# Naval Aviation Enterprise
# 2012 - 2013

# Science & Technology Objectives


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July 2012

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NAVAL AVIATION
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# NAVAL AVIATION ENTERPRISE SCIENCE AND TECHNOLOGY OBJECTIVES

July 2012

To deliver future force capabilities to meet current and emerging needs, the Naval Aviation Enterprise conducts research across a broad spectrum of areas to provide the best technologies / solutions to the warfighter. The Science and Technology (S&T) portfolio attempts to balance near-term needs without sacrificing basic research or the pursuit of long-term revolutionary technologies tied to future capabilities. The distribution and balance among these efforts is critical to ensure that NAE S&T investments are healthy, relevant and address documented needs and requirements.

To that end, the NAE has identified Science and Technology Objectives (STOs) that align to Fleet needs and established requirements. These objectives represent the goals of the NAE S&T program and are used as the baseline, a framework for identifying, aligning, and synchronizing S&T efforts throughout the enterprise. They represent a broad strategy for the future, while retaining sufficient flexibility to allow the S&T community to meet near term challenges. The NAE S&T community, in collaboration with the Office of Naval Research (ONR), the Department of Defense, other federal government, academia and industry, will continue to evolve detailed technology development strategies and conduct the necessary research to address these objectives.

The Department of Defense is facing a period of reduced resources. The NAE will be facing additional pressures to balance the operation and maintenance of existing platforms with the pursuit of new capabilities. The NAE S&T community is well positioned to assist with providing options for NAE leadership to address these issues. ONR's establishment of the Sea Based Aviation (SBA) National Naval Responsibility (NNR) in 2011 acknowledged SBA as a critical area, and will ensure continued focus on necessary S&T talent and resources to meet future aviation needs specific to the Navy and Marine Corps. Implementation of the Naval Innovative Science and Engineering (NISE) program (Section 219) will ensure that the vitality of Naval Warfare Centers' in-house laboratories is maintained by supporting the development, maturation, and transition / support of beneficial innovative high-risk RDT&E solutions / technologies while developing the workforce.

This document is the biennial update and replaces the April 2010 NAE S&T Objectives. This is the fourth edition of the NAE STOs, and the changes contained within this document incorporate lessons learned and insights gained through STO roadmapping exercises and the establishment of Naval Air Warfare Center (NAWC) Core Capabilities. It expands the need for Reduced Total Ownership Cost and emphasizes increased energy efficiency.

The NAE Chief Technology Officer (CTO) and the entire NAE S&T team continue to support the warfighters and to ensure that the S&T investments made on the NAE's behalf provide the best options to meet their needs.

DR. JAMES B. SHEEHY
NAE Chief Technology Officer

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# INTRODUCTION

Throughout its hundred year history Naval Aviation has been a leader in innovation. Science and technology (S&T) has not only revolutionized the way conflicts have been contested, but has transformed the means and methods by which warfighting forces are trained, maintained, and sustained. Through innovation, Naval Aviation has gone from a tactical capability in its infancy to the critical instrument of national security that it is today. However, there are challenges that must be overcome in order for Naval Aviation to remain a formidable, modern force for the next century.

## Naval Aviation Enterprise (NAE) Science and Technology

The role of S&T is not to avoid risk, but to understand the technical options and accept scientifically feasible risk to respond to current critical needs while maintaining a robust S&T foundation to discover, develop and demonstrate high-payoff technologies to ensure the NAE maintains technological advantage over potential adversaries. A balanced portfolio of near, mid, and long-term research is essential to meeting the needs of the current and emerging warfighter while delivering future force capabilities.

The NAE, in partnership with the Office of Naval Research (ONR), conducts scientific research in pursuit of revolutionary capabilities for U.S. Naval air forces, translates successful research into militarily useful technologies, matures S&T to improve U.S. Naval capabilities, and demonstrate technologies in relevant operational environments to facilitate transition to programs of record. The goal of the NAE S&T portfolio is to provide solutions that will enable the future force while simultaneously seizing opportunities to enhance current readiness and mitigate risk.

## NAE Chief Technology Officer (CTO)

The CTO acts as the primary S&T advisor to NAE leadership. The CTO office is comprised of a group of technically competent, highly qualified professionals. The CTO organization leads an S&T Integrated Product Team that includes command Chief Technologists and other respected members of the NAE S&T community, who provide support to S&T projects/programs and maintain organizational knowledge of S&T portfolios and investments.

The CTO supports the Assistant Secretary of the Navy for Research, Development and Acquisition (ASN RDA), OPNAV and USMC Resource Sponsors, ONR, and other Naval Enterprise CTOs in planning and executing an effective Naval S&T portfolio. The CTO maintains strong ties to the warfighting community, and fosters relationships with potential technology providers and sponsors, including industry, academia, and other services.

In addition to the publication of NAE S&T Objectives (STOs), the CTO produces NAE S&T road maps, publishes Naval Air System Command (NAVAIR) core capabilities documents, and provides quality control for NAE S&T proposals, ensuring that the NAE S&T community is developing relevant technology that address warfighting needs.

## NAE S&T Portfolio

The CTO provides strategic investment planning and oversight of the Naval Aviation Enterprise's S&T project portfolio, ensuring that all current and future S&T initiatives align with established NAE objectives. The current NAE S&T program is comprised of over 900 active projects with an annual investment of approximately $340M. All projects are captured within the NAE S&T web-based relational database, which provides comprehensive project information for the entire portfolio.

The CTO annually reviews every active project to ensure proper alignment with NAE STOs and conducts the S&T portfolio assessment that examines the health, transitions and project alignment to NAE critical gaps. Health assessments of all executing projects are conducted, using standard criteria to evaluate technical approach, resources, alignment and project management. Project transitions are reviewed through a structured process that identifies deliverables and stakeholders.

Whereas the NAE S&T database tracks projects in execution, the road mapping process decomposes capability needs for each STO into technology investment areas, identifies and maps current workload/projects, and identifies where future work may be required to achieve/meet a required capability.

Proposed research, transition and workforce development projects (e.g., advanced degrees, strategic rotations, capability development) are evaluated for alignment to STOs and core capabilities, technical merit, relevance and benefit to Naval Aviation, laboratory benefit, capability impact, technical risk and associated payoff, investigator ability and quality of planning, and level of advocacy within a technical competency, program and resource sponsor.

Executing projects are evaluated annually for progress towards meeting technical objectives, to ensure continued alignment with S&T priorities, and effective program management. The assessments of ongoing and proposed S&T projects influence decisions related to initiation, continuation or termination of efforts within areas of investment, and transition potential.

## NAE S&T Objectives

The STO document is updated biennially. This 2012 version replaces the 2010 NAE S&T Objectives. Changes have been made to keep current with user needs, leverage emerging technology opportunities and incorporate lessons learned through STO road mapping activities and the NAVAIR core capabilities. The 2012 edition contains 10 capability needs with 33 supporting STOs.

This document is the result of the combined effort of representatives from NAE stakeholder organizations. The STOs were developed by both warfighters and technologists working together to represent Naval Aviation. The STOs are derived from analysis of national defense and Naval strategic guidance documents and through discussions with NAE stakeholders on current and future capability needs. Capability gaps have been identified that require technology development for a solution; the STOs are objectives for improving capabilities within each gap area.

The STOs in this document facilitate the alignment of the NAE's S&T investments with the current and projected capability requirements of Naval Aviation. They serve as a foundation for technology thrusts that when matured will address current and future operational capability needs.

## Reduced Total Ownership Cost and Energy Conservation, Flexibility and Security

The Naval Aviation Total Obligation Authority (TOA) continues to decline, impacting both the Navy and Marine Corps ability to acquire new/additional capabilities, maintain their legacy assets, and ultimately achieve force structure and readiness targets. Despite a continued reduction in flight hours, aircraft and manpower, the overall costs to Naval Aviation continue to increase at a pace that erodes Naval Aviation's buying power. This in turn exacerbates challenges with keeping aging aircraft and equipment operational up to and beyond their intended service lives.

Controlling rising operational and sustainment costs is key to maintaining and modernizing the fleet. Our current challenges with recapitalization and modernization also highlight the importance of developing new systems that are affordable, reliable, and sustainable. Readiness of our Naval Aviation forces will need to be produced with a focus on cost effectiveness.

