

2018 U.S. MARINE CORPS S&T STRATEGIC PLAN



UNITED STATES MARINE CORPS

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FOREWORD



The *Marine Corps Science & Technology Strategic Plan* establishes priorities and provides guidance and direction for investment in science & technology (S&T) necessary to enable the future Marine Corps and maintain a technological advantage over our adversaries.

This plan is the result of collaboration throughout the Marine Corps while working through the Capabilities Based Assessment process and in developing the Marine Corps Enterprise Integration Plan (MCEIP). The recently published *Marine Corps Operating Concept (MOC)* describes how the Marine Corps will fight and win in 2025 and beyond. This plan uses the MOC as the foundation to develop the STOs that support the design and development of the future force. The five critical tasks outlined in the MOC are key in identifying where S&T can support the warfighter of the future with capabilities not available today. This plan also used the *2015 Marine Corps Security Environment Forecast: Futures 2030-2045* to inform our STOs.

The plan is organized around Joint Capability Areas (JCA); however, within those JCAs you will find Science & Technology Objectives (STO) titled by their more familiar warfighting function such as Fires, Maneuver, and Force Protection. The STOs contained in this document are not ends in themselves. They should be used as the basis for engagement between the combat developer, S&T developer, and the materiel developer. Only through a close and collaborative partnership can we hope to invest our scarce S&T dollars in those capabilities we truly need, and take advantage of emerging technical opportunities.

The CG, MCWL, is assigned as the S&T Proponent by the Commandant of the Marine Corps and Executive Agent for Marine Corps S&T. The Deputy Commandant for Combat Development and Integration is assigned as the S&T Advocate. The CG, MCWL will be responsible for planning and executing S&T for the Marine Corps within the Naval Research and Development Enterprise (NRDE) and the Department of Defense Research and Development Enterprise. While this does not limit access to the NRDE, Marine Corps entities shall work with the CG, MCWL to ensure a collaborative and coordinated effort in this important combat development area.

A handwritten signature in black ink that reads "Robert S. Walsh". The signature is written in a cursive, flowing style.

Robert S. Walsh
Lieutenant General, U.S. Marine Corps
Deputy Commandant for Combat Development
and Integration

PREFACE



Marine Corps S&T Vision:

Provide science and technology solutions to ensure the future Force will have the best-organized, trained, and equipped Marines to win across the range of military operations in an uncertain and complex world.

The wide range of probable and plausible futures, challenges our ability to develop meaningful capabilities that address future needs. The Marine Corps Warfighting Laboratory/Futures Directorate (MCWL/FD) identifies future challenges and opportunities, develops warfighting concepts, and comprehensively explores options to inform the combat development process to meet the challenges of the future operating environment. The end state for Marine Corps S&T investment is an agile, lethal, and expeditionary force capable of executing missions across the full Range of Military Operations (ROMO) given the future threat. One of MCWL/FDs supporting responsibilities is to periodically publish the *U.S. Marine Corps S&T Strategic Plan*.

The primary principle underpinning the Marine Corps Science and Technology strategy is a purposeful, strategic investment. These investments aim at solving challenges and providing opportunities through Science and Technology to ensure that Marine operating forces remain the “most ready when the nation is least ready.”¹

To ensure a common perspective amongst all of the stakeholders within the Marine Corps S&T community, this strategic plan will reference the 2016 *Marine Corps Operating Concept (MOC)* -- the Marine Corps capstone operating concept--to establish current ends for S&T development.² The MOC provides an objective end state for future force development efforts.³ It communicates how the Marine Corps plans to fight in the future and, outlines five critical tasks and associated issues that must be addressed to ensure the Corps can adapt and win in a future conflict.

The S&T Strategic Plan does not seek to create new processes or change existing processes, but to identify areas of potential alignment in planning and investment where the technically possible and affordable align with anticipated need. Three primary stakeholder groups affect S&T development as depicted in Figure 1. The combat developer defines requirements, capability gaps, and funding; the materiel developer identifies technical gaps in programs of record; and the S&T developer manages S&T development programs and identifies the “art of the possible” to address existing and emerging gaps.

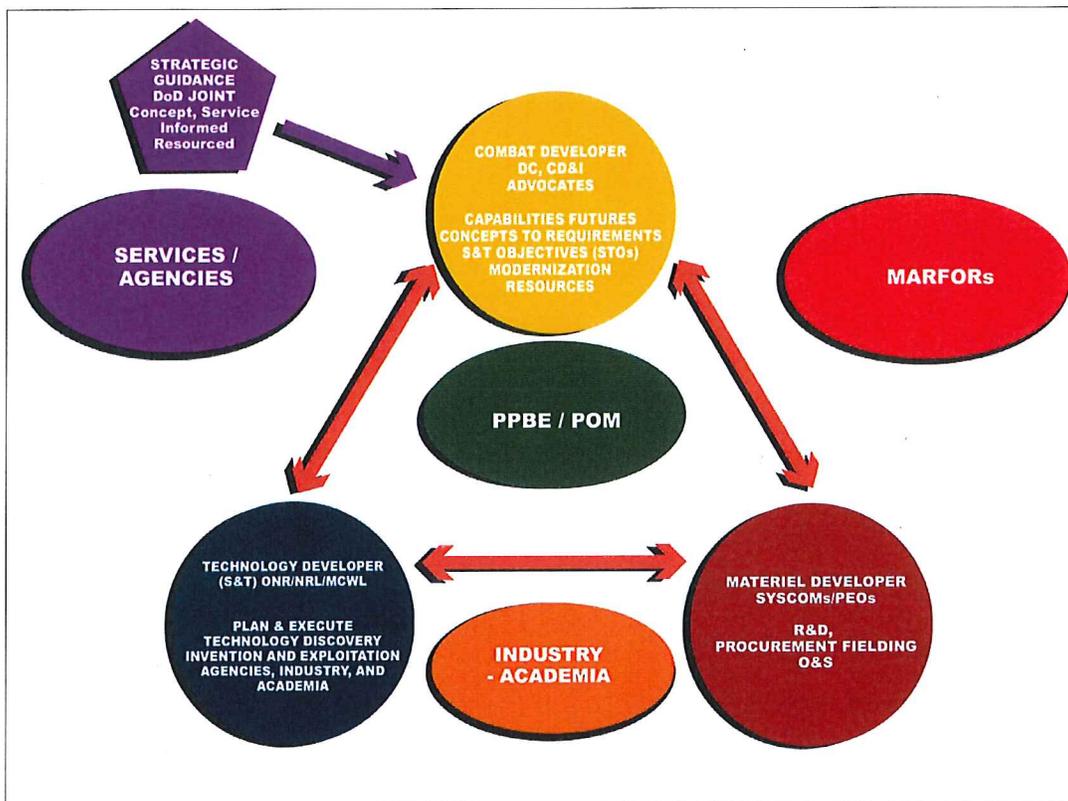


Figure 1. S&T Stakeholders

Harnessing the opportunities that exist within S&T requires continuous effort among the stakeholders to interface across all development levels of the futures continuum. STOs are the ways for the Marine Corps S&T Strategy:

- S&T Objectives (STOs):** The Combat Developer community introduces these objectives in response to defined near and mid-term Marine Corps gaps and ensures their linkage to expected capability needs based on recent technology trends and threat analyses. These STOs are the traditional mechanism for an interface between S&T stakeholders and are an important part of S&T development in support of the current and interim objective force. Because Marine Corps S&T stakeholders recognize them as well established and vetted needs, the STOs describe the direction for Marine Corps S&T investment.

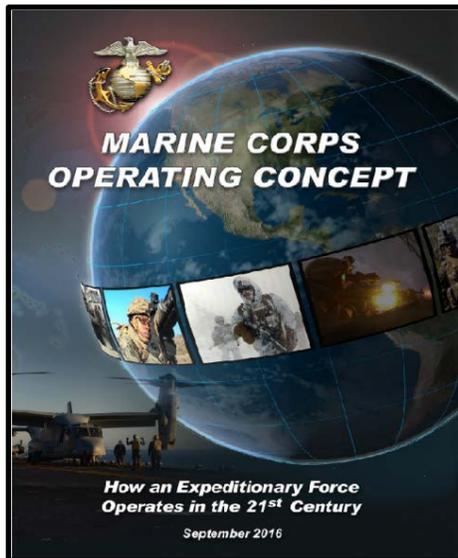
This S&T Strategic Plan outlines the ways and means needed to achieve these ends. The means address both the fiscal resources and human capital necessary to realize them.

Christian F. Woltman
 Brigadier General, U.S. Marine Corps
 Commanding General, Marine Corps
 Warfighting Lab / Director, Futures Directorate

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1.0 FUTURE SECURITY ENVIRONMENT AND RELATED GUIDANCE

In Sep 2016 the Marine Corps published the *Marine Corps Operating Concept (MOC)*. The MOC provides a framework within which to consider the future force and the many challenges--technological, geopolitical, and fiscal--that will shape how the Marine Corps will operate and fight in the future. The 37th Commandant of the Marine Corps' CMC *FRAGO 01/2016: Advance to Contact* tells us that to remain the most ready when the nation is least ready, we must innovate and experiment to maintain a technological advantage.⁴ To incorporate this direction, our S&T and force development strategies require a common view of the future operating environment that extends through the mid-term and into the far-term horizon.



The 2016 *Marine Corps Operating Concept*, states that while the character of warfare is changing, the basic tenants of maneuver warfare remain critical to future mission success. Accordingly, the future maritime force must be agile, lethal, naval and expeditionary. A supporting effort in achieving this goal is the evaluation of new technologies with an ability to support maneuver warfare in highly complex terrain, which includes facing an increasingly sophisticated threat possessing robust and highly capable reconnaissance, surveillance, and strike capabilities.

Critical to future success is the ability to produce both materiel and non-materiel solutions in response to new adversary capabilities. The ability to adapt doctrine to emerging systems is a hallmark of successful military organizations. Information is a

weapon, and our new technology solutions must address the requirement to both out-think and out-fight our opponents.

The Marine Corps Warfighting Laboratory's 2015 *Marine Corps Security Environment Forecast: Futures 2030-2045 (MCSEF)* provides a detailed look at technology and demographic trends over the next thirty years.⁵ Appendix A of this plan is a future operating environment 2045 vignette that emphasizes the key patterns and trends that highlight S&T challenges and opportunities through the Marine Corps near-, mid- and far-term force development horizons. Its purpose is to set the operational stage for the development of technology objectives for the future force.

2.0 MARINE CORPS S&T ENDSTATE (ENDS)

The five critical tasks identified in the *MOC*, as well as the associated issue areas listed below, outline the required capabilities needed to support the agile and expeditionary future force. Importantly, these issues are not associated with a specific technology or knowledge product. They outline capabilities needed to support a balanced and integrated force and to enable the individual Marine to accomplish the mission in any complex operating environment in the future.

MOC Critical Tasks

- Integrate the Naval force to fight at and from the sea
- Evolve the MAGTF
- Operate with resilience in a contested-network environment
- Enhance our ability to maneuver
- Exploit the competence of the individual Marine

3.0 NAVAL S&T RESOURCES (MEANS)

To achieve the five critical tasks and address the associated issue areas outlined in the MOC, the Office of Naval Research (ONR) allocates S&T resources as described below. These resources are primarily fiscal in nature, but a knowledgeable and experienced supply of human capital is indispensable to achieving long-term goals related to technological developments.

3.1 S&T Fiscal Resources

Overview

The Department of Defense divides Research, Development, Test & Evaluation (RDT&E) appropriations into seven specific Budget Activities (BAs). S&T programs, by definition, fall into the first three categories: BA-1 Basic Research, BA-2 Applied Research, and BA-3 Advanced Technology Development.

BA-1 Basic Research (6.1). Basic research involves systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and/or observable facts without specific application toward processes or products in mind. Not tied to specific requirements, basic research focuses primarily on achieving long-term goals that will lead to new or improved technologies. While the Marine Corps does not have 6.1 funding, ONR provides a level of 6.1 funding for Marine Corps direction.

BA-2 Applied Research (6.2). This is systematic study to increase knowledge or understanding necessary in order to discover how to meet specifically recognized needs.⁶ It translates promising basic research into solutions for broadly defined military needs and includes studies, investigations, and non-system specific technology efforts.

BA-3 Advanced Technology Development (6.3). This category includes all efforts that have moved into the development and integration of hardware for field experiments and tests. Advanced Technology Development supports larger scale hardware development, integration, and experiments that can demonstrate capability in more operationally realistic settings. Efforts in this category have the goal of moving technology projects and capabilities out of S&T and into the acquisition process.



Marine Corps S&T Program Elements

The Marine Corps programs resources for S&T efforts through four Marine Corps Program Elements identified in the Defense budget. As depicted in Figure 2, two of these Program elements support Joint Non-Lethal Weapons Directorate activities. The remaining two support applied research (6.2) activities and advanced technology development (6.3) efforts, to include concept-based experimentation efforts led by the Marine Corps Warfighting Laboratory/Futures Directorate (MCWL/FD).

Although some Marine Corps 6.3 funding goes directly to MCWL for experimentation, the Navy and Marine Corps S&T developer is the Chief of Naval Research (CNR). The CNR leads the efforts of the Office of Naval Research. The Commanding General, MCWL/Director, FD in his roles as the Vice Chief of Naval Research (VCNR) and Executive Agent for Marine Corps S&T, assists the CNR in these efforts. Another key player in Marine Corps S&T efforts is the Head of ONR's Expeditionary Maneuvers Warfare and Combating Terrorism Department (ONR Code 30) where the majority, but not all, Marine Corps S&T programs reside.

In addition to the Marine Corps funding ("Green" dollars) for 6.2 and 6.3 efforts, there are Navy funds that contribute to the Expeditionary Warfare S&T portfolio. These "Blue in support of Green" funding sources, to include the entire Basic Research 6.1 funding line, are an important source of funding for the Marine Corps S&T Program.

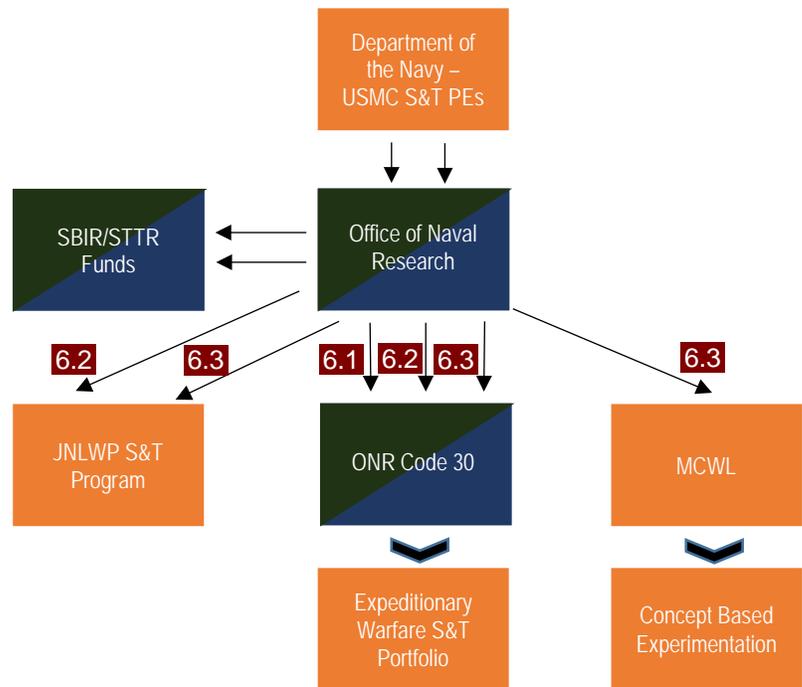


Figure 2. USMC S&T Program Elements

3.2 S&T Human Capital

The proper development and exploitation of Marine Corps S&T efforts are not limited to a series of program element lines in the yearly budget. Experienced, technically educated, motivated personnel are vital to shepherding S&T projects, managing transition opportunities, and developing an effective future force enabled by new technologies. S&T personnel at the HQMC Combat Development and Integration (CD&I) Department, MCWL/FD, ONR, Marine Corps Systems Command (MCSC), and the Program Executive Officer Land Systems (PEO LS) are the leaders that will turn the next new idea into a force enabler for the Marine Corps.

4.0 MARINE CORPS S&T PROCESSES (WAYS)

The following sections outline the processes by which the Marine Corps S&T community applies S&T resources to contribute to future force development as outlined by the MOC. The sections run in sequence along the S&T development continuum. New technologies or capability needs are not limited to the endpoints but can be created and fleshed out anywhere within the process.

4.1 Marine Corps Force Development Strategic Plan (FDSP)

The *FDSP* provides a framework designed to promote a collaborative, cohesive, “learning organization,” that can effectively prepare the Nation’s expeditionary force in readiness for a complex and uncertain future envisioned by the Department of Defense, Department of the Navy, and the Commandant. The framework guides Marines and civilians involved in developing the future force with a common understanding of how we intend to conceptualize and develop the future force with an integrated and collaborative approach.

Of interest to the S&T community, the process recognizes technology as a key driver of change and identifies a number of venues for identifying and analyzing specific technological change drivers. These venues include wargames, experiments, exercises, academia, and industry with a focus on concepts, innovation, and experimentation. The process also emphasizes modeling and simulation, wargaming, and studies to analyze and address Warfighting Challenges.

4.2 Governance and Stakeholder Input into S&T Development

The *FDSP* establishes venues to provide input into the force development process, to include S&T development.⁷ The force development process is depicted in Figure 3.

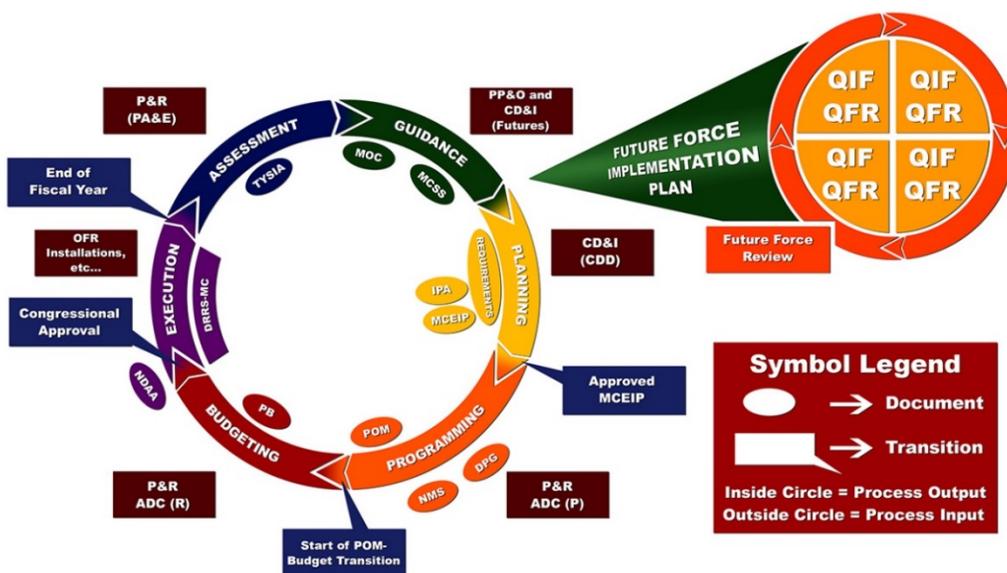


Figure 3. Force Development Process

Future Force Implementation Plan (FFIP). The Marine Corps Warfighting Laboratory and Futures Directorate (MCWL/FD) conceptualizes future challenges and opportunities, develops warfighting concepts, leverages analysis and innovation, conducts wargaming, and conducts experimentation and technology development in order to develop the Future Force Implementation Plan (FFIP). As portrayed in Figure 4, the FFIP is the primary output that serves as the starting point for the MC CBA process. A series of recurring events lead to the development of the FFIP and are outlined below:

Future Force Review (FFR). The FFR is a semi-annual CMC information and guidance forum that focuses on issues related to the future development of the Marine Corps.

Quarterly Futures Review (QFR). The QFR is the CG, MCCDC/DC CD&I tool to manage future force development matters and warfighting challenges.

Quarterly Integration Forum (QIF). The CG, MCWL/Director, FD chairs a quarterly forum to identify topics for presentation at the QFR.

Campaign of Learning (CoL). DC, CD&I directs the combat development enterprise through a Campaign of Learning. The CoL integrates and synchronizes all activities informing force development to include experiments, studies, wargames, exercises, and related efforts supporting future concept and capability development.



Figure 4. Futures Reviews/Campaign of Learning

4.3 Marine Corps Warfighting Lab/ Futures Directorate Concept Based Innovation

The Campaign of Learning’s feedback loops supports the MCWL/FD Concept Based Innovation Process as depicted in Figure 5. A primary output of these parallel efforts is the provision of information to decision makers to support prioritization of technology development. Appendix B provides a more detailed rendering of the inputs, outputs and supporting actions included in the Concept Based Innovation Process.

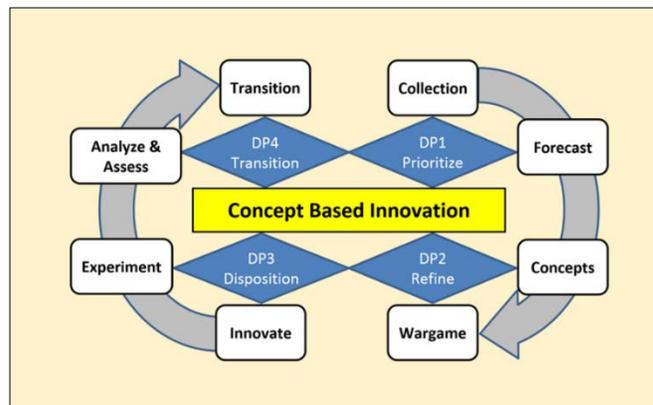


Figure 5. MCWL/FD Concept Based Innovation Process

4.4 Operating Force Science, Technology and Experimentation Operational Advisory Group (OST&E OAG)

In recent years, the MarFors and MEFs have strongly supported more consistent and transparent methods to inject operating force perspectives into the innovation process primarily through their participation in the Marine Corps CBA process, Advocate OAG's and through the Deliberate Universal Needs Statement (D-UNS) process. DC, CD&I, in his capacity as the S&T Advocate, chartered the OST&E OAG in 2010. The OAG provides the operating forces another venue to provide their input and recommendations into the CBA and S&T process. The operating force effort to provide their input and perspectives lead to the publication of the annual Unified Priority List (UPL), which is the primary output of the annual OST&E OAG. The UPL provides the combat developers and the S&T community with a prioritized list of operating force recommended S&T areas of effort. The UPL can be found on the Marine Corps Warfighting Laboratory SharePoint site at:
<https://mccdc.portal.usmc.mil/org/mcwl/snt/sti/stoag/default.aspx>

4.5 S&T Executive Steering Committee and Alignment Group

In early 2015, leaders from each of the three stakeholder circles signed a Memorandum of Understanding (MOU) to establish the S&T Executive Steering Committee (STESC) and S&T Alignment Group (STAG).⁸ The purpose of the STESC is collaborative governance of the S&T portfolio through the integration of S&T development and experimentation. The STESC is a key organization in the Campaign of Learning and the Concept Based Innovation Process. It feeds information regarding S&T development into the integration forums and force reviews described in the Force Development Strategic Plan.

The S&T Alignment Group (STAG) provides a working group at a senior management level to address S&T portfolio investment. The STAG meets at least twice per year. Its primary purpose is to support the STESC by addressing action items from previous STESC meetings and developing agenda items for upcoming STESC meetings. The STAG taps into the expertise of its member organizations to facilitate information exchange on emerging technologies and opportunities where S&T could solve technical challenges with moving the operating forces toward the future force described in relevant concepts. The STAG also supports DC CD&I and CG, MCWL/Director, FD as the S&T advocate and proponent, respectively, in the development of the Marine Corps S&T Strategic Plan.⁹

4.6 Naval Research Enterprise

Overview

The primary means for executing Naval S&T funding falls to the Naval Research Enterprise (NRE) consisting of the Office of Naval Research (ONR), ONR Global, and the Naval Research Laboratory. CNR determines the strategic plan for naval S&T and leads the efforts of the broader Naval Research & Development Establishment (NR&DE).¹⁰ The NRE works to transition S&T projects and gets new technologies and



Figure 6. Naval Research and Development Establishment

capabilities into the hands of the warfighter through coordination with the NR&DE, specifically the Naval Warfare Centers and systems centers as well as the Program Executive Officers (PEO) and Systems Commands. For the Marine Corps, the “three circles” stakeholder communities (combat developer, material developer, technology developer) further integrate the combat development process into the naval S&T planning process.

ONR, as the lead organization for the management and execution of Naval S&T funding, is responsible for the development of projects from Basic Research to Advanced Technology Development and the eventual transition into 6.4 funding and a program of record within the NRD&E. It publishes the document *Naval Research & Development: A Framework for Accelerating to the Navy & Marine Corps After Next*. The “framework” is a new document that aligns the R&D continuum to corporate priorities, allocates resources to balance both short- and long-term uncertainties and seeks to accelerate capability delivery. Within ONR, Code 30 (led by the Expeditionary Maneuver Warfare & Combating Terrorism Department Head) is the primary organization focused on expeditionary and irregular warfare technology to support the Marine Corps’ S&T efforts. ONR’s overall organization is shown in Figure 7 below.

