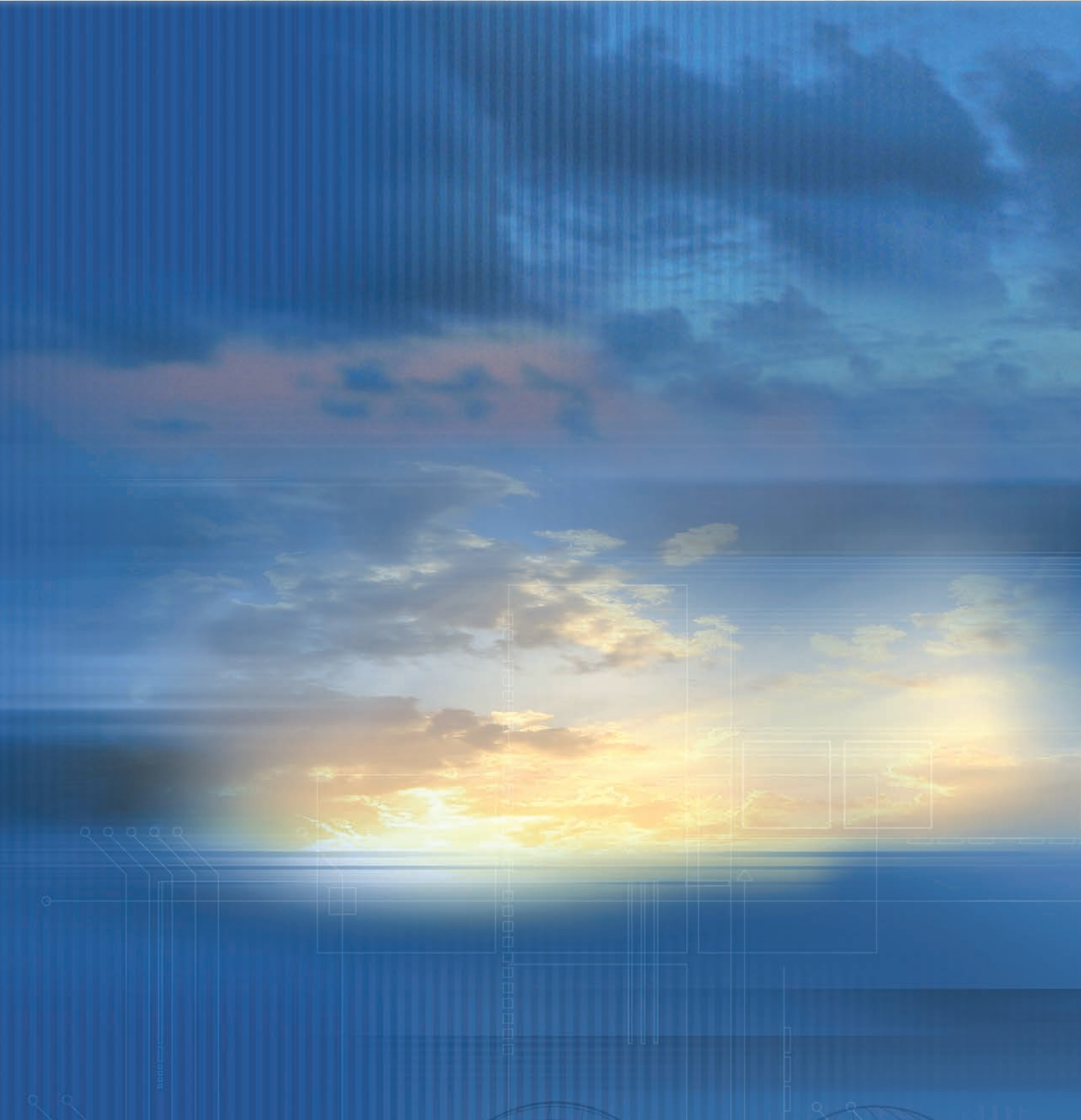
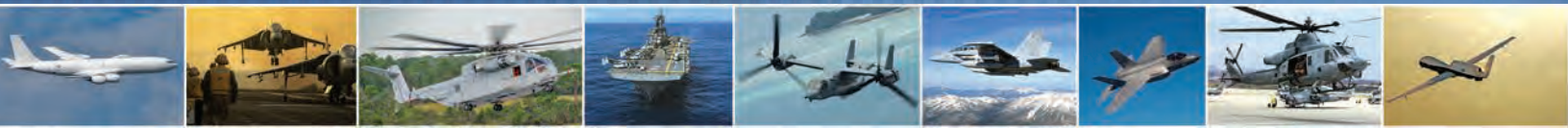




2016-2025 NAVAL AVIATION VISION



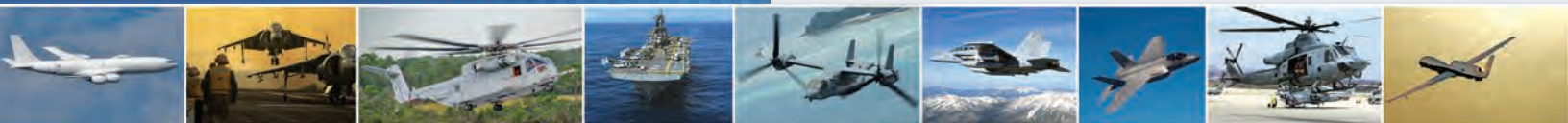


Cover concept by Noel Hepp; created by Fred Flerlage

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Letter from the Leadership of Naval Aviation

Naval Aviation forces are forward, engaged and ready—every day. Expeditionary forces, amphibious forces, nuclear-powered aircraft carriers, air wings, manned and unmanned platforms, rotary- and fixed-wing aircraft are on station, valued and in increasingly higher demand. No other service or community can deliver the capabilities Naval Aviation brings in support of our national interests. It is a national priority to sustain, resource and ultimately expand these capabilities to ensure that when called, Naval Aviation is at the hold short, takeoff checks complete...

Ready to Go.

This document is a partner piece to “The Vision for Naval Aviation 2025,” and together they are the roadmap to ensuring Naval Aviation possesses the readiness, capabilities and capacity to deliver on the five essential functions outlined in the maritime strategy, “A Cooperative Strategy for 21st Century Seapower.” The essential functions—All Domain Access, Deterrence, Sea Control, Power Projection and Maritime Security—are missions that depend upon Naval Aviation to guarantee their success. It is essential that our vision fully supports and aligns to this cooperative strategy.

The planning horizon described by both the United States Navy Master Aviation Plan and United States Marine Corps Aviation Plan extend far enough into the future to capture deployments that will occur during the timeframe of this document. The points on the horizon that define our present execution and our future vision are converging. This document aligns with the vision for 2025 while identifying investments to position Naval Aviation to move beyond 2025. It is based on the expected transition of the major components of the Carrier Air Wing and the Expeditionary Strike Group, manned-unmanned teaming efforts and the changing operating environment. It is also based on the evolution of DoD’s current strategy to incorporate commercially driven technology such as robotics, autonomously operated vehicles, guidance and control systems, visualization, biotechnology, miniaturization, advanced computing, big data analytics and additive manufacturing that ensure a technological advantage over an adversary.

As leaders entrusted with the course of Naval Aviation, it is our responsibility to define our threat-based future requirements and deliver the readiness our nation demands of this warfighting community while smartly navigating the fiscal shoal waters. Our three-pronged approach aims at achieving wholeness through the synergy of readiness, capability and capacity.

Readiness remains the essential key to our warfighting proficiency. Ready for tasking aircraft, ships ready to get underway, Sailors and Marines fully trained in their missions are the means by which Naval Aviation will protect and advance our national interests. In a resource-constrained environment, the requirements must be established and defined in order to make deliberate and thoughtful choices to ensure all units are combat-ready when required.

Naval Aviation must plan and resource to obtain,



maintain and retain the capabilities that allow our military to achieve global reach and superiority of the sea, air, land, space, cyberspace and the electromagnetic spectrum. Naval Aviation is leaning forward, transitioning nearly every legacy aircraft to a more capable and technologically advanced platform able to deliver lethal combat and credible non-combat effects across the spectrum of conflict. This strategy is mirrored as well in our carrier and amphibious fleet as we move into the more lethal, affordable and survivable *Ford*-class carrier and the *America*-class amphibious assault ship.

Capacity is the third pillar of our vision and remains a priority. Aggregate capacity is force structure and a matter of national policy, whereas operational capacity is the quantity of existing Naval Aviation capabilities that can be leveraged to succeed across any of the five essential functions in the maritime strategy. Possessing the right operational capacity requires a credible deterrent capability and optimal readiness levels.

Despite fiscal pressures, Naval Aviation is developing groundbreaking technologies and implementing ways to improve operational capacity.

Readiness based on flight line warfighting requirements, superior capability, wholeness of the fleet and sufficient capacity are the strategic goals. Creating and implementing integrated warfighting capabilities; balancing live, virtual and constructive training; leveraging advances like additive manufacturing while optimizing proficiency and harmonizing sustainment accounts reinforce our goals and are the work of all Naval Aviation Enterprise stakeholders. This document describes our vision to maximize limited resources while fielding tomorrow's fleet efficiently and capitalizing on future technologies.

We are undeniably the best maritime aviation fighting force in the world. That said, near-peer nations and non-state actors pose credible threats to our security. The vision outlined in this document acknowledges our fiscal realities and illustrates that Naval Aviation has the readiness, capability and capacity to prevail. It is consistent with Secretary of the Navy Ray Mabus' declaration that we as a sea service "get there sooner, stay there longer, bring everything we need with us and we don't have to ask anyone's permission. We provide our nation's leaders with options in times of crisis."

We share this vision to inform and guide the actions of those serving Naval Aviation today and those whose support is critical to our continued success as a ready and superior warfighting force. ▲

"As leaders entrusted with the course of Naval Aviation, it is our responsibility to define our threat-based future requirements and deliver the readiness our nation demands of this warfighting community while smartly navigating the fiscal shoal waters."

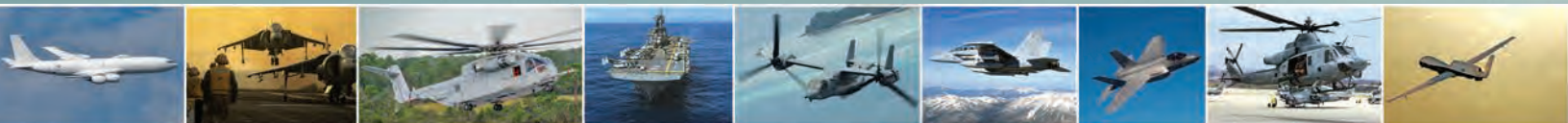
VADM Mike Shoemaker, USN
Commander, Naval Air Forces

LtGen Jon D. Davis, USMC
Deputy Commandant for Aviation

VADM Paul A. Grosklags, USN
Commander, Naval Air Systems Command

RADM Michael C. Manazi, USN
Director, Air Warfare Division

RADM Nancy A. Norton, USN
Director of Warfare Integration
for Information Warfare/
Deputy Director, Navy Cybersecurity



A V-22 Osprey takes off from the flight deck of amphibious assault ship USS Bonhomme Richard (LHD 6).

U.S. Navy photo by MC3 Taylor A. Elberg



Delivering Readiness

Readiness is the pre-eminent focus of the Navy and Marine Corps.

The day Adm. John Richardson took command as Chief of Naval Operations, five carrier air wings (CVWs) and three amphibious ready groups (ARGs) were underway. Two CVWs were deployed, one was conducting workups and two were changing homeports. Meanwhile, one ARG was deployed and two were training for deployment, or supporting Marine Expeditionary Unit (MEU) training. Fleet operations ranged from conducting airstrikes to freedom of navigation operations to training partner nation forces. Each of these requires a rigorous matrix of training events, planned maintenance and logistics to ensure the operation is executed flawlessly. Even while performing peacetime operations, naval forces must be prepared to react to warfighting contingencies. This strategy-to-task methodology helps determine the readiness requirements for Naval Aviation to execute our national strategy.

As the dominant maritime aviation fighting force, Naval Aviation must continue to examine how we maintain our high degree of readiness. We must continue to balance near-term readiness spending—such as flight hours and repairs—with long-term readiness investments—such as the use of advanced data analysis tools, live, virtual, and constructive (LVC) training concepts and additive manufacturing—while achieving our required readiness.

Naval Aviation leadership's approach to maintaining superiority over the maritime domain is outlined in "The Vision for Naval Aviation." Our readiness is predicated on the execution of three key strategic elements:

- Ensuring wholeness by managing resources available to organize, man, train and equip Naval Aviation across its full range of missions
- Sustaining capability superiority by taking an evolutionary approach to improving already fielded platforms and payloads, and integrating enabling technologies into the battlespace
- Maintaining sufficient capacity—having the right number of units manned, trained and equipped in the right configuration to meet demand

The long-term readiness investments described in this section support the Naval Aviation vision and are the tools by which we will deliver decisive combat power at home and abroad.

The flexibility and dedication of our ready forces, while a credit to our planning, is more a credit to our Sailors and Marines. Naval Aviation's long-term vision recognizes that readiness investments today and in 2025 are a commitment to our troops and our nation. ▲





U.S. Navy photo by MC1 Rafael Martie

Aircraft carrier USS Dwight D. Eisenhower (CVN 69), the flagship of the Eisenhower Carrier Strike Group, transits the Atlantic Ocean during a Composite Training Unit Exercise (COMPTUEX).

Flexible, Strategic Options

Aircraft carriers (CVNs), amphibious assault ships, carrier air wings (CVWs) and Marine Expeditionary Units (MEUs) provide flexible strategic options for the U.S. military now and into the future.

National interests require the speed, endurance, flexibility and autonomous nature of the Navy's carrier strike group (CSG). Typically comprised of a nuclear-powered aircraft carrier and its embarked air wing, one guided-missile cruiser, guided-missile destroyers and a supply ship, the CSG provides our national command authority with options, access and forward presence that allow for rapid response to a wide spectrum of threats.

Likewise, the Expeditionary Strike Group (ESG), with its Aviation Combat Element (ACE) and MEU afloat, provides forward deployed, physical presence from the sea with the ability to respond across all five essential functions within the maritime strategy.

Taken as a team, the ESGs and the CSGs are trained in well-established integrated tactics, techniques and procedures that allow them to deploy and operate freely in the global commons.

Each CSG possesses a versatile, highly maneuverable, and perhaps most importantly, an independent strike force capable of engaging targets at sea and hundreds of miles inland. An aircraft carrier and its embarked air wing operate across all warfare areas.

An ESG is typically comprised of a large deck amphibious assault ship, two smaller amphibious landing ships and 2,500 Marines and their equipment that form a MEU. The MEU, the smallest Marine Air Ground Task Force (MAGTF), is made up of a headquarters element, an ACE (task organized and usually comprised of 29 fixed- and rotary-wing aircraft), a battalion landing team ground combat element, and a logistics combat element. This is a lethal assault force capable of operating across the continuum of conflict. With



U.S. Navy photo courtesy Lockheed Martin



An F-35C Lightning II prepares to commence night operations aboard USS Dwight D. Eisenhower (CVN 69).

READINESS

seven MEUs covering the globe, and at least three activated, a quarter of Marine operating forces are forward deployed at any given time—ensuring about 30,000 Marines are spread across

the combatant command areas of responsibility.

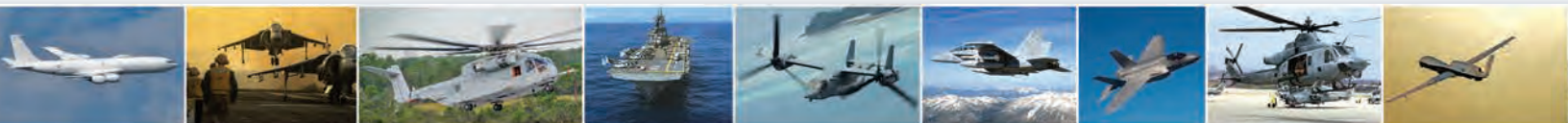
Our nation values the strategic options and flexibility that carrier strike groups, expeditionary strike groups and

our expeditionary aviation forces bring. Naval Aviation is focused on sustaining the capacity to generate these forces and ensure they are ready to operate forward where and when needed. ▲

U.S. Marine Corps photo by Cpl. Thor Larson



Marines with the Maritime Raid Force, 31st Marine Expeditionary Unit prepare to jump from a UH-1Y Huey during helocast training. Once the Marines jumped into the water, they swam to the waiting Combat Rubber Rafting Craft which brought them to shore.



Naval Aviation in Action

The stability and security provided by the carrier strike group (CSG) often goes unnoticed as merchant ships maneuver the seas, terrorist groups lie dormant and nations seek peaceful resolutions. Though it can be difficult to quantify conflict avoided, sometimes we are reminded of this deterrent effect by what does not occur, when tensions defuse quietly or are altogether avoided thanks to U.S. Navy presence.

In April 2015, while on station in the Arabian Gulf, USS *Theodore Roosevelt*

(CVN 71) transited the Strait of Hormuz to the Arabian Sea, joining forces conducting maritime security operations to ensure vital shipping lanes off the Yemeni coast remained open and safe. Following CVN 71's move, an Iranian convoy traveling toward Yemen reversed course, underscoring the stabilizing effect a carrier force can have overseas. Additionally, the U.S. Navy is daily countering Chinese claims to swaths of the Pacific Ocean; Marine CH-53E *Super Stallion* aircraft support ground forces with the Marine Rotational Force-Darwin in Australia as a strategic presence in the South Pacific; MV-22B *Osprey* and KC-130J *Super Hercules* aircraft operate from Morón, Spain, to cover the African littoral as a part of Special Purpose MAGTF—Crisis Response—Africa; Marine F/A-18s work out of Bahrain to combat the rising Islamic State Group threat; and Marines are going back into Afghanistan as part of

Operation Freedom's Sentinel. All these show the value of forward presence and power projection of naval forces.

In addition to acting as a deterrent, forward presence also enables rapid response to disasters, as demonstrated by the USS *George Washington* CSG supporting the Third Marine Expeditionary Brigade in Operation Damayan in the aftermath of Super Typhoon Haiyan/Yolanda in the Republic of the Philippines in November 2013. The tropical cyclone devastated portions of Southeast Asia, particularly the Philippines, killing more than 6,000 people and leaving an estimated 4.2 million without basic necessities.

Sailors and Marines delivered more than 368,000 liters of water and 160,000 pounds of food and dry goods to remote areas. More than 500 distressed individuals were recovered and transported to receive aid and medical attention.

Sailors signal the pilot of an F/A-18F Super Hornet from the "Diamondbacks" of Strike Fighter Squadron (VFA) 102 on the flight deck of Nimitz-class aircraft carrier USS *George Washington* (CVN 73).



U.S. Navy photo by MC3 Bryan Mai



In August 2015 in coordination with FEMA, USS *Ashland* (LSD 48) arrived in Saipan to provide relief in the aftermath of Typhoon Soudelor. *Ashland*, part of the *Bonhomme Richard* Amphibious Readiness Group, and the 31st Marine Expeditionary Unit (MEU) transported supplies and relief equipment. In total, the U.S. services, including the U.S. Army and Air Force, provided more than 200,000 gallons of water and 47,000 meals to the people of Saipan.

When the president needed immediate options to curb the Islamic State Group's sudden and vicious advance across the Middle East in the summer of 2014, the *George H. W. Bush* (CVN 77) Strike Group was on station in the Arabian Gulf and ready within 30 hours of tasking. The *Bush* CSG was the only strike option on station for the first 10 days of the conflict and remained there for 54 days as the only viable U.S. asset, until the authorization of air and cruise missile strikes.

CSGs have maintained a constant presence in that region, with seamless transitions between strike groups during rotations. Likewise, MEUs and Marine fighter/attack aircraft provided support from land bases across the Middle East, amphibious shipping, as well as from the carrier.

The continuous forward presence the MEUs and CSGs provide around the world comes with a cost. After nearly 14 years of sustained combat operations, Naval Aviation forces must continue to recapitalize to ensure readiness for the future. The frequency and extended duration of CSG deployments accelerate wear on the force, leading to increased maintenance and repair requirements, and subsequently, longer maintenance unavailability periods. Despite the stresses of near-continuous combat footing, innovative planning and resourcing described in this "Vision 2016-2025" help Naval Aviation ensure naval combat forces are where they need to be, when they need to be, for the immediate future. ▲

"In addition to acting as a deterrent, forward presence also enables rapid response to disasters."



U.S. Navy photo by MC2 Huey D. Younger Jr.

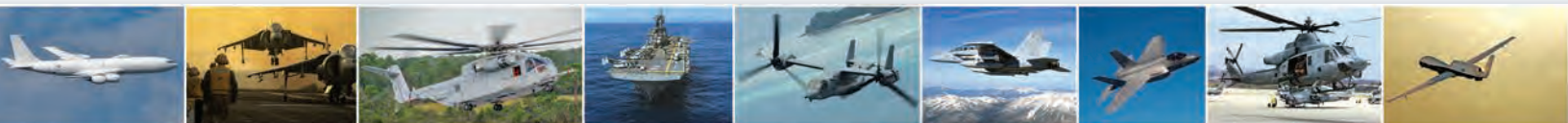
Sailors perform maintenance checks on an MH-60S Seahawk helicopter on the flight deck aboard Wasp-class amphibious assault ship USS *Essex* (LHD 2).

SS
READINESS



U.S. Marine Corps photo by Combat Camera Staff Sgt. Jeffrey D. Anderson

An MV-22B Osprey crew chief uses his intercom to communicate with the pilots while waiting for earthquake victims at a landing zone near Chericot, Nepal, after a 7.3-magnitude earthquake struck the country April 2015.



U.S. Navy photo by MCS L. E. Skelton

Sailors aboard guided-missile destroyer USS Gravely (DDG 107) refuel an MH-60R Seahawk helicopter during night flight operations.

Training Readiness

Training Requirements

Producing trained Sailors and Marines is paramount to sustaining our nation's global presence and implementing our technological edge. The heart and soul of Naval Aviation—its people—deploy around the globe 365 days a year, ready to conduct a wide range of operations from peacetime to wartime activities.

We need both the capability and capacity to train our Naval Aviation force. Capability comes in the form of training techniques and devices that not only replicate the anticipated warfighting domain, but develop skill elements that will allow our forces to prevail in combat. The second challenge is capacity. While it is desirable to train

everyone to the highest standards with the newest equipment, we must manage professional development, flight hours on aircraft, access to ranges and simulators as well as quality of life. Naval Aviation is implementing operating constructs that emphasize a balance of live, virtual and constructive (LVC) training devices ashore and afloat while researching techniques to optimize the effectiveness of our training systems and considering deployments that maximize training time.

The Optimized Fleet Response Plan (OFRP) provides the Navy's framework for training and deployment certifications to meet the Global Force Master Allocation Plan (GFMAP) and responds to any Combatant Commander's Operational Response Plan. The key tenets of warfare capabilities reside within different aviation communities within the Navy and are captured in detailed training

and readiness matrices based on each community's mission-essential task list. T-rating is measured on a scale of 1.0-4.0, and describes a unit's capability to execute its mission essential tasks (METs). To provide the resourcing to sustain OFRP and GFMAP goals, the Navy maintains a T-Rating of 2.5.

Marine Aviation trains to produce core competent units at a T-2.0 rating, which is a unit capable of executing 80 percent of its METs. Achieving and maintaining this T-2.0 level requires the entire squadron to have trained pilots and aircrew, qualified maintainers, and the appropriate number of aircraft on the flight line that are certified safe for flight and appropriately equipped to execute the assigned mission. The ultimate goal is for the entire fleet to be consistently ready to quickly and successfully respond when the nation calls.

Naval Aviation is finding innovative, groundbreaking and efficient ways to train.



Optimizing Aircrew Proficiency through New Training Methods and Tools

Proficiency is critical to Naval Aviation forces. Our aviators and maintainers are more than “current” and qualified; they achieve a level of performance that guarantees mission success and safety in operation. Expanding operational commitments, increasingly complex and integrated missions and declining budgets are testing Naval Aviation’s ability to effectively train our forces for all possible missions.

To maintain our warfighting advantage, Naval Aviation requires training environments and tools that replicate diverse operating environments, realistic adversary tactics and equipment, and battlespace complexity. These environments must replicate as closely as possible the real-life scenarios aviators can expect to encounter in joint and coalition warfare.

In 2013, NAE stakeholders created the Proficiency Optimization initiative that uses an investigative, data-driven approach and family of decision support tools to assess return on investment of a wide range of training scenarios. Phase one of the Proficiency Optimization effort is complete with the creation of the F/A-18C/E/F proof-of-concept Readiness Cost Assessment Tool (RCAT). This enterprise-level, data-driven, predictive decision support model uses the science of learning and human performance to decompose training and readiness requirements so that we can assess and potentially optimize proficiency.

Phase two of the project will incorporate more capable proficiency and sustainment modeling with the ultimate goal of informing investment decisions to achieve the optimal mix of training solutions to enable proficiency



U.S. Marine Corps photo by Cpl. Allison J. Herman

U.S. Marine Corps MV-22B Osprey aircraft fly over Lake Tahoe, Calif.



U.S. Navy photo by MC3 Ryan G. Greene

A Marine Corps Gunnery Sgt. assigned to Marine Aviation Logistics Squadron (MALS) 36 punctures the eyelet of a microchip during an in-class exercise at Naval Air Facility Atsugi’s Center for Naval Aviation Technical Training (CNATT).

READINESS



“LVC training results in a more operationally advanced, safer and more cost-effective training environment for Naval Aviation aircrews.”

across the spectrum of integrated warfighting.

Live, Virtual and Constructive Training

The long-term vision for achieving Naval Aviation readiness incorporates live, virtual and constructive (LVC) training that includes using realistic virtual or synthetic scenarios to develop the essential decision-making skills required to conduct air warfare in a joint environment.