Scientific and technological innovations will be a critical piece of the solution to reducing and controlling total ownership costs (TOC) of Naval Aviation assets. Solutions must be considered that not only provide and improve capabilities, but reduce costs across capabilities within each of the STOs detailed in this document. The 2012 NAE S&T Objectives include a specific objective for reduction of TOC. This remains an important goal and critical focus of the NAE S&T program.

Secretary of the Navy, Ray Mabus outlined the Navy and Marine Corps' energy goals in 2009. These goals include "incorporating lifetime system energy costs in Navy and Marine Corps contracts; by 2012, creating a Green Strike Group composed of nuclear vessels and ships powered by biofuels and deploying that fleet by 2016; by 2015, reducing petroleum use in the Navy Department's 50,000 commercial vehicle fleet by 50 percent; producing at least half of shore-based energy requirements from renewable sources; and, by 2020, ensuring at least 40 percent of the Navy's total energy consumption comes from alternative sources." ONR, in turn, has designated power and energy as a Naval S&T focus area, and has identified objectives in the areas of energy security, efficient power and energy systems, and high energy pulsed power. The 2012 NAE STOs include a specific objective for improvements in energy conservation, flexibility and security. We acknowledge that solutions across all of the NAE STOs must take energy efficiency into account, and energy ramifications will be considered in the evaluation of all S&T portfolio efforts.

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## FORCE PROTECTION (FP)

*Vision: Protect Naval assets and provide increased survivability across the spectrum of conflict. This task includes those measures the force needs to remain viable and functional by protecting itself from the effects of enemy activities.*

### FP STO-1: Platform Survivability

Advances in threat technology have resulted in improved weapon capabilities and kinematics and other capabilities that place joint and coalition air and carrier forces within the threat envelope.

Develop technologies to improve survivability of Naval platforms in current and emerging threat environments. Increase the defensive capabilities of joint and coalition platforms against advanced current and emerging threats, including both airborne and surface-based threats (small boats, swimmers, etc.). Platform survivability includes ability to avoid detection/tracking and withstand both kinetic and non-kinetic effects through protective means and to reconfigure subsequent to a battle damage event. Low observable, warning, and countermeasure technologies include the development of laser countermeasures for soft and hard-kill solutions, high power/high efficiency optical amplifiers/switches, hostile fire indication and cueing systems, advanced electronic warfare/radio frequency (RF) countermeasure technologies, advanced kinetic hard-kill defensive systems and low maintenance tactical paints. Vulnerability reduction technologies include lightweight conformal armor, improved self-sealing and/or hydrodynamic ram resistant fuel systems, and adaptable flight control systems.

**RESEARCH**

*Electromagnetic Fire Supression*

As the Navy moves towards all-electric ships, researchers are developing environmentally-friendly yet effective fire suppression systems.

If one considers electricity as a fire extinguishing agent, the potential availability of the agent is limitless. Current research efforts are investigating the use of an electric current field to influence the behavior of flames within a prescribed fire zone.

Successful implementation of this research would provide unlimited fire extinguishing/prevention capability, and would ensure Naval laboratories can evaluate electric fire suppression-based systems for platform specific applications.

## FP STO-2: Mine and IED Detection and Neutralization

Joint and coalition forces must be able to safely maneuver from deep water to land in order to perform their missions.

Develop technologies to improve capabilities to locate and neutralize mines and improvised explosive devices (IEDs) in areas where joint forces must operate. Capabilities include intelligence, surveillance and reconnaissance/intelligence preparation of the battlefield in addition to engagement abilities. Research areas include: shipboard and airborne area mine and IED detection and neutralization; deep and shallow water mine detection, classification, localization, identification and neutralization in all environments (sea state, water clarity, hard/soft rocky bottom conditions, etc.); and beach mine and IED detection, identification and neutralization.

## FP STO-3: Electronic Protection

Advances in threat airborne jamming systems, including the incorporation of Digital Radio Frequency Memory (DRFM) technology, require advanced counter-countermeasures for joint and coalition forces.

Develop technologies to improve joint and coalition air-land-and ship-wide systems resistance to electronic attack (EA), including electromagnetic pulse.

Develop technologies that provide for netted collaboration between platforms to mitigate or alleviate adversary electromagnetic attacks.

## FP STO-4: Surface Torpedo Detection and Neutralization

Joint and coalition forces must be able to safely maneuver in all operational waters up to and including the littoral in order to perform their mission.

Develop technologies to improve capabilities to detect, locate and neutralize torpedoes in areas through which joint forces must operate.

Develop technologies to protect U.S. aircraft carriers and provide increased survivability across the spectrum of conflict.

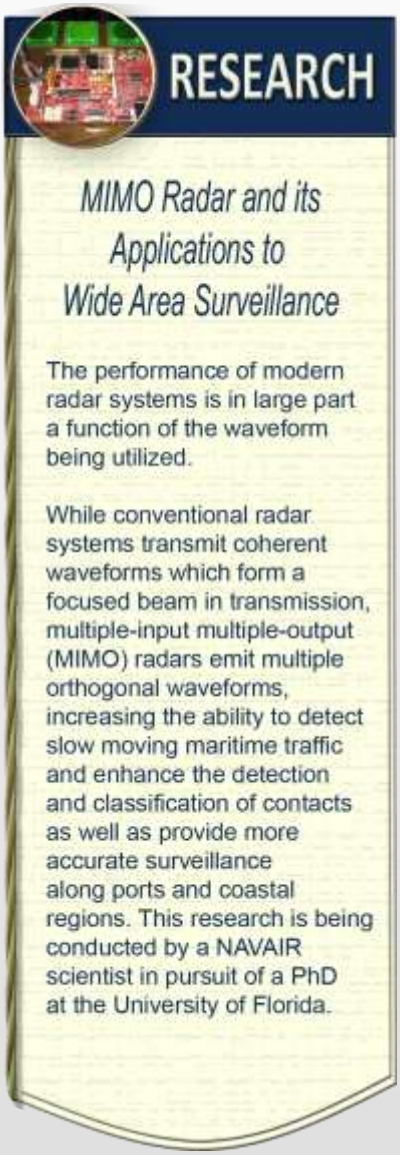
*Vision: Project power within the open ocean and littoral regions and preserve open access to key shipping lanes. This capability includes all efforts taken to control the battlespace by warfare commanders, strikes against high payoff and high value targets such as missile launching ships and other strike and power projection units throughout the theater, and efforts to undermine the enemy's will to fight.*

## SUW STO-1: Maritime Surveillance and Interdiction

Naval forces must maintain the ability to project power in the open ocean and within the littoral regions and preserve open access to key shipping lanes. Improved capability to detect, identify, track and determine intent of surface contacts and engage hostile vessels is required.

Tracking/identification capability is required for ship classes ranging from traditional surface combatants to small vessels with low radar cross section (RCS) and thermal signatures. This capability is required in high and low density shipping traffic and during unintentional/intentional jamming scenarios.

Develop technologies to detect, classify, identify and maintain persistent tracking of surface contacts (friendly, hostile, and neutral) in all weather conditions, across breaks in surveillance coverage, during both day and night operations, and over long standoff ranges (beyond projected surface threat envelopes). This capability must endure modern hostile EA and electronic surveillance capabilities. Develop technologies that provide timely, relevant and actionable intelligence to counter planned and opportunistic hostile swarm attacks against Naval surface forces operating in congested littoral operational areas.



Develop weapon technologies that can be employed from a sanctuary with high probability of mission kill and low probability of collateral damage to support the engagement of surface combatants, amphibious vessels, and other high value surface assets in the most challenging scenarios. Endure hostile EA, ES, and defensive capabilities, and ensure rapid engagement of multiple fast small vessels in a swarm attack.

## UNDER SEA WARFARE (USW)

*Vision: Establish battlespace dominance in the underwater environment to permit friendly forces to accomplish the full range of potential missions and deny opposing forces the effective use of underwater systems and weapons*

### USW STO-1: Environmental Sensing, Assimilation and Tactical Decision Aid

As sensors and weapons are developed to pace the advances in the increasingly complex and variable USW battlespace, more comprehensive real-time environmental, environmental compliance and target characteristic data is required. Onboard tactical decision aids that rapidly assimilate the expanded data set are needed to decrease workload, optimize new sensor and weapon employment, and provide effective single as well as multi-platform, tactical employment options across all phases of the anti-submarine warfare (ASW) kill chain.

