircraft in the ship's elevator, and loading and unloading supplies. BGen John Broadmeadow, 1st Marine Expeditionary Brigade's commanding officer, called it "a historic moment for the Corps."

**Tomorrow:** Expeditionary warfare–or military operations mounted from a sea base, consisting of forward-deployed or rapidly deployable and self-sustaining naval forces–remains a core capability of the Navy and Marine Corps team. In addition to the traditional mission of establishing beachheads, expeditionary forces are also used as quick reaction force (such as the expeditionary strike group responding to the Libya crisis) and for non-combatant evacuations and humanitarian assistance. Modern expeditionary forces carry capabilities far beyond the beach. The addition of the MV-22, the expanded connection of sensors, and the increased range of platforms such as the F-35B *Lightning II* are greatly extending the reach of expeditionary forces. The Marine Corps is developing concepts of operation and investing in common systems with open architectures to facilitate the integration of capabilities throughout the Navy-Marine Corps team. Investments include F-35B data fusion capabilities, Marine Air-Ground Task Force Electronic Warfare (MAGTF EW) distributed systems, and self-defense gear such as advance threat warning sensors integrated into the CH-53K and the AN/APR-39 family of radar warning receivers for Navy fixed-wing aircraft and helicopters. AN/APR-39 detects threats from radar ground sites, radar-guided missiles, and provides 360-degree coverage around the aircraft on threat types, bearing, and severity, alerting the aircraft crew with audio warnings and graphic symbols in the cockpit display.



*The U.S. Marine Corps marks history on 14 June 2013 by landing an MV-22* **Osprey** *tiltrotor aircraft on a Japan Maritime Self-Defense Force helicopter destroyer JS* **Hyuga** *(DDH 181) for the first time during Amphibious Exercise* **Dawn Blitz.** *(Photo by Sgt. Isaac Lamberth)*

## Information Dominance: Achieving Cyber Supremacy

**Present Day:** Information dominance is defined as the operational advantage gained from integrating the Navy's information capabilities, systems, and resources to optimize decision making and maximize warfighting effects in the complex maritime environment of the 21st- century. The establishment of U.S. 10th Fleet/Fleet Cyber Command, combined with the Deputy Chief of Naval Operations for Information Dominance (N2/N6), forms an enterprise able to address the opportunities and challenges for cyber systems and operations. Within the realm of information dominance is a host of different capabilities, ranging from information operations, electronic warfare (EW), ISR operations to cyber warfare that collectively combine to assure command and control, achieve battlespace awareness, and integrate kinetic and non-kinetic Navy fires. Naval Aviation figures prominently in all of these capabilities. Future conflicts will not be won simply by using the electromagnetic spectrum and cyberspace; wars will be won *within* them. Wireless networks can keep far-flung forces, aircraft, and ships connected with each other and the full command structure back home. Naval forces have a unique opportunity to exploit this access because of their presence around the world and their ability to approach opponents by the sea. Executing the Navy's EW, ISR, and cyber warfare operations is increasingly a job for integrated manned and unmanned aviation assets.

The MQ-4C *Triton* and P-8A *Poseidon* are entering the fleet together as the centerpiece of the Navy's maritime patrol and reconnaissance force family of systems. The *Triton* will provide combat information to operational and tactical users, supplying a more continuous source of information to maintain a common operational and tactical picture of the battle space. Engineered to operate in all-weather conditions, the *Triton*'s mission set includes the ability to descend from its maximum height of 56,500 feet to lower altitudes if necessary to identify ships, watercraft, and coastal items/targets. The aircraft can be re-tasked as mission requirements dictate, and works in tandem with the manned fixed-wing surveillance aircraft P-8A *Poseidon*. The *Triton*'s ability to perform persistent ISR at great ranges while networked with all aircraft and the carrier strike group allows P-8As and other aircraft to share information while focusing on their core missions.

Tactical unmanned systems such as the RQ-21A *Blackjack*, RQ-11 *Raven*, RQ-7B *Shadow*, and MQ-8 *Fire Scout*, and manned aircraft such as the EA-18G *Growler* are carrying a host of different sensors and airborne electronic attack systems that are interconnecting and advancing the front lines of the electromagnetic battlefield farther and farther. At the same time, the increasingly cloud-based storage and dissemination of global information means that the very concept of the front line is breaking down as cyber warfare transforms warfare itself.




> ***"The EM-cyber environment is now so fundamental to military operations and so critical to our national interests that we must start treating it as a warfighting domain on par with–or perhaps even more important than–land, sea, air, and space."***
>
> ***-Adm. Jonathan Greenert, CNO***

**TOMORROW:** Trends within the worldwide information and operating environments drive the continuing development of a Navy-wide information dominance capability, which are predicted to stress the military's freedom of movement and capabilities in future conflicts.

### *Information Operations*

Information Operations integrate information-related capabilities with other military operations to influence, disrupt, corrupt, or usurp adversary decision making. The growth of potential adversary capabilities combined with the rapid proliferation of complex technology and accompanying tactics increasingly threaten U.S. and partner nation interests. The United States is developing and fielding new, improved information-related capabilities to gain and maintain a decisive advantage in the information environment. Information Operations are primarily a staff planning function at the operational and strategic levels of war and require identification and employment of those information-related capabilities most likely to achieve desired effects. All Naval Aviation assets provide numbered fleet commanders with responsive, powerful, and scalable information-related capabilities necessary to achieve their missions.

## ELECTRONIC WARFARE

The Navy and Marine Corps' dominance in EW lies in the ability to conduct unfettered operations within the electromagnetic spectrum utilizing electronic support, attack, and deception in all arenas and phases of major combat operations, while denying adversaries the same. EW begins with the transit of Naval Aviation forces into a contested area where an adversary may deny entry of U.S. forces into a theater of operations (anti-access) or prevent the maneuver of U.S. forces within an area (area denial) and concludes with the ability to access and operate freely within a contested environment. Naval Aviation platforms must be able to engage in electromagnetic spectrum operations anywhere on the globe. Marine Air Ground Task Force Electronic Warfare will integrate multiple aviation platforms (manned and unmanned) and ground-based EW nodes that will provide the commander with an organic and persistent EW capability. Our ability to fully leverage the electromagnetic spectrum while limiting adversary use of the spectrum is a key tenet of Electromagnetic Spectrum Maneuver Warfare (EMMW). Some of the programs that help ensure EW superiority include:

*Cpl. Aaron H. Gibson, Cpl. Joe A. Barnard, and Lance Cpl. Randy C. Akaeze, with Marine Unmanned Aerial Vehicle Squadron 3, prepare an RQ-7B* **Shadow** *for the first operational launch of a VMU-3 UAV from Camp Leatherneck, Afghanistan. (U.S. Marine Corps Photo)*

- Electronic Warfare Battle Management (EWBM), enabled by Electronic Warfare Services Architecture (EWSA), is integral to MAGTF EW's distributed, networked approach and will connect EW and signals intelligence nodes to unit EW officers, Cyber/EW Coordination Cells (CEWCC), and other tactical electromagnetic spectrum (EMS) nodes. The CEWCC will coordinate the integrated planning and execution of Cyberspace Operations (CO), EW, ISR, Information Related Capabilities (IRCs), and electromagnetic spectrum management in order to gain, maintain, and exploit operational advantage.
- The ALQ-99 Tactical Jamming System is integrated on both the EA-18G and EA-6B and is designed to jam radar and communications targets.
  - The Low Band Transmitter is integrated on both the EA-18G and EA-6B and is designed to jam low-frequency radar and communications targets.
- The Next-Generation Jammer will replace the ALQ-99 carried on EA-18Gs and improve the airborne electronic attack capability.
- The Intrepid Tiger II is a precision EW pod providing Marine Corps fixed- and rotary-wing aircraft with a distributed, adaptable, and net-centric airborne electronic attack capability.

## Intelligence, Surveillance, and Reconnaissance Operations

Today's complex and networked battle space demands that key information be collected and shared as rapidly as possible with those who require it, in a common and usable format, whenever and wherever required. The Navy can maintain a decisive information advantage over potential adversaries by fielding an optimal mix of maritime airborne ISR systems and supporting capabilities. Modular and scalable airborne sensing capabilities (e.g., radar, electro-optical/infrared, full-motion video, signals intelligence, etc.) are critical to satisfy growing warfighting demands. Future sensor packages will be more autonomous and closely integrated with host platforms to make sure sensors stay in the air—and perform their missions—longer. The Navy is developing a family of systems to recapitalize airborne ISR capabilities in the EP-3 and Special Projects Aircraft by the end of the decade, building common sensor payloads that can be delivered by a wide range of manned and unmanned aircraft such as the MQ-4C *Triton*, MQ-8B/C *Fire Scout*, UCLASS, and P-8A *Poseidon*.



**Future conflicts will not be won simply by using the electromagnetic spectrum and cyberspace; wars will be won within them.**

## Command, Control, and Communications

Naval Aviation is investing in personnel, equipment, facilities, and procedures to assist commanders in planning, directing, coordinating, and controlling forces and operations in the accomplishment of their missions. For instance, the Marine Corps Common Aviation Command and Control System consolidates existing functionality into a single system and provides common hardware, software, equipment, and facilities to command, control, and coordinate aviation operations. This suite of scalable modules will support MAGTFs as well as joint and coalition forces. Increment 1 improves current aviation command-and-control systems in the Direct Air Support Center, Tactical Air Command Center, and Tactical Air Operations Center. Future increments will encompass Marine Air Traffic Control Detachment, Low-Altitude Air Defense Battalion, UAS, and airborne node capabilities. In addition, the Navy is continuing to improve its Tactical Data Links. Incorporating new systems into the Multifunctional Information Distribution System Joint Tactical Radio System (MIDS-JTRS) will increase Link-16 capacity and improve situational awareness and is a prerequisite for fielding network-enabled weapons and supporting the Navy's integrated fires capability.

## Cyberspace Operations

As a forward-deployed force, the fleet is highly dependent on cyberspace, the electromagnetic spectrum, and space-based systems. Modern wars will increasingly involve operations in each of these interdependent domains. The United States has enjoyed uncontested superiority in space for several decades, but ever-cheaper access to space and the emergence of anti-satellite and other space weapons have begun to level the playing field. As more nations and non-state actors develop counter-space capabilities, threats to U.S. space systems and challenges to the stability and security of the overall space environment will increase. The convergence of the cyberspace domain and the electromagnetic spectrum presents additional opportunities for Naval Aviation to leverage EW tactics with cyber payloads that will impact enemy combat capability, while increasing our own land, sea, and space-based network security and exploitive capabilities.

Naval Aviation is preparing to deter and defeat potential adversaries with expanded cyber roles projected for the *Growler*, *Hornet*, *Advanced Hawkeye*, and *Lightning II*. Electromagnetic spectrum and cyber operations will attack and break an adversary's




*Two Northrop Grumman MQ-4C* **Triton** *unmanned aerial vehicles are seen on the tarmac at a Northrop Grumman test facility in Palmdale, Calif. (Photo courtesy of Northrop Grumman by Chad Slattery)*

kill chain, a sequence of actions he must complete in order to attack our forces. The Marine Corps continues to advance these capacities through the collaborative efforts of Marine Corps Forces Cyber Command (MARFORCYBER) and Marine Aviation Weapons and Tactics Squadron One (MAWTS-1), as they demonstrate these advanced tactical cyber capabilities by featuring the tactical-level integration of Electromagnetic Spectrum Operations and Cyber Operations, in a combined-arms approach. Using asymmetrical methods (e.g., defeating missiles with EW instead of with another missile; or disrupting Command, Control, Communications, Computers (C4) ISR systems with electromagnetic or cyber attacks), Naval Aviation will prevent enemy visualization or tracking of naval forces, deny their ability to communicate targeting information, destroy weapon launchers, and decoy, divert, and/or destroy launched weapons.

# *Surface Warfare: Evolving Integrated Capabilities*

**Present Day:** Integration of UAVs with surface combatants is a perfect example of the evolution of surface warfare. Circling over the world's hot spots, these small UAVs provide situation awareness and precision targeting support for any aviation-capable warship, whether it is keeping tabs on pirates in East Africa, insurgents in the Middle East, drug runners in the eastern Pacific, or engaging in humanitarian rescue missions. Deployed aboard frigates, destroyers, and amphibious assault ships for the past several years, the *Scan Eagle* and MQ-8B *Fire Scout* have frequently worked alongside shipboard crews to successfully integrate mission payloads into the fleet, such as the electro-optical/infrared video, Automatic

*MQ-8B* **Fire Scout,** *the Navy's Vertical Takeoff Unmanned Aerial Vehicle (VTUAV), hovers over the flight deck of USS* **Fort Worth** *(LCS 3) during dynamic interface operations at the Point Mugu Test Range. (U.S. Navy Photo)*

Identification System, Remote Viewing Terminal, and Tactical Common Data Link communications relay. During past deployments to Africa with special operations personnel aboard for antipiracy missions, cameras aboard UAVs have aided crews conducting boarding operations on pirate ships. These unmanned systems gained valuable ISR data on suspected mother ship vessels off the coast of Somalia and relayed live imagery of the pirate camps to task force commanders. This invaluable data from a sea-based littoral platforms was used by coalition forces attached to NATO Combined Task Forces to capture suspected pirates, contributing to an overall reduction of piracy. Additionally, these systems deployed with teams that developed a number of ISR tactics and rendered humanitarian aid, using both manned and unmanned assets, including responding to multiple distress calls from merchant vessels, interdicting hostile boarding parties, and providing aerial support during ship transits through straits. To date, the MQ-8B variant has amassed more than 12,000 flight hours, and is on its eighth deployment aboard a Navy frigate in support of geographic combatant commanders. The latest variant, the higher-performance MQ-8C, will carry the same ISR capabilities, fly longer, and carry additional payloads. The MQ-8C completed its first flight on 31 October 2013, and its first deployment is planned for FY15.

**Tomorrow:** Surface warfare missions continue to evolve, encompassing a wide range of military operations. Naval Aviation is critical to the ability to control the seas in multiple environments including A2/AD, contested littorals, and even support of irregular warfare. Engagements within these environments include long-range engagement of high-end naval vessels to the engagement of multiple, small, fast-attack craft in a crowded shipping lane. Naval Aviation will continue to perform multiple functions in these engagements in the foreseeable future. Today's surface warfare weapons will continue to increase overall capability through the implementation of interoperability. For example, efforts conducted by the Surface/Aviation Interoperability Laboratory (SAIL) incorporate experimental and operational airborne and surface systems in an LVC environment to address complex warfighting challenges and provide acquisition programs with the ability to "test like we fight." With a focus on Naval Aviation mission systems interoperability, SAIL provides a multitude of resources and capabilities which are used for Research, Development, Test and Evaluation and Training. This reduces technical risk and cost for Navy aircraft and aircraft weapons systems, while ensuring Naval Aviation mission systems interoperability.

In the future, the number of weapons that must be maintained in inventories will decrease while the commonality of supply lines will increase, resulting in a leaner, efficient weapons inventory. Improvements to planned weapons such as the Offensive Anti-Surface Weapon will be complemented by research into deep magazine technologies available through both aviation and surface forces. Naval Aviation units are maximizing capabilities in many engagements through cooperation between aviation platforms, and data links such as the Navy Tactical Common Data Link are increasing the cooperation between aviation platforms and surface vessels. Further integration with LCS mission packages will bring more information to bear for warfighters who must respond to the wide range of threats in complex and potentially crowded environments.

# Air-Sea Battle: Sustaining Freedom of Action and Joint Access

An important component of the Department of Defense's strategic mission is to project power and sustain operations in the global commons during peacetime or crisis. Implementation of the Air-Sea Battle Concept is designed to develop the force over the long-term, and it will continue to inform institutional, conceptual, and

programmatic changes for the services for years to come. Air-Sea Battle is described by the Joint Staff Joint Operational Access Concept (JOAC), which indicates that an essential access challenge for US military forces will be the ability to project force into a contested operational area, and to sustain it in the face of armed opposition by increasingly capable enemies equipped with sophisticated A2/AD defenses. To this end, naval air forces are perfecting effects chains, a series of integrated end-to-end tasks required to achieve the desired effects kinetically or non-kinetically. This concept describes an ability to find the target; determine the target's identification, location, course, and speed (or relative motion); communicate that information coherently to a platform or unit that can launch an attack; and execute an attack using anything from a kinetic weapon to electromagnetic systems to cyber. Naval forces are

***"Strategically, Air-Sea Battle can help us deter adversaries, reassure our partners and allies by demonstrating the ability to honor our security commitments and to be able to act worldwide for humanitarian assistance and disaster relief. Operationally, Air-Sea Battle provides us the ways and means to assure access."***

***-Adm Jonathan Greenert, CNO***

focusing on effects chain functions where the adversary has a vulnerability that can be exploited and/or to which an asymmetrical advantage can be applied.

Air-Sea Battle not only includes the air, maritime, and land domains, but also and equally as important, the space and cyberspace domains. The *Navy Strategy for Achieving Information Dominance Roadmap (2013-2017)* describes the I&I capabilities needed to synchronize Navy's diverse information-related programs, systems, functions and initiatives for future warfighting, and it outlines the expected operational and informational environments over the next 15 years through 1) assuring command and control for deployed forces regardless of the threat environment; 2) enhancing battlespace awareness to shorten the decision cycle inside of the adversary and to better understand the maritime operating environment; and 3) fully integrating traditional kinetic and emerging non-kinetic fires to expand warfighting options to both Navy and joint commanders.