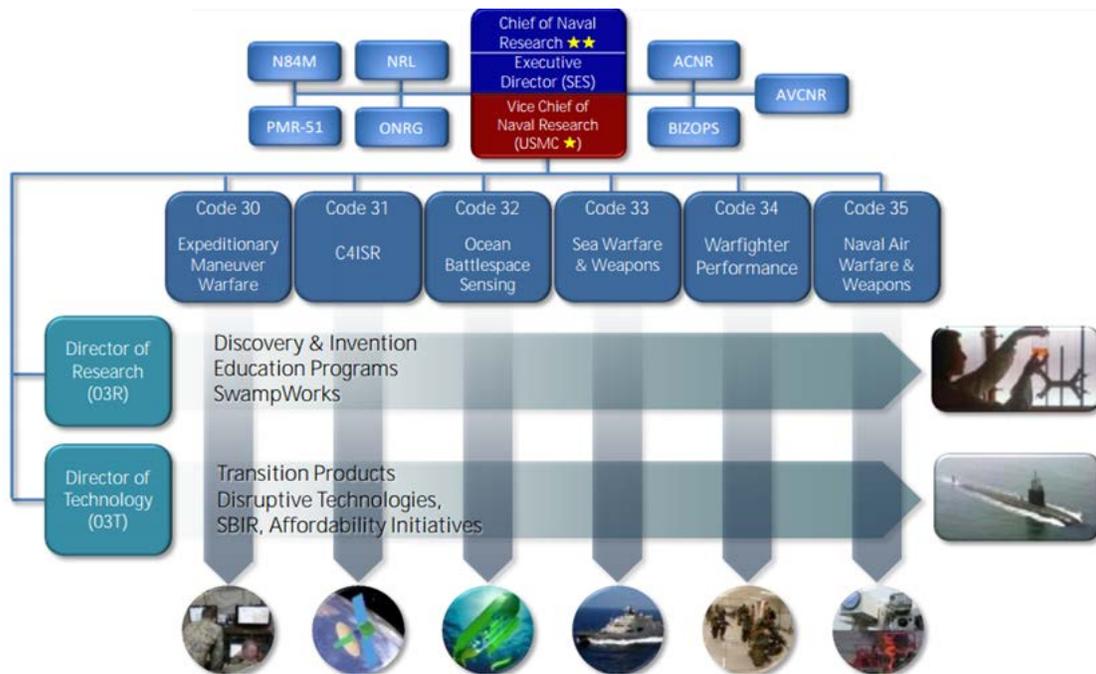


Figure 7. ONR Organization

Investment Portfolio

ONR organizes its S&T portfolio into investments based on anticipated project end states. It defines the missions of each of its Departments by the platforms or capabilities that the end state technology supports. ONR executes the funds in the portfolio depicted in Figure 8 through processes that facilitate tracking and oversight of execution.

Discovery & Invention (D&I) Portfolio. This research is primarily Basic Research, and Applied Research early in development focused on technologies that are 5-20 years out.

Innovative Naval Prototypes (INPs). INPs push technology boundaries to deliver transformational warfighting capabilities to the U.S. Navy and Marine Corps in 4-8 years. Programs in this category may be disruptive technologies, which for reasons of high risk or radical departure from established requirements and concepts of operation are unlikely to survive without senior leadership endorsement. Some examples include the Electromagnetic Rail Gun, Autonomous Aerial Cargo Utility System (AACUS) and Low-Cost UAV Swarming Technology (LOCUST) INPs.

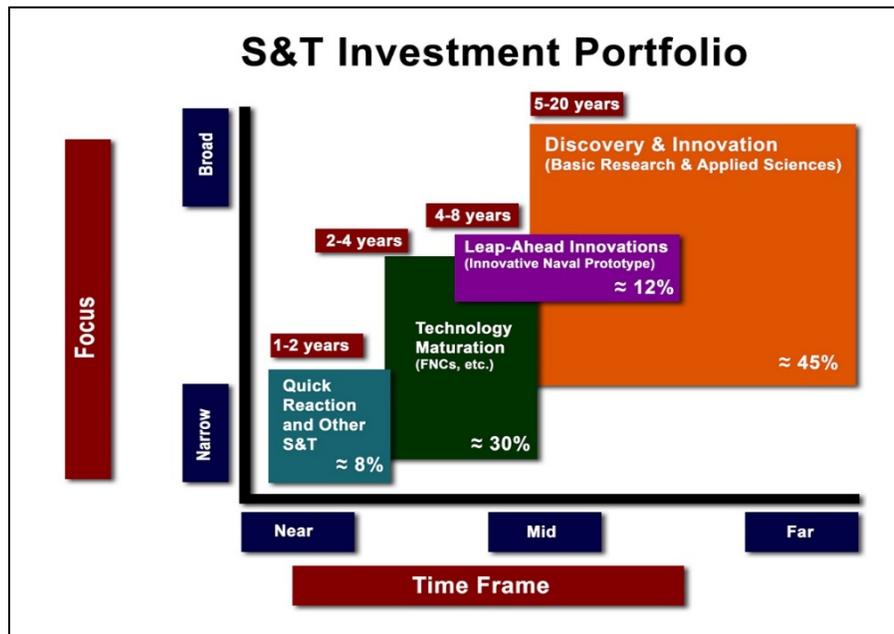


Figure 8. ONR S&T Investment

Future Naval Capabilities (FNCs). Within the Technology Maturation Portfolio, the FNC program seeks to provide Program of Record technology solutions within three years. The MCWL Office of S&T Integration (OSTI) coordinates Marine Corps input into the FNC process through the various Marine Corps stakeholders, with the ultimate customers being the Operating Forces and materiel developer organizations (PEO LS and MCSC).

Other ONR Processes:

- **SwampWorks** develops and demonstrates newly invented or recently discovered technologies that address emergent and enduring operational problems in an accelerated timeframe.
- **Naval Warfare Experimentation** develops prototypes using recent technology breakthroughs and provides them to the warfighter for experimentation during fleet battle experiments, limited objective experiments or sea trials.
- **TechSolutions (TS)** is a transformational business process created by the CNR to provide Sailors and Marines with a web-based tool for bringing technology needs to the NRE for rapid response and delivery. The program provides a direct means for the fleet and force to reach the S&T community and enables rapid development and delivery of prototypes. It ideally delivers a demonstration or prototype within 1 to 2 years.
- **Manufacturing Technology (MANTECH) Program** works with defense contractors, naval acquisition program offices, the Naval Research Enterprise, Navy acquisition program offices, and academia to develop improved processes and equipment. The program’s structure promotes timely implementation to strengthen the defense industrial base.

- **Small Business (SBIR/STTR).** SBIR is a competitive program that is designed to stimulate technological innovation, increase private sector commercialization of federal R&D, increase small business participation in federally funded R&D, and foster participation by minority and disadvantaged firms in technological innovation.

4.7 Marine Corps S&T Strategic Plan and S&T Capability Areas

The DC CD&I’s Capabilities Development Directorate (CDD), through its Capability Portfolio Managers (CPMs), assesses, develops, and integrates capabilities across the DOTMLPF solution space and manages cross-portfolio integration while participating in the future force development process.

To ensure the proper alignment of S&T projects within the future force development process, the Marine Corps STOs align with the JCAs as outlined in Table 1 below. In acknowledgment of the CPMs’ assessment and alignment role within the Marine Corps force development system, the CPMs led STO development within their capability area and associated three-circle stakeholder community organizations.



STO/ Capability Area	Lead	Functional Areas
1: Force Support	CDD JCA 1	Training and Education, Medical
2: Battlespace Awareness	CDD JCA 2	Intelligence, Surveillance, Reconnaissance
3: Force Application	CDD JCA 3	Force Maneuver, Fires, Seabasing, EW
4: Logistics	CDD JCA 4	Logistics, Expeditionary Energy, Seabasing
5/6: Command and Control/Communications and Computers	CDD JCA 5/6	C4, Cyber, EW
7: Protection	CDD JCA 7	Force Protection
8: Building Partnerships	CDD JCA 8	Irregular Warfare, Small Wars Center
9: Corporate Management & Support	CDD JCA 9	MAGTF Integration

Table 1. STO/JCA

The organization of Marine Corps STOs via the JCA “lens” seamlessly aligns technological and capability improvements with the force development process. This construct will not only focus S&T efforts in support of the Marine Corps Capabilities Based Assessment (MC CBA) process but also will allow S&T efforts outside the NR&DE to map to our objectives. The construct also provides for the potential of expanding the population of supporting technology developers, in part by using accepted joint force lexicon.

5.0 MARINE CORPS S&T OBJECTIVES (STOs)

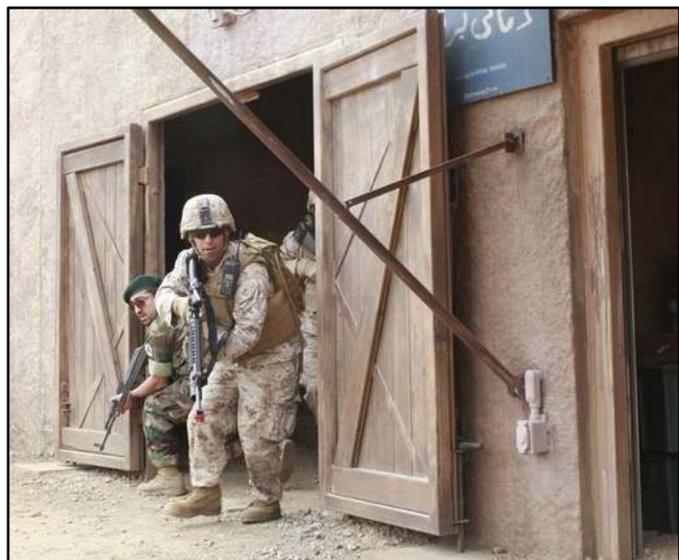
STOs provide combat development guidance to the S&T community, primarily within the NRE, but also to other Services, defense agencies, industry, and academia. STOs in this document are listed in priority order within each JCA area. STOs are also aligned with the current (POM 19) CBA process capability gaps.

5.1 Joint Capability Area 1 (JCA 1) – Force Support

Training and Education (T&E)

To enable Marines to succeed in increasingly volatile and complex environments, the Marine Corps seeks to provide Marines with the most effective and efficient training and education (T&E). S&T investments assist in developing capabilities that enable the Marine Corps of the future to be prepared to advance to contact, fight, and win where and when the Nation requires. The *Marine Corps Operating Concept* (MOC) communicates how the Marine Corps plans to fight in the future, outlines five critical tasks, and associated issues that must be addressed to ensure that the Marine Corps can adapt and win in a future operating environment. The Marine Corps' role as the Nation's premier expeditionary force in readiness means that it must be ready to conduct land, sea, and air operations essential to the prosecution of a naval campaign, expeditionary operations in the urban littorals and other challenging environments, amphibious operations, and power projection operations to assure access. The MOC calls for an agile, forward, and ready naval expeditionary force that can quickly respond when the Nation calls and effectively operate with resilience in contested environments characterized by complex terrain and technology proliferation. The MOC emphasizes the importance of naval, SOF, Joint, and coalition interoperability and integration across the full ROMO that will enable the Marine Corps to effectively deploy and employ as scalable units around the world. It is an expectation that all Marines and all Marine units are physically and mentally ready to deploy to every clime and place, at any time.

The Marine Corps Training and Education Command (TECOM) develops, coordinates, resources, executes, and evaluates T&E concepts, policies, plans, and programs to ensure Marines are prepared to meet the challenges of present and future operational environments. In accord with the MOC, the Marine Corps aims to exploit the competence of the individual Marine by training and educating Marines for the integrated naval force, developing Marines to effectively operate in complexity by leveraging simulation capabilities, developing leaders at every echelon, emphasizing quality in leadership, and supporting cultural learning at all levels of operations.



The primary TECOM entity that interfaces with the S&T community is the TECOM Science and Technology Working Group that facilitates coordination regarding S&T initiatives across the command. TECOM collaborates with MCWL to identify changing training and education needs as new warfighting concepts are developed and tested. The Program Manager for Training Systems (PM TRASYS)/MCSC, TECOM's primary acquisition partner, acquires and sustains training systems and devices. S&T is vital to developing and enhancing T&E capabilities that assist Marines in acquiring and sustaining the knowledge, skills, and abilities (KSAs) that are necessary for Marines to be ready to respond rapidly and operate effectively in every clime and place. Scientific products, tools, technologies, and training capabilities need to be based on proven cognitive, social, behavioral, and learning science principles to assist Marines with developing and maintaining the KSAs necessary to succeed on future battlefields.

The Vision: The Marine Corps will leverage S&T to provide the best trained and educated expeditionary force in readiness that is prepared to respond, fight, and win where and when the Nation requires.

The Marine Corps leverages innovative scientific knowledge products and technologies, including immersive training capabilities and simulation technologies, to meet the demanding T&E requirements across the ROMO. The desired end state is to leverage the range of S&T enablers to prepare Marines to succeed in distributed operations and increasingly complex environments around the world.

Goal: To obtain innovative T&E S&T capabilities to improve individual and collective performance across the full ROMO. S&T enablers must be effective, affordable, deployable, and scalable. To support Marine Corps T&E needs and requirements, S&T enablers must be able to integrate with current Marine Corps systems and interoperable with Marine Corps, other services, naval, joint, and partner nation capabilities so that Marines can train as they will fight.



T&E STO-1: Learning and Performance Assessment

The Marine Corps needs capabilities that substantially enhance learning and performance assessment and that can be easily employed by users to determine how well Marines are learning and applying their skills.

- Develop integrated multidisciplinary evaluation technologies and methodologies based on learning, performance, and cognitive science research, scenario-based measures to enhance feedback and after-action review (AAR), and results that can be easily exported to other Marine Corps systems.

- Develop valid and reliable scientific products and affordable technologies to unobtrusively assess and enhance learning, performance, situational awareness, unit cohesion, and team coordination in realistic training environments.
- Develop knowledge products and tools to better identify, develop, and assess Marines' KSAs so that Marines can obtain and maintain the necessary KSAs more efficiently.
- Develop scientific tools and technologies that reliably and accurately assess human performance and learning transfer and effectiveness. These tools need to be affordable and unobtrusive, and capable of being integrated into the design and implementation of Marine Corps instructional products, training systems, and simulations/simulators.
- Develop performance assessment tools that augment instructors' assessments, address the nuances of the wide range of training task performance and learning objectives, and are appropriate for the learners' specific developmental (i.e., mastery) level.
- Further develop andragogical models grounded in outcome-based learning that assist with understanding, development, and assessment of higher order cognitive skills.

T&E STO-1 maps to the following Program Objective Memorandum (POM) 19 gaps:

- 19-3.1.1-G16: Ground maneuver element live-fire training
- 19-3.1.1-G17: Ground maneuver element operating environment training
- 19-8.2.3-G2: Stability operations effects assessment
- 19-8.2.3-G3: Train and educate forces to conduct Counter-Insurgency (COIN)

T&E STO-2: Experiential Learning Technologies and Methodologies

Innovative experiential learning technologies and methodologies are needed to increase the capacity, realism, scalability, and quality of T&E. Multidisciplinary scientific products and technologies should seek to optimize practical exercises and experiential learning across the cognitive, psychomotor, and affective domains. Because of limited time, resources, range areas, and the limited number of role players, Marines need enhanced capabilities to engage in realistic tactical, cultural, and behavioral interactions in live, virtual, and distributed learning environments. Additionally, Marines need systems to provide greater situational awareness for after-action review of live fire and force on force training evolutions. T&E technologies must provide timely, focused individual and collective performance feedback and assessment at the point of need.

T&E STO-2 maps to the following POM 19 gaps:

- 19-3.1.1-G17: Ground maneuver element operating environment training
- 19-1.2.1-G3: Pacific Command (PACOM) training ranges and training areas
- 19-8.2.3-G3: Train and educate forces to conduct COIN

T&E STO-3: Warrior Decision-Making



In the complex and unpredictable modern battlespace, small unit leaders have to make difficult decisions with incomplete information, while functioning as distributed teams. These decisions have previously been made by more senior and experienced Marines. Scientific products and technologies are needed to assist Marines at all levels to better prepare for combat. S&T products are needed to assist Marines in making better, timely

decisions in ambiguous and dangerous conditions, and execute to achieve the commander's intent. Low cost, deployable training technologies are needed that can be effectively operated in expeditionary field conditions to provide realistic, tactical decision-making scenario based training for individual Marines, small distributed units, and tactical operations center staffs. Develop innovative capabilities to enhance the maturity of small unit leadership and increase the cognitive, relational, and perceptual skills for small unit leaders to make sound tactical and ethical decisions in distributed operations. Enhancements and capabilities include, but are not limited to attentional control, expertise, situational awareness, cognitive readiness, and accelerated learning. Develop capabilities to support the entire T&E continuum to assist in developing critical reasoning and ethical decision-making in scenarios spanning the full ROMO.



T&E STO-3 maps to the following POM 19 gaps:

- 19-1.2.1-G4: Military Operational Specialty (MOS) and skills progression training
- 19-1.2.1-G10: Immersive training capability
- 19-1.2.1-G5: Division (DIV) training and exercising enhancement
- 19-3.1.1-G16: Ground maneuver element live-fire training
- 19-3.1.1-G17: Ground maneuver element operating environment training
- 19.8.2.3-G2: Stability operations effects assessment
- 19-8.2.3-G3: Train and educate forces to conduct COIN

T&E STO-4: Warrior Resilience

The term Marine is synonymous with young men and women who are disciplined, smart, physically and mentally tough, and who always remain faithful to each other and to our Corps. Marines need to be able to remain mentally and physically resilient, and be able to endure extended exposure to stressful and ever-changing situations, while exhibiting the highest standards of tactical, ethical, and moral leadership. The Marine Corps needs scientific knowledge products and technologies that will enhance training for individual and collective resilience that can be easily used both in garrison and during deployment. The objective is to develop T&E products that will enhance mental and physical skills, fitness, MOS proficiency,

leadership, endurance, and recovery from stressors so that Marines will not only better address the challenges of combat, but develop and sustain skills to excel in complex and demanding environments over time. Develop tools, methods, and measures to better address the mental, physiological, and social factors that affect the stress response, resilience, fitness, performance, and recovery. Develop innovative, valid, and reliable tools to train, assess, and monitor mental and physical fitness training at the individual, unit, and organization levels in real-time.



Develop valid and reliable tools to select for critical positions that require high resiliency and resistance to stressors.

T&E STO-4 maps to the following POM 19 gaps:

- 19-1.2.1-G4: Military Operational Specialty (MOS) and skills progression training
- 19-1.2.1-G5: Division (DIV) training and exercising enhancement
- 19-1.4.1-G4: Dismounted ground maneuver element health monitoring
- 19-9.2.3-G1: Enterprise monitoring and assessment (includes strategic health assessment)
- 19-8.2.3-G3: Train and educate forces to conduct COIN

T&E STO-5: Warrior Simulation and Adaptive Entities

In combat, the Marine Corps succeeds with mission tactics founded on implicit communications forged in the crucible of demanding and realistic training. Enhanced, innovative simulation capabilities are needed to improve training realism and ensure that Marines can train as they would fight. Simulations need unobtrusive, embedded assessment capabilities to improve learning transfer to live conditions and maximize after action review capabilities. Simulations need to broaden training opportunities, increase the amount of training that cannot be conducted live due to resource constraints or safety considerations and maximize the return on investment/cost offset of these valuable investments. Capabilities are needed to address the Marines' need to train kinetic and non-kinetic skills in complex environments containing realistic, adaptive constructive entities. Develop behaviorally accurate simulation entities representing a variety of opposing forces, cultures, indigenous populations, and others in the operating environment. These capabilities should provide increasingly demanding challenges to progressively build critical thinking and decision-making skills in complex environments. Simulation capabilities are needed to enable Marines to shoot, move, and communicate using the full range of equipment functions in training to assist with training transfer. Marines need training simulations to be interoperable and contain the full complement of Marine Corps tactical equipment to include radios, command and control, and target location/designation. Simulation capabilities are needed that enable the synthetic environment to stimulate and be stimulated by Marine Corps tactical equipment. Marines need to be able to train against cunning, adaptive, and innovative simulated enemies representative of those that they would face. Enhanced entity behaviors are needed to provide Marines with behaviorally realistic reactive threats that not only effectively provide a dynamic opposing enemy, but also model blue force behaviors and the behaviors of others that Marines would encounter in the environment. Marine Corps staff training needs capabilities that better account for Diplomatic, Information, Military and Economic

(DIME) actions and the Political, Military, Economic, Social, Information and Infrastructure (PMESII) effects within the operating environment. Develop capabilities that accurately and realistically simulate all major elements of power, including DIME actions and PMESII effects that comprise the operational environment so that Marines at all levels will be able to "train as they fight" to support realistic training. Capabilities are needed that enable Marines to better train to fight from the sea and in denied amphibious environments.

T&E STO-5 maps to the following POM 19 gaps:

- 19-1.2.1-G1: Seabasing force preparation
- 19-1.2.1-G4: Military Operational Specialty (MOS) and skills progression training
- 19-1.2.1-G5: Division (DIV) training and exercising enhancement
- 19-1.2.1-G10: Immersive training capability
- 19-3.1.1-G12: Dismounted ground maneuver element C2 capability
- 19-3.1.1-G16: Ground maneuver element live-fire training
- 19-3.1.1-G17: Ground maneuver element operating environment training
- 19-8.2.3-G3: Train and educate forces to conduct COIN
- 19-8.2.5-G1: III MEF MAGTF tactical warfare simulation training



T&E STO-6: Live, Virtual, and Constructive Training Environment across the MAGTF

Marines need capabilities that support MAGTF integration so that they are able to encounter their initial tactical and ethical dilemmas in a simulated battlespace vice actual combat and be ready to fight together as a MAGTF in every clime and place. The Marine Corps Live, Virtual, and Constructive-Training Environment (LVC-TE) combines a combination of the three training domains (live, virtual, and constructive) to create a common battlefield or environment by which units can seamlessly interact across LVC domains as though they are physically located together in the same battlespace. The LVC-TE will provide the means to conduct realistic, collaborative training and exercise of warfighting functions across the full range of military operations. The LVC-TE will be the Marine Corps means for addressing capabilities identified in the Joint Training Functional Concept (JTFC).

The Marine Corps may achieve these capabilities by executing the following strategies (or tasks, as necessary) in support of improving learning and performance assessment:

- Develop affordable capabilities to support the Marines' need to train and rehearse in an environment that is similar to the operational environments that they will encounter during their missions.
- Develop a training environment that can be accessed both in garrison or while deployed that behaves realistically and provides accurate cues to stimulate Marines' senses so that they will learn to respond appropriately.
 - The training environment needs to provide an efficient, interoperable capability so that Marines can use their current equipment, conduct distributed training, train with other Services and partner organizations in real-time, and be compliant with the Global Information Grid supporting simulation training systems and platforms.
- Develop capabilities to facilitate small unit dismounted virtual or augmented reality operations as a complement to live training.

- Simulations should provide real-time effects and realistically engage the senses during challenging, rapidly reconfigurable scenarios to increase small units' opportunities to train.
- Develop capabilities to realistically simulate entities, systems, munitions (friendly and enemy), electromagnetic warfare, cyber effects, space operations, and their effects within live, virtual, and constructive training environments.
- Develop the ability to simulate operational equipment used in live training environments from virtual or constructive environments, to improve the capability of simulations to augment and enhance live training opportunities, and to reinforce realistic training using actual equipment as often as possible in conjunction with simulators and simulations.
- Develop and provide an affordable direct export/import capability for geospatial and capability data, so that real-world data can be integrated into the training environment.
- Develop a common training environment that Marines can share and exchange relevant tactical training information to create a common understanding, supporting LVC-TE concept.

T&E STO-6 maps to the following POM 19 gaps:

- 19-1.2.1-G1: Seabasing force preparation
- 19-1.2.1-G10: Immersive training capability
- 19-3.1.1-G12: Dismounted ground maneuver element C2 capability
- 19-3.1.1-G16: Ground maneuver element live-fire training
- 19-3.1.1-G17: Ground maneuver element operating environment training
- 19-5.5.1-G1: Interoperability with mission partners
- 19-8.2.3-G3: Train and educate forces to conduct COIN
- 19-8.2.5-G1: III MEF MAGTF tactical warfare simulation training

T&E STO-7: Tactical Cyber and Electronic Warfare (EW) Training Tools

Emerging technologies can rapidly transform how populations live, influence the balance of power, and create new security challenges. Threats will continue to include the proliferation of modern conventional, asymmetric, and cyber weapons, violent extremism, transnational crime, and piracy. Marines will have to fight not only in the domains of land, sea, and air, but also in space and cyberspace. It is increasingly critical for the MAGTF to better understand and seize opportunities in the cyber and EW domains, while meeting the associated challenges. Today, most equipment includes microchip controls and components, the number of microchips on the battlefield is proliferating rapidly, and interconnecting these components into networks is increasing. Less widely recognized, however, are the implications of cyber and EW vulnerabilities and the need for cyber training at the tactical level for Marines in all domains. The benefits of such developments must be balanced by awareness and training of the vulnerabilities that equipment can have to cyber and EW attack. Although specialists (e.g., Radio Battalions) understand the capabilities and employment of cyber and EW capabilities, tactical commanders can also benefit from enhanced cyber and EW training to better understand how to employ capabilities and defend against/mitigate the effects of cyber and EW attacks. Scientific knowledge of developing technologies for rapidly training large numbers of Marines at tactical levels in cyber and EW effects are needed because these domains are changing so rapidly and can affect other warfighting capabilities. The end state is to develop innovative training capabilities that will help increase the capacity and capability of all levels of the MAGTF to operate in and exploit the cyber and EW domains. Therefore, S&T is needed to:

- Develop capabilities that will improve training for planning, employing, targeting, coordination and leveraging offensive and defense cyber and EW capabilities for warfighting and crisis response across the MAGTF.
- Develop capabilities that will improve training for mounted and dismounted small units (company and below) in a distributed, population dense, cyber and EW rich environment by enhancing situation awareness, communication, understanding of effects, and increasing the ability of small units to maneuver and dominate their battlespace to achieve mission success.
- Develop capabilities that will assist Marines to sense, adapt to, and counter emerging cyber and EW threats in their battlespace, supporting kinetic and non-kinetic operations.