Develop technologies that provide real time comprehensive sensing of the USW battlespace environment (air, ocean, and situational awareness of marine mammals) along with integrated onboard and ground based decision aids that rapidly assimilate data, optimize multi-sensor and weapons employment, and improve ASW effectiveness.

Develop technologies that provide improved calibrated sensing and processing of target characteristics for USW intelligence purposes.

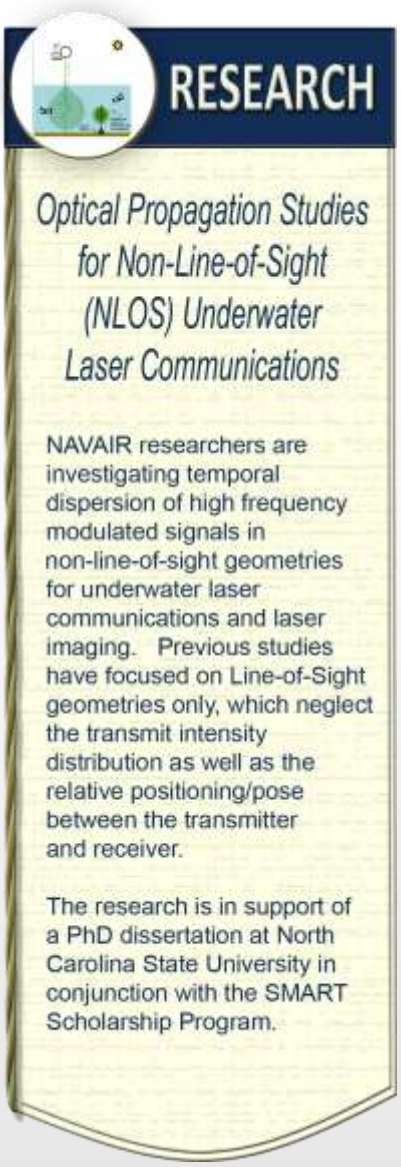
## USW STO-2: Wide Area Search and Detection

Continued advances in threat submarine capability to avoid acoustic and non-acoustic detection increasingly challenge air ASW platforms' ability to cover tactically significant search areas in both deep and shallow water.

Develop effective aerial search capability against threat submarines that facilitate covering large areas at high search rates in shallow to deep water with high probability of detection and low probability of false alarm/detection.

Develop methods to mitigate RF interference at all altitudes in littoral or adverse RF environments.

Develop technologies to enable automatic detection and discrimination of small targets (i.e., periscope) from all altitudes and/or standoff ranges, and improve active/passive/multi-static (distributed netted sensors) identification algorithms to minimize false detects.




## USW STO-3: Precision Localization/Identification/Attack

Continued advances in threat submarine capability to counter acoustic and non-acoustic sensors and weapons increasingly challenge air ASW platforms' ability to rapidly localize, track, determine and deliver effective precision attacks. Stand-off or high altitude flight profiles are required in littoral or hostile threat environments, but high-altitude littoral ASW capability is severely constrained by RF interference and RF jammers.

Develop technologies for rapid and sustained precision localization and tracking, and positive identification of threat submarines given initial air platform search sensor detection.

Develop an advanced precision delivery ASW weapon with high probability of kill for all-altitude attack of targets at any depth.

# THEATER AIR AND MISSILE DEFENSE (TAMD)

*Vision: Detect, track, target, and neutralize or destroy enemy aircraft and missiles in flight, including disruption of the enemy's theater missile operations through an appropriate mix of mutually supportive kinetic and non-kinetic means, and supporting C4ISR measures.*

## TAMD STO-1: Anti-Air Warfare (AAW) Performance

Air superiority requires the ability to engage the air threat, potentially superior in number, prior to an enemy's ability to launch weapons at joint and coalition force combatants, ground stations/bases and logistical vessels. Advances in and proliferation of air-to-air threat technologies have resulted in improved threat air platforms (reduced RCS, enhanced sensors, improved Command and Control (C2) and situational awareness), threat weapon kinematics/sensitivity, and EA/EP capabilities that pose a threat to joint and coalition air forces. It is imperative joint and coalition sensors and weapons provide sufficient situational awareness and standoff to ensure that they can counter threats posed by enemy weapons/systems.

Develop weapon systems technologies to neutralize or destroy advanced air threats outside of their projected sensor ranges and employment range in an EA environment. Technologies addressing detecting, tracking, identification, and targeting are addressed under the C4ISR STOs.

## TAMD STO-2: Airborne Missile Defense

Advances in and proliferation of advanced cruise missiles both land attack and anti-ship variants and theater ballistic missile threat technologies have resulted in an increased threat to joint and coalition forces.

Defense of joint and coalition forces requires the ability to detect and engage emerging missile threats at ranges sufficient to ensure the safety of our forces (while minimizing the reliance on point defense systems – i.e. threats need to be successfully detected and engaged as far from the target as possible in a layered defense CONOPs).

Develop weapons systems technologies to neutralize or destroy emerging missile threats at ranges that support a shoot-look-shoot versus a shoot-shoot strategy. Technologies addressing detecting, tracking, identifying, and targeting are addressed under the C4ISR STOs.

## STRIKE OPERATIONS (STK)

*Vision: Apply combined-arms Naval combat power, as part of a joint and coalition force, to disrupt, divert, delay, destroy, suppress, neutralize, or seize military objectives. Strike operations incorporate and integrate multi-dimensional capabilities for power projection with various combinations of forces and platforms.*

### STK STO-1: Responsive Engagement

Rapid changes in operational circumstances and enemy action result in a need for engagement due to limited vulnerability windows/danger to friendly forces. Timely awareness of these opportunities, detection and neutralization of targets and the capability to successfully prosecute multiple targets with organic assets and weapons is essential to joint and coalition operations. Effective, responsive, precise fire in support of mobile ground forces near friendly forces and in urban areas, any time of day or night and in all weather conditions, is essential to responsive engagement missions including close air support/strike coordination reconnaissance and interdiction missions. These operations require a common and coherent picture of the battlefield.

Develop technologies that enable: persistent, precise, and responsive engagement any time of day or night, in all weather conditions and in denied or degraded communications/navigation (COMM/NAV) RF environments; selectable level of non-kinetic effects set rapidly by the operator; and a weapon's ability to select the right target and aim point for a range of time critical targets in multiple locations, including moving ballistic missile launchers, surface-to- air missile systems, small buildings, light bunkers, critical nodes to lines of communication, moving vehicles, multi-axis small boat swarms and maritime moving targets in the most challenging scenarios and in rough terrain. Deep magazine, weapon time-of-flight inside the threat's ability to counter the intent of the weapon engagement, multi-engagement, and interoperable weapons are needed as well as technologies that allow intuitive, heads up target designation by the joint terminal air controller. Technologies addressing detecting, tracking, identifying, and targeting communications/global positioning system (GPS) denied or degraded environments, are addressed in the C4ISR STOs.

### STK STO-2: Engagement of Non-Time Critical Targets

The ability to engage pre-planned and non-time critical targets including mobile targets in an anti-access/area denial environment increases the ability of joint and coalition forces to neutralize enemy threats to joint and coalition forces. Improvements in the weapon's ability to reduce the uncertainty of mobile or re-locatable target location after its initial detection and launch and fly out are required. Improvements in neutralizing mobile targets and integrated air defense system (IADS) elements in adverse weather, denied or degraded COMM/NAV environments, counter-measure environments, and rough terrain are required.

Develop technologies to improve stand-off, target recognition and combat identification, lethality, non-kinetic selectable effects, mission flexibility, weapon survivability, and interoperable weapon capabilities against strike targets including trucks, missile launchers, hard targets, IADS elements (including hardened C2 sites), and larger maritime targets.

These technologies must support employment of weapons with positive target identification at any time, in all weather, in denied or degraded COMM/NAV environments, in countermeasure environments, and in rough terrain environments. Technologies addressing detecting, tracking, identifying and targeting, as well as communications/GPS denied or degraded environments, are addressed in the C4ISR STOs.

### STK STO-3: Unmanned Strike Capability

In suppression/destruction of enemy air defense, strike, SUW and AAW missions, future joint and coalition forces will encounter contested and denied environments that will necessitate the integration of penetrating manned and unmanned aircraft to enhance mission effectiveness while penetrating the battle space. Attributes of unmanned aircraft will allow portions of these missions to be completed without risk to human crews while providing gains in range, persistence, and maneuverability.