***The Laser Weapon System (LaWS) temporarily installed aboard the guided-missile destroyer USS* Dewey *(DDG 105). The Office of Naval Research's Solid State Laser (SSL) portfolio includes LaWS development and upgrades providing a quick reaction capability for the fleet with an affordable SSL weapon prototype. (Photo by John F. Williams)***

***This still image taken from video shows an exercise conducted by a technical team from the Naval Surface Weapons Center Dahlgren Division and managed and funded by ONR, Naval Sea Systems Command, OSD's High Energy Laser Joint Technology Office and supported by U.S. Fleet Forces Command. (U.S. Navy photo)***

NIFC-CA is an organizing principle that will play a key role in the Air-Sea Battle Concept. Since NIFC-CA incorporates Link-16, other Link-16-equipped sensors such as the Air Force Airborne Warning and Control System could also participate in the network. The first NIFC-CA-equipped carrier strike group is scheduled to field in 2015 and will pursue greater joint and coalition employment with future NIFC-CA improvements.

The effects chain approach described by the JOAC is a common theme throughout the Naval Aviation Enterprise and is consistent with IWC that will make our forces more effective, resilient, and maintain long-term affordability.

# ENSURING WHOLENESS AND AFFORDABILITY

In today's environment of constrained resources and geopolitical challenges, the demand for Naval Aviation forces is growing, and the need has never been greater for an enterprise approach to generating readiness. Affordability is approaching the same level of importance as performance. A decade after its formation, Naval Aviation leadership maintains the enterprise approach to generating readiness pioneered by the Naval Aviation Enterprise (NAE). It remains a strong partnership among leaders and stakeholders who ensure Naval Aviation will remain a whole and ready force by creating a cost-wise and collaborative culture of continuous improvement that addresses both current and future readiness requirements. This enterprise approach, coupled with a "should cost" and a Type Commander-implemented readiness kill chain approach, a Navy Type Wing Command, and a Marine Air Group Commander-led Type/Model/Series (TMS) team, allows our leaders to make superior decisions that benefit all of Naval Aviation. Together they generate the greatest possible efficiencies in a transparent and seamless manner.



**Affordability is approaching the same level of importance as performance.**

## ENTERPRISE WHOLENESS

The NAE is led by Commander, Naval Air Forces, and the Marine Corps' Deputy Commandant for Aviation, with the Commander, Naval Air Systems Command (NAVAIR) as the provider to the Enterprise. With a mission *to advance and sustain Naval Aviation's warfighting capabilities at an affordable cost*, NAE processes provide a means for all major Naval Aviation stakeholders to align their efforts, and to ensure that Naval Aviation maintains wholeness and addresses challenges. The single fleet-driven metric–*Naval Aviation forces efficiently delivered for tasking*–remains a focal point for all Enterprise members.

The NAE employs the following principles that encourage leaders to share information and participate in dialog that result in superior decision making, and to place the welfare of Naval Aviation ahead of individual organizational interests:

- Consistently focus on improved readiness and increased efficiencies
- Systemically apply cross-functional process thinking
- Establish and maintain process discipline
- Use a set of consistent, integrated, and hierarchical metrics
- Ensure full and consistent transparency of data, information, and activities
- Establish and maintain accountability for actions and results
- Understand the single fleet-driven metric
- Commit to active participation

Enterprise principles and processes are enabled through staff and executive drumbeat forums and cross-functional and TMS teams that engage on the various aspects of cost-wise readiness initiatives, including manpower efficiencies; logistics and supply chain management improvements; and training and readiness efficiencies realized through the incorporation of advanced simulators. The reduction over the past 10 years in the number of TMS aircraft within the carrier strike group is a tangible example of cost reductions realized through logistics chain streamlining.

# WHOLENESS, NOT HOLLOWNESS

To perform its missions successfully, Naval Aviation must organize, man, train, and equip *as a whole*. Like interconnected and smoothly meshing gears, each component part is driven by the partner elements: squadrons need people, aircraft and resourcing to function; air wings are dependent on combat-ready squadrons; and aircraft carriers do not deploy in combat without fully manned air wings. These days it is generally "business as usual" to operate in a resource-constrained environment—and it's likely to be that way for many years to come. This places the wholeness of Naval Aviation at risk, and places the impetus on us to manage our resources as efficiently as possible to execute our portfolio of warfighting capabilities. Wholeness also requires smart investments that provide the greatest return and adoption of an approach to acquisition that closes the gaps in existing processes in mission area capabilities.

*Sailors, assigned to the "Desert Hawks" of HSC-26, check the engine of an MH-60S* **Seahawk** *helicopter on the flight deck of USS* **Harpers Ferry** *(LSD 49) during a vertical replenishment at sea. (Photo by MC3 Mark El-Rayes)*

Wholeness is made possible by affordability, which is driven largely by two elements—the acquisition cost to develop and procure platforms and capabilities, and the cost to man, operate, and sustain them throughout their service lives. As the Naval Aviation's acquisition arm, NAVAIR manages both short-term rapid response programs and long-term Programs of Record (POR), and is also implementing "should cost" initiatives throughout all levels of the acquisition process, from contract negotiation, to benchmarking best practices, to creating support mechanisms. Wholeness and affordability encompass multiple efforts described below that will help Naval Aviation leaders find the right balance between demand and resources, so that our forces around the world can continue to provide maritime air superiority whenever needed.

# CROSS-FUNCTIONAL TEAMS

The NAE's cross-functional teams contribute to wholeness by providing venues and information to help Naval Aviation leadership, TMS teams, and multiple stakeholders collaboratively focus on, and promote, cost-wise readiness. Cross-functional teams include Current Readiness, Total Force, Future Readiness, and Integrated Resource Management.

# Current Readiness

The Current Readiness Cross-Functional Team (CFT) brings operators and providers together to produce the required "ready for tasking" Naval Aviation assets at an affordable cost. The team's core is its platform leadership teams. For example, TMS teams, who are the NAE front line for readiness, are performing "should cost" analysis today through the leveraging of their institutional acumen. The TMS teams are led by the lead Type Wing Commander for that type, assigned Marine Aircraft Group (MAG) Commanders, and the Program Managers at NAVAIR. At the Office of Chief of Naval Operations (OPNAV) level, each TMS is resourced by OPNAV N98 (Director, Air Warfare) or OPNAV N2/N6 (Deputy Chief for Information Dominance). TMS Operations and Maintenance, Navy (O&M,N) requirements are established by OPNAV N43 (Director, Fleet Readiness) and resourced by N98 or N2/N6. TMS teams are responsible and accountable for the readiness and associated costs for their respective models of aircraft. They brief the NAE Air Board (a forum of Flag/General Officers and Senior Executive Service leaders that govern the NAE) on their status yearly, but more often if needed to work important issues. TMS teams analyze and identify what the cost should be, as well as pinpointing investment opportunities that could continue to lower cost. Other Current Readiness sub-teams



***A Marine does a final check on the rotor of a CH-53E helicopter during flight operations aboard USS* New York *(LPD 21). (Photo by MCSN Cyrus Roson)***

include the Carrier Readiness Team; Air-Launched Weapons Team; and Naval Aviation Production Team. Each team includes Navy and Marine Corps fleet leaders, program managers, resource sponsors, and other provider staff leaders. Working with other NAE CFTs, the Current Readiness CFT supports its peers identifying and resolving barriers to producing cost-wise readiness.

The Maintenance and Supply Chain Management Team, a sub-team within Current Readiness, oversees force-wide maintenance and supply processes to ensure production of prescribed levels of equipment "ready for tasking" at reduced product-line costs. This team focuses on the efficiency and effectiveness of all integrated logistics support processes, including material requirements forecasting, scheduling, contracting, purchasing, buying management, inventory management, distribution, repair induction, planning, diagnostics, repair, quality assurance, and analysis.

## Total Force

The Total Force CFT serves to optimize and align Naval Aviation's manpower and manning supply chain of Sailors, Marines, and civilians in support of Naval Aviation readiness. The team improves processes, drives innovation, and positions Naval Aviation for future Total Force requirements by identifying, removing, or mitigating performance gaps and barriers impacting readiness. The team conducts risk assessments and uses innovations such as the Manpower-Master Aviation Plan (M-MAP) tool, manpower war games, and other workforce planning initiatives. Over the next 10 to 20 years, every major community in Naval Aviation is scheduled to transition to a new aircraft type. The M-MAP tool will help Naval Aviation leadership navigate the manpower and training changes between legacy squadrons and their replacement TMS aircraft. M-MAP is tied to the Master Aviation Plan (MAP), the 10-year lay-down of Naval Aviation squadrons, and is playing an integral role in the Program Objective Memorandum (POM)-15 budget development.

## Future Readiness

The Future Readiness CFT is dedicated to gathering, scoring, and championing initiatives that improve the reliability, maintainability, and availability of Naval Aviation systems at optimized costs. For the FY12-15 budget cycles, the team garnered investments in excess of $330 million associated with 22 initiatives. The calculated lifespan return on these investments was $3.3 billion (a 9:1 return). Their efforts increase awareness of requirements, acquisition processes, systems engineering technical reviews, and independent logistics assessments for new programs. The team also leverages science and technology at optimized cost for the benefit of future readiness. They do this by facilitating the selection of science and technology projects focused on readiness improvement, cost reduction, and subsequent project transition to Programs of Record.

***The Current Readiness Cross-Functional Team brings operators and providers together to produce the required "ready for tasking" Naval Aviation assets at an affordable cost.***

## Integrated Resource Management

The Integrated Resource Management Team maintains a future-year focus and manages a balanced risk approach to Naval Aviation resource and investment decision making. The team provides planning, programming, budgeting, and execution support to resource sponsors developing budgets in the Office of the Chief of Naval Operations. The team also provides an integrated view of the Naval Aviation portfolio to NAE leaders, and offers financial analysis and recommendations to balance that portfolio.

# AFFORDABLE: "SHOULD COST" VS. "WILL COST"

In September 2010, the Under Secretary of Defense for Acquisition, Technology, and Logistics released a memorandum titled "*Better Buying Power: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending*." One of the actions in this memo was to drive productivity improvements during contract negotiation and program execution through "will cost"/"should cost" management. Simply put, "will cost" is an independent cost estimate used to forecast what a program will cost based on historical experience. Its purpose is to support budgeting and programming. While "will cost" estimates are reasonable extrapolations of historical program costs, they do not define what the program "should cost" if appropriate efficiency and productivity enhancing actions are taken.

"Should cost" analysis and management justifies each element of program cost and shows how it is improving year after year. Ideally, programs that deploy "should cost" management strategies, such as requirements management, acquisition affordability strategies, detailed analysis of all costs, aggressive schedule management and active risk and opportunity management, drive toward a negotiated price that is substantially lower than the historical based "will cost" estimate. "Should cost" management means driving toward program execution targets that are based on realistic technical and schedule baselines and that implement efficiencies, lessons learned, and best practices. Other "should cost" strategies include reducing life-cycle costs through alternative technologies and materials, open architecture designs, hardware commonality, streamlining program teams for better efficiency, using modeling and simulation to reduce overall testing costs, and using government-furnished equipment instead of items provided by prime contractors. These efforts are in tandem with the NAE's Future Readiness CFT Initiatives Process.

Naval Aviation programs are developing and executing "should cost" management strategies, business processes, and best practices. NAVAIR is also developing a training methodology to reinforce, sustain, and improve these best practices so the program teams can establish a cost baseline and provide a process for showing progress in a consistent fashion.



***The* Arleigh Burke*-class guided missile destroyer USS* Barry *(DDG 52) launches a* Tomahawk *cruise missile. (Photo by MC3 Jonathan Sunderman)***

## Naval Aviation "Should Cost" Program Examples

In response to additional 2012 budget challenges, the *Tactical Tomahawk* weapons system team was tasked to find potential areas to save money or avoid future costs. Through a combination of contract negotiations and Government Furnished Equipment re-use, the program saved $117 million in FY12/13; these funds were either recapitalized within the program or returned to the resource sponsor. To continue their migration from "will cost" to "should cost," the *Tactical Tomahawk* weapon systems program employs a three-step approach: identify and analyze cost drivers (acquisition strategy, technical and vendor management, and schedule and requirements management); analyze and prioritize cost-savings opportunities (canister manufacturing, competitive procurement of parts, and the target production contract); and develop an implementation plan and set cost reduction targets.

The E-2D *Advanced Hawkeye* program is also leveraging "should cost" opportunities. Labor efficiencies of $15.4 million are projected across contractor and government teams by combining future engineering efforts. Multi-year procurements between FY14 and FY18 are projected to save $522.8 million in production and delivery. Savings from funding avionics obsolescence efforts will amount to $19.8 million. Event-based maintenance, which requires fewer preventive maintenance hours at the squadron level, will result in operations and sustainment cost reductions beginning in FY15. During low-rate initial production, the E-2D team implemented a tandem buy concept, where pricing was based on two lots and the prime and sub-tier contractors assumed the risk by offering option pricing and self-funding. This action saved $73 million.

The F/A-18 and EA-18 *Growler* program procured airborne electronic attack kits ($22 million in savings through competitive pressure), executed affordability trade-offs between requirements and cost on the infrared search and track system (saving $3.1 million), and saved $145.5 million from the FY11 multi-year procurement. Based on the FY12 budget, the projected program savings for the F/A-18 and EA-18G between FY12 and FY17 is approximately $1.09 billion.

The MV-22 *Osprey* program also has experienced successes in both acquisition and sustainment cost reductions. Two multi-year procurements have saved significant taxpayer dollars and are expected to yield a cost avoidance of more than $1 billion. A significant number of initiatives have reduced life cycle costs, such as repairing more than 400 parts that otherwise would have been discarded. Another initiative was the application of a phased strategy to the program's performance-based logistics support efforts. This strategy involves different levels of supply chain maturity, while setting




***An Aviation Structural Mechanic assigned to the Pioneers of Air Test and Evaluation Squadron (VX)1, directs an E-2D* Advanced Hawkeye. *(Photo by MC2 Kenneth Abbate)***

desired levels of performance for industry in key areas (technical assist turnaround time, engineering investigation turnaround time, supply response time, etc.). Industry is helping the program mature its intermediate- and depot-level maintenance capabilities by leading depot establishment support, providing equipment, bills of material, drawings, and lending training and technical assistance. In addition, the aircraft itself is undergoing improvements through component changes that will avoid life-cycle costs of more than $2 billion. As a result of these cost-reduction initiatives, the MV-22 TMS team achieved a 19 percent reduction in cost-per-flying-hour from FY09 to FY12, and improved the mission-capable rate by 15 percent.

Similar initiatives are being applied to all platforms. Root cause analysis is performed in four areas–maintenance practices, maintenance planning, repair capability, and contract strategies–with an eye on depot-level repairable and consumable cost drivers that present potential opportunities to reduce costs per flying hour. In the process, actual failure rates are compared to current maintenance plans, opportunities to turn high-cost consumables into repairables are investigated, and additional repair capabilities are established as needed. Under contract strategies, supply chain management support contracts are reviewed for opportunities to reduce sustainment costs by broadening the vendor base. A good example of root cause analysis driving smart business and technical decisions is the change in maintenance planning on the single-point hook on the H-53, used to pick up and deliver cargo loads. The original maintenance plan mandated depot repair if the safety wire was broken, which involved unnecessary costs for every trip to the depot. NAVAIR engineers have since determined that Sailors and Marines can perform these repairs at the squadron level. This adjustment will avoid costs of $384,000 per year.

## OPERATIONS AND SUSTAINMENT "SHOULD COST"


*Marine Capt. Joseph White, left, of Barstow, Calif., the deputy logistics officer of the 31st Marine Expeditionary Unit and Philippine Army PFC Vic D. Victorlano carry USAID relief supplies from an MV-22* Osprey *tiltrotor aircraft. Range, payload, and landing site versatility make the* Osprey *a transformational platform. (Photo By Capt. Caleb Eames)*

Current budget planning provides approximately equal funding for military personnel, operating and maintenance, and acquisition accounts. Program life cycle costs have tended to exceed expectations during execution. Efforts to account for shortfalls in acquiring systems are often balanced with affordability goals in operating and support of the new and legacy systems. Historical trends and forecasts suggest that the estimated operations and sustainment planning figures would require as much as a 15-percent reduction in costs to sustain fleet operations as currently envisioned. Naval Aviation is making "should cost" a priority to understand and manage affordability, while balancing risk and meeting operational requirements. Reducing the overall cost per flying hour of each TMS is a key component of reducing operations and sustainment costs. There are a number of initiatives under way to assist in achieving these goals.

# Integrated Logistics Support Management System

The Integrated Logistics Support Management System (ILSMS) data analysis tool assists in identifing root causes of readiness cost degraders, and enables triage of logistics assessment data triage process as platform teams enter their NAE briefing cycles. The ILSMS tool uses a 10-year historical baseline to identify components that perform outside established parameters, providing early indications of potential degraders before they affect readiness or costs. ILSMS also provides more than 100 top-level metrics with detailed transactional data to assist in trend analysis. The logistics assessment process standardizes the way teams identify readiness costs and degraders via advanced analytical capabilities, standardized process models, and improved access to aggregated data. At the end of logistics assessments, teams work on initiatives and courses of action to reduce the ready-for-tasking gaps, and operations and sustainment costs.

