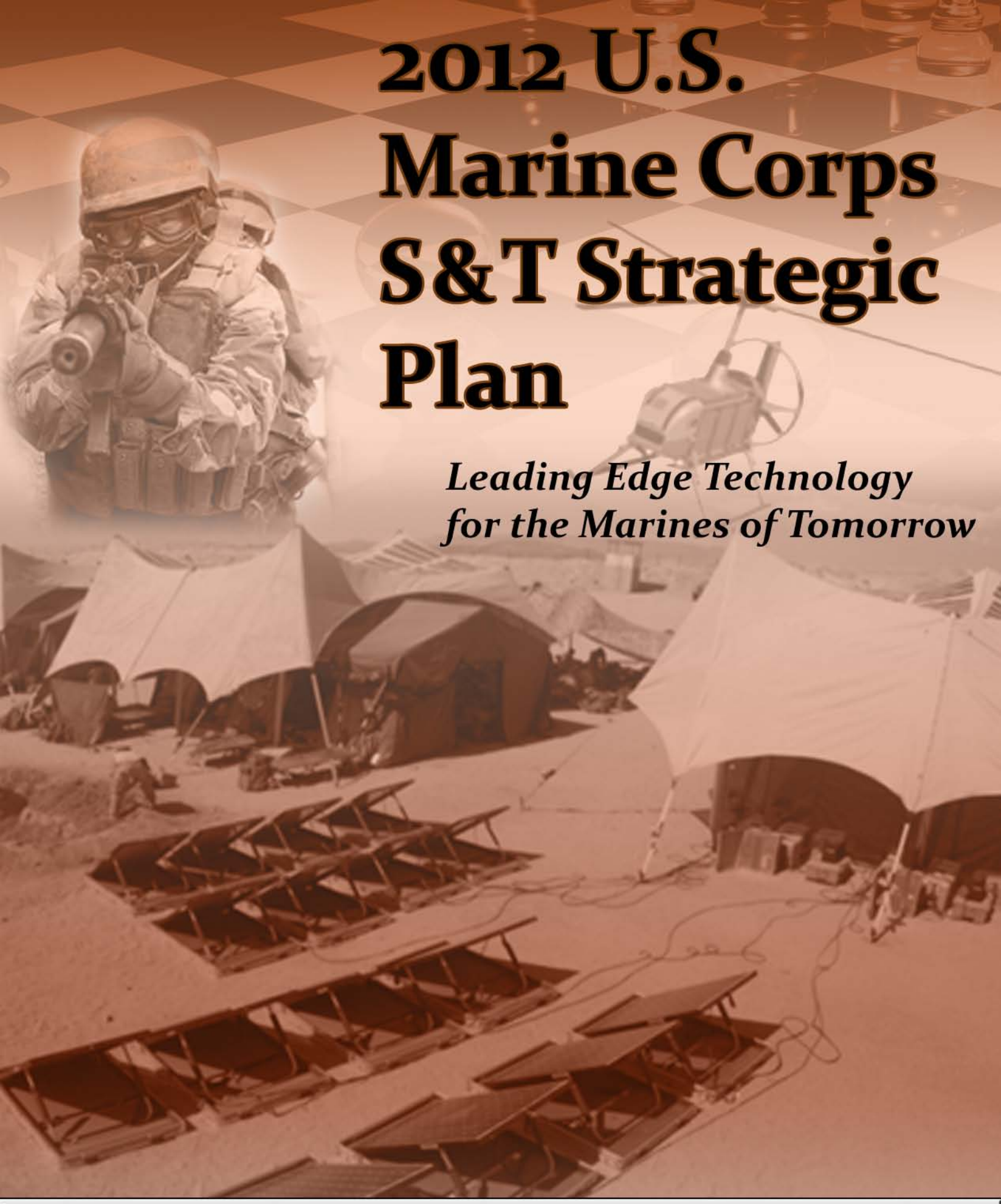

2012 U.S. Marine Corps S&T Strategic Plan

Leading Edge Technology for the Marines of Tomorrow

UNITED STATES MARINE CORPS

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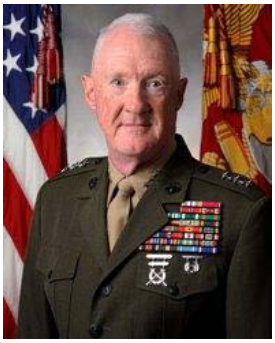

MARINE CORPS SCIENCE & TECHNOLOGY STRATEGIC PLAN

17 Jan 2012

The *Marine Corps Science & Technology Strategic Plan* establishes priorities and provides the combat developer's guidance and direction for investment in the science and technology (S&T) necessary to enable our future Marine Corps. As you read this plan, you will find that it addresses capability needs for each of the elements of our Marine Air-Ground Task Force as well as key enabling needs resourced by the Navy; these include support to the Sea Base, Naval Aviation, and Naval Medicine and Human Performance. Recognizing the importance of reducing the demand for power and energy to our warfighters, we have included a Power & Energy section in this year's plan.

This Plan is derived from analyses undertaken while developing the *Marine Corps Expeditionary Maneuver Warfare Capabilities List* and the *Solutions Planning Directive* produced to close the capability gaps identified in the former. This Plan identifies Science and Technology Objectives (STO) as those technology capability enhancements most needed to enable the warfighting capabilities of our future operating forces. The STOs are not all inclusive and neither are they an end in themselves. The STOs are the opening salvo in the engagement between the S&T "three circles" (consisting of the combat developer, technology developer, and the materiel developer) in defining what is required, the "art of the possible," and what can and will transition into a program of record. Only in this coordinated fashion can we ensure that our S&T dollars are spent wisely and effectively. While each of the participants in this process is important, requirements drive the S&T process.

We continue to use *Marine Corps Vision and Strategy 2025* as well as the *35th Commandant of the Marine Corps Commandant's Planning Guidance* as keystone documents in developing the S&T way ahead. You will note the plan addresses resiliency, irregular warfare, lightening the MAGTF, and increased energy efficiency. In addition, we continue to focus on the lightening the load carried by the individual dismounted Marine. At the same time, we continue to identify gaps and develop STOs that address the MAGTF as a whole in areas of improved communications, tactical mobility, and networked intelligence to the lowest tactical level.

This plan is the culmination of coordinated engagement across all stakeholders and forms the basis for continued engagement and development of specific S&T programs / projects to enable the Marine Corps of the future.

Richard P. Mills
Lieutenant General, U.S. Marine Corps
Deputy Commandant for Combat Development and Integration

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Marine Corps Science and Technology Strategic Plan

Ref: (a) Marine Corps Vision & Strategy 2025
(b) MCO 3900.15B; Marine Corps Expeditionary Force Development System (EFDS)
(c) Naval S&T Strategic Plan 2011
(d) POM-14 MAGTF Capabilities List (MCL)
(e) POM-14 MAGTF Gap List (MGL)
(f) POM-14 Solutions Planning Directive (SPD)
(g) U.S. Marine Corps Science & Technology Campaign Plan FY 2011-2012
(h) Program Executive Officer Land Systems Advanced Technology Investment Plan 2010
(i) Naval Aviation Enterprise Science and Technology Objectives, April 2010
(j) U.S. Marine Corps Forces, Special Operations Command S&T Strategic Plan

Annexes: (A) Seabasing
(B) Aviation
(C) Naval Medicine and Human Performance

1. **Purpose**. To provide the combat developer's strategic guidance for the Marine Corps Science & Technology (S&T) enterprise. This plan focuses Marine Corps S&T efforts to pursue S&T initiatives and support experimentation of concept-based capabilities in accordance with the vision set forth in reference (a) and through the Expeditionary Force Development System (EFDS) described in reference (b).

2. **Background**

a. The Marine Corps S&T enterprise is an integral part of the larger Naval Research Enterprise (NRE). It is a collaborative effort led by the Deputy Commandant, Combat Development & Integration (DC, CD&I), but inherently involves the Marine Corps Systems Command (MCSC), the Program Executive Office, Land Systems (PEO, LS), and the Office of Naval Research (ONR). This relationship is depicted in Figure 1.

b. The Commandant of the Marine Corps provides the future vision for the Marine Corps based on strategic guidance as currently defined in reference (a). The DC, CD&I expands on the CMC's vision by developing Marine Corps warfighting concepts and determines required capabilities through Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, and Facilities (DOTMLPF) analysis to enable the Marine Corps to field combat-ready and relevant forces. Marine Corps S&T is an integral part of the EFDS process and the Science & Technology Objectives (STO) articulated in this strategic plan are products of that process and are developed in coordination within the Marine Corps S&T enterprise.

c. DC, CD&I is the combat developer and integrator for the Marine Corps, the MCSC and PEO, LS serve as the materiel developer, and the ONR serves as the technology developer for the Department of the Navy (Navy and Marine Corps). Coalescing these

responsibilities requires a synergistic partnership with a common vision, strategy, and an implementing plan. Staff responsibility for coordinating Marine Corps S&T combat development efforts is assigned by DC, CD&I to the Commanding General, Marine Corps Warfighting Laboratory under the title of Executive Agent for Marine Corps S&T (EA, S&T). Within MCWL, the Office of S&T Integration is tasked with executing that responsibility. An S&T Integrated Product Team with broad membership across the community of interest as reflected in Figure 1 supports the EA for S&T in this coordination role.