LVC training gets its name from

the ability to integrate actual combat aircraft (live) with networked ground-based simulators (virtual) and computer-generated threats (constructive). An integrated LVC training environment with today’s battle complexity is essential to improving proficiency across all current and future mission sets.

LVC technology provides Naval Aviation aircrews with exposure to the full spectrum of integrated warfare, while mitigating capacity limitations and potential operational security concerns. LVC decreases the number of aircraft or

other physical assets typically involved in training missions, mitigating scheduling issues and physical space limitations inherent in using actual ranges for training. LVC training results in a more operationally advanced, safer and more cost-effective training environment for Naval Aviation aircrews. Additionally, LVC can replicate current threats that are not available in existing training systems. By leveraging the capabilities of the LVC environment, our warfighters will train more effectively and efficiently, and have the opportunity to validate existing tactics, techniques and procedures (TTPs), as well as develop new TTPs for future threats.

Since 2005, the training community has been implementing small changes to existing training systems to execute the Naval Aviation Simulator Master Plan (NASMP). Embedded within the NASMP are high-fidelity training simulators, which deliver enhanced graphics displays, accurate aerodynamic modeling and leading-edge technology processing using high-fidelity training simulators. The plan incorporates objective measurements of proficiency from several analysis tools, enabling Naval Aviation leadership to make informed decisions on future simulator fidelity upgrades and the appropriate mix of emerging LVC infrastructure and capabilities. This reallocation of training to appropriately configured, networked simulators and/or an LVC environment will accomplish two important objectives. One, it increases aircrew proficiency via an increase in the number of training “reps and sets” in a variety of complex mission events,



U.S. Marine Corps photo Cpl. Danifer Flynn

Copilots with Marine Aerial Refueler Transport Squadron 152, Marine Aircraft Group 36, 1st Marine Aircraft Wing, use the KC-130J flight simulator to rehearse flight patterns for taking off and landing on Okinawa.



to include scenarios that cannot be replicated using only live assets. Two, it frees up aircraft flight hours from one set of training events and reallocates them to more effective training events that truly require flying hours in the actual aircraft.

Naval Aviation is committed to expanding its use of networked, virtual and constructive training. The Navy is constructing the Air Defense Strike Group Facility at Naval Air Station Fallon, Nevada, which will provide a central location to inject constructive elements into virtual training events. The facility will be focused primarily on the development of aircrew TTPs that support Naval Integrated Fire Control-Counter Air (NIFC-CA). The facility will be a fully integrated training facility by 2022 with connections to live aircraft and surface assets to include joint platforms. Marine Aviation, as a signatory and participant to the NASMP, is committed to LVC training and has plans for construction of the Marine Aviation Virtual Warfare Center (MAVWC) at Marine Corps Air Station Yuma, Arizona.

MAGIC CARPET Carrier Landing

Another technological advancement for pilot proficiency is the Maritime Augmented Guidance with Integrated Controls for Carrier Approach and Recovery Precision Enabling Technologies—MAGIC CARPET. Designed originally for the F/A-18E/F *Super Hornet* and also implemented in the F-35C *Lightning II*, MAGIC CARPET is an enhanced set of flight control commands paired with Heads-Up-Display (HUD) symbology that simplifies a pilot's control inputs in conducting aircraft carrier landings. This impacts Naval Aviation readiness by allowing money traditionally spent on Field Carrier Landing Practices (FCLP) to be used



U.S. Navy photo by Teri Thomas

This pilot's view of MAGIC CARPET helps the pilot stay on course and on glideslope.

for increased mission training. MAGIC CARPET software enables pilots to adjust line-up and glideslope corrections independent of one another while holding angle-of-attack at the approach reference setting, leading to improved touchdown precision and safer recoveries aboard carriers.

With current F/A-18 flight software, adjusting the aircraft's glideslope, lineup or angle-of-attack directly affects the individual approach parameters. Consequently, pilots must learn how to compensate for these coupled inputs by demonstrating their ability to coordinate the individual corrections while minimizing changes in the other controlled parameters through numerous FCLP approaches. MAGIC CARPET decouples the three parameters, greatly reducing the time it takes for pilots to become proficient in FCLPs, which ultimately translates to improved performance in the carrier qualification phase. As a result of reducing flight

hours associated with carrier qualification and performance in the carrier landing environment, NAE leadership can reinvest this cost savings in other training areas.

MAGIC CARPET completed its first at-sea testing April 2015 aboard USS *George H. W. Bush* (CVN 77). Tests confirmed that carrier landings can be achieved with a lower pilot workload and with increased accuracy of the targeted hook touchdown point.

Test pilots, engineers and landing signal officers from Air Test and Evaluation Squadron (VX) 23 will continue to test MAGIC CARPET demonstration software on F/A-18E/F aircraft through early 2016. Production-level software for the fleet is scheduled to start flight testing in 2017, with general fleet introduction to follow via the F/A-18 and EA-18G program office. The system is designed and will be fielded in the F/A-18E/F, EA-18G and F-35C platforms. ▲



Material Readiness

Naval Aviation is entering an era of modernization and sustainment at a time when operational tempo is high, budgets are tight and threats are evolving at an unprecedented pace. Our fleet airframes are flying more hours than

Naval Aviation Enterprise (NAE) stakeholders measure equipment readiness using common metrics, including the “ready-for-tasking” (RFT) metric, which is a monthly average combination of “ready basic aircraft” (RBA) and specific mission systems, which enable squadron aircrews to achieve training in mission qualifications across primary mission areas, or capability areas, during particular phases of the Fleet Response Training Plan.

Supply Chain Management

One of the critical nodes in ensuring the required material readiness is Supply Chain Management (SCM). It is an effective process that has provided years of successful material readiness, but like any good process, it needs to be reviewed and updated to remain operationally viable. Therefore, Naval Aviation has renewed its focus on determining the appropriate maintenance and supply chain metrics to more accurately identify—based on historic trends—and predict—



Vice Adm. Mike Shoemaker, left, commander, Naval Air Forces, studies a yoke assembly bushing with Lt. Gen. Jon Davis, deputy commandant for Marine Aviation, during a Boots on Ground event.

U.S. Navy photo by Jacquelyn Millham

they were originally designed to fly, creating new maintenance and supply challenges.

Equipment readiness refers to the material condition of an asset necessary to support a squadron’s level of effort during a specified training profile for the unit or detachment as required by the Optimized Fleet Readiness Plan (OFRP) for the Navy and T-2.0 for the Marine Corps.

Using the enterprise approach—emphasizing data analysis and metrics-based decision-making—Naval Aviation leaders have developed the Naval Aviation Readiness Recovery Plan, which includes lines of effort focused on improving supply support, ensuring sufficient repair capacity, achieving depot production for all type/model/series (TMS), and ensuring maintainer standardization and training.

based on forward looking models—parts shortfalls and weaknesses in SCM that negatively impact readiness.

SCM is a complex process. First, the demand signal is created—correctly identifying the part. Then the vendor that manufactures the part must be identified. The manufacturer must build the part to the appropriate standard, in the desired quantity and within a given timeframe. Then the part must be deliv-



ered to the appropriate supply center for rapid distribution to maintenance personnel. Finally, the part must be installed correctly to produce a properly functioning aircraft. While a profuse number of parts for each TMS reach their destination on time every year, it only takes one incorrect demand signal, one vendor shortfall in quality or quantity or one substandard critical part to have a negative impact on the whole system. Having the correct metrics will improve supply chain system performance and overall

into Fleet Readiness Centers (FRC) for inspection and repair.

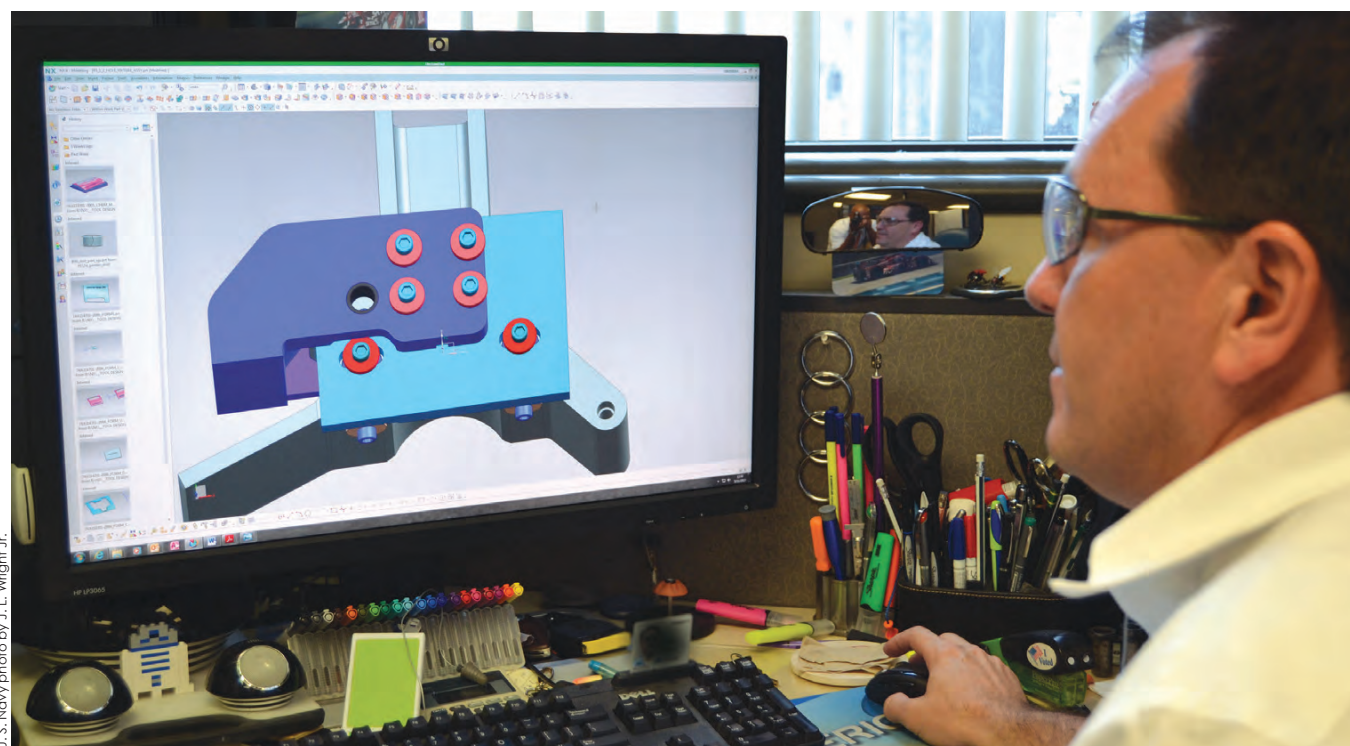
To improve production line output—returning aircraft to warfighters on the flight line as quickly as possible—Naval Aviation is using an industry-tested project management method from the “Theory of Constraints” tool set along with innovative data analysis tools.

Critical Chain Project Management (CCPM) is a Theory of Constraints-based project management philosophy

their throughput by 43 percent for non-planned maintenance interval two major depot events for legacy *Hornets* in fiscal year 2015, delivering 20 more aircraft than in fiscal year 2014.

“**Jonah**” is a project management tool for maximizing efficiency and productivity in a throughput process. Named for a character in the book “The Goal,” the Jonah methodology views bottlenecks as both hindrances to productivity and leverage points with which to increase

READINESS



U. S. Navy photo by J. L. Wright Jr.

A mechanical engineering technician uses a 3-D computer software program to analyze a tooling design at Fleet Readiness Center Southeast. Additive manufacturing was used to print a 3-D prototype of a repair fitting to fix a P-3 Orion.

readiness. At the end of the day, we must ensure that we get the right part at the right time in the right place.

Tools for Improving Material Readiness

Budget constraints, high operating tempos and the need for some aircraft to fly longer than their designed service life have resulted in an unprecedented number of F/A-18 A-D *Hornets* inducted

that accounts for variability and resource sharing across projects. This philosophy focuses on increasing throughput to send aircraft back to the flight line where they are needed. In 2014, Commander, Fleet Readiness Centers (COMFRC) began the implementation of CCPM on the F-18 lines to rapidly arrest the rate of growth in the number of out-of-reporting aircraft—a readiness challenge causing significant problems for the fleet. The FRCs increased

productivity. This process illuminates constraints associated with a particular system and allows the organization to eliminate or manage those constraints to optimize overall system performance.

Naval Aviation’s Sustainment Harmonization Tool is a web-based readiness improvement application that provides the proper balance of funding, readiness and aircraft flying hours to drive



efficiencies, improve productivity and maximize resources. The tool provides the ability to harmonize the funding across the accounts to maximize the number of RBA that will be available within reduced budgetary levels. Currently, Operations and Maintenance, Navy (O&MN) and sustainment-related Aircraft Procurement (APN) accounts for Naval Aviation are championed and funded as individual entities, leading to sub-optimal funding from a Naval Aviation perspective. Each account is interrelated, contributing to overall TMS readiness and must be balanced to effectively use the dollars that exist within Naval Aviation.

The Integrated Logistics Support Management System (ILSMS)/Vector is a data analysis tool that provides fleet operators, program teams and the logistics community with a common system to make data-informed decisions on readiness and cost. This powerful tool acts as a data warehouse that aggregates 10 years of historical data from 19 disparate data systems into a single source, providing readiness, cost, inventory, maintenance, supply and operational flight-hour data in a standardized format. ILSMS can produce more than 100 top-level metrics to identify components that perform outside their established parameters. With this information, Naval Aviation leaders can see early indicators of potential readiness degraders and cost drivers and proactively address them.

Enabling Faster Manufacturing: Additive Manufacturing and Digital Thread

Additive manufacturing (AM) is a digital manufacturing technique that prints parts from digital 3-D drawings, requires little setup and can be used to quickly produce custom parts and complex tooling much more quickly than typical manufacturing techniques.



A composite technician discusses repairs on a yoke assembly bushing with Navy Capt. Tim Pfannenstien, commander, Fleet Readiness Center Southwest.

Naval Aviation has successfully applied AM technology in its prototyping facilities since the early 1990s. Today, Naval Aviation has moved beyond printing plastic prototypes to printing actual parts and components made of metal, composites, ceramics and compound materials that have never existed until now. AM technology that prints explosives, food, integrated circuits and sensors will soon be available, and will revolutionize how the Naval Air Systems Command (NAVAIR) and DoD design, develop and support weapon systems.

Because there is no specialized tooling required, production processes can be customized faster than ever before. AM technology can produce highly complex shapes without extensive machining, and use less material than conventional subtractive manufacturing, or “machine from solid processes.” AM techniques are particularly well-suited for the following:

- Complex or custom parts that are difficult to produce or have excessive lead times
- Alternative designs for existing parts that will improve performance, reduce weight or use different materials

- Custom repair designs that require unique tooling or parts
- Low-use items that can be made on-site as needed and do not need to be stocked
- Parts that have a limited or non-existent supplier base

NAVAIR’s aviation depots have used AM extensively to accelerate maintenance and repair. In June 2014, an AV-8B *Harrier* damaged the frame of its nose cone during a controlled hard landing on USS *Bataan* (LHD 5). NAVAIR’s FRC Southeast technicians in Jacksonville, Florida, used AM-made tools to produce and deliver replacement parts within seven days. Technicians at Naval Air Warfare Center Aircraft Division, Lakehurst, New Jersey, designed and used AM technology to fabricate a custom tooling wrench used to change oil on an H-60 *Seahawk* helicopter without removing the transmission, saving 80 work hours per oil change.

AM systems are maturing rapidly and manufacturing safety-critical metal parts—parts that have been identified as critical to maintaining safe flight of an aircraft—are the next steps in NAVAIR’s plan to accelerate the use of AM across

U.S. Navy photo by Jacquelyn Millham



U.S. Navy photo by MCS Veronica Mammola

A Marine conducts a non-destructive inspection (NDI) on an MV-22 Osprey aboard amphibious assault ship USS Boxer (LHD 4).



fleet support teams and administered by the Naval Aviation Technical Engineering Center.

The representatives provide knowledge-based training and “over-the-shoulder” mentoring to a generation of maintainers more experienced with composite materials and less familiar with traditional hands-on corrosion control practices. To date, site representatives have trained more than 8,000 maintainers and aircrew and continue to identify opportunities to mitigate high cost/high man-hour corrosion degraders across all targeted platforms.

The objective is to improve Naval Aviation platform material condition and mission readiness by reducing corrosion-related maintenance resource consumption. This effort was successfully piloted on the F/A-18 platform and subsequently expanded to 11 additional platforms at 13 Navy and Marine Corps sites.

As a result, Naval Aviation expects to improve aircraft material condition, reduce in-service repair planner and estimator costs, reduce the number of out-of-reporting aircraft, improve reliability centered maintenance data collection, and reduce the number of corrosion list items across all platforms. Aircraft that have undergone a planned maintenance interval (PMI) event with the benefit of MRT involvement are showing a significant decrease in the number of man-hours required for PMI events and corrosion focus area list item repairs, which has reduced the PMI event turnaround time and cost.

The MRT concept is a critical example of Naval Aviation's commitment to improving material readiness. While the idea of leveraging industry through the use of strategic contracting is not new, Naval Aviation must use all available levers to meet current readiness shortfalls and be better prepared for future aviation readiness. ▲

Naval Aviation. NAVAIR's Additive Manufacturing Integrated Program Team has identified five safety critical metal parts that will be manufactured via AM and fielded by 2017 on the H-1 Marine Corps Light/Attack Helicopters, V-22 Osprey and CH-53K King Stallion platforms. The safety-critical AM parts fielded on these platforms will allow NAVAIR to develop the processes and digital data standards needed to extend AM to other classes of parts and components.

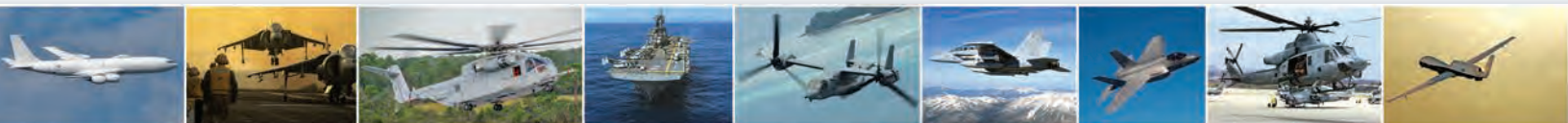
AM and other digital manufacturing techniques give NAVAIR the ability to “stock the data, not the part,” reducing supply timelines, enabling faster maintenance and repairs and reducing packaging, handling, storage and transportation costs. Using these techniques enables NAVAIR to integrate its design, engineering, manufacturing and production processes and move to all-digital 3-D data. This capability, called digital thread, provides the network connectivity, digital data, security, processes, tools and trained workforce to integrate product life cycle and use advanced manufacturing techniques. Digital thread capability is under development at NAVAIR's aviation depots

with initial capability scheduled for 2016. Phase 2 of digital thread capability will include linking to industry, supply, extending out to intermediate level maintenance facilities, and ultimately providing the fleet with improved access to all the data needed to manage its aircraft.

As AM and digital thread capabilities mature, NAVAIR will greatly accelerate its product life cycle management process. These capabilities should ensure Naval Aviation can buy and maintain its aircraft at maximum readiness and best possible cost.

Maintenance Readiness Teams

In August 2014, NAE's corrosion prevention team deployed maintenance readiness teams (MRT) to Navy and Marine Corps sites around the country to educate Sailors and Marines on how to better inspect, detect, correct and prevent corrosion. These teams are comprised of contractor subject matter experts with extensive on-platform airframe experience. They are aligned with fleet Type Wings and Marine Aviation Logistics Squadrons (MALS) via platform in-service support centers/



Manning

Accessing and Retaining Highly Qualified Maintainers/Aircrew

The Navy and Marine Corps are defined by the Sailors and Marines that fill their ranks. From the CNO and the CMC to the newest seaman and private in boot camp, our people make the Navy/Marine Corps team the finest in the world. And while it is necessary to design, build and acquire the most current, cutting-edge weapons systems, they are ineffective without the manpower to direct, operate and maintain them.

While conventional warfighting tactics will always be relevant, current and future generations of Sailors and Marines are engaging adversaries using technology-enabled and increasingly sophisticated weapon systems. We must ensure they have the proficiency necessary to successfully execute the full range of missions as new platforms, such as the F-35B *Lightning II* and unmanned aerial systems, enter the fleet.

One of the most critical elements to achieving readiness is the ability to retain and continue to train the most qualified maintainers and aircrew. After years of training and on-the-job experience, they reach the pinnacle of their profession—be it a maintenance chief, a multi-systems maintainer, or a weapons and tactics instructor—and the Navy and Marine Corps must work to ensure they continue their service and share their knowledge with subsequent generations.

Retention is not a simple task. The Navy and Marine Corps offer a challenging and rewarding way of life, which competes with private industry for the best talent. Balancing competing choices in favor of continued service begins with fostering a culture that values and recognizes everyone's contribution to increasing Navy/Marine Corps readiness—an esprit de corps, one team, one fight.

As force requirements evolve, expecta-

tions and incentives will be modified to ensure the end strength supports initiatives across the entire enterprise. Manpower policies will continue to focus on retaining the best and brightest with the goal to retain the right aircrews and maintainers in the right numbers, with the right skill, at the right time and in the right place. It is up to leadership, at all levels, to ensure that we keep, train and promote the future leaders of Naval Aviation. For example, the Marine Corps assigns additional military occupational specialties (AMOS) to specific qualifications and certifications. This will make it easier for promotion boards to breakout and promote the more highly qualified maintainers, and for headquarters, wings and MAGs to more accurately track and match the skills needed to maintain a 21st century aviation fleet.

Enlisted Maintenance: A Force in Readiness

Over the last 14 years of combat operations and deployments, Navy and Marine Corps Aviation maintenance has been hyper-focused on accomplishing the mission. Now, as we draw down the force and shape it for the future, we have to ensure that we retain and train the best and brightest enlisted maintainers to train future Sailors and Marines. The Navy and Marine Corps must continue to reinforce the fundamentals of maintenance. An experienced, well-trained maintainer is the bedrock, and one who will ensure maintenance is performed efficiently, effectively and in accordance with Navy/Marine Corps Aviation standards and all TMS-specific maintenance instructions. Additionally, these seasoned maintainers are responsible for training the next generation to the same high standards they achieved. To this end, the Navy and Marine Corps are reviewing their initial, follow-on and advanced maintainer training programs to make them more efficient and more effective.



An aviation machinist's mate inspects an F/A-18 afterburner in the jet shop aboard Nimitz-class aircraft carrier USS George Washington (CVN 73).

U.S. Navy photo by MCS Bryan Mai



The Marine Corps is looking at sister service and international examples to base its Maintenance Training Instructor (MTI) initiative. The goal of the MTI initiative will be to take staff sergeants and gunnery sergeants, who are already recognized as leaders in their units, and provide them the necessary training to be future maintenance chiefs. These future maintenance chiefs will oversee the maintenance and management of a 21st century aviation fleet. Additionally, the Marine Corps is looking at ways to further improve on-aircraft maintenance competency by creating a curriculum and identifying instructors to provide enhanced maintenance training for unit collateral duty inspectors and collateral duty quality assurance representatives. All of these efforts are designed to help units to better maintain their aircraft—not just repair them.

Talent Management: Maximizing Sailor Experience

Several manpower, personnel, training and education developing initiatives are improving our readiness and combat capability by enhancing and leveraging our Sailors' experience, better aligning talents to tasks and rewarding those who demonstrate superior performance.

Ready Relevant Learning (RRL) is the latest in training and education technologies, and when implemented, will tie together rate, billet, fleet, type command, formal on-the-job and non-occupational training to form a learning continuum for each Sailor. RRL content will be delivered to our Sailors on the flight lines, giving them more time in their units and lessening time away from home.

Billet-based distribution provides fleet activity manning managers with access to the same information on their Sailors that detailers and placement coordinators see.

This allows for more accurate alignment of Sailors and their unique skill sets to specific billets, resulting in better detailing decisions and ultimately enhancing talent management and personnel readiness.

The Meritorious Advancement Program (MAP) is overseen by the type commands through their command triads and is used to actively manage the resident talent. The program enables Naval Aviation to advance the best and most qualified Sailors without waiting for the cyclic Navy-wide advancement exams. The MAP is also expanding to include specified shore units critical to Naval Aviation's success. This program directly recognizes and rewards our most talented Sailors.

The Aviation Community Detailing Initiative (ACDI) is a Navy Personnel Command Enlisted Aviation Detailers (PERS-404) project aimed at maximizing investment in Sailors by keeping them in their communities and Navy Enlisted Classifications (NECs) specific billets whenever possible. This initiative—currently focused on CNAP/

CNAL squadrons—mandates that every reasonable effort be made to match a Sailor with a billet requiring that Sailor's skillset. Using the ACDI report tool, PERS-404 collects data to create a monthly report to examine success at billet detailing for career NECs (83XX) within the Aviation Machinist's Mate (AD), Aviation Electrician's Mate (AE), Aviation Structural Mechanic (AM), Aviation Structural Mechanic-Safety Equipment (AME), Aviation Ordnance man (AO) and Aviation Electronics Technician (AT) ratings.

The Aviation Maintainer Experience (AMEX) metric provides Naval Aviation leadership with a measurement of the experience levels existing within each unit for all TMS communities for the above ratings. AMEX is a metric that captures the aggregated maintenance experience levels within Navy squadrons over time. The trend, whether up or down, may indicate to leadership possible risks associated with producing required readiness and accomplishing the mission. ▲



An aviation electrician's mate performs a 14-day special inspection on a MH-60R Seahawk in the hangar bay aboard USS George Washington (CVN 73).



An MQ-4C Triton is lifted inside an anechoic chamber for electromagnetic compatibility testing at Patuxent River, Md. This event marked the first time that an unmanned aircraft inside the chamber was controlled from an external ground control station.