Develop technologies to enable collaborative and autonomous sea-based unmanned strike capabilities against the full spectrum of potential threats and targets. This includes technologies that increase unmanned air systems (UAS) autonomy, advance UAS integration with manned platforms, and enable seamless integration into sea-based aviation operations.

### STK STO-4: Airborne Electronic Attack

Current Naval airborne EA capability is well suited to earlier generation radars but does not offer any countermeasure to netted passive sensors and requires improvement against newer radar and communication technologies. Networked, collaborative EA across multiple security levels is necessary to effectively maneuver within the electromagnetic battle space.

Develop airborne EA technologies that can effectively engage both conventional military and asymmetric forces and tactics (such as the use of RF triggering devices), prevent, deceive or degrade enemy advanced search and tracking radars, and can effectively disrupt modern communication and data links.

Develop technologies that enable EA nodes, air, surface, and ground, to effectively communicate and collaborate to efficiently engage targets in the electromagnetic spectrum.

Develop technologies to predict, and assess combined effects.

# INTEGRATED LOGISTICS SUPPORT (ILS)

*Vision: Sustain forces, U.S. agencies and friendly nations in the combat zone by arming, fueling, maintaining equipment, moving, supplying, manning, and providing personnel and health services.*

## ILS STO-1: Enhanced Logistical Support of Joint Assets

The ability of Naval forces to generate and sustain combat readiness indefinitely, anywhere on the globe requires that materiel flow seamlessly from the industrial base to where it is ultimately used.

To position/pre-position assets in critical areas of the world, Naval logistics capability must develop better models, planning tools and deployment strategies that reduce cost and increase logistic capabilities that link customer demands with the supply chains.

Develop technologies that improve aerial delivery of both internal and external cargo to include automated handling systems.

Develop technologies that enable automatic, real-time, asset identification/tracking and sense/respond logistics in order to optimize effective throughput within and from the sea base to ashore combat operations.

Develop intelligent planning aids that maximize the ability to provide "just-in-time" inventory and enable "lean" methodologies that minimize staged material.

**RESEARCH**

### *Weapon Decision Support*

Aviation weapons handling on aircraft carriers and other air capable ships play a crucial role in sortie generation and combat effectiveness of the ship. The process of transporting weapons from the magazine to the flight deck and onto the aircraft can be a major barrier to increasing tempo of operations. In addition, the process of planning and executing a weapons underway replenishment can take days using the manual procedures in place today. Studies being conducted in Weapon Decision Support will enable naval weapons personnel to select the optimum weapons to maximize sortie rates and minimize weapons staging using intelligent agents and decision aids. If successful, the system will also provide the tools needed to help plan more efficiently, resulting in significant labor savings, process efficiencies and workload reductions associated with weapons planning and operations.

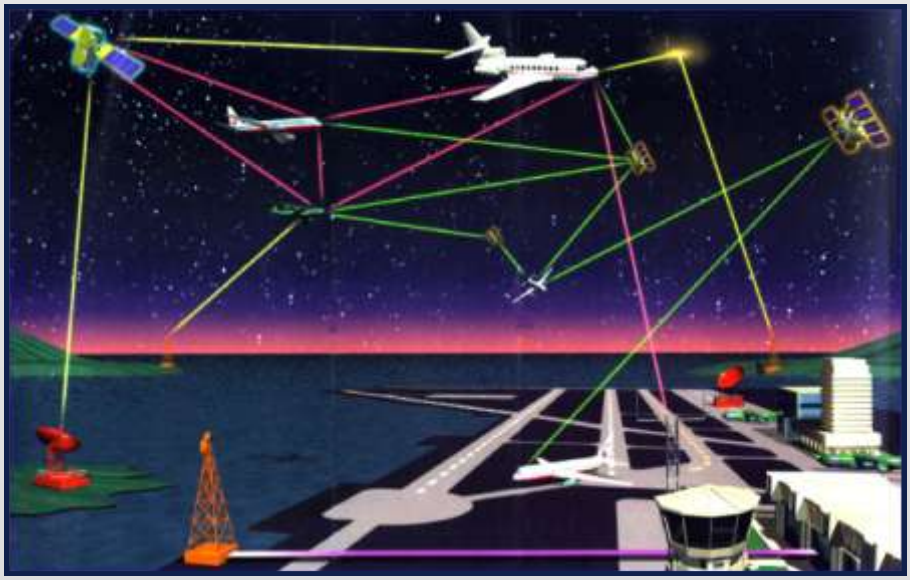
## ILS STO-2: Improved Diagnostic and Maintenance Capability

Legacy aircraft must be able to sustain operations longer than installed technologies remain relevant. Avionics systems rapidly face availability and maintainability challenges become obsolete as the industrial base terminates sustainment of replacement parts. Current and future aircraft are increasingly complex and require advanced technologies to maintain the airframe, systems, and the electronics suites.

Develop technologies that enable rapid redesign for integration of components to sustain maximum combat readiness. Develop automation tools that will reduce maintainer workload and turnaround time.

# COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS, INTELLIGENCE, SURVEILLANCE AND, RECONNAISSANCE (C4ISR)

*Vision: Enable the generation and seamless flow of all forms of actionable information to the warfighter across fault tolerant, adaptable, self-organizing, holistically engineered, secure, and continuously available networks across a wide range of transmission paths in an interoperable manner with Naval, joint, coalition and civil/law enforcement agencies. Platforms and vehicles should communicate freely and autonomously with other elements of the architecture in a manner where the existence and functions of the underlying network including the collection, transmission, and service techniques are transparent to the warfighter in all types of environments (all-weather, satellite denied) and facilitate rapid and accurate decision making.*



## C4ISR STO-1: Command and Control

Joint and coalition forces must have the ability to task, process, exploit, and disseminate information to/from the appropriate entity within the force with enough fidelity to be acted upon in a timely manner. With multiple sensors providing more information, operators must assimilate an increasing volume of data and information as missions become more complex. All relevant and available information needs to be filtered, organized, and coalesced to enable timely, informed decisions in order to manage, control, and manipulate the battle space.

Develop technologies to enable rapid and accurate decision making and efficient battle management. Technologies can include intelligent agents or decision aids for rapid and reliable threat/intent determination, distributed weapons/sensor coordination and control, real-time operations and improved mission planning.

**RESEARCH**

### *Atom Interferometers for UAV Applications*

The Navy and Marine Corps are concerned with the ability of UAVs to accurately report their position in the absence of GPS. High performing inertial navigation systems that can maintain positional accuracy are extremely costly and often large and require a lot of power.

Naval researchers are investigating the use of atom interferometers, which provide benefits offered by a low drift, sensitive gyroscope-accelerometer system with substantial reductions in both size and cost.

## C4ISR STO-2: Communications and Networks

Network centric warfare (NCW) is a concept that includes collaborating at the machine-to-machine level for mutual support of widely dispersed combat assets.

To fully realize the vision of automated collaboration at the machine-to-machine level, combat platforms require a seamless, scalable, interoperable architecture that ensures secure and timely distribution of information for managing the efficient employment of sensors, platforms, weapons and relays.

Develop reliable and sustainable NCW technologies that enable early entry and sustained forces to communicate beyond line-of-sight. Naval, joint and coalition forces must be interoperable with each other to enable distributed maneuver and execute responsive, persistent, lethal and adaptive full-spectrum operations.

Develop technologies to improve, manage, and optimize aircraft, ship/aircraft carrier, and expeditionary aviation combat element communications and network connectivity performance (speed, range) throughout the battlespace.

## C4ISR STO-3: Intelligence, Surveillance, Reconnaissance and Targeting

The ability to maintain constant, enduring contact with a potential target increases understanding about the target enables a faster decision cycle at all levels of command and supports the application of precision force to achieve desired effects. The ability to provide persistent, flexible, scalable, common, accurate, timely, and actionable tactical situational awareness to all participants is required to meet the information requirements of joint and coalition forces.

Develop technologies to conduct persistent surveillance, automatically integrate sea, ground, space, and air sensors in theater and confidently identify friendly, neutral and hostile contacts while collaboratively tracking and localizing potential targets at standoff ranges. Provide real time targeting data and battle damage assessment to joint and coalition forces with sufficient accuracy and confidence to prosecute targets as required.

Develop technologies for improved combat classification and identification to enable engagement decisions at longer ranges while reducing fratricide, improving battlefield coordination, providing de-confliction, and avoiding engagement of non-hostile targets.