T&E STO-7 maps to the following POM-19 gaps:

- 19-1.2.1-G9: Information Warfare (IW)/Cyber mission force training
- 19-2.2.1-G2: Electronic warfare support
- 19-2.2.4-G1: Cyber Intelligence, Surveillance, and Reconnaissance (ISR)
- 19-3.1.1-G16: Ground maneuver element live-fire training
- 19-3.1.1-G17: Ground maneuver element operating environment training
- 19-3.2.2-G2: Electronic attack
- 19-5.2.2-G1: Understanding the electromagnetic environment
- 19-5.3.2-G1: Cyberspace operations planning for enabling operations
- 19-5.3.2-G3: Cyberspace operations planning coordination
- 19-5.3.2-G2: Cyberspace operations planning Command and Control (C2)
- 19-5.3.2-G4: Implication of cyber effects
- 19-5.6.2-G2: Cyber indications and warnings
- 19-5.6.2-G3: Cyber combat assessments
- 19-6.1.1-G14: Sense the electromagnetic environment
- 19-8.2.3-G3: Train and educate forces to conduct COIN
- 19-8.2.4-G4: Cyber analysis of intelligence/situational awareness

T&E STO-8: Socio-Cultural Research and Tools

Marines need to be educated and trained to understand and operate in complex environments wherever the President may direct. To do so, Marines need to understand not only the anticipated specific populations, partners, and enemies, but also to obtain new knowledge and act effectively in complex unexpected or rapidly changing cross-cultural situations. Sources of conflict will include water, energy, and food scarcity, weak governments resulting in ungoverned spaces, territorial and tribal disputes, and regional competition. The Marine Corps needs innovations in effective, sustainable, and accurate approaches and tools to support development of Culture, Region, and Language (CRL) capability through training and education. CRL capability is construed broadly to include knowledge and skills that, in combination, comprise cross-cultural competence. These include, but are not limited to, regional knowledge, culture-specific knowledge, language, and culture-general concepts and skills.

The Marine Corps may achieve these capabilities by executing the following strategies (or tasks, as necessary) in support of improving learning and performance assessment:

- Develop innovative andragogical strategies and delivery methods for Marine Corps CRL content.
- Develop andragogically sound approaches to culture general training and education.
- Develop approaches and tools that enhance development and retention of language familiarization and language proficiency.
- Develop scientifically valid, updatable approaches to CRL-related simulation, including, but not limited to avatars, pattern of life, and geospatial modeling of cultural landscape features that are interoperable with other Marine Corps training and education M&S systems, and can be aligned with Service approaches to CRL.
- Develop reliable tools to support real-time reach back to Marine Corps subject matter experts for cultural advising and/or research and analysis. These tools should allow collaboration to ensure full understanding of requirements and operationally relevant answers.
- Develop tools to allow existing content and expertise to be leveraged across commercially available devices and platforms.
- Examine the viability of the use of fictitious cultures, designed around learning objectives for training, education, and exercises. Both innovative scientific knowledge outcomes and technology outcomes are needed within this objective.



T&E STO-8 maps to the following POM 19 gaps:

- 19-1.2.2-G7: Civilian role players and AAR technology for SLTE and OPFOR MEX/MEBEX training
- 19-1.4.1-G5: Medical stability operations
- 19-3.1.1.-G23: Mission partner tactical situational awareness
- 19-3.1.4-G5: MAGTF Personnel Recovery (PR) operations training
- 19-3.2.2-G2: Electronic attack
- 19-5.5.1-G4: Provide mission partner environment
- 19-8.1.2-G1: Cultural and language awareness training
- 19-8.1.3-G5: Develop host nation civil security forces
- 19-8.2.3-G2: Stability operations effects assessment
- 19-8.2.3-G3: Train and educate forces to conduct COIN
- 19-8.2.4-G1: Teach basic advising
- 19-8.2.4-G4: Develop partner nation security forces engagement plan
- 19-8.2.3-G5: Support foreign police development
- 19-8.2.4-G5: Surge advisor capacity

Medical

The S&T investment in medical is directed toward the expansion and development of a comprehensive expeditionary system to meet the specific medical requirements of Marine Corps Operations with particular attention to requirements during combat. These requirements align to and fully support the *Commandant's Marine Corps Vision & Strategy 2025*. The Science and Technology Objectives (STOs) for medical are organized by the elements of: *Casualty Management, Force Health Protection and Prevention, and Medical Logistics*. The prioritization of these STOs is due to limited resources within the Marine Corps for Medical Research & Development (R&D). This prioritization also assumes that the Department of Defense is actively pursuing research in other relevant areas where the Marine Corps and the Joint Forces share medical equities. In addition, medical S&T initiatives will be designed for full integration into the USMC S&T Strategic Plan.



The Vision: An integrated and modular medical system that provides Commanders with medical situational awareness, far forward resuscitative care, and scalable logistics solutions to meet the unique requirements of the Marine Corps during combat.

Goal: To develop systems and technologies to meet Naval/Marine Corps medical ability to support the future expeditionary nature of the Marine Corps. The Naval Medicine S&T planning process will identify and prioritize relevant capability gaps, requirements, and emergent needs for the next generation of Force Health protection and Expeditionary Medicine. The process owners will both develop and champion a high level investment strategy in support of Naval Medicine and Marine Corps strategic goals for research of operational readiness, military health care, and health promotion.

Med STO-1: Casualty Management: Stabilize Far Forward for Movement toward Definitive Care.

Casualty Management: Stabilize activities develop technologies that improve forward resuscitative care activities, mitigate the effects of trauma on morbidity and mortality, and prepare casualties for evacuation. Medical assets are placed within supporting distance of the supported maneuver forces, but not close enough to impede ongoing combat operations. Most immediate S&T efforts should focus on the following areas:

- Non-compressible and compressive hemorrhage control that also provides infection control and bone wound healing acceleration. There is need for a new class of hemostatic agent that can function independently of host coagulation activity.
- Suitability studies on the administration of Tranexamic Acid as far forward as possible, to include Company level corpsmen. Tranexamic Acid is used to prevent or to treat excessive blood loss from trauma.
- Development of Class VIII delivery UAV/UAS to meet the expeditionary nature of the Marine Corps.
- Realistic pre-hospital training modalities for breathing, circulation, burn, fracture, amputations, and laceration for all medical staff. This should also include surgical airway training methods.

- Provide the Commander with situation awareness of forward resuscitative care activities through integrating medical-focused information into the existing common operating picture. Similar information needs to be automatically provided to the logistics combat element and to medical regulators.
- Explore physiological effects upon of casualties during unpiloted CASEVAC. Explore the systemic implications (DOTMLPF-P) of use of unmanned CASEVAC during sea-based operations ashore.

Med STO-1 maps to the following POM 19 gaps:

- 19-1.4.1-G1: Point of injury, Casualty Evacuation (CASEVAC), enroute care
- 19-1.4.1-G3: Health service (AMAL/ADAL)



Med STO-2: Casualty Management: Preserve.

Casualty Management: Preserve activities prevent loss of life and limb; transfuse blood and blood products, maintain sensory systems, brain function, and minimize pain. Most immediate S&T efforts should focus on the following areas:

- Improve the ability to transport, store and monitor the condition of blood products in austere environments. Due to the perishability of all blood products, blood transportation and blood storage solutions will need robust temperature monitoring (to the individual packaged unit level), improved ability to track each packaged unit in far forward locations, redundant power, and high grade, light weight insulation.
- Improve quality and quantity of shelf stable blood products, to include freeze dried plasma.
- Advance burn care methods, products, and initial treatment approaches for burns far forward, to include fluid resuscitation.
- Advance the ability to control of internal bleeding without surgical access.
- Develop an automated casualty care system that is small, lightweight (under 20 lbs), is compatible with over 75% of standard issue litters, and has the ability to maintain a critically injured/ill patient for a minimum of two hours without any degradation in clinical status.
- Improve hypothermia prevention and patient warming equipment to automatically detect the casualty's temperature (or receive information from temperature sensors), raises the temperature of the casualty to the desired level, and maintains the desired temperature across the evacuation chain. Patient warming equipment should silently operate. Patient warming equipment elements should be designed as patient movement items, to maintain consistency across the evacuation chain and minimize need for patient handling.
- Improve the quality and availability of artificial resuscitation fluid(s) designed to increase blood volume, deliver oxygen to ischemic tissues, replenish coagulations factors depleted by hemorrhage, and modulate immune response.



Med STO-2 maps to the following POM 19 gaps:

- 19-1.4.1-G3: Health service (AMAL/ADAL)
- 19-1.4.1-G4: Dismounted ground maneuver element health monitoring

Med STO-3: Casualty Management: Repair and Resolve.

Casualty Management: Repair and Resolve activities focus on interventions following resuscitative care and on activities that treat patients to optimize outcomes (preserve, ensure, and restore physical and psychological function). Most immediate S&T efforts should focus on the following areas:

- Develop single man-carry/portable oxygen generators/concentrators that provide 15 liters per minute flow rate and a 90% concentration.
- Develop single man-carry/portable sterilization methods for surgical instruments. Sterilizers should require low/no power. Sterilizers should be compact, designed for use in very small working spaces.
- Develop novel analgesics/anesthetics suitable for use in the field environment and for long-term pain management.



Med STO-3 does not map to any POM 19 gaps.

Med STO-4: Force Health Protection and Prevention: Assess.

Force Health Protection and Prevention: Assess activities analyze the environment, the service member's operational requirements, service member's medical readiness requirements for future operations and activities, service member's health and readiness, and assess the institutional capabilities Operational Medicine provides to the Joint Force. Most immediate S&T efforts should focus on the following areas:

- Understanding technologies that will minimize the physiological and psychological effects of extreme heat and cold in operational settings. Explore how extreme conditions affect unit cohesion, communication, problem solving, and overall effectiveness at individual and group levels. Explore mitigation techniques through incorporating advanced technologies and training.
- Understanding the longer-term impact of combat-related concussion/MTBI and comorbid PTSD on combat veterans' health and well-being.
- Understanding the physics of blast upon the brain and vital organs (to include repeated exposure to lesser intensity explosions such as those experienced in training and with artillery units). Explore the ability of different types of body armor to mitigate these effects. Explore the feasibility of small, lightweight sensors to record instantaneous, near term, and long term exposure to blast/impact (e.g., clip-on recorders similar to personal dosimeters).
- Provide situation awareness to the Commander of the health status of his forces through integrating medical-focused information into the existing common operating picture.



Med STO-4 maps to the following POM 19 gaps:

- 19-1.4.1-G2: Health system support – Garrison
- 19-1.4.1-G4: Dismounted ground maneuver element health monitoring

Med STO-5: Force Health Protection and Prevention: Protect.

Force Health Protection and Prevention: Protect activities safeguard and restore a service member's fitness and health, including measures to prevent, protect, and counter immediate, adverse effects of the

threats, hazards, and stressors presented by environments and adversaries. Most immediate S&T efforts should focus on the following areas:

- Being able to immediately test for the presence of chemical, biological, and/or blood pathogens at forward locations with hand held detection devices to reduce morbidity and mortality in the field. Devices should be designed (hardware and software interface protocols) to be able to connect to program of record communications/data transmission equipment, allowing transmission of these results to provide situation awareness to the Command through integrating medical-focused information into the existing common operating picture.
- Developing realistic injury models that facilitate understanding the energy transfer to/through bone and tissue and the resultant biological response during combat and training.
- Developing predictive auditory performance models influenced by realistic operational and training environments.

Med STO-5 maps to the following POM 19 gaps:

- 19-1.4.1-G4: Dismounted ground maneuver element health monitoring



Med STO-6: Force Health Protection and Prevention: Sustain.

Force Health Protection and Prevention: Sustain activities maintain the service member's fitness and health over their lifecycle, including health monitoring/surveillance, long-term maintenance/restoration of fitness and health. Most immediate S&T efforts should focus on the following areas:

- Exploring psychosocial aspects of managing pain to include sleep management and professional development.
- Researching the failure to maintain lean body mass and activities of daily living during prolonged healing periods.
- Developing metrics and standards by which to measure fitness/conditioning and preexisting injuries/conditions to determine the likely impact on readiness.
- Assess the relationship between sleep disruption and dysfunction and physical and psychological health during training and combat operations.

Med STO-6 maps to the following POM 19 gaps:

- 10-1.4.1-G2: Health system support - Garrison

Med STO-7: Force Health Protection and Prevention: Optimize.

Force Health Protection and Prevention: Optimize activities that optimize a service member's performance to reach a required baseline of performance, and then if able, improve the service member's performance beyond that baseline. Most immediate S&T efforts should focus on the following areas:

- Developing science-based models able to predict individual environmental (heat, cold, and altitude) tolerance in training and operational settings.

- Understanding the relationship between an individual’s body composition, physical fitness, and likelihood of sustaining injury in both a non-deployed and deployed environment.
- Developing a fatigue intervention and recovery model that can predict average individual performance across 0–48 hours of sleep loss and that incorporates the effects of post-mission recovery rates, variability in effects of sleep loss, and fatigue countermeasures.
- Understanding of the role of physical fitness as a factor in individual resistance to disease.



Med STO-7 maps to the following POM 19 gaps:

- 10-1.4.1-G2: Health system support - Garrison

Med STO-8: Medical Logistics: Predictive.

Medical Logistics: Predictive activities develop the ability to predict and fulfill the medical supply and maintenance requirements of modular medical force elements as they aggregate and/or disaggregate with other modular elements provided by health service mission partners. Most immediate S&T efforts should focus on the following areas:

- Developing predictive models to support logistics and planning for water requirements in support of forward-based medical operations. Provide situation awareness to Commanders of these results through integrating medical-focused information into the existing common operating picture. Similar information needs to be automatically provided to the logistics combat element and to medical regulators.
- Developing predictive models to inform Class VIII and blood products available supply at the sea-base during combat operations. Provide situation awareness of these results through a medical common operating picture.
- Developing predictive models to inform Class VIII and blood products for push and pull resupply down to the platoon level during sea-based combat operations. Provide situation awareness of these results through a medical common operating picture.
- Developing automated flight and mission planning for unmanned delivery of Class VIII supplies for sea-based operations ashore.



Med STO-8 maps to the following POM 19 gaps:

- 19-1.4.1-G3: Health service (AMAL/ADAL)
- 19-1.4.1-G5: Medical stability operations
- 19-1.1.1-G5: Casualty estimation system with grade and MOS

Med STO-9: Medical Logistics: Modular and Interoperable Medical Capabilities.

Medical Logistics: Modular and Interoperable Medical Capabilities are activities that meet a core set of Joint standards and requirements while also conforming to Service specific requirements. Most

immediate S&T efforts should focus on the following areas:

- Developing interoperable (V-22, CH-53, C-130 AAV, and LCAC platforms) resuscitative care capability sets, distinct from current authorized medical allowance list (AMAL) configurations, for forward resuscitative care far forward from the sea-base. Systems should be scalable to support battalion to company level operations.
- Developing interoperable “care on and carry off” capability sets for inflight resuscitative care and enroute care teams aboard V-22, CH-53, C-130 AAV, and LCAC platforms.
- Based upon consumption patterns observed in current and representative historic operations, create a model-based application to identify the most commonly used blood and medical consumable supplies. These supply kits should be distinct from the current AMAL configurations. These supply kits (also known as “speedballs”) should be designed for quick-reaction, modular based, predictive push logistics, to include blood and other consumables, for sea-based operations that will conform to the restrictions of the V-22, CH-53, C-130 AAV, and LCAC platforms. Ensure that speedball movement ashore is tracked through integrating medical-focused information into the existing common operating picture, logistics planning tools, and interoperable with autonomous delivery systems.

Med STO-9 maps to the following POM 19 gaps:

- 19-1.4.1-G1: Point of injury, Casualty Evacuation (CASEVAC), enroute care
- 19-1.4.1-G3: Health service (AMAL/ADAL)

5.2 Joint Capability Area 2 (JCA 2) – Battlespace Awareness

Intelligence

The S&T investment in intelligence is directed toward the expansion and development of a comprehensive Intelligence, Surveillance, and Reconnaissance (ISR) Enterprise that supports all elements of the intelligence cycle: Planning and direction, collection, processing and exploitation, production, dissemination, and utilization. As importantly, S&T investment must enable a Marine Corps ISR Enterprise (MCISRE) that can Sense, Make Sense and Act across the five warfighting domains in which the Force 2025 Marine Air Ground Task Force (MAGTF) will operate. The warfighting domains of Space and Cyberspace, to include the information environment, will be as important to future Marine intelligence operations as the traditional domains of Air, Land and Sea.

The Vision: An integrated intelligence architecture that provides Commanders and individual Marines with both the situational awareness and understanding of their battlespace necessary to accomplish their assigned missions from the individual position to the Marine Expeditionary Force Command Operations Center.

The intent is a continuously improving MCISRE that is capable of conducting reconnaissance, surveillance, target acquisition, analysis and assessment functions that enable Marines to engage and influence in all five warfighting domains. This intelligence enterprise leverages the Joint, Coalition and national ISR architecture and seamlessly accesses and blends intelligence



information from them with that collected by MAGTF organic assets. This enterprise is underpinned by a robust and resilient transport layer, at multiple classification levels, that provides the ability to rapidly move data across the battlefield, providing timely intelligence to every warfighter and across every level of the MAGTF.

Goal: Develop a more responsive, comprehensive capability at every level of the MAGTF to collect and analyze data, develop useable intelligence products, and then quickly distribute relevant intelligence products to users across the battlefield. As stated in the Director of Intelligence MCISRE Plan, the future state of the operational enterprise design “shares information across a unified knowledge enterprise that extends to tactical formations, continuously operates in garrison and seamlessly projects the intelligence warfighting function forward in support of multiple, simultaneous MAGTFs. To achieve this goal, data and information must be conditioned, curated and accessed utilizing a modernized information architecture that relies on “Big Data” analytics and is supported by an information/data provisioning schema that is commensurate with commercial global knowledge management frameworks. Tactical units require on demand access to integrated sensor data and finished intelligence products supported by communication across significant distance and the ability to receive precisely tailored information that is relevant to their current situation to support a rapid decision-making cycle. Science and technology investments that focus on next generation user interfaces, backend automated analytics, and resilient transport mechanisms that gracefully degrade thereby allowing the enterprise to “maneuver in the electromagnetic spectrum” will positively influence the results of future intelligence operations in all five dimensions that the Force 2025 MAGTF will operate.



Intel STO-1: “Big Data” Analytics and Infrastructure for Intelligence and Operations

Develop tools that utilize Big Data Analytics in support of Intelligence and Operations. The rise of social media and an increasingly complex application infrastructure creates an unprecedented management challenge for intelligence and operational professionals. As joint and national intelligence producers mature their infrastructure it provides tactical intelligence professionals an opportunity to utilize that information to drive better informed decisions based on operational realities and with shorter decision cycles. However, this presents Intelligence Analysts with significantly more data to analyze and drives a need to combine new



technology and legacy tools to gather this diverse data. USMC requires new analysis tools that can handle this data volume at speed to produce intelligence.

Intel STO-1 maps to following POM 19 gaps:

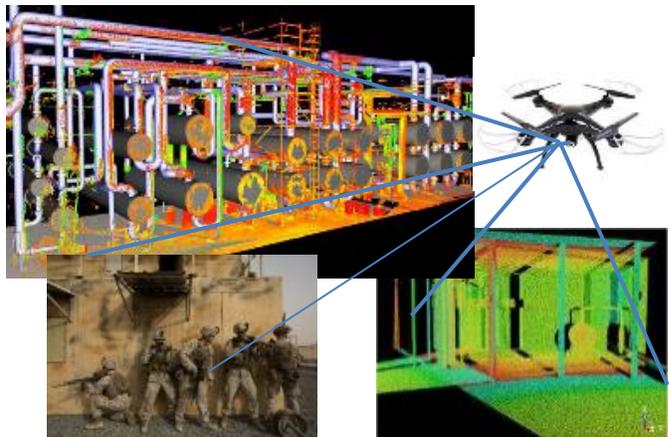
- 19-2.2.1-G3: Intelligence processing and exploitation
- 19-2.5.0-G1: Disseminate and integrate intelligence
- 19-2.2.4-G1: Cyber intelligence, surveillance, and reconnaissance
- 19-5.5.1-G3: Tactical situational awareness
- 19-2.4.0-G1: Intelligence production

Intel STO-2: Near real time collection tasking and analytic response

Develop software tools to allow for dynamic interaction between collection management processes and sensors. Such tools should allow for: 1) Analysts and tactical users to request collection in real time based on emergent information requirements; 2) tailored support provided to small unit leaders with limited bandwidth and computing power. Develop software tools to provide question answering and semantic search capabilities to warfighters and intelligence analysts. Develop ontologies that are dynamic and able to incorporate probability.

Intel STO-2 maps to following POM 19 gaps:

- 19-2.2.1-G1: Planning and directing intelligence & reconnaissance collection management
- 19-2.2.1-G3: Intelligence processing and exploitation
- 19-2.5.0-G1: Disseminate and integrate intelligence
- 19-2.2.4-G1: Cyber intelligence, surveillance, and reconnaissance



Intel STO-3: Intelligence Support to Cyber and Information Warfare

Develop technologies for Cyber ISR and Intelligence Analysis that enable an intelligence analyst to characterize the cyber battle space in a manner suitable for informing command decisions. Develop deployable technologies that will correlate data on cyber activities from outside USMC networks to sensor data within USMC networks. Attain a real-time capability to inform and predict imminent cyber-attacks based on information gathered by Cyber ISR Assets observing USMC networks' edges and correlated in real-time with data from various local network sensors. Create the ability to conduct Cyber Intelligence Preparation of the Battlespace and identify the equivalent of key terrain in the Cyber, Information and Electromagnetic Spectrum domains. Focus on technologies in this STO that create the intelligence picture to enable Electro Magnetic Spectrum Maneuver Warfare. Develop the technical capacity within the

intelligence portfolio to effectively support Information Warfare. Develop software and analytical tools to monitor, track, and synthesize multiple social media, news sources, and publically available web mission areas and topics of interest. Enhance tools for social media intelligence analysis production and fusion that will allow the utilization of social media in the op/intel cycle.



Intel STO-3 maps to following POM 19 gaps:

- 19-2.2.1-G3: Intelligence processing and exploitation
- 19-2.5.0-G1: Disseminate and integrate intelligence
- 19-2.2.4-G1: Cyber intelligence, surveillance and reconnaissance (8)
- 19-2.2.1-G4: Cyber collection (1)
- 19-2.2.1-G1: SIGINT collection
- 19-8.1.3-G4: Design, develop, and produce MISO products
- 19-5.3.4-G1 Electronic attack planning (to support Electromagnetic Spectrum Maneuver Warfare)
- 19-5.3.2-G3 Cyberspace operations planning coordination
- 19-2.2.1-G2 Electronic warfare support
- 19-5.3.2-G4 Implication of cyber effects
- 19-9.4.4-G2 Cyberspace operating environment

Intel STO-4: Tactical Intelligence/Operations Sensor Enabled Heads Up Display

Develop technologies that enhance tactical ground surveillance, intrusion detection, and force protection in the contested urban littoral of the future operating environment. Advance technologies that enable Counter Tactical Surveillance and Targeting Detection / neutralization of adversary ISR Systems including; detection of optics used for observation and recording, such as binoculars and camcorders, small commercial Unmanned Systems, and information environment enabled sensors enabled by state and non-state actors turning civilian IT infrastructure into a surveillance network targeting friendly forces. Enhance our ability to address emerging needs in irregular, asymmetric and hybrid warfare such as captured material exploitation, and pandemic/environmental propagation analysis, and Chemical, Biological, Radiological, Nuclear and Explosive (CBRN-E) detection, identification, and mitigation. These technologies address improvised and unconventional weapon modalities such as dirty bombs and biological agents, and they also enhance HA/DR capabilities. Develop the capability to detect and locate enemy personnel and caches in civilian and heavily populated urban environment. Future MAGTF Sensors must be netted and feed an information environment that is populated with operational and intelligence data at multiple classification levels, displays that information to individual Marines, commanders, and intelligence analysts in a way that first avoids cognitive overload and secondly responds to natural language queries. Provide this technology in a form factor that resembles “points of interest” in a smartphone display but in a tactical heads-up display for dismounted Marines.