U.S. Navy photo



Expanding Capability

Naval Aviation forces will continue to arrive on station with the means—the capability—to prevail in combat. Sustaining Naval Aviation's warfighting supremacy starts with expanding our capabilities, which are driven by warfighting requirements critical to the future force. Success relies on maintaining our technological edge.

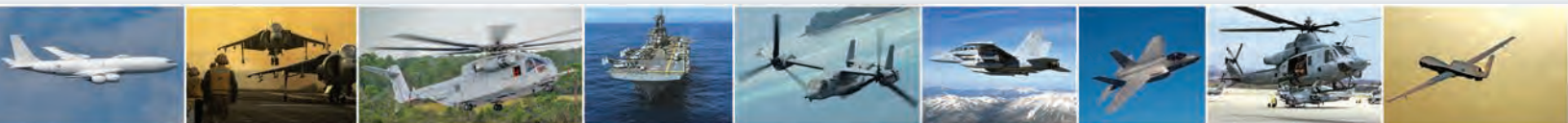
The Navy and Marine Corps continue to implement the long-range strategy of transitioning nearly every legacy aircraft to a more capable and technologically advanced platform. Commanders at sea, in the air and on the ground are supported by the F-35 *Lightning II*'s instantaneous, high-fidelity view of ongoing operations, which integrates data from the MQ-4C *Triton*, P-8A *Poseidon*, E-2D *Advanced Hawkeye*, EA-18G *Growler* and F/A-18E/F *Super Hornet*. At the same time, our carrier and amphibious fleet are becoming more lethal and survivable with the *Ford*-class carrier and the *America*-class amphibious assault ship.

Naval Aviation is leveraging integrated warfighting capabilities (IWC) to ensure multiple systems operate together across platforms, weapons, networks and sensors. This system-of-systems approach by all Naval Aviation stakeholders gives warfighters the capabilities needed in the battlespace to fight and win.

Innovation helps mature and transition key manufacturing technologies and processes with investments focused on affordability and those most beneficial to the warfighter. There is also an ongoing shift from a hardware-centric world to a software-centric world using common development standards and the requirement for modular weapon components.

Naval Aviation is seizing the advantage where cyberspace and the electromagnetic spectrum converge while refining and implementing its vision toward greater tactical and technical integration.

At the foundation of all these changes and innovations is the need for the right capability in the hands of the warfighter. ▲



Artist's rendering

A joint Office of Naval Research (ONR) and Defense Advanced Research Projects Agency (DARPA) research and development program, called Tern, is creating a demonstrator for a long-endurance and long-range aircraft that would operate from a variety of Navy ships.

Increasing Technological Edge

Naval Aviation relies on Office of Naval Research (ONR) to coordinate all science and technology (S&T) investments for DoN. ONR's Naval S&T Strategy leverages naval leadership's vision to discover, develop and deliver decisive naval capabilities, near- and long-term, by investing in a balanced portfolio of breakthrough sci-

entific research, innovative technology and talented people.

Discovery and Invention (D&I) includes basic research and early applied research, investing in new ideas and nascent technologies that are explored for future application. This portfolio has a broad focus with a long time span (five

to 20 years) needed to mature discoveries, and activities include investment in air vehicle technology, structures and materials, propulsion, autonomy, energetic materials and counter-directed energy weapons.

Leap-Ahead Innovations include Innovative Naval Prototypes (INPs) and SwampWorks efforts. INPs achieve a level of technology suitable for transition in four to eight years. SwampWorks efforts are smaller in scope and are intended to produce results in one to three years.

ONR works diligently to leverage partner investments with other services



or organizations. Tern is a Joint ONR/ Defense Advanced Research Projects Agency Leap Ahead program to develop and demonstrate vertical take-off and landing air vehicle technologies for long endurance presence from small-deck air capable ships.

Technology Maturation covers Future Naval Capabilities (FNCs) that mature technology for transition to the fleet in a two- to four-year time frame, and turns products from the late stages of applied research and advanced technology development into critical component technologies for naval acquisition programs. ONR starts more than 10 FNC programs a year. For example, investments in upgrades to existing missile systems; a new primer/topcoat system that will provide aviation and amphibious platforms with high-performance structural protection; as well as novel technologies such as the Helicopter Active Rocket Propelled Grenade (RPG) Protection FNC that will develop and demonstrate a prototype hard-kill countermeasure system for defeating RPGs that target helicopters. Another FNC will provide an upgraded lift-fan capability to the Marine Corps F-35B.

The Quick Reaction component funds technology solutions, as well as Navy and Marine Corps experimentation, responding to urgent operational needs statements and high-priority fleet demands. These warfighter-centric technology projects apply to immediate needs identified by the fleet for introduction within one to two years. The Navy Manufacturing Technology Program continues to improve affordability of

naval platforms critical to the future force. Investments focus on manufacturing technologies to assist key acquisition program offices in achieving affordability goals by developing, maturing and transitioning key manufacturing technologies and processes. Investments are focused on those having the most benefit to the warfighter, such as the F-35 *Lightning II* and CH-53 *Sea Stallion*.

ONR is committed to ensuring our Sailors and Marines maintain a decisive technological warfighting advantage, today and tomorrow.

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

The supersonic, multi-role, multi-service F-35 *Lightning II* represents a quantum leap in air superiority capability. Combining the next-generation fighter characteristics of radar-evading stealth, supersonic speed and fighter agility with the most powerful and comprehensive integrated sensor package of any fighter

aircraft in history, the F-35 delivers unprecedented lethality and survivability to Naval Aviation.

Advanced avionics equip the pilot with real-time, spherical access to battlespace information. Commanders at sea, in the air and on the ground are empowered with the F-35's instantaneous, high-fidelity view of ongoing operations integrating data from the MQ-4C *Triton*, P-8A *Poseidon*, E-2D *Advanced Hawkeye*, EA-18G *Growler* and FA-18E/F *Super Hornet*.

Marine Corps Variant: F-35B

The F-35B represents the centerpiece of the Marine Corps Aviation transformation, replacing both the AV-8B *Harrier* and F/A-18 *Hornet*. The single-seat strike fighter will revolutionize close-air support of ground forces by leveraging unmatched, fifth-generation stealth, enhanced precision strike and multi-spectral, integrated sensors, along with the expeditionary responsiveness of a short



U.S. Navy photo by Lt. Cmdr. Darin Russell

Two F-35C *Lightning II* aircraft initiate a break maneuver with an F/A-18E *Super Hornet* from Naval Air Station Lemoore, Calif.

CAPABILITY



Photo courtesy of Lockheed Martin

Photo courtesy of Lockheed Martin

An F-35C Lightning II aircraft is loaded with two AIM-9Xs, four GBU-12's and a gunpod during a symmetrical external stores and refueling mission.

An F-35B Lightning II aircraft takes off from amphibious assault ship USS Wasp (LHD 1). The F-35B is the Marine Corps variant of the Joint Strike Fighter and was undergoing testing aboard Wasp.



U.S. Marine Corps photo by Lance Cpl. Remington Hall

Four F-35B Lightning II aircraft sit secured to the deck after their arrival aboard amphibious assault ship USS Wasp (LHD 1). As the future of Marine Corps aviation, the F-35B will eventually replace all aircraft from three legacy Marine Corps platforms: the AV-8B Harrier, the F/A-18 Hornet and the EA-6B Prowler.

takeoff and vertical landing (STOVL) fighter-attack platform. The F-35B can operate from damaged airstrips and austere expeditionary operating sites as well as land bases and large deck amphibious ships.

Carrier Variant: F-35C

The F-35C, flown by the Navy and the Marine Corps, is capable of overcoming a variety of threats—surface-to-air missiles, air-to-air missiles and tactical aircraft—while enhancing mission success through its unprecedented stealth-at-sea capability, fused targeting, advanced jamming, network-enabled operations threat system detection, command and control supremacy, and interoperability with other aircraft. With a broad wingspan, reinforced landing gear and durable coatings, the F-35C can withstand harsh shipboard conditions while delivering a lethal combination of fighter capabilities to the fleet.



“UAS will play a key role in all missions including forward presence, security cooperation, counterterrorism, crisis response, forcible entry, prolonged operations and counterinsurgency.”

Unmanned Family of Systems

In line with “A Cooperative Strategy for 21st Century Seapower,” the Navy’s unmanned family of systems features innovative technology that makes our existing manned platforms more effective by extending range and endurance. For example, the MQ-8 *Fire Scout* enhances the range and sensor suite of the MH-60 *Seahawk* by providing greater persistent coverage for the littoral combat ship or small surface combatant. The MQ-4C *Triton* complements

the surveillance capabilities of the P-8A *Poseidon*.

Similarly, the Marine Corps’ family of unmanned aircraft systems (UAS)—RQ-21 *Blackjack*, RQ-7 *Shadow*, RQ-20, RQ-12 *Wasp Puma* and RQ-11 *Raven*—will support all Marine Air Ground Task Forces (MAGTFs) with offensive air support, cyber/electronic warfare capabilities, aerial reconnaissance, signals intelligence, target acquisition, force protection and digital communication bridges. UAS will play a key role in all missions including forward presence, security cooperation, counter-

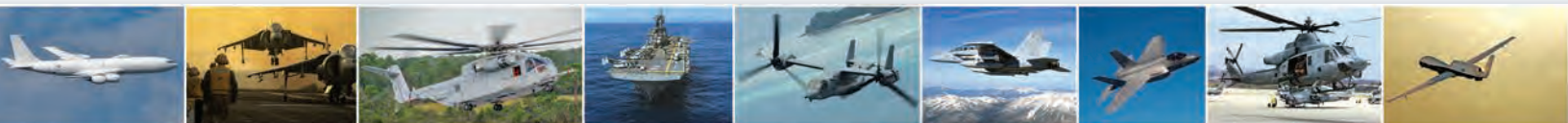
terrorism, crisis response, forcible entry, prolonged operations and counterinsurgency.

Providing even more emphasis on unmanned systems, Secretary of the Navy Ray Mabus created two positions in April 2015—a director of unmanned weapons systems and deputy assistant secretary of the Navy for unmanned systems—to “coordinate and champion ... all aspects of unmanned—in all domains—over, on and under the sea and coming from the sea to operate on land.” The Navy named Rear Adm. Robert P. Girrier in June 2015 as its first director of unmanned weapon systems (N99). This new office exists alongside the service’s directorates of surface, air and undersea warfare as part of the Office of the Chief of Naval Operations (OPNAV) staff. SECNAV named retired Brig. Gen. Frank Kelley as the first deputy assistant secretary of the Navy (DASN) for unmanned systems in October 2015.



U.S. Navy photo John Dougherty

An MQ-8C Fire Scout completes a test flight Nov. 19 at the Point Mugu Sea Range in California. This flight was one of 11 operational assessment events to validate the system’s performance, endurance and reliability.



Unmanned Carrier-based Capability: MQ-XX

The Navy plans to field an unmanned carrier-based capability in the mid-2020s that will deliver an organic refueling and high-endurance intelligence, surveillance and reconnaissance (ISR) capability. It will significantly extend the carrier air wing (CVW) mission effectiveness range, mitigate the current carrier strike group organic ISR shortfall and future CVW-tanker gap, and preserve F/A-18E/F *Super Hornet* fatigue life expectancy.

A Persistent Picture: MQ-4C Triton

The MQ-4C *Triton* UAS is a key element in the Navy's recapitalization of airborne intelligence, surveillance and reconnaissance (ISR) capabilities. *Triton* will be a force multiplier for fleet commanders and the joint force by enhancing their situational awareness and shortening the sensor-to-shooter

kill chain—the sequence of actions from finding a target to engaging in attack—with its multiple-sensor, persistent maritime ISR capability. *Triton* will provide a continuous source of combat information to the fleet to maintain a common operational and tactical picture of the battlespace.

A single *Triton* orbit provides continuous surveillance at a maximum radius of 2,000 nautical miles. Engineered to operate in all-weather conditions, *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 targets. The land-based MQ-4C will operate from designated sites around the globe.

Triton's predecessor, the Broad Area Maritime Surveillance-Demonstrator (BAMS-D), has operated in 5th Fleet since 2009, providing near real-time, high-resolution tactical imagery in

support of combat operations. The development of maritime patrol and reconnaissance capabilities incorporates lessons learned from BAMS-D.

Maritime Identification: MQ-8 Fire Scout

The MQ-8 *Fire Scout* program provides sea-based ISR onboard the Navy's littoral combat ship and follow-on small surface combatant fleet, while supporting maritime requirements across military operations. The MQ-8C will improve on the MQ-8B, currently in operation, by extending the vehicle's range and endurance. The MQ-8C is a commercial Bell 407 airframe that includes radar, a dual-band broadcast capability with full-motion video and an automated identification system to locate and identify ships.

The minimum payload for both the MQ-8B and C variants includes electro-optical/infrared sensors and a laser designator/laser range finder, which



The Navy's unmanned MQ-4C Triton flies over Naval Air Station Patuxent River, Md., while completing a ferry flight from Northrop Grumman's California facility.

U.S. Navy photo by Erik Hildebrandt



enables *Fire Scout* to locate, track and designate targets, and accurately provide targeting data to strike platforms and assess battle damage.

Runway Independent: RQ-21A Blackjack

The RQ-21A *Blackjack* is a tactical multi-intelligence UAS that will support Marine Corps operations, and eventually Navy operations, including expeditionary units and regiments, U.S. Naval Expeditionary Combat Command, L-Class (amphibious) ships and Naval Special Warfare customers. *Blackjack* can operate with minimal space for takeoff and recovery and is well-suited for unimproved expeditionary/urban environments or the deck of Navy ships. The system consists of five air vehicles, two ground control stations and several multi-mission payloads. Payloads can be mission-specific, configured from a variety



U.S. Navy photo by Sabrina Fine

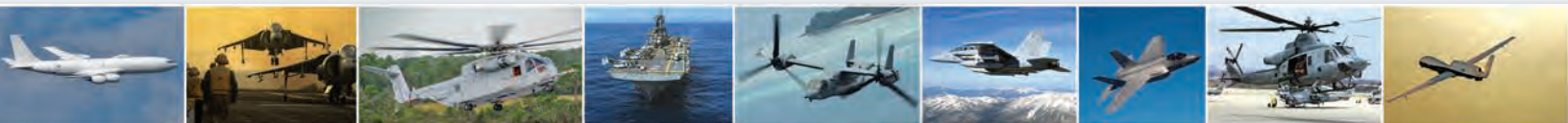
The unmanned RQ-21A *Blackjack* is a twin-boom, single-engine monoplane for surveillance and reconnaissance. It can be launched and recovered on land or at sea without runways, using a pneumatic launcher and net-type recovery system.

CAPABILITY



U.S. Navy photo by Kimberly Brown

Vice Adm. Paul Grosklags, commander, Naval Air Systems Command, and Cmdr. Sam Hanaki, commanding officer for Air Test and Evaluation Squadron (VX) 30, discuss MQ-8C *Fire Scout* operations during a tour of Naval Air Warfare Center Weapons Division facilities in Point Mugu, Calif.



U.S. Air Force photo by Airman 1st Class Timothy Kim

A P-8 Poseidon maritime surveillance aircraft from Patrol Squadron Eight assigned to Naval Air Station Jacksonville, Fla., rests on a ramp on the flightline of Spangdahlem Air Base, Germany.

of components including day/night full-motion video cameras, infrared markers, laser range finders, communications relay packages and automatic identification system receivers. Ancillary equipment includes launch and recovery mechanisms and tactical communications equipment.

RQ-21A can provide ISR and communications relay for up to 12 hours per day continuously with a short surge capability for 24 continuous hours. The system will have an operating radius of approximately 50 nautical miles and airspeeds up to 80 knots with a ceiling of 15,000 feet.

Open Architecture

Open architecture, or open systems development, allows Naval Aviation to affordably add, upgrade and swap components or software within a system in the same way that personal computers can use parts and code developed by

either the original manufacturer or a third-party vendor.

Traditionally, hardware and software built for aircraft, systems, weapons and sensors were owned by the company that developed it, and these proprietary systems could only be upgraded by that company. Today's battlespace no longer allows for such independent functioning and requires an integrated and interoperable approach to both hardware and software.

For software, the future airborne capability environment (FACE) consortium plays a major role in establishing open architecture design without proprietary interfaces and allows developers to compete for portions of the architecture.

FACE is a government-industry collaboration establishing standards for open software and promoting reusable software. Specifications are made public to encourage third-party vendors to

develop add-on products or to make the software interfaces compatible with other vendors' products.

Currently there is no mandate for any DoD program office to include FACE standards in requirements documents, but vendors are building to the standards and measuring compatibility with existing systems. Once the FACE authority independently certifies each technology, program managers can advertise products as FACE-conformant. Each new product that adheres to the FACE standards is cataloged in a library database where program managers can search for technologies that suit individual hardware platforms.

The shift from a hardware-centric world to a software-centric world can be expensive. However, by using common development standards, FACE promotes competition and innovation, thus lowering the cost of developing new, advanced weapons and aircraft.



Photo courtesy of Huntington Ingalls Industries

The aircraft carrier pre-commissioning unit Gerald R. Ford (CVN 78) is moved to Pier 3 at Newport News Shipbuilding, Va., where the ship is undergoing additional outfitting and testing.

Redesigned from Keel to Mast: The Ford-Class

Featuring an array of technological improvements, the Navy's newest aircraft carrier will lead Naval Aviation into its second century. Pre-commissioning unit *Gerald R. Ford* (CVN 78), the lead ship of this new class, is the largest, most powerful warship ever built. The centerpiece of the 21st century carrier strike group (CSG), CVN 78 is set for commissioning in 2016 as the replacement for *USS Enterprise* (CVN 65), inactivated in December 2012 after more than 50 years of service. The ship's crew moved aboard in August 2015 when construction was more than 92 percent complete.

The *Ford*-class incorporates significant design and technology changes, improved integrated warfighting capabilities originally planned for later ships, and lessons learned from 100 years of aircraft carrier operations. *Ford* is also the first carrier designed

with all-electric utilities that eliminate steam service lines. Compared to their *Nimitz*-class counterparts, each *Ford*-class carrier will save approximately \$4 billion over its expected 50-year service life through improved corrosion control, decreased manning and reduced maintenance requirements.

Another significant change is the transition from manpower-intensive steam catapults to the Electromagnetic Aircraft Launch System (EMALS). By using an electrically generated moving magnetic field to propel aircraft to launch speed, EMALS expands the launch envelope, allowing for the launch of heavier strike fighters and potentially lighter future unmanned aircraft. The projected capability of EMALS—working in concert with a redesigned flight deck—to launch more than 160 sorties per day represents a 25 percent increase in launch capacity over *Nimitz*-class carriers. During short periods of high-tempo

“Featuring an array of technological improvements, the Navy’s newest aircraft carrier will lead Naval Aviation into its second century. Pre-commissioning Unit Gerald R. Ford (CVN 78) is the largest, most powerful and transformational warship ever built.”



operations, *Ford* is projected to have the ability to launch more than 270 sorties per day. Shipboard dead-load testing of the EMALS bow catapults began in June 2015. More than 100 dead-loads—large, wheeled vessels weighing up to 80,000 pounds to simulate the weight of actual aircraft—were successful. EMALS will be capable of launching all conventional and short-takeoff, fixed-wing carrier aircraft currently projected for the Navy inventory through 2050, including the F-35C *Lightning II*. Shipboard aircraft testing of EMALS is slated for 2016.

Also new to the *Ford*-class is the Advanced Arresting Gear (AAG), a system consisting of energy absorbers, power conditioning equipment and digital controls that replace the existing MK-7 arresting gear found on *Nimitz*-class carriers. Shipboard testing of the AAG system began in July 2015. 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 potentially result in lower equipment and aircraft maintenance costs. They are also designed to accommodate unmanned systems, with a goal of launching all future aircraft projected to be in the inventory through 2050.

The redesigned flight deck of the *Ford*-class includes more deck space, a smaller island set 140 feet farther aft on the ship and three feet farther outboard to enhance launch and recovery, and a NASCAR-inspired “pit stop” concept that reduces the time required to refuel, conduct maintenance and launch aircraft. The new deck also features electromagnetic field-driven weapon elevators, a relocated “bomb farm”—where bombs and missiles are stored during flight operations—and an

updated shipboard ordnance arrangement that will improve the flow of weapons from magazines to aircraft, further contributing to increased sortie rates.

The smaller island features an advanced dual-band radar integrated warfare system to provide full surveillance, weapon targeting and air traffic control for the carrier 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.

Substantial work is underway on the next ship in the *Ford*-class, *John F. Kennedy* (CVN 79), with scheduled delivery in two phases. The first phase will deliver in 2022, followed by a 2024 phase-two delivery of a fully operational ship to replace USS *Nimitz* (CVN 68) before her inactivation in 2025. Using lessons learned from the design and construction of CVN 78, CVN 79 will deliver the same capability while requiring 18 percent fewer production man-hours to build and cost about \$1 billion less. The keel-laying ceremony for CVN 79 was August 2015.

Weapons: Modular Components

With the constantly changing nature of warfare and our adversaries, it is challenging to predict the next generation of weapons. Regardless, weapons will need to fly faster, go farther, be more precise and function from any platform in any domain. To give our warfighters flexibility “on the fly,” there is a need to develop weapons with modular capability.

Until now, industry partners provided the Navy with “all-up-round” systems that included the warhead, seeker, guidance and motor all in one package. Because the Navy did not have the flexibility to change out these modules, a new solution was required to pace the threat: swappable weapon modules built on an open architecture framework with interfaces owned by the government.



U.S. Navy photo by MCI Joshua J. Wahl

Sailors from PCU USS Gerald R. Ford (CVN 78) prepare to launch a dead-load sled from the ship's Electromagnetic Aircraft Launch System (EMALS).



Interchangeable modules could include the weapon's seeker, rocket motor, mission computer and/or sensor.

The Navy will have greater responsibility from an acquisition perspective for overall architecture of the weapons and take technical control of the interfaces between different components. This will allow for the integration of a weapon with all Naval Aviation platforms, rather than buying a new interface every time a new system is loaded on an aircraft or ship.

In recent years, a new class of bombs was developed that uses GPS to navigate to a specific target, known as Joint Direct Attack Munitions (JDAM). The Advanced Precision Kill Weapons System (APKWS) was fielded by integrating a low-cost guidance kit into rockets and wings from the Joint Stand-Off Weapon (JSOW) that allows it to glide to its target without a propulsion system.

The next-generation strike capability will counter new anti-access/anti-denial threats and share common components of existing systems, like *Tomahawk* and *Harpoon*.

We envision this new family of weapons will deploy on multiple platforms using a modular approach, giving the warfighter the ability to quickly swap out various weapon components for a specific target. By using this modular approach, the warfighter can choose the right weapon for the right target.

Cyberspace Operations

The Navy's ability to operate and maintain secure and reliable networks, and develop as well as maintain cyber resiliency, is critical to every warfare area and all aspects of daily operations. The fleet is highly dependent on cyberspace, the electromagnetic spectrum and space-based systems. Modern wars will increasingly take place in these interrelated domains.

The convergence of the cyberspace domain and the electromagnetic spectrum presents additional opportunities

for Naval Aviation to leverage electronic warfare (EW) tactics with cyber payloads that will impact enemy combat capabilities, while increasing our land, sea and space-based network security and exploitive capabilities. Resiliency of Naval Aviation includes data management and control systems, research and development of tactical solutions and command, control, communications, computers and intelligence (C4I) systems.

Naval Aviation is preparing to deter and defeat potential adversaries with expanded cyber roles for the EA-18G *Growler*, F/A-18E/F *Super Hornet*, E-2D *Advanced Hawkeye* and F-35B/C *Lightning II*. Electromagnetic spectrum and cyber operations will target and break an adversary's kill chain.

The Marine Corps Forces Cyber Command and Marine Aviation Weapons and Tactics Squadron (MAWTS) 1,

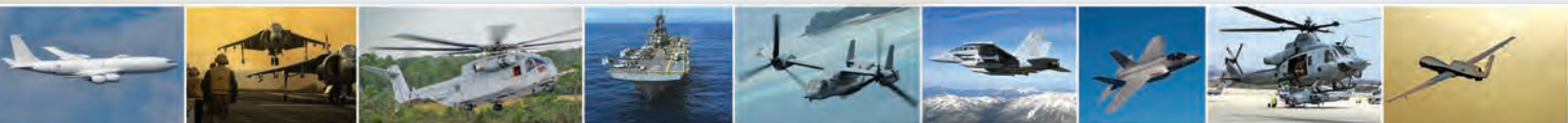
are demonstrating these advanced cyber capabilities by featuring the tactical-level integration of electromagnetic spectrum operations and cyber operations in a combined-arms approach. Using asymmetrical methods—defeating missiles with EW instead of with another missile, or disrupting Command, Control, Communications, Computers (C4) ISR systems with electromagnetic or cyber-tactics—Naval Aviation forces will prevent enemy visualization or tracking of naval forces, deny them the ability to communicate targeting information, destroy weapon launchers, and decoy, divert and/or destroy launched weapons. U.S. Fleet Cyber Command/10th Fleet's strategy, "Navy Cyber Power 2020" and "Strategic Plan 2015-2020" provide the framework that will enable the Navy to achieve and maintain an operational advantage over its adversaries in all domains. ▲

CAPABILITY



U.S. Navy photo by MCS Bryan Mai

"Liberty Bells" of Airborne Early Warning Squadron (VAW) 115 prepare an E-2D Advanced Hawkeye for a mission on the flight deck of Nimitz-class aircraft carrier USS George Washington (CVN 73).



Creating *and* Delivering *Integrated* Warfighting Capabilities

Our nation benefits significantly from the technology, power and influence wielded by the carrier and its embarked air wings. The Navy's challenge is to continue to develop and integrate advanced technologies and assets into the fleet within today's resource-constrained environment.