## C4ISR STO-4: Navigation and Geolocation

Joint and coalition forces are dependent on precision navigation to assure operational maneuver and weapons employment in all environments and with the highest possible confidence. Evolving threats create the need for sustainable and adaptive technologies capable of ensuring navigation in communications degraded and denied environments.

Develop technologies to improve GPS related positioning and robustness in an anti-access/area denied environment with organic navigational capabilities (i.e. inertial, celestial, earth magnetic, etc.) that are independent of outside signals.

## C4ISR STO-5: Computing, Processing, and Architectures

Joint and coalition forces are collecting and utilizing vast amounts of data and information from on and off board sources. The real-time use of digital data and resultant information drives the need for flexible, advanced computing architectures, increased storage capacity, and improved processing speed of components without an increase in size, weight, or power of those components.

Develop technologies that increase real-time availability of information derived from digital data including increased storage capacity, processing power and flexible computing architectures.

### C4ISR STO-6: Information Security/Information Assurance

Naval forces operate with joint, NATO, allied, coalition, and homeland security forces, each of which has specific "need-to-know" and security requirements. The need exists for real-time automated information guards to control/regulate secure information sharing and enable efficient and effective operations with a mix of forces and security levels.

Develop technologies that facilitate rapid information sharing (down to the platform level) using multi-level security systems and cross domain solutions for joint and coalition operations that provides intra-, cross-, and inter-domain authentication, encryption, and information assurance/integrity services in all operating conditions. This includes areas of intermittent connectivity and limited throughput in restricted and hostile environments.

## ENTERPRISE AND PLATFORM ENABLERS (EPE)

*Vision: Leverage existing and emerging technologies to enhance and achieve operational capabilities and readiness across multiple warfare areas, providing cost savings and increased operational effectiveness.*

### EPE STO-1: Enterprise Enablers

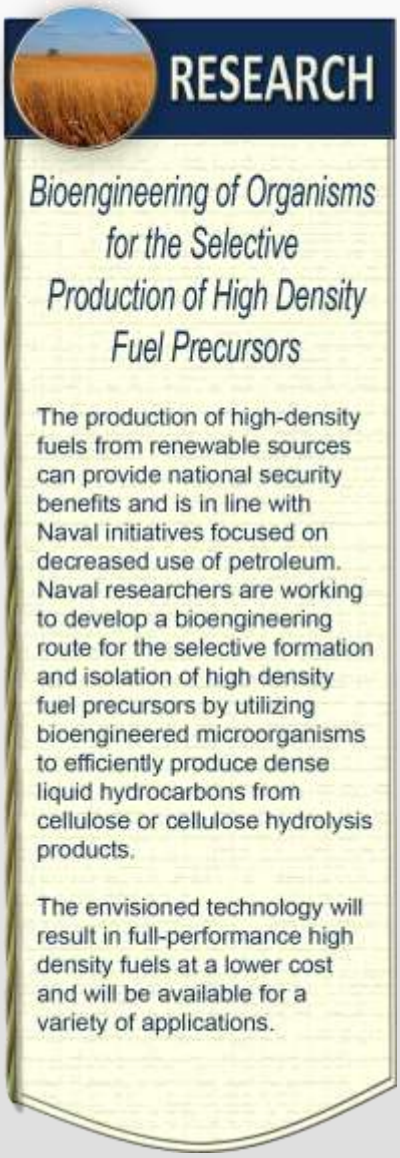
Enterprise enablers provide the technology base with options that affect future capabilities, maintain critical U.S. S&T capacity and develop the next generation of the S&T workforce. The portfolio, by design, has a broad focus and applicability across multiple platforms and systems. Pervasive research areas such as modeling and simulation, manufacturing, test and evaluation capabilities, advanced instrumentation, and workforce development should be considered as key elements of this objective.

Develop skills and new technologies to enable the NAE to develop and produce legacy and future systems to provide long range, persistent, flexible and responsive capabilities at reduced TOC that assist and strengthen our forces, allies and partners.

## EPE STO-2: Fixed Wing Platform Enablers

Fixed wing aircraft enablers provide the technology base with options that affect future capabilities and maintain critical U.S. S&T capacity. The portfolio, by design, has a broad focus and applicability across multiple fixed-wing manned and unmanned aircraft, systems, and subsystems.

Develop technologies to: improve aerodynamic efficiencies; decrease aircraft weight; increase speed, range and payload capability; and improve durability. Pervasive research areas such as advanced propulsion and power (including hypersonic capability), reduced IR and acoustic signature, advanced flight control/algorithms, advanced material development, and systems integration should be considered as key elements of this objective.




## EPE STO-3: Vertical Lift Platform Enablers

Vertical lift platform enablers provide the technology base with options that affect future capabilities and maintain critical U.S. S&T capacity. The portfolio, by design, has a broad focus and applicability across multiple vertical lift manned and unmanned aircraft and subsystems.

Develop technologies to improve heavy lift and rotor performance, decrease aircraft weight, increase speed, range and payload capability, and improve durability. Develop technologies that improve the take-off/landing/high density altitude performance required to increase tactical effectiveness and survivability in all weather.

## EPE STO-4: Weapon Enablers

Weapon enablers provide the technology base with options that affect future capabilities and maintain critical U.S. S&T capacity. The portfolio, by design, has a broad focus and applicability across kinetic and non-kinetic weapons and multiple missions.

Develop technologies to improve kinetic weapon lethality and insensitivity without size or weight penalties.

Develop technologies to increase speed and range, increase responsiveness and flexibility of employment (all environments, multi-mission/effect, ease of use), reduce size, weight, and cost of kinetic weapons while maintaining or improving lethality effects.


Develop technologies to reduce physical stressors/impact on personnel in weapons assembly, disassembly and handling while maintaining or increasing throughput. Develop technologies to reduce time and/or cost of weapons maintenance and test. Develop technologies to reduce the environmental impact of materials used in energetics or in the manufacturing of energetics, and to improve the reliability of weapons.

Develop technologies enabling non-kinetic weapons employment on Naval aircraft delivering variable effects at the speed of light with deep magazine capability.

## EPE STO-5: Energy Conservation, Flexibility and Security [1]

Support overall Naval energy goals to increase energy security while also reducing greenhouse gas emissions, reduce tactical petroleum consumption, increase energy efficiency and increase use of non-petroleum based fuels. The volatility of energy costs, dependence on limited foreign oil sources, and the carbon footprint of energy consumption puts the Navy in a vulnerable position.

To reduce this vulnerability the Navy and Marine Corps must transform energy supply, demand and security. Technology areas to address these goals can include more efficient engines, decreased aircraft drag, power and thermal management integration, optimized mission planning, alternative fuels, training efficiencies and increased simulator usage.

Develop technologies to enable legacy, emerging and future systems to operate more efficiently, consume less energy and have the ability to utilize alternative fuel and power sources.

Develop fuel efficient technologies and methodologies to increase maritime operational energy security, maintain operational flexibility, support forward presence and reduce the carbon footprint while reducing the risk associated with an extended energy supply line.

Develop advanced and/or renewable power generation technologies. Develop high density power storage capabilities.

### EPE STO-6: Aircraft/Ship Integration

Aircraft operations at sea are inherently dangerous, costly and labor intensive. Operating within the maritime environment imposes unique limitations upon sea-based aircraft (i.e., fixed wing and rotary wing aircraft, both manned and unmanned) which need specific technology solutions to ensure their continued success and integration in naval warfare. Aircraft carriers and air-capable ships (e.g., amphibious ships, guided missile cruisers and destroyers) must support aircraft during pre-/post-flight deck operations, launch, mission execution, recovery and maintenance. Aircraft/ship integration must be able to support all aircraft operations and maintenance to safely maximize sortie generation rates and maintain aircraft operational availability.

Develop technologies that mitigate the negative effects of the dynamic interface between aircraft, aircraft carriers and air-capable ships; automate launch, recovery and deck operations; and improve structural materials and coatings to withstand high loadings, corrosion and high flight deck temperatures.

[1] Energy Security is ensuring secure, sufficient, reliable and sustainable energy for Naval tactical forces and shore installations. Energy security is focused on transforming vulnerabilities associated with energy supply and demand into strategic and operational advantages.

Develop technologies that enhance aircraft design for shipboard space constraints and improve flying qualities and performance while conducting sea-based operations.