Intel STO-4 maps to following POM 19 gaps:

- 19-2.5.0-G1: Disseminate and integrate intelligence
- 19-3.1.1-G3: MAGTF standoff explosive hazard detection in ship-to-shore maneuver

- 19-3.1.1-G5: Dismounted ground maneuver element capability to identify, locate, and classify targets
- 19-2.2.3-G1: Persistent ground based terrestrial surveillance
- 19-3.2.1-G2: Acquisition of threat indirect fires at maximum range of enemy weapons systems
- 19-3.1.1-G12: Dismounted ground maneuver element C2 capability
- 19-2.2.4-G2: CI/HUMINT collection
- 19-2.4.0-G1: Intelligence production
- 19-2.2.4-G1: METOC environmental sensing equipment
- 19-2.2-G4: Share and exchange information and/or materials of potential forensic value
- 19-2.2.1-G1: SIGINT collection

Intel STO-5: Unmanned Platforms (Manned and Unmanned Teaming)

Develop aerial and terrestrial sensors with the following attributes: (1) ability to support precision fires with highly accurate time and geographic location; (2) generate imagery capable of differentiating armed and unarmed personnel; (3) ability to detect Homemade Explosives (HME) and narcotics precursors; (4) be modular, software defined, and/or multi-mission (e.g. EO/IR/SAR/RF) capable. Sensors that have object tracking features. Develop algorithms for generating moving object tracks.



Such algorithms should be applicable across various forms of collection (e.g. Imagery, RADAR, etc.) and have: (1) high Probability of Detection; (2) low false positive rates; (3) high probability of associating moving object detections to the correct track; (4) the ability to operate with constrictive size, weight, and power requirements. Develop a Long range (500-1000nm)/ long endurance (24/7) OTH unmanned systems, operating ISO of an afloat MAGTF that integrates multiple payloads (sensors, electronic warfare, communications) at the tactical level. Develop software definable radio applications to reduce payload weight/space requirements. Desired technologies would be affordable, lightweight, modular link capability that expands nodal capability to vehicles and/or individual with a VPN-like software encryption method for a secure common data link. Develop Multi-int, scalable persistent ISR payloads with a secure common data link. Develop Ground and Aerial Unmanned Sensors that are frequency agile allowing Marines to operate SUAS/UAS/GUV in any frequency environment without interference, similar to an unlocked cell phone.

Intel STO-5 maps to following POM 19 gaps:

- 19-3.1.1-G8: Dismounted ground maneuver element unmanned systems capability
- 19-3.1.3-G4: UAS beyond-line-of-sight capability
- 19-2.2.3-G1: Persistent ground based terrestrial surveillance
- 19-3.2.1-G3: UAS offensive air support
- 19-2.5.0-G1: Disseminate and integrate intelligence
- 19-2.2.0-G2: Airborne sensing
- 19-2.2.1-G1: SIGINT collection

Intel STO-6: National to Tactical Integration of National Technical Means (NTM) Sensors and Non-Traditional ISR Sensors.



Develop technologies for airborne and NTM sensing to characterize the littoral zone conditions (e.g., water, mud flats, beaches, very shallow water mines and MLOS, obstructions in the surf zone) in order to prepare the amphibious battlespace for ship to objective operations. Technologies for airborne and NTM sensing should characterize the terrestrial and Subterranean Battlespace (e.g. foliage penetration, structure penetration, counter tunneling and UFAC detection). Develop technologies that utilize NTM to

characterize the A2/AD Environment, and are capable of targeting enemy assets. Shorten the kill chain by enabling NTM assets to receive operational tasking from a deployed MAGTF in a time critical environment (less than 12 hours from tasking to collect). Integrate technologies for visibility of coverage, tasking, and PED onto tactical Marine Corps Intelligence Systems by utilizing, Software, Platform and Infrastructure as a Service (SaaS, PaaS, IaaS) technologies. Integrate Sensors and Data from Non-Traditional ISR Platforms available to the Joint Force and the MAGTF by extensible architectures that do not require separate receive stations or data links apart from MAGTF Intelligence Systems and communications. Fully Integrate the F-35B as a C4I asset to the fleet operating forces. Leverage the platform's ability to characterize the battlespace enable and assist both intelligence and operations throughout the ROMO.

Intel STO-6 maps to following POM 19 gaps:

- 19-2.2.2-G3: METOC support across the MAGTF
- 19-2.2.2-G2: Geospatial collection
- 19-2.2.2-G1: Integrated air and missile defense detect threats
- 19-2.2.0-G2: Airborne sensing
- 19-3.1.1-G3: MAGTF standoff explosive hazard detection in ship-to-shore maneuver
- 19-3.1.1-G5: Dismounted ground maneuver element capability to identify, locate, and classify targets
- 19-3.2.1-G2: Acquisition of threat indirect fires at maximum range of enemy weapons systems
- 19-3.1.4-G2: F-35 IR pointing and FMV transmission capability



Intel STO-7: Joint and Coalition Intelligence Interoperability Technologies

Provide a critical, multiple intelligence battlespace visualization, processing, exploitation, and dissemination capability that can plug in on cruisers, destroyers and LPD-17 class platforms, and other unit level ships. Technologies should leverage both shipboard organic video data and a wide-range of Joint and Navy airborne ISR platforms, and would enable Marine Corps intelligence integration with the Navy for small-unit missions aboard opportune or non-traditional sealift. Provide technologies for the bi-static transmission, receipt and tasking and utilization of intelligence and information with coalition partners. Leverage Joint and National Architectures that pre-assess, transmit and share data between MAGTF and Coalition Partners. Develop robust, secure communications and networking systems that

work across all classification and coalition enclave domains which are compatible aboard vehicles, ships and aircraft. Cross-domain/multi-classification data sharing solution is needed to allow Information processing across domains and with coalition partners JWICS, NSAnet, Centrix, SIPR, APIIN, NIPR etc. Develop coalition and civilian compatible secure communications as required (bi-lateral, multi-lateral, HA/DR) and a single network solution for a multi-level security on a single system.

Intel STO-7 maps to following POM 19 gaps:

- 19-2.5.0-G1: Disseminate and integrate intelligence
- 19-2.5.2-G2: Coalition intel system interoperability
- 19-3.1.1-G23: Mission partner tactical situational awareness
- 19-5.1.2-G2: C2 aboard non-traditional naval platforms
- 19-6.1.1-G3: Plan and direct networks
- 19-9.3.0-G1: Information management policy/planning

Intel STO-8: Meteorological Exploitation of Radar (formerly Intel STO-10)

Using 'Through-the-sensor' processing, tactical radars can effectively provide weather radar data as a secondary output from their normal operation. Develop software and tools that exploit airborne, shipboard and ground based tactical radars in order enhance METOC forecasters situational awareness, and to provide for responsive tracking of weather elements and systems. Software and tools must be OGC (Open Geospatial Consortium) compliant, able to be ingested, manipulated and displayed on current and future METOC systems as well as DCGS. Radar data and information should be able to combine as layers in a mosaic depiction that can be integrated with future intelligence and operational software and displays. Environmental data elements should provide for the three dimensional graphical depiction of reflectivity, velocity, spectrum width, echo tops, wind profiles, storm intensity and tracking, and clutter mapping.

Intel STO-8 maps to the following POM-19 gaps:

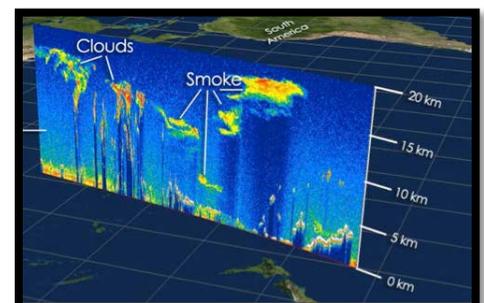
- 19-2.2.2-G3: METOC support across the MAGTF
- 19-2.2.0-G2: Airborne sensing
- 19-2.2.2-G2: Geospatial collection
- 19-2.5.0-G1: Disseminate and integrate intelligence

Intel STO-9: High Resolution Vertical Atmospheric Sounding from Satellites

Develop software tools that enhance the resolution and scope of METOC data and information received from vertical sounding equipment on geostationary and polar orbiting weather satellites. Software and tools must be OGC (Open Geospatial Consortium) compliant, able to be ingested, manipulated and displayed on current and future METOC systems as well as DCGS.

Intel STO-9 maps to the following POM-19 gaps:

- 19-2.2.2-G3: METOC support across the MAGTF
- 19-2.2.2-G2: Geospatial collection
- 19-2.5.0-G1: Disseminate and integrate intelligence



Intel STO-10: Flood and Storm Surge Inundation Modeling and Prediction

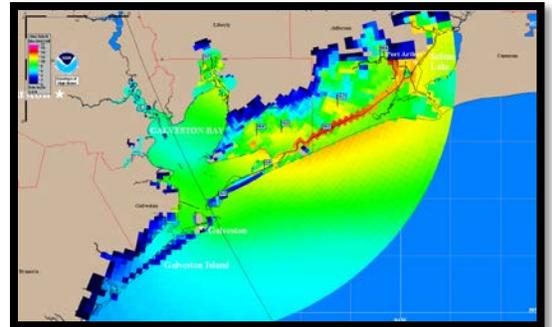
Develop software tools that allow for the dynamic ingest and modeling of environmental data, information and imagery that will enable the monitoring of current environmental conditions, the prediction of flooding and surge inundation on a georectified and defined area of the world. The Marine Corps lacks the ability to depict the extent of water inundation to coastal and riverine areas that occur due to tropical cyclones, tsunamis and major weather systems. Advances in computing power, geospatial modeling, numerical weather prediction, data analytics and virtualization as well as an increase in sensors throughout the battlespace make this a capability that the MAGTF can pursue.

Intel STO-10 maps to the following UNS:

- 07208UA Flash flood forecasting support

Intel STO-10 maps to the following POM-19 gaps:

- 19-2.2.2-G3: METOC support across the MAGTF
- 19-2.5.0-G1: Disseminate and integrate intelligence
- 19-3.1.1-G23: Mission partner tactical situational awareness



Intel STO-11: In-Flight Weather Briefs / Updates for Pilots and Aircrews

Develop software tools that allow for the dynamic interaction between meteorological and oceanographic (METOC) forecasters and pilots that enhance situational awareness, provide for the communication of advisories, indications and warnings. Tools should allow for 1) beyond-line-of-sight communication, 2) transmission and reception of graphical and textual products to pilot equipment (tablet, kneeboard, cockpit display, etc.), 3) the ability for pilots to request information and updates, and 4) the ability for pilots/aircrews to provide in situ updates of atmospheric conditions to the forecasters.

Intel STO-11 maps to the following POM-19 gaps:

- 19-2.2.2-G3: METOC support across the MAGTF
- 19-2.2.2-G2: Geospatial collection
- 19-2.2.0-G2: Airborne sensing
- 19-2.5.0-G1: Disseminate and integrate intelligence

Intel STO-12: Meteorological Sensors on Ground and Aviation Platforms

Develop sensors for manned and unmanned terrestrial and aerial platforms with the ability to 1) sense the environmental conditions, 2) be modular, software defined and/or multi-mission capable, 3) operate with constrictive size, weight and power requirements, 4) integrated with current and emerging sensor payloads, 5) sensors must be capable of sharing data and fusing information with other sensors as part of the



common operating picture, 6) over the horizon transmission of data and imagery to METOC personnel/units.

Intel STO-12 maps to following POM 19 gaps:

- 19-2.2.2-G3: METOC support across the MAGTF
- 19-2.2.3-G1: Persistent ground based terrestrial surveillance
- 19-2.2.0-G2: Airborne sensing
- 19-2.2.2-G2: Geospatial collection
- 19-2.5.0-G1: Disseminate and integrate intelligence
- 19-3.1.1-G8: Dismounted ground maneuver element unmanned systems capability
- 19-3.1.3-G4: UAS Beyond-line-of-sight capability
- 19-3.2.1-G3: UAS offensive air support

Intel STO-13: 3-D Meteorological Predictive Fly-Through

Develop a meteorological modeling and simulation capability in support of MAGTF operations. The MAGTF currently lacks the ability to identify, understand, and model the physical environment in a timely manner. The MAGTF needs to gain access to tools and effects, be able to model the physical environment in which these capabilities will be used, depicting and describing environmental impacts to operations, platforms and weapons systems. Visualization would also provide environmental effects prediction for solar and lunar positions and illumination as well as the predictive analysis for shadows. Advances in computing power, data analytics and virtualization, as well as an increase in sensors throughout the battlespace make this a capability that the MAGTF can pursue.

Intel STO-13 maps to the following POM-19 gaps:

- 19-2.2.2-G3: METOC support across the MAGTF
- 19-2.5.0-G1: Disseminate and integrate intelligence
- 19-3.1.1-G23: Mission partner tactical situational awareness



Intel STO-14: Wearable Meteorological Sensors

Develop wearable sensors that collect and transmit environmental information such as temperature, pressure, humidity, winds and precipitation. The sensors would provide near-real time in-situ data to METOC forecasters without the need for interaction from the wearer. Sensors must be capable of sharing data and fusing information with other sensors as part of the common operating picture.

Intel STO-14 maps to following POM 19 gaps:

- 19-2.2.2-G3: METOC support across the MAGTF
- 19-2.2.3-G1: Persistent ground based terrestrial surveillance
- 19-2.2.2-G2: Geospatial collection
- 19-2.5.0-G1: Disseminate and integrate intelligence
- 19-3.1.1-G8: Dismounted ground maneuver element unmanned systems capability

5.3 Joint Capability Area 3 (JCA 3) – Force Application

Maneuver

The S&T investment in maneuver is primarily focused in increasing the mobility of ground forces while continuing to ensure they are compatible with our expeditionary role. We are striving to improve the air-mobility of vehicles either through making them internally aircraft transportable or through development of a means to transport them externally from aircraft at high speeds. We continue to focus on fielding a survivable and fuel-efficient family of vehicles, more survivable aviation connectors, and improving our ability to protect and insert capabilities at greater distances in reduced times. Our intent is to improve mobility for the entire MAGTF, to include specifically both the mounted and dismounted Marine, enabling unrestricted maneuver across the littoral battle space to include at sea, in the surf zone, over the beach, and ashore.

Essential to unrestricted movement across the battle space is counter explosive hazard technology. The S&T investment of interest to the Marine Corps in counter explosive hazards, including mines and IEDs is focused in two specific areas: detection and neutralization.

The Vision: Marines will maneuver from the seabase in a family of high-speed connectors that include amphibious vehicles, tilt-rotor and rotary bladed aircraft, and high-speed surface craft. Once ashore, Marines will have freedom of maneuver either dismounted or utilizing a family of highly mobile and survivable combat vehicles. Marines maneuvering from the seabase will be able to conduct assault breaching of complex obstacles (including minefields) and follow assigned tracks through the shallow water, the surf zone, over the beach, and inland without impediment to maneuver.

Goal: The focus is to achieve needed operational and tactical mobility in support of Distributed Operations. This includes projecting forces from the seabase, and once ashore, employing vehicles that are significantly more sustainable through Autonomic Logistics and survivable with alternative power systems, a reduced requirement for fuel, along with crew and manpower reductions. Mobility systems will be more reliable with a reduced requirement for routine maintenance and employ autonomic features to integrate functions of crew, vehicle, and weapon system. Dismounted Marines will employ technologies that enhance their performance: in speed, range, and in load bearing capacity. The maneuvering forces will have the ability to detect and neutralize mines and IEDs from sufficient stand-off distance that they do not put the maneuvering force at risk with minimal impact to rate of advance. Once established ashore, MAGTF elements will have the ability to continue to detect, avoid, and neutralize mines in complex terrain including urban environments. Where mines and/or IEDs are detected, the MAGTF commander will have the ability to rapidly apply investigative methodologies to determine source of devices.

MVR STO-1: Explosive Hazard Detection from the Surf Zone to Inland Objectives

Develop the technologies to enable the detection of mines and minefields from the surf zone through to inland objectives for sustained operations ashore. Detection technologies must encompass a variety of threats including buried and surface laid mines and IEDs. Detection includes both near-field/far-field

detection and it will consist of multi- spectral approaches with particular emphasis on 1) explosive material, 2) IED precursor materials, and 3) other IED signature materials.

MVR STO-1 maps to following POM 19 gaps:

- 19-3.1.1-G2: MAGTF Standoff explosive hazard mitigation in Ship-to-Objective Maneuver (STOM)
- 19-3.1.1-G3: MAGTF Standoff explosive hazard detection in STOM
- 19-3.1.1-G14: Dismounted ground unit detection of explosive hazards

MVR STO-2: Ground Vehicle Mobility

Develop advanced suspensions and vehicle stability systems to enable USMC ground vehicles to seamlessly maneuver across the battlefield environment. Achieve desired combat speeds over varying off-road terrains and obstacles while accounting for increased payload and armor weight with no reduction in safety.

MVR STO-2 maps to following POM 19 gaps:

- 19-3.1.2-G1: Surface assault lift during amphibious maneuver
- 19-3.1.3-G1: Light Armored Vehicle (LAV) survivability and mobility
- 19-3.1.3-G2: Next Generation Armored reconnaissance Operations
- 19-3.1.1-G19: Scalable assault gap crossing capability
- 19-3.1.1-G1: Light combat and tactical expeditionary protected mobility
- 19-3.1.1-G34: Arctic mobility

MVR STO-3: Advanced Materials and Survivability Technology to Enhance the Performance and Survivability of Combat Vehicles and Surface Craft

Develop technologies to improve the survivability of both current and future tactical and combat vehicles through the use of innovative passive and active technologies. Develop technologies that have better blast and ballistic protection qualities while reducing the overall weight to the vehicle or platform. Where applicable, develop technologies that enable threat-specific protection kits to be readily added to vehicles and platforms as needed for a specific mission or to counter an emerging threat.

MVR STO-3 maps to following POM 19 gaps:

- 19-3.1.2-G1: Surface assault lift during amphibious maneuver
- 19-3.1.2-G2: Ship-to-shore connectors
- 19-3.1.3-G1: Light Armored Vehicle (LAV) survivability and mobility
- 19-3.1.3-G2: Next Generation Armored reconnaissance Operations
- 19-3.1.1-G1: Light combat and tactical expeditionary protected mobility
- 19-3.1.1-G25: M1A1 force protection and system survivability

MVR STO-4: Advanced Robotic Systems in Support of Ground Maneuver



Develop affordable technologies to enhance effective and efficient employment of ground robotics. Focus on improving capabilities while reducing training and operating requirements of user Marines. Fully autonomous vehicles are not necessarily the goal. Technologies that enable effective “supervised autonomy” by the Marine user, to include teleoperation, machine vision, perception, obstacle avoidance, convoy following, and the ability to self-navigate pre-planned routes are desired capabilities.

MVR STO-4 maps to following POM 19 gaps:

- 19-3.1.1-G8: Dismounted ground maneuver element unmanned systems capability
- 19-3.1.3-G2: Next Generation Armored Reconnaissance Operations

MVR STO-5: Marine Performance Enhancements

Develop vehicle and surface craft with interoperable technologies that provide protective equipment, communications equipment, weapons, ammunition, sensors, optics, and power harvesting for the mounted and dismounted Marine that are multifunctional, lighter, and provide greater capability. Technologies, such as exo-skeletons and dermoskeletons are needed to enhance the performance of the Marine by improving load carrying capacity and speed and distance of movement.

MVR STO-5 maps to following POM 19 gap:

- 19-3.1.1-G4: Dismounted ground maneuver element combat loading
- 19-3.1.1-G27: Dismounted ground maneuver element integrated CBRNE capability

MVR STO-6: Advanced Materials and Survivability for Sub-Surface and Airborne Capabilities

Advanced materials and survivability are needed for sub-surface and airborne capabilities to facilitate clandestine and overt maneuver of reconnaissance forces.

Develop technologies that improve amphibious and ground clandestine maneuver in all operating environments, projecting and recovering designated units over the horizon via surface, sub-surface, or by air means (i.e. HRST and parachute) day or night, in sea state 3 or less, under enemy Electrical Optical (EO)/Infrared (IR)/Image Intensification (I2) detection capabilities.

MVR STO-6 maps to following POM 19 gaps:

- 19-3.1.1-G4: Dismounted ground maneuver element combat loading
- 19-3.1.3-G3: Reconnaissance mobility
- 19-3.1.1-G26: Opposed surface VBSS

MVR STO-7: Technology that Provides Improved Protection for the Individual Against Fragments, Projectiles, Blast Effects, Fire, and Lasers with Reduced Bulk, Weight, Stiffness and Impact on Ability to Perform Required Functions While Improving Mobility.

Develop all infantry personal protective equipment (PPE) around the Warfighter, using a system of systems approach in order to create an integrated, tailorable, combat suite that enhances the Warfighters' effectiveness on the battlefield against a variety of threats. PPE as a system of systems includes force protection, communication systems, load distribution and management, individual battlefield power, target acquisition and defeat, sensing capabilities and other lightweight acquisitions that reduce individual loads by focusing the effort to reduce the overall unit load. Eye protection – to include optics – is needed to counter the emerging threat of multi-spectral battlefield lasers. These capabilities when developed and integrated as a system will improve mobility while reducing bulk, weight, and stiffness to create a more efficient and effective fighting stance for both the individual and the force.

MVR STO-7 maps to following POM 19 gaps:

- 19-3.1.1-G4: Dismounted ground maneuver element combat loading

MVR STO-8: Augmented Cognition for Combat Vehicle Crews and Operators of Maneuver Systems

Develop technologies to assess cognitive state and workload of human operators non-invasively and to manage workload of the combat vehicle and surface craft crew, the weapon system, and the IT infrastructure to improve man/machine performance while moving, shooting, and communicating.

MVR STO-8 maps to following POM 19 gaps:

- 19-3.1.2-G1: Surface assault lift during amphibious maneuver
- 19-3.1.1-G1: Light combat and tactical vehicle expeditionary protected mobility



MVR STO-9: Fuel Efficient and Power Generating Vehicle Systems

Develop technologies to enable fuel efficient power plants and drive trains for new and legacy vehicles that result in fuel consumption reduction. Reduce the MAGTF logistic footprint and increase combat mission range and endurance capability through reduced fuel consumption. New and legacy vehicle platforms should also be capable of self-producing, storing, and exporting the power required to support battlefield demands.

MVR STO-9 maps to following POM 19 gaps:

- 19-3.1.2-G1: Surface assault lift during amphibious maneuver
- 19-3.1.1-G1: Light combat and tactical vehicle expeditionary protected mobility
- 19-3.1.3-G2: Next generation armored reconnaissance operations (light Armored Vehicle) replacement
- 19-3.1.1-G30: M1A1 energy performance

MVR STO-10: Identifying Threat Marksmen

Develop technologies for the mounted and dismounted Marine to detect, locate and report snipers, trained marksmen, and armed irregulars through the entire enemy engagement cycle. Develop technologies that display the range, elevation, and bearing of detected threats on existing networking systems.



MVR STO-10 maps to following POM 19 gaps:

- 19-3.1.1-G5: Dismounted ground maneuver element capability to identify, locate, and classify targets

Fires

The Fires S&T investment is focused in four areas: (1) targeting and engagement, (2) advanced ammunition, (3) advanced weapon systems, and (4) energetic materials.

The Vision: Marines, capable of being employed in small, distributed units, will locate and decisively engage larger enemy forces by applying timely, reliable, precise, and accurate fires (kinetic and non-kinetic) from a myriad of platforms.

Tactical units will be able to operate well beyond conventional parameters of direct fire mutual support. Marines will use integrated, lightweight optics and sensors to see through all battlefield conditions (day, night, low light, and obscuration) and they will use lightweight, organic, manned and



unmanned platforms and advanced weapons for the rapid, accurate, effective application of firepower across the full range of military operations. They will also apply non- organic and joint fires optimally. Increased intelligence capabilities delivered by company intelligence cells will generate more potential targets in the future.

Goal: Fires S&T investments are based upon the premise that Marines, as soldiers of the sea, are an integral part of the Naval Services. They will remain organized, trained, and equipped to conduct naval campaigns and operate on and from naval platforms, or to fight in protracted campaigns ashore; with the expectation of operating in inhospitable conditions against committed and competent foes. The individual Marine is the most formidable weapon on the battlefield and will remain so in the future. Marines will be able to engage enemy formations with scalable air, ground, and maritime capabilities in major contingencies, equally able to employ irregular warfare skills, and capable of transitioning seamlessly between fighting, training, advising, and assisting. Being a persistently engaged, multi-capable force, addressing the full range of future contingencies, the Marine Corps will be preventative in approach, leaner in equipment, versatile in capabilities, innovative in mindset, and increasingly reliant on naval deployment. Fires S&T efforts will support the Marines emphasis of speed of execution, agility, and flexibility; and will strike a balance between being heavy enough to sustain expeditionary warfare and light enough to facilitate rapid deployment. As an example, the ability to quickly and accurately locate a target and deliver timely precision fires is a means to increase agility and combat power while at the same time, reducing the logistics required to support the delivery of high volumes of fires necessary to compensate for target location inaccuracies.