For Naval Aviation, integrated warfighting capabilities (IWC) encompass the combined interaction of people, equipment and training to launch weapons or gather intelligence. The goal is to get the networked platforms, systems and training to the fleet quickly and affordably using a system-of-systems approach, which networks diverse resources to create new and enhanced interoperable systems with increased capability.

Historically, Naval Aviation designed, developed and tested new systems as stand-alone assets that did not always operate well—or plug and play—with other aircraft and systems in the battlespace. This placed the burden of integration and future logistics support in the hands of the operators, often at significant cost and reduced ability to perform their mission. Naval Aviation has returned that responsibility to the acquisition community to ensure systems are compatible and supportable early in the development of new technology.

Implementing Integrated Warfighting Capabilities

Naval platforms train, deploy and operate together in combat as a carrier strike group (CSG) or expeditionary strike group (ESG) rather than as individual aircraft or ships. While individual platforms historically are responsible for executing a single thread of an effects chain, an integrated approach increases combat flexibility, fixes breaks



A UH-1Y Venom helicopter lands aboard the San Antonio-class amphibious transport dock ship USS Green Bay (LPD 20).

U.S. Navy photo by MC3 Scott Barne



in the chain quicker and leverages multiple systems to dramatically reduce the time required to execute the chain. This integrated warfighting approach requires us to better employ existing test and evaluation and training infrastructure.

Developing Mission Expertise

As Naval Aviation's primary provider of platforms, weapons, networks and sensors, Naval Air Systems Command (NAVAIR) established an IWC enterprise team to facilitate IWC implementation across Naval Aviation. The team, which includes representatives from engineering, test and evaluation and logistics communities, develops and enforces mission-level technical standards and looks across commands for ways to integrate facilities, people and tools for building system-of-systems efforts. The team collaborates with other systems commands and communicates with

resource sponsors and fleet representatives to maintain technical standards.

Developing Mission-Level Technical Standards

Mission-level technical standards are created for current capabilities, Programs of Record and future capabilities. These mission technical baselines—a line drawn in the sand to measure progress—capture the fleet's desired concept of operations for a given threat and are compared to current Program of Record and anticipated future capabilities to ensure compatibility. The next step is to document an integrated capability technical baseline that connects fleet-driven concepts of operations to the technical underpinnings of aircraft platforms, weapons, networks and sensors, and identify current gaps and guide the new acquisition process to close gaps as they emerge.

Addressing Warfighting Gaps

The systems commands, Commander, Operational Test Force (COTF) and the fleet use the integrated capability technical baseline to assess the technical feasibility of executing high-priority warfare chains or mission sequences. This warfare capability baseline identifies any gaps in the effects chains and serves as a feedback loop to the acquisition process by documenting fielded system performance.

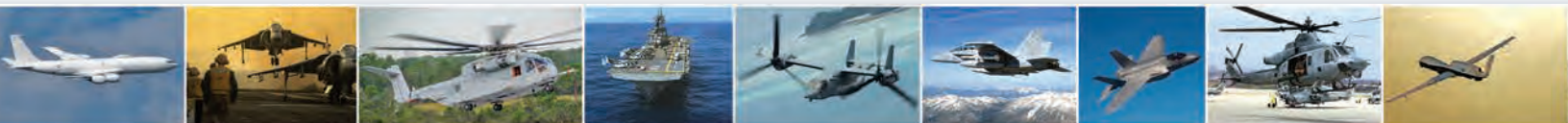
Identifying, prioritizing and resolving gaps in mission sequences is fundamental to integrated warfighting. Gaps in effects chains highlight deficiencies or risks in executing the desired outcome. Analyzing effects chains provides valuable insight into where gaps exist and how to close them.

Additionally, when we build a new weapon or improve an existing system, we need to understand the impacts to the mission sequence and apply that



U.S. Marine Corps photo by Lance Cpl. Alvin Pujols

An air officer for the 13th Marine Expeditionary Unit coordinates the landing of a MV-22B Osprey onto San Clemente Island, Calif. The exercise is the first time Marines and Sailors worked together at sea as they prepare for deployment to the Pacific and Central Command areas of responsibility in early 2016.



U.S. Navy photo by MC2 David Glenda

Lt. Brett Eckert, assigned to the Pro's Nest of Patrol Squadron (VP) 30, observes Royal Air Force squadron leaders Andy Bull and Mark Faulds, as they participate in a flight simulator exercise for the P-8A Poseidon as part of a fleet exercise.

information to design the system to fit seamlessly into existing and future sequences. Over time, this approach will inform a more resilient and adaptive warfighting capability.

Conducting Integrated Training

Integrated warfighting requires that training exercises incorporate all aspects of the CSG or Marine Air Ground Task Force (MAGTF) mission, for example: from launch and recovery aboard the carriers and the amphibious assault ships to the intelligence-gathering EA-18G *Growler* aircraft to the weapons delivery of the F-35B/C *Lightning II*.

It is no longer possible to replicate a future battlespace by relying solely on live training. To meet that need, live, virtual and constructive (LVC) exercises

immerse today's warfighters in a collaborative, networked environment of live, simulated and constructed aircraft, ships and weapons. These realistic environments deliver training at multiple levels of complexity and security.

The following methods and tools enable Naval Aviation to extract the most pilot and aircrew proficiency from every training dollar.

Government Test and Evaluation Laboratories and Ranges

Government labs and facilities provide ideal testing environments due to their non-proprietary nature. NAVAIR's Naval Air Warfare Centers are linking the government's nationwide infrastructure of labs and ranges—large tracts of land, sea and air space operated for testing and training—to create large-scale

life-like scenarios that allow pilots and platforms to operate with other systems across multiple locations nationwide.

NAVAIR scientists and engineers apply modeling and simulation techniques to network several platforms to evaluate how well the systems work together and to create training scenarios not available otherwise.

Managing Research, Development, Test and Evaluation Infrastructure

NAVAIR developed the Naval Infrastructure Capability (NICAP) database to ensure the cost-effective use of the command's research, development, test and evaluation (RDT&E) assets.

NICAP is a tool that compiles a portfolio of available Navywide assets such as labs, ranges and facilities, and highlights any infrastructure gaps or redundancies. The tool shows how efficient it is to reuse several components, such as code, models, threat definitions scenarios and standards. By incorporating NICAP, Naval Aviation can transfer those efficiencies to capability development efforts such as LVC. NICAP also facilitates the creation of advanced battle environments and aligns infrastructure to mission areas. This reduces the cost of battlespace simulations and the time needed to integrate new technologies into the modeled environment. Additionally, acquisition programs can now focus on simulations of their systems built to open standards instead of recreating complex threat environments in proprietary frameworks.

The LVC environment is also well-suited to understanding cyber threats. Integrating the National Cyber Range and Joint Information Operations Range with LVC enables the assessment of offensive and defensive cyber/network capabilities and techniques, ensuring our systems are effective, interoperable and secure.



Simulator Training

With the advances in modern technology, we are now able to “fly” simulators that very closely match the performance of actual aircraft. Upgraded simulators allow aircrew to design, experiment with, evaluate and perfect unique combat techniques. It also allows us to train with new techniques and perfect the most difficult ones before introducing them into live training.

In addition to improving individual flight and decision-making skills, increased simulator performance enables the networking of multiple, dissimilar aircraft and other combat elements to train together in any simulated “clime and place” mission before executing these missions on the live training range.

AIRWorks Provides Rapid Response

Rapid Response initiatives address urgent warfighting needs that arise during fleet operations. These projects leverage existing contracts and technologies to field an “80 percent” solution within months, versus years, dramatically improving speed to the fleet.

NAVAIR’s Warfare and Fleet Readiness Centers have proven they are capable of delivering urgent fleet needs in less time and with less money while achieving equal or superior performance

as compared to traditional acquisition processes. Called AIRWorks, this networking of engineering, prototyping, building, installing and testing of one-time or low-volume solutions is also being applied to Programs of Record, where appropriate, to save time and money.

The AIRWorks rapid delivery model fosters a healthy balance between process and innovation through critical checks and balances. The overarching principle is one of minimal oversight so

project teams are 100-percent focused on execution and delivery. Teams take greater risks while bounded by proper acquisition standards and discipline.

This work is critical to the continued development of Naval Aviation’s technical workforce and a key enabler to achieving affordability goals.

An early success story is the advanced ballistic stopping system for the V-22. After three Air Force Special Operations Command CV-22s came under fire, causing multiple injuries and systems failures,



U.S. Navy photo by MC3 Giovanni Squadrillo

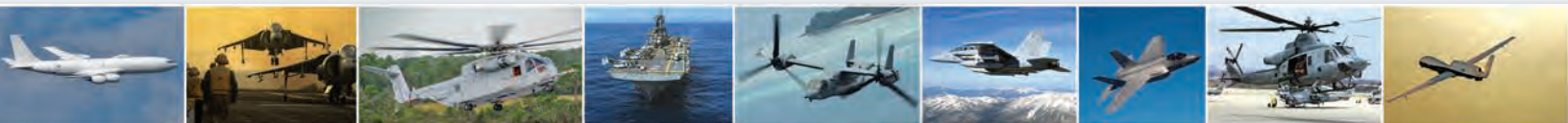
An air traffic controller demonstrates the first air traffic control simulator installed on board a Navy aircraft carrier in the USS Carl Vinson air traffic control center.

CAPABILITY



Photo courtesy of Lockheed Martin

Pilots in Eglin Air Force Base, Fla., use full mission simulators as part of their training with F-35 Lightning IIs. The F-35 simulators can also be found at Marine Corps Air Station Yuma, Ariz., where Marine Fighter Attack Squadron (VMFA) 121 trains.



U.S. Marine MV-22B Ospreys from Special-Purpose Marine Air-Ground Task Force Crisis Response-Africa deliver a platoon of Marines from the Black Sea Rotational Force to support a multilateral training exercise.



U.S. Marine Corps photo by Sgt. Paul Peterson

the V-22 program needed to deliver a fully qualified ballistic protection system.

The AIRWorks project team developed an improved protection system and pushed the equipment to its limits to uncover any issues. Technical and programmatic decisions occurred when appropriate, and all Advanced Ballistic Stopping System team members had the authority to make critical decisions. As a result, a qualified ballistic system for the CV-22 aircraft was fielded in less than 180 days by a collaborative government/industry rapid response team.

Integrated Warfighting Capability Successes

With Naval Aviation entering a period of modernization and sustainment in the wake of budget constraints, affordable and rapid delivery of integrated warfighting capabilities (IWC) are crucial for the future battlespace. Systems and platforms themselves are moving toward being more network-centric,

making IWC efforts the next logical step in maintaining naval superiority.

The following examples demonstrate progress on ensuring warfighters, aircraft, sensors and weapons communicate and operate as one.

Naval Integrated Fire Control-Counter Air

NIFC-CA increases the lethal range of the CSG and ESG by networking otherwise individual platforms, weapons and sensors to work as one. This network extends the Navy's range over land and water and increases the over-the-radar horizon of surface ships, allowing us to fire at more distant targets.

March 2015 marked the first deployment of a NIFC-CA-capable CSG, primarily made up of USS *Theodore Roosevelt* (CVN 71), USS *Normandy* (CG 60) guided missile cruiser and a squadron of E-2D *Advanced Hawkeye* maritime surveillance aircraft.

This system-of-systems environment consists of three kill chains: from the

air, from the sea and from the land. By 2025, "from the air" will, at a minimum, consist of the F-35B/C *Lightning II*, the F/A-18E/F *Super Hornet*, the E-2D *Advanced Hawkeye*, the EA-18G *Growler*, the multifunctional information distribution system and the AIM-120 Advanced Medium Range Air-to-Air Missile.

NIFC-CA's efforts bring the following benefits: long-range fire control and projection; ability to operate in and control contested battlespace; and high situational awareness. Lower costs are possible by investing in common components, conducting high-fidelity modeling and simulation, and analyzing associated test data.

Offensive Anti-Surface Warfare

OASuW is another system-of-systems capability that is long-range, survivable and available for launch from multiple platforms. OASuW will incorporate existing and emergent technologies to support an improved capability against future surface threats.



OASuW involves developing an air-launched weapon that can go farther, survive longer and target more accurately than previous missiles. This joint force capability will deliver game-changing, offensive strike capability to our warfighters in theater as quickly as possible.

Network-Enabled Weapon Controller Interface Module

Developed by NAVAIR's Naval Air Warfare Center Weapons Division, NEWCIM is a community software tool and engineering reference model that provides standardized design guidance for network-enabled weapon development, implementation, simulation and testing.

NEWCIM can also test the interaction between network-enabled weapon role-players using tactical data link (TDL) messages. NEWCIM weapon and platform developers can code their TDL messages, and test their implementation with and against the reference model in a controlled lab environment. Ensuring compatibility with NEWCIM greatly reduces the risk of identifying network integration issues during ground and flight test.

NEWCIM identifies compatibility issues at earlier stages, helping developers save time and money. The Joint Interoperability Test Command (JITC) issued its interoperability certification for the module in August 2014, and the Space and Naval Warfare Systems Command completed its assessment of compliance with Mil-STD-6016E in August 2015. The next phase is to expand NEWCIM capability by incorporating additional message sets.

Next Generation Land Attack Weapon

NGLAW is a successor to the *Tomahawk* weapon system, and a system-of-systems capability that is long-range, survivable and can be launched from multiple surface and subsurface



U.S. Navy photo by MC2 John Philip Wagner Jr.

An EA-18G Growler assigned to the "Cougars" of Electronic Attack Squadron (VAQ) 139 launches from aircraft carrier USS Carl Vinson (CVN 70).



U.S. Navy photo by MC2 Ernest R. Scott

An E-2D Advanced Hawkeye assigned to the "Tiger Tails" of Carrier Airborne Early Warning Squadron (VAW) 125 flies over Naval Station Norfolk, Va.

CAPABILITY



“In the future, we must accelerate advanced manufacturing qualification and certification processes and continue to invest in digital infrastructure to reap the benefits.”

platforms. NGLAW will incorporate existing and emergent technologies to support an improved strike capability against increasing threats and expanded target sets.

NGLAW will mirror previous and ongoing analytical efforts, including data link studies, threat assessments and target sets that have identified critical kill-chain gaps. Follow-on assessments of alternatives will address all of these gaps to ensure the full-required capability can be delivered to the fleet.

Common Standards and Interoperability Team

Established by the Program Executive Office for Unmanned Aviation and Strike Weapons, the common standards and interoperability team ensures the integration of unmanned aircraft

systems (UAS) and applicable external systems while identifying innovative contracting and programmatic initiatives to reduce costs and delivery turnarounds. If all UAS comply with the same standards, they will be easier and cheaper to build. Much of the team’s effort focuses on the following:

- Developing command-and-control and imagery-intelligence interfaces
- Aligning naval UAS under a standard architecture framework that modularizes major UAS components (platform, sensors, control system, etc.) with the goal of providing commanders the flexibility to “mix and match” available assets, and consistently depicting the interoperability attributes of each system
- Documenting the government-developed interfaces in architectures to in-

form industry of the specific interface definitions required for the system.

Common Control System

CCS is software that provides UAS command and control and sensor/payload processing. CCS has been developed for Multi-Mission Unmanned-XX (MQ-XX) and other UAS platforms. CCS is based on the DoD UAS Control System (UCS) Working Group standard, a service-oriented architecture designed for reuse among unmanned platforms.

The key goal for CCS is to reduce the costs of developing and supporting separate software for each UAS platform by replacing them with a single product that can leverage enhancements made for one platform to others. The UCS-based modular architecture and acquisition strategy results in competitive development of new services, application and interface components. This strategy will provide new capabilities to existing platforms and extend CCS to support new platforms.

Advanced Manufacturing and the Digital Thread

Advanced manufacturing and the digital thread offer a new approach to product manufacturing that applies innovative technologies such as 3-D additive manufacturing and integrated processes to manufacture products. The “digital thread” is an all-digital approach to managing the design, engineering, manufacturing, production and support of a given product. With a secure digital thread for additive manufacturing, small-batch products, one-of-a-kind prototypes and unique or customized parts or tools can be produced quickly and cost-effectively.



U.S. Navy photo by Liz Wolter

The Navy’s unmanned X-47B, right, conducts flight operations aboard aircraft carrier USS Theodore Roosevelt (CVN 71). The aircraft completed a series of tests demonstrating its ability to operate safely and seamlessly with manned aircraft.



Several advanced manufacturing technologies will reduce costs, minimize obsolescence and improve capability and readiness across the life-cycle of systems. These technologies include reverse engineering; creation of 3-D models and environments; sending digital data directly to the shop floor; and use of computed tomography scanners, which combine a series of X-ray images taken from different angles and use computer processing to create cross-sectional images to aid in non-destructive inspection of aircraft.

A standardized set of digital tools and product data accelerate the development process and save money. Operational readiness is enhanced through quick access to the authoritative data necessary to enable next-generation manufacturing and logistics.

In the future, we must accelerate advanced manufacturing qualification and certification processes and continue to invest in digital infrastructure to reap the benefits.



Artisans at Fleet Readiness Center Southeast (FRCSE) in Jacksonville, Fla., test the functionality of a P-3 Orion's landing gear. A team of tool designers, artisans and engineers from FRCSE used additive manufacturing to repair the Orion's wheel-well truss.

U.S. Navy photo by J.L. Wright Jr.

Business and acquisition processes must be able to operate in the digital realm by making advanced manufacturing and the digital thread a priority. Understanding data rights, intellectual

property and cost models is fundamental to determining where and when advanced manufacturing is appropriate.

NAVAIR developed a roadmap on the broad use of advanced manufacturing and digital thread, accelerating its use across the Naval Aviation Enterprise. NAVAIR's advanced manufacturing team is also working with the aviation program executive offices, program managers and industry to identify processes to improve readiness and capabilities, manage these items and ensure their safe use. Efforts include the following:

- Increasing collaboration opportunities across the advanced manufacturing community
- Developing an advanced manufacturing data architecture to tie data together across the defense enterprise
- Working with our suppliers, Defense Logistics Agency and Naval Supply Systems Command to source advanced manufacturing parts
- Validating DoD cost models and managing the data rights for maximum reuse. ▲



U.S. Navy Photo by Kaylee LaRocque

A Fleet Readiness Center Southeast sheet metal worker removes a modeled form block for an F/A-18 Hornet bracket from the Statasys Fortus 400mc printer in the military depot's manufacturing division. The printer creates the 3-D model from a computer-aided design one layer at a time using a thermoplastic product. The modeled form block is then used to form the metal bracket used on the aircraft.



U.S. Navy photo by MC3 Anthony N. Hilkowski

The aircraft carrier USS Theodore Roosevelt (CVN 71) operates in the Arabian Sea conducting maritime security operations.

Strategic Imperative of Integrated Warfighting

The integrated warfighting objective is to control fires—the use of weapon systems or other actions to create specific lethal or nonlethal effects on a target. Integrated warfare leverages the capabilities of multiple systems operating independently in a coordinated or com-

ing independently. Coordinated fires require platforms to communicate with each other so the most effective system reacts to the target. Systems operating in a combined manner to perform a task within an effects chain will function better than any single platform. The embodiment of integrated warfare

comes from the fire control systems of modern weapons. From investments in science and technology, through managing our test and evaluation environments, to the March 2015 deployment of the first Naval Integrated Fire Control-Counter Air (NIFC-CA) capable carrier strike group (CSG) centered around USS *Theodore Roosevelt* (CVN 71), integrated warfighting is maturing and advancing.

Still, Naval Aviation knows the concept of integration is not new; it is embodied in the idea of “jointness” that has been at the core of the American way of war for decades, and is the guiding principle of combatant commanders who use combined Navy, Marine Corps, Air Force, Army and allied forces to fight and win our nation’s wars. What’s changing is the speed of action required

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“What’s changing is the speed of action required by the integrated systems of the modern force. While integration has been the letter and the law at the highest level of command, making it a reality at the tactical and technical level has been more of a challenge.”

by the integrated systems of the modern force. While integration has been the letter and the law at the highest level of command, making it a reality at the tactical and technical level has been more of a challenge.

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 requirements and acquisition processes. With the rising cost of military capabilities, integration improves upon systems that were once considered independent with minimal costs. Integration also increases our forces’ resilience through complementary systems with multiple approaches.

Air Warfare: Maintaining Maritime Dominance in the Skies

The September 2014 operations in Syria reaffirmed our nation’s ability to work with partner nations, gather forces and conduct targeted airstrikes against adversaries with minimal threat to our air forces. Operation Inherent Resolve is a reminder of the importance of air dominance. The airspace in areas controlled by the Islamic State Group is untested due to a continued presence of an integrated force that dominates the air, destroys land-based threats to aviation and leverages the existing electromagnetic spectrum.

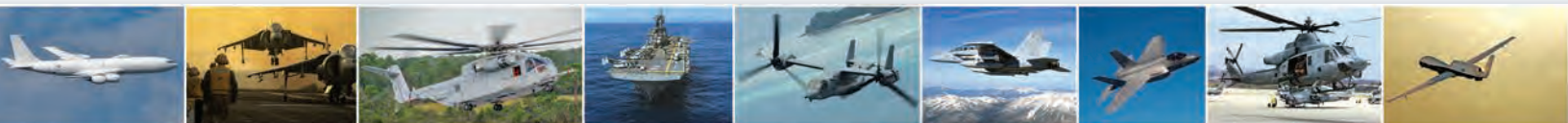
Air dominance has traditionally been achieved by dominating the battlespace with friendly air forces capable of clearing

a path, defending an area or interdicting an adversary’s flight profile. However, today’s adversaries are more advanced, which in turn increases the volume of airspace to monitor and potentially control. The integration of other naval aircraft such as the E-2D *Advanced Hawkeye*, F-35B/C *Lightning II*, EA-18G *Growler* and maritime intelligence, surveillance, reconnaissance (ISR) platforms such as the MQ-4C *Triton* greatly expand the area of control available to fighter aircraft. Further integration with Navy surface assets through cooperative engagement capability (CEC), and eventually NIFC-CA, not only increases the control area, but also expands the range of weapons on the aggregate platforms. Cooperation with Air Force and Army partners through cross-domain integration eliminates single points of vulnerability. Networked information sharing within the global grid further increases the area of awareness. Many of these capabilities are also expanding to partner nations, including those participating in the international Joint Strike Fighter program and Australia’s purchase of the F/A-18E/F, EA-18G, P-8A, MQ-4C and MH-60R.



The Navy’s unmanned MQ-4C Triton flies over Naval Air Station Patuxent, Md., while completing a ferry flight from Northrop Grumman’s California facility.

U.S. Navy photo by Erik Hildebrandt



U.S. Navy photo by Lt. CoeHtee

A P-8A Poseidon arrives at Naval Air Station Patuxent River, Md.

Anti-Submarine Warfare: Nowhere to Run, Nowhere to Hide

Patrol Squadron (VP) 16 returned to Naval Air Station Jacksonville, Florida, in July 2014 after the P-8A *Poseidon's* inaugural six-month deployment to the Pacific. One year later, in the summer of 2015, Joint Warrior NATO exercise included 50 warships, four submarines and 70 aircraft in anti-submarine warfare training events. This was the first deployment for the "Vipers" of Helicopter Maritime Strike Squadron (HSM) 48 with the MH-60R—the Navy's next-generation submarine hunter and anti-surface warfare helicopter. The performance of the MH-60R APS-153 radar was particularly impressive. Even more indicative of our future operations was the coordinated operations between maritime patrol aircraft, including P-3Cs and one P-8A, and USS *Vicksburg* (CG 69) and her MH-60R. This integration of three platforms and a surface vessel highlighted the importance of new systems and future upgrades of the P-8A that will improve communications and open architecture. Onboard P-8A, all sensors contribute to a single-fused tactical situation display, shared over both military standard and Internet protocol data links, allowing seamless, precise information exchange among U.S. and coalition forces.

Mine Warfare: Up from the Depths—Airborne Countermeasures

Effective mine warfare is a key tenet of the Navy's anti-access/area-denial (A2AD) strategy, and Airborne Mine Countermeasures (AMCM) play an important role in executing that strategy. AMCM will become an integrated mission area for the littoral combat ship (LCS) when the mine countermeasures mission package reaches initial operational capability. The mission package comprises the MH-60S, employing two onboard systems: the

An MH-60R Seahawk helicopter attached to the "Vipers" of Helicopter Maritime Strike Squadron (HSM) 48 lands on the flight deck of guided-missile destroyer USS Porter (DDG 78.)



U.S. Navy photo by MCS Ryan U. Kleczik



U.S. Marine Corps photo by Cpl. Travis Gershaneck

CAPABILITY

An F-35B Lightning II with Marine Fighter Attack Squadron (VMFA) 121, based out of Marine Corps Air Station Yuma, Ariz., performs a vertical landing as part of required flying field carrier landing practices. The landing field simulates the flight deck of an aircraft carrier to prepare pilots for landing and taking off at sea.

Airborne Laser Mine Detection System and the Airborne Mine Neutralization System, and the MQ-8 employing the Coastal Battlefield Reconnaissance & Analysis (COBRA) payload. 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 sharing information with other airborne platforms such as the P-8A.

Naval Aviation will continue to invest in the unmanned underwater vehicle, which is changing AMCM concepts, and will continue to sustain the MH-53E *Sea Dragon* to maintain the necessary capabil-

ity and capacity while in transition. The mine countermeasures modular packages are tailored for individual missions, 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.

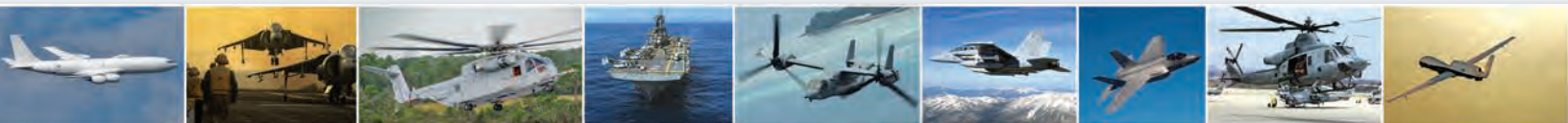
Strike Warfare: Integrated Lethality

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, enabling *Super Hornets* 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 its operational picture. This process automatically formulates weapons tracks for each target to share with other aircraft and ships so they can then engage the target.