Develop technologies that enhance aircraft carrier, air-capable ship and aircraft design to improve hu-man-machine interface; improve shipboard air wing sustainment support infrastructure; reduce and simplify maintenance actions and procedures; reduce hazardous materials and enable interoperability with legacy and future logistic systems.

## SYSTEM SAFETY, AVAILABILITY AND AFFORDABILITY ENABLERS (SSAA)

*Vision: Utilize advanced technology to improve safety, reduce cost and improve reliability of Naval operations and platforms.*

### SSAA STO-1: System Safety and Availability

Ensure that safety, consistent with mission requirements, is designed into systems, subsystems, equipment, and facilities, and their interfaces. Improvements in inspection techniques, maintenance procedures and health management technologies can enhance long term mission performance, system safety, and platform availability.

Develop technologies to achieve acceptable mishap risk, within the constraints of operational effectiveness, time, and cost, throughout all phases of the system life cycle. Develop, integrate and transition technologies to improve system safety, increase platform availability, extend useable service life, and reduce maintenance actions.

**RESEARCH**

*Automated Fiber Optic Cleaner for Aerospace Connector Maintenance*

Naval researchers are developing a new and novel cleaning media with the ability to quickly and efficiently clean a fiber optic connector end-face.

The new media will reduce key issues that fleet operational level maintainers are experiencing with the application of next generation optical communications in support of network centric warfare.

The media will improve efficacy to >99 percent, reduce the time of cleaning, will not cross contaminate, and will be a drop-in replacement for the existing tool. No retraining of technicians or refitting cleaning fits will be necessary.

Develop and implement methods and technologies including condition based maintenance, prognosis and health management that can predict, identify and provide solutions to address safety risks and manage system life. Develop remote/tele-operation or automation technologies to remove Sailors or Marines from hazardous or hostile environments.

Develop technologies that enable longer on-station times and minimize maintenance requirements.

Develop technologies that enable Naval Aviation to better comply with environmental regulations at reduced cost.

## SSAA STO-2: Total Ownership Cost (TOC)

The increasing TOC of naval platforms threatens the ability to recapitalize the aging in-service systems and acquire new systems in sufficient quantities to maintain required force structure.

Naval Aviation platforms can often be expected to provide up to 50 years of service with associated costs in all life cycle phases that have been frequently greater than predicted. Investment in innovative technologies and new methodologies is required to bring rising TOC under control.

Total ownership cost includes development, acquisition, Operations & Support (O&S) and disposal. Technology advances that reduce development costs (e.g. modeling and simulation) and target acquisition costs (e.g. manufacturing) are needed as well as those that target O&S cost by reducing the maintenance burden through increases in reliability (e.g. solid state or direct drive) or innovative corrosion prevention.

Develop technologies that reduce the TOC of all Naval systems including aircraft, weapons, support equipment, training systems, aircraft carriers, and air capable ships.

# NAVAL WARFIGHTER PERFORMANCE (NWP)

*Vision: Sustain warfighter performance and enhance decision making through optimized training technologies, protection, system integration, health management and combat casualty care tools and training.*

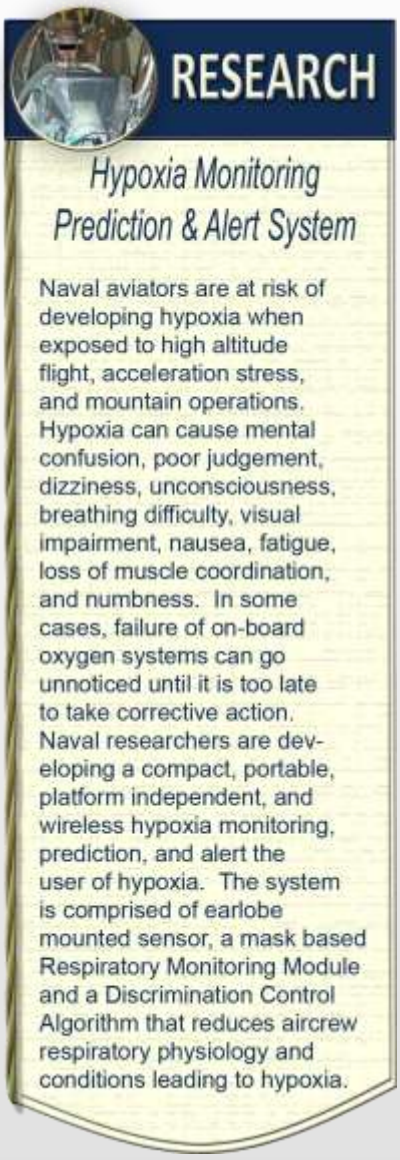
## NWP STO-1: Training and Education

Increasing mission complexity, asymmetric warfare, high live/range exercise costs, and growing operational demands driven by reduced timelines directed by fleet response plans all require new metrics-driven processes, high fidelity training environments, and fully linked training and readiness competencies to achieve operator/maintainer qualifications and proficiency while reducing training life-cycle cost drivers.

The rapid creation of combat readiness and operational proficiency, while optimizing the use of live, virtual, and constructive assets, is required.

Develop education and training technologies and strategies to cost-effectively maximize transfer of knowledge from the classroom and trainer to the operational environment.

Technologies and strategies may include adaptive training, medical modeling and simulation, virtual environments, persistent virtual worlds, game-based training, distributed team competencies, mobile training technologies and integrated design and training data.



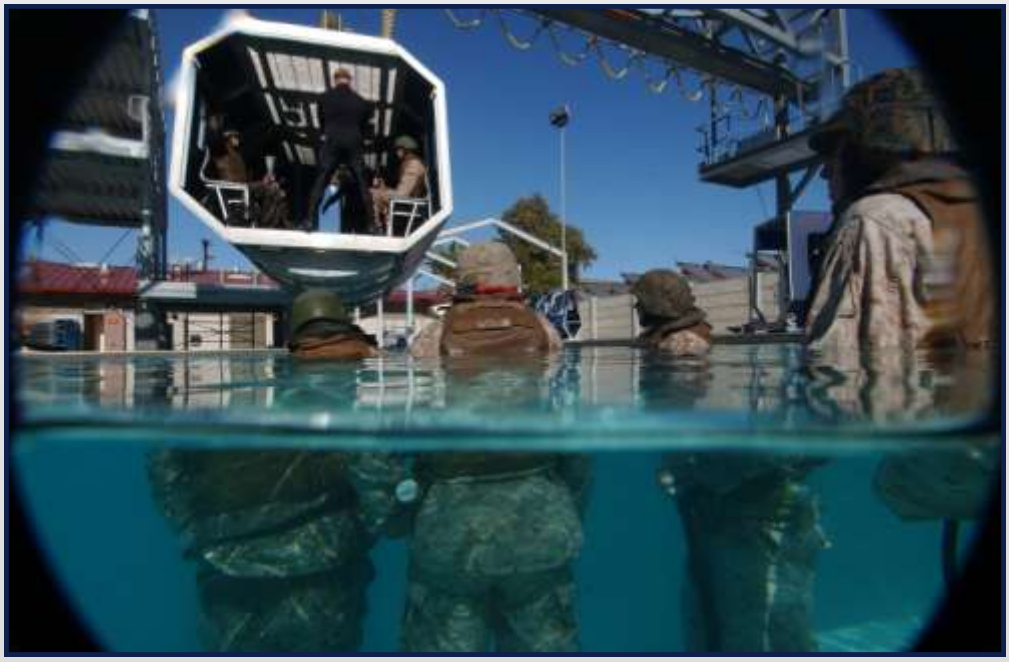

## NWP STO-2: Human Systems Design and Decision Support

Operator workload in a non-optimized data rich environment degrades effectiveness, resulting in slowed decision making with potential for increased human error and injury.

Through the effective use of human performance modeling and assessment, develop technologies to: improve human systems design to reduce operator workload, mitigate stress (physiological and psychological) and the risk of injury; and to improve human social and cultural behavioral modeling for decision making. These models and assessment methodologies will provide a means for enhanced decision making relative to system and platform design, manpower requirements, workload determination, design tradeoffs and mission effectiveness/ sustainability.