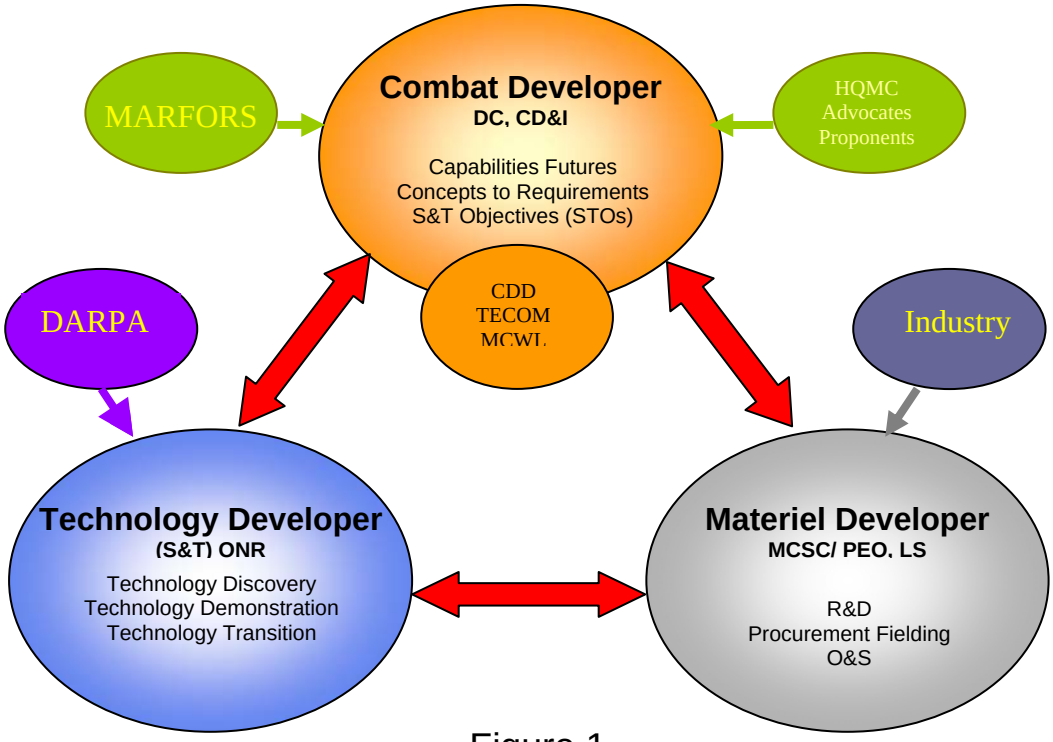


Figure 1

d. The *Marine Corps S&T Strategic Plan* is based on the S&T guidance of the Office of the Secretary of Defense and that of the Department of the Navy in reference (c) as approved by the Naval S&T Corporate Board. The Naval S&T Corporate Board consists of the Assistant Secretary of the Navy for Research, Development, and Acquisition (ASN, RDA), the Vice Chief of Naval Operations (VCNO), and the Assistant Commandant of the Marine Corps (ACMC). In addition, the Marine Corps S&T Strategic Plan is derived as an inherent function of the EFDS.

e. The EFDS is used to develop future warfighting capabilities to meet national security objectives. This system guides the identification, development, and integration of Warfighting and associated support and infrastructure capabilities for the MAGTF. EFDS is a deliberate, four-phased process that is executed cyclically and is synchronized with the Planning, Programming, Budgeting, and Execution System (PPBES) and the Defense Acquisition System.

f. EFDS is a coordinated effort, led by the combat developer (DC, CD&I) and involving participation in all phases by the Deputy Commandants (DC) / MAGTF advocates and proponents; COMMARFORs; DoN Deputy CIO (MC), the functional

advocates (Director, Intelligence and Director, C4); Commander, MCSC, and PEO, LS. The major products of interest for S&T are the MCL, MGL, and the SPD as depicted below in Figure 2. It is chiefly through participation in EFDS and development of these products that Marine Corps S&T integrates with the combat development process. The STOs contained in this plan are the result of continuous engagement and participation by the Marine Corps S&T community in the combat development process and reflect those areas where Marine S&T can contribute to the development of future Marine Corps warfighting capabilities.

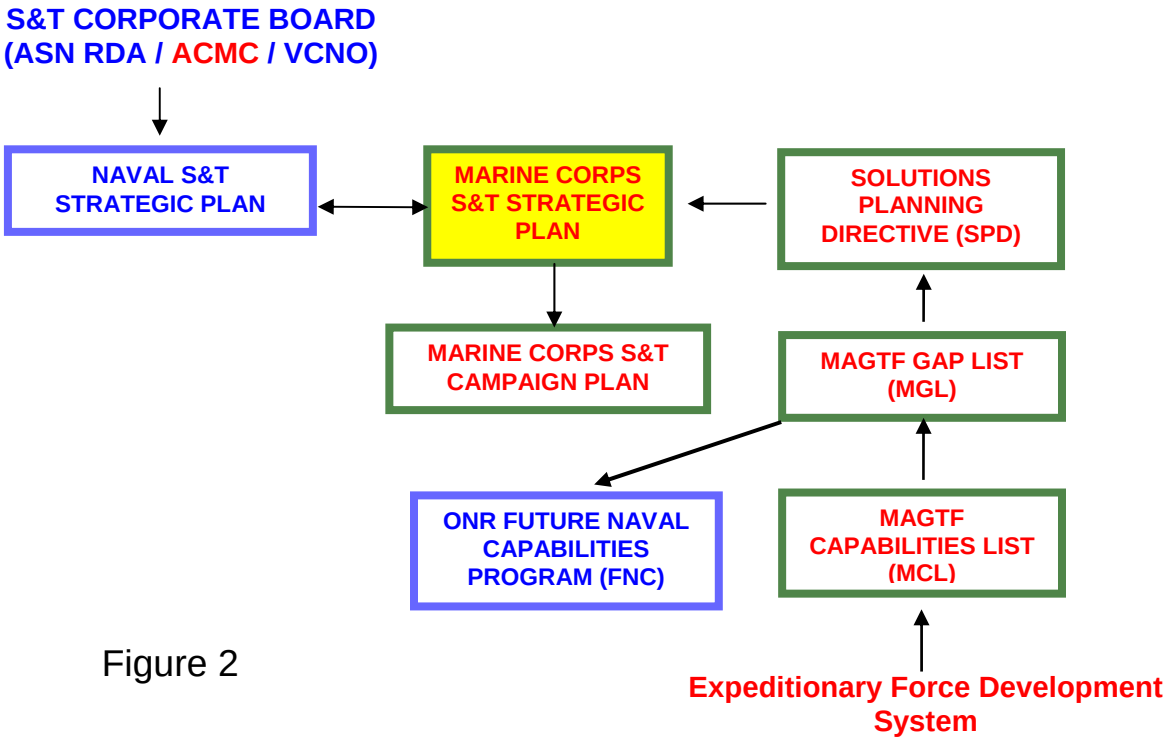


Figure 2

g. The Marine Corps leverages the investments of ONR, the Defense Advanced Research Projects Agency (DARPA), other Services--specifically that of the Army[1] -- and industry while focusing our Marine Corps unique investment to support Marine Corps combat development and future materiel needs. This approach ensures that we are meeting our near-term needs focused primarily on those of the current operating forces; our mid-range needs – primarily those of the materiel developer in technology enhancements to acquisition programs for the next Marine Corps; and the far-term needs of the *Marine Corps After Next* as articulated in our future concepts.

3. **<u>Capability Needs</u>**

a. Marine Corps capability needs are determined as a result of the EFDS and articulated principally through reference (d) and as identified in Universal Needs Statements (UNS), Initial Capability Documents, Capability Development Documents, and Capability Production Documents.

b. Marine Corps S&T capability gaps, developed during the EFDS process and articulated through reference (e) represent shortfalls in our ability to meet capability needs. In addition to providing the baseline for developing the Solution Planning Directive, the capability gaps are also integrated into the Navy's S&T gap analysis process that supports the Future Naval Capabilities (FNC) program. The goal of the FNC is to ensure that a defined portion of the ONR S&T investment focuses specifically on transitioning technologies into naval acquisition programs targeted at priority warfighting capability gaps. Engagement by the Marine Corps in this inherently naval process ensures that we compete for funding and programs in the larger naval S&T arena.

c. During the development of the SPD, Marine Corps S&T participation peaks in influencing specific technical solutions *(art of the possible)* in the combat development continuum. During SPD development, solutions are explored and identified as desirable solutions to close the gaps articulated in reference (e). This is where S&T inputs to the proposed solutions are developed and documented.