# Aviation Rapid Action Team



The Fleet Readiness Centers' Aviation Rapid Action Team comprises engineering, maintenance, and logistics experts who quickly develop, test, and deploy solutions to maintenance problems. They identify potential opportunities, improve or create repair capabilities, certify procedures, train organic technicians, and help sites establish their own permanent capability and support. Since it was launched as a reduction of total ownership cost initiative in 2011, the team has generated $31.8 million in cost avoidance and is on track to achieve nearly $200 million in cost avoidance over the Future Years Defense Program.

***Cost-reduction initiatives resulted in the MV-22 TMS Team achieving a 19 percent reduction in cost-per-flying hour from FY09 to FY12, and improving the mission-capable rate by 15 percent, increasing readiness.***

# Co-Located Maintenance

Co-located maintenance alters the traditional depot-level maintenance repair process by moving the intermediate and depot maintenance capabilities closer to each other. Under this new process, Sailors and Marines work at the depot site and perform intermediate repairs on items inducted into the depot repair cycle. When finished, they hand the items over to civilian artisans who perform the remaining depot repairs. This process lowers the charges for aviation depot-level repairable items. A demonstration of this process at Fleet Readiness Center Southeast has resulted in a cost avoidance of nearly $713,000 for FY11-12.

Naval Aviation's maintenance and repair organization, the Fleet Readiness Centers (FRCs), utilize a Beyond Capabilities of Maintenance Interdiction (BCM I ) methodology that has reduced three main levels of aircraft maintenance to two, with associated cost savings. The BCM I process carefully selects Aviation Depot-Level Repairs (AVDLRs) that are 'beyond the capability' of the local I-level. Then, by co-locating a depot-trained and authorized artisan, a collaborative repair is made without having to BCM that AVDLR off-station into the wholesale system. This reduces overall repair cycle time, often enhances readiness, and results in less total system cost to effect the repairs. During FY13, the NAE's FRCs utilized the BCM-I technique 5,041 times and achieved a net cost change of $136.6 million. These BCM-I repairs also positively influenced readiness by increasing the availability of ready-for-issue AVDLRs.

# Training and Proficiency Optimization

As persistent budgetary pressures make it more challenging to generate required readiness levels due to reductions to the Navy's Flying Hour Account, our ability to develop and sustain aircrew proficiency safely is of particular concern. To meet this challenge, Commander, Naval Air Forces, has established a Proficiency Optimization Working Group (WG) chartered to generate a data-driven, fact-based analysis of variables effecting proficiency and readiness that will help to inform leadership of ways to enable the NAE to remain proficient despite budget decreases. The Working Group is developing a family of decision-quality tools, including the Readiness Cost Analysis Tool (RCAT) that will help inform leadership of impacts executing the Fleet Readiness Training Plan, while predicting levels of readiness, proficiency, cost, and safety. The project is in Phase I and is scoped to only examine Navy F/A-18C/E/F aircraft. Phase II will incorporate additional Naval Aviation platforms, including Marine Aviation. Information learned by the Department of Navy through the Proficiency Optimization project may help to inform USMC readiness production models on how to influence




*A T-45C* **Goshawk** *from Training Wing (TW)2 taxies to the bow catapults on the flight deck of USS* **Carl Vinson** *(CVN 70). (Photo by MC3 Scott Fenaroli)*

the variables associated with developing and maintaining sufficient readiness in a resource-constrained environment. The Proficiency Optimization WG also coordinates closely with the Naval Safety Center to harness similar tools and expertise to manage risk more effectively and better promulgate lessons learned across the force.

# Magic Carpet

Magic Carpet is an acronym for Maritime Augmented Guidance with Integrated Controls for Carrier Approach and Recovery Precision Enabling Technologies. It is a cockpit system that makes carrier approaches and landings easier and safer for Navy and Marine Corps pilots by reducing the vulnerabilities associated with fully-automated systems that are susceptible to jamming, poor reliability, and electronic failure. Magic Carpet's integrated direct lift improves short-term flight-path response, which is critical to final glide slope corrections prior to landing. This system is currently flown in the F-35C and being retrofitted for testing in the F/A-18E/F. The potential cost-saving impacts of Magic Carpet are significant. Millions of dollars are spent yearly on landing practices ashore and actual carrier qualifications while underway. The money saved could be repurposed to train pilots to employ the weapon systems of their aircraft, dramatically changing their priorities from landing proficiency to warfighting proficiency. Conservative estimates indicate that Magic Carpet could save tens of millions of dollars per year, which include reducing the maintenance and repairs after hard landings aboard ship.

## BEGINNING-TO-END: THE READINESS KILL CHAIN

*The readiness kill chain is an end-to-end process for ensuring tight coordination across fleets, Systems Commands, type commands, and other partners throughout the readiness production battlespace.*

U.S. Fleet Forces Command recently initiated an integrated approach called the Readiness Kill Chain (RKC) to assess the Navy's ability to generate combat-ready units. RKC is an end-to-end process for ensuring tight coordination across fleets, Systems Commands, type commands, and other partners throughout the readiness production battle space. RKC maps the processes involved in producing ready forces, in much the same way that the concept of the traditional kill chain documents the processes involved in getting weapons on target. RKC helps identify performance and readiness gaps, and improves root cause analysis. RKC also identifies best practices and barriers to readiness production; it also aligns responsible commands to resolve those barriers.

RKC focuses on the "ways," "means," and "ends," of the readiness process, correlating the resources available with the way they will be used and the desired strategic outcomes. Under this kill chain approach, the warfighting communities are the weapons. Ready, forward-deployed forces are the desired outcomes, or "ends." The readiness pillar resources–personnel, equipment, supplies, training, and ordnance–are the "means" by which the "ends" are accomplished. Policies and resourcing, accessions and procurement, introduction to the fleet, and the phases of the fleet response training plan are the "ways" in which the "means" become the "ends." When the Navy's resources and processes are properly organized and synchronized, outcomes can be achieved more efficiently and effectively. The key to effective execution will be the Navy's ability to shape activities early enough in the RKC so that the relevance and quality of inputs for the fleet readiness training plan process can be optimized. Success will be determined by the strength of the working relationships across all echelons. The RKC is a natural extension of existing NAE processes and tenets and provides a standard framework for enterprise engagement across all echelons.



## MAKING MANNING AND TRAINING AFFORDABLE

People are the strength of the NAE. The primary goal of the NAE's Total Force vision is to prepare our people to develop, acquire, operate, and maintain new aircraft, unmanned systems, and aviation ships while continuing to operate and maintain legacy platforms. The NAE works across the manning and training supply chains to help shape manpower requirements, training strategies, and personnel policies to build future force capability efficiently, reduce costs, and transition to new platforms. Out-year manpower planning identifies and plans the Total Force required to support the future of Naval Aviation.

The NAE's training commands and staffs will remain second to none. Their vision and focus is to train and develop the finest aviation professionals capable of an immediate and positive impact to the fleet. The NAE's training commands use mature metrics and models and cutting edge technology to continually improve the aviation training process to deliver quality Naval Aviation training in the most effective and efficient manner possible.

Retention continues to be one of Naval Aviation's most significant challenges. When retention levels fall, the costs incurred—loss of experience and technical knowledge, additional recruiting requirements, and increased training demands—are high. The focus on retention begins with sustaining a culture that values and recognizes everyone's contribution to warfighting readiness. The NAE will work to create an environment that is conducive to retaining a productive and motivated Total Force by providing challenging and rewarding career choices and recognizing the contributions and sacrifices of people and their families.

The NAE will focus on building and enriching the Total Force to deliver a more competent, diverse, and agile workforce able to support the evolving needs of the Enterprise. By emphasizing effective engagement, collaboration, and sharing of best practices, the NAE will work to ensure its principles and values are commonly understood across the Total Force. Naval Aviation is also devoted to recognizing, developing, and rewarding the contributions of its diverse Sailors, Marines, and civilians. To guarantee a steady supply of talented people, the NAE will work to understand better the demographics of its current and future workforce. The NAE continues to improve its diversity outreach and mentoring programs to maintain awareness of the issues that affect minority and gender-specific hiring and retention. Naval Aviation is dedicated to sustaining a culture that values the warfighting contributions made by every member of its workforce.

***"I'm not out for quotas. I'm out to attract the best young men and women of our nation."***

***-General James F. Amos, USMC CMC***

In the years ahead, new TMS aircraft, unmanned systems, and a new class of aircraft carrier will change the manpower and manning requirements of the workforce. The NAE will use new and effective tools such as the Manpower-Master Aviation Plan to assess personnel risks associated with transitioning platforms. The NAE will use this capabilities-based approach to enable out-year manpower planning to identify, plan, and build the Total Force required to support the future of Naval Aviation.

To ensure wholeness in the Total Force, the NAE relies on readiness and capability demand signals from the fleet to define work requirements clearly, to train and shape the workforce correctly, and to affect budgeting and programming decisions positively. The NAE will align resources to attack barriers through targeted continuous process improvement initiatives, programmatic enhancements, and effective planning to build capability efficiently and maintain Naval Aviation as a preeminent warfighting force.

The end result will always be focused on having the right aviators, maintainers, and support personnel in the right numbers, with the right skills, at the right time, and in the right place. As part of our exceptional teams, Sailors, Marines, and civilians will be motivated to stay in Naval Aviation, have opportunities to achieve their full potential, and gain the knowledge, skills, and abilities to fight and win in combat now and in the future.

## SAFETY

Fleet Forces Command, Pacific Fleet, and the Naval Safety Center have partnered to develop a Safety Campaign Plan with wide-reaching and significant implications for Naval Aviation. The overarching intent is to align safety and risk management processes across warfighting communities in order to reduce personnel injuries/losses, materiel damages/losses, and the resulting negative effects on combat readiness. Key tenets of this plan include the sharing of best practices and lessons learned across the Navy and Marine Corps–from aviation to afloat to shore and to ground–and to implement flexible Safety Management Systems (SMS) across the NAE.

The SMS concept is an international best practice used widely in the global aviation community. The Secretary of the Navy has identified SMS as a collection of processes that proactively manages day-to-day safety in the organization, collectively supports the effective implementation of the unit's overall safety program, and demonstrates the organization is managing safety as effectively as any other critical administrative/business function. Modern SMS approaches to operations have proven to contribute to mission effectiveness for relatively little cost.

Modern warfighting platforms and systems introduce new complexities into the battle space. In turn, this invites new considerations for safety as Naval Aviation becomes a High-Reliability Organization (HRO) that operates in complex environments with high-level technology, processes, people, and sophisticated systems. One mistake or mishap in one section of an HRO can have costly impacts throughout the system. Many tried and true tenets of Naval Aviation safety remain: leadership, stewardship over resources, traditional safety practices, and safety awareness education. However, the approach to safety must keep pace with the development of new warfighting systems and integrated capabilities. Emphasis on continued improvement in safety technology integrated into warfighting platforms will be essential to reducing mishaps that degrade warfighting capability.


*Jim Blesse, standing, from the Office of Naval Research (ONR), explains project BlueShark to Lt. Col. John Moore from the Marine Corps Warfighting Laboratory. Project BlueShark is an ONR effort to create a high-tech, futuristic environment to demonstrate what operational work environments might look like and what emerging innovative technologies might provide in the next decade. (Photo by John F. Williams)*

## CONTRIBUTIONS TO READINESS

As the demand for Naval Aviation forces increases while resources decrease, an enterprise approach continues to be the right way to do business. The focus on cost-wise current and future readiness, collaborative cultural changes, and the cost avoidance and outright savings that have resulted from collaborative partnerships are helping to ensure the continued wholeness and efficient production of Naval Aviation forces.

The benefits are both qualitative and quantitative, and each contributes positively to the overall readiness posture of Naval Aviation forces. Metrics linking readiness, cost, resources, and safety are essential in the necessary trade-off discussions taking place now and into the foreseeable future. The success of the MV-22 TMS team in reducing the cost-per-flying-hour is one example of how NAE processes benefit wholeness and affordability. Open dialog ensures informed decisions, with risks understood. Sharing of best practices across all stakeholders and the suspension of business through stove-piped organizations create an aperture for leadership that gives them insight into Naval Aviation wholeness.


Measurable decreases in the cost-per-flight-hour growth rate over the last 10 years buys readiness in the form of flight hours that would otherwise be lost. Thousands of continuous process improvement events drive cost avoidance and savings in every TMS may be small–but in the aggregate–equate to hundreds of millions of dollars saved annually.

Naval Aviation adheres to warfighting first and foremost, but the Navy and Marine Corps Aviation Team has learned how to produce combat readiness in a cost-wise, collaborative manner. We will continue to prioritize our resources and make the hard choices that ensure Naval Aviation is ready today, as well as tomorrow.

# MAINTAINING CAPACITY

For Naval Aviation, capacity has two distinctly different sets of requirements. The first is aggregate capacity, or force structure. Force structure comprises the total number of units manned, trained, and equipped to meet steady-state presence and crisis response requirements. For aircraft carrier and air wing force structure, aggregate capacity is a matter of national policy. The second element of capacity is operational capacity, defined by the quantity of capabilities that can be brought to bear by a given Naval Aviation force. Operational capacity is determined by


***Chief of Naval Operations (CNO) Adm. Jonathan Greenert, left, and Secretary of the Navy (SECNAV) Ray Mabus observe an X-47B Unmanned Combat Air System (UCAS) demonstrator make an arrested landing on the flight deck of USS* George H.W. Bush *(CVN 77). (Photo by MC2 Tony D. Curtis)***

the number of aircraft within a squadron and the number of aircrews available to operate them, directly affecting the ability to provide desired effects along the spectrum of operations. For steady-state presence, operational capacity requirements are largely driven by two factors: providing a credible deterrent capability in the execution of national policy, and sustaining minimum levels of readiness for combat operations. For major combat operations, operational capacity requirements are determined as the capacity needed to succeed in combat. In the following section, we outline Naval Aviation's current and projected operational capacity, and provide the transformation roadmaps that show how we will build the capacity of the future.

# TRANSFORMATION ROADMAPS

## *Ships*

### CARRIERS

The Chief of Naval Operations, Admiral Jonathan Greenert, included three key tenets in his guidance, "Sailing Directions." These tenets guide how the Navy will organize, train, and equip its future force: "Warfighting First," "Operate Forward," and "Be Ready." Combined, these tenets provide near and long-term guidance for important operational and budgetary decisions facing our service. In order to maintain sufficient, credible core warfighting capacity and capability, the Navy must operate forward to enable strategic influence upon global events, while maintaining the readiness to respond on demand.



***To meet the demands of 21st-century warfare, Nimitz and Ford-class aircraft carriers will deploy long-range manned and unmanned strike aircraft. Advanced weapons and sensors, combined with high-speed sealift platforms, tiltrotor aircraft, and advanced amphibious assault vehicles, will generate more flexible combat power.***

For the Naval Aviation arm, executing the "Operate Forward" tenet is central to who we are as a Naval Aviation force and directly supports the Defense Strategic Guidance, *Sustaining U.S. Global Leadership: Priorities for 21st-Century Defense* issued by the President in 2012.

"Sailing Directions" states that the Navy provides "offshore options to deter, influence, and win in an era of uncertainty." What clearly distinguishes the U.S. Navy from the rest of the world is its nuclear-powered aircraft carrier (CVN) and extremely effective embarked carrier air wings (CVWs). Carriers and their CVWs provide the right balance of forward presence and surge capability to conduct warfighting and peacetime operations around the globe in support of national priorities. Sailing the world's oceans, always ready, each Carrier Strike Group (CSG) possesses a versatile, deadly, and perhaps most importantly, an independent, highly maneuverable strike force capable of engaging targets hundreds of miles at sea or inland. This capability is principally known as a kinetic effect, limited to what the Navy calls "the right side of the kill chain." An aircraft carrier and its embarked air wing, meanwhile, have the capability to operate across the *full spectrum of warfare*, including the electromagnetic spectrum and the non-kinetic or "left side of the kill chain."

The mobility and operational flexibility of aircraft carriers provides a unique level of access that does not require host-nation support. Nuclear-powered aircraft carriers can remain on station for months at a time, replenishing ordnance, spare parts, food, consumables, and aircraft fuel while simultaneously conducting air strikes and other critical missions. Further, unlike other classes of ships, the aircraft carrier does not need to be retired when its primary weapons system become obsolete or when aircraft require upgrades. Similarly, defensive systems are more easily upgraded aboard an aircraft carrier than any other ship.

***USS* George H.W. Bush *(CVN 77) sails in the Atlantic Ocean while conducting a Composite Training Unit Exercise (COMPTUEX). (Photo by MCSN Brian Stephens)***

Admiral Greenert showcased the USS *Enterprise* (CVN 65) as a prime example in his "Payloads Over Platforms" theme for the future design of our Navy, and it is a testament to the aircraft carrier's proven track record of strategic adaptability and continued relevance in a changing threat environment. Those who advocate that a larger number of smaller surface combatants would be a better investment neglect the qualitative value of naval presence afforded by a CVN and her embarked air wing–the very essence of power–that epitomizes the fundamental purpose of naval presence: deter, influence, and win.