Expeditionary Warfare: From the Sea, Ready to Fight with Today's Force

The Marine Air-Ground Task Force (MAGTF) is a balanced air-ground, combined arms task organization of Marine Corps forces under a single



commander structured to accomplish a specific mission. The MAGTF can move from over the horizon into hostile areas, from blue water into green water, and the commander can project forces ashore at any time or place. Moving forces this way requires sealift, at-sea vertical and surface connectors and a fleet of amphibious vehicles. A critical enabler of a MAGTF is the integration of the air component with the ground component.

As U.S. forces move closer to shore in forcible entry scenarios, ships and units comprising the MAGTF will separate into smaller units to re-form on a fluid battlespace. The Marine Expeditionary Brigade (MEB) is the “middleweight” MAGTF, which can be aggregated for large-scale combat or broken down into smaller, more agile teams below the Marine Expeditionary Unit (MEU) level, and frequently down to the company landing team (CLT) level. The MEB is the steady state for forcible entry, while the MEU

is evolving, maneuvering and adapting, posturing its MAGTF for success—in an aggregated or disaggregated form; executing split operations, integrating Special Operations Forces, working from prepositioned equipment and advanced expeditionary bases.

Special Purpose MAGTF-Crisis Response (SPMAGTF-CR) is becoming a high-profile task force for the Marine Corps. SPMAGTFs, along with MEUs, are built around operational agility and highly dependent upon aviation. For example, the SPMAGTF in Morón, Spain, can reach across the Mediterranean to the seven countries in the North African littoral and beyond; they are staged and ready to move entirely by MV-22 *Osprey* and the KC-130J *Hercules* or joint tankers.

It is expected that forward deployed MEUs and SPMAGTF-CR forces will help address global threats for the foreseeable future (especially until the inventory of amphibious ships matches combatant

commander and national demand). As the Marine Corps evolves, ground combat units will be deployed around infantry battalions, but future capacity will be built to employ the battalion as three separate CLTs. These teams have young officers and senior non-commissioned officers assuming authority over large swaths of terrain that used to be the responsibility of commanders at the battalion level. To support these small, agile teams, leaders must be provided with more flexible fire support capabilities and technology: radios, optics, assault and maneuver support, vehicles and vertical lift. It is incumbent upon Marine Corps Aviation to lift, resupply and support by fire the Marine on the ground at any time and any place.

Digital Interoperability

DI is the seamless digital exchange of tactically relevant information between the different elements of the MAGTF, increasing the effectiveness and efficiency



U.S. Marine Corps photo by Cpl. James Marchetti

Marine Infantry Officer Course (IOC) students await a CH-53E Super Stallion helicopter fast rope drill at Marine Corps Air Station Yuma, Ariz. The fast rope training instills the skills necessary to complete IOC's final exercise, Talon Reach IV.



U.S. Navy photo by MC3 Pedro A. Rodrique

Operations specialists monitor radar in the Combat Information Center (CIC) aboard amphibious assault ship USS Bataan (LHD 5).

of the force as a whole. The goal of DI is not just the connection of nodes on the battlespace, but it is also the effective communication of tactically relevant information that gives decision makers more time and information. To facilitate this effort, Marine Corps Aviation is procuring systems that provide distributed electronic warfare (EW), and intelligence, surveillance, and reconnaissance (ISR) capability to the MAGTF and joint force. By making every platform a sensor, an EW node, a shooter and a connector, we will optimize legacy and newly acquired gear. Additionally, the Deputy Commandant for Aviation has directed that all Marine Corps Aviation platforms be equipped with data link capability, which will allow all aircraft and the Marines that they are supporting to share a common picture.

“New normal” mission requirements demand effective linked operations over longer distances, in smaller formations, removed from traditional support elements. To address this, the Marine Corps

“Our mastery of cyberspace puts a hefty weapon in our hands; and our reliance on cyberspace places a weighty vulnerability in our path.”

continues to define the concept of “maneuvering within spectrum.” This new concept will help the Marine Corps find the optimal portion of the electromagnetic spectrum, at the appropriate time, to conduct its digital communication. Awareness of the surroundings within the spectrum is one aspect; the Marine Corps will also employ diverse, resilient and redundant networks and waveforms that allow for movement within the spectrum and within satellite-degraded communications environments.

The Marine Corps is leveraging new technologies to accomplish traditional missions. As the nation’s naval expeditionary force, it is incumbent upon the Marines to assure access and operate in

austere environments. The Marine Corps is ready for today’s fight.

Information Warfare

Information warfare is the operational advantage gained from integrating the Navy’s information functions, capabilities and resources to optimize decision-making and maximize warfighting effects. Information warfare is a warfighting domain, on par with surface, subsurface, air and space, and gives commanders battlespace awareness, assured command and control, and integrated fires to face threats by potential adversaries in today’s complex maritime environment.

The establishment of the Deputy



Chief of Naval Operations for Information Warfare (N2N6), in conjunction with U.S. Fleet Cyber Command/10th Fleet, forms an enterprise focused on the opportunities and challenges for cyber systems and operations. The realm of information warfare includes a host of capabilities ranging from information operations, electronic warfare (EW), ISR operations to cyber warfare. These collectively ensure that command and control achieves battlespace aware-

future conflicts will involve making full use of the electromagnetic spectrum and cyberspace. Our communication networks can keep far-flung forces, aircraft and ships connected with each other and the full command structure at home. The U.S. Fleet Cyber Command/U.S. 10th Fleet's "Strategic Plan 2015-2020" states "our mastery of cyberspace puts a hefty weapon in our hands; and our reliance on cyberspace places a weighty vulnerability in our

picture of the battlespace. Tactical unmanned systems such as the MQ-4 Triton, RQ-21A Blackjack, RQ-11 Raven, RQ-7B Shadow and MQ-8 Fire Scout carry a host of different interconnected sensors, and when used in conjunction with manned aircraft, such as the EA-18G Growler with its advanced airborne electronic attack systems, are advancing the frontlines of the electromagnetic battlefield. At the same time, the increasingly cloud-based storage and dissemination of global information means that the very concept of the frontline is breaking down as cyber warfare transforms warfare itself.

In the future, trends within the worldwide information and operating environments will drive the continuing development of a Navywide information warfare capability.

Electronic Warfare

Navy and Marine Corps' superiority in EW lies in the ability to conduct unfettered operations within the electromagnetic spectrum while using 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 communications-contested area where an adversary may deny use of U.S. forces into a theater of operations (anti-access), or an adversary may prevent the maneuver of U.S. forces within an area (area denial) based on access within the electromagnetic spectrum; and concludes with the ability of U.S. forces to access and operate freely within the contested environment.

Naval Aviation platforms must be able to engage in electromagnetic spectrum operations anywhere around the globe. Marine Air Ground Task Force Electronic Warfare (MAGTF EW) will integrate multiple aviation platforms (manned and unmanned) and ground-based electronic warfare nodes that



U.S. Navy photo by MC1 Joann E. Jennings

An MH-60R Seahawk helicopter and an MQ-8B Fire Scout unmanned helicopter, both assigned to Helicopter Maritime Strike Squadron (HSM) 35, conduct coordinated flight operations with Littoral Combat Ship USS Freedom (LCS 1).

ness and integrates kinetic—bullets, missiles, etc.—and non-kinetic Navy fires. Non-kinetic fires include EW, jamming, electronic attack, offensive cyberspace operations, psychological operations, and military deception—attacks through the networks that the adversary uses. Naval Aviation plays a prominent role in all of these capabilities.

In addition to fighting within the traditional warfare domains, successful

path." Executing the Navy's electronic warfare, ISR and cyber warfare operations is a job for integrated manned and unmanned aviation assets.

The P-8A Poseidon and MQ-4C Triton are the centerpiece of the Navy's maritime patrol and reconnaissance force. The Triton provides combat information to operational and tactical users, supplying a more continuous source of information to maintain a common operational and tactical



will provide the commander with an organic—internal to command—and persistent EW capability.

The ability to fully leverage the electromagnetic spectrum while limiting adversary use of the spectrum is a key tenet of Electromagnetic Spectrum Maneuver Warfare. Some of the current programs that help ensure EW superiority include:

- Electronic Warfare Battle Management, enabled by Electronic Warfare Services Architecture, 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 nodes. The CEWCC will coordinate the integrated planning and execution of cyberspace operations, EW, ISR, information-related capabilities, and electromagnetic spectrum management in order to gain, maintain and exploit operational advantage.
- The ALQ-99 Tactical Jamming System on both the EA-18G and EA-6B is designed to conduct offensive cyberspace operations such as psychological operations and military deception by attacking the adversary's networks.
- The Next-Generation Jammer is slated to replace the ALQ-99 carried on EA-18Gs, beginning in 2021, significantly improving the aircraft's airborne electronic attack capability.
- The Low-Band Transmitter on both the EA-18G and EA-6B is designed to jam low-frequency radar and communications targets.
- 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.
- According to CNO's "Navigation Plan 2016–2020," Real-Time Spectrum Operations (RTSO) are key to EW and

will optimize the use of EW systems while minimizing electromagnetic interference to other spectrum-dependent systems.

Battlespace Awareness: ISR Operations

Today's complex and networked battlespace demands key information be collected and shared as rapidly as possible in a common and usable format, whenever and wherever

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 signals intelligence reconnaissance aircraft 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*, Multi-Mission



U.S. Navy photo by MC2 John Philip Wagner, Jr.

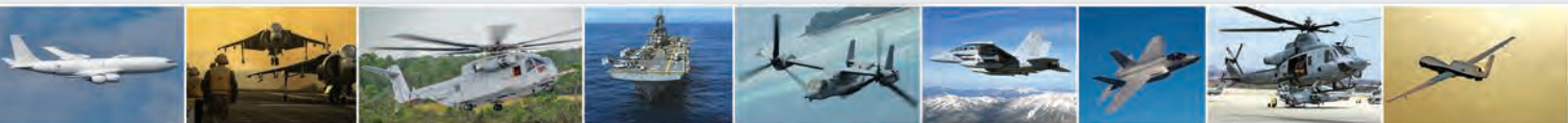
A naval aviator, assigned to the "Cougars" of Electronic Attack Squadron (VAQ) 139, conducts a pre-flight inspection on an EA-18G Growler aboard aircraft carrier USS Carl Vinson (CVN 70).

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—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

Unmanned-XX (MQ-XX) aircraft and P-8A *Poseidon*.

Assuring Command, Control and Communications

Assuring command and control means making sure commanders can effectively control their forces to put weapons on target and achieve their objectives. The Navy's future information infrastructure must be able to maintain essential network and datalink



“Surface warfare missions encompass many military operations, and Naval Aviation is critical to the ability to control the seas in multiple environments.”

services across secured segments of the electromagnetic spectrum. It also must 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.

To accomplish the mission, Naval Aviation is investing in personnel, equipment, facilities and procedures to assist commanders in planning, directing, coordinating and controlling forces and operations. For example, 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.

The first increment 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 protected transport and tactical data links. These efforts include engineering changes to enhance current systems for communications in a contested environment as well as incorporating new systems into the Multifunctional Information Distribution System Joint Tactical Radio System (MIDS-JTRS). This will increase

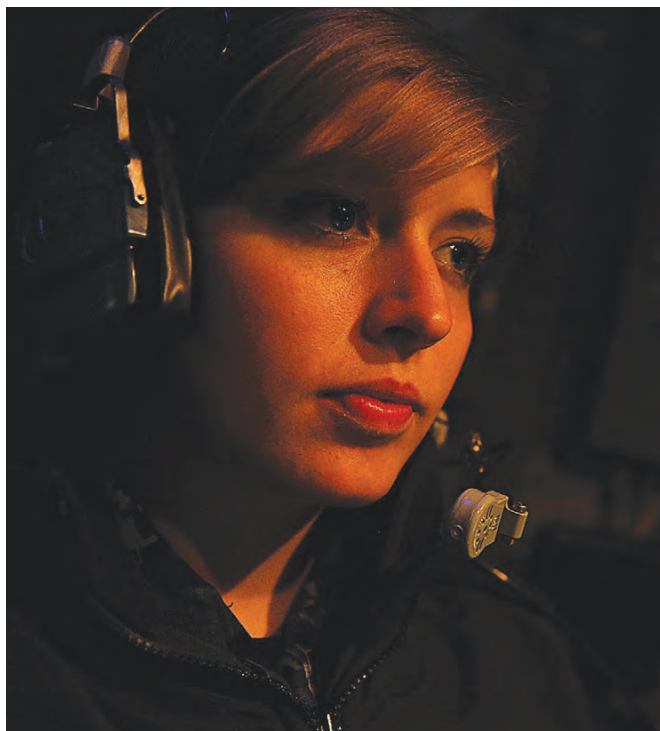
capacity, improve situational awareness and serve as a prerequisite for fielding network-enabled weapons and supporting the Navy’s integrated fires capability. Further, RTSO will provide the electromagnetic spectrum common operational picture, identify performance degradation resulting from intentional or unintentional electromagnetic interference, and provide recommended solutions for minimizing it.

Integrated Fires

Integrated fires is the coordination and synchronization of the full range of available fires—ISR, target identification, force dispatch to target, decision and order to attack the target, and, finally, application of specific weapons—to seize and hold the initiative in combat and limit an enemy’s ability to maneuver and act. It is the ability to produce kinetic/non-kinetic effects through networks, wire, spectrum, space, gun barrel or missile warhead. By coordinating the use of all available kinetic and non-kinetic capabilities, the Navy will be able to achieve all desired lethal and nonlethal effects in every warfare environment, including 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 systems to complement air, surface and subsurface systems.

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 warfare highlights long-term opportunities for fully integrating its information-



U.S. Navy photo by MC2 Brian G. Reynolds

A cryptologic technician mans the electronic warfare module aboard aircraft carrier USS Theodore Roosevelt (CVN 71), conducting training in preparation for future deployments.



related activities, resources, processes and capabilities to optimize warfighting effects and maintain decision superiority—the ability to make faster decisions than the enemy—in every area of warfare. Today’s current information-based capabilities require continual changes and improvements in a number of areas: assured command and control for our deployed forces regardless of threat environment; enhanced battlespace awareness to make decisions faster than our adversaries and improve understanding of the maritime operating environment; and fully integrated fires that expand warfighting options for both the Navy/Marine Corps team and joint commanders.

Information Operations

Information operations integrate information-related capabilities with other military operations to influence, disrupt, corrupt or seize 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 partnership 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 is no longer limited to an enabling role: Navy information in warfare amplifies weapons; Navy information as warfare delivers expanded space to maneuver new operational and strategic options, asymmetric operational effects and capability for dominant control of the battlespace. The Navy will employ information as a weapon to influence, deny, degrade, disrupt or destroy across the full range of maritime and naval missions.

Information operations are primarily a staff planning function at the operational and strategic levels of war and require identification and employment of information-related capabilities that will



U.S. Navy photo by MC3 Christopher A. Velociano

An operation specialist operates an advanced combat directional system console in the Combat Information Center aboard Wasp-class amphibious assault ship USS Essex (LHD 2).

most likely achieve the desired effects. All Naval Aviation assets provide commanders with responsive, powerful and scalable information-related capabilities necessary to achieve their missions.

Surface Warfare: Distributed Lethality

Surface warfare missions encompass many military operations, and Naval Aviation is critical to the ability to con-

trol the seas in multiple environments including anti-access/anti-denial and contested littorals. The introduction of the Surface Warfare Enterprise concept of distributed lethality is consistent with Naval Aviation’s efforts toward integrated surface warfare operations. The deployment of the first NIFC-CA CSG is only the beginning of a series of more capable CSG deployments over the term of this *Vision*. ▲



The sun rises over aircraft carrier USS John C. Stennis (CVN 74).

U.S. Navy photo by MC3 Andre T. Richard



Maintaining Capacity

For Naval Aviation, capacity has two distinct 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, Marine Expeditionary Forces 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 the number of aircraft within a squadron and the number of aircrews available to operate them. This directly affects the nation's ability to meet operational goals. For steady-state presence, operational capacity requirements are largely driven by two factors: providing a credible deterrent in the execution of national policy, and sustaining minimum levels of readiness for combat operations. For major combat operations, whatever is needed to succeed in combat is the determined operational capacity requirements.

In the following section, we outline Naval Aviation's current and projected operational capacity and provide the transformation roadmaps that show how we plan to build the capacity of the future. ▲



Transformation Roadmaps



The lead ship in the first new U.S. carrier class in more than four decades, PCU Gerald R. Ford (CVN 78), seen here from the bow in dry dock in Newport News, Va., is slated for delivery in 2016.

Aircraft Carriers

What clearly distinguishes the U.S. Navy from foreign navies is its nuclear-powered aircraft carrier (CVN) and 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. Each carrier strike group (CSG) possesses a versatile, deadly, and perhaps most importantly, independent, highly maneuverable strike force capable of engaging targets hundreds of miles out at sea or inland.

Aside from survivability, the mobility and operational flexibility of aircraft carriers provide a unique level of access that does not require host-nation support. Nuclear-powered aircraft carriers can rapidly respond to crises across the full spectrum of operations—from humanitarian assistance and disaster relief to full military conflict—and remain on station for months at a time, replenishing ordnance, spare parts, food, consumables and aircraft fuel at sea while simultaneously conducting air strikes and other critical missions. Through life-cycle planning and inherent design margin, aircraft carriers provide an upgradable combat capability that can incorporate installed systems improvements and accommodate future aircraft to remain highly viable and relevant throughout their 50-year service life.

Pre-commissioning unit *Gerald R. Ford* (CVN 78), the lead ship of the first new class of aircraft carriers in more than 40 years, will deliver in 2016. CVN 78's design includes a redesigned flight deck plan and numerous new technologies that significantly increase the ship's mission effectiveness, operational capacity and maintainability. Improved nuclear reactors support the ability to convert all auxiliary systems outside the main propulsion plant from steam to electric power. The new, more efficient reactors generate an electrical capacity nearly three times that of a

Photo courtesy of Huntington Ingalls Industries



U.S. Navy photo by Jennifer Neal



The island superstructure on PCU Gerald R. Ford (CVN 78) is smaller and farther aft than Nimitz-class carriers, increasing space for flight deck operations and aircraft maintenance.

Nimitz-class carrier, enabling a host of new technologies from the Electromagnetic Aircraft Launch System (EMALS) to advanced command-and-control systems, as well as electrical growth-margin to integrate and upgrade weapon systems of the future.

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 as the numerical replacement for USS *Nimitz* (CVN 68) in 2025. 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.

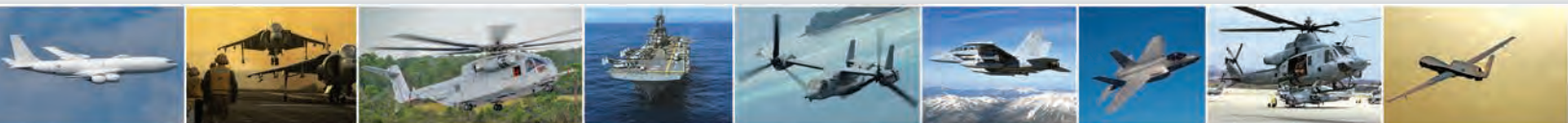
New class ship design and technology upgrades reduce manpower requirements for *Ford*-class ships by 500 to 900 Sailors compared to *Nimitz*-class carriers. These reductions, coupled with improved reliability and reduced maintenance requirements, will save about \$4 billion during the 50-year life of each *Ford*-class ship. Additionally, through a combination of improved process flow, ship lay-out and systems innovations, *Ford*-class aircraft carriers will support a 33 percent increase in sortie generation rate—or the number of aircraft capable of being launched and recovered in a given period of time. This *Ford*-class capability is a direct increase to the lethality available in the aircraft carrier’s operational capacity. 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*



U.S. Navy photo by MC1 Ronald Guiridge

Marines prepare to launch from the flight deck of amphibious assault ship USS Makin Island (LHD 8) during an off-load of personnel and equipment.

CAPACITY



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.

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 versatile options for joint force commanders tasked with conducting conventional or irregular operations in the littoral regions, or near-shore areas.

Resembling small aircraft carriers, amphibious assault ships are the largest amphibious warfare ships. In addition to launching aircraft, they deliver Marine expeditionary forces and their equipment onto land by way of small watercraft. These ships symbolize the warfighting relationship between the Navy and the Marine Corps, taking the fight to the enemy in "every clime and place." Large-deck amphibious assault ships were designed to embark, deploy and land Marine Corps and special operations forces by tilt-rotor and rotary-wing aircraft, landing craft and amphibious vehicles while providing close air support with rotary- and fixed-wing aircraft. These platforms are routinely deployed as one of the centerpieces of forward-deployed forces, which also include *San Antonio*-class, *Whidbey Island*-class and *Harpers Ferry*-class vessels with embarked Marine Air Ground Task Forces (MAGTFs). Together they provide a unique tool supporting all military operations.

LHD: Amphibious Assault Ship-Multi Purpose

The *Wasp*-class Landing Helicopter Dock (LHD) has an improved flight deck, elevator scheme and can accommodate a mix of 31 rotary- and fixed-wing aircraft. LHDs were the first amphibious vessels designed to carry the AV-8B *Harrier* 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. 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 LHD can function as a primary casualty receiving and treatment ship with six operating rooms and 600 hospital beds. All LHDs will be modified by fiscal year 2025 to operate 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 6: America-Class

The *America*-class general-purpose amphibious assault ships—formerly the LHA Replacement (LHA(R)) program—provide

U.S. Navy photo by MCI Michael McInabb

The amphibious assault ship USS America (LHA 6) travels through the U.S. Southern Command and U.S. 4th Fleet area of responsibility on her maiden transit. America is the first ship of its class, replacing the Tarawa-class of amphibious assault ships.



U.S. Navy photo by MC3 Liam Kennedy

An AH-1 Cobra helicopter from the "Greyhawks" of Marine Medium Tiltrotor Squadron (VMM) 161 (Reinforced) is given an operational test on the flight deck of the San Antonio-class amphibious transport dock ship USS Anchorage (LPD 23).

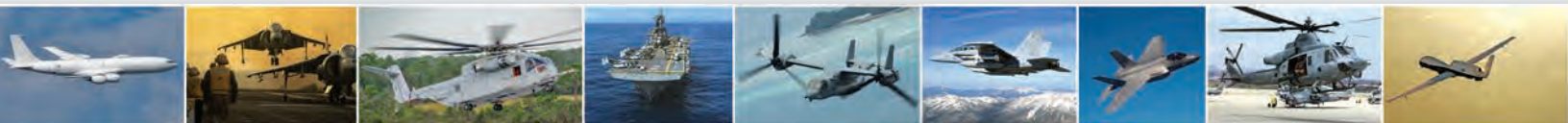
forward presence and power projection as elements of U.S. expeditionary strike groups. With elements of a Marine landing force, *America*-class ships can embark, deploy, control, support and operate helicopters for sustained periods. The *America*-class vessels will also support contingency response, 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, includes LHA 8's gas turbine propulsion plant and all-electric auxiliaries enhancements designed to employ the F-35B and MV-22B. *America* represents a significant increase in aviation lift, sustainment and maintenance capabilities for the future MAGTF aviation combat element and includes space for a Marine Expeditionary Unit (MEU), amphibious group, or small-scale joint task force staff; allows for new-generation Marine Corps aviation systems; and features substantial survivability upgrades.

LHA 8: LHA(R) Flight 1

LHA 8 is a modified version of the LHA 6, which restores the well deck with capacity for two landing craft air cushions. The reduced island increases the aircraft capacity of the flight deck while retaining the enhanced aviation support capabilities of LHA 6. LHA 8 will provide a functional replacement for the aging LHD 1 *Wasp*-class ships, which will begin to retire in fiscal year 2029. This technologically advanced amphibious ship will provide forward presence and power projection as an integral part of joint, interagency and multinational maritime expeditionary forces while exploiting fifth-generation aviation assets like the F-35 *Lightning II*.

LPD: San Antonio-Class

The amphibious transport dock (LPD) 17 class's mission is to operate offensively in a medium-density, multi-threat environment, as an integral member of an Expeditionary Strike Force



(ESF) or Expeditionary Strike Group (ESG). During amphibious assault operations, the LPD 17 class can almost simultaneously conduct combined and coordinated air- and surface-launched operations from over the horizon or close to the shoreline under restricted maneuvering conditions by coordinating landing and recovery of aircraft and landing craft.

LX(R) LSD Replacement

The new LX(R) amphibious assault ship replaces landing ship docks (LSD) 41/49 class ships for embarking, transporting, controlling, inserting, sustaining and extracting MAGTF elements and supporting forces by helicopters, landing craft and amphibious vehicles. The inherent capabilities in the LPD 17 derivative hull-form give LX(R) the necessary capabilities to conduct operations in an increasingly complex environment. As a 25,000-ton hull form, LX(R) will possess greater

troop and flight deck, fuel, medical and command-and-control capabilities than the smaller 16,000-ton LSD 41/49 class ships. The increased hull size will accommodate future changes to afloat MAGTF operational requirements. Balanced capabilities and capacities will enable LX(R) to operate across a broader range of military operations, while supporting operational objectives for independent Amphibious Ready Group/Marine Expeditionary Unit (ARG/MEU) and Amphibious Task Force/Marine Expeditionary Brigade (ATF/MEB) missions. Substantial increases in aviation capabilities offset the reduction in landing craft capacity, resulting in an equitable balance between ship aviation and surface interface capabilities. Eleven LX(R) amphibious warships with a 40-year service life will replace 12 LSD 41/49 class ships that will decommission between fiscal years 2027 and 2038, with the 11th LX(R) scheduled for delivery in fiscal year 2035. ▲



The Wasp-class amphibious assault ship USS Essex (LHD 2), the San Antonio-class transport dock ship USS Anchorage (LPD 23), and the Whidbey Island-class amphibious landing dock ship USS Rushmore (LSD 47) are underway while conducting an amphibious squadron and Marine expeditionary unit integration training exercise.