4. **Assumptions**

a. Marine Corps-unique expeditionary maneuver warfare capabilities and naval character remain relevant and essential.

b. Marine Corps core competencies as contained in reference (a) and principal warfighting concepts remain unchanged.

c. S&T resources available to the Marine Corps will remain relatively stable across the FYDP.

d. Marine Corps warfighting functions remain unchanged.

e. Capabilities identified in emerging concepts in support of distributed operations, enhanced company operations, enhanced MAGTF operations, urban operations, irregular warfare, and / or hybrid warfare will influence S&T investment as will lessons learned from combat operations.

5. **S&T Budget Categories**

a. The Department of Defense delineates budget activities with specific funding categories for science and technology known as: basic research, applied research, and advanced technology development.

(1) **Basic Research (6.1)** includes scientific study and research to increase knowledge and understanding in the physical, engineering, environmental, and life sciences related to long-term naval needs. Its focus is knowledge of scientific

phenomena. Discovery and Invention (D&I) is the responsibility of ONR and current research areas of primary interest to the Marine Corps are:

- Robotics and Autonomous Systems
- Communications
- Lightweight Power Sources
- Information Efficiency and Networks
- Sensing
- Human Performance
- Landmine and Improvised Explosive Device (IED) countermeasures (to include both detection, induced pre-detonation, and survivability)
- Energetic Materials
- Irregular, Urban/Asymmetric Warfare
- Small Unit Excellence

(2) **Applied Research (6.2)** is the systematic study to understand the means to meet recognized and specific naval needs. Applied research translates promising basic research into solutions for broadly defined military needs, short of system development projects. Its focus is proving technology feasibility when applied to solving military problems. It includes D&I technology efforts.

(3) **Advanced Technology Development (6.3)** includes the development of subsystems and components and the efforts to integrate subsystems and components into system prototypes for field experiments and/or tests in a simulated environment. The focus is on demonstrating the military utility of technologies and applying them to acquisition programs. It supports the FNC program, as well as the warfighting experimentation conducted by MCWL.

6. Science & Technology Objectives (STOs)

a. STOs are developed as part of the EFDS process and in response to strategic guidance articulated in documents such as reference (a). The STOs provide combat development guidance to the S&T community, primarily within the NRE, but also to other Services, defense agencies, industry, and academia. A STO states a major technological advancement to be achieved and is in support of a capability need identified and prioritized during S&T gap analysis. STOs state the overall S&T *requirement*.

b. The STOs are developed, prioritized, and aligned to EFDS gaps by the Functional Working Groups (FWG) under the guidance of the S&T IPT. Each FWG draws membership from *the three circles* (Figure 1) to ensure that the STOs are coordinated and S&T offers an appropriate solution opportunity. Within the plan, STOs are listed in priority order within the functional areas and gaps are listed that align to each STO.

c. In keeping with the Marine Corps participation in the NRE, the STOs are also the principal driver for Navy S&T investment in the land warfare component of naval expeditionary warfare as articulated in reference (c).

d. The organization of this Plan mirrors the six-warfighting functions inherent to the framework of the MCL, MGL, and the SPD (Command and Control, Intelligence, Maneuver, Fires, Force Protection, and Logistics) as contained in references (d) through (f). Warfighting functions assist commanders in achieving unity of effort to build and sustain combat power when used in concert, and should not be viewed independently but rather as inseparable parts of a whole. Each warfighting function is designed to depict the linkage of the general statement, vision, and goal to the individual STOs. In recognition that not all areas of significant importance to the Marine Corps fit into the six warfighting functions, we have included four additional areas in the main body of this strategic plan. These areas of significant importance are Escalation of Force, Expeditionary Energy, Training and Education, and Irregular Warfare.

e. The *maneuver* functional area specifically addresses the area of *mine countermeasures* which includes technology responses to the threat of IEDs and unexploded ordnance in keeping with the emphasis currently placed on this warfighting gap through extensive investment outside of the DoN. Two interconnected combat development working groups (Mine Counter Measures under the lead of DC, PP&O and the IED Working Group under the lead of the CG, MCWL) are focused on closing this significant warfighting gap.

f. In recognition of the fact that various functions are not *warfighting* functions, and are primarily funded by *blue dollars*, but are of significant importance to the Marine Corps, we have included three Annexes in this plan. These are Aviation, Seabasing, and Naval Medicine and Human Performance. Expenditures for seabasing, aviation, and naval medicine and human performance STOs are Navy *blue* dollars and capability gaps are developed via the Navy capability gap process as well as through the Marine Corps EFDS process.

7. **Marine Corps S&T in support of America, British, Canadian, Australian (ABCA), and New Zealand Coalition Interoperability Program**

a. One venue for Marine Corps participation in, and benefit from other nation's S&T efforts, is the ABCA program. While the program is not an alliance, these nations have served together in ad hoc coalitions on numerous occasions to pursue common objectives. The Technical Cooperation Program (TTCP) is the primary forum for S&T collaboration between the defense establishments of the ABCA nations.

b. The U.S. Marine Corps, is an *associate member* of the ABCA Armies Program, and as such engages with ABCA as a member of the US delegation, led by the US Army.

c. Assigned by the EA for S&T, the Marine Corps representative to the ABCA S&T effort will engage with members of the Marine Corps S&T enterprise to provide information and opportunities on the ABCA S&T program and priorities.[2]

8. **Marine Corps S&T Program Elements (PEs)**

a. The Marine Corps programs resources for S&T efforts through four Marine Corps PEs identified in the Defense budget. Two of these PEs 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 that of the MCWL concept-based experimentation efforts.

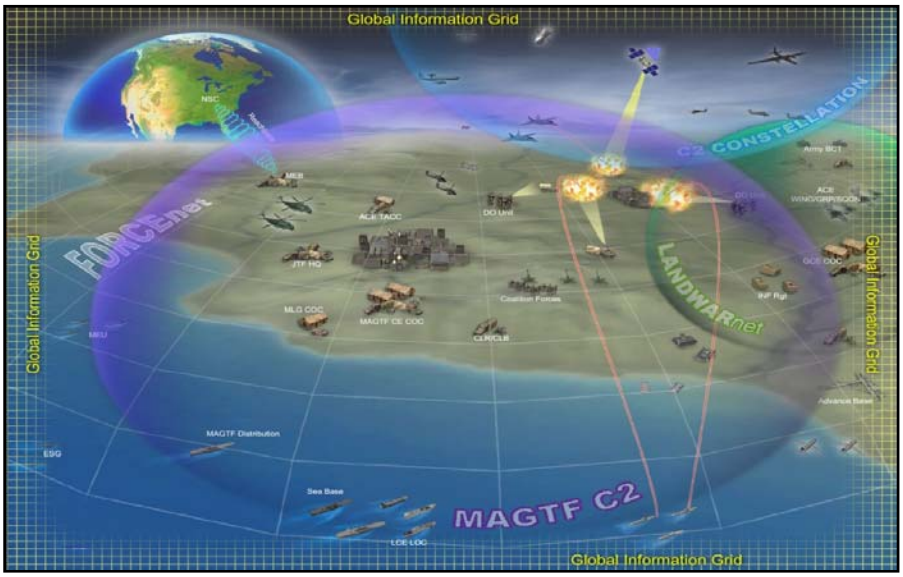
b. All four Marine Corps programmed PEs are administered by the Deputy Chief of Naval Research (Expeditionary Maneuver Warfare & Combating Terrorism) at ONR 30 in his CNR assigned role as Director, Marine Corps S&T[3]. Updated annually, reference (g) is published by the Director, Marine Corps S&T to present the portfolio of Marine Corps funded S&T programs and align those investments with the Marine Corps S&T needs and expectations as defined by the STOs within the current revision of the *Marine Corps S&T Strategic Plan*. Reference (h) is published by PEO, Land Systems to identify and prioritize technical issues within PEO, LS with the goal of informing, influencing and aligning S&T investment to resolve issues and transition technology into Programs of Record (POR) as rapidly as possible.

Command and Control

Marine Air-Ground Task Force Command and Control (MAGTF C2), the strategy by which the Marine Corps will implement the Naval *FORCEnet Functional Concept* and is the functional and conceptual equivalent to the other Service's net-centric concepts of *LandWarNet* (Army) and *C2 Constellation* (Air Force). The S&T investment in Command and Control is focused on three areas required to implement MAGTF C2: (1) communications and networking systems to enable data exchange with and among distributed tactical forces; (2) decision support systems; and (3) effective combat identification of enemy combatants, friendly forces, and non-combatants.