Fires STO-1: Advanced Ammunition

Develop ammunition, fuze, propellant, warhead shell casing, and other peripheral technologies that improve range, area effects, accuracy, maneuverability, reliability, safety, maintenance, and service life for all ammunition types, and provide an ability to effectively engage moving targets with indirect fires. Additional, desired technologies include improvements in scalable lethality, blast, fragmentation, and penetration against the full range of natural and constructed targets, as well as reduced weight for direct fire



munitions. Develop technologies that provide a persistent indirect fire capability to ranges that complement the target acquisition capabilities of Ground/Air Task Oriented Radar (60km). Develop technologies to correct or improve the course of sniper rounds for increased accuracy and range. Develop novel lightweight methods of packaging ammunition that enable faster transition from re-supply to utility or use without burden of packaging materials while still meeting transportation safety requirements.

Fires STO-1 maps to following POM 19 gaps:

- 19-3.2.1-G1: Engage targets with appropriate weapons/target pairing
- 19-3.2.1-G5: NSFS of MAGTF expeditionary operations

Fires STO-2: Targeting Technologies for Faster, More Precise Engagements

Develop lightweight, durable, reliable, and ergonomic low-power consumption technologies to enable mounted and dismounted Marines the ability to locate, classify, identify, and engage targets in all weather, all terrain, day or night, in accessible, obscured, and amongst civilian populations, out to the maximum effective range of assigned weapons.

Fires STO-2 maps to following POM 19 gaps:

- 19-3.1.1-G5: Dismounted ground maneuver element capability to identify, locate, and classify targets
- 19-3.2.1-G2: Acquisition of threat indirect fires at maximum range of enemy weapons system



Fires STO-3: Technologies that Utilize the Electromagnetic Spectrum to Detect, Exploit and Target Systems, Equipment, or Individuals

Develop technologies for coherent energy systems that operate within the electromagnetic spectrum. Objectives may include technologies to improve upon existing platforms that utilize the electromagnetic spectrum to provide fully integrated and networked systems in order to target developing and evolving threats to provide the unit commander the ability to control the spectrum at a time and place of his choosing; systems that make maximum use of available bandwidth - ensuring interoperability within joint standards and protocols providing commonality across platforms; coherent high energy systems that are compact, frequency agile, and energy efficient, with effective thermal management means; explosively driven isotropic radiators; technologies that can produce high average power and high peak power for tailored lethality against a variety of targets that are modular and scalable; and technologies to use direct or indirect fire weapons systems to deliver effects other than kinetic munitions, such as small communications devices, software driven and reprogrammable jammers, wireless intrusion devices, or Intelligence, Surveillance, and Reconnaissance (ISR) devices to name a few.



Fires STO-3 maps to following POM 19 gaps:

- 19-3.1.1-G5: Dismounted ground maneuver element capability to identify, locate and classify targets
- 19-3.2.1-G2: Acquisition of threat indirect fires at maximum range of enemy weapons systems

Fires STO-4: Increased Capabilities and Reduced Weight of All Ground Combat Weapons Systems

Develop technologies for increased range, improved precision, increased responsiveness, improved user ergonomics, and scalability of direct and indirect fire weapons, small arms through major caliber, to decrease weights, costs, and logistics burden, to increase operating, transportation, and storage safety, and to increase weapons systems or components service life extensions.



Fires STO-4 maps to following POM 19 gaps:

- 19-3.1.1-G5: Dismounted ground maneuver element capability to identify, locate, and classify targets
- 19-3.2.1-G2: Acquisition of threat indirect fires at maximum ranges of enemy weapons systems
- 19-3.2.1-G1: Engage targets with appropriate weapons/target pairing

Fires STO-5: Sight Technologies Suitable for Expeditionary Operations

Develop technologies that enable precision target detection, identification and designation by direct fire weapons in all light and weather conditions at the maximum effective range of the weapon system. Technologies must be lightweight, durable, low- power consumers and easy to use. Systems will utilize powered rail interfaces in order to utilize high energy to weight centralized power sources and data connectivity for universal control capability. Systems are required for both individual and crew-served infantry weapons.

Fires STO-5 maps to following POM 19 gaps:

- 19-3.1.1-G5: Dismounted ground maneuver element capability to identify, locate, and classify targets
- 19-3.1.1-G15: Dismounted ground maneuver element IFF capability



Fires STO-6: Advanced Weapon Ballistic Signature Suppressors

Develop light-weight maintainable, modular weapon ballistic signature suppression technologies for all weapons in the infantry company as well and future weapon systems without deterring from the effectiveness of the weapon system and projectile.

Fires STO-6 maps to following POM 19 gap:

- 19-3.1.1-G32: Weapons/equipment signatures

Fires STO-7: Advanced Energetic Materials

Develop advanced energetic materials to help ammunition achieve increased range, accuracy, maneuverability, safety, reliability, service life, reduced weight, reduced maintenance, as well as scalable lethality, blast fragmentation, and penetration. Specifically, propellant technologies should look to increase performance of direct and indirect fire weapons, small arms through major caliber, and to increase safety for munitions rapidly exposed to hot chambers and other adverse environmental conditions. Objectives include developing propellants to increase mortar and other projectile muzzle velocities within chamber pressure design constraints, decreasing propellant weights for various classes of ammunition, and reducing weapons launch signatures. Develop technologies to increase the performance of explosives for fires applications, to include energetic structural materials to increase munitions blast yields, improving performance, reliability, and safety of safe/arm devices and fuzes of various classes while maintaining the accuracy of the munition.

Fires STO-7 maps to following POM 19 gaps:

- 19-3.2.1-G1: Engage targets with appropriate weapons/target pairing
- 19-3.1.1-G7: Infantry company capability to engage targets with multiple effect rocket fire

Fires STO-8: Electromagnetic Deception Capability

Develop modular, dynamically-taskable transceivers that simulate the EMS signature of select nodes of MAGTF formations in order to conduct non-kinetic engagements against an adversary's use of the range of electromagnetic radiation. The Marine Corps lacks an electromagnetic deception capability. Electromagnetic deception is the deliberate radiation, re-radiation, alteration, suppression, absorption, denial, enhancement, or reflection of electromagnetic energy in a manner intended to convey misleading information to an enemy or to enemy electromagnetic-dependent weapons, thereby degrading or neutralizing the enemy's combat capability.

Fires STO-8 maps to following POM 19 gap:

- 19-5.5.2-G5: Direct military deception
- 19-5.3.3-G4: Plan military deception

5.4 Joint Capability Area 4 (JCA 4) – Logistics

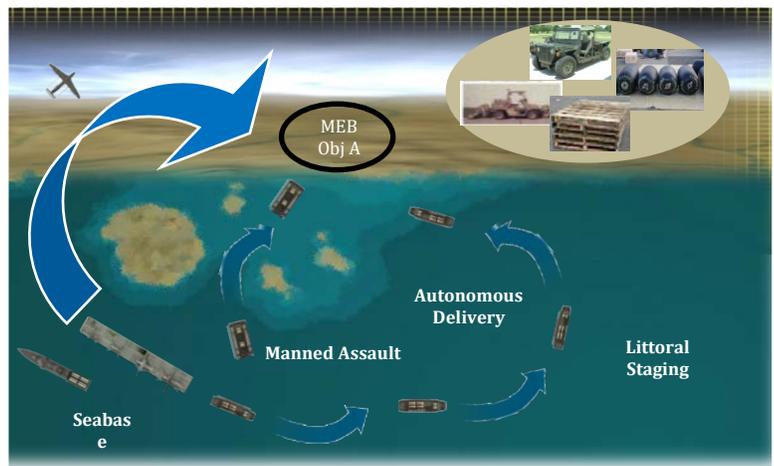
Logistics

The S&T investment in logistics is directed toward opportunities where advancements in Science and Technology can reduce the requirement for logistic support, enhance the timeliness of logistic responsiveness, or enhance the operational sustainment value and versatility of assets provided via the logistics chain.

The Vision: Marines of the future will benefit from a precisely tailored level of logistic sustainment from seabased platforms to rapidly maneuvering forces ashore. Logistic delivery systems of the future will be more responsive and versatile, enabling Marines to out-pace rapidly changing operational scenarios.

Likewise, delivered logistic commodities will provide more operational value per unit weight, enhancing combat self-sufficiency and maneuverability. Finally, operational units will benefit from technologies that maximize equipment readiness by minimizing both down-time and maintenance requirements.

Goal: The focus is to provide support from a Seabase to the operational echelons ashore down to the tactical level of operations adaptive to the needs of dispersed and highly mobile forces. Reducing the requirement for support as well as enhancing the operational versatility of sustainment related assets are integral parts of this goal. Towards these ends, technologies that provide for enhanced self-sufficiency for water, fuel and electrical energy are critical, as are technologies that reduce maintenance and extend the operational readiness of vehicles and equipment. Components for assembly of temporary expeditionary infrastructure must be easily transportable and efficiently stored in addition to providing for rapid deployment and reconstitution.



Log STO-1: Asset Versatility, Interoperability, and Modularity

Asset versatility simplifies logistics. It's provided by ensuring that technologies incorporated in future versions of basic inventoried items serve to expand Warfighter flexibility in adapting to a broad range of potential operational environments. Technologies consistent with three design concepts (scalable modularity, functional modularity and transport modularity) may be particularly beneficial. Scalable modularity enables expansion of a capability by creating compatible building blocks that can be linked to function as a larger system. System interoperability is enhanced by cargo transport and packaging modularity as we try to maximizing the available options for air, sea or ground delivery platforms. It ensures that equipment weights and volumes (including vehicles) are optimized throughout the entire logistics process including shipboard storage, inter-connector cargo transfer, intra-connector handling, as well as end-user handling.



Log STO-1 maps to following POM 19 gaps:

- 19-4.1.2-G2: Conduct distribution operations
- 19-4.1.1-G1: MPF at sea selective offload and assembly

Log STO-2: Asset Tracking, Visibility, and Condition Monitoring

Apply cost-effective technologies that facilitate asset location during transit, storage and use. For those assets, such as vehicles, that are maintenance intensive, apply technologies that sense condition based operational readiness and report timely maintenance information necessary to prevent equipment failure. Automation of inventory control and maintenance processes facilitates the intelligent management required to support the force with precision logistics. The selective offload and transfer at sea capabilities that are critical to seabased logistics will not be possible without enhancements in automated asset visibility.

Log STO-2 maps to following POM 19 gaps:

- 19-4.1.1-G2: Distribution In transit Visibility
- 19-4.2.4-G2: Ground equipment staging program
- 19-4.1.3-G1: Inventory management
- 19-4.2.2-G1: Disposal options/solutions



Log STO-3: Cargo Transport and Delivery

Cargo transport and delivery: Develop cost effective transport and delivery technologies for providing logistics support to highly mobile combat units operating across potentially hostile terrain. The 'last mile of logistics' will, as always, involve a great deal of risk when conducting distributed operations in the face of anti-access threats. The defense of land supply lines has proven too costly and vulnerable. Multiple methods of resupply from ship to shore, or even ship to objective, will be required to meet the demands of decentralized forces ashore.



Log STO-3 maps to following POM 19 gaps:

- 19-4.1.1-G1: MPF at sea selective offload and assembly
- 19-4.1.2-G2: Conduct distribution operations
- 19-4.1.1-G3: Dismounted ground maneuver element unmanned systems sustainment capability
- 19-4.1.2-G3: Conduct independent sustainment operations utilizing alternate platforms

Log STO-4: Logistic Transport and Handling in Austere Environments

Develop novel weight-effective approaches for small, dispersed units, without the benefit of cargo handling infrastructure or motor vehicles to more effectively load, unload, store and transport their own supplies.

Log STO-4 maps to following POM 19 gaps:

- 19-4.1.2-G2: Conduct distribution operations
- 19-4.1.1-G3: Dismounted ground maneuver element unmanned systems sustainment capability
- 19-4.1.2-G3: Conduct independent sustainment operations utilizing alternate platforms

Log STO-5: Enhanced Self-Sufficiency for Portable Electric Energy

Develop technologies for providing small units or individuals with cost effective alternative portable electric power sources providing enhanced specific energy (watt hours per kilogram) and consequently longer service life per kilogram. Improve the management of power for hand carried devices to both reduce energy consumption and enhance power source compatibility supporting the expanded operational use of hand-held electronic devices. Tactically viable alternative energy solutions including solar, wind, hybrid, kinetic recovery, fuel cells, and biofuels for use at remote, austere locations by small units which ultimately reduce the Marine combat load. A key consideration is to ensure battlefield and indigenous population energy resources can be scavenged and made useable in developed technologies.



Log STO-5 maps to following POM 19 gaps:

- 19-3.1.1-G4: Dismounted ground maneuver element combat loading
- 19-4.1.2-G2: Conduct distribution operations
- 19-4.6.3-G1: Energy foraging

Log STO-6: Materials for Reduced Maintenance

Develop and apply materials technologies to reduce maintenance required for vehicles and machinery. Technologies will emphasize corrosion and wear prevention, and will be applied to specific components that most adversely affect required maintenance intervals or operational readiness. Proper design of tools, sets, chests, kits and diagnostic equipment is critical to equipment maintenance, to expeditiously return Marine Corps equipment to an operational ready posture.

Log STO-6 maps to the following POM 19 gap

- 19-4.3.1-G1: Intermediate and organizational maintenance

Log STO-7: Temporary Mobile Infrastructure

Develop novel concepts for expanding the operational versatility, decreasing the weight, enhancing the energy efficiency, or increasing the speed of deployment of temporary infrastructure necessary to support expeditionary operations ashore. Examples include shelters, bridges, piers, fortifications, and aircraft landing surfaces.



Log STO-7 maps to following POM 19 gaps:

- 19-4.1.2-G2: Conduct distributed operations
- 19-3.1.1-G19: Scalable assault gap crossing capability
- 19-4.6.1-G3: Transportation of heavy equipment, off road

Log STO-8: Fuel Management and Logistics

In order to meet the operational requirement of the MOC the Marine Corps must optimize fuel logistics to include: fuel consumption, fuel transportation, fuel delivery, fuel availability, planning, and management; while operating in a contested environment. To meet the operational reach of 30 days for the MEB and 60 days for the MEF, distributed operations, and growing fuel requirements from new platforms like the F-35 and ACV (note that while the ACV requirement is to get at least as good of fuel efficiency as the AAV, it carries fewer marines; therefore more ACVs are required to carry the same amount of infantry ashore requiring an estimated 40% more fuel to complete the same mission); the Naval infrastructure requires better planning aids to optimize options, material and non-material ways to increase fuel efficiency on existing platforms, capabilities to forward stage fuel stores (covertly when required), capabilities to increase capacity of existing refueling platforms, capabilities to transport and deliver fuel from ship-to-shore in contested and hazardous landing zones, and fuel platforms that can self-monitor and autonomously optimize efficiency while reporting vital information to planners (requires real-time or near real-time communications). The net result must be more fuel availability to sustain well understood operational mission requirements.

Log STO-8 maps to following POM 19 gaps:

- 19-3.1.1-G30: M1A1 Energy performance
- 19-3.1.2-G1: Surface assault lift during amphibious maneuver
- 19-3.1.2-G2: Ship-to-shore connectors
- 19-4.1.1-G2: Distribution In transit visibility
- 19-4.1.2-G2: Conduct distribution operations

Expeditionary Energy

Over the last decade of combat, the U.S. Marine Corps (USMC) has become a more lethal force, but at the expense of increased requirements for fuel and batteries. These dependencies increase the logistics footprint and combat weight of our force, impairing our expeditionary responsiveness. The Commandant of the Marine Corps, Chief of Naval Operations, and Secretary of the Navy reiterated the significance of energy optimization with the following statement: "New systems we are deploying, such as the Joint Strike Fighter, Medium Tactical Vehicle Replacement, the rail gun, and directed energy weapons, will place additional demands on our energy supply. Every gallon of fuel or kilowatt-hour of electricity we save through more efficient operations can be used to enable or enhance our combat capabilities." (Tri-Sign Msg dated 1 Feb 2016) The USMC Expeditionary Energy Strategy focuses our capability development on increasing expeditionary energy, water and waste performance, efficiency and self-sufficiency; reducing logistics vulnerabilities and enabling a lighter, more maneuverable, Enhanced MAGTF Operations-capable force.

Vision: To be the premier self-sufficient expeditionary force, instilled with a warrior ethos that equates the efficient use of vital resources with increased combat effectiveness. The tenets of our vision are illustrated below:

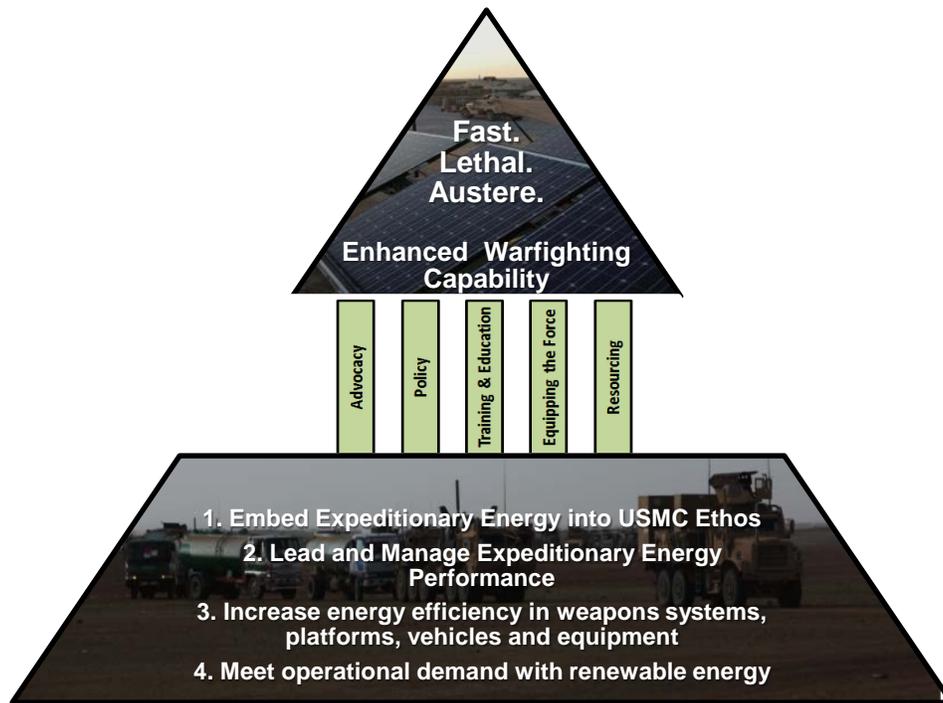


Figure 9. Expeditionary Energy Vision

Goal: The USMC Expeditionary Energy Strategy states that “By 2025, [the USMC] will deploy Marine Expeditionary Forces that can maneuver from the sea and sustain its C4I and life support systems in place; the only liquid fuel needed will be for mobility systems which will be more energy efficient than systems are today”. The Marine Corps Expeditionary Energy program is focused on increasing the operational reach of Marine forces, increasing Marines’ agility, and empowering Marines with information on energy use – creating a lighter, more efficient force that goes farther and stays longer on every gallon of fuel we use. In order to accomplish our mission the Marine Corps must leverage and drive S&T advancements that increase energy efficiency and the performance of equipment, platforms and weapons systems.

Our S&T investments will identify opportunities to lighten the load and increase efficiency for Marines at the tip of the spear, farthest away from operating bases where the risk is highest on the battlefield. The systemic impact of power-consuming materiel solutions must be considered in order to balance performance with the provisioning of energy in relevant threat environments. We will optimize energy in movement and maneuver through improvement in planning and management of information technology advancements. We will harvest available potential energy from renewable sources and recapture kinetic energy from individuals and mobility systems. Investments in our mobility platforms will drive increased fuel efficiency, integration of renewable power, and more efficient power supplies to onboard and off-board systems. We will pursue greater aircraft efficiency and employment to increase time-on-station and range, and reduce the need for fuel logistics.

EE STO-1: Expeditionary energy harvesting

Develop effective and efficient capabilities to harvest and/or scavenge energy from available resources like the sun, low quality power grids, fuel cells, battlefield waste, vehicles, and personnel. Technologies must be embarkable aboard naval shipping and transportable aboard ground and air assault transportation. Energy harvesting systems should be tailored to meet the operational requirements at different unit levels.

EE STO-1 maps to following POM 19 gaps:

- 19-4.6.3-G1: Energy foraging
- 19-3.1.1-G4: Dismounted ground maneuver element combat loading
- 19-4.1.2-G2: Conduct distribution operations



EE STO-2: Austere environment capable electronics

Develop electronics (i.e., computers, servers, radios, data-links, radar and fire-control systems, intelligence, surveillance, and reconnaissance systems, etc.) that do not require external heating, cooling, or protection to operate effectively regardless of environmental conditions. For example, systems should be able to operate at full capacity in temperatures ranging from -30 degrees F to +130 degrees F without external heating and cooling in ergonomic methods of load carriage that integrate with the Marine's equipment.

EE STO-2 maps to following POM 19 gaps:

- 19-9.2.1-G5: Warfighting concepts: Integrate MAGTF energy requirements to extend operational reach and increase readiness
- 19-3.1.1-G12: Dismounted ground maneuver element C2 capability

EE STO-3: Optimize performance of dismounted forces

Develop innovative technologies that enhance the maneuverability, self-sustainability, and performance of dismounted forces. Solutions should increase the lethality and agility of the warfighter while adhering to Dismounted Forces Energy Requirements. Systems should not require the burning of fossil fuel or liquid fuels to maintain personnel at optimum performance in any operational mode, mission profile, environment, or climate.

EE STO-3 maps to following POM 19 gap:

- 19-4.1.2-G2: Conduct distribution operations
- 19-4.1.1-G3: Dismounted ground maneuver element unmanned systems sustainment capability
- 19-4.6.3-G1: Energy foraging

EE STO-4: Compact high density energy storage

Develop lightweight high energy density (watts/kilogram) and high energy volume (watts/liter) approaches to store harvested energy (e.g. on individuals, vehicles, fixed sites, weapon systems, etc.). Technology must support expeditionary operations that facilitate energy self-sufficiency by bridging the gap between on-site energy harvesting and demand. Technology must emphasize energy storage commonality across weapon systems and enable solutions that reduce the market risks associated with fluctuations in military energy storage demand. Technologies must meet all applicable safety standards for air and naval shipping and storage.



EE STO-4 maps to following POM 19 gap:

- 19-5.2.2-G7: Logistics integration C2 data: Fuel and power
- 19-9.2.1-G5: Warfighting concepts: Integrate MAGTF energy requirements to extend operational reach and increase readiness

EE STO-5: Expeditionary water harvesting

Develop water systems that harvest from all sources and are able to recycle black, grey, brown, and salt water into potable water. Develop robust, lightweight technologies that enable dismantled, man-portable water harvesting, purification, and desalination by individuals and small units (rifle company and below). Technologies must meet military drinking water standards consistent with system concept of employment, be transportable via air and naval shipping, and require no fossil fuel to operate.

EE STO-5 maps to following POM 19 gaps:

- 19-4.6.3-G2: Water foraging
- 19-4.1.2-G2: Conduct distribution operations
- 19-9.2.1-G5: Warfighting concepts: Integrate MAGTF energy requirements to extend operational reach and increase readiness

EE STO-6: Energy efficient, combat effective mobility

Develop integrated technologies that evolve current and future vehicles into multi-capable platforms, which perform designated combat mobility functions while enabling an efficient and flexible MAGTF energy network. Technologies must increase mobile fuel efficiency and enable efficient energy harvesting, storage, and exportation to support Forward Operating Bases and onboard and off-board systems both on the move and at the halt.

EE STO-6 maps to following POM 19 gaps:

- 19-3.1.1-G30: M1A1 energy performance
- 19-3.1.2-G1: Surface assault lift during amphibious maneuver
- 19-3.1.2-G2: Ship-to-shore connectors

EE STO-7: Energy command and control

Timely access to energy is critical to success on the battlefield. The availability of energy to friendly forces is essential to the application of the modern force's considerable combat power at the time and place of its choosing. Therefore, energy security directly creates a warfighting advantage over the enemy. Without timely and accurate information about how energy is being produced, consumed, stored, and transported, commanders will be forced to rely on outdated methods to produce these critical metrics. Modernization of how the force manages its energy must include automated reporting and data consolidation in order to produce actionable reports to commanders and their staffs.

EE STO-7 maps to following POM 19 gaps:

- 19-4.6.1-G2: Operational energy awareness
- 19-3.1.2-G2: Ship-to-shore connectors
- 19-4.1.1-G2: Distribution in transit visibility
- 19-9.2.1-G5: Warfighting concepts: Integrate MAGTF energy requirements to extend operational reach and increase readiness
- 19-5.1.2-G1: C2 aboard non-traditional naval platforms

5.5 Joint Capability Area 5 (JCA 5) – Command and Control

Command and Control

Command and control (C2) is the ability to exercise authority and direction by properly designated commander or decision maker over assigned and attached forces and resources in the accomplishment of the mission. C2 integrates all elements of the MAGTF, the headquarters, and the supporting establishment, to create synergistic effects and meet mission needs across the range of military operations (ROMO).