U.S. Navy photo by MC2 Christopher B. Janik



Photo courtesy of Lockheed Martin



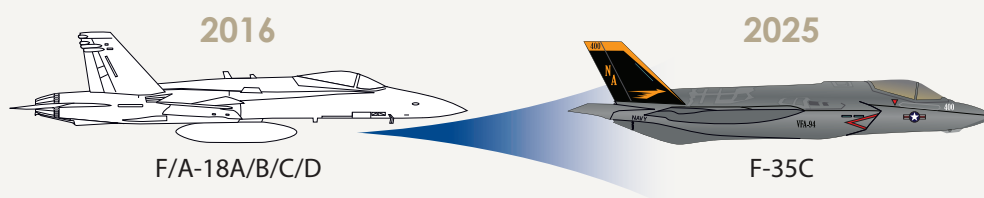
An F-35 Lightning II from the Pax River Integrated Test Force (ITF) assigned to the Air Test and Evaluation Squadron (VX) 23 launches from USS Dwight D. Eisenhower (CVN 69) while conducting the second phase of F-35C carrier suitability and integration developmental testing (DT-II).

Aircraft Navy Tactical [+ unmanned]

■ F-35C Lightning II

The F-35 program is building the fifth-generation strike fighter for the U.S. Navy, Marine Corps and Air Force. 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*, currently the Navy's premier strike fighter, and enhance the flexibility, power projection and strike capabilities of CVWs and joint task forces. The last F/A-18A/B/C/D aircraft used by operational Navy squadrons will retire in 2026.

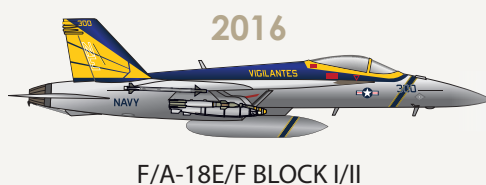


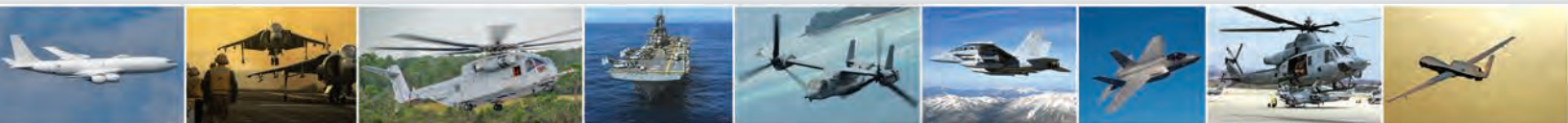
■ F/A-18E/F Super Hornet

A number of enhancements to the F/A-18E/F *Super Hornet* will sustain its lethality well into the future. Upgrades include critical growth capability, enhanced survivability and the ability to land on carriers while carrying more 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 serves as an aircraft refueling tanker for CVWs, 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 aircraft designation F/A-XX is in the concept development phase with the goal to replace the F/A-18E/F and EA-18G when they retire. The future air wing will be an integrated family of systems that combine for greater effectiveness than the sum of its parts. F/A-XX will complement the air wing's *Lightning II*, *Advanced Hawkeye* and rotary-wing aircraft. The ultimate concept must reliably and affordably incorporate future key technologies, including propulsion, sensors, networks and automation.

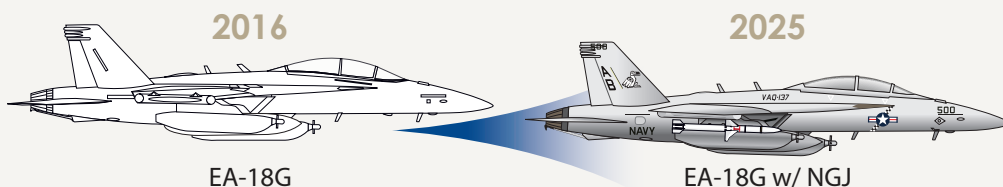




■ **EA-18G Growler**

The EA-18G *Growler* is the nation's foremost tactical airborne electronic attack platform. The *Growler* leverages the investments made in the F/A-18 *Super Hornet* and ALQ-218 receiver system, which was the heart of the EA-6B Improved Capability III program. The next evolution in electronic attack is the Next Generation Jammer (NGJ) initial operational capability (IOC) 2021, which replaces the ALQ-99 Tactical Jamming System. NGJ development is critical to the Navy's vision for the future of airborne electronic attack and is a vital component

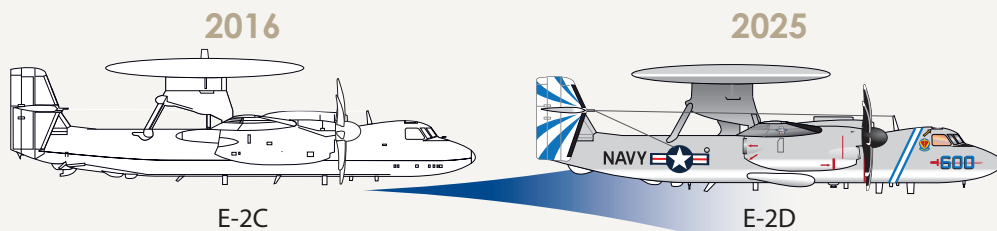
of DoD's plan to build a joint system-of-systems electronic attack capability. Future upgrades to the EA-18G include critical growth capability, enhanced survivability, avionics upgrades consistent with the F/A-18E/F Block II and advanced sensor integration, all of which will keep the *Growler* at the forefront of electromagnetic maneuver warfare. Like the *Super Hornet*, future avionics upgrades will enable network-centric operations, enhancing situational awareness and the transfer of data to command-and-control nodes.



■ **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 CVWs, 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, cooperative engagement capability (CEC), and a communication suite connects CVWs and CSGs 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 *Advanced Hawkeye*, with an electronically scanned array radar providing a two-generation leap in technology. The E-2D's Space Time Adaptive Processing (STAP) radar detects and tracks emerging air/cruise missile threats in high-clutter environments, making it the central pillar of CSG's integrated air and missile defense. The E-2D completed flight testing and is in full rate production. The E-2D achieved IOC in October 2014 and the first E-2D squadron deployed in 2015. The last E-2C is expected to be out of the fleet by 2025.



■ **Multi-Mission Unmanned-XX**

The Navy plans to field an unmanned carrier-based capability in the mid-2020s that will deliver an organic refueling and high-endurance intelligence, surveillance and reconnaissance (ISR) capability. It will significantly extend the carrier

air wing mission effectiveness range, mitigate the current carrier strike group organic ISR shortfall and future CVW-tanker gap, and preserve F/A-18E/F *Super Hornet* fatigue life expectancy.





Marine Corps Tactical [+ unmanned]

■ F-35B/C Lightning II

The F-35B Short Take Off/Vertical Landing (STOVL) and F-35C Carrier Variant (CV) support Marine Corps expeditionary operations by providing flexible basing options that allow tactical aircraft to be more responsive and freely maneuver across military operations. The F-35B provides a unique joint warfighting capability that allows us to work from L-class ships concurrently with operations at main bases, austere forward-deployed sites and aircraft carriers. This distribution of forces lets us conduct sea- and land-based operations. Both the B and C variants are network-enabled and digitally interoperable aircraft ready for full-spectrum operations. The first operational F-35B squadron, Marine Fighter Attack Squadron (VMFA) 121 “Green Knights,” started flight operations in early 2013, declared IOC in summer 2015, and is preparing for the first deployment in fall 2017. The F-35B training squadron, Marine Fighter Attack Training Squadron (VMFAT) 501 “Warlords,” continues to train instructors and pilots.

In summer 2016, VMFA-211 “The Wake Island Avengers” will standup as the second F-35B squadron in Yuma, Arizona, increasing the F-35B’s ability to support operational requirements. The Marine Corps also has five F-35C aircraft with the Navy Fighter Attack Training Squadron (VFA) 101.

■ MAGTF Electronic Warfare System-of-Systems

The Marine Corps’ comprehensive plan to address electronic warfare (EW) requirements after the EA-6B *Prowler* sundown in fiscal year 2019 is Marine Air Ground Task Force (MAGTF)



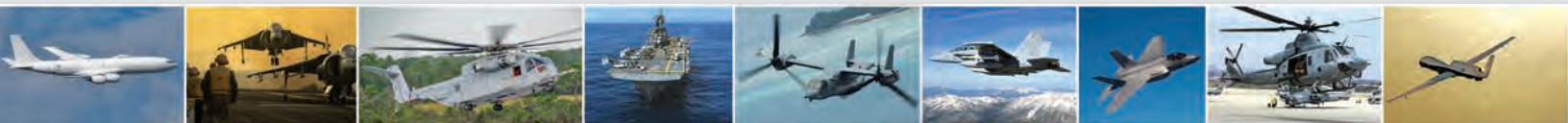
An EA-6B Prowler, assigned to “Banshees” of Marine Tactical Electronic Warfare Squadron One (VMAQ-1), conducts a mission over the Persian Gulf.

U.S. Air Force photo by Tech. Sgt. Rob Tabor



EW, which uses modern technologies and integrates multiple aviation platforms (unmanned, fixed-wing and rotary-wing assets), payloads, ground-based EW nodes, and cyber effects to provide commanders with an organic and persistent EW capability. The MAGTF EW concept transitions the Marine Corps from focusing on low-density/high-demand EW to a distributed, networked, platform-agnostic approach. MAGTF EW will complement joint EW assets in support of ground forces and fifth-generation aircraft flying against sophisticated integrated air defense systems.

CAPACITY



Navy Helicopters [+ unmanned]

■ MH-60R/S *Seahawk*

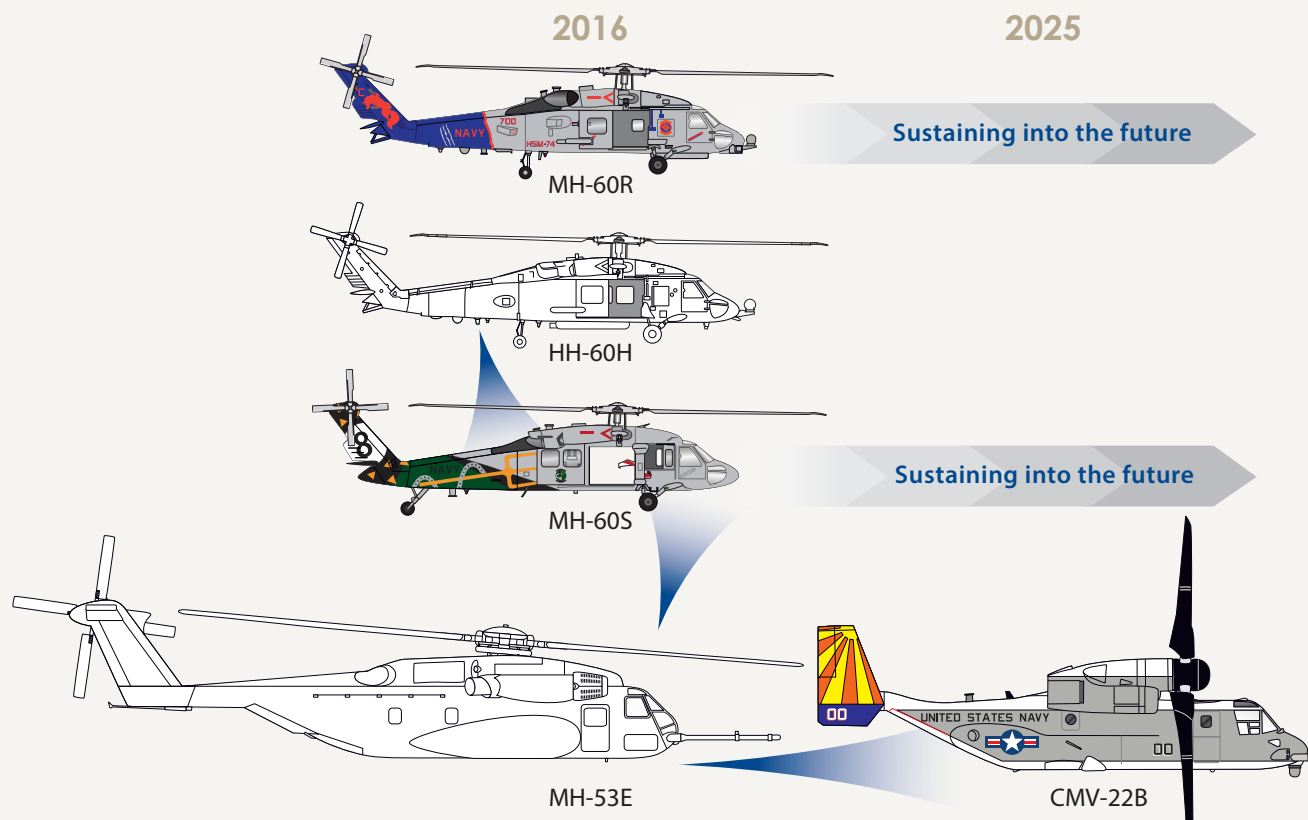
The MH-60R and MH-60S *Seahawk* multi-mission combat helicopters are the pillars of the Navy's 21st-century rotary air wing. These two variants share 85 percent common components to facilitate maintenance and logistics support. CVW squadrons deploy on aircraft carriers and strike group escort ships under the leadership of CVW commanders. Expeditionary squadrons deploy as detachments embarked on amphibious assault ships (LHAs/LHDs), surface combatants and logistics vessels.

The MH-60R conducts surface and subsurface warfare with datalinks Hawk Link and 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. Critical to ensuring maritime dominance, the MH-60R is the only airborne anti-submarine warfare asset within strike groups and on independently deploying warships.

The MH-60S conducts surface and mine countermeasures warfare, as well as combat search and rescue, logistics and Special Operations Forces support with the Link-16 datalink, advanced forward-looking infrared system, airborne laser mine detecting and mine neutralization systems, precision air-to-ground missiles, 20-mm fixed forward firing gun, and crew-served machine guns. The MH-60S deploys with CSGs, ARGs and littoral combat ships.

MH-XX is the recapitalization effort of the maritime capabilities currently provided by the MH-60S and MH-60R.



■ Future Vertical Onboard Delivery Aircraft

The MH-53E *Sea Dragon* continues to conduct airborne mine countermeasures, vertical on-board delivery and heavy-lift missions in the fleet. Current plans include transitioning the MH-53E airborne mine countermeasures capability to the Littoral Combat Ship Mine Countermeasures Mission Package, which includes the MH-60S and various unmanned airborne, surface and subsurface vehicles. Although the Navy has not yet identified a replacement for the MH-53E's heavy lift capability, the CMV-22B will provide interim vertical onboard delivery mission support beginning in 2021 as an adjunct capability.

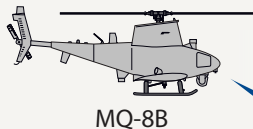


■ **MQ-8 Fire Scout**

The MQ-8 *Fire Scout* System was designed to operate from suitably equipped air-capable ships. Currently employed as an organic intelligence, surveillance and reconnaissance (ISR) asset, it employs an electro-optical/infrared system, automatic identification system and other modular mission payloads. Two air vehicles, MQ-8B or MQ-8C, fill gaps in surface and mine countermeasures mission sets with a range of up to 115 nautical miles, an endurance of five to eight hours and the synergistic capability of simultaneously operating two airframes (MH-60 and MQ-8) from a single spot ship.

The MQ-8 *Fire Scout* System is maintained by members of a composite MQ-8/MH-60 aviation detachment and fielded from expeditionary helicopter squadrons Helicopter Maritime Strike (HSM) and Helicopter Sea Combat (HSC). In November 2014, USS *Fort Worth* (LCS 3) deployed with a single MQ-8B and a single MH-60R to provide airborne support for surface warfare missions. This marked the first time a composite detachment

2016



MQ-8B

2025

Sustaining until phased out



MQ-8C

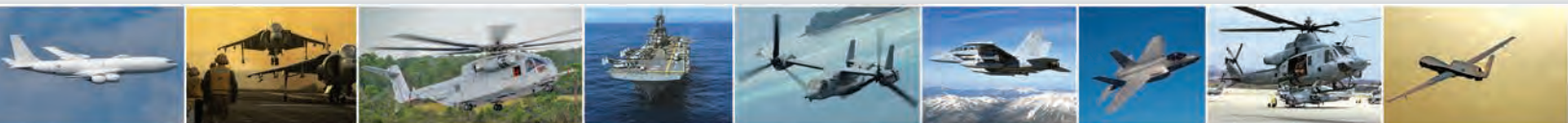
operationally deployed from a littoral combat ship (LCS). The MQ-8B will continue to support LCS until the MQ-8C completes its test and evaluation and then joins the MQ-8B in support of the LCS Program of Record. The MQ-8C will provide increased airborne endurance and payload carrying capacity over the MQ-8B while providing the same ISR capabilities. The MQ-8C completed its first flight in October 2013 and is forecasted to achieve initial operational capability in late fiscal year 2018.



Photo courtesy of Northrop Grumman

An MQ-8C Fire Scout conducts a developmental test flight from Naval Base Ventura County at Point Mugu, Calif. Since its first flight in October 2013, the Navy's new, larger unmanned helicopter has completed 327 flights and logged over 450 hours. The system has met all of its performance objectives that allow it to begin operational test later this year.

CAPACITY



Marine Corps Assault Support Aircraft [+ unmanned]

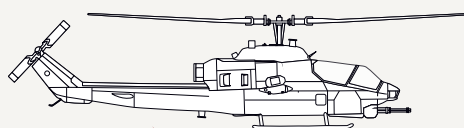
■ AH-1Z *Viper* and UH-1Y *Venom*

The AH-1Z and UH-1Y, which are in full rate production, are equipped with a four-bladed rotor system and vastly increased payload (25 percent and 76 percent, respectively), range (125 percent and more than 200 percent, respectively), and time-on-station from an increased internal fuel capacity of 32 percent and 90 percent, respectively. Additionally, they are 10,000-hour airframes with integrated avionics, glass cockpits and significantly improved sensors and helmet-mounted displays. 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), resulting in reduced support requirements, training, logistical footprint and total ownership costs. The

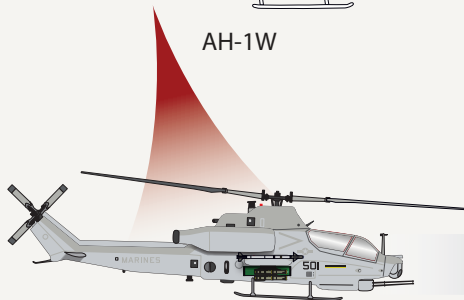
UH-1Y supported combat operations in Operation Enduring Freedom from October 2009 to May 2014. The West Coast MEUs now deploy with *Viper* and *Venom*. The East Coast and 31st MEUs are sourced with the UH-1Y. In the third quarter fiscal year 2016, the 31st MEU and unit deployment program squadron will operate the UH-1Y and the AH-1Z. Individually, the *Viper* and *Venom* are already arguably the best attack and utility helicopters in the world, but their benefits increase even further when operated together. Recent deployments proved that the increased speed, range and payloads of both aircraft significantly extended the reach and influence of expeditionary units.

2016

2025



AH-1W



AH-1Z

Sustaining into the future



UH-1Y

Sustaining into the future



An AH-1Z *Viper* helicopter from the "Greyhawks" of Marine Medium Tiltrotor Squadron (VMM) 161 (Reinforced) sits on the flight deck of San Antonio-class amphibious transport dock ship USS Anchorage (LPD 23).

U.S. Navy, photo by MC2 Liam Kennedy



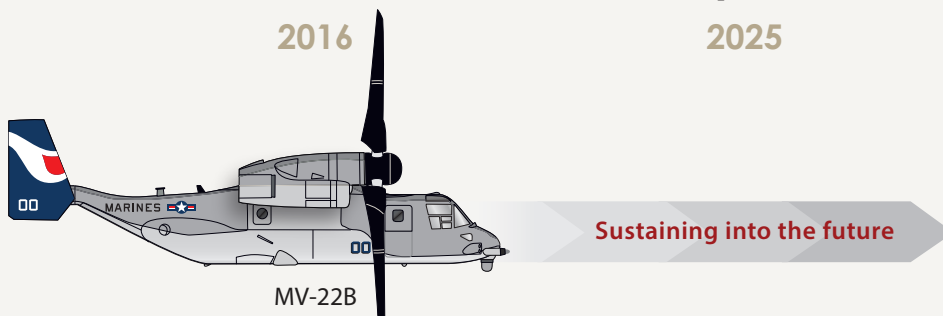
U.S. Navy photo by MC2 Christopher Lindahl

A CH-53E Super Stallion helicopter from Marine Heavy Helicopter Squadron (HMH) 463 launches from the flight deck of amphibious transport dock ship USS Anchorage (LPD 23) during deck landing qualifications.

■ MV-22B Osprey

The MV-22B Osprey tilt rotor, vertical/short takeoff and landing aircraft provides the U.S. Marine Corps with medium-lift assault support capability. It is used to transport troops, equipment and supplies from ships and land bases for combat assault. Continu-

ously deployed since 2007, the MV-22B has twice the speed, six times the range, and three times the payload compared to the CH-46E and some CH-53D assault support helicopters that it replaces. The MV-22 has the lowest Class A Flight Mishap rate of

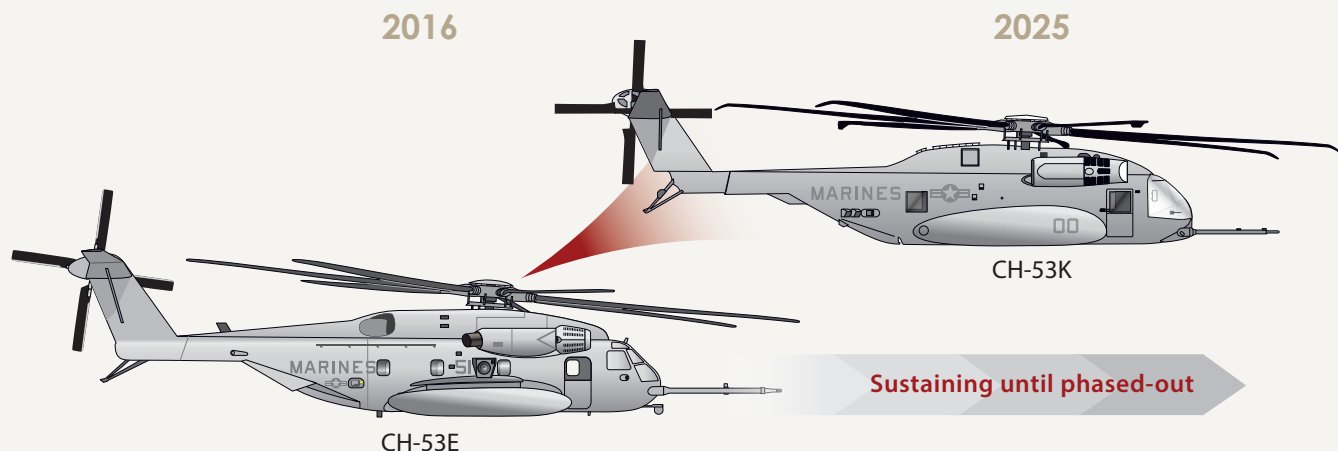


all Marine Corps rotorcraft through the first 200,000 flight hours. Currently, the MV-22B supports combat operations in the Central Command area of responsibility and is deployed with two Special Purpose MAGTFs and all three MEUs. The transition to the MV-22B Osprey is on track to be completed by end of fiscal year 2019.

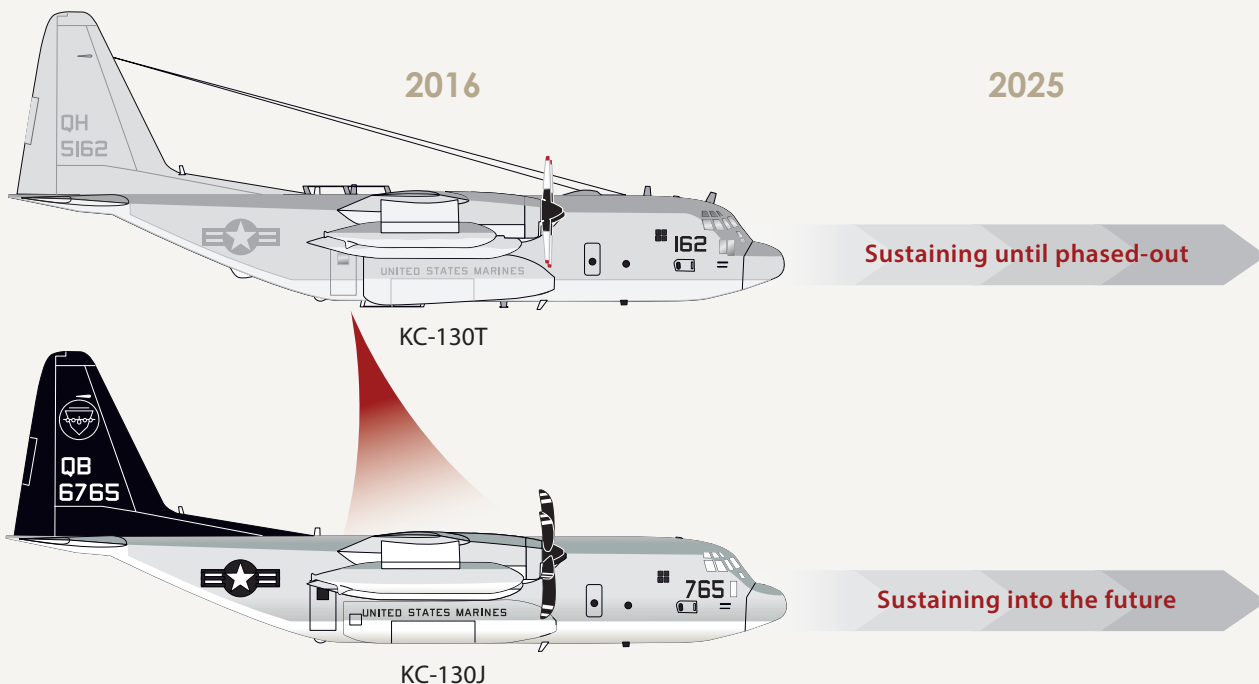
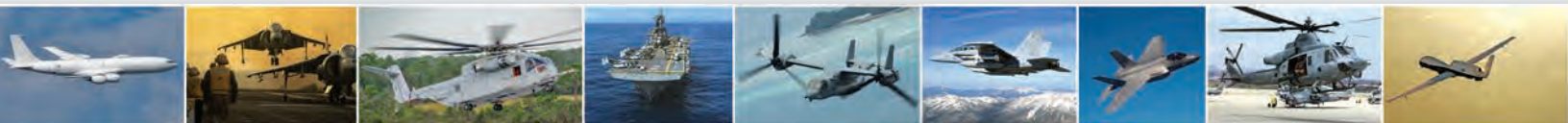
■ CH-53K King Stallion

Approaching 32 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 growing and will be critical to successful land- and sea-based operations. Able to transport 27,000 pounds of external cargo to a range of 110 nautical miles under high-altitude and hot weather conditions, the CH-53K can carry nearly triple that of the CH-53E while fitting within the same shipboard footprint.