*Gerald R. Ford* (CVN 78), the lead ship of the first new class of aircraft carriers in more than 40 years, is slated for delivery in 2016. The CVN 78 design includes improved nuclear reactors and the ability to convert all auxiliary systems outside the main propulsion plant from steam to electric power. This conversion will greatly reduce the requirement for steam, hydraulic, and pneumatic piping that is costly to build and maintain. The new and more efficient reactors provide an electrical generating capacity nearly three times that of a *Nimitz*-class carrier. This additional electrical capacity enables a host of new technologies from the Electromagnetic Aircraft Launch System to advanced command-and-control systems. The design and development investment in the *Ford*-class will deliver a product that is more capable and has lower life cycle costs than its predecessors, and which will continue paying dividends for nearly a century.

The second ship of the *Ford*-class, *John F. Kennedy* (CVN 79), began the advanced construction phase in December 2010 and is expected to enter the fleet in 2022 as the numerical replacement for USS *Nimitz* (CVN 68). To meet the demands of 21st-century warfare, *Nimitz*- and *Ford*-class aircraft carriers will deploy long-range manned and unmanned strike aircraft. Joint concepts of operation, centered on the aircraft carrier, will leverage the strengths of all the services, bringing cooperative muscle to the fight. When compared to their *Nimitz*-class counterparts, manpower requirements for *Ford*-class ships will be reduced by 500 to 900 Sailors. These manpower reductions, coupled with improved reliability and reduced maintenance requirements, will enable the Navy to save approximately $4 billion during the 50-year life of each ship. The design approach and spiral development of the *Ford*-class will help to reduce risk by introducing new technologies and capabilities at an affordable pace. Armed with advanced aircraft such as the F/A-18E/F *Super Hornet*, EA-18G *Growler*, F-35C *Lightning II*, E-2D *Advanced Hawkeye*, and unmanned strike and reconnaissance aircraft, the Navy's aircraft carriers will continue to provide maritime combat power well into the future.

***Perhaps more than any other asset, these ships symbolize the warfighting relationship between the Navy and the Marine Corps: delivering the fight to the enemy in "every clime and place."***



## Amphibious Assault Ships

The Marine Corps is our nation's amphibious, expeditionary, air-ground team with the flexibility to conduct military operations from the air, land, and sea. Amphibious forces provide highly versatile options for any joint force commander tasked with conducting conventional or irregular operations in the littoral regions of the world. Amphibious assault ships are the largest of all amphibious warfare ships, resembling small aircraft carriers. In addition to launching aircraft, they deliver Marine Expeditionary Forces and their equipment onto land by way of small watercraft. Perhaps more than any other asset, these ships symbolize the warfighting relationship between the Navy and the Marine Corps: delivering the fight to the enemy in "every clime and place." Large-deck amphibious assault ships were designed to embark, deploy, and land elements of Marine Corps and special operations forces by tilt-rotor and rotary-wing aircraft, landing craft, and amphibious vehicles while providing organic close air support with fixed-wing aviation. These very capable platforms are routinely deployed as the centerpieces of forward-deployed expeditionary strike groups, which also include *San Antonio*-class, *Whidbey Island*-class, and/or *Harpers Ferry*-class vessels with embarked Marine air-ground task forces (MAGTFs). Together they provide a unique tool capable of supporting the full range of military operations.

## LHA: Amphibious Assault Ship–General Purpose

Landing Helicopter Assault (LHA) vessels are amphibious assault ships that have been modified to accommodate fixed-wing and tilt-rotor aircraft. Each ship can carry a mix of 31 rotary-wing and fixed-wing vertical/short takeoff and landing aircraft with one air-cushioned landing craft (or four utility landing craft) and more than 1,700 troops. These ships can also support sea-based command and control of waterborne and aerial ship-to-shore movements. With a fleet surgical team embarked, an LHA can function as a primary casualty receiving and treatment ship with extensive medical facilities on board. USS *Peleliu* (LHA 5), the remaining *Tarawa*-class LHA, will reach the end of its service life in 2015. The *America*-class will replace the *Tarawa*-class.

***An artist's rendering of an* America*-class amphibious assault ship. USS* Tripoli *(LHA 7) will be 844 feet long, 106 feet wide and will displace 44,971 tons. (Courtesy of Huntington Ingalls Industries)***

## LHD: Amphibious Assault Ship–Multipurpose

The *Wasp*-class Landing Helicopter Dock (LHD) has an improved flight deck and elevator scheme and can accommodate a mix of 31 rotary-wing and fixed-wing aircraft. LHDs were the first amphibious vessels designed to carry both the AV-8B *Harrier* aircraft and multiple air-cushioned landing craft. Their enhanced well decks are capable of carrying three air-cushion or three utility landing craft, and they can embark more than 1,680 troops. *Wasp*-class LHDs have the same Navy and Marine Corps command-and-control facilities as the *Tarawa*-class LHA and also have six operating rooms and 600 hospital beds. All LHDs are being modified to operate the MV-22 *Osprey* and the F-35B *Lightning II*. USS *Makin Island* (LHD 8), the last of the *Wasp*-class LHDs to be commissioned, has a gas-turbine propulsion system and an all-electric auxiliary system.

## LHA Replacement: America-Class

The *America*-class general-purpose amphibious assault ships (formerly the LHA Replacement program) provide forward presence and power projection capabilities as elements of U.S. expeditionary strike groups. With elements of a Marine landing force, *America*-class ships can embark, deploy, land, control, support, and operate helicopters, landing craft, and amphibious vehicles for sustained periods. The *America*-class vessels will also support contingency response, forcible entry, and power projection operations as an integral element of joint, interagency, and multinational maritime expeditionary forces. LHA 6, the first of the *America*-class, is a variant of *Makin Island* (LHD 8) and includes LHD 8's gas turbine propulsion plant and all-electric auxiliaries enhancements. America also has a significant increase in aviation lift, sustainment, and maintenance capabilities; space for a Marine Expeditionary Unit, amphibious group, or small-scale joint task force staff; allowances for new-generation Marine Corps aviation systems; and substantial survivability upgrades.

**_Manned and unmanned aviation will be an integral part of the LCS' organic capabilities in the form of detachments of MH-60R/S and MQ-8B/C aircraft._**

### *LH(X): Amphibious Assault Ship–General/Multipurpose (Next)*

The LH(X) will replace all amphibious assault ships to capitalize on lessons learned with the *America*-class design. Some of the enhancements for LH(X) will include center-of-gravity/displacement growth margins and a surface interface point aimed at maximizing the combat power of MAGTFs. From a shipbuilding standpoint, the strategy is to consolidate amphibious ship designs into a single big-deck class and a single small-deck class (based on the LPD 17 hull form). This strategy will support economies across doctrine, organization, training, equipment, and supplies.

## Surface Ships

### *LCS: Littoral Combat Ship*

*The future USS* Coronado *(LCS 4) conducts at-sea acceptance trials in the Gulf of Mexico. The ship was delivered to the Navy in September 2013. (Photo courtesy of Austal USA)*

Successful joint and combined operations will increasingly depend on our ability to gain and sustain access to the littorals in the face of unpredictable and asymmetric threats. The anti-access threats challenging our naval forces in this environment include quiet diesel submarines, mines, and small, highly maneuverable surface-attack craft—all of which could be employed by many less-capable countries or non-state actors to prevent access by U.S. forces to littoral areas. The LCS is a key element of Navy's future force and is optimized to defeat these anti-access threats. Using an open-architecture design, modular weapons and sensor systems, and a variety of manned and unmanned vehicles to gain, sustain, and exploit littoral maritime supremacy, the LCSs will capitalize on emerging technologies to deliver focused-mission capability in mine countermeasures, surface warfare, and anti-submarine warfare. Aviation–manned and unmanned–will be an integral part of the LCS' organic capabilities in the form of detachments of MH-60R and MQ-8B/C aircraft.

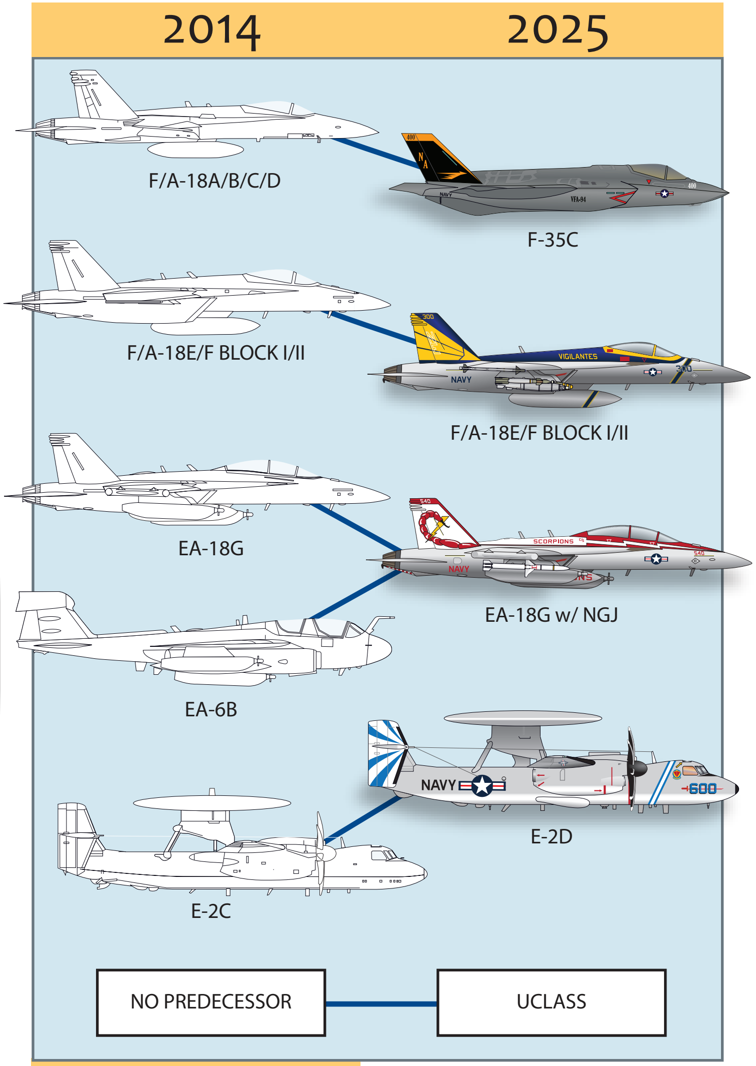
## *DDG: Guided-Missile Destroyer*

Flight IIA variants of the *Arleigh Burke*-class guided-missile destroyer currently under construction incorporate facilities to support two embarked helicopters, significantly enhancing the ship's sea-control capability. A mid-life modernization for these capable vessels commenced in FY10 with DDGs 51 and 53. The program consists of two phases. The first will concentrate on the hull, mechanical, and electrical systems and include new gigabit Ethernet connectivity in the engineering plant, a digital video surveillance system, an integrated bridge system, an advanced galley, and other habitability and manpower reduction modifications. The second phase will install a complete open-architecture computing environment for each ship. The upgrade plan consists of an improved multimission signal processor integrating air and ballistic missile defense capabilities and enhancements improving radar performance in the littorals. Upon the completion of the



*USNS* **Patuxent** *(T-AO 201), center, conducts a simultaneous replenishment at sea with the amphibious transport dock ship USS* **New Orleans** *(LPD 18), left, and USS* **John Paul Jones** *(DDG 53). (Photo by MC2 Jason Behnke)*

modernization program, the ships will have the following weapons and sensors: Cooperative Engagement Capability (CEC), Evolved *Sea Sparrow* Missile (ESSM), Close-In Weapon System (CIWS) Block 1B, Surface Electronic Warfare Improvement Program (SEWIP), and Nulka decoys. The *Arleigh Burke*-class Mk 41 Vertical Launching System (VLS) will be upgraded to support SM-3 and newer variants of the Standard Missile family.




# Aircraft

## Navy Tactical Aircraft

### F-35C Lightning II

The F-35 program is building a tri-service family of next-generation strike-fighter aircraft that is flexible and survivable. With its all-aspect stealth design, internal weapons carriage, fully-fused mission systems, and unrefueled combat radius of more than 600 nautical miles, the Navy's F-35C *Lightning II* will complement the capabilities of the F/A-18E/F *Super Hornet* now serving as the Navy's premier strike fighter. The F-35C will enhance the flexibility, power projection, and strike capabilities of carrier air wings and joint task forces.

### F/A-18E/F Super Hornet

There are a number of enhancements to the F/A-18E/F *Super Hornet* that will sustain its lethality well into the 21st-century. Upgrades include critical growth capability, enhanced survivability, and the ability to land on carriers with a greater quantity of unexpended ordnance without exceeding maximum landing weight. Avionics upgrades for the F/A-18E/F Block II include the APG-79 Active Electronically Scanned Array Radar System, the Infrared Search and Track System, and advanced sensor integration. Future avionics upgrades will enable network-centric operations, which will enhance situational awareness and the transfer of data to command-and-control nodes. The *Super Hornet* also fills the critical organic tanking mission for carrier air wings, extending the operational reach of the nation's sea power. Naval Aviation continues to study the capabilities required when the F/A-18E/F reaches the limits of its service life. The last F/A-18A/B/C/D aircraft utilized by operational Navy squadrons will be out of the fleet in 2022. The last EA-6B aircraft will be out of the Navy in 2014.

***Near-future Naval Aviation revolutionary capabilities include stealth; over-the-horizon air defense; extended strike capability; networked platforms, sensors, C2, weapons, and electronic self protection and attack.***

F/A-XX is the current designation for the material solution concept that will fill the gaps met by the *Super Hornet* with a requirement to be operationally ready to meet the retirement of the F/A-18E/F and EA-18G. The future air wing will be an integrated Family of Systems (FoS) that networks and integrates its capability with greater effectiveness than the sum of its parts. F/A-XX will host mission payloads that will complement the capabilities of the carrier air wing's *Lightning II, Advanced Hawkeye*, and rotary-wing components. The ultimate concept must reliably incorporate future key technologies–propulsion, sensors, networks, automation, and others–within the bounds of affordability.

### EA-18G Growler

The EA-6B *Prowler* has long served as the nation's foremost tactical airborne electronic attack platform. The *Growler* is replacing the EA-6B and leveraged the investments made in the ALQ-218 receiver system, which is the heart of the EA-6B Improved Capability III program. The next step is to replace the ALQ-99 Tactical Jamming System with the Next-Generation Jammer (NGJ), with an initial operational capability anticipated in 2020. Development of NGJ is critical to the Navy's vision for the future of airborne electronic attack and is a vital component of the Defense Department's plan to build a joint System-of-Systems (SoS) electronic attack capability. The EA-18G is already in service, and saw its first combat sorties in Libya. Full operational capability is scheduled for 2015.

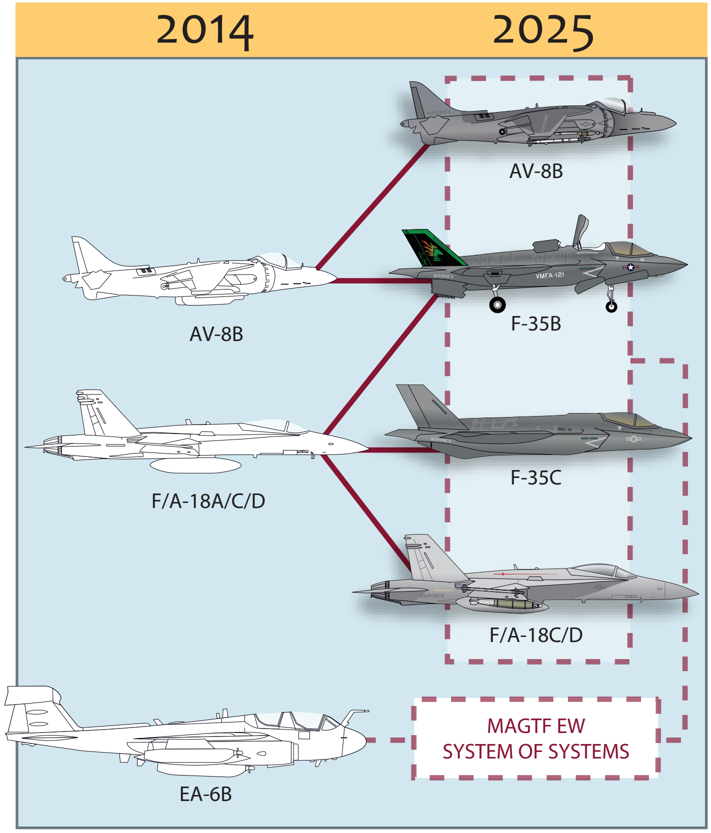
## *E-2D* Advanced Hawkeye

The E-2C *Hawkeye* provides all-weather, airborne early warning, airborne battle management, and command-and-control functions for strike group and joint force commanders. An integral component of carrier air wings, the E-2C uses its radar, identification friend or foe, electronic surveillance sensors, as well as off-board data sources to provide early warning threat analysis against potentially hostile air, surface, and ground targets. E-2C/D usage of Link-11, Link-16, CEC, and a communication suite connects carrier air wings and strike groups at the tactical level to the operational level of warfare. The Navy is recapitalizing its E-2C airborne early warning aircraft with the E-2D, carrying electronically scanned array radar providing a two-generation leap in technology. The *Advanced Hawkeye*'s Space Time Adaptive Processing radar detects and tracks emerging air/cruise missile threats in high-clutter environments, making it the central pillar of carrier strike group integrated air and missile defense. The E-2D has completed flight testing and has been approved for full-rate production. The first E-2D squadron has commenced transition, with an initial operational capability in October 2014. The last E-2C is expected to be out of the fleet by 2023.