The Vision: C2 systems must enhance mission command and control to enable commanders at every echelon to conduct assured C2 from anywhere in the operational environment as part of an integrated naval force. Systems must provide subordinates situational awareness and effectively communicate commander's intent, even in denied or austere environments. Systems must be leader-centric, network enabled, interoperable, and seamlessly connect all elements of the MAGTF with joint forces and mission partners to allow for unencumbered information-sharing and collaboration, the creation of adaptive organizations, enablement of a greater unity of effort via synchronization, and the integration of force elements down to the small unit level. Such systems and applications must allow effective C2 in a complex information environment and cope with challenges in the electromagnetic spectrum and contested cyberspace.

Goal: To enable the Marine Corps to contribute fully to globally integrated operations by providing commanders the systems and applications they require to make timely and effective decisions that enable mission accomplishment. Commanders and their staffs will achieve a refined, collective understanding of the situation through widespread information-sharing, understanding of the commander's intent, view of the operational environment, and collaborative situation assessments. New mobile technologies and C2 platforms will free commanders from their command centers and allow them to conduct critical C2 functions from anywhere in the operational environment with minimal risk.



The planning process will be enhanced due to broader information-sharing and more extensive collaboration. Continuous collaboration will result in faster and better-informed decisions and plans as well as facilitate the self-synchronization of forces in fluid situations. To achieve this, systems must facilitate integration and information sharing across multiple security levels, all domains, organizational echelons, and with partners and allies; they must be sufficiently common and scalable to facilitate micro to macro adjustments as the force expands or contracts to adjust to the fluid environment.

C2 STO-1: Artificial Intelligence to Support Development of Knowledge and Situational Awareness

Develop artificial intelligence (AI) to support development of knowledge and situational awareness. The Marine Corps currently lacks the ability to automate many staff functions. The automation of staff functions requires something more than data mining algorithms and the ability to communicate the synthesized data in an easily understood manner. The automation needs to "learn" and grow with usage while providing information and understanding to decision-makers. AI holds the potential to provide commanders and their staffs the ability to synthesize data and impart understanding throughout all phases the planning and execution cycle, shrink the footprint of command elements while concurrently increasing operational tempo, and making forces more effective across the entire ROMO by optimizing capabilities. Advances in computing power and miniaturization as well as data storage, retrieval, and synthesis services make AI a viable long term goal for the Marine Corps future force.

C2 STO-1 maps to the following POM 19 gaps:

- 19-5.5.1-G3: Tactical situational awareness
- 19-6.1.3-G6: Analyze activities

C2 STO-2: Cyberspace Modeling and Simulation

Develop a cyberspace modeling and simulation capability in support of MAGTF operations. The MAGTF currently lacks the ability to identify, understand, and model the cyberspace environment in a timely manner. Tactical commanders cannot gain confidence in any activity happening within this domain. The MAGTF needs to gain access to tools and effects, be able to



model the cyberspace environment in which these capabilities will be used, and be able to forecast the effects throughout all five domains. Advances in computing power, data analytics and virtualization, as well as an increase in sensors throughout the battlespace make this a capability that the MAGTF can pursue.

C2 STO-2 maps to the following POM 19 gaps:

- 19-5.3.2-G1: Cyberspace operations planning for enabling operations

5.6 Joint Capability Area 6 (JCA 6) – Communications and Computers

Communication and Computers

Communications and computers provide a framework for full human and technical connectivity and interoperability that allows all users and mission partners to share the information they need, when they need it, in a form they can understand and act on with confidence, and protect information from those who should not have it.

The Vision: To design, build, configure, secure, operate, maintain, and sustain networks to create and preserve information assurance on the Marine Corps information networks. These networks are the globally interconnected, end-to-end set of information capabilities, and associated processes for collecting, processing, storing, disseminating, and managing information on-demand to warfighters, policy makers, and support personnel, including owned and leased communications and computing systems and services, software (including applications), data, and security. Effective defense of the information networks requires the Marine Corps to forecast, detect, identify, and respond to adversarial actions and protect resident information. Responses to unauthorized or malicious activity will require commanders to dynamically reestablish, re-secure, reroute, reconstitute, or isolate degraded or compromised networks to ensure continuous access to specific portions of the electromagnetic spectrum.

Goal: Improve the Marine Corps' capability and capacity to operate in and exploit the electromagnetic spectrum. The Marine Corps must acquire and employ increasingly resilient networks and systems in order to remain operationally effective during network failure, degradation, or significant compromise. Commanders must have the ability to command, control, and coordinate an interdependent force in rapidly changing scenarios involving distributed, simultaneous, or sequential operations often with other agencies and nations. The rapid, assured exchange of information is crucial to the success of MAGTF operations.

Systems must provide autonomous detection and response capabilities. Defending communication networks requires greater understanding of the operational environment through finding, mitigating, and fixing threats and vulnerabilities. Effective defense also requires threat monitoring, detection, analysis, and response actions.



Comms & Comp STO-1: Tactical Autonomic Network Control

Develop automated network and spectrum monitoring and control mechanism that reduces the warfighter burden while providing the improved resilience and throughput necessary to command and control in a cyber-contested environment. The information requirements of the MAGTF have resulted in the deployment of increasingly complicated network architecture across all echelons of command e.g. NOTM and fielding of PRC-117G radios to the squad level. Improved network and spectrum management automation is needed to support company and below operations.

Comms & Comp STO-1 maps to the following POM-19 gaps:

- 19-6.1.1-G3: Plan and direct networks

Comms & Comp STO-2: Cognitive Radios

Develop Cognitive Radios (CR). A CR whether software-defined or not, is aware of its environment and internal state and uses parameters such as channel occupancy, free channels, the type of data to be transmitted, the modulation types, regulatory requirements and even geography to detect available channels in the spectrum through Dynamic Spectrum Management. CRs communicate with each other about the status of channels and transfer the control to the right transmitter based on their knowledge of the channel status. Beyond simply selecting a channel to transmit on, the CR would adjust the radio's power settings to only what is needed for a successful transmission, conserving energy. These capabilities would allow Marine units to deploy with fewer radios yet be able to aggregate with other MAGTF, Joint, Coalition, or Emergency Responders. CRs would make more efficient use of the spectrum while being more jam-resistant, avoid spectrum congestion, and improve interoperability especially in ad hoc networks supporting HA/DR or Joint/Coalition missions.

Comms & Comp STO-2 maps to the following POM-19 gaps:

- 19-2.5.0-G1: Disseminate and integrate intelligence
- 19-3.1.1-G23: Mission partner tactical situational awareness
- 19-6.1.1-G5: On-the-move network capacity
- 19-6.1.1-G19: EHF ground terminal

Comms & Comp STO-3: Situational Awareness of the Network and All End-User Devices

Develop a means to provide situational awareness of the network and all end-user devices on the network. The Marine Corps currently lacks the ability to have situational awareness of all devices connected to its network. The Marine Corps has the ability to see networks devices such as switches, routers, and servers, but this is not all devices that are connected to our network. This ability needs to be able to see all devices that are connected, in real time and across multiple domains. This capability needs to be visible from MCNOSC down to the regional areas for security, response, and maintenance. This would give the Marine Corps the ability to have "eyes on" all devices that are connected to its networks, not just switches, routers, and servers; and give the Marine Corps a better overall view of what is connected to our network. Right now, the only way for this to happen is through physical inspection.

Comms & Comp STO-3 maps to the following POM-19 gap:

- 19-6.1.2-G9: Cyber standardized management

5.7 Joint Capability Area 7 (JCA 7) – Protection

Force Protection

The S&T investment in Force Protection is focused on individual protection, platform protection, and autonomous systems. The investment in individual and platform protection is intended to provide increased survivability across the spectrum of conflict. Protection technologies are needed to reduce the weight while increasing the levels of protection for individuals and platforms. The inclusion of autonomous systems recognizes the advantages of these systems in performing dangerous tasks remotely.

Escalation of Force (EoF) capabilities fall within JCA 7. These capabilities seek to embrace the entire continuum of force to enhance the combat effectiveness of the MAGTF by providing flexible and scalable capabilities that will provide an improvement in force protection and force application over current systems. The shifting operational environment is likely to include a greater mix of enemy combatants with non-combatants and an increase in situations where lethal force is undesirable. Operations increasingly occur in urban terrain, and the enemy has shifted to asymmetric, irregular warfare not only to protect themselves, but also to place those who support the United States in jeopardy. With this shift in tactics comes the challenge of identifying and engaging the enemy, while reducing collateral damage and ensuring the safety of noncombatants and friendly forces. EoF capabilities will enhance the Marine's ability to operate in a fluid asymmetric/irregular threat environment by providing improved technologies that are applicable to force protection and force application and that are flexible and scalable from less lethal to lethal -- that is, capabilities that address the entire continuum of force.

The Vision: Protection for the individual and MAGTF that enables their successful engagement against the threat in both conventional and irregular warfare. Protection is achieved through both non-materiel and materiel means focused at countering or defeating targeted enemy capabilities.

The Escalation of Force vision is to develop capabilities to augment, but not replace, lethal weapons. EoF Capabilities will provide the MAGTF with flexible and scalable options that permit the minimum application of force necessary to achieve desired effects, while minimizing collateral damage and casualties to noncombatants. EoF capabilities that warn, deter and dissuade noncombatants in current and future mission are essential characteristics of EoF capabilities. EoF Capabilities will enable Marines to achieve this goal while maintaining a high level of force protection.

Goal: The focus is on the individual Marine's equipment, platforms and vehicles, and autonomous systems. Marines should be equipped with lighter weight protective clothing and equipment that reduces the individual's optical and heat signature, and improves survivability against the most common threats while minimizing the impact on mission accomplishment. Vehicles and platforms should be designed to minimize the effects of blast – specifically from mines detonating in the vicinity of wheel wells – and with the capability to readily adapt to threat-specific armor additions. Active defense systems counter the most common threats to vehicles and platforms. Autonomous systems provide tools that reduce the risk

to Marines conducting specific tasks to include but not limited to reconnaissance, local security, mine clearing, and EOD.

EoF capabilities are intended for use during situations found primarily, but not exclusively, while operating under restricted Rules of Engagement (ROE) and in environments where the ratio of noncombatants to combatants is high. EoF capabilities are needed in situations where the use of lethal weapons is limited, where threats are unclear, and where collateral damage is a concern, but they must not inhibit mission accomplishment or the use of lethal force when required. The solutions needed to accomplish several different tasks that support MAGTF missions, especially during Phases 4 and 5 of the Continuum of Operations. The Marine Corps needs options to generate effects that immediately neutralize or incapacitate targets. EoF capabilities that warn, deter, and dissuade noncombatants in current and future missions are an essential characteristic of required capabilities. EoF capabilities will provide a full range of lethal and non-lethal effects to protect personnel and materiel through active and passive measures in a dynamic and evolving security environment.

FP STO-1: Counter-Bomber Detection

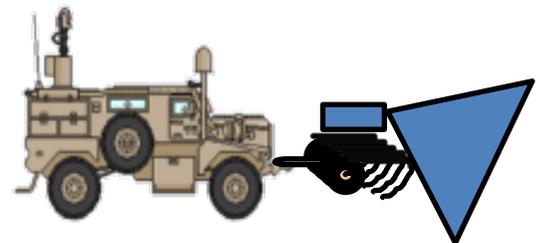
Develop technologies that enable dismounted Marines at checkpoints and entry points to detect and identify multiple types of explosive hazards and explosive precursors at sufficient distance to ensure stand-off and enable effective response to the threat of a suicide bomber or VBIED. Technologies must be capable of screening multiple individuals or vehicles rapidly over a wide area and not limited to a single point or isolated individual or vehicle. Assessment and warning must be accurate, reliable and near instantaneous.

FP STO-1 maps to following POM 19 gaps:

- 19-3.1.1-G3: MAGTF standoff explosive hazard detection in Ship to Objective Maneuver (STOM)
- 19-7.2.1-G1: EOD detect, locate, access, diagnose, render safe, & exploit Improvised Explosive Devices (IED), Unexploded Explosive Ordnance (UXO) and Weapons of Mass Destruction (WMD)

FP STO-2: Standoff Detection of Explosive Hazards and Explosive Precursor Components

Focusing on mobility and expeditionary employment with in the littoral as the key drivers: Develop technologies that enable mounted, dismounted, and fixed-sites that enable Marines to detect explosive hazards and explosive precursor components from safe standoff distances from very shallow water depth through to inland objectives. Standoff detection is: “detection of the target device/substance with both the operator and the detector positioned outside the serious injury zone”. Development of remote detection (detector inside the serious injury zone) technologies is also desired as long as the operator is positioned outside the serious injury zone. This capability must be able to locate, identify/classify, mark, and report explosive hazards at standoff distances. It should be scalable and adaptable to support global environments and capable to be man portable and or vehicle mounted. Thresholds may include improvements to existing standoff detection technologies; however, the goal is to develop transformational standoff detection technologies.



FP STO-2 maps to following POM 19 gaps:

- 19-3.1.1-G3: MAGTF standoff explosive hazard detection in Ship to Objective Maneuver (STOM)
- 19-7.2.1-G1: EOD detect, locate, access, diagnose, render safe, & Exploit Improvised Explosive Devices (IED), Unexploded Explosive Ordnance (UXO) and Weapons of Mass Destruction (WMD)

FP STO-3: Mobile sensors for the detection of Low Observable/ Low Radar Cross Section (LO/LRCS) threats

Focusing on mobility and expeditionary employment with in the littorals as the key driver:

Develop modular and scalable ground based and airborne sensor network(s) that enable on-the-move, near-real time fire control quality detection, tracking and positive combat identification of UAVs, cruise missiles, fixed and rotary wing aircraft, in all weather, and other LO/LRCS targets. Sensors must operate autonomously or on an integrated fire control network of cooperative engagement weapons and sensors. Sensors must be capable of sharing data and fusing information with other sensors as part of the common operating picture.

FP STO-3 maps to following POM 19 gaps:

- 19-2.2.2-G1: IAMD detect threats
- 19-7.1.1-G3: IAMD low radar cross section (detect)
- 19-7.1.1-G7: IAMD radar mobility
- 19-7.1.1-G4: IAMD data fusion

FP STO-4: Mobile Weapons Systems Capable of Intercepting Low Observable/Low Radar Cross Section (LO/LRCS) Threats

Focusing on mobility and expeditionary employment with in the littorals as the key driver, develop networked vehicle, foot mounted and or both technologies that enable engagement of LO/LRCS UAV threats, within a keep-out range of approximately 15km while on the move. The weapon system must be capable of independent operations or as part of an integrated fire control network of cooperative engagement weapons and sensors, with an inherent kinetic (missile and gun) and non-kinetic (directed energy/other) capability to destroy UAVs, cruise missiles, fixed and rotary wing aircraft, in all weather. It must be a robust expeditionary weapon system capable of destroying LO/LRCS threats but light and mobile enough to keep pace with Marine Corps maneuver forces.



FP STO-4 maps to following POM 19 gaps:

- 19-7.1.1-G1: IAMD defense in depth (air/ground Defense)
- 19-7.1.1-G2: IAMD defense in depth (maintain pace)
- 19-7.1.1-G3: IAMD low radar cross section (detect)

FP STO-5: Standoff Visual Localization of Radiological Materials

To enable the Marine Air-Ground Task Force (MAGTF) the ability to visually localize radiological hazards and materials (alpha, beta, neutron, gamma, and x-ray) from a standoff distance to identify these threats with level of confidence of greater than 99% (personnel and equipment removed from the serious injury zone).

The intent of this capability is to support the force, installation protection and operational decision making by localizing (detect & identify) radiological hazards and materials (e.g., radioactive sources, Special Nuclear Material (SNM)) on surfaces, in liquids, and in the air. Radiological detection is used in support of early warning and all phases of Counter-Weapons of Mass Destruction (WMD) operations. Focusing on mobility/expeditionary employment as the key driver, develop technologies that enable mounted, dismounted, and fixed-site Marines the capability to visually detect radiological materials at standoff distances with level of confidence of greater than 99%. For the dismounted operators, the systems have to be handheld, ruggedized, less than 2 lbs, and operate no less than 8 hours of continuous use - for both amphibious and expeditionary operations. Standoff detection has been defined as detection of the target device/substance with both the operator and the detector positioned outside the serious injury zone (DSI). Development of remote detection (detector inside the serious injury zone (DSI)) technologies is acceptable as intermediate capability as long as the operator is positioned outside the serious injury zone (DSI). This capability must include the ability to support mission planning and analysis prior to contact with radiological materials, be scalable and adaptable to suit a wide range of mission and environmental conditions. Thresholds may include improvements to existing technologies to enhance the standoff and remote detection capability of current systems; however, the best long term approach is the pursuit of transformational technologies that are not easily countered or defeated.

- Detect - The capability to detect radioactive particles and energies at safe distances and over the range of operational conditions (interferents, operator use, environments, power sources, etc.).
- Identify - The capability to identify specific isotopes IAW DoD Radiological Clearance Criteria Guidelines. Metric: (Identify all isotopes in Group 4 = 1, Identify all isotopes in Group 3 = 2, Identify all isotopes in Group 2 = 3, Identify all isotopes in Group 1 = 4).
- Interoperability - Capability to rapidly and accurately provide information through C2 networks. Metric: (interface with host platforms = 2.5, network sensors (three or more) = 5, interface with Service C4ISR systems = 7.5, interface sensors to GCCS = 10).

FP STO-5 maps to following POM 19 gaps:

- 19-7.2.1-G1: EOD detect, locate, access, diagnose, render safe, & Exploit Improvised Explosive Devices (IED), Unexploded Explosive Ordnance (UXO) and Weapons of Mass Destruction (WMD)

FP STO-6: Escalation of Force (EoF) Technologies to Stop and/or Disable Vehicles and Vessels (Counter-Materiel)

Develop EoF technologies (kinetic and non-kinetic) to enhance the MAGTF's counter-materiel capabilities to stop and/or disable threat vehicles, aircraft and vessels through precision and area engagements that minimize the risk of significant injury and collateral damage, that produce reversible effects, that are suitable for expeditionary operations, and that maximize stand-off distance. Target engagements will focus on locations where the application of lethal fires could be counterproductive to US objectives and

strategic goals, and where the threat is irregular and unclear (i.e., environments with a high non-combatant to combatant ratio).

FP STO-6 maps to following POM 19 gaps:

- 19-3.1.4-G4: Stop vehicles, small vessels, or A/C (on the ground) through non-lethal means
- 19-3.1.4-G11: Disable vehicles, vessels, or A/C (on the ground) through non-lethal means

FP STO-7: EoF Technologies to Warn, Deny, Move, Disable and Suppress Individuals (Counter-Personnel)

Develop EoF technologies (kinetic and non-kinetic) to warn, deny, move, disable, and suppress individuals or multiple personnel through precision and area engagements that minimize the risk of significant injury and collateral damage, that produce reversible effects, and that maximize stand-off distance. Target engagements will focus at locations where the application of lethal fires could be counterproductive to US objectives and strategic goals and where the threat is irregular and unclear (i.e. environments with a high non-combatant to combatant ratio). Develop technologies that are suitable for expeditionary operations and that utilize low energy directed energy techniques, and coherent and incoherent light at various optical frequencies for degrading enemy personnel techniques. Develop mounted, dismounted and fixed site, directed energy technologies that generate terahertz, millimeter, and microwave electromagnetic radiation at high average and/or peak power. Radio Frequency sources should be made frequency agile and should strive for compactness, energy efficiency, and effective thermal management. In addition, develop technologies that enable scalable directed-energy effects that can provide weapon systems that can deliver non-lethal or lethal effects (scalable from lethal to less than lethal). Both technology development and bio-effects research are required concurrently.

FP STO-7 maps to following POM 19 gaps:

- 19-3.1.4-G6: Deny area to personnel
- 19-3.1.4-G10: Disable individual(s)
- 19-3.1.4-G7: Suppress multiple personnel through non-lethal fires

FP STO-8: Clear a Space

Develop technologies that provide a less lethal alternative to kinetic/blast weapons for employment in operations to clear any man-made structure to include: single and multi-story buildings, building complexes, aircraft, trains, command bunkers, and subway/sewer networks. Target engagements will focus on locations where the application of lethal fires and/or unintended collateral damage could be counterproductive to US objectives and strategic goals, and where the threat is irregular and unclear (i.e., environments with a high non-combatant to combatant ratio).

FP STO-8 maps to following POM 19 gaps:

- 19-3.1.1-G29: Clear facilities through non-lethal means

5.8 Joint Capability Area 8 (JCA 8) – Building Partnerships

Irregular Warfare

Since its inception, the Marine Corps has been involved in what we now associate as Irregular Warfare (IW), and currently has a very experienced and mature force capable of operating in the IW environment. However, the complex operational environment of the future requires that these current skills and capabilities will continually need to be enhanced to keep up with an ever-adaptive adversary, and an ever-changing environment.

Consistent with the dynamic nature of the operating environment, the training and education of Marines are continuously reviewed, validated, and adjusted to incorporate lessons learned, based upon dynamic adversarial tactics. Understanding that the successes or failures of winning in an IW environment is all about understanding the operational environment and honing our training and skills to counter the *threat*, technologies currently on-the-shelf or under development need to be applied to better enable Marines to operate effectively in what will remain a complex environment.

The Vision: The S&T investment in Irregular Warfare is intended to identify and develop those potential technological capabilities that can enhance the mission success and increase the survivability of Marines in the IW environment, through training, education and superior tactical capabilities on the future battlefield.

Goal: Irregular Warfare is focused on influencing the relevant populations and Marines at every level will require improved operational analysis and reach back capabilities for use during all phases of an operation. Marines need tools to enable them to rapidly assess the human terrain and then assess, problem solve, and implement effectively both Security Force Assistance (SFA) and Stabilization Operations. IW S&T solutions are intended to rapidly bridge the gap in professional education and training that would otherwise have only been filled by PhDs, city planners, and cultural experts. In addition, Marines require the capability to achieve and maintain language proficiency and cultural intelligence to prepare forces for the expanded interaction with local populations.

5.9 Joint Capability Area 9 (JCA 9) – Corporate Management & Support

Overview

The Marine Corps lacks an effective "big data" / analytics capability to support senior leader decision-making in the areas of strategic planning; capabilities development; program, budget and finance; enterprise-wide assessment; and force generation. These organizational management processes would be greatly enhanced through sophisticated analysis of the large volumes of data that already exist in great variety and are drawn from numerous sources. Currently, however, when confronted with a question requiring decision support, the challenge of even locating the correct data often consumes an extraordinary portion of the time expended on the work, leaving little time to actually critically consider the data and perform useful analysis. As a result, decision support products presented to senior leaders

often fail to consider all available data, and do not reflect the level of in-depth analysis that technology makes available today.

The Vision: The Marine Corps must develop integrated tools that effectively support senior leader decision requirements by employing all relevant data sources and sophisticated analytical approaches. These tools must be capable of delivering results presented as clear and compelling visualizations within minutes or hours.

Goal: The tools should enable access to all data sources used in the execution of tasks associated with JCA 1 and JCA 9. While the tools should be designed for use by action officers at Headquarters, U.S. Marine Corps and the Command Elements of Commanders, Marine Forces, such systems might require data science expertise for the design of inference models and other sophisticated skills. The tools should enable real-time connections to all relevant data sources at the UNCLASSIFIED and SECRET levels. This capability should be readily accessible from standard desktop computer terminals.

CM STO-1: Enterprise Capabilities Data Management and Analysis Tools

Develop technologies which will enable all Marine Corps data systems to be linked in a "Ready Data Environment" that is accessible for use by data / analytics tools. Data / analytics capability must have access to relevant Joint data sources and non-DoD data sources such as social media networks, news networks, etc., in real time. Such data sources can be used to develop "Business Insights" and to collect relevant sentiment information.

CM STO-1 maps to following POM 19 gaps:

- 19-9.3.0-G2: Data management / Ready data environment
- 19-9.3.0-G4: Enterprise data governance
- 19-9.3.0-G5: Enterprise reference & master data management
- 19-9.2.2-G1: Enterprise capabilities data management analysis

ANNEX A – SEABASING

Seabasing: the deployment, assembly, command, projection, [sustainment], reconstitution, and reemployment of joint power from the sea without reliance on land bases within the operational area. - *Joint Pub 1-02*

Since its approval in 2005, no concept has been the focus of more analysis and discussion than the Seabasing Joint Integrating Concept (JIC). Driving the interest in Seabasing is the increasingly difficult problem of operational access for our military forces—not only of an adversary seeking to deny access to an operating area but also of reluctant allies struggling to balance domestic sensitivities and priorities with their regional security obligations. For the Marines operating in this environment, Seabasing provides MAGTFs the capabilities needed for engagement, crisis response, and power projection across the range of military operations.