The CH-53K was designed with the maintainer in mind, and improved technology and upgrades will be more reliable, decrease recurring operating costs, and improve aircraft efficiency and operational effectiveness. In addition, the aircraft will better endure enemy threats while enhancing force protection for both air crew members and passengers, broadening what heavy-lift operational support means to Marine and joint commanders. The CH-53E is expected to remain part of the fleet until 2030.



CAPACITY



■ **KC-130J Hercules**

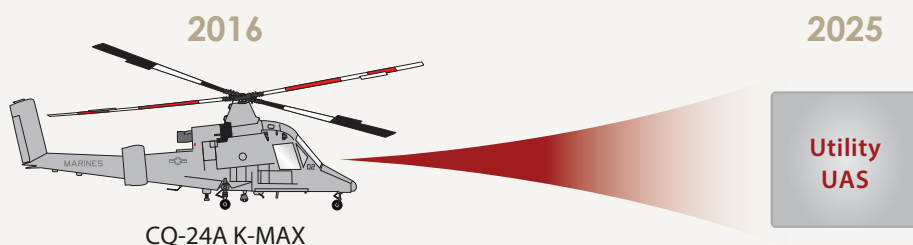
The KC-130J *Hercules* is a multi-mission tactical tanker and assault support aircraft well suited to the needs of forward-deployed MAGTF. As the replacement for active-component KC-130F/R aircraft, the KC-130J provides increased speed by 10 percent, range by 10 percent and survivability, and an improved refueling system and a digital cockpit with heads-up display. The KC-130J is also replacing reserve squadron KC-130Ts, bringing commonality and interoperability to active and Reserve Marine Corps

components. This Reserve transition began in 2014 and reserve component IOC was declared in August 2015. The full operational capability date for the two Reserve KC-130 squadrons is planned for fiscal year 2025. With the addition of *Harvest HAWK* (Hercules Airborne Weapons Kit), the KC-130J can be quickly reconfigured to provide precise targeting and launch onboard weapons with precision accuracy. The KC-130T is expected to be out of the fleet by 2025.

■ **CQ-24A K-MAX, Utility UAS**

K-MAX provides a low-risk, persistent capability for dispersed forces that will mitigate the requirement for manned ground vehicles to resupply in remote locations. K-MAX will also augment manned aviation assault support assets and airdrop methods when weather, terrain and enemy threats increase the risk involved. 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.” Marines deployed with the K-MAX helicopter from 2012-2014. While

deployed in support of Operation Enduring Freedom, K-MAX flew more than 2,100 hours and carried 4.5 million pounds of cargo. The Marines plan to move the system out to Marine Corps Air Station, Yuma, Arizona, and operate it under Marine Operational Test and Evaluation Squadron (VMX) 22 in fiscal year 2016 to continue to refine and develop the capability in close coordination with MAWTS-1. The potential exists for leveraging K-MAX’s 4,500-pound payload capacity by increasing capabilities through a spiral upgrade approach. This includes



a high definition electro-optical/infrared/IR laser designator sensor ball and high bandwidth satellite communication datalink to a shipboard weapons capability. The Marine Corps envisions the highly reliable, cost effective K-MAX evolving to a multi-mission utility UAS.



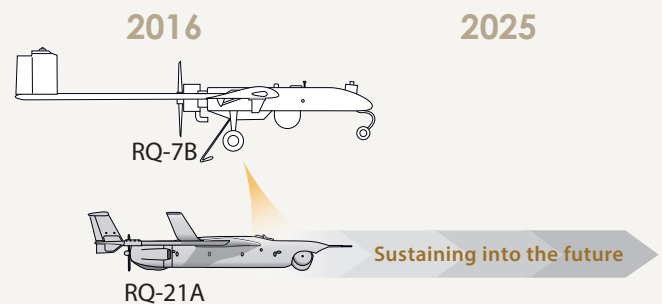
Marine Corps Unmanned Systems

■ Marine Corps Tactical Unmanned Aircraft Systems

The RQ-7B *Shadow* is an expeditionary, multi-mission tactical unmanned system that provides 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, flying more than 36,000 combat hours in support of Marine Corps, joint and allied operations. Four Marine UAS squadrons now operate 12 *Shadow* systems, which are currently upgrading to the Tactical Common Data Link v2 configuration, a transition from analog to digital technology that provides a fully encrypted datalink. *Shadow* will be replaced in the next decade by Tern. The future Marine Corps UAS will provide a highly capable expeditionary system with strike, ISR and EW capabilities.

■ RQ-21A *Blackjack*

The RQ-21A *Blackjack* will provide a tactical ISR capability for amphibious assault ships, Marine Corps units ranging from expeditionary units to regiments and Navy special warfare operators. When fully loaded, the RQ-21A is a 135-pound unmanned aerial vehicle with a 35-pound payload consisting of an electro-optical/infrared sensor ball, infrared pointer, automatic identification system receiver and communications relay. A synthetic aperture radar/ground moving target indicator, EW



payload, wide-area motion imagery, laser designator, and weapons can also be added to the payload bay. *Blackjack* is a good complement to MEUs because it is a multi-mission platform that is also shipboard capable. *Blackjack* will also operate from land-based forward operating bases. The system is characterized by its runway independence and multi-sensor and EW capabilities. With its multiple payloads, *Blackjack* will be able to meet the MAGTF commander's shifting priorities. Compatibility aboard L-class amphibious carriers is key to realizing the full capability of RQ-21A. Currently, ship installs are ongoing for LPD-17 class. Marine Aviation is pursuing *Blackjack* compatibility for all ARG ships to support the MAGTF commander both afloat and ashore. The RQ-21A completed initial operations test and evaluation in December 2014. IOC is scheduled for first quarter fiscal year 2016 with the first operational deployment on a MEU in summer 2016.

■ Family of Small Unmanned Aircraft Systems—Battalion/Company Level of Support

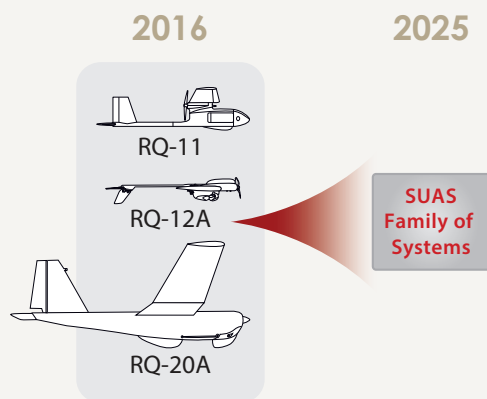
The family of Small Unmanned Aircraft Systems (SUAS) provides a capable, responsive and cost-effective organic airborne intelligence, surveillance, reconnaissance, (AISR)/kinetic capability to the operating force maneuver units at the team/company/battalion level.

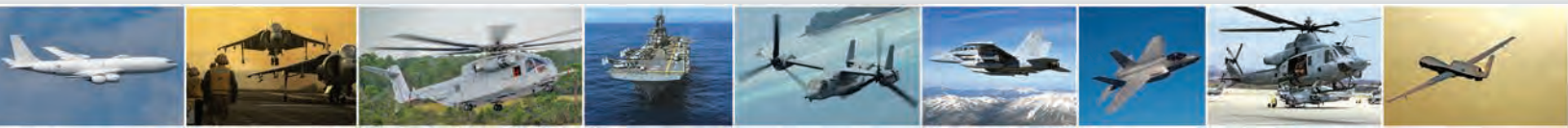
RQ-11B *Raven*: The *Raven* is hand-launched and rucksack-

packable, with an endurance of up to two hours and a range of 10 kilometers, providing maneuver units with a unique ISR capability. Equipped with color electro-optical, black-and-white low light, and infrared payloads, the *Raven* provides small units with day/night full-motion video capability via a laptop-based ground control station.

RQ-12A *Wasp*: The *Wasp* SUAS is organic to the infantry battalion, but employed by the company's platoons and squads. The *Wasp* is a small, portable, lightweight, rugged SUAS designed to be used by small tactical units for frontline day and night reconnaissance and surveillance. The system provides day and night full-motion video capability via a laptop-based ground control station. The system is waterproof and can be recovered on land or water.

RQ-20A *Puma*: The *Puma* is a hand-launched reconnaissance and surveillance SUAS that transmits live video images and location information to the ground control station and remote video terminals. The *Puma* uses a digital datalink and a gimbaled electro-optical/infrared/laser illumination payload. Its capabilities include laser marking, signals intelligence and communications relay. The system is waterproof and can be recovered on land or water.

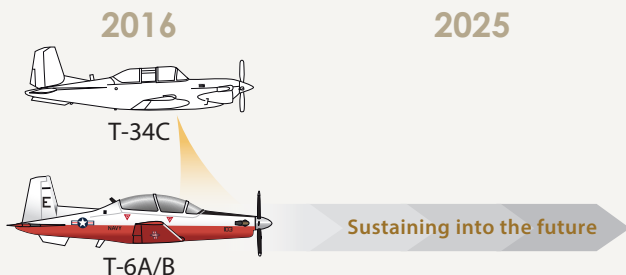




Pilots climb into a new T-6B Texan II for its first flight from Naval Air Station Corpus Christi, Texas.



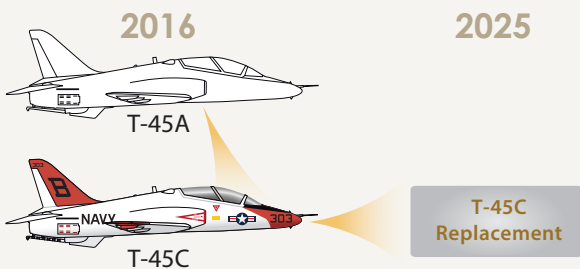
U.S. Navy, photo by Richard Stewart



Navy and Marine Corps Training Aircraft

■ T-6A/B Texan II

Navy and Marine Corps will complete the transition to the T-6B as the primary pilot training aircraft with final delivery in 2016. The T-6A will continue to be used for naval flight officer training. The T-34C is no longer used for pilot training, but some aircraft will remain for range clearance and spotters through 2026.



■ T-45C Goshawk

The T-45 *Goshawk* is the single advanced strike trainer for tail hook pilots and naval flight officers. The T-45A aircraft is being 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. In addition, the virtual mission training program is employed for strike NFO training, integrating a virtual multi-mode radar into the T-45C to enable basic tactical skills training, preparing students for the advanced tactical jet aircraft of the future. Work to identify a replacement for the T-45C will begin by 2020 as this aircraft reaches the end of its service life, which will depend on future service life extension plan.

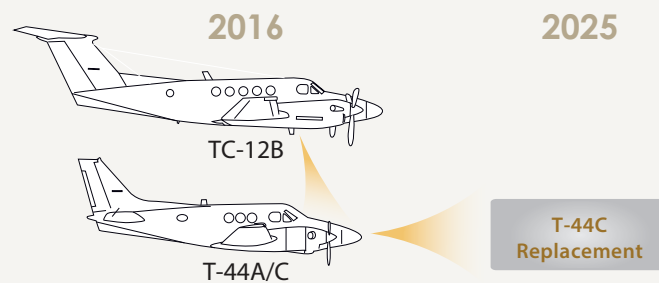


A T-45C Goshawk training aircraft attached to Training Air Wing (CTW) 1 lands on the flight deck of aircraft carrier USS Dwight D. Eisenhower (CVN 69).

U.S. Navy photo by MCS Anderson W. Branch

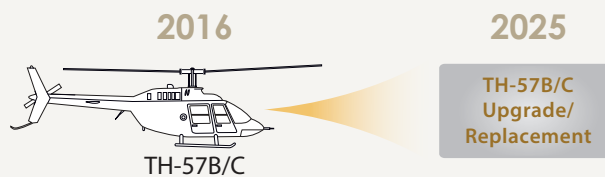
■ T-44 Replacement

The T-44A *Pegasus* and TC-12B *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. NOTE: T-44C is slated to be replaced by 2025, but efforts will likely be undertaken to extend airframe life.

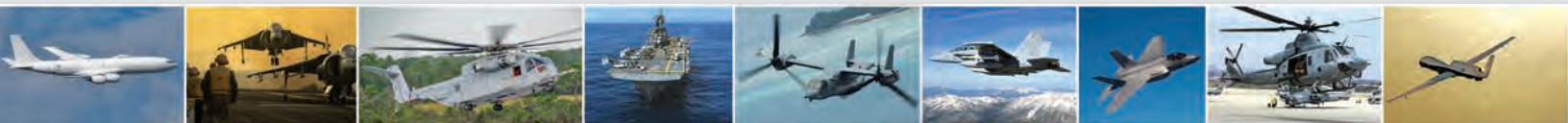


■ TH-57B/C *Sea Ranger*

The TH-57B/C *Sea Ranger* will continue as Naval Aviation's single rotary-wing and tilt-rotor aircraft training platform for 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. Options are being explored for a follow on aircraft to close the gaps identified in a capabilities-based assessment done by Office of the Chief of Naval Operations Air Warfare Division (OPNAV N98). NOTE: Like the T-44C, the TH-57 is slated to be gone by 2025. Efforts are underway for future Advance Helicopter Training.



CAPACITY



Navy Maritime Patrol and Reconnaissance Aircraft [+ unmanned]

■ P-8A Poseidon

The P-8A *Poseidon* continues to gradually replace the P-3C *Orion*. At the end of 2015, five fleet squadrons transitioned to P-8A, with transition of all 12 active component squadrons scheduled for completion in 2019. Beginning with the first P-8A deployment in December 2013, the fleet has maintained a continuous P-8A presence in the Western Pacific. The *Poseidon* delivers robust anti-submarine and anti-surface warfare capabilities in the littorals and maritime domain while also providing 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 rapid 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* generates a force with the lethality and capacity needed to support strike groups and the joint battle force in any maritime environment.

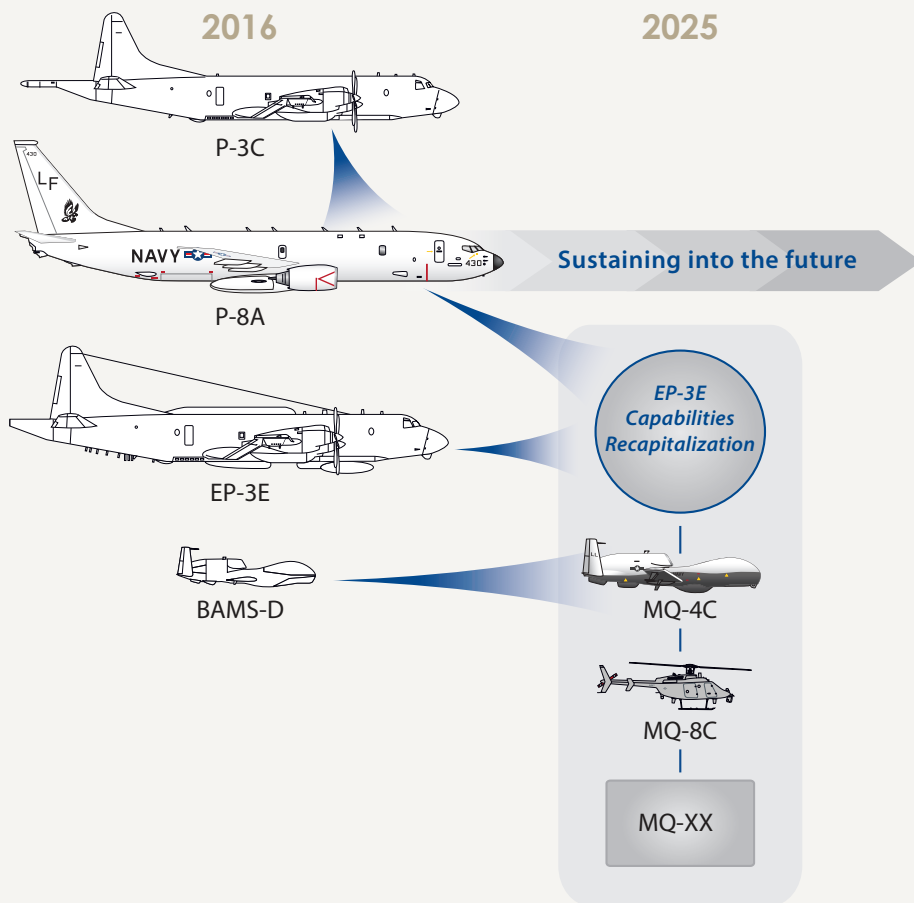
■ EP-3E Capabilities Recapitalization

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 MQ-4C *Triton*, MQ-8 *Fire Scout*, MQ-XX and P-8A *Poseidon*. 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.

■ MQ-4C Triton

The MQ-4C *Triton* will conduct maritime ISR missions and complement the P-8A *Poseidon* on maritime patrol. Land-based and forward deployed, the *Triton's* long range and networked sensors provide persistent maritime ISR and basic communications relay capabilities from five operational orbits worldwide in support of fleet commanders and coalition and joint forces. The MQ-4C is undergoing developmental flight testing with IOC planned for 2018, and full operational capability early next decade. *Triton* Multi-Intelligence will enter the fleet in 2020, adding 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 to develop the *Triton's* maritime patrol and reconnaissance capabilities.





Navy-Unique Fleet-Essential Aircraft

Navy-unique fleet-essential airlift assets are operational aircraft that provide combatant commanders and Navy component commanders with short-notice, fast-response and intra-theater logistics support. These aircraft deliver medium- and heavy-lift capabilities in support of the fleet and provide reliable and flexible airborne transportation for the wartime movement of personnel and heavy cargo. They can move essential fleet personnel and cargo to mobile sea-based forces worldwide quickly and on demand.

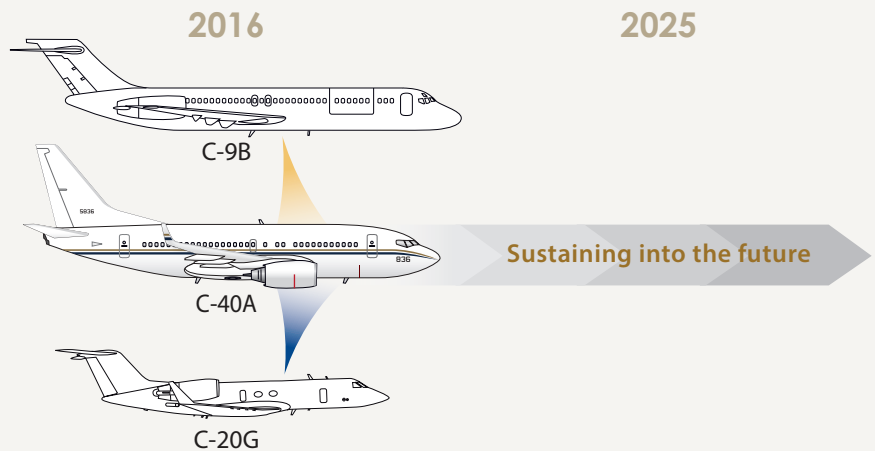


U.S. Navy photo by Lt. Westley Holzapfel

A naval air crewman assigned to the "Globemasters" of Fleet Logistics Support Squadron (VR) 56, signals to a C-40A Clipper during a run-up onboard Naval Air Station Oceana in Virginia Beach, Va.

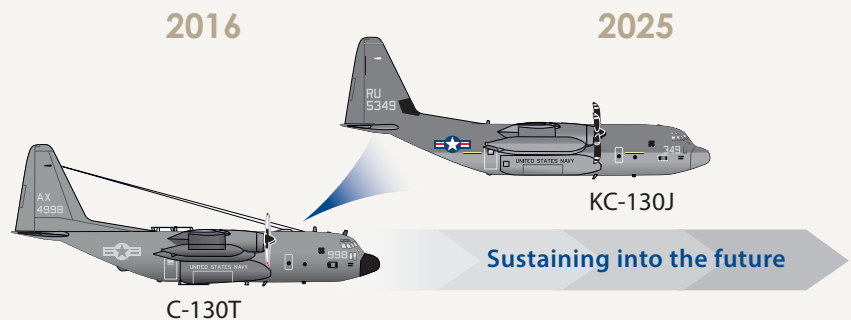
■ C-40A Clipper

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 now serving in the capacity of the Navy's retired C-9B *Skytrain* and will assume the role of the C-20G *Gulfstream* fleet. The venerable C-9B has served the fleet well for years, but with an average age of more than 35 years, its maintenance costs are escalating. Communications Navigation Surveillance/Air Traffic Management System upgrades (a future Federal Aviation Administration mandate) have extended the service life of the C-20G until its departure from the fleet, which will begin transition to the C-40A in 2021. The Marine Corps will replace the C-9B with the C-40A.

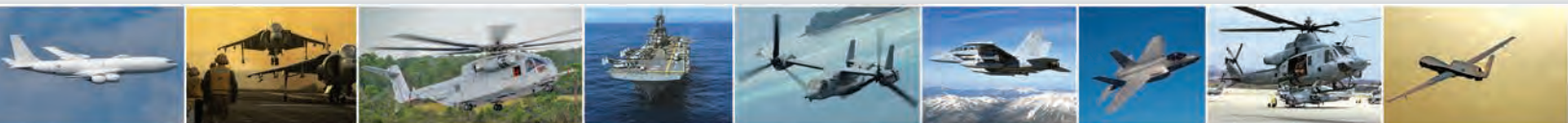


■ KC-130J Hercules

The KC-130J *Hercules* 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) over 1,800 nautical miles at 350 knots. The KC-130J is projected for delivery to the Navy between 2020 and 2030.



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U.S. Navy photo by MC2 John Philip Wagner Jr.

A C-2A Greyhound from the Providers of Fleet Logistics Support Squadron (VRC) 30 taxis to a catapult on the flight deck of Nimitz-class aircraft carrier USS Carl Vinson (CVN 70).

Future Carrier Onboard Delivery Aircraft

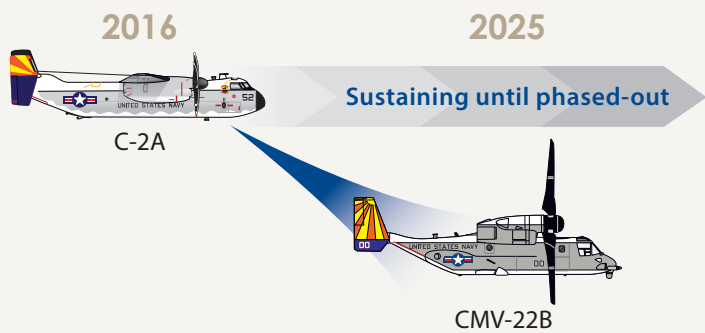
■ C-2A Greyhound

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 CSGs 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, special operations and distinguished visitor transport support. The aircraft has undergone several modifications and a service life extension program that extended the *Greyhound's* service life through 2028.

■ Navy V-22 Osprey

The Navy V-22 *Osprey* will replace the C-2A as the Navy's medium-lift/long-range sea-based logistics support aircraft. The C-2A has served in the carrier onboard delivery role for more than 50 years, but with an average aircraft age of more than 27 years, its maintenance costs continue to rise. The Navy's variant of the *Osprey*, designated CMV-22B, will have an increased unrefueled operational range of 1,150 nautical miles, enhancing the flexibility and span of carrier strike groups. The cargo bay can be reconfigurable to accommodate passengers, litter patients or time-critical cargo, and with its roll-on/roll-off capabilities, the *Osprey* will expedite the transport of palletized payloads between forward logistics sites and the sea base. The Navy will begin to transition to the CMV-22B in 2020.



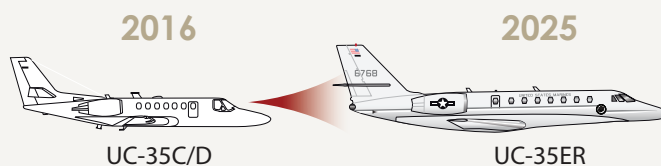


Operational Support Airlift

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.