***The Vision*: Our C2 systems must enhance mission command and control and give subordinates sufficient understanding of the situation and the commander's intent before the battle, while encouraging initiative and creativity once the fight is joined. The end state is a born joint, common, scalable, modular MAGTF C2 capability, seamlessly employable on land, at sea, and in the air that enhances the lethality and effectiveness of the MAGTF across the range of military operations through better decision-making, collaboration, and shared understanding. The objective is to provide a holistic, end-to-end, turnkey C2 capability to execute commander's intent, facilitate implicit communications, visualize battlespace reality, promote initiative, enable centralized command and decentralized control, and ultimately accomplish the mission.[4]**

<u>Goal</u>: Integration of all force elements throughout the battlespace and across the Range of Military Operations (ROMO) including attended and unattended space, air, ground and sea sensors down to the individual warfighter. Flagpole to fighting hole*, forces, activities and platforms are interconnected in this networked, collaborative command and control environment, thereby benefiting from the advantages of decentralization (e.g. initiative, adaptability, and increased tempo) without sacrificing the coordination or unity of effort typically associated with centralization. These systems provide a shared understanding of the battlespace and connect the Operating Forces with information dominance that multiplies combat power. Commanders at all levels are able to gain and maintain situational awareness, make better decisions, and exercise authority and direction over assigned forces via an adaptable, distributive, and seamless system.*



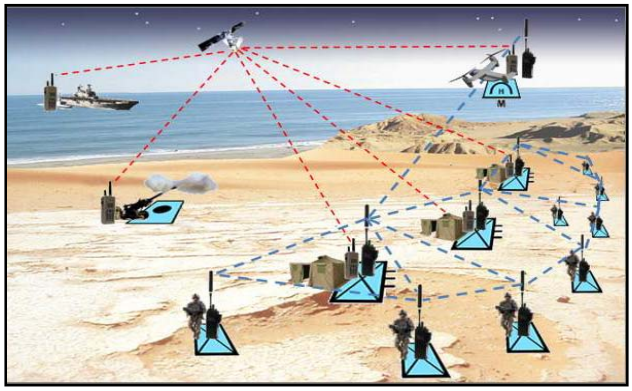
-- C2 STO-1: Converged service networks with assured, robust communications linking all echelons of the MAGTF

Develop assured network centric warfare technologies that enable early entry forces to communicate over the horizon, beyond line of sight and on the move (OTH/BLOS/OTM)[5] with each other, and interoperate with other naval, joint, and coalition forces to enable distributed maneuver, and to leverage joint fires, intelligence and logistics on the future battlefield in a space denied environment. Develop services oriented architectures that allow data distribution across the enterprise, to include challenged users. Develop low cost, high bandwidth technologies that support both line of sight and beyond line of data distribution.

C2 STO-1 maps to following POM 14 gaps:
I.03-04-G1: Limited ability to identify time critical information
I.05-06-G1: Limited dissemination means
C.21-01-G1: Systems throughput capacity
C.19-03-G1: Network capacity

-- C2 STO-2: Multilevel information security and information assurance

Develop technologies that facilitate seamless information sharing (down to the platform and entity level) and enable the integration of unclassified and classified systems for joint and coalition operations. Provide bi-directional intra-, cross-, and inter-domain authentication, encryption, and information assurance/integrity services in conditions typical to Marine Corps operations (distributed, size, weight, and power (SWAP) challenged, such as intermittent connectivity and limited throughput in restricted and hostile environments.



C2 STO-2 maps to following POM 14 gap:
I.04-01-G1: Limited ability to integrate information across security domains

-- C2 STO-3: Improved situational awareness for warfighters at all echelons

Develop improved situational awareness capabilities that operate with high levels of automation to provide Marines (across all echelons and elements of the MAGTF) intelligent access to digital information. Enable near-real time distribution of tailored information using cognitive tools, intelligent agents, tailored services, and other relevant technologies. Develop fused sensor and C2 user defined tools and services to assist commanders with battlespace visualization, to include area structures capabilities organizations people and events (ASCOPE) data from both classified and unclassified sources. Develop interactive, non-intrusive situational awareness assessment metrics to enable improved mission planning and team training interventions.

C2 STO-3 maps to following POM 14 gaps:
C.03-03-G1: Situational awareness gap
C.03-12-G1: Common operational picture

-- C2 STO-4: Intelligent network planning, monitoring, maintenance, and mobility

Develop intelligent network management technologies to enable network planning, real time monitoring, maintenance, and distribution of the network status. Develop technologies to provide seamless, automated, self-healing mobile ad hoc networks and network management. Provide technologies that include the capability to employ Modeling and Simulation (M&S) techniques to evaluate network performance, enable automatic recovery, alerting, and net intrusion countermeasures; and graceful network reconfiguration and/or degradation as nodes are lost and recovered.

C2 STO-4 maps to following POM 14 gap:
I.02-30-G1: Limited computer network collection capability

-- C2 STO-5: Blue force tracking/PLI/combat ID

Develop passive and active methods for timely determination of location and identity of battlespace entities in a GPS denied environment. Provide tools for training, discovery, retrieval and presentation of most relevant/highest quality location and identification data regardless of source.

C2 STO-5 maps to following POM 14 gaps:
C.03-03-G1: Situational awareness gap
C.03-12-G1: Common operational picture

-- C2 STO-6: Collaborative planning and synchronized execution

Develop intuitive non-user-intensive decision aids and collaborative planning tools tailored for mission, location and echelon appropriate for the distributed battlespace. Automate processes wherever possible using artificial intelligence. Facilitate dynamic and rapid mission adaptation through transparent user information pull and automated information push**.**

C2 STO-6 maps to following POM 14 gaps:
I.03-04-G1: Limited ability to identify time critical information
I.04-01-G1: Limited ability to integrate information across security domains
I.05-03-G1: Limited ability to disseminate intelligence
C.03-12-G1: Common operational picture

Intelligence

The S&T investment in intelligence is directed toward development of a comprehensive Intelligence, Surveillance, and Reconnaissance (ISR) capability set that supports all elements of the intelligence cycle: Planning and direction, collection, processing and exploitation, production, dissemination, and utilization.

The Vision: ***Commanders at all levels have both the capability to leverage the Joint ISR architecture, and to conduct reconnaissance, surveillance, and target acquisition functions commensurate with their mission, with assets that they control[6], and with the ability to quickly and succinctly move data across the battlefield down to squad-level elements.***

Goal: To identify and develop a more responsive, comprehensive ability for commanders at all levels to collect and analyze data, develop useable intelligence products, and then quickly distribute relevant intelligence products to users across the battlefield. To achieve this goal, data and information must be capable of flowing seamlessly across the battlefield in formats and quantities that allow tactical units very specific access to integrated sensor data, communication across significant distance, and the ability to access joint intelligence and operational expertise. We are exponentially increasing our ability to gain access to significant, sometimes overwhelming, amounts of data. The ability to intelligently and precisely filter and automate processing of much of this data is critical to our capacity to ingest it into our decision-making cycle and to provide information which is urgently relevant to the current situation. Science and technology must help commanders and small unit leader's access and move data in a manner that accelerates our ability to selectively and intelligently integrate key intelligence into current operations in such a way that we positively influence the results of operations.

-- Intel STO-1: Data conditioning for dissemination to tactical users

Develop technologies that allow bandwidth limited sensors to exchange data and information with bandwidth restricted tactical users. Develop technologies to enable small unit leaders to set their own intelligence requirements (IRs) and receive intelligence feeds. These feeds would disseminate responses to the IRs that were informed by geographic location, mission, threat level, etc. These tools will make it possible to provide the lowest tactical level warfighter with all available information, including national asset intelligence, in near real time in a format capable of protecting sources and methods.

Intel STO-1 maps to following POM 14 gaps:
I.03-04-G1: Limited ability to identify time critical information
I.05-06-G1: Limited dissemination means
I.04-01-G1: Limited ability to integrate information across security domains
I.05-03-G1: Limited ability to disseminate intelligence
I.01-08-G1: Limited collection management capability

-- 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.

Intel STO-2 maps to following POM 14 gaps:
I.03-04-G1: Limited ability to identify time critical information
I.05-06-G1: Limited dissemination means
I.04-01-G1: Limited ability to integrate information across security domains
I.05-03-G1: Limited ability to disseminate intelligence
I.01-08-G1: Limited collection management capability

-- Intel STO-3: Semantic technology for intelligence analysis

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-3 maps to following POM 14 gaps:
I.03-04-G1: Limited ability to identify time critical information
I.03-03-G1: Limited threat personnel identification capability
I.04-01-G1: Limited ability to integrate information across security domains

-- Intel STO-4: Human network discovery

Provide tools capable of detecting the existence of human networks and determining their organization. Such tools need to be able to operate on a wide variety of data sources, to include unstructured data.