With the introduction of the Expeditionary Transfer Dock (T-ESD), formerly MLP, into the sea base, comes the ability to transfer heavy equipment to and from amphibious and maritime prepositioning ships. The Expeditionary Fast Transport ship (EPF), formerly the JHSV, is now operational in the fleets, along with the planned recapitalization of both non-displacement and displacement landing craft (LCAC-100, LCU-1700) increase the capacity and speed of forces and sustainment flowing in to, between, and from the sea base. By capitalizing on successful technologies recently completed, already in development, and new technology initiatives, there is substantial progress towards making the Seabasing concept a reality. The Large Vessel Interface Lift-on/Lift-off (LVI LO/LOL) is a prototype crane systems developed to quickly and safely move cargo between ships in higher sea states. The Interface Ramp Technology (IRT) is a prototype ramp capable of transferring an M1A1 tank between vessels thru SS4. The Advanced Mooring System (AMS), a hydraulic vacuum system capable of mooring two vessels skin to skin on open seas, recently

completed successful sea trials. These technologies are ready to be harvested during the recapitalization of the current inventory of ships. The Environmental Ship Motion Forecaster (ESMF) in its final year of development will transition and provide ship masters a critical decision support tool for predicting changing sea states. The development of the Dense Packed Asset and Retrieval System (DPART) will provide for ever-greater selective access and retrieval of equipment and supplies. And last but not least is the significant increase in our Seabasing capability stemming from Sailors and Marines putting the concept in to practice using today's platforms and systems.

Even with this progress, there is still much work to do before the reality of Seabasing can approach the capabilities articulated in the Seabasing JIC, in particular operating *through* Sea State 4. Emerging Naval operating concepts will identify new capabilities and new gaps that will require technology solutions. Provided is a series of Science and Technology Objectives that the Marine Corps will champion with our Navy partners as the latter develops its Seabasing technology investment plan to meet the requirements outlined in the JIC.

The Vision: By embracing legacy and future platforms and technology efforts, the Navy and Marine Corps team will develop the Seabasing capabilities needed to close, assemble, employ, sustain, and reconstitute a force for missions across the range of military operations and in more adverse environmental conditions, amidst ever increasing challenges to operational access.

Goal: The overarching goal for the 2017-2018 Marine Corps Seabasing Science and Technology Strategic Plan is to ensure that the various components of the seabase are interoperable (connected), optimized to support force employment in the 2025 operating environment, and operated in the most cost-effective manner possible. Using the CAESR construct outlined above, Marine Corps priorities for Seabasing Science and Technology development are provided below.

Closing the Force

Amphibious and prepositioning forces provide a significant advantage over other forces in their ability to rapidly close to a crisis location. They possess enhanced capabilities to close to the joint operating area (JOA) in A2AD conditions while prepositioning forces specifically enable the rapid closure of a heavier force with significant organic sustainment.

SEA-STO-1: Ramp and interface technologies

Develop the ramp and interface technologies needed to close flow-in echelon, assault follow-on echelon, and strategic sea- and air-lift forces to the sea base through SS-4. Current technology initiatives in this area generally support transfer in to SS-3.

SEA STO-1 maps to the following POM 19 gaps:

- 19-3.1.2-G1: Surface assault lift during amphibious maneuver
- 19-3.1.2-G2: Ship-to-shore connectors
- 19-4.1.1-G1: MPF at-sea selective offload and assembly
- 19-3.1.2-G5: Assault amphibian at-sea recovery
- 19-4.1.2-G2: Conduct distribution operations

SEA-STO-2: Reduce sea states

Develop technologies to reduce sea states from SS-4 to SS-2 within the seabase environment in order to facilitate closure for ships and surface connectors delivering forces from an advance- or intermediate staging-base to ships of the sea base.

SEA STO-2 maps to the following POM 19 gaps:

- 19-3.1.2-G1: Surface assault lift during amphibious maneuver
- 19-3.1.2-G2: Ship-to-shore connectors
- 19-4.1.1-G1: MPF at-sea selective offload and assembly
- 19-3.1.2-G5: Assault amphibian at-sea recovery
- 19-4.1.2-G2: Conduct distribution operations

Assembling the Force

Assembly involves the integration of personnel and equipment to prepare the force for employment. Assembly includes actions required to make a unit combat ready such as issuing ammunition and filling fuel tanks. Assembly commences with the arrival of the advance elements and is complete when the force is ready to conduct operations. As MPF (SE) reaches FOC, Marine and Navy forces will employ the capability to combine amphibious and prepositioning ships to provide a limited at-sea assembly capability.

SEA-STO-3: Improve vessel-to-vessel mooring capabilities

Develop technologies to enable vessel-to-vessel mooring capabilities through SS-4 in order to affect vehicle and container transfers in adverse environmental conditions.

SEA STO-3 maps to the following POM 19 gaps:

- 19-3.1.2-G2: Ship-to-shore connectors
- 19-4.1.2-G1: Amphibious force sufficiency and strategic lift
- 19-1.2.1-G1: Seabasing force preparation
- 19-4.1.1-G1: MPF at-sea selective offload and assembly
- 19-5.1.2-G2: C2 aboard non-traditional naval platforms
- 19-4.1.2-G2: Conduct distribution operations



SEA-STO-4: Forecasting adverse sea conditions

Develop technologies and decision support tools to forecast wind, waves, and ship motions far enough in to the future to make go/no-go decisions for equipment and cargo transfers between vessels.

SEA STO-4 maps to the following POM 19 gaps:

- 19-3.1.2-G2: Ship-to-shore connectors
- 19-3.1.1-G11: Heavy Rotary Wing (RW) airlift operations in STOM
- 19-4.1.1-G1: MPF at-sea selective offload and assembly
- 19-5.1.2-G2: C2 aboard non-traditional naval platforms
- 19-3.1.2-G5: Assault amphibian at-sea recovery
- 19-4.1.2-G2: Conduct distribution operations

SEA-STO-5: Improving equipment stowage factors

Develop technologies that reduce the amount of lost equipment stowage space aboard ships due to increasing tie-down (gripping) requirements. As MAGTF equipment weight increases, there is a corresponding increase in tie-down/gripping requirements and a decrease in the amount of equipment that can be stowed aboard ship.

SEA STO-5 maps to the following POM 19 gaps:

- 19-3.1.2-G2: Ship-to-shore connectors
- 19-4.1.1-G1: MPF at-sea selective offload and assembly
- 19-4.1.2-G1: Amphibious force sufficiency and strategic lift

Employing the Force

Surface and air connectors facilitate the employment of amphibious forces directly from the sea base. Using the freedom of maneuver offered by the maritime domain, amphibious forces can operate without reliance on host-nation facilities and can loiter indefinitely in the area of operation (AO). In Marine Corps expeditionary operations, amphibious forces, supported by MPF, provide the nation's primary means of establishing access, by forcible entry if needed, to introduce follow-on joint forces. The completed introduction of the seabasing module in 2015 (IOC), along with the incremental development of procedures and technologies for increased interoperability with amphibious ships, will enable limited employment from MPF (SE). The ultimate objective is to transition to a fully sea-based capability that provides a broader range of employment options through enhanced surface connector and aviation interfaces.

SEA-STO-6: Shipboard integration and interoperability of UAVs

Develop standardized command and control technologies in order to ensure UAV interoperability and integration aboard all classes of amphibious ships, selected combat logistics force ships, and selected preposition ships.

SEA STO-6 maps to the following POM 19 gaps:

- 19-3.2.1-G3: Unmanned Aerial Systems (UAS) Offensive Air Support (OAS)
- 19-5.1.2-G2: C2 aboard non-traditional naval platforms

SEA-STO-7: Greater Ship-to-Shore Surface Connector Capability, Capacity, and Speed

Develop technologies that increase the capability of future surface connectors to overcome obstacles on a beach, which increase their carrying capacity, and speed their movement from ship to shore.

SEA STO-7 maps to the following POM 19 gaps:



- 19-3.1.2-G1: Surface assault lift during amphibious maneuver
- 19-3.1.2-G2: Ship-to-shore connectors
- 19-4.1.2-G1: Amphibious force sufficiency and strategic lift
- 19-4.1.1-G1: MPF at-sea selective offload and assembly
- 19-5.2.2-G4: MEF Blue Force Tracker (BFT) Tactical Operations Center (TOC) amphibious capability
- 19-4.1.2-G2: Conduct distribution operations

Sustaining the Force

Both the amphibious and prepositioning programs include organic self-sustainment capability that provides significant sustainment for both MAGTFs and joint or coalition forces. MPF sustainment is currently limited to the initial (up to) 30 days MEB support. Prepositioning ships provide the bulk of the initial sustainment, to include fuel, needed to support a MEB conducting sustained operations. While much of the MPF's sustainment is packaged in containers (twenty-foot equivalent units (TEUs)), which require movement ashore, and unpacking prior to issuing supplies to the supporting unit, the addition of the T-AKE and MLP provide a significant increase in capability. The T-AKE significantly reduces the need to move containers ashore and enhances the capability of afloat prepositioning to provide selective offload of sustainment. The load-out of the T-AKE provides a combination of selective access to supplies, such as ammunition and repair parts, and dense pack bulk supplies, such as packaged rations (i.e., meals ready to eat (MREs)), allowing for the configuration of these supplies to support the delivery and issue of tailored pallet loads directly to maneuver units via air and surface connectors (currently not organic to the T-AKE). The MLP provides a platform that can be utilized for the reorganization, repositioning and/or breakdown of containerized cargo.

SEA-STO-8: Improved near-shore vehicle transit capabilities.

Develop technologies to improve and increase the MAGTF's ability to employ vehicles and equipment from lighterage, craft, or vessels to a beach. Systems developed through these technologies should be easily transported, deployable, and recoverable; and capable of supporting operations in more adverse surf conditions than the current class of lighterage systems.

SEA STO-8 maps to the following POM 19 gaps:

- 19-3.1.2-G1: Surface assault lift during amphibious maneuver
- 19-3.1.2-G2: Ship-to-shore connectors
- 19-3.1.2-G5: Assault amphibian at-sea recovery

SEA-STO-9: Selective access and retrieval aboard ship

Develop technologies that facilitate the selective access and retrieval of equipment and supplies aboard ship. Technologies developed under this STO increase the operational capability of preposition shipping with the added benefit of reducing operating costs.

SEA STO-9 maps to the following POM 19 gaps:

- 19-3.1.2-G2: Ship-to-shore connectors
- 19-4.1.1-G1: MPF at-sea selective offload and assembly
- 19-5.1.2-G2: C2 aboard non-traditional naval platforms



SEA-STO-10: Reduce retrograde requirements

Develop packaging and handling technologies to reduce the amount of material that needs to be returned to ship during sea-based sustainment operations. Technologies developed under this STO should reduce material handling requirements for smaller units conducting distributed operations and reduce the time spent and fuel consumed by allowing aircraft to drop cargo loads and quickly depart the area without waiting to recover slings and/or containers.

SEA STO-10 maps to the following POM 19 gaps:

- 19-3.1.2-G2: Ship-to-shore connectors
- 19-4.1.1-G1: MPF at-sea selective offload and assembly
- 19-4.2.2-G1: Disposal Options/Solutions

SEA-STO-11: Selective vertical sustainment during distributed operations

Develop the technologies necessary to support multiple-unit, point of need sustainment of small units conducted distributed operations. Technologies developed under this STO should be usable by both land- or sea-based helicopters and UAVs.

SEA STO-11 maps to the following POM 19 gaps:

- 19-3.2.1-G3: Unmanned Aerial Systems (UAS) Offensive Air Support (OAS)
- 19-3.1.3-G4: Unmanned aerial system beyond line of sight capability
- 19-3.1.1-G11: Heavy Rotary Wing (RW) airlift operations in STOM
- 19-4.1.1-G1: MPF at-sea selective offload and assembly
- 19-5.1.2-G2: C2 aboard non-traditional naval platforms
- 19-4.1.2-G2: Conduct distribution operations

SEA-STO-12: Improved asset visibility aboard ship

Develop technologies that improve the ability of logistics planners to know the amount of supplies and the specific location of supplies aboard a combat logistics force or preposition force ship.

SEA STO-12 maps to the following POM 19 gaps:

- 19-5.1.2-G2: C2 aboard non-traditional naval platforms
- 19-5.2.2-G4: MEF Blue Force Tracker (BFT) Tactical Operations Center (TOC) amphibious capability
- 19-4.1.2-G2: Conduct distribution operations
- 19-4.1.1-G2: Distribution in transit visibility

Reconstituting the Force

Reconstitution is the process of restoring units to "a desired level of combat effectiveness commensurate with mission requirements and available resources" to make them ready for subsequent employment. Reconstitution includes reorganization and regeneration. There are different levels of reconstitution; the options provide commanders the flexibility to conduct operations while concurrently preparing for follow-on missions.

SEA-STO-13: Automatic equipment/system software upgrades aboard ship

Develop automatic equipment/system software upgrade technology. There are thousands of pieces of equipment stowed within the sea base that have upgradeable electronic systems. Automatic (wireless) upgrade technology would help ensure that those systems are fully mission-capable upon issue.

SEA STO-13 maps to the following POM 19 gaps:

- 19-6.1.4-G1: Cyberspace operations resiliency
- 19-6.1.3-G3: Network interoperability

Reducing Cost. Although not specifically addressed in the Seabasing JIC, the need to reduce ship construction and operating costs has become a primary consideration in all Navy-Marine Corps ship programs. The following STOs partially address this issue.

SEA-STO-14: Improved manufacturing technologies

In partnership with industry, develop manufacturing technologies and composite material uses that lead to reduced construction and lower life cycle maintenance costs.

SEA STO-14 maps to the following POM 19 gaps:

- 19-3.1.2-G1: Surface assault lift during amphibious maneuver
- 19-3.1.2-G2: Ship-to-shore connectors
- 19-4.1.2-G1: Amphibious force sufficiency and strategic lift

SEA-STO-15: Improved ship design tools

Develop design and analysis tools that reduce ship design costs and times.

SEA STO-15 maps to the following POM 19 gaps:

- 19-3.1.2-G1: Surface assault lift during amphibious maneuver
- 19-3.1.2-G2: Ship-to-shore connectors
- 19-4.1.2-G1: Amphibious force sufficiency and strategic lift

SEA-STO-16: Reducing shipboard manpower costs

Develop autonomous and semi-autonomous shipboard robotic systems to increase throughput and reduce operating costs aboard Maritime Prepositioning Ships and Combat Logistics Force ships.

SEA STO-16 maps to the following POM 19 gaps:

- 19-4.1.2-G1: Amphibious force sufficiency and strategic lift
- 19-1.2.1-G1: Seabasing force preparation

ANNEX B – AVIATION

Marine Aviation is an integrated and essential component of the Marine Air-Ground Task Force (MAGTF), supporting and sustaining Naval and Joint Forces throughout the range of military operations. Aviation resources must be available to the MAGTF/Joint Force Commander regardless of the operational scenario, austerity of engagement, or level of lethality. Due to the complexity and expense normally associated with aviation combat and support systems, it is necessary to include extensibility/upgradeability as a key aspect of all components to ensure future utility regardless of the threat or operational environment.

The Vision: Now, more than ever, as we execute the Commandant’s Planning Guidance and the 2017 AVPLAN in complex, hybrid environments of the future, we must be well postured to remain the Nation’s force in readiness, regardless of the operational context. To this end, the Aviation vision is for a network-enabled and digitally-interoperable expeditionary aviation combat element postured to execute responsive, persistent, lethal and adaptive full-spectrum operations as directed by the MAGTF or Joint Force Commander.

Aviation S&T Strategic Guidance. This Annex serves to articulate Marine Corps unique S&T needs to those agencies devoted to Aviation S&T priorities. Aviation focal points include both S&T Program Opportunities and Legacy S&T Investment Category Priorities.

a. Key Program Challenges. These are the major Aviation program areas that have opportunity for high-payoff S&T investments:

- Data links and Information/Capability Management Networks
- Heavy Lift Replacement (HLR)
- Electronic Warfare (EW)
- Unmanned Aerial Systems (UAS) and associated payloads

b. Legacy (Rotorcraft) Investment Category Priorities. These are prioritized categories in terms of current aviation-related S&T technology modernization/transition/insertion as well as future aviation programs.

(1) Survivability/Safety: Improvement in the ability to avoid detection, tracking and engagement in a complex threat environment and survive hit/crash.

(2) Battlefield situational awareness: Improvement in the ability to know and comprehend the location, intent, and actions of blue/red forces, non-combatants, environment condition, terrain, and obstacles in the area of operational responsibility. This includes increased situational awareness for embarked Marines while maneuvering.



(3) Lethality: Improvement in the ability to precisely deliver a spectrum of intended effects (lethal or non-lethal).

(4) Battle Command: Improvement in the ability of the commander to rapidly decide on a course of action and execute command.

(5) Affordability: Reduction in development, acquisition, operating and support cost while maintaining or increasing capability.



(6) Supportability/Maintainability: Improvement in reliability, availability and maintainability.

(7) Training: The efficiency with which commanders/staff, pilots, operators and maintainers are initially and continuously trained to proficiency.

(8) Footprint: Reduction in the weight and volume of the personnel, materiel, equipment and supplies that support an aerial system and must be moved.

(9) Deployability: Reduction in the time, effort, and support systems to prepare, transport, and restore a force capability.

(10) Mobility: The ability to responsively maneuver and transport troops, supplies and equipment on the battlefield in complex terrains/sea states.



2. Aviation S&T Relationships. Relationships with the following agencies are essential in order for the Marine Corps S&T IPT to ensure visibility on adequate Aviation leverages, sharing unique leverage opportunities, and ensuring an overall balanced Marine Corps Aviation S&T investment.

a. Naval Aviation Enterprise (NAE). The leadership of the NAE publishes a biennial S&T Plan¹¹ and its own STOs¹² to provide guidance to the NAE. Marine Corps aviation is dependent upon the NAE for much of its S&T investment and coordinates as appropriate for development efforts of mutual Navy and Marine Corps benefit.

Office of Naval Research (ONR) and the Naval Research Laboratory (NRL). Achieved primarily via the Executive Agent for Marine Corps S&T, but also through a direct relationship with ONR and NRL.

c. Air Force Research Lab (AFRL) and Army Research Lab (ARL). Key S&T partners providing insight into cross service opportunities for collaboration across a wide variety of platforms, programs, and interests.

d. Defense Advanced Research Projects Agency (DARPA). Provides cutting edge research applicable to all of DoD with potentially large payoffs for Marine Aviation.

e. ARMDEC. U.S. Army Research, Development and Engineering Command: responsible, by charter, for rotorcraft S&T. This is a key relationship as rotorcraft S&T investment has been minimal for over a decade.

3. Marine Corps specific Aviation STOs:

AVN STO-1: Sand and dust-penetrating radar, providing precision (landing quality) navigation video in brownout and dust-out visibility conditions

Develop technologies that enable passive obstacle detection at range (i.e., uncharted wires/cables) and a “see through” capability that enables precision support of distributed operations in unprepared landing zones for current rotary wing and tilt rotor aircraft, as well as supporting technology transition into future UAS. Develop complementary technologies to precision quality navigation in brown-out/dust-out that enables precise, landing quality, non-visual air and groundspeed reference.

AVN STO-1 maps to the following POM 19 gaps:

- 19-3.1.2-G3: TR/RW airlift operations in all weather conditions

AVN STO-2: Medium Altitude Long Endurance (MALE) ship-based unmanned aircraft system (UAS) and future autonomy

Develop a ship launch/recoverable, VTOL, expeditionary, all-weather, long operational radius (700+ nm), high endurance (24+ hours), high speed (245+ knot), multi-mission/multi-payload (1500+ lbs. or sufficient to host a directed energy (DE) weapon in the future) UAS. It should be capable of operating from austere locations and ships, providing networked, interoperable systems to enhance the MAGTF and Joint Force Commander’s force application, battle-space awareness, and C4. System will routinely function as Assault Support Escort and requires manned-unmanned teaming functionality.



Future system may also provide some ship to ship and ship to shore logistics transport function. Further refinement and development of Unmanned System Interoperability Profiles (USIP) standards for aircraft configuration, payload interfaces, data transmission, and UAS control will enable seamless integration between manned/unmanned systems and command and control networks. Advancements in standard interfaces will allow for interchangeable, mission-tailored payloads such as electro-optical/infrared, electronic warfare, signals intelligence, synthetic aperture radars, communications relay, laser designators, wide area scan, ground moving target indicators, and network enablers.

MALE UAS should also be able to operate in autonomous (not remotely controlled) modes in GPS denied environments, following mission guidance and “commanders intent”. Perform C4ISR and Logistics roles with minimal human direct input.

AVN STO-2 maps to the following POM 19 gaps:

- 19-2.2.0-G2: Airborne sensing
- 19-2.2.1-G1: SIGINT collection
- 19-3.1.2-G2: Ship to shore connectors
- 19-3.1.1-G5: Dismounted ground maneuver element identify, locate, classify targets
- 19-3.1.1-G8: Dismounted ground maneuver element UAS capability
- 19-3.1.1-G24: TR/RW airlift ability to identify targets and coordinate targeting
- 19-3.1.3-G4: UAS BLOS capability
- 19-3.2.1-G4: F35 weapons sufficiency in SEAD/DEAD
- 19-3.2.2-G1: F35 bandwidth sufficiency in EA
- 19-3.2.1-G3: UAS OAS
- 19-3.2.2-G2: Electronic attack
- 19-3.2.1-G7: Vertical assault force persistent extended range and precision indirect fires
- 19-3.2.2-G4: EW services architecture
- 19-3.2.2-G3: VMU EW capability

AVN STO-3: Cargo UAS

Develop advanced UAS vertical lift technologies in order to provide force sustainment to multiple company-level operations over a widely dispersed area. Explore autonomous and semi-autonomous line of sight and beyond line of sight UAS control in remote deployed environments to facilitate navigation and cargo delivery during 24/7 operations. Cargo UAS platforms are required to operate at high density altitudes, delivering multiple in-stride cargo drops reducing the number of ground transport delivered items.



AVN STO-4: Advanced rotor/prop technologies for performance across wider envelope 13 - FVL (V-22, H-1, CH-53)

Develop advanced technologies for rotors/props as components of assault support propulsion as well as tactical UAVs. As rotorcraft/helicopters (MV-22/VUAV) requirements grow in terms of hover load and harsh environments (heat/dust/high altitude), as well as top-end speed (i.e., MV-22 escort), advanced rotor performance enhancement (dynamic blade shaping) will garner performance as well as efficiency (fuel/load savings). Develop V-22 capability enhancements to sustain performance KPPs and improve high altitude operations. V-22 design is based on tropical day at 3000 ft/91.5° F. Scenarios requiring self-deployment, at a moment’s notice, over a long range in a future distributed battlefield will

necessitate an increased vertical lift capability. Development of technology that can increase vertical lift by at least 2000 lbs, increase operational radius by at least 40 nm, and preserve 10,000 lb load KPP are paramount for the MAGTF's freedom of maneuver abilities moving forward.

AVN STO-5: Advanced electronic warfare (EW) systems

Develop technologies that enable adaptive electronic attack techniques to defeat unknown and known communication or radar signals incorporating waveform diversity techniques that mitigate legacy jamming. Develop solid-state transmit/receive modules that provide suitable power, advanced jamming techniques, adequate number of frequency beams, and sufficient instantaneous and operational bandwidths against threats in highly dense areas. Develop real- or near-real time situational awareness tools that automatically and rapidly locate, identify and classify unknown complex threat waveforms across the radio frequency, electro-optical, and infrared spectrums.

AVN STO-5 maps to the following POM 19 gaps:

- 19-3.2.2-G4: EW services architecture
- 19-3.2.2-G3: VMU EW capability

AVN STO-6: Collaborative networking

Develop technologies that facilitate and provide for a network-enabled and digitally- interoperable expeditionary aviation combat element postured to execute responsive, persistent, lethal and adaptive full-spectrum operations.

AVN STO-7: Active kinetic and non-kinetic aircraft self-protection

Develop technologies such as high energy liquid and fiber laser systems and continued investment in technologies which enabled systems such as Tactical Aircraft Directable Infrared Countermeasures (DIRCM). Develop technologies that enable unlimited magazine self-protect capabilities against both IR SAMs and RPGs while reducing requirement for magazine (i.e. flares). Additionally investigate Electromagnetic Pulse (EMP) and High Power Radio Frequency (HPRF) technologies development for both offensive and defensive lethal and non-lethal effects.

AVN STO-7 maps to the following POM 19 gaps:

- 19-3.1.1-G6: TR/RW airlift ability to counter surface threats
- 19-3.1.1-G21: TR/RW airlift sufficiency in force protection of embarked troops

AVN STO-8: Net-enabled weapons

Develop technologies that enable aviation ordnance to rapidly join the battlefield network in order to allow terminal control, ISR, and Bomb Damage Assessment (BDA). Additionally,



develop small form factor jammers (i.e. Digital RF Memory (DRFM) systems) capable of being utilized in ordnance, artillery, expendables.

AVN STO-9: Multi-function, low-drag VHF, UHF, and SATCOM (broadband) antenna

Develop technologies that enable reduced airframe antennae and reduced airframe signature, including conformal arrays and active elements, as communications and data link requirements grow, while allowing communications growth without additional apertures.

AVN STO-10: UAS universal ground control station (UGCS)

Develop UAS Universal Ground Control Station (UGCS) with Type I encrypted Tactical Common Digital Link (TCDL) capable of controlling USMC and Joint UAS Family of Systems. Advancement in UGCS interoperability enables ground control of current and future UAS platforms to provide increased operational capability and scalable UAS options to the war fighter. It will also facilitate the rapid development and acquisition of system compatible UAS platforms.