*An E-2C* **Hawkeye** *assigned to the Seahawks of Carrier Airborne Early Warning Squadron (VAW) 126 prepares to launch from USS* **Harry S. Truman** *(CVN 75). (Photo by MC3 Lorenzo J. Burleson)*

## Unmanned Carrier-Launched Airborne Surveillance and Strike System

The Unmanned Carrier Launched Airborne Surveillance and Strike System (UCLASS) will provide a persistent, aircraft-carrier-based reconnaissance and strike capability to support air wing operations. Early operational capability (one deployable system) is expected very early next decade. The system will maximize the use of existing technology to launch and control the air vehicle, transfer data (using existing Department of Defense tasking, processing, exploitation, and dissemination systems) in support of precision strike and persistent surveillance operations. It will consist of an air vehicle, a control-and-connectivity segment, and a carrier segment. It will also be integrated into carrier-controlled airspace operations and maintained in accordance with standard fleet processes as tailored for unmanned application. A formal acquisition strategy for the technology development phase has been approved by the Under Secretary of Defense for Acquisition, Technology and Logistics.




# Marine Corps Tactical Aircraft

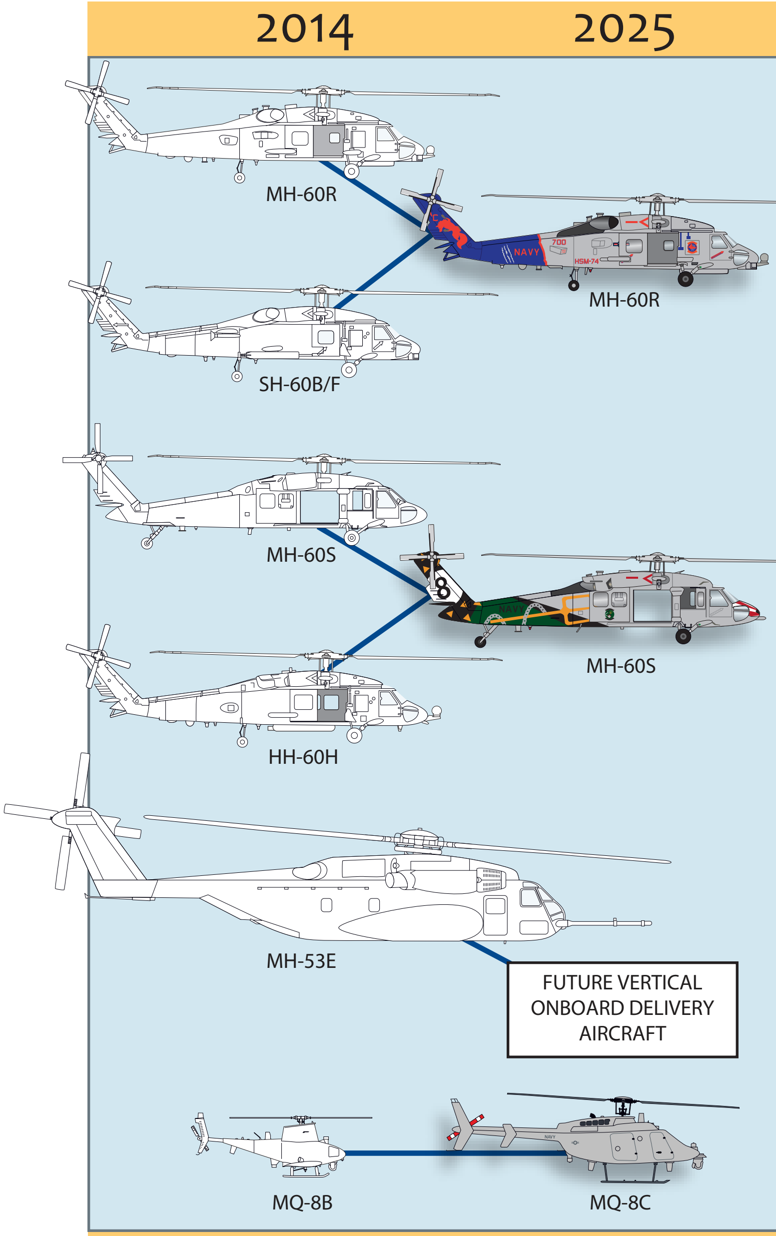
## F-35B/C Lightning II

The F-35B and F-35C support the rapidly changing nature of Marine Corps expeditionary operations by providing flexible-basing options that allow tactical aircraft to improve responsiveness and increase operational agility to maneuver freely across the range of military operations. The *Lightning II* provides a significant joint warfighting capability that will allow us to work detachments aboard L-class ships concurrently with operations at main base facilities, austere forward deployed sites, and conventional carriers. This capability allows us to conduct economy of force at sea and land-based operations with minimal disruption to the main effort. Both the B and C variants are network-enabled and digitally interoperable aircraft ready for full-spectrum operations. The VMFAT-501 Warlords, the F-35B training squadron, continues to train instructors and pilots. In summer 2014 the Warlords will relocate to new F-35B training facilities at Marine Corps Air Station Beaufort, South Carolina. The VMFA-121 Green Knights, the first operational F-35B squadron, started flights in early 2013. The Green Knights continue to accept aircraft and expand their combat readiness training syllabus. In the coming year, new Block 2A software will provide weapon and sensor capability improvements and modifications to correct early production deficiencies. F-35B initial operational capability is expected in 2015, followed by deployment of the first 5th-generation-capable Marine Expeditionary Unit in 2017.

*An F-35B* **Lightning II** *from the Green Knights of Marine Fighter Attack Squadron (VMFA) 121, Marine Aircraft Group 13, 3rd Marine Aircraft Wing, conducts the first short takeoff and vertical landing at Marine Corps Air Station Yuma, Ariz. (Photo by Staff Sgt. Jessica Smith)*

## MAGTF Electronic Warfare System-of-Systems

The Marine Corps will continue to fly the Improved Capability III EA-6B *Prowler* through FY19 as a capability bridge to a scalable System-of -Systems able to support the needs of MAGTF and joint commanders. Integration of unmanned systems payloads, ground systems, and joint improvements to the F-35 under development will enable a distributed electronic warfare capability suitable for Marine operations. The last USMC EA-6B aircraft is expected to transition out of the fleet in 2019.




***The MH-60R and MH-60S multimission combat helicopters are the pillars of the naval helicopter concept of operations for the 21st-century.***

*An MH-60R* Seahawk *helicopter from the Saberhawks of Helicopter Maritime Strike Squadron (HSM) 77 lands on USS* George Washington *(CVN 73) during the air wing fly-on. (Photo by MC3 Ramon G. Go)*

# Navy Helicopters

## MH-60R/S

The MH-60R and MH-60S multimission combat helicopters are the pillars of the naval helicopter concept of operations for the 21st-century. These two variants share 85-percent commonality to facilitate maintenance and logistics support. Carrier air wing squadrons deploy on aircraft carriers and strike group escort ships under the leadership of carrier air wing commanders. Expeditionary squadrons deploy as detachments embarked on LHAs/LHDs, surface combatants, and logistics vessels.

The MH-60R provides surface and subsurface warfare support with its Hawk Link, Link-16, airborne low-frequency dipping sonar, sonobuoys, inverse synthetic aperture radar with automatic periscope detection and discrimination modes, electronic support measures, advanced forward-looking infrared system, precision air-to-ground missiles, machine guns, and lightweight torpedoes. The MH-60R is the only organic airborne anti-submarine warfare asset within strike groups and on independently deploying warships and is critical to ensuring maritime dominance. The SH-60 B/F is expected to be out of the fleet by 2016.

The MH-60S provides surface warfare and mine countermeasures, as well as combat search and rescue and logistics support with its Link-16, advanced forward-looking infrared system, airborne laser mine detecting system, airborne mine neutralization system, precision air-to-ground missiles, 20-mm fixed forward firing gun, and crew-served machine guns. The MH-60S deploys with strike groups, amphibious ready groups, and the LCS. The HH is expected to be out of the fleet by 2023.

MH-XX is the recapitalization effort of the maritime capabilities currently provided by the MH-60S and MH-60R. MH-XX is required to be operational in time to meet the expected end of service of the MH-60 variants.

## Future Vertical Onboard Delivery Aircraft

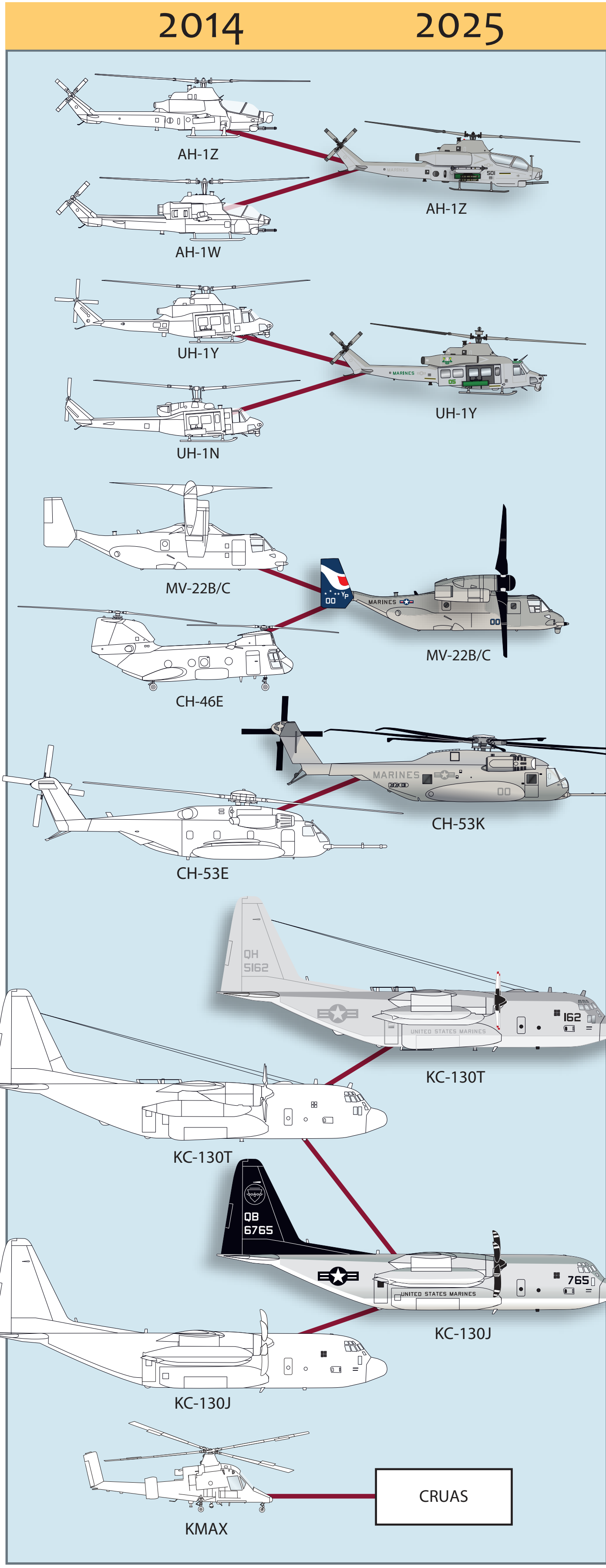
The MH-53E *Sea Dragon* continues to conduct dedicated airborne mine countermeasures and vertical on-board delivery and heavy-lift missions in the fleet. Future plans include transitioning the mine countermeasures capability from the *Sea Dragon* to the MH-60S and identifying an MH-53E Replacement for the Navy's future heavy-lift capability.

## MQ-8C Fire Scout

The MQ-8 *Fire Scout* vertical takeoff and landing tactical Unmanned Aerial Vehicle (UAV) system was designed to operate from all suitably equipped air-capable ships with the Tactical Control System. Currently employed as an Intelligence, Surveillance, and Reconnaissance (ISR) asset with an electro-optical/infrared payload and other modular mission payloads, *Fire Scout* is capable of filling capability gaps in surface, mine countermeasures, and anti-submarine warfare mission sets with a range of 115 nautical miles and an endurance of more than eight hours, depending on payload and environment. *Fire Scout* is maintained by members of a composite MQ-8/MH-60R/S aviation detachment and fielded from the expeditionary HSM/HSC communities. Upgrades for payload, range, and endurance have commenced with the introduction of the Bell 407 platform (MQ-8C, the latest variant) to replace the existing Schweitzer 333-based model (MQ-8B). The higher-performance MQ-8C will have the same ISR capabilities, fly longer, and carry additional payloads. Integration and test efforts to weaponize the system with the Advanced Precision Kill Weapons System (APKWS) concluded successfully in June 2013 and testing efforts to integrate radar are planned for mid-2014. *Fire Scout* surpassed 12,000 flight hours in December 2013 and continues to develop and grow in preparation for its integration with the LCS. The *Fire Scout* MQ-8B is scheduled for its maiden deployment aboard an LCS with USS *Fort Worth* (LCS 3) in late 2014. The MQ-8B is expected to be out of the fleet around the 2022-2024 timeframe. The MQ-8C completed its first flights on 31 October 2013, and its first deployment is expected in FY15.

***Upgrades for payload, range, and endurance have commenced with the introduction of the high-performance MQ-8C Fire Scout.***


***An MQ-8C* Fire Scout *Unmanned Aerial Vehicle takes off from Naval Base Ventura County at Point Mugu. (U.S. Navy Photo)***




# Marine Corps Assault Support Aircraft

## *AH-1Z Viper* and *UH-1Y Venom*

These aircraft, now in full-rate production, are equipped with a four-bladed rotor system, 10,000-hour airframes, integrated avionics, glass cockpits, significantly improved sensors, helmet-mounted displays, and have vastly increased payload, range, and time-on-station capability. The *Viper* and *Venom* share 85 percent of their significant components (a common tail boom, engines, rotor system, drive train, avionics architecture, software, controls and displays) which results in reduced support requirements, training, logistics footprint, and total ownership costs. The UH-1Y has supported combat operations in Operation *Enduring Freedom* since October 2009. The West Coast Marine expeditionary units now deploy with both aircraft. When considered individually, the *Viper* and *Venom* are arguably the best attack and utility helicopters in the world. When operated together, the benefits increase exponentially. Recent deployments have demonstrated that the increased speed, range, and payload capabilities of both aircraft significantly extend the reach and influence of the expeditionary units. The AH-1W will be out of the fleet by 2020. The UH-1N has begun its transition out of the fleet, which is scheduled to be completed in 2014.

## *MV-22B/C Osprey*

The MV-22B/C *Osprey* is a tilt rotor vertical/short takeoff and landing aircraft and is replacing the CH-46E *Sea Knight* assault support helicopter. The transition is proceeding on pace and will be completed by 2017. The *Osprey* can operate as a helicopter or as a turboprop aircraft. It incorporates advances in composite materials, airfoil design, fly-by-wire controls, and digital avionics. It has twice the speed, six times the range, and three times the payload of the aircraft it replaces. In June 2013, the V-22 program surpassed 180,000 flight hours and has successfully deployed multiple times to Iraq and Afghanistan and aboard ships. It currently supports combat operations in the Central Command area of responsibility and is deployed with all three Marine expeditionary units. The CH-46E will be out of the fleet by 2017.

## CH-53K Heavy Lift Replacement

The CH-53D was retired from the active forces in FY13. Approaching 31 years of service, the CH-53E is undergoing safety, survivability, and sustainment efforts required to maintain its heavy-lift capability until delivery of the CH-53K. Expeditionary heavy-lift requirements are expanding and will continue to be critical to successful land and sea-based operations. The CH-53K will have unprecedented heavy-lift capabilities, with the ability to transport 27,000 pounds of external cargo to a range of 110 nautical miles under high-altitude and hot-weather conditions. The lift capability of the CH-53K nearly triples that of the CH-53E while fitting within the same shipboard footprint. Maintainability and reliability enhancements will significantly decrease recurring operating costs, and will greatly improve aircraft efficiency and operational effectiveness. In addition, survivability and force protection enhancements will dramatically increase protection for both air crew members and passengers, broadening the depth and breadth of heavy-lift operational support to Marine and joint commanders. The CH-53E is expected to be out of the fleet by 2023.