Intel STO-4 maps to following POM 14 gaps:
I.03-04-G1: Limited ability to identify time critical information
I.03-03-G1: Limited threat personnel identification capability
I.04-01-G1: Limited ability to integrate information across security domains

-- Intel STO-5: Object tracking

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.

Intel STO-5 maps to following POM 14 gaps:
I.03-04-G1: Limited ability to identify time critical information
I.03-03-G1: Limited threat personnel identification capability
I.04-01-G1: Limited ability to integrate information across security domains

-- Intel STO-6: Advanced sensors

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.

Intel STO-6 maps to following POM 14 gaps:
I.05-06-G1: Limited dissemination means
I.03-03-G1: Limited threat personnel identification capability
I.02-27-G1: Limited GEOINT collection capability
I.02-01-G2: Limited SIGINT collection capability

-- Intel STO-7: GEOINT for littoral regions

Technologies for airborne and satellite sensing to characterize the littoral zone conditions (e.g., water, mud flats, beaches) in order to prepare the amphibious battlespace for ship to objective operations.

Intel STO-7 maps to following POM 14 gap:
I.02-27-G1: Limited GEOINT collection capability

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.[7] 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.[8]

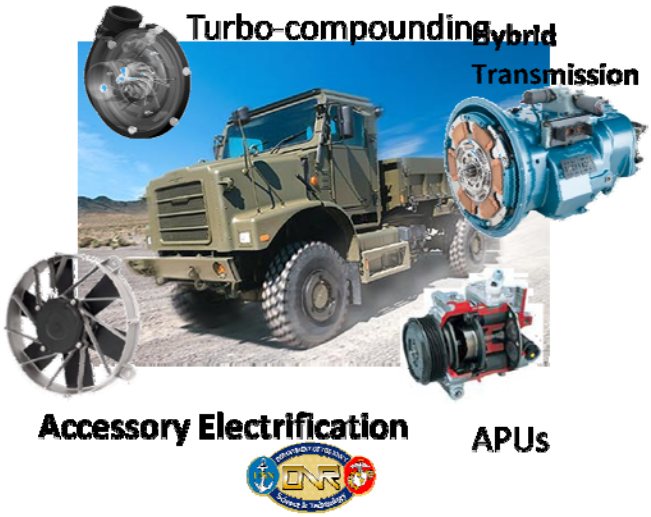
Essential to unrestricted movement across the battle space is counter explosive hazard technology. The S&T investment of interest to the Marine Corps in counter explosive hazards, including mines and IEDs is focused in two specific areas: detection and neutralization.

***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.**

<u>Goal</u>: 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: Fuel efficient and power generating vehicle systems

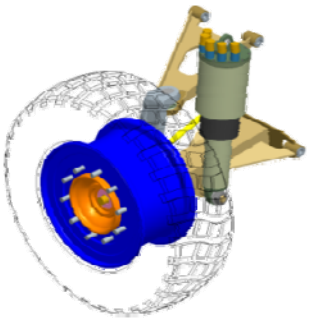
Develop technologies to enable fuel efficient power plants and drive trains for new and legacy vehicles that result in fuel consumption reduction.[9] Reduce the MAGTF logistic footprint and increase combat mission range and endurance capability through reduced fuel consumption.[10] New and legacy vehicle platforms should also be capable of self-producing, storing, and exporting the power required to support battlefield demands.



MVR STO-1 maps to following POM 14 gaps:
L.09-21.01: Alternate power sources
L.09-21.02: Power generation/distribution

--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 14 gaps:
M.01.01-G1: Movement standards
M.02.02-G2: STOM mobility platforms

-- MVR STO-3: 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-3 maps to following POM 14 gaps:
L.01-11-G1: Supply for small dispersed units
M.02.02-G2: STOM mobility platforms
M.01.03-G4: Clandestinely maneuver

-- MVR STO-4: 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 in order to decrease the impact on performance. Where applicable, develop technologies that enable threat-specific protection to be readily added to vehicles and platforms as needed for a specific mission or to counter an emerging threat.

MVR STO-4 maps to following POM 14 gaps:
M.01.01-G1: Movement standards
M.02.02-G2: STOM mobility platforms

-- MVR STO-5: Vehicle and surface craft design for Marine usability, habitability, and survivability

Define vehicle occupant survivability and human machine interface standards that are based on quantitative metrics and measurable criteria. Develop standards for combat equipped Marines and enable them to seamlessly interface with novel seating configurations that promote operational usability and platform egress. Develop an abbreviated injury scale for vehicle occupant protection and metrics that are medically based, quantitative, repeatable, and analogous to U.S. automotive industry standards.

MVR STO-5 maps to following POM 14 gaps:
M.01.01-G1: Movement standards
M.02.02-G2: STOM mobility platforms

-- MVR STO-6: Mine and IED neutralization

Develop technologies to either neutralize mines and IED's from a safe distance or induce a pre-detonation/deflagration in order to remove the threat from maneuvering forces. These technologies include active and passive countermeasures to devices, energetic neutralization methods to render IED's harmless, and mechanical methods to rapidly clear devices.[11]

MVR STO-6 maps to following POM 14 gap:
M.01.05-G9: Detect and neutralize obstacles

-- MVR STO-7: 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[12] 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, 3) other IED signature materials.

MVR STO-7 maps to following POM 14 gaps:
M.01.05-G9: Detect and neutralize obstacles
M.03.05-G1: Inspect/detect (P/V/E)

-- MVR STO-8: Marine performance enhancements

Develop vehicle and surface craft with interoperable technologies that provide protective equipment, communications equipment, weapons, ammunition, sensors, and optics for the mounted and dismounted Marine that are multifunctional, lighter, and provide greater capability. Technologies, such as exo-skeletons[13] and dermoskeletons are needed to enhance the performance of the Marine by improving load carrying capacity and speed and distance of movement.

MVR STO-8 maps to following POM 14 gap:
M.05.08-G2: Tactical tasks

-- MVR STO-9: 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-9 maps to following POM 14 gaps:
M.01.01-G1: Movement standards
M.05.08-G2: Tactical tasks

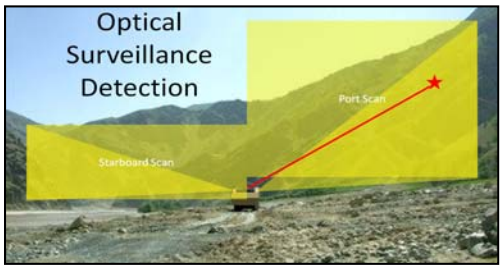
-- MVR STO-10: Technology that provides improved protection for the individual against fragments, projectiles, blast effects, fire, and lasers with reduced weight and impact on ability to perform required functions.



Develop technologies that improve the helmet, body armor, and eye protection for the combat Marine against a variety of threats improving comfort and ease of employment while performing combat functions such as using the service weapon in a prone position or with the gas mask. Eye protection – to include optics – is needed to counter the emerging threat of multi-spectral battlefield lasers.

MVR STO-10 maps to following POM 14 gaps:
M.01-01-G1: Movement standards

--MVR STO-11: 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-11 maps to following POM 14 gaps:
P.02-07-G2: Persistent surveillance-threat detection
M.01-10-G8: Gunshot detection
M.02-05-G6: Precision engagement

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, multicapable 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: Targeting technologies for faster, more precise engagements

Develop lightweight, durable, reliable, and ergonomic low-power consumption technologies to enable mounted and dismounted Marines to locate, discriminate, tag, track, acquire targets. Technologies should enable Marines to transmit information without being first detected for engagement by fires at extended ranges, in all weather, all terrain, day or night, in accessible, obscured, or denied operating environment.[14]

Fires STO-1 maps to following POM 14 gaps:
I.03-03-G1: Limited threat personnel identification capability
C06-55-G1: Target validation
M.02.05-G5: Engage moving targets
M.0205-G6: Precision engagement

--Fires STO-2: 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.[15] 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-2 maps to following POM 14 gaps:
I.02-30-G1: Limited computer network collection capability
I.03-03-G1: Limited threat personnel identification capability
I.03-04-G1: Limited ability to identify time critical information
I.04-01-G1: Limited ability to integrate information across security domains
I.04-01-G2: Limited ability to disseminate intelligence
F.01-03-G1: Electronic attack assets
F.02.02.G1: Automated fires C2 infrastructure
F.02.10.G2: Indirect fire detection correlation and networking capability

-- Fires STO-3: Advanced ammunition

Develop ammunition fuze, propellant, warhead shell casing, and other peripheral technologies that improve range, accuracy, maneuverability, reliability, safety, maintenance, and service life at reduced weight. Additional, desired technologies include improvements in scalable lethality, blast, fragmentation, and penetration against the full range of natural and constructed targets. 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-3 maps to following POM 14 gap:
M.05.08-G2: Tactical tasks

-- 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 14 gap:
M.05.08-G2: Tactical tasks

-- 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 14 gaps:
I.03-03-G1: Limited threat personnel identification capability
M.02.05-G6: Precision engagement

-- 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 14 gap:
M.02.05-G4: Weapons/equipment signatures

-- Fires STO-7: Engagement damage assessments

Develop technologies to enable rapid determination of results of combat action (both kinetic and non-kinetic), day and night, through obscurants, for immediate re-targeting or re-engaging.