AVN STO-10 maps to the following POM 19 gaps:

- 19-2.1.2-G1: Planning and directing intelligence and reconnaissance collection management
- 19-2.2.0-G2: Airborne sensing
- 19-3.1.1-G5: Dismounted ground maneuver element identify, locate, classify targets
- 19-3.1.1-G8: Dismounted ground maneuver element UAS capability

AVN STO-11: Small Unmanned Aircraft Systems (SUAS) (Group 1/2) Common Control Architecture (common ground control stations)

Each new small UAV system brings a unique proprietary ground control station. Marines need a common platform to control a variety of small UAV types, e.g. fixed wing, and VTOL UAS operated from the same controller.

Develop a SUAS common control architecture, a MILSPEC set of software and hardware that provides interoperability between Small Unit Remote Scouting System (SURSS) aerial vehicles and other C4I systems. A modular, reconfigurable Government standard (MILSPEC) for ground components defines:

- Waveforms and encryption
- Human interface requirements
- C2 software
- Interface methodology
- Transmitters and receivers
- Routers and modems
- Energy requirements
- Capabilities such as MAFIA and KILSWITCH



AVN STO-11 maps to the following POM 19 gaps:

- 19-3.1.1-G5: Dismounted ground maneuver element capabilities to identify, locate, and classify targets
- 19-3.1.1-G8: Dismounted ground maneuver element unmanned systems capability

AVN STO-12: Advanced laser systems suitable for countermeasure, sensor, and attack applications

Develop laser enabling technologies including multi-scan mirrors, high power/high efficiency optical amplifiers and switches, dual/multi band laser systems, lightweight open and closed loop IRCM systems, and high duty cycle systems. Resulting technologies must be applicable to both rotary and fixed wing air vehicles and provide exceptional reliability. Systems developed should interoperate with existing air-vehicle subsystems with minimal integration effort and provide countermeasure, sensor and attack capabilities.

AVN STO-13: Radio frequency (RF) countermeasure, decoy, and expendables systems

Develop technologies related to RF countermeasures applicable to fixed and rotary wing aircraft. Systems include towed decoys, released/launched decoys, RF jamming systems, and RF expendables. Develop both active and passive RF systems that contribute to, and collaborate with, the EW system-of-systems construct in an EW battle-managed environment as well as provide offensive RF capabilities. Develop technologies that assure that RF systems can interoperate with blue force systems in all domains and environments.

AVN STO-14: Interference cancellation system and adaptive/cognitive radio technologies to eliminate communication system interference from electronic attack systems

Develop interference cancellation technologies and adaptive/cognitive radio systems to enable assured communications and information distribution for emerging platforms and systems that suffer communications degradation from electronic attack systems.

AVN STO-15: Small form factor, lightweight expeditionary ordnance for fixed and rotary wing aircraft

Develop technology supporting a family of small, lightweight expeditionary ordnance for both fixed and rotary wing aircraft. Given the logistic challenges of transporting aviation ordnance to expeditionary Forward Operating Bases (FOBs), as seen in Iraq and Afghanistan, it is necessary to have small, lightweight ordnance available that can be easily transported overland or by aircraft (e.g. KC-130, CH-53E/K, MV-22) to austere sites rapidly and then loaded quickly and easily by minimal personnel. Small form factor ordnance, on the order of 50-250 lbs explosive equivalent, will further increase number of weapons fixed and rotary wing aircraft can deliver during a single sortie while both scaling effects and minimizing collateral damage. Develop technologies that can enable basic ordnance to have a variety of fusing, guidance and propelling packages thereby increasing functionality of this family of ordnance.

AVN STO-16: Low collateral damage/low energetic weapons

Develop technology supporting a family of Low Collateral Damage/Low Energetic weapons. Existing methods of obtaining Low Collateral Damage munitions include reducing the amount of explosive filler of existing weapons. Develop technologies to improve accuracy thereby reducing the risk of collateral damage when an appropriate lethality warhead and fuse are applied. Develop technologies that ensure weapon fusing and weapon yield is selectable from within the cockpit.

AVN STO-17: SUAS (Group 1/2) rapid systems design, modification, and manufacturing (advanced manufacturing and 3D printing)

Military SUAS capability must keep pace with rapidly changing commercial sector UAS development by having the ability to integrate commercial components and conduct limited manufacturing to increase operational availability and reduce costs.

Develop advanced manufacturing, to include 3D printing, capability in the near-term to rapidly produce, assemble, and field SUAS and SUAS components from Government-owned digital data. Develop a far-term process and environment where NAVAIR owns a variety of SUAS designs to modify, test, and implement configuration and performance changes through additive manufacturing to enable rapid capability fielding as technology evolves or advances.



AVN STO-17 maps to the following POM 19 gaps:

- 19-2.1.2-G1: Planning and directing intelligence and reconnaissance collection management
- 19-3.1.1-G5: Dismounted ground maneuver element capabilities to identify, locate, and classify targets
- 19-3.1.1-G8: Dismounted ground maneuver element unmanned systems capability

AVN STO-18: Composite materials in expeditionary environments

Develop technologies for health monitoring of composite structures enabling condition based maintenance and predictive failure of composite structures on aircraft in order to reduce time in Depot Level Maintenance facilities as well as reducing NDI inspections. The increased use of composite structures requires an enhanced capability to rapidly make repairs to these structures in all environmental conditions (heat, cold, sand, humid, etc.).

AVN STO-19: Standardized force tracking system

Develop technologies that provide 100% assured, covert, real-time identification of friendly forces for fratricide avoidance as well as battlefield coordination, maneuver deconfliction, command SA, future re-

supply/CASEVAC, etc., during future distributed operations. Incorporate tracking technologies applicable to enemy forces and high value targets.

AVN STO-20: Distributed networking of aviation simulators

Develop simulators and technologies to enable aviation Marines to train the way they fight. This includes engaging the senses in realistic, challenging, and rapidly reconfigurable scenarios which allows scenario-based training and mission rehearsal. The goal is to optimize the application of simulation training across the Live, Virtual, and Constructive (LVC) training construct throughout Marine Aviation.

AVN STO-21: Aviation technologies that increase the capacity of aviation assets

Develop technologies for rotary wing and heavy-lift applications to increase survivability and decrease the weight of aircraft in order to increase performance of rotary wing transport aircraft. Development of unmanned alternatives to manned helicopters¹⁴ for the delivery of logistics support with reduced risk to manned aircraft is also desired.

AVN STO-22: Mass Memory Technologies for Tactical Applications

Develop cost effective solutions with low SWAP to support tactical operations for mass memory (terabytes) data management. This includes the development of improvements for Digital Map and other avionics systems capable of higher speed data transfer, as well as sensor data/information storage, retrieval, and dissemination compatible airborne and shipboard platforms. Develop technologies that enable autonomous operations with comprehensive information onboard. Information storage onboard autonomous platforms reduce the risk in distributed and net-centric operations against an EW-capable adversary where link information is potentially degraded or denied.

AVN STO-23: Variable-speed air refueling drogue

Develop technologies that enable refueling drogues to refuel fast tactical aircraft as well as slower rotorcraft.



APPENDIX A – FUTURE OPERATING ENVIRONMENT 2045 VIGNETTE

By 2045, approximately 60% of U.S. military forces are deployed throughout the Pacific. Some of the most politically delicate megacities are in the U.S. Pacific Command (PACOM) Area of Responsibility (AOR), and the need to counter Chinese influence and support U.S. interests drives continued interventions in response to natural and manmade crises throughout the region.

While the United States maintains its status as a leader in innovation and technology, research and development expertise, as well as the resources to fund these efforts have diffused around the globe. The spread of autonomous systems, information technology and precision weapons directly affects daily operations. Information access has become highly competitive, and the protection of cyberspace and the electronic spectrum is an enduring mission for DoD forces.

Marine Expeditionary Units (MEUs) conduct distributed operations with a key maneuver element being the Expeditionary Landing Team (ELT). These teams are able to rapidly aggregate and disaggregate to meet the shifting mission requirements of the dynamic security environment. This environment requires our forces to conduct operations at the lowest tactical level and work as manned-unmanned teams.

The MEU is responding to a natural disaster that has devastated a western Pacific megacity. The area has been involved in a simmering radical extremist Islamic insurgency for many years. In addition to the

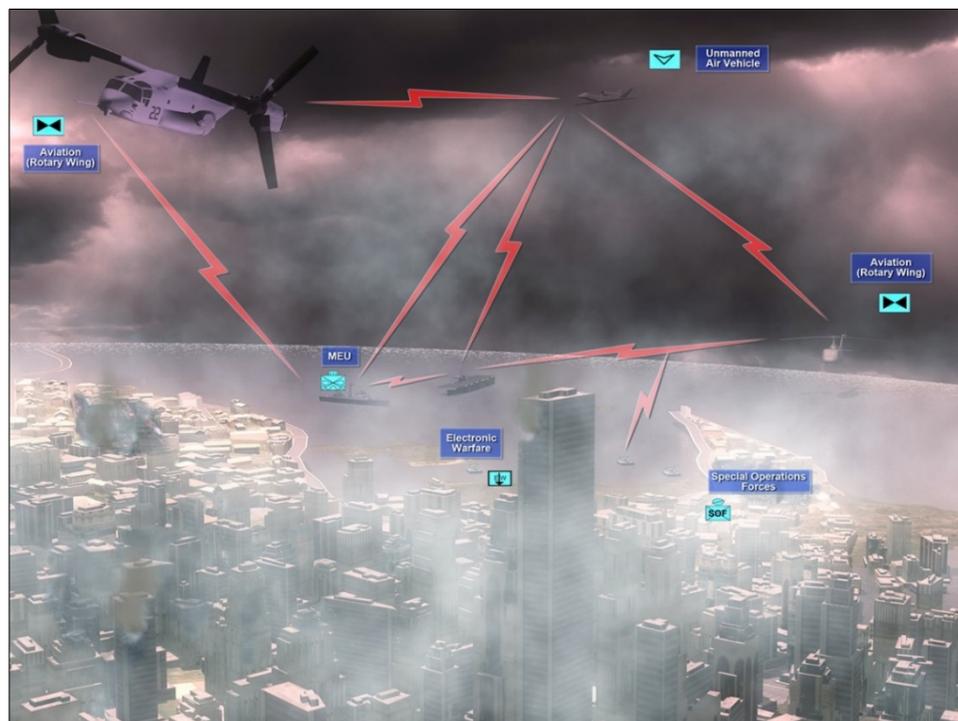


Figure 10. MEU Operational View

hardships imposed by natural disaster, it is likely that the insurgents will exploit the situation to cause additional casualties, take hostages, and damage the reputation of the U.S. and its allies.

As the MEU distributes company teams across the area of operations, some units conduct combat patrols for engagement and counterinsurgency operations while others support disaster relief and humanitarian assistance efforts. Some operate in the slums or hard hit rural areas at the same time that others operate in the urban canyons of the city.

Units operating in the urban canyon experience the greatest technical challenges. The diverse array of structures degrades communications over even short distances. Marines operate on the ground, below its surface, and in buildings. The enemy embeds threats in structures surrounded by non-involved bystanders. Careful control of the use of force and achieving cognitive effects in a truly multi-dimensional battlespace demands unprecedented man-machine teaming and mastery of information warfare, to include information operations, deception, and cyber operations across the entire electromagnetic spectrum. Marines rely heavily upon machines functioning at varying levels of autonomy for precision fires, logistics, and intelligence, surveillance, and reconnaissance (ISR) support.

In previous eras, we often heard Marine Corps operations described by the phrase “three block war.” In 2045 the ELT finds itself on patrol in the urban canyon and facing a “three level war” requiring actions to address well-armed insurgents operating below the street level, a peaceful but escalating protest occurring at a major street intersection, and humanitarian assistance requirements at a makeshift clinic on the lower floors of the adjacent high-rise apartments.

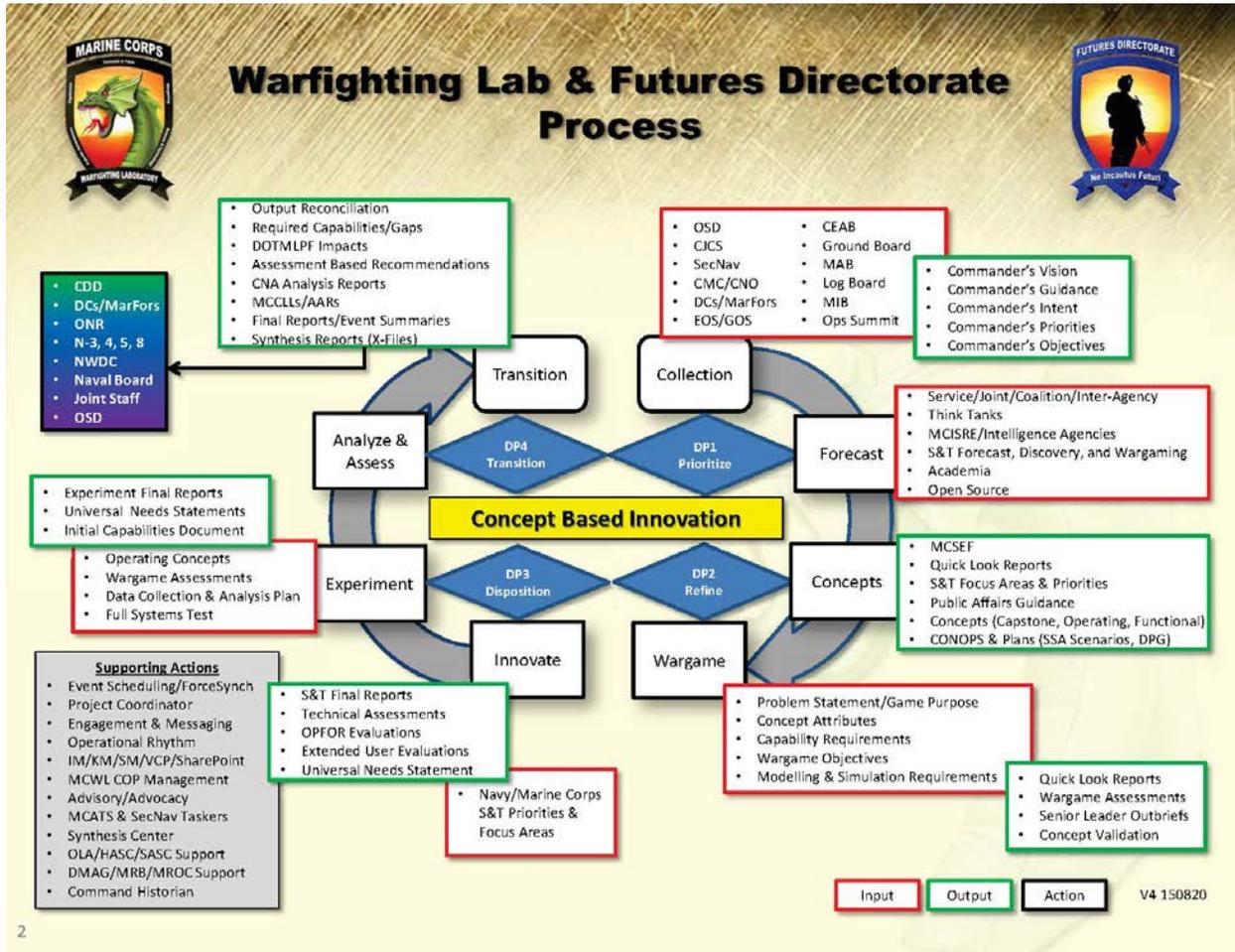


Figure 11. Company Level Manned-Unmanned Teaming

The 2045 strategic corporal is physically isolated in the urban environment from all but the few of his squad members in direct view, teamed with a variety of systems that address the full range of battlespace functions, and surrounded by thousands of people with unknown intent above, below and around the unit. The patrol is under constant surveillance by devices managed by friendly, enemy, and neutral parties. Every Marine is still a rifleman in 2045, but primary weaponry now includes armed Group 2-5 unmanned aerial systems (UAS), the armed unmanned ground vehicle (UGV) assigned to the company team, and the interface for these systems woven into the unit's uniforms.

The 2045 NCO simultaneously receives intelligence from sensors under his control in the next room, as well as in geosynchronous orbit and enhanced by real-time analytics capture of the local population's social media activity. Data is parsed, analyzed and tailored to his requirements before transmission to aid decision-making at the lowest level. He receives logistics support primarily through the autonomous air and ground systems. His company team manages those systems, with the option to launch resupply or casualty evacuation missions day or night, in almost any weather, with the support of optionally manned systems.

APPENDIX B – CONCEPT BASED INNOVATION PROCESS



APPENDIX C – LIST OF ACRONYMS

AACUS	Autonomous Aerial Cargo Utility System
AAR	After-Action Review
A2/AD	Anti-Access/Area Denial
AFRL	U.S. Air Force Research Laboratory
ARL	U.S. Army Research Laboratory
AMS	Advanced Mooring System
AO	Area of Operation
AOR	Area of Responsibility
ARMDEC	Aviation and Missile Research, Development, and Engineering Center
BA	Budget Activity
BAA	Broad Agency Announcements
BDA	Bomb Damage Assessment
BLOS	Beyond Line-of-Sight
C2	Command & Control
C4	Command & Control, Computers, Communications
CASEVAC	Casualty Evacuation
CBA	Capabilities-Based Assessment
CBRN-E	Chemical, Biological, Radiological, Nuclear and Explosive
CD&I	Combat Development & Integration
CDD	Capabilities Development Directorate
CG	Commanding General
CI/HUMINT	Counter Intelligence/Human Intelligence
CMC	Commandant of the Marine Corps
CNR	Chief of Naval Research
COIN	Counter-Insurgency
CoL	Campaign of Learning
CR	Cognitive Radio
CRL	Culture, Region, and Language
CPM	Capability Portfolio Manager
DARPA	Defense Advanced Research Projects Agency
DC, CD&I	Deputy Commandant, Combat Development & Integration
D&I	Discovery and Innovation
DIME	Diplomatic, Information, Military and Economic
DIRCM	Directable Infrared Countermeasures
DON	U.S. Department of the Navy

DOTMLPF	Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel and Facilities
DPART	Dense Packed Asset and Retrieval System
DRFM	Digital Radio Frequency Memory
EAB	Expeditionary Advanced Base
EC	Enabling Capability
EF 21	Expeditionary Force 21
EMP	Electromagnetic Pulse
EO	Electro Optical
EoF	Escalation of Force
EOD	Explosive Ordnance Disposal
EPF	Expeditionary Fast Transport ship
ESMF	Environmental Ship Motion Forecaster
EW	Electronic Warfare
FDSP	Force Development Strategic Plan
FFIP	Future Force Implementation Plan
FFR	Future Force Review
FNC	Future Naval Capability
FY	Fiscal Year
FYDP	Future Years Defense Program
HA/DR	Humanitarian Assistance and Disaster Relief
HLR	Heavy Lift Replacement
HME	Homemade Explosives
HPRF	High Power Radio Frequency
HRST	Helicopter Rope Suspension Training
I2	Image Intensification
IAMD	Integrated Air and Missile Defense
IED	Improvised Explosive Device
IFF	Identification, Friend or Foe
INP	Innovative Naval Prototype
IPT	Integrated Product Team
IR	Infrared
IRT	Interface Ramp Technology
ISR	Intelligence, Surveillance and Reconnaissance
IW	Irregular Warfare
JCA	Joint Capabilities Area
JCIDS	Joint Capabilities Integration and Development System

JFTC	Joint Training Functional Concept
JIC	Joint Integrating Concept
JIIM	Joint, Inter-Agency, Intergovernmental, and Multinational
JNLWP	Joint Non-Lethal Weapons Program
KSA	Knowledge, Skills, and Abilities
LOCUST	Low-Cost UAV Swarming Technology
LVC-TE	Live, Virtual, and Constructive-Training Environment
LVI LO/LOL	Large Vessel Interface Lift-on/Lift-off
M&S	Modeling and Simulation
MPF	Maritime Prepositioning Force
MAGTF	Marine Air Ground Task Force
MALE	Medium Altitude Long Endurance
MANTECH	Manufacturing Technology
MARFOR	Marine Corps Forces
MARSOC	Marine Special Operations Command
MARSOF	Marine Special Operations Forces
MC CBA	Marine Corps Capabilities Based Assessment
MCEIP	Marine Corps Enterprise Integration Plan
MCIA	Marine Corps Intelligence Activity
MCISRE	Marine Corps Intelligence, Surveillance, and Reconnaissance Enterprise
MCNOSC	Marine Corps Network Operations Security Command
MCSEF	Marine Corps Security Environment Forecast: Futures 2030-2045
MCSC	Marine Corps Systems Command
MCTIMS	Marine Corps Training Information Management System
MCWL	Marine Corps Warfighting Laboratory
MCWL/FD	Marine Corps Warfighting Laboratory/Futures Directorate
MISO	Military Information Support Operations
MEDEVAC	Medical Evacuation
MEB	Marine Expeditionary Brigade
MEF	Marine Expeditionary Force
METOC	Meteorological and Oceanographic
MEU	Marine Expeditionary Unit
MOC	Marine Operating Concept
MOU	Memorandum of Understanding
MTO	Marine Corps Forces Special Operations Command Technology Objective
NAE	Naval Aviation Enterprise
NAE STO	Naval Aviation Enterprise Science and Technology Objectives
NCO	Noncommissioned Officer

NOTM	Networking On-The-Move
NR&DE	Naval Research & Development Establishment
NRE	Naval Research Enterprise
NRL	Naval Research Laboratory
NSFS	Naval Surface Fire Support
ONR	Office of Naval Research
ONR CODE 30	Office of Naval Research, Expeditionary Maneuver Warfare and Combating Terrorism Department
OSTI	Office of Science & Technology Integration
OTH	Over the Horizon
PACOM	U.S. Pacific Command
P&R	Program & Resources
PEO	Program Executive Officer
PEO LS	Program Executive Officer, Land Systems
PMESII	Political, Military, Economic, Social, Information and Infrastructure
PM TRASYS	Program Manager for Training and Systems
POM	Program Objective Memorandum
PP&O	Plans, Policies & Operations
PPE	Personal Protective Equipment
QFR	Quarterly Futures Review
QIF	Quarterly Integration Forum
RF	Radio Frequency
ROE	Rules of Engagement
ROMO	Range of Military Operations
RPED	Rapid Prototyping, Experimentation and Demonstration
RDT&E	Research, Development, Test and Evaluation
S&T	Science and Technology
SBIR	Small Business Innovative Research
SFA	Security Force Assistance
SIGINT	Signals Intelligence
SOF	Special Operations Force
SS	Sea State
STAG	Science & Technology Alignment Group
STESC	Science & Technology Executive Steering Committee
STO	Science and Technology Objective
STOM	Ship-to-Objective Maneuver
STTR	Small Business Technology Transfer Research

STWG	Science and Technology Working Group
T&E	Training and Education
T-ESD	Expeditionary Transfer Dock
TECOM	Training and Education Command
TCDL	Tactical Common Digital Link
TIPS	Technology Insertion Program for Savings
TS	TechSolutions
TTA	Technology Transition Agreement
TTP	Tactics, Techniques and Procedures
UAS	Unmanned Aerial System
UGCS	Universal Ground Control Station
UGV	Unmanned Ground Vehicle
UPL	Unified Priority List
UXO	Unexploded Explosive Ordnance
VBIED	Vehicle Born-Improvised Explosive Device
VCNR	Vice Chief of Naval Research
WMD	Weapons of Mass Destruction

APPENDIX D – MASTER DOCUMENT LIST

National Strategic Documents

- Sustaining U.S. Global Leadership: Priorities for 21st Century Defense (2012)
- National Security Strategy (Feb 2015)
- National Military Strategy of the United States of America, (June 2015)
- Quadrennial Defense Review (2014)

Joint and Naval Strategic Documents

- Capstone Concept for Joint Operations: Joint Force 2020 (2012)
- Joint Operational Access Concept (JOAC) Version 1.0 (2012)
- Joint Concept for Rapid Aggregation (2015)
- Joint Operating Environment (2010)
- The Defense Innovation Initiative (2014)
- Mission Command White Paper (2012)
- Department of the Navy Objectives for FY 2016 (2015)
- A Cooperative Strategy for 21st Century Seapower (2015)
- Naval Aviation Vision 2014-2025 (2014)
- Naval Operations Concept (2010)

U.S. Marine Corps Documents

- Marine Operating Concept (2016)
- FRAGO 01/2016: Advance to Contact (2016)
- Message to the Force 2017: “Seize the Initiative”
- U.S. Marine Corps Service Strategy 2016
- United States Marine Corps Service Campaign Plan 2014-2022 (2014)
- Marine Aviation Plan 2016
- POM-18 Marine Corps Enterprise Integration Plan (MCEIP) (2016)
- The Marine Corps Combat Development Command/Combat Development and Integration (MCCDC/CD&I) Force Development Strategic Plan (2015)
- 2015 Marine Corps Security Environment Forecast: Futures 2030-2045 (2015)
- Memorandum of Understanding for the Stand-up and Implementation of the Science and Technology (S&T) Executive Steering Committee (STESC) and S&T Alignment Group (STAG) (2015)
- Marine Corps Installations and Logistics Roadmap 2015
- Seabasing Annual Report for Program Objective Memorandum 2017 (2015)
- 2014 Command Element Roadmap, Deputy Commandant for Combat Development and Integration

- MAGTF Cyberspace and Electronic Warfare Coordination Cell (CEWCC) Concept (2014)
- Marine Corps Operating Concept for Information Operations (2013)
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