***The KC-130J* Hercules *is a multi-mission tactical tanker and assault support aircraft well suited to the needs of the forward-deployed MAGTF.***

## KC-130J Hercules

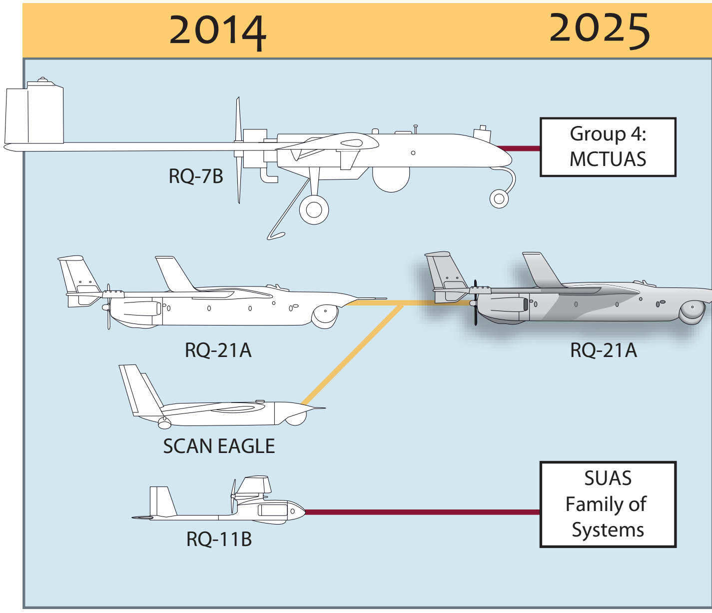
The KC-130J *Hercules* is a multi-mission tactical tanker and assault support aircraft well suited to the needs of forward-deployed MAGTF. As the replacement for active-component KC-130F/R aircraft, the KC-130J provides increased speed, range, and survivability, an improved refueling system, and a digital cockpit with heads-up display. The KC-130J will replace reserve KC-130Ts beginning in 2014, bringing commonality and interoperability to active and reserve Marine Corps components. With the addition of the Harvest Hercules Airborne Weapons Kit (HAWK) for a mission, the KC-130J can be rapidly reconfigured into a platform capable of persistent targeting and precision fires. The KC-130T is expected to be out of the fleet by 2027.




***Two CH-53E* Super Stallion *helicopters assigned to Marine Medium Tiltrotor Squadron (VMM) 263 (Reinforced), 22d Marine Expeditionary Unit (22d vvvvv), perform an aerial refueling training exercise with a KC-130J* Hercules*.*
***(Photo by MC3 James Turner)***

## Cargo Resupply Unmanned Aerial System

The Cargo Resupply Unmanned Aerial System (CRUAS) supports the Marine Corps's requirement to "get trucks off the roads" in combat zones and minimize the threat of improvised explosive devices to logistics convoys. The system will provide a low-risk, persistent capability for dispersed forces that will mitigate the requirement for manned ground vehicles to resupply forces in remote locations. CRUAS will also augment manned aviation assault support assets and airdrop methods when weather, terrain, and enemy threats elevate the levels of risk. A ground control station at a main operating base and a remote terminal at the drop-off zone will deliver cargo by air between main logistical hubs and remote "spokes." This initiative began as a military user assessment in November 2011 that will inform a follow-on Program of Record (POR).




# Marine Corps Unmanned Systems

## Marine Corps Tactical UAS

The RQ-7B *Shadow* is an expeditionary, multi-mission tactical unmanned system that provides dedicated reconnaissance, surveillance, and target acquisition and designation to regimental-sized and larger Marine Corps units. Since 2007, *Shadow* systems have deployed to Iraq, Afghanistan, and elsewhere, where they have flown more than 36,000 combat hours in support of Marine Corps, joint, and allied operations. Four Marine UAV squadrons now operate 12 *Shadow* systems. *Shadow* will be replaced in the FY24 timeframe by a larger Group-4 system currently known as MCTUAS (Marine Corps Tactical UAS). The future Group-4 MCTUAS will provide a highly capable and expeditionary system with strike, ISR, and EW capabilities.

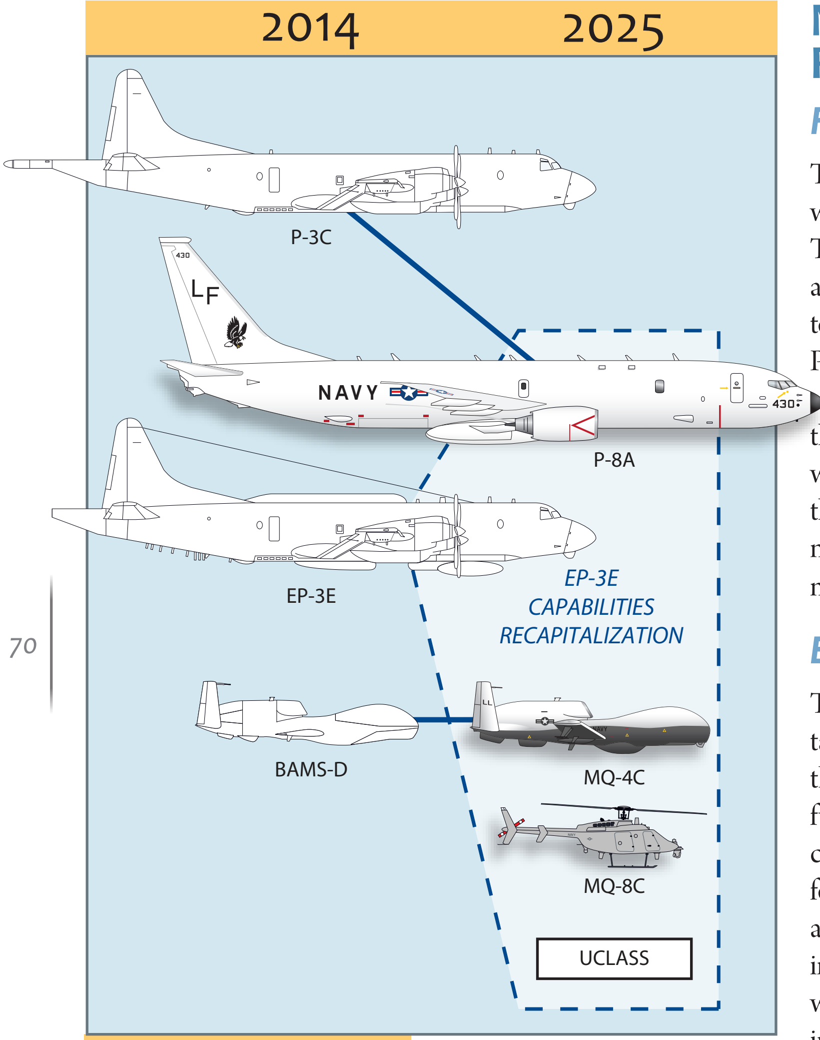
## RQ-21A Blackjack

The RQ-21A *Blackjack* Small Tactical Unmanned Aircraft System will provide a tactical ISR capability for amphibious assault ships, Marine Corps units ranging from expeditionary units to regiments, and Navy special warfare operators. The RQ-21A is a 135-pound UAV (fully loaded) with a 37-pound payload consisting of an electro-optical/infrared sensor ball, infrared pointer, automatic identification system receiver, and communications relay payload. Additional payloads can be integrated into the payload bay and may include synthetic aperture radar/ground moving target indicator, an electronic warfare payload, wide-area motion imagery, laser designator, and weapons. The RQ-21A completed its first operational test phase in January 2011 at the Yuma Proving Ground in Arizona. The Marine Corps procured two early operational capability systems in 2011. Developmental testing occurred in October 2012 (land-based) and July 2013 (ship-based). Operational testing began in October 2013. Initial operational capability is expected in March 2014, with the first deployment aboard a ship in the first quarter of FY15.

***The MKIV launcher prepares to launch the RQ-21A Small Tactical Unmanned Air System (STUAS) from the flight deck of USS* Mesa Verde *(LPD 19) for its first flight at sea. (Photo by MC2 Stuart Phillips)***

## Small UAS Family of Systems

The *Raven B* provides small Marine Corps units with near-real-time reconnaissance and surveillance information. The system consists of a ground control station, three air vehicles, and a field support kit. The system has an endurance of up to two hours with a range of 10 kilometers. It provides day/night live video feedback to users by way of a laptop-based ground control station with color, low-light, and infrared payloads. *Raven B* systems are currently being upgraded to a digital data link. *Raven B* will transition over time to a Family of Small Unmanned Aircraft Systems designed to meet mission requirements and the needs of battalions to which they are assigned.




# Navy Maritime Patrol and Reconnaissance Aircraft

## P-8A Poseidon

The P-8A *Poseidon* will gradually replace the P-3C *Orion*, which will continue flying until phase-out in the 2018-2019 timeframe. The *Poseidon* will engage in maritime and littoral anti-submarine and anti-surface warfare and provide armed ISR capabilities to joint warfighters. To keep pace with emerging threats, the P-8A features a sensor and communications suite built within an open architecture to facilitate the insertion of state-of-the-art sensors, net-ready technologies, and the latest joint weapons throughout its service life. The procurement plan for the *Poseidon* provides for a force with the lethality and capacity needed to support strike groups and the joint battle force in any maritime environment.

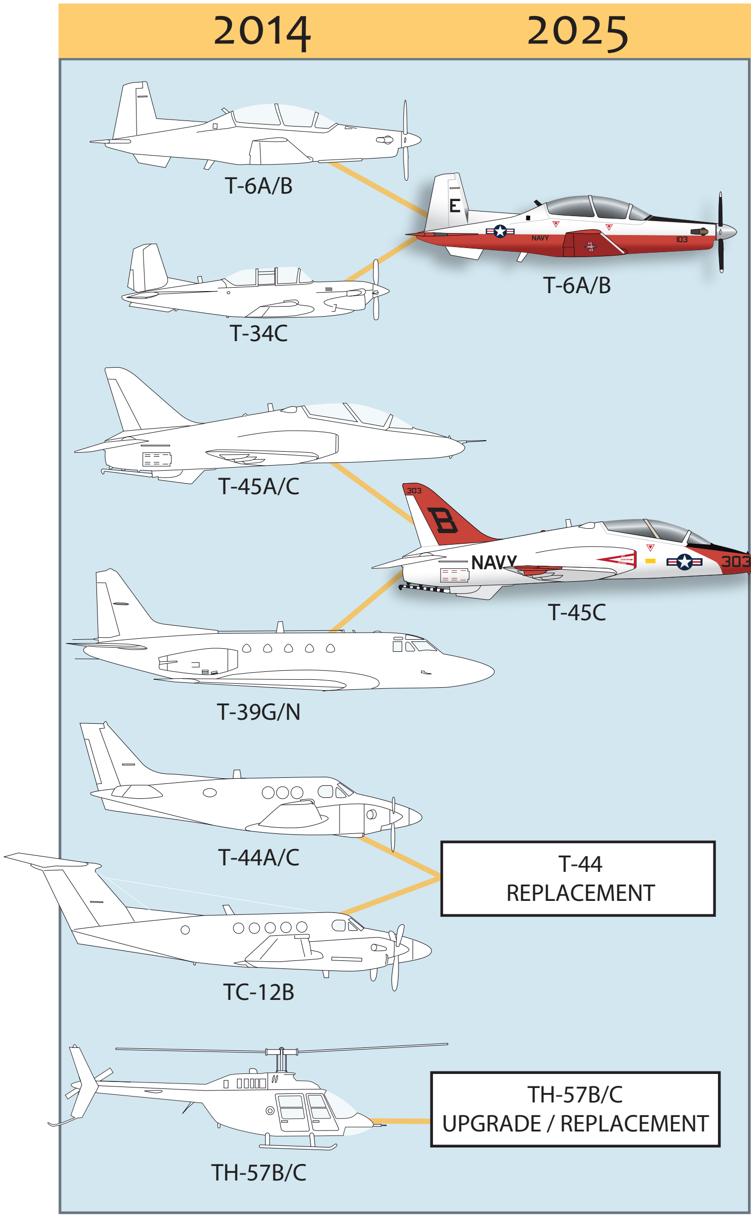
## EP-3E Capabilities Recapitalization

The EP-3E *Aries* is the Navy's premier manned airborne ISR, targeting, and information operations platform. Upgrades to the aircraft have created significant multi-intelligence, data-fusion, and cue-to-kill targeting capabilities essential to support current overseas contingency operations. Though optimized for the anti-surface warfare targeting mission in the maritime and littoral environments, recent capability upgrades have improved the EP-3E's mission effectiveness in supporting warfighters in all environments around the globe. Multi-intelligence sensors, data links, and a flexible and dependable airframe ensure effective support to conventional and nonconventional warfare operations. Naval Aviation is developing a family of systems to be in place by the end of the decade to recapitalize the airborne capabilities currently provided by the *Aries*. Those systems include P-8A *Poseidon*, MQ-4C *Triton* , MQ-8 *Fire Scout* , and the UCLASS system. Until then, investment in the EP-3E joint common configuration program will ensure the aircraft's mission systems keep pace with current and emerging threats. The EP-3E is expected to reach the end of its service life by the end of the decade.

***The proven 737 airframe and networking capability of the P-8A Poseidon will augment the aircraft's flexibility, range, speed, and persistence.***

## MQ-4C Triton

The MQ-4C *Triton* will conduct maritime ISR missions and can serve as an adjunct to P-8A *Poseidon* for maritime patrol. The MQ-4C will be land-based and forward deployed, providing persistent maritime ISR and basic communications relay capabilities from five operational sites (orbits) worldwide in support of fleet commanders and coalition and joint forces. The MQ-4C's long range, combined with networked sensor data, will enable the unmanned aircraft family of systems to meet requirements more effectively. The MQ-4C completed its first flight in May 2013 and is scheduled to begin early fleet operations in 2017, with full operational capability early next decade. An advanced version of *Triton*, *Triton* Multi-INT, will enter the fleet very early in the next decade, providing signals intelligence capabilities to fleet and joint commanders. Since 2009, a Broad Area Maritime Surveillance (BAMS) demonstrator has served operationally in the 5th Fleet, providing near-real-time, high-resolution tactical imagery in support of combat operations. Lessons learned from the demonstrator are being used in the development of maritime patrol and reconnaissance capabilities.




*Cmdr. James Norris, assigned to Training Air Wing (TAW) 4, and Lt. Cmdr. Jeffrey Shanahan prepare a new T-6B* **Texan II** *for its first flight from Naval Air Station (NAS) Corpus Christi. (U.S. Navy photo by Richard Stewart)*

# Navy and Marine Corps Training Aircraft

## T-6A/B Texan II

Navy and Marine Corps primary pilot training is transitioning to the T-6B *Texan II* from the T-34C *TurboMentor*. The T-6A will continue to be used for naval flight officer training. The T-34C is expected to be out of the fleet in 2014; however, some aircraft will remain to serve as spotters through 2026.

## T-45C Goshawk

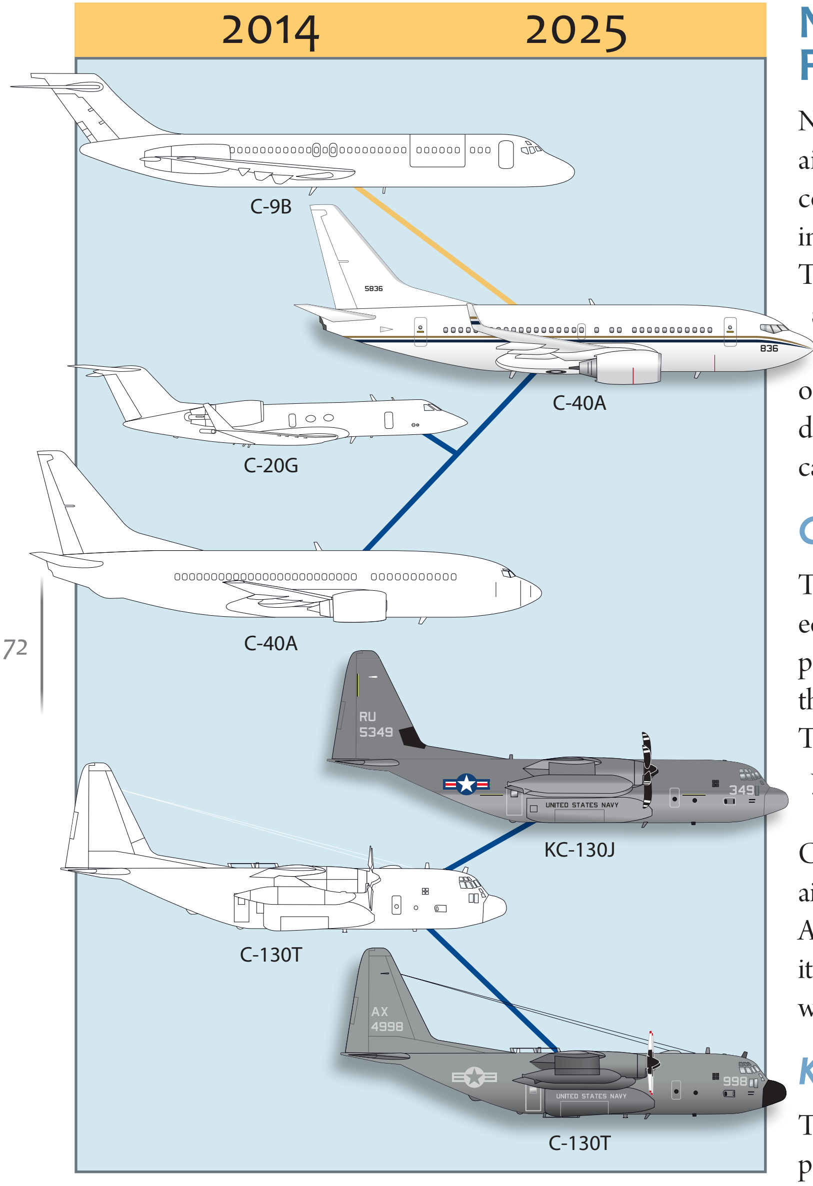
The T-45C *Goshawk* will be the single advanced strike trainer for tail hook pilots and naval flight officers as the T-39G/N *Sabreliner* is retired (only one test aircraft remains in inventory) and the T-45A aircraft is retrofitted to the T-45C configuration. All T-45A cockpits will be digitized through the required avionics modernization program, which consists of a glass cockpit upgrade with two multi-function displays, mission display processor, recorder, and cockpit controls. The virtual mission training system program will integrate a virtual multi-mode radar capability into the T-45C to enable basic tactical skills training that will prepare students for the advanced tactical jet aircraft of the future. By 2020, work will have begun to identify a replacement for the T-45C as this aircraft reaches the end of its service life.