Fires STO-7 maps to following POM 14 gaps:
I.04-01-G1: Limited ability to integrate information across security domains
F.02.02.G2: Joint fire support coordination
F.02.10.G1: Indirect fire detection capability
F.02.10.G2: Indirect fire detection correlation and networking capability

-- Fires STO-8: 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-8 maps to following POM 14 gap:
M.05.08-G2: Tactical tasks

Escalation of Force

Escalation of Force (EoF) capabilities seeks 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.[16] 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.[17] 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.[18]

<u>The Vision:</u> The S&T investment in EoF is intended 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.

<u>Goal</u>: The focus is on providing operational EoF capabilities 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.

-- EoF STO-1: EoF technologies to stop and/or disable vehicles and vessels (counter-materiel)

Develop EoF technologies (kinetic and non-kinetic) to enhance counter-materiel capabilities to stop and/or disable vehicles 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).[19]

EoF STO-1 maps to following POM 14 gaps:
F.01.10-G1: Engage area targets with non-lethal effects
F.01.14.G1: Engage point targets with non-lethal effects
F.01.17-G1: Stop (vehicles /vessels/aircraft)

-- EoF STO-2: Communicate with indigenous personnel

Develop technologies that provide a portable capability to translate from English to the local language and the reverse, using audio, visual, and written forms. Develop technologies that allow languages and multiple dialects to be selected, documents to be scanned and translated, and audio output to be amplified to support broadcast announcements. Develop technologies that do not depend on consistent tone, volume, or perfect enunciation, but that do enable direct near-real-time language translation into recognizable electronic speech. Systems that are developed optimally would strive to operate on near term C2 platforms as an integrated capability enhancement and reduce additive systems at the small unit level.

EoF STO-2 maps to following POM 14 gap:
F.05.04-G1: Communicate

-- EoF STO-3: 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 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).[20] 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 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.[21] In addition, develop technologies that enable scalable directed-energy effects[22] 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.

EoF STO-3 maps to following POM 14 gaps:
F.01.10-G1: Engage area targets with non-lethal effects
F.01.14.G1: Engage point targets with non-lethal effects
F.01.21-G1: Move (individuals/vehicle/aircraft)
F.01.07-G1: Deny access

-- EoF STO-4: Clear a space

Develop technologies that provide a less lethal alternative to kinetic/blast weapons for employment in urban operations to clear spaces, facilities, or compartments, without the need for Marines to enter. 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).

EoF STO-4 maps to following POM 14 gaps:
F.01.10-G1: Engage area targets with non-lethal effects
F.01.14.G1: Engage point targets with non-lethal effects

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.

<u>The Vision</u>: 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-material and material means focused at countering or defeating targeted enemy capabilities.

<u>Goal</u>: 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.

-- FP STO-1: Counter-bomber detection

Develop technologies that enable dismounted Marines at checkpoints and entry points to detect and identify multiple types of explosives at sufficient distance to enable effective response to the threat of a suicide bomber. Technologies must be capable of screening multiple individuals rapidly over a wide area and not limited to a single point or isolated individual. Assessment and warning must be reliable and near instantaneous.

FP STO-1 maps to following POM 14 gaps:
P.02-23-G2: EOD explosive hazard standoff detection
P.02-23-G1: EOD detect, locate, access, diagnose, render safe, and exploit surface and subsurface IED, UXO, WMD devices
M.03-05-G1: Inspect/detect personnel/vehicles, explosives

-- FP STO-2: Tactical sensors for persistent force protection surveillance

Develop small, light-weight, autonomous sensors that can capture data with respect to the electromagnetic spectrum, acoustic, seismic, and magnetic properties in a commander's battlespace that leads to combat information by sensing unique features of entities or their actions, allowing the system to observe, classify, track, record, and report information on enemy movements, habits, and intentions. Sensor technologies must be low size, weight, and power; unattended; hand-emplaced; tripod, vehicle, tower, or UAS-mounted; and modular within a scalable framework. These sensors must be capable of processing data, differentiating between different types of explosives at a sufficient stand-off distance, cueing other sensors, and providing alerts through common network interfaces. The enabling technologies include nanotechnology, wireless sensor networks, and micro-electromechanical sensor technology.

FP STO-2 maps to following POM 14 gaps:
P.04-21-G1: Persistent ground surveillance
P.02-07-G2: Persistent surveillance –threat detection

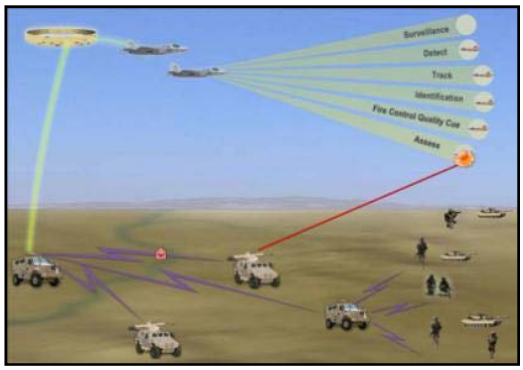
-- FP STO-3: Mobile sensors for the detection of Low Observable/ Low Radar Cross Section (LO/LRCS) threats

Focusing on mobility/expeditionary employment as the key driver: Develop modular and scalable technologies that enable on-the-move, near-real time fire control quality detection, tracking and positive combat identification of UAV's, cruise missiles and other LO/LRCS targets. Sensors must operate autonomously or on an integrated fire control network of cooperative engagement weapons and sensors.

FP STO-3 maps to following POM 14 gaps:
P.02-07-G3: Persistent surveillance –threat detection
P.02-09-G3: IAMD data fusion
P.04-22-G1: IAMD detect threats
P.04-22-G2: IAMD radar mobility
P.02-09-G2: IAMD low radar cross section
P.02-07-G1: IAMD low radar cross section

-- FP STO-4: Mobile weapons systems capable of intercepting Low Observable/Low Radar Cross Section (LO/LRCS) threats

Focusing on mobility/expeditionary employment as the key driver: Develop 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 autonomous operation 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 middle-weight weapon system capable of neutralizing LO/LRCS threats but light and mobile enough to keep pace with Marine Corps expeditionary maneuver forces.



FP STO-4 maps to following POM 14 gaps:
P.02-07-G3: IAMD defense in depth
P.02-09-G2: IAMD low radar cross section
P.02-09-G1: IAMD defense in depth
P.02-07-G1: IAMD low radar cross section

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

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. An example might include compatible power system elements that can be connected in various ways to provide optimally tailored solutions over the diverse range of expeditionary power needs. Functional modularity enables the function or attributes of a particular asset to change by installing or

removing mission specific modules. Future examples might include installing a mobile casualty treatment module on a cargo vehicle, or installing a tele-operated robotic module on an aircraft or vehicle conducting hazardous operations. Transport modularity is an approach toward maximizing the available options for air, sea or ground transport while minimizing choke points in the logistic flow. 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. Examples might include modular armor and/or arming to reduce the logistic burden of transporting vehicles to operational areas, or modular packaging optimized at appropriate scales for compatibility with shipboard storage, air transport, vehicular transport and human transport.

Log STO-1 maps to following POM 14 gaps:
L.05-03-G1: Conduct arrival and assembly phase of MPF ops and ISO MCPP-N missions
L.01-12-G1: Provide materiel handling services

-- Log STO-2: Asset tracking 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 track condition based operational readiness to ensure the timely maintenance necessary to prevent equipment failure.

Log STO-2 maps to following POM 14 gap:
L.03-01-G1: Plan and direct logistics operations

-- Log STO-3: Air 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. Small unit tactical resupply with affordable alternatives minimizes the squad load on multiday missions by providing a reliable method of resupply.

Log STO-3 maps to following POM 14 gaps:
L.05-09-G1: Conduct distribution operations
L.01-11-G1: Supply for small dispersed units
L.05.23-G1: Air/surface distribution

-- 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 14 gaps:
L.05-09-G1: Conduct distributed operations
L.01-11-G1: Supply for small dispersed units

-- 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 hrs 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. A key consideration is to ensure battlefield and indigenous population scavengeable fuels are useable in developed technologies.