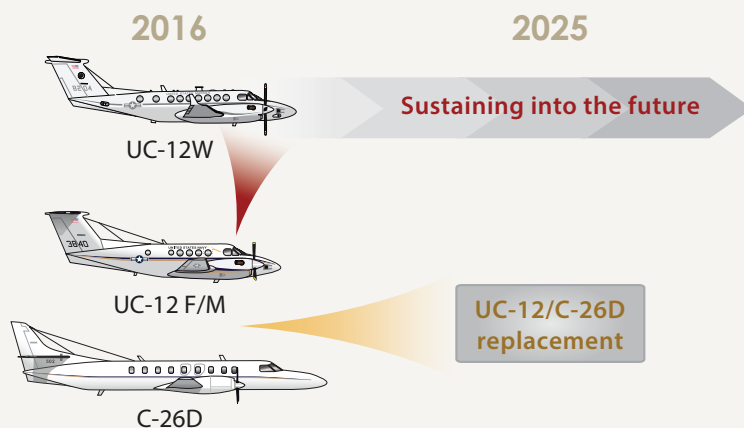
■ UC-35ER Extended-Range Replacement

The UC-35C/D provides high-speed transport for forward-deployed Marine forces that have time-sensitive passengers 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.



■ U-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 and 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.

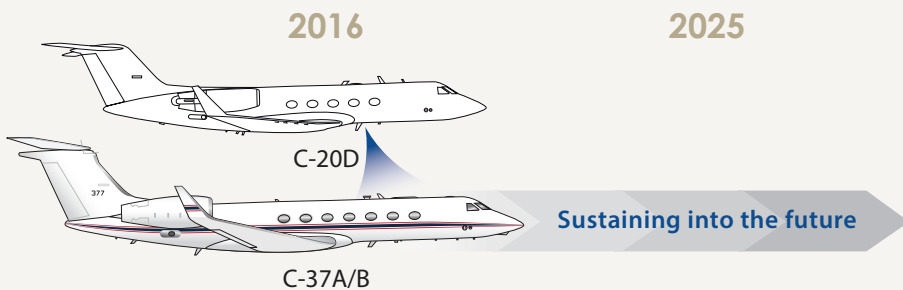


■ C-12/C-26D Replacement

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 Marine Corps 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.

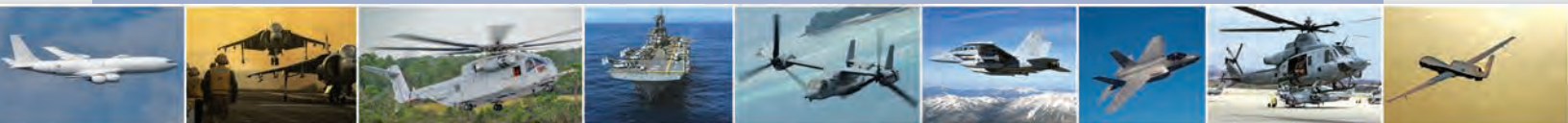


■ C-20G Replacement

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.



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U.S. Air Force photo by Josh Plueger

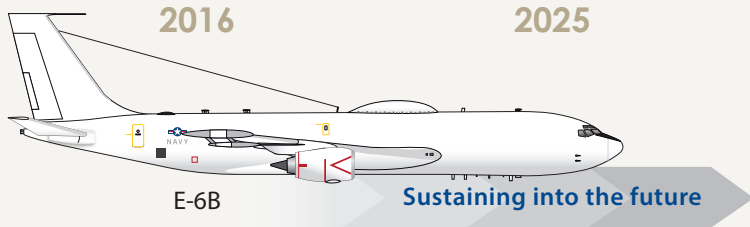
A U.S. Navy E-6B Mercury strategic airborne command post aircraft takes flight from Offutt Air Force Base, Neb. The E-6B aircraft communicates with ballistic missile submarines while also expanding the mission to include ground missiles and nuclear-armed strategic bombers.

Specialized Naval Aircraft

■ **E-6B Mercury**

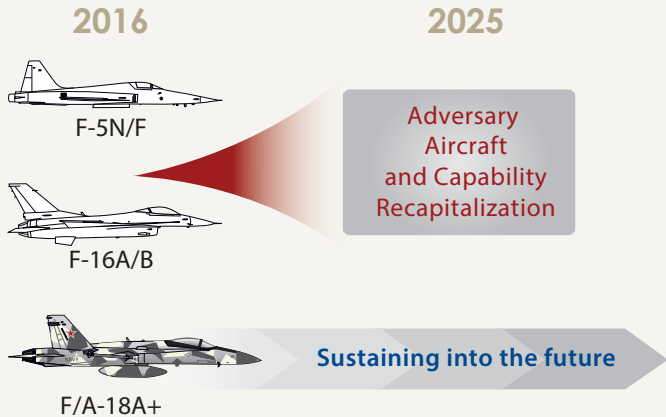
The Navy’s E-6B *Mercury* aircraft, derived from the Boeing 707, provides U.S. Strategic Command with the command, control and communications capability needed to manage strategic forces. Designed to support a strong and flexible nuclear deterrent posture well into the 21st century, the E-6B is capable

of performing low-frequency emergency communications, the U.S. Strategic Command airborne command post mission, and the airborne launch control of ground-based intercontinental ballistic missiles. Through Block I program and Internet protocol bandwidth expansion improvements, 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. Future 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+ *Hornets*. The Naval Strike Air Warfare Center in Fallon, Nevada, 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 timeframe.





U.S. Navy photo by MC1 Joseph R. Vincent



An F/A-18A Hornet attached to the "Fighting Omars" of Fighter Squadron Composite (VFC) 12 taxis at Naval Air Station Fallon, Nev.

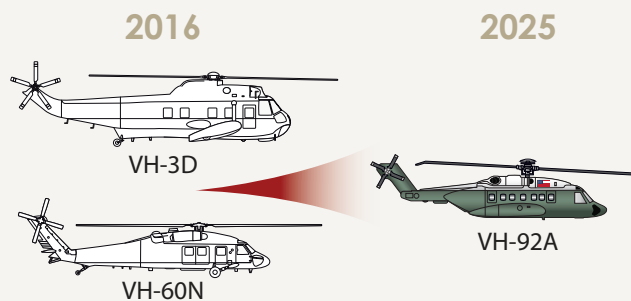
Artist's rendering courtesy of Sikorsky



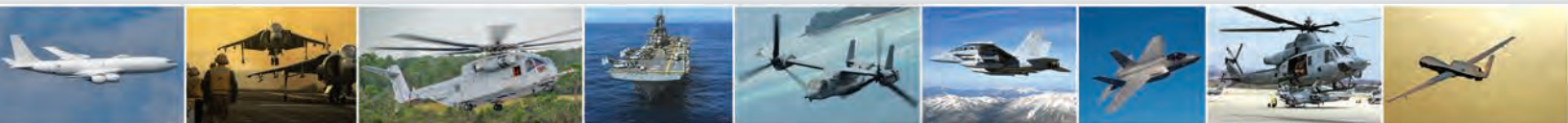
An artist's rendering of the future VH-92A presidential helicopter, which is under development and will replace the existing VH-3D and VH-60N helicopters.

■ 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 (VH-92) will provide mobile, command-and-control-hardened VIP transportation and a host of integrated systems necessary to meet current and future presidential transport mission requirements.



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Weapons

Air-to-Air

■ AIM-9X Block II/II+ *Sidewinder*

The AIM-9X *Sidewinder* is the latest of the *Sidewinder* family of short range air-to-air missiles. The AIM-9X system features a high off-boresight, focal-plane-array seeker mounted on a highly maneuverable airframe with greatly improved infrared counter-countermeasure capabilities. The AIM-9X incorporates many AIM-9M legacy components (rocket motor, warhead and active optical target detector), but its performance exceeds the legacy *Sidewinder*. Unlike previous AIM-9 models, the AIM-9X can even be used against targets on the ground.

The AIM-9X Block II is the most advanced short range air-to-air missile in the U.S. inventory, capable of using its data-link, thrust vectoring maneuverability, and advanced imaging infrared seeker to hit targets behind the launching fighter. The AIM-9X Block II achieved IOC in March 2015 and the full rate production milestone in August 2015. AIM-9X Block II+ will be fielded in 2019 to support the F-35B/C.

Sidewinder is managed as a joint program between the Air Force and Navy, with the Navy taking the lead.

■ AIM-120D Advanced Medium Range Air-to-Air Missile

The AIM-120 Advanced Medium Range Air-to-Air Missile (AMRAAM) is the beyond-visual-range follow-on to the AIM-7 *Sparrow* missile. The AIM-120 can be launched day or night in any weather. It is faster, smaller and lighter than AIM-7 and has improved capabilities against low-altitude targets. It incorporates active radar with an inertial reference unit and micro-computer system, which makes the missile less dependent upon the aircraft's fire-control system. AMRAAM's software can be updated as threats evolve. The AMRAAM is employed on Air Force F-15, F-16 and F-22 aircraft and Navy and Marine Corps F/A-18, EA-18G, AV-8B and F-35B aircraft.



U.S. Navy photo

An AIM-9X Block II *Sidewinder*, a within and beyond visual range air-intercept missile, is loaded on an Air Force F-15 Eagle shortly before take-off from Eglin Air Force Base, Valparaiso, Fla.

It will also be employed on Air Force F-35A and Navy F-35C when they become operational.

The latest variant, AIM-120D, incorporates a conformant antenna with an enhanced two-way data link, GPS for improved navigation, better high off-boresight capability, enhanced kinematics and increased weapons effectiveness.

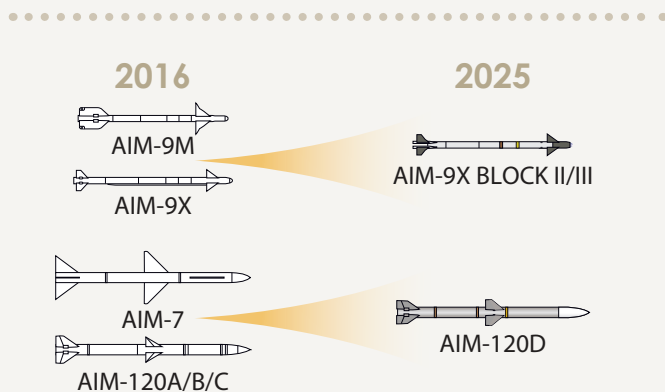
AMRAAM is managed as a joint program between the Air Force and Navy. The Air Force is the lead service headed by the Senior Materiel Leader, Air Dominance Division, Air Force Life Cycle Management Center, Air Force Materiel Command, Eglin Air Force Base, Florida.

■ AIM-7 *Sparrow*

The AIM-7 *Sparrow* is an all-aspect, highly maneuverable, all-weather, medium-range, semi-active air-to-air missile. AIM-7 has a high-explosive warhead and demonstrated capability against a variety of threats including low radar-cross-section air vehicles, low-to-high altitude, in electronic counter-measure, multi-target and high-clutter environments. The launching aircraft illuminates the target with radio frequency energy. The seeker acquires the reflected energy and guides the missile using proportional navigation.

AIM-7 is currently planned to remain in service in the U.S. Navy through 2018 and is being replaced by the AIM-120D Advanced Medium Range Air-to-Air Missile (AMRAAM).

AIR-TO-AIR





U.S. Navy photo by MC3 Jason Kolonow

Sailors assigned to Patrol Squadron (VP) 30 load an AGM-84K SLAM-ER missile on a P-8A Poseidon aircraft in preparation for a conventional weapons technical proficiency inspection.

AIM-7 is operated by the Navy and Marine Corps as well as many international partners. The missile also exists in a ship-based intercept version where it is designated RIM-7 *Seasparrow*.

Long-Range Standoff

■ Standoff Land Attack Missile Expanded Range

The Standoff Land Attack Missile-Expanded Response (SLAM-ER) is a long-range weapon system designed to provide day, night and adverse weather precision strike capability against a broad range of high value land and sea targets. SLAM-ER provides surgical strike capability against high-value, fixed land targets, ships in port or at sea. Most significant weapons characteristics include a highly accurate, GPS-aided guidance system; an imaging infrared seeker and two-way data link with the AWW-13 Advanced Data Link pod for Man-In-The-Loop (MITL) control; improved missile aerodynamic performance characteristics that allow both long-range and flexible terminal attack profiles; an ordnance section with good penetrating power and lethality; and a user-friendly interface for both MITL control and mission planning.

Designed for deployment from carrier-based and land-based aircraft, SLAM-ER missiles are launched from a distance and fly a subsonic flight, navigating by GPS/Inertial Navigation System (GPS/INS). The missile can also receive in-flight target position updates on its mid-course flight to enable effective engagement

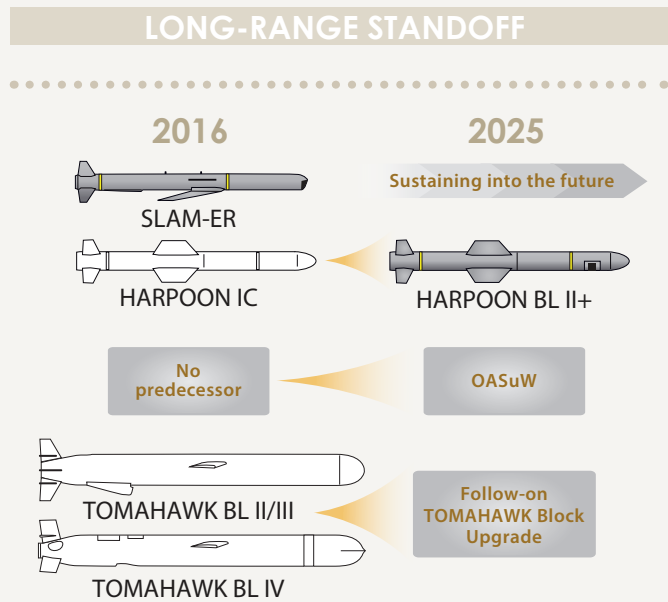
of moving targets such as surface ships at sea. Several miles from the target, during the terminal phase of the flight, the SLAM-ER activates its imaging infrared sensor. Images are processed by the Automatic Target Acquisition (ATA) processor, which enables the weapon system operator or pilot to designate a specific aim-point to be attacked or verify the decision taken by the missile. To provide faster, clear image transfer over narrow-band datalink, the system uses a special stop motion aim-point update, which can be viewed on the F/A-18 multifunction display console in the launch aircraft or any other aircraft equipped with compatible datalink, to provide near-real time battle damage assessment.

■ Harpoon

The A/U/RGM-84 *Harpoon* is an all-weather, over-the-horizon, anti-ship missile system that provides the Navy with a common missile for air and ship launches. The weapon system uses midcourse guidance with a radar seeker to attack surface ships. Its active radar guidance, low-level, sea-skimming cruise trajectory, terminal mode sea-skim or pop-up maneuvers and warhead design ensure high survivability and effectiveness. Harpoon can be launched from surface ships, submarines, shore batteries or aircraft.

The newest missile iteration scheduled to be introduced into the fleet during the fourth quarter of 2017 is the *Harpoon* Block II+. It will employ with a network-enabled data link interface that provides in-flight updates, improved target selectivity, an abort option and enhanced resistance to electronic countermeasures. These improvements along with a new GPS guidance kit will increase reliability and survivability of the weapon.

When fielded to the fleet, *Harpoon* Block II+ will join the Joint Standoff Weapon C-1 as the Navy's only two air-to-ground network-enabled weapons.





An F/A-18 carries a model of the Long Range Anti-Ship Missile (LRASM) during a flight test over Patuxent River, Md., completing the first phase of inflight loads testing for the weapon program.

US Navy Photo by Liz Wolter

■ Long Range Anti-Ship Missile

The Long Range Anti-Ship Missile (LRASM) is a near-term solution for the Offensive Anti-Surface Warfare (OASuW) air-launch capability gap that will provide flexible, long-range, anti-surface capability against high-threat maritime targets. The weapon relies less on ISR platforms, network links and GPS navigation in electronic warfare environments. Semi-autonomous guidance algorithms will allow it to use less-precise target cueing data to pinpoint specific targets in the contested domain. The LRASM Deployment Office is developing the Lockheed Martin-built LRASM as the OASuW Increment 1 solution. When operational, LRASM will provide the first increment of a next-generation of offensive anti-surface weapon to the warfighter, and will play a significant role in ensuring military access to the ocean and littorals due to its enhanced ability to discriminate and conduct tactical engagements from extended ranges. Early operational capability for the LRASM is slated for 2018 on the Air Force B-1 *Lancer* and 2019 on the Navy F/A-18E/F *Super Hornet*.

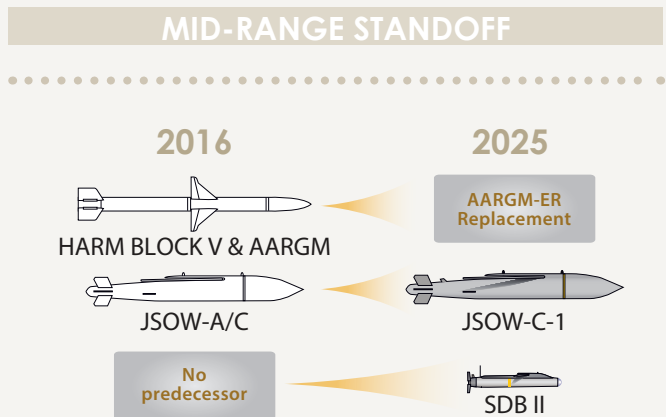
■ Follow-on Tomahawk Block Upgrade

The *Tomahawk* land-attack missile is a long-range, subsonic cruise missile used for deep land-attack warfare launched from Navy surface ships and U.S. and U.K. 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 support special operations forces with a precise weapon system. Potential future capabilities for the *Tomahawk* Block IV include improvements to the warhead, such as the Joint Multiple Effects Warhead System, which allows *Tomahawk* to be fully compliant with the *Tomahawk* Operational Requirements Document for all target sets, and a maritime interdiction multi-mission capability, or 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.

Midrange Standoff

■ AGM-88E Advanced Anti-Radiation Guided Missile

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 suppression of enemy air defense systems 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/GPS; and a weapon impact assessment transmitter to aid and cue the battle damage assessment process. In the near term, an integrated broadcast service receiver for network-centric connectivity reception of off-board targeting information will be added to the configuration. AARGM correlates multiple sensors and geospecific capabilities to locate and attack both stationary and moving targets with precision while countering enemy tactics designed to defeat anti-radiation missiles. The follow-on version of the missile—AARGM-ER (Extended Range)—will add a new motor section to increase range, and has a target IOC in 2023 on F/A-18E/F and EA-18G.

■ **AGM-154 Joint Standoff Weapon**

The Joint Standoff Weapon (JSOW) is a joint family of armaments capable of attacking targets at increased standoff distances. The weapon uses inertial navigation and GPS 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. 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. It includes GPS/ inertial navigation system guidance, terminal infrared seeker and a Link 16 weapon data link. When fielded in 2016, the JSOW C-1 will introduce a stand-off range of 70 nautical miles. The system will maintain JSOW-C functionality to be effective against targets during day or night and 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



U.S. Navy photo by MCS Veronica Mammitta

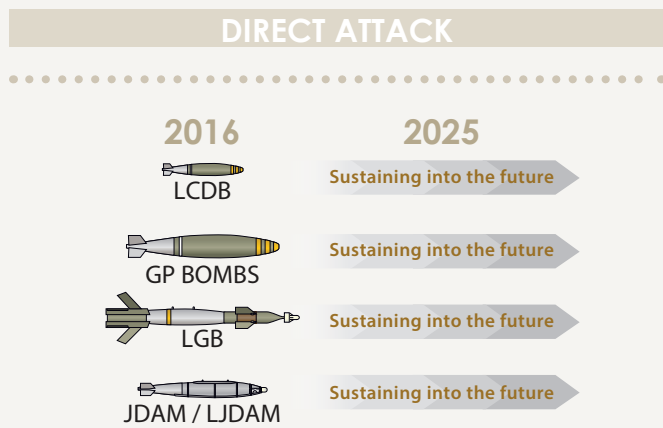
Marines assigned to the 13th Marine Expeditionary Unit attach a Joint Direct Attack Munition (JDAM) to an AV-8B Harrier II.

attack mobile targets at standoff ranges in all types of weather. This 250-pound-class weapon will feature a GPS/inertial navigation system to guide to the vicinity of a moving target. The weapon has the capability to receive updated target coordinates midflight via two-way datalink (Link-16 or UHF) communications. Using these network options, SDB II allows airborne or ground controllers the ability to send in-flight target updates and the capability to abort a mission post-release. SDB II integration is planned for the F-35B/C *Lightning II* and the F/A-18E/F *Super Hornet*.

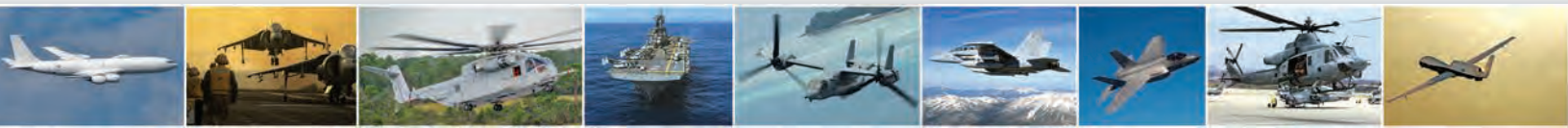
Direct Attack

■ **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



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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 (GP) 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.

■ **GBU-54 Laser Joint Direct Attack Munition**

The Laser Joint Direct Attack Munition (JDAM) converts the GPS/inertial navigation system-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.

■ **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 Marine Corps AH-1Z is the only Navy threshold platform with a JAGM Increment I capability and is expected to reach IOC 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**

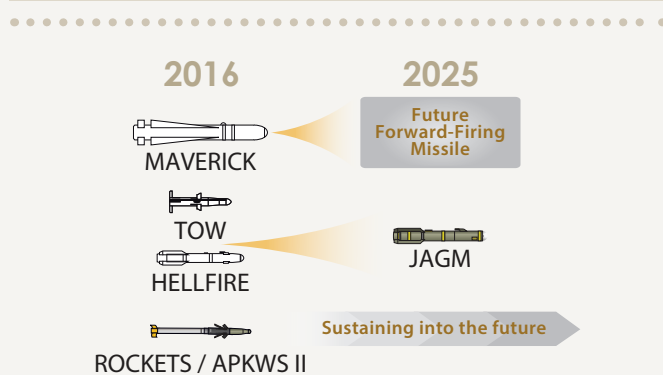
The Advanced Precision Kill Weapon System II (APKWS II) provides precision guidance to the existing Hydra 70 rocket system by placing a laser-guided seeker on existing rocket motors and warheads. APKWS II provides an excellent low-cost, midrange weapon that is well-suited to urban environments. Accurate 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 1.5 to 5 kilometers.

Torpedoes

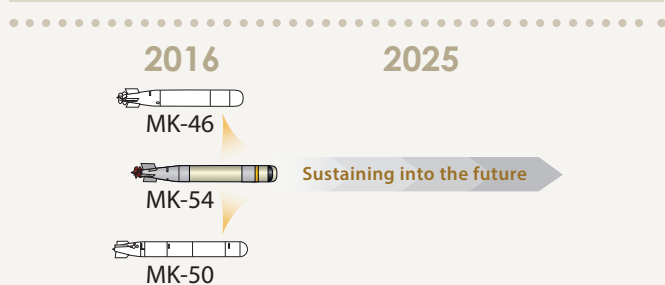
■ **MK-54 Lightweight Torpedo**

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 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. ▲

DIRECT ATTACK



TORPEDOES





Summary

Naval Aviation is a warfighting force that continues to evolve to out-pace threats and ensure continued combat success into the future.

To ensure our ability to deter and defeat future potential adversaries, we will continue to innovate and invest in platforms, payloads, sensors and communications required to secure access, project power and enable sea control in the future fight. In doing so, we will focus on making smart investments that support Naval Aviation's ability to deliver required warfighting readiness while preserving the capability and sustainability of the future force.

This evolution is deliberate and will span the full spectrum of Naval Aviation missions and activity. New warfighting capabilities and positive changes will be evident in the significant expansion of the live, virtual and constructive training capabilities; the fielding of the F-35B/C *Lightning II* aircraft with its low observable stealth technology and integrated sensor suite; the introduction of MAGIC CARPET to improve pilot proficiency in the carrier landing environment; the quantifiable advances in supply chain management to boost material readiness; the design and commission of the transformational *Gerald R. Ford*-class carrier; the enterprise's ability to leverage additive manufacturing and digital thread to enable faster maintenance and repairs; the flexibility and

"I believe naval assets offer not only the best value to preserve our national security by advancing our global interests, but also the best value in supporting our own and the world's economy to help meet our fiscal challenges."

—The Honorable Ray Mabus, *Secretary of the Navy*





“Our Sailors and Marines are proud members of the world’s finest maritime aviation team, and are committed to making this vision for our future Naval Aviation force a reality.”

growing capability of our unmanned family of systems; and the keen focus on innovative ways to train and manage the talent resident in the people of Naval Aviation. These are examples of evolving capability, but they are not all-inclusive. Naval Aviation will continue to move forward with transitioning nearly every legacy aircraft to a more technologically advanced platform while maintaining a system-of-systems approach. Naval Aviation will also make certain warfighters are equipped with next-generation weapons and will develop weapons with modular components that can be swapped out and tailored for specific targets.

Naval Aviation is an in-demand force that serves essential, unique roles around the globe, often serving as the nation’s first line of defense far from our shores. Naval Aviation will continue to ensure its current and future readiness to respond when the nation calls. Whether operating from sea or land—from aircraft carriers, austere forward deployed locations or main base facilities—our forces will be trained, equipped and ready to achieve mission success.

This vision for Naval Aviation, consistent with “The Vision for Naval Aviation 2025,” reinforces our commitment to the three pillars of capability, readiness and capacity. In uncertain and increasingly contested environments, Naval Aviation will continue to provide a persistent, flexible, forward-deployed force that will remain a stabilizing presence around the world. Our Sailors and Marines are proud members of the world’s finest maritime aviation team, and are committed to making this vision for our future Naval Aviation force a reality. ▲



U.S. Navy photo by MCS Eric S. Powell

Carriers USS Abraham Lincoln (CVN 72) and USS John C. Stennis (CVN 74) underway in the Arabian Sea.



Acknowledgments

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