## NWP STO-3: Warfighter Health, Survivability and Protection

Current technologies were designed as stand-alone systems that do not adequately protect or enhance survivability of the individual warfighter. Legacy systems were not developed to accommodate the expanded anthropometric range, support extended operations, repetitive trauma, which leads to cognitive and physiologic fatigue, reduced endurance, and increased risk of injury. As the emphasis shifts to asymmetric warfare, life support systems must support non-traditional missions and provide protection against multiple environmental and physiologic stressors.



Develop state-of-the-art life support technologies and protective devices to optimize warfighter performance, effectiveness, safety, and survival.

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# ACRONYMS

| | |
|---|---|
| AAW | Anti-Air Warfare |
| ASW | Anti-Submarine Warfare |
| AVN | Aviation |
| C2 | Command and Control |
| C4ISR | Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance |
| COMM/NAV | Communications/Navigation |
| CTO | Chief Technology Officer |
| DoD | Department of Defense |
| EA | Electronic Attack |
| EPE | Enterprise Platform Enablers |
| ES | Electronic Warfare Support |
| EW | Electronic Warfare |
| FP | Force Protection |
| GPS | Global Positioning System |
| IADS | Integrated Air Defense System |
| IED | Improvised Explosive Device |
| ILS | Integrated Logistics Support |
| ISR | Intelligence, Surveillance and Reconnaissance |
| NAE | Naval Aviation Enterprise |
| NATO | North Atlantic Treaty Organization |
| NAVAIR | Naval Air Systems Command |
| NAWC | Naval Air Warfare Center |
| NCW | Network Centric Warfare |
| NWP | Naval Warfighter Performance |
| ONR | Office of Naval Research |
| O&S | Operations and Sustainment |
| RCS | Radar Cross Section |
| RF | Radio Frequency |
| SBA | Sea Based Aviation |
| SSAA | System Safety, Availability and Affordability |
| S&T | Science and Technology |
| STK | Strike Operations |
| STO | Science and Technology Objective |
| SUW | Surface Warfare |
| TAMD | Theater Air and Missile Defense |
| TOC | Total Ownership Cost |
| UAS | Unmanned Air System |
| USW | Under Sea Warfare |


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# APPENDIX A

## Alignment of NAE STOs to Joint Capability Area

| | Force Support | Battlespace Awareness | Force Application | Logistics | Command & Control | Net Centric | Protection |
|---|---|---|---|---|---|---|---|
| FP STO-1: Platform Survivability | | | | | | | X |
| FP STO-2: Mine and IED Detection and Neutralization | | | | | | | X |
| FP STO-3: Electronic Protection | | | | | | | X |
| FP STO-4: Surface Torpedo Detection and Neutralization | | | | | | | X |
| SUW STO-1: Maritime Surveillance and Interdiction | | X | | | X | X | |
| USW STO-1: Environmental Sensing, Assimilation and Tactical Decision Aids | X | X | X | | X | X | |
| USW STO-2: Wide Area Search and Detection | | X | X | | X | X | |
| USW STO-3: Precision Localization/Identification/Attack | | X | X | | X | X | |
| TAMD STO-1: Anti-Air Warfare Performance | | | X | | | | |
| TAMD STO-2: Airborne Missile Defense | | | | | | | X |
| STK STO-1: Responsive Engagement | | X | X | | X | X | |
| STK STO-2: Engagement of Non-Time Critical Targets | | X | X | | X | X | |
| STK STO-3: Unmanned Strike Capability | | X | X | | X | X | |
| STK STO-4: Airborne Electronic Attack | | X | X | | X | X | |
| ILS STO-1: Enhanced Logistical Support of Joint Assets | | | | X | | | |
| ILS STO-2: Improved Diagnostic, Prognostic and Maintenance Capability | | | | X | | | |

# Alignment of NAE STOs to Joint Capability Area

| | Force Support | Battlespace Awareness | Force Application | Logistics | Command & Control | Net Centric | Protection |
|---|---|---|---|---|---|---|---|
| C4ISR STO-1: Command and Control (C2) | | X | X | | X | X | |
| C4ISR STO-2: Communications and Networks | | X | X | | X | X | X |
| C4ISR STO-3: Intelligence, Surveillance, Reconnaissance (ISR) and Targeting | | X | X | | X | X | |
| C4ISR STO-4: Navigation and Geolocation | | X | | | X | | |
| C4ISR STO-5: Computing, Processing, and Architectures | | | | | | X | |
| C4ISR STO-6: Information Security / Information Assurance | | | | | | X | |
| EPE STO-1: Enterprise Enablers | X | X | X | X | X | X | X |
| EPE STO-2: Fixed Wing Platform Enablers | X | X | X | X | X | X | X |
| EPE STO-3: Vertical Lift Platform Enablers | X | X | X | X | X | X | X |
| EPE STO-4: Weapon Enablers | X | X | X | X | X | X | X |
| EPE STO-5: Energy Conservation, Flexibility and Security | X | X | X | X | X | X | X |
| EPE STO-6: Aircraft/Ship Integration | X | X | X | X | X | X | X |
| SSAA STO-1: System Safety and Availability | X | | | X | | | |
| SSAA STO-2: Total Ownership Cost | X | | | X | | | |
| NWP STO-1: Training and Education | X | | | | | | |
| NWP STO-2: Human Systems Design and Decision Support | X | | | | | | |
| NWP STO-3: Warfighter Health, Survivability and Protection | X | | | | | | |

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# APPENDIX B

## Alignment of NAE STOs to Naval S&T Focus Areas

| | Assure Access to the Maritime Battlespace | Autonomy and Unmanned Systems | Expeditionary and Irregular Warfare | Information Dominance |
|---|---|---|---|---|
| FP STO-1: Platform Survivability | | | | |
| FP STO-2: Mine and IED Detection and Neutralization | **X** | | **X** | |
| FP STO-3: Electronic Protection | | | | |
| FP STO-4: Surface Torpedo Detection and Neutralization | **X** | | **X** | |
| SUW STO-1: Maritime Surveillance and Interdiction | **X** | | | |
| USW STO-1: Environmental Sensing, Assimilation and Tactical Decision Aids | **X** | | | |
| USW STO-2: Wide Area Search and Detection | **X** | | | |
| USW STO-3: Precision Localization/Identification/Attack | **X** | | | |
| TAMD STO-1: Anti-Air Warfare Performance | **X** | | | |
| TAMD STO-2: Airborne Missile Defense | | | | |
| STK STO-1: Responsive Engagement | **X** | | | |
| STK STO-2: Engagement of Non-Time Critical Targets | | | | |
| STK STO-3: Unmanned strike capability | | **X** | | |
| STK STO-4: Airborne Electronic Attack | **X** | | | |
| ILS STO-1: Enhanced Logistical Support of Joint Assets | | | | |
| ILS STO-2: Improved Diagnostic, Prognostic and Maintenance Capability | | | | |

# Alignment of NAE STOs to Naval S&T Focus Areas

| | Assure Access to the Maritime Battlespace | Autonomy and Unmanned Systems | Expeditionary and Irregular Warfare | Information Dominance |
|---|---|---|---|---|
| C4ISR STO-1: Command and Control (C2) | | | | **X** |
| C4ISR STO-2: Communications and Networks | | | | **X** |
| C4ISR STO-3: Intelligence, Surveillance, Reconnaissance (ISR) and Targeting | | | | **X** |
| C4ISR STO-4: Navigation and Geolocation | | | | **X** |
| C4ISR STO-5: Computing, Processing, and Architectures | | | | **X** |
| C4ISR STO-6: Information Security / Information Assurance | | | | **X** |
| EPE STO-1: Enterprise Enablers | **X** | **X** | **X** | **X** |
| EPE STO-2: Fixed Wing Platform Enablers | **X** | **X** | | |
| EPE STO-3: Vertical Lift Platform Enablers | **X** | **X** | | |
| EPE STO-4: Weapon Enablers | **X** | **X** | | |
| EPE STO-5: Energy Conservation, Flexibility and Security | | | | |
| EPE STO-6: Aircraft/Ship Integration | | | | |
| SSAA STO-1: System Safety and Availability | | | | |
| SSAA STO-2: Total Ownership Cost | | | | |
| NWP STO-1: Training and Education | | | | |
| NWP STO-2: Human Systems Design and Decision Support | | | | |
| NWP STO-3: Warfighter Health, Survivability and Protection | | | | |