Energy Harvesting Backpack

Log STO-5 maps to following POM 14 gap:
L.09-21-01: Alternate power sources

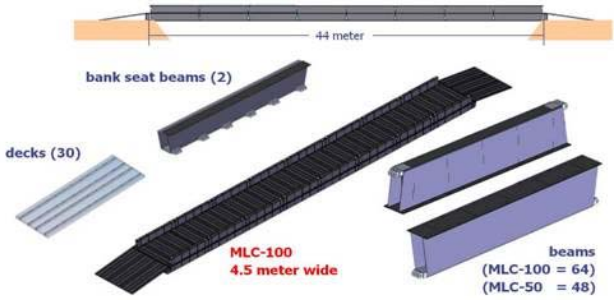
-- Log STO-6: Materials for reduced maintenance

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 following POM 14 gap:
L.02-05-G1: Perform expeditionary 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.

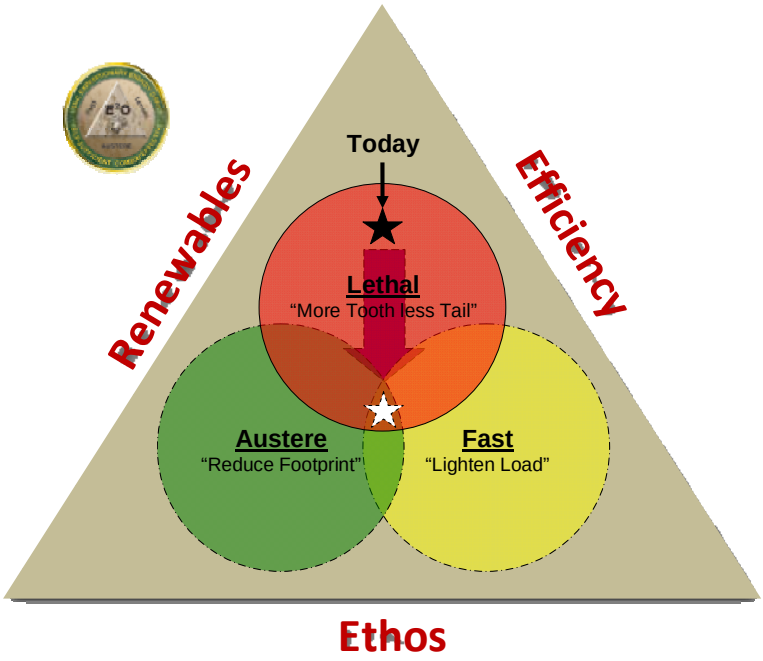


Modular Composite Bridging

Log STO-7 maps to following POM 14 gap:
M.01-01-G3: Assault gap crossing
L.08-02: Conduct rapid runway airfield damage repair

Expeditionary Energy

In the last 10 years, the Marine Corps' requirement for energy on the battlefield has increased exponentially, driven by new and powerful Warfighting capabilities. While these capabilities have made the Marine Corps more lethal, they have an unintended consequence: our forces are heavier, and dependent on logistic trains that are exposed to risk. The Commandant of the Marine Corps (CMC) focused the Marine Corps' energy priorities with the following statement: *The current and future operating environment requires an expeditionary mindset geared toward increased efficiency and reduced consumption, which will make our forces lighter and faster. We will aggressively pursue innovative solutions to reduce energy demand in our platforms and systems, to increase our self-sufficiency in our sustainment, and reduce our expeditionary foot print on the battlefield. Transforming the way we use energy is essential to rebalance our Corps and prepare it for the future.*[23] The USMC Expeditionary Energy Strategy targets 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.



***The 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.**

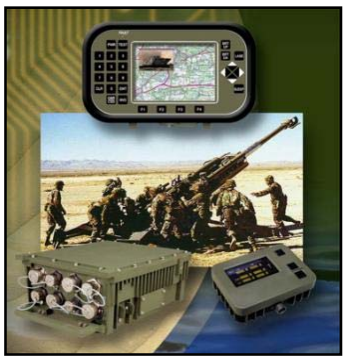
Goal: The USMC Expeditionary Energy Strategy states that By 2025, [the USMC] will deploy Marine Expeditionary Forces that can maneuver from the sea and sustain its C4I and life support systems in place; the only liquid fuel needed will be for mobility systems which will be more energy efficient than systems are today.[24] *In order to accomplish this mission and achieve the Strategy's overall goal of reducing battlefield fossil fuel consumption by 50% by 2025, the Marine Corps must leverage and drive S&T advancements to increase energy efficiency and performance of equipment, platforms and weapons systems and increase the supply of energy, with the goal of increasing self sufficiency, and lightening the MAGTF load and footprint on the battlefield. Our S&T investments will identify opportunities to increase efficiency, performance, and supply in the context of the MAGTF. Rather than consider solutions in isolation, we will seek new opportunities by leveraging the system of equipment and personnel by taking a systems approach that considers both energy consumption and production. We will improve energy performance in our systems: those used for heating and cooling equipment and personnel, C4ISR equipment, and individual equipment.*[25] *We will also improve planning and management of energy performance and needs by leveraging 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 cost effective and efficient capabilities to harvest energy from the sun, battlefield waste, vehicles, and personnel. Technologies must be embarkable aboard naval shipping and transportable aboard ground and air assault transportation.

EE STO-1 maps to following POM 14 gap:
L.09-21.01: Alternate power sources

--EE STO-2: Temperature-independent 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 and cooling to operate effectively regardless of ambient temperatures. 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 14 gaps:
All C4ISR electronics-related gaps

--EE STO-3: Optimized personnel performance

Develop novel and light weight approaches to optimize personal comfort and performance in all operating environments without the need for external heating and cooling systems. 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 14 gap:
L.06-06-G1: Provide health services

-- EE STO-4: Energy storage other than liquid

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.

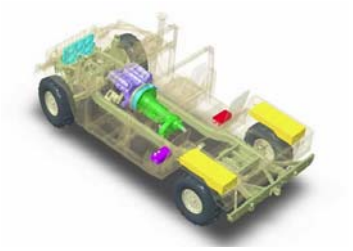
EE STO-4 maps to following POM 14 gap:
L.09-21-01: Alternate power sources
L.09-21-02: Power generation/distribution

-- EE STO-5: Expeditionary water harvesting

Develop water systems that harvest from all sources and are able to recycle black, grey, and brown water into potable water. Develop robust, lightweight technologies that enable dismounted, man-portable water harvesting and purification 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 14 gap:
L.09-18-G1: Alternate water sources

-- 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 14 gaps:
L.09-21-01: Alternate power sources
L.09-21-02: Power generation/distribution

Training and Education

To enable Marines to succeed in distributed operations and increasingly complex environments,[26] the Marine Corps seeks to provide Marines with the most effective and efficient training and education possible, while conserving valuable resources. S&T investments assist in developing capabilities that help Marines prepare to successfully confront future challenges.[27] The *35th Commandant of the Marine Corps Planning Guidance 2010* and *Marine Corps Vision and Strategy 2025* are the current Marine Corps principle strategic planning documents, identifying Training and Education (T&E) capability needs to meet the challenges of the 21st Century.

The Marine Corps Training and Education Command (TECOM) develops, coordinates, resources, executes, and evaluates training and education concepts, policies, plans, and programs to ensure Marines are prepared to meet the challenges of present and future operational environments.[28] The primary TECOM organizations who interface with the S&T Community are MAGTF Training Simulations Division (MTSD)[29] regarding constructive and virtual simulations, Range and Training Area Management Division (RTAM)[30] regarding live training, Ground Training Division (GTD)[31] regarding individual and collective ground training, Center for Advanced Operational Culture Learning (CAOCL) [32] regarding language and culture, the College of Distance Education and Training (CDET)[33] regarding distance learning, the Command and Control Training and Education Center of Excellence (C2 TECOE)[34] regarding C2 training and education, and Marine Corps University (MCU)[35] regarding professional military education.

To identify changing training and education needs as new warfighting concepts are developed and tested, TECOM collaborates with MCWL, which conducts concept-based experimentation to develop and evaluate TTPs and technologies in order to enhance current and future warfighting capabilities. Program Manager for Training Systems (PM TRASYS), TECOM's acquisition partner, acquires and sustains training systems and devices. Science and technology are integral to developing capabilities which assist Marines in acquiring and sustaining the knowledge, skills, and abilities that are necessary to the force that America relies on to be ready to respond in every clime and place. Scientific products, tools, technologies, and training environments are needed that are based on proven cognitive, social, behavioral, and learning science principles to assist Marines with developing and maintaining the kinetic and non-kinetic skills necessary to address the Nation's crises and succeed on future battlefields.