## T-44 Replacement

The T-44A *Pegasus* and TC-128 *Huron* are pressurized, twin-engine, fixed-wing aircraft used to conduct multi-engine aircraft training for Navy, Marine Corps, and Coast Guard pilots. The T-44C, which upgrades the T-44A with a digital cockpit, will become the single multi-engine training platform for Naval Aviation. The TC-12B will be discontinued in 2016, and the T-44 Replacement will be in place by 2025.

## TH-57B/C Sea Ranger

The TH-57B/C *Sea Ranger* will continue as Naval Aviation's single rotary-wing and tilt-rotor aircraft training platform in the near future. Future upgrades may include a digital cockpit and passenger protection to enhance training and safety and to match more closely the capabilities of Navy and Marine Corps fleet rotary-wing platforms. Recently initiated studies will explore acquisition strategies that may enable a cost-neutral training system.






## Navy-Unique Fleet-Essential Airlift

Navy-unique fleet-essential airlift assets are operational aircraft that provide combatant commanders and Navy component commanders with short-notice, fast-response, intra-theater logistics support when and where it is needed. These aircraft deliver medium- and heavy-lift capabilities in support of the fleet and provide a reliable and highly flexible airborne logistics capability for the wartime movement of personnel and heavy cargo. They respond to immediate demands for the movement of essential fleet personnel and cargo to mobile sea-based forces worldwide.

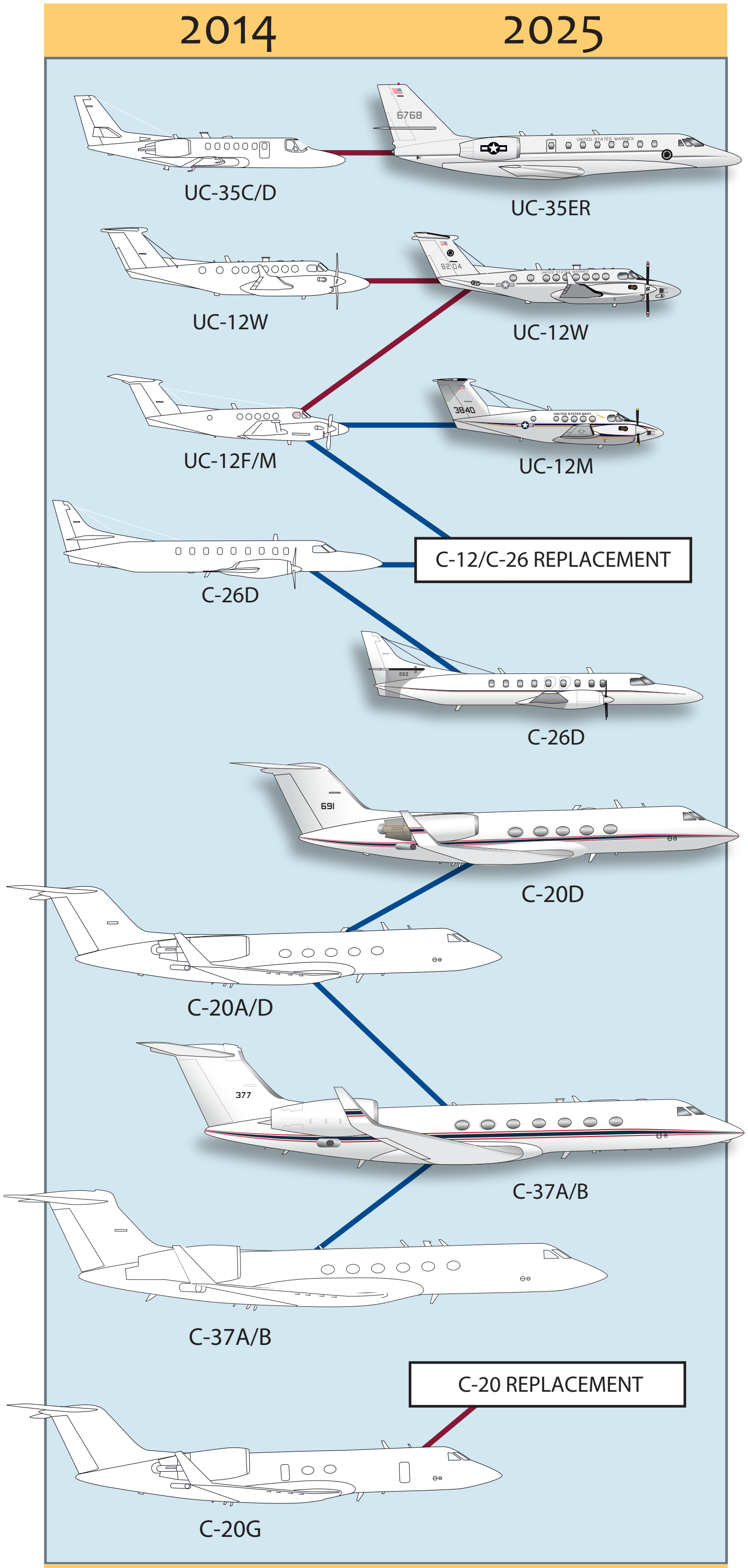
### C-40A Clipper

The C-40A *Clipper* is a Boeing 737-700 next-generation aircraft equipped with an oversized cargo door that offers multiple passenger and cargo configurations. The *Clipper* is replacing the Navy's aging C-9B *Skytrain* and C-20G *Gulfstream* fleet. The venerable C-9B has served the fleet exceptionally well for years, but with an average aircraft age of more than 35 years maintenance costs continue to rise. The last remaining Navy C-9B squadron (VR-61, Whidbey-island based) will divest aircraft by 1 July 2014, while transitioning to the C-40A. CNS/ATM upgrades have extended the service life of the C-20G until its departure from the fleet by 2022, to be replaced by the C-40A with transition starting in 2021.

### KC-130J Hercules

The KC-130J will replace the C-130T. With increased performance, fuel efficiency, and maintenance reliability, the KC-130J is fully compliant with the Communications Navigation Surveillance/Air Traffic Management System and comes equipped with an electronic flight deck. This aircraft can transport up to 35,000 pounds of cargo (or 75 passengers) 1,800 nautical miles at 350 knots. The KC-130J delivery to the Navy is projected for the 2020-2030 decade.

***A C-40 Clipper assigned to Fleet Logistics Support Squadron (VR) 57 lands at Naval Air Station North Island. (Photo by MCSN Carlos M. Vazquez II)***




***Operational Support Airlift aircraft transport high-priority passengers and cargo when requirements are time-, place-, or mission-sensitive.***

# Operational Support Airlift

Operational Support Airlift aircraft are used to transport high-priority passengers and cargo when requirements are time-, place-, or mission-sensitive. They are stationed worldwide and perform airlift missions for combatant commanders to and from remote locations where commercial sources are not available or viable.

## UC-35ER Extended-Range Replacement

The UC-35C/D provides high-speed transport for forward-deployed Marine forces that have time-sensitive passenger and cargo requirements. Operating forces require a jet transport with increased range and improved passenger and cargo capabilities. The UC-35 Extended-Range Replacement aircraft will meet these needs.

## UC-12W Huron

The Marine Corps is replacing the UC-12F/M with the UC-12W *Huron*, which will provide light-lift capability through 2034. With a crew of three and a maximum range of 2,100 nautical miles, the *Huron* can transport up to eight passengers while flying at a speed of 300 knots at an altitude of 35,000 feet. The UC-12W is a deployable light-lift aircraft equipped with survivability equipment and has the secure communications equipment necessary to operate in the Marine Corps Aviation Command and Control System.

## C-12/C-26D Replacement

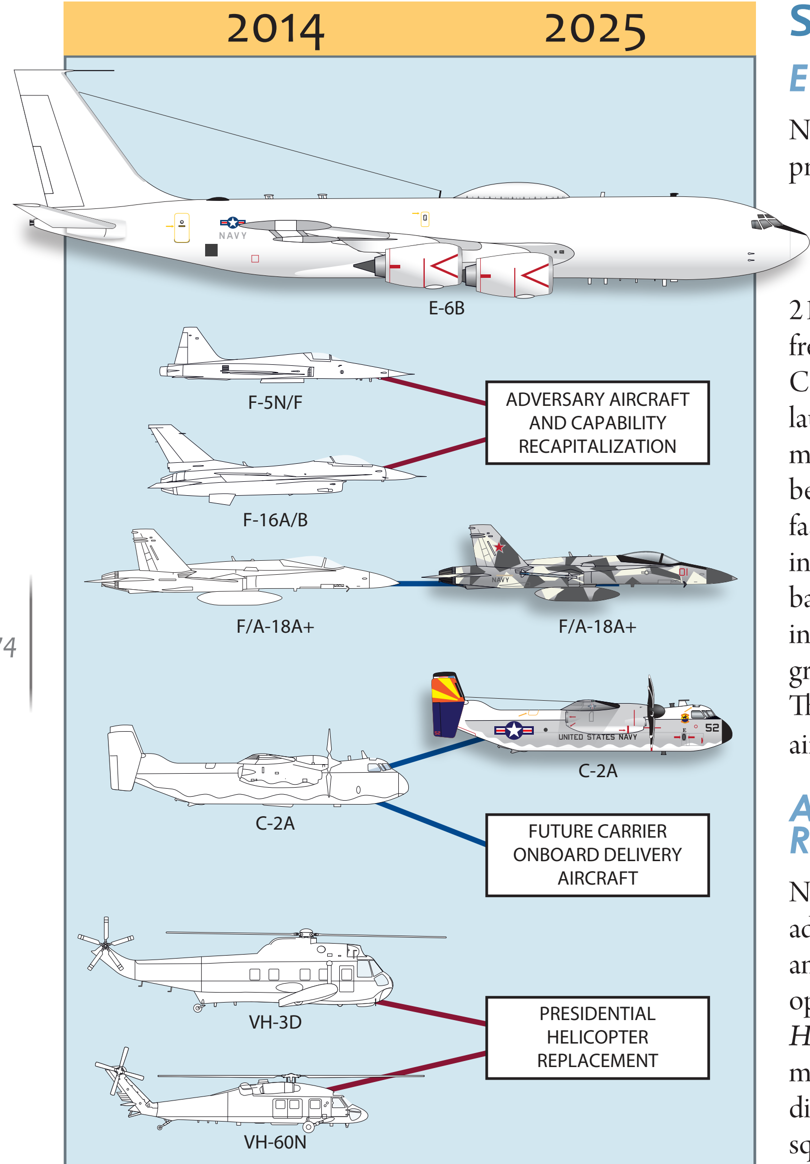
A C-12 replacement aircraft will be identified to replace the Navy's current fleet of UC-12F/M *Huron* and C-26D *Metroliner* aircraft to provide continued light-lift capability. Transition of USMC UC-12F/M aircraft out of the fleet is currently underway.

## C-37A/B

The C-37A/B executive transport aircraft provide senior Navy leaders with high-speed, long-range transportation with a secure communications capability. Flying at speeds up to 585 knots, the C-37A/B can travel 6,750 nautical miles at 45,000 feet and transport 12 or 14 passengers depending on configuration. C-20A is expected to reach end of its service life in 2018. No decision has been made at this time on replacement aircraft.

## C-20G Replacement

The Marine Corps has identified a need to replace the C-20G. Range, payload, and performance characteristics similar to those of the C-20G will be required.




**C-2As can transport payloads up to 10,000 pounds between carrier strike groups and forward logistics sites.**

*A C-2A* **Greyhound** *from the Providers of Fleet Logistics Combat Support Squadron (VRC) 30 launches from USS* **John C. Stennis** *(CVN 74). (Photo by MCSA Ignacio D. Perez)*



# Specialized Naval Aircraft

## E-6B Mercury

Navy E-6B *Mercury* aircraft, derived from the Boeing 707, provide U.S. Strategic Command with the command, control, and communications capability needed for the execution and direction of strategic forces. Designed to support a strong and flexible nuclear deterrent posture well into the 21st-century, the E-6B is capable of performing very-low-frequency emergency communications, the U. S. Strategic Command airborne command post mission, and the airborne launch control of ground-based intercontinental ballistic missiles. The E-6B's mission communications systems are being upgraded to provide the on-board battle staff with faster, more reliable access to classified and unclassified information through Block I program and Internet protocol bandwidth expansion upgrades. Upcoming upgrades will increase line-of-sight and satellite-based data links and enable greater data throughput for high-capacity communications. The service life extension program will ensure continued airframe viability beyond 2025.

## Adversary Aircraft and Capability Recapitalization

Navy and Marine Corps adversary squadrons provide advanced training support to active-duty squadrons. The Navy and Marine Corps Reserve squadrons dedicated to this mission operate the F-5N and F-5F *Tiger II,* in addition to F/A-18A+ *Hornet*s. The Naval Strike Air Warfare Center in Fallon, Nev., maintains a fleet of F-16A/B *Fighting Falcons* that provide dissimilar, fourth-generation threat simulation. Adversary squadrons provide air-to-air training for strike fighter and electronic warfare advanced readiness programs, large force exercises, unit-level training, and fleet replacement squadron training. Recapitalization of the F-5 and F-16 advanced training capabilities are envisioned for the 2025 time frame.

## Future Carrier On-Board Delivery Aircraft

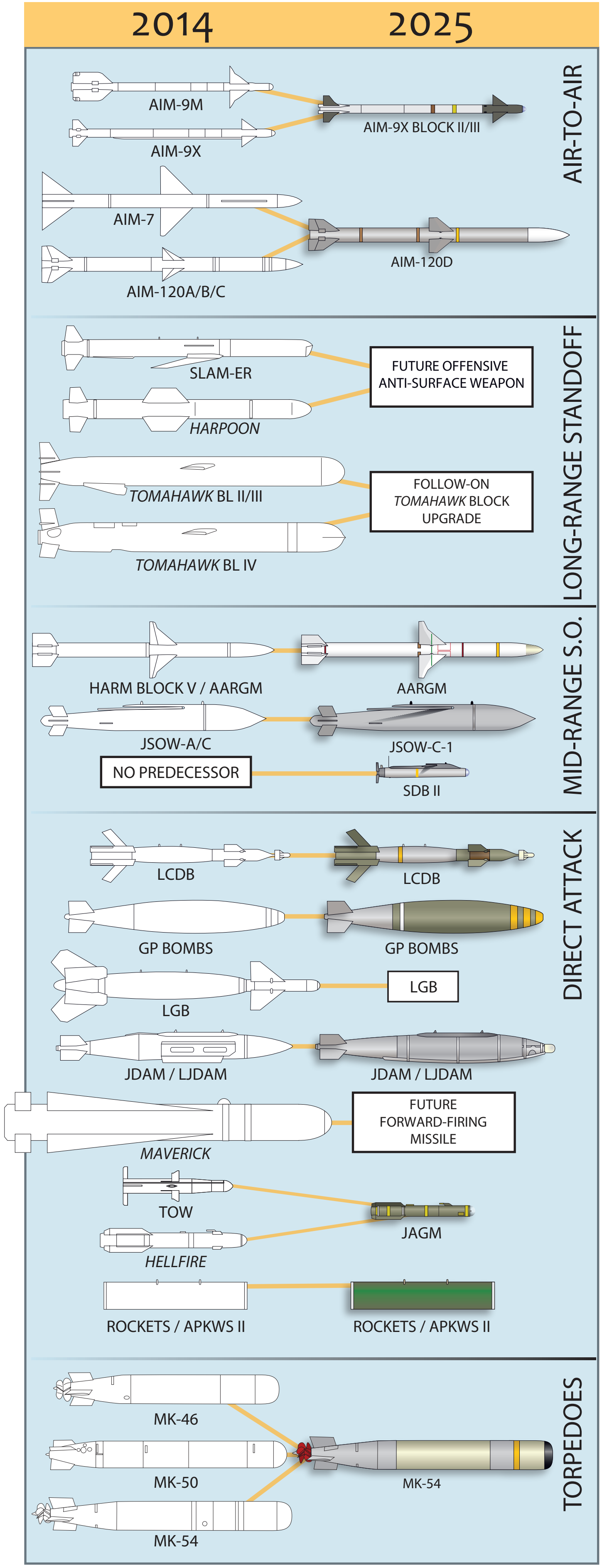
The C-2A *Greyhound* is the Navy's medium-lift/long-range logistics support aircraft. Capable of operational ranges up to 1,000 nautical miles, C-2As can transport payloads up to 10,000 pounds between carrier strike groups and forward logistics sites. The *Greyhound*'s cargo bay can be rapidly reconfigured to accommodate passengers, litter patients, or time-critical cargo. The large rear cargo ramp allows direct loading and unloading for fast turnaround and can be operated in flight to air drop supplies and personnel. Equipped with an auxiliary power unit for unassisted engine starts, the C-2A can operate independently from remote locations. The versatile *Greyhound* can also provide casualty evacuation and special operations distinguished visitor transport support. The aircraft has undergone several modifications and a service life extension program that extended the *Greyhound*'s service life until 2028. The Navy recently updated the Airborne Resupply/Logistics for Sea Basing (AR/LSB) Analysis of Alternatives focusing on mature options for the material solution concept of a CVN-suitable, manned, aerial logistics aircraft that can be fielded by 2026.