# Alignment of NAE STOs to Naval S&T Focus Areas

| | Platform Design and Survivability | Power and Energy | Power Projection and Integrated Defense | Total Ownership Cost | Warfighter Performance |
|---|---|---|---|---|---|
| FP STO-1: Platform Survivability | X | | | | |
| FP STO-2: Mine and IED Detection and Neutralization | X | | X | | |
| FP STO-3: Electronic Protection | X | | X | | |
| FP STO-4: Surface Torpedo Detection and Neutralization | X | | X | | |
| SUW STO-1: Maritime Surveillance and Interdiction | | | X | | |
| USW STO-1: Environmental Sensing, Assimilation and Tactical Decision Aids | X | | X | | |
| USW STO-2: Wide Area Search and Detection | X | | X | | |
| USW STO-3: Precision Localization/Identification/Attack | X | | X | | |
| TAMD STO-1: Anti-Air Warfare Performance | X | | X | | |
| TAMD STO-2: Airborne Missile Defense | X | | X | | |
| STK STO-1: Responsive Engagement | | | X | | |
| STK STO-2: Engagement of Non-Time Critical Targets | | | X | | |
| STK STO-3: Unmanned Strike Capability | | | X | | |
| STK STO-4: Airborne Electronic Attack | X | | X | | |
| ILS STO-1: Enhanced Logistical Support of Joint Assets | | | | X | |
| ILS STO-2: Improved Diagnostic, Prognostic and Maintenance Capability | | | | X | |

# Alignment of NAE STOs to Naval S&T Focus Areas

| | Platform Design and Survivability | Power and Energy | Power Projection and Integrated Defense | Total Ownership Cost | Warfighter Performance |
|---|---|---|---|---|---|
| C4ISR STO-1: Command and Control (C2) | | | | | |
| C4ISR STO-2: Communications and Networks | | | | | |
| C4ISR STO-3: Intelligence, Surveillance, Reconnaissance (ISR) and Targeting | | | X | | |
| C4ISR STO-4: Navigation and Geolocation | | | | | |
| C4ISR STO-5: Computing, Processing, and Architectures | | | | | |
| C4ISR STO-6: Information Security / Information Assurance | | | | | |
| EPE STO-1: Enterprise Enablers | X | X | X | X | X |
| EPE STO-2: Fixed Wing Platform Enablers | | | X | | |
| EPE STO-3: Vertical Lift Platform Enablers | | | X | | |
| EPE STO-4: Weapon Enablers | | | X | | |
| EPE STO-5: Energy Conservation, Flexibility and Security | | X | | | |
| EPE STO-6: Aircraft/Ship Integration | X | | X | | |
| SSAA STO-1: System Safety and Availability | X | | | X | |
| SSAA STO-2: Total Ownership Cost | X | | | X | |
| NWP STO-1: Training and Education | | | | | X |
| NWP STO-2: Human Systems Design and Decision Support | | | | | X |
| NWP STO-3: Warfighter Health, Survivability and Protection | | | | | X |

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# APPENDIX C

## Alignment of NAE STOs to Marine Corps S&T AVN STOs

The USMC leadership publishes an S&T Plan and its own STOs to provide guidance to the Marine Corps. The NAE and Marine Corps aviation are dependent upon each other for leveraging S&T investment and coordinate as appropriate for development efforts of mutual Navy and Marine Corps benefit.

AVN STO-1: Collaborative networking

NAE STO: C4ISR STO-2, Communications and Networks

AVN STO-2: Advanced electronic warfare (EW) systems

NAE STO: STK STO-4, Airborne Electronic Attack

AVN STO-3: Sand and dust-penetrating radar, providing precision (landing quality) navigation video in brownout and dust-out visibility conditions

NAE STOs: C4ISR STO-4, Navigation and Geolocation and EPE STO-3, Vertical Lift Platform Enablers

AVN STO-4: Command and control (C2) data fusion and networking

NAE STOs: C4ISR STO-1, Command and Control (C2) and C4ISR STO-2, Communications and Networks

AVN STO-5: Standardized force tracking system

NAE STO: C4ISR STO-3, Intelligence, Surveillance, Reconnaissance (ISR) and Targeting

AVN STO-6: Group 4 (Tier III) unmanned aircraft systems (UAS)

NAE STO: STK STO-3, Unmanned Strike Capability; C4ISR STO-3, Intelligence, Surveillance, Reconnaissance (ISR) and Targeting; and C4ISR STO-5, Computing, Processing, and Architectures

AVN STO-7: Advanced multi-function EW transceiver

NAE STO: STK STO-4, Airborne Electronic Attack

AVN STO-8: Ground based C2 and surveillance systems

NAE STO: C4ISR STO-2, Communications and Networks

AVN STO-9: Advanced laser systems suitable for countermeasure, sensor, and attack applications

NAE STOs: STK STO-1, Responsive Engagement and STK STO-2, Engagement of Non-Time Critical Targets

AVN STO-10: Scalable, light weight, interference cancellation system and adaptive/cognitive radio technologies for both co-situated RF emitters and RF saturated environments to eliminate VHF, UHF, SATCOM RF interference between multiple radio and electronic attack systems.

NAE STOs: C4ISR STO-2, Communications and Networks; C4ISR STO-5, Computing, Processing, and Architectures; and C4ISR STO-6, Information Security/Information Assurance

AVN STO-11: Net-enabled weapons

NAE STOs: STK STO-1, Responsive engagement; STK STO-2, Engagement of Non-Time Critical Targets, STK STO-4, Airborne Electronic Attack; EPE STO-4: Weapon Enablers; and C4ISR STO-2, Communications and Networks

AVN STO-12: Cargo UAS

NAE STOs: ILS STO-1: Enhanced Logistical Support of Joint Assets and C4ISR STO-1, Command and Control (C2)

AVN STO-13: UAS universal ground control station (UGCS)

NAE STOs: C4ISR STO-1, Command and Control (C2); C4ISR STO-2, Communications and Networks; and C4ISR STO-4, Navigation and Geolocation

VN STO-14: Active kinetic and non-kinetic aircraft self-protection

NAE STOs: FP STO-1, Platform Survivability; FP STO-3, Electronic Protection; and TAMD STO-2: Airborne Missile Defense

AAVN STO-15: Radio frequency (RF) countermeasure, decoy, and expendables systems

NAE STOs: FP STO-1, Platform Survivability and FP STO-3, Electronic Protection

AVN STO-16: Advanced rotor/prop technologies for performance across wider envelope

NAE STOs: EPE STO-1, Enterprise Enablers and EPE STO-3, Vertical Lift Platform Enablers

AVN STO-17: Small form factor, lightweight expeditionary ordnance for fixed and rotary wing aircraft

NAE STOs: EPE STO-1, Enterprise Enablers; EPE STO-2, Fixed Wing Platform Enablers; EPE STO-3, Vertical Lift Platform Enablers; EPE STO-4, Weapon Enablers

AVN STO-18: Low collateral damage/low energetic weapons

NAE STOs: EPE STO-4, Weapon Enablers and STK STO-1, Responsive Engagement

AVN STO-19: Cost effective mass memory (terabytes)

NAE STOs: C4ISR STO-5, Computing, Processing, and Architectures

AVN STO-20: Distributed networking of aviation simulators

NAE STOs: C4ISR STO-5, Computing, Processing, and Architectures and NWP STO-1, Training and Education

AVN STO-21: Multi-function, low-drag VHF, UHF, and SATCOM (broadband) antenna

NAE STOs: FP STO-1, Platform Survivability and C4ISR STO-2, Communications and Networks

AVN STO-22: Composite materials in expeditionary environments

NAE STOs: EPE STO-1, Enterprise Enablers and ILS STO-2, Improved Diagnostic, Prognostic and Maintenance Capability

AVN STO-23: Lightweight De-ice/Anti-ice capability for aircraft

NAE STOs: EPE STO-1, Enterprise Enablers and FP STO-1, Platform Survivability

AVN STO-24: Variable-speed air refueling drogue

NAE STOs: EPE STO-1, Enterprise Enablers; EPE STO-2, Fixed Wing Platform Enablers; and EPE STO-3, Vertical Lift Platform Enablers

AVN STO-25: Aviation technologies that increase the capacity of aviation assets

NAE STOs: FP STO-1, Platform Survivability; EPE STO-3, Vertical Lift Platform Enablers; and ILS STO-1: Enhanced Logistical Support of Joint Assets

# APPENDIX D

## PHOTOGRAPH ACKNOWLEDGEMENTS


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# Shaping The Future of Naval Aviation