### Presidential Helicopter Replacement

A replacement is under development for the VH-3D and VH-60N helicopters, currently providing transportation for the President of the United States, foreign heads of state, and other dignitaries as directed by the White House Military Office. The Presidential Helicopter Replacement program (VXX) will provide a mobile, command-and-control hardened VIP transportation capability and a host of integrated systems necessary to meet current and future presidential transport mission requirements.

*The E-6B* Mercury *(U.S. Navy photo)*

***The E-6B Mercury is designed to support a strong and flexible nuclear deterrent posture well into the 21st-century.***






# *Weapons*

## Air-to-Air

### *AIM-9X Block II/III Sidewinder*

The AIM-9X *Sidewinder* is the successor to the AIM-9M short-range air-to-air missile that provides U.S. fighters with the ability to defeat tomorrow's advanced threats. The AIM-9X system contains a focal-plane-array guidance-control section, a highly-maneuverable airframe, and signal processors that enhance kinematics and infrared countermeasure capabilities. The AIM-9X Block III will provide increased lethality, high off-boresight capability, and a data link to take full advantage of increased kinematics and range. When combined with the Joint Helmet-Mounted Cueing System, AIM-9X provides a "first-look, first-shoot" option. *Sidewinder* was originally a "within visual-range missile;" with modernization, it has become a "beyond visual-range missile."

### *AIM-120D Advanced Medium-Range*

The Advanced Medium-Range Air-to-Air Missile (AMRAAM) is fielded on the F/A-18A/B/C/D *Hornet*, F/A-18E/F *Super Hornet*, EA-18G *Growler*, and AV-8B *Harrier*. The F-35 will also use AMRAAM. The AIM-120D program modernizes prior versions of this missile to maintain a beyond-visual-range engagement capability. This modernization plan includes an enhanced data link, a global positioning system, improved high off-boresight capability, enhanced kinematics, and improved electronic counter-countermeasures capabilities through software upgrades.

## Long-Range Standoff

### *Future Offensive Anti-Surface Weapon*

An Offensive Anti-Surface Weapon (OASuW) program is under way to develop a weapon with an increased standoff capability against maritime targets that will replace existing AGM-84H/K Standoff Land-Attack Missile-Expanded Response (SLAM-ER) and AMG/RGM-84D *Harpoon* missiles. In the interim, the Navy is also pursuing the *Harpoon* Block II+ variant with enhanced weapon navigation and target discrimination through the addition of GPS and a network-enabled data link.

AGM-84H/K (SLAM-ER) is a long-range, precision, air-launched strike missile capable of attacking fixed and mobile land and maritime targets. Terminal control of the weapon is achieved when the pilot designates the impact point on the imaging infrared scene transmitted by the weapon to the cockpit display. Man-in-the-loop commands are sent to the SLAM-ER by way of a data-link pod carried by the controlling aircraft.

The AGM/RGM-84D *Harpoon* Block 1C is an all-weather, air- or surface-launched anti-ship cruise missile that employs an autonomous active radar seeker to attack a wide variety of surface ship targets from standoff ranges. The *Harpoon* is currently carried by F/A-18 and P-3C aircraft as well as a portion of the Navy's DDG-51 and CG-47 surface ship classes, and is used by the navies of 27 other countries.

***The AIM-9X Sidewinder is the successor to the AIM-9M short-range air-to-air missile that provides U.S. fighters with the ability to defeat tomorrow's advanced threats.***

### Follow-on Tomahawk Block Upgrade

The *Tomahawk* Land-Attack Missile is a long-range, subsonic cruise missile used for deep land-attack warfare launched from U.S. Navy surface ships and U.S. Navy and United Kingdom Royal Navy submarines. There are currently three main versions: the Block II nuclear variant, which contains the W80 warhead; the Block III conventional variant, which can carry either a 1,000-pound unitary warhead or a submunition-dispensing warhead; and the Block IV, or *Tactical Tomahawk*, which is network-enabled and capable of changing targets while in flight. *Tomahawk* provides on-scene commanders with the flexibility to attack long-range fixed targets or to support special operations forces with a lethal, responsive, precise weapon system. Potential future capabilities for the *Tomahawk* Block IV include improvements to the warhead (the Joint Multiple Effects Warhead System) and a maritime interdiction multi-mission capability (Multi-mission *Tomahawk*). The *Tomahawk* program office is currently investigating industry seeker technologies for maritime interdiction that could potentially be integrated into the existing Block IV weapon system. The office is also studying a next-generation supersonic cruise missile capability for *Tomahawk* that will increase responsiveness against time-critical targets.


*Aviation ordnance men assigned to the Red Rippers of Strike Fighter Squadron (VFA) 11 remove an AIM-9X missile from an F/A-18F* Super Hornet. *(Photo by MC3 Scott Pittman)*

# Mid-Range Standoff

## AGM-88E Advanced Anti-Radiation Guided Missile

*The AARGM mission to destroy enemy air defenses addresses critical mobile target destruction and advanced air defense system enemy tactics, while minimizing collateral damage.*

The Advanced Anti-Radiation Guided Missile (AARGM) upgrade program transforms a portion of the existing AGM-88 High-speed Anti-Radiation Missile inventory into lethal strike weapons with enhanced time-critical strike and precision attack capabilities. The AARGM upgrade includes: an advanced digital anti-radiation homing receiver for greater sensitivity and enhanced air defense system capabilities; an active millimeter wave terminal radar to increase lethality against modern air defense units, such as surface-to-air missile radars that use radar shutdown and countermeasures designed to defeat anti-radiation missiles; inertial navigation/global positioning systems; a weapon impact assessment transmitter to aid and cue the battle damage assessment process; and an integrated broadcast service receiver for network-centric connectivity reception of off-board targeting information. AARGM correlates multiple sensors and geospecific capabilities to locate and attack both stationary and fixed targets with precision while countering enemy tactics designed to defeat anti-radiation missiles.




*AGM-88E Advanced Anti-Radiation Guided Missile (AARGM) VCD OT-9 Live Fire conducted at the NAVAIR Land Range, China Lake, California. (Photo by Michael "Mugs" McGinnis)*

## AGM-154 Joint Standoff Weapon

The Joint Standoff Weapon (JSOW) is a joint family of armaments that permits Navy and Air Force aircraft to attack targets at increased standoff distances. The weapon uses inertial navigation and global positioning systems for guidance. JSOW provides low- and high-altitude launch capabilities to enable launch platforms to remain outside the range of defenses, which enhances aircraft survivability. All JSOW variants share a common body but can be configured for use against area targets or bunker penetration. The JSOW-C unitary variant adds an imaging infrared seeker and an autonomous target acquisition capability to attack targets with precision accuracy. The JSOW-C-1 will incorporate new target tracking algorithms into the seeker and a strike common weapon data link, giving joint force commanders an affordable, air-delivered, standoff weapon effective against moving maritime targets as well as fixed land targets. The system will maintain JSOW-C functionality to be effective against targets in day or night or through adverse weather conditions.

### GBU-53 Small-Diameter Bomb Increment II

The Small-Diameter Bomb Increment II (SDB II) is a joint program that will provide warfighters with the capability to attack mobile targets at standoff ranges in all types of weather. This 250-pound-class weapon is also capable of multiple ordnance carriage, precision munitions capability, reduced munitions footprint, increased weapon effectiveness, minimized potential for collateral damage, reduced susceptibility of munitions to countermeasures, and an incremental development path to a network-centric operations capability. SDB II integration is planned for the F-35B/C *Lightning II* and the F/A-18E/F *Super Hornet*.




***Low Collateral Damage Bomb impact test conducted at the NAVAIR Land Range, China Lake, California. (U.S. Navy Photos)***

## Direct Attack

### BLU-126 Low Collateral Damage Bomb

The Low Collateral Damage Bomb (LCDB) is ideal for modern urban warfare where target discrimination between noncombatants and friendly and enemy forces requires exceptional blast control. LCDB provides a reduced blast that yields lower collateral damage and adheres to the rules of engagement currently dictated by U.S. Central Command. A precision strike weapon, LCDB can be used with the same guidance kits as those used for laser-guided bombs, Dual-Mode Laser-Guided Bombs (DMLGBs), Joint Direct Attack Munitions (JDAMs), and Laser JDAMs. LCDB is the result of a modification of an existing weapon system, which reduced its design, production, and sustainment costs.

## General Purpose Bombs

MK-80/BLU series General Purpose 500-, 1,000-, and 2,000-pound bombs provide blast and fragmentation effects against a variety of non-hardened targets and are used extensively for direct attack, close air support, and suppression missions. The thermally protected warhead is used for JDAMs, Laser JDAMs, DMLGBs, and LCDBs.

**The laser JDAM has been successfully employed in combat by the Navy, Marine Corps, and Air Force.**

## GBU-54 Laser Joint Direct Attack Munition

The Laser JDAM converts the GPS/INS-guided JDAM currently in inventory into a dual mode configuration using common components and expands the capabilities of JDAM. Laser JDAM incorporates a laser seeker kit into the forward fuze well of the MK-80/BLU series general purpose warhead. By illuminating the target, the Laser JDAM will continually update the estimated target location at impact, allowing for decreased air crew workload, increased accuracy, and the ability to hit stationary or fast-moving targets. Laser JDAM has been successfully employed in combat by the Navy, Marine Corps, and Air Force.

*Marine Aviation Logistics Squadron 40 assembles GBU-54 bombs at Kandahar Airfield, Afghanistan. (Photo by Pfc. Sean Dennison)*

## Joint Air-to-Ground Missile

The Joint Air-to-Ground Missile (JAGM) is an Army-Marine Corps initiative, with the Army designated as the lead service. The JAGM program seeks to incrementally achieve an all-weather, moving target capability through a 100-pound-class, direct-attack weapon system that will use a multi-mode seeker (semi-active laser, millimeter wave radar, and imaging infrared), a multipurpose warhead, and an extended-range rocket motor to destroy high-value hardened and non-armored stationary and moving targets.

JAGM as a direct-attack capability is envisioned as the eventual replacement for the AGM-114 *Hellfire* and AGM-71 TOW missile systems. The USMC AH-1Z is the only Navy threshold platform with a JAGM Increment I capability expected to reach initial operational capability in 2019. Increment I will provide increased lethality over the current AGM-114 *Hellfire* by incorporating a dual-mode seeker (semi-active laser and millimeter wave radar) onto the aft section.

### Advanced Precision Kill Weapon System II

The Advanced Precision Kill Weapon System II (APKWS II) provides precision guidance to the existing Hydra 70 rocket system by placing a laser-guided seeker on existing rocket motors and warheads. APKWS II provides an excellent low-cost, mid-




*A P-8A* **Poseidon** *assigned to Air Test and Evaluation Squadron (VX) 20 replicates the characteristics of an MK-54 torpedo. (Photo by Greg L. Davis)*

range weapon that is well suited to urban environments. Accurate to within two meters of the aim point, the weapon will destroy target sets consisting of personnel, unarmored vehicles, lightly armored vehicles, armored personnel carriers, structures, and man-portable air defense systems at ranges from one-and-a-half to five kilometers.

## Torpedoes

### MK-54 Lightweight Torpedo

The MK 54 Lightweight Torpedo is a modular upgrade to the lightweight torpedo inventory and adds the capability to counter quiet diesel-electric submarines operating in the littorals. The MK-54 combines existing torpedo hardware and software from the MK-46, MK-50, and MK-48 programs with advanced digital commercial off-the-shelf electronics. The resulting MK-54 offers significantly improved shallow-water capability at reduced life-cycle costs. A modernization plan will introduce new hardware and software updates providing stepped increases in probability of kill, while reducing life-cycle cost and allowing the torpedo to remain ahead of the evolving littoral submarine threat. The MK-54 is replacing the MK-46 as the payload in the Vertical-Launch Anti-Submarine Rocket.

# Information Dominance and Cyberspace

The Navy is improving its information-based capabilities to prevail in the higher-threat, information-intensive combat environments of the 21st-century. The Navy's plan for achieving information dominance highlights long-term opportunities for fully integrating Navy's information-related activities, resources, processes, and capabilities to optimize warfighting effects and maintain decision superiority in every area of warfare. Today's current information-based capabilities will require continual changes and improvements in a number of areas: assured command and control for our deployed forces regardless of threat environment; enhanced battle space awareness to make decisions faster than our adversary's and improve understanding of the maritime operating environment; and fully integrated fires that expand warfighting options for both Navy and joint commanders.



**Integrated fires means coordinating all elements within the kill chain to seize and hold the initiative in combat and limit an enemy's ability to maneuver and act.**

## Assuring Command and Control

Assuring command and control means making sure commanders can control their forces most effectively to put weapons on target and achieve their objectives. The Navy's future information infrastructure must be able to maintain essential network and data-link services across secured segments of the electromagnetic spectrum. It must also transport, share, store, protect, and disseminate critical data and combat information required by forward-deployed units and on-scene commanders. Of particular importance is the "operationalization" of the electromagnetic and cyberspace realms into warfighting domains, turning these into new "maneuver" spaces.

## Battlespace Awareness

Threats from non-state actors as well as traditional states demand that we take a layered, defense-in-depth approach. Defeating these threats will require improving and structuring the Navy's overall information content for use in combat, and will require enhanced sensing, collecting, and processing of data, and better analysis, evaluation, and exploitation of critical intelligence. Our future information content will serve as the basis from which nearly all timely decisions will be made during information-intensive combat, enabling our forces to maneuver and coordinate actions to target more effectively and to make decisions and achieve results faster than enemies can react.

## Integrated Fires

Integrated fires mean coordinating all elements within the kill chain to seize and hold the initiative in combat and limit an enemy's ability to maneuver and act. By coordinating the use of all available kinetic and non-kinetic capabilities, the Navy will

*Sailors from the Operations Department plot contacts and monitor radars in the commanding officer's tactical operations plot room aboard USS* **Theodore Roosevelt** *(CVN 71). (Photo by MCSN Stephane Belcher)*

be best positioned to achieve all desired lethal and nonlethal effects in every warfare environment—including in anti-access/area-denial scenarios. Integrating fires will require new capabilities to employ integrated information effects in warfare, especially expanding the use of advanced electronic warfare and offensive cyber effects that will complement air, surface, and subsurface effects. Future information effects will be designed to influence adversary behaviors, or control, manipulate, deny, degrade, or destroy their warfighting capabilities.

# SUMMARY

Naval Aviation is a warfighting enterprise that continues to be the preeminent forward-deployed force ready to fulfill any mission assigned. Our aircraft carriers, amphibious assault ships, carrier air wings, aviation combat elements, and maritime patrol and reconnaissance forces maintain a combat-ready posture as an instrument of our nation's will.

For the past century, Naval Aviation has been at the forefront of operational and tactical innovation. Consistent with *The Vision for Naval Aviation 2025*, we remain focused on systematically establishing an enduring, affordable, lethal, and adaptable approach to meet and shape strategic objectives. We will continue to operate forward with revolutionary Integrated and Interoperable capabilities designed to face future threats in an increasingly-contested operating environment. Our nation's demand for access, commerce, and maneuver will require us to continue to evolve capabilities and capacities to assure our nation's and Navy's global leadership from the sea. Naval Aviation is a major stakeholder in these operations, and will continue to play key roles in the rebalancing of our nation's global posture and presence to an emphasis on the Pacific and sustaining support for our partners in the Middle East. This vision for Naval Aviation aspires to ensure an affordable, powerful Navy that maintains our core competencies across the spectrum of military operations. Our Sailors and Marines embrace the privilege of this awesome responsibility with pride, determination, and enthusiasm.

***USS* George Washington *(CVN 73) transits toward the Military Sealift Command dry cargo and ammunition ship USNS* Charles Drew *(T-AKE 10) before a replenishment-at-sea. (Photo by MC3 Brian H. Abel)***

# ACKNOWLEDGMENTS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***Cover Concept by Ken Collins; Created by Dave Bradford***
***Cover Images: Artist's conception of* Ford*-class aircraft carrier USS* Gerald R. Ford *(CVN 78) (Courtesy of Huntington Ingalls Industries). All other images are U.S. Navy Photos.***

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*Thanks to the many others in Naval Aviation who contributed to the creation of this document.*

*Special thanks to the members of the strategic planning and communications team from*
OMNITEC Solutions, Inc.
*for their expertise in writing, editing, and designing this document.*

The information provided in this book was current as of February 2014.

***F-35B aircraft BF-1 performs STOVL operations aboard USS* Wasp (LHD 1). *(Photo Courtesy of Lockheed Martin)***