<u>The Vision</u>: The Marine Corps will leverage S&T enablers to provide the best trained and educated Marines as America's Expeditionary Force in Readiness that is prepared to respond to any crisis. The need to develop and maintain readiness across the spectrum of Marine Corps missions, especially in a resource constrained environment, places a premium on using the most effective and efficient means available for Training and Education. To meet these demanding Training and Education requirements, the Marine Corps leverages scientific products and technologies, including simulation technologies. 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.[36]

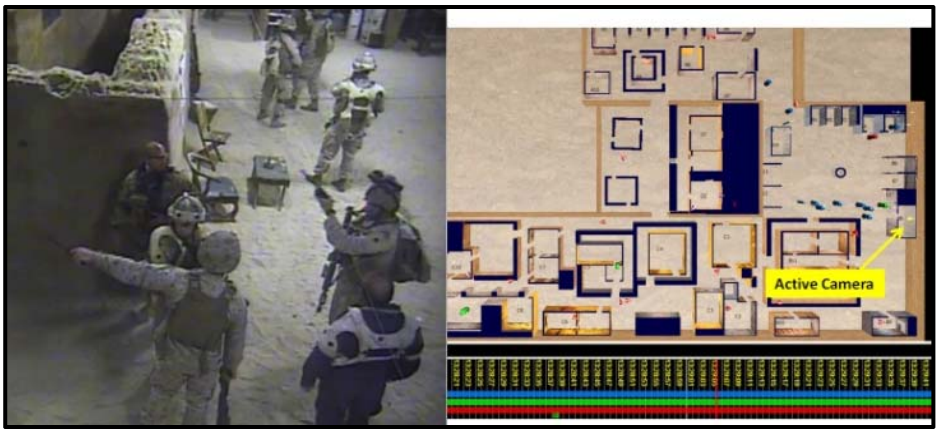
<u>Goal</u>: To obtain Training and Education (T&E) science and technology capabilities to improve individual and team performance across the full range of military operations. S&T enablers must be effective, affordable, deployable, and have the ability to be integrated or interoperable with current systems to support Marine Corps T&E needs and requirements.

-- T&E STO-1: Warrior decision-making[37]

Small unit leaders are increasingly required to make difficult decisions that used to be made by Marines with more experience. Develop scientific products and technologies to assist Marines at all levels better prepare for missions in complex environments to: make decisions in ambiguous and dangerous conditions, operate from a commander's intent, and act with minimal supervision.[38] Develop capabilities to enhance cognitive, relational, [39] and perceptual skills for small unit leaders to make effective decisions in complex environments; enhancements include attentional control, expertise, metacognitive skills, and accelerated learning outcomes. Develop capabilities to support the entire T&E continuum to assist in developing critical reasoning and ethical decision-making in scenarios spanning the full range of military operations.[40] Develop scientific tools and technologies, to include but not limited to neurocognitive measures, to effectively and efficiently evaluate human performance and cognitive states so that assessment can be affordably and unobtrusively integrated into the design and implementation of all instructional products.

T&E STO-1 maps to following POM 14 gap:
M.05-08-G2: Tactical tasks

-- T&E STO-2: **Small unit learning and performance assessment**[41]



Marines need reliable and valid capabilities 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 provide results that can be easily exported to the Marine Corps Training Information Management System. Develop valid scientific products and affordable technologies to unobtrusively assess and predict performance, situational awareness, unit cohesion, and team coordination in complex dynamic operational environments.

T&E STO-2 maps to following POM 14 gap:
M.05-08-G2: Tactical tasks

-- T&E STO-3: **Warrior resilience**[42]

The evolving security environment requires a physically and mentally resilient Marine able to endure extended exposure to ambiguous, stressful, and ever-changing situations[43] to accomplish missions. Develop scientific products and technologies that enhance training for individual and collective resilience that can be used both in garrison and while deployed. The objective is to develop mental and physical skills, strategies, expertise, tools, and measures so that Marines can not only better cope with the complex challenges of combat, but develop and sustain skills to excel in complex and demanding environments over time. Identify tools and methods to better manage the mental and physiological factors that affect the stress response and resilience, including mental, physical, and social factors of performance and recovery. Develop validated and reliable measures to assess factors that affect resilience and the stress response to select for critical MOSs and positions that require high resiliency and resistance to stressors.

T&E STO-3 maps to following POM 14 gap:
M.05-08-G2: Tactical tasks

-- T&E STO-4: **Experiential learning technologies and methodologies**

Because of limited time and resources available for training and education, more productive methodologies and measures are needed to increase the capacity and quality of training and military education.[44] Multidisciplinary scientific products and technologies should seek to optimize practical exercises and experiential learning across the cognitive, psychomotor, and affective domains. Because of limited resources and the availability of role players, Marines need enhanced capabilities to engage in accurate social, cultural, and behavioral interactions in live, virtual, and distance learning environments. Technologies applied to both training and education must include timely, focused feedback and assessments on the users' performance.

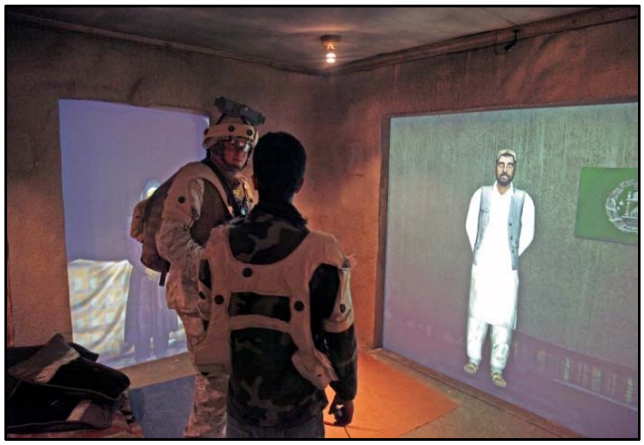
T&E STO-4 maps to following POM 14 gap:
M.05-08-G2: Tactical tasks

-- T&E STO-5: Adaptive simulated entities[45]

Simulation capabilities are needed to enable Marines to train as they fight, using the full range of equipment functions in training. Develop technologies that address the Marines' need to train kinetic and non-kinetic skills in complex, simulated environments containing realistic, adaptive entities. Develop behaviorally accurate virtual role players representing a variety of cultures, populations, and domains that would allow Marines to apply learned skills. These capabilities should provide increasingly demanding challenges to progressively build critical thinking and decision-making skills in complex environments.

T&E STO-5 maps to following POM 14 gap:
M.05-08-G2: Tactical tasks

-- T&E STO-6: Warrior simulation[46]



Marines need to train as they would fight as small units, particularly for dismounted operations. However, live training resources, facilities, ranges and training areas are limited. Simulation capabilities are needed to provide real-time effects and realistically engage the senses during challenging, rapidly reconfigurable scenarios to increase small units' opportunities to train when they do not have access to live resources. Develop capabilities to realistically simulate munitions (friendly and enemy) effects within live, virtual, and constructive training environments.[47] Develop the ability to stimulate 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. Additionally, Marine Corps staff training needs capabilities to 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 national 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 would fight to support realistic training.

T&E STO-6 maps to following POM 14 gap:
M.05-08-G2: Tactical tasks

-- T&E STO-7: **High-fidelity geospatial synthetic environment**[48]

Marines must be ready to fight in *every clime and place*; therefore, they need to be able to train and rehearse for different geographic, topographic, and environmental conditions. Develop affordable technologies to support the Marines' need to train and rehearse in a common synthetic environment that is similar to the real-world environments that they will encounter during their missions. Develop a high-fidelity Geospatial synthetic environment to include scientifically-based, physically accurate environmental considerations. The environment needs to be compliant with the Global Information Grid supporting simulation training systems and platforms. Develop and provide an affordable direct export/import capability for geospatial data, so that real-world data can be integrated into the synthetic environment. Develop a common synthetic environment supporting the Live, Virtual, Constructive – Training Environment (LVC-TE) concept.

T&E STO-7 maps to following POM 14 gap:
M.05-08-G2: Tactical tasks

--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.[49] To do so, Marines need to be trained and educated not only to understand cultures and populations, but to thrive and adapt in chaotic environments[50] that include the complex and changing cross-cultural situations presented in traditional Marine operations, as well as sustained interactions with local populations or foreign militaries. Scientific research is needed to identify core factors and skills, including but not limited to cognitive, metacognitive, behavioral, and affective factors associated with the ability to operate effectively in culturally complex environments. Basic social science research is needed to create relevant data sets to assist in identifying germane cross-cultural skills to train Marines, effective cross-cultural instructional methodologies, and to assess social science theory utility. Develop affordable capabilities to facilitate acquisition and application of regional/culture-specific knowledge and skills, culture-general knowledge and skills, and cross-cultural communication capabilities. Develop human social, culture, and behavior modeling tools and products based on validated social science to improve socio-cultural training and education. Develop effective procedures and mechanisms that enable models to incorporate critical data structures and elements during model development, and that enable model developers to communicate types of data needed to improve model effectiveness.

T&E STO-8 maps to following POM 14 gaps:
M.05-08-G2: Tactical tasks
I.02-07-G2: Limited HUMINT collection capability
I.02-07-G1: Limited cultural and social information collection capability

-- **T&E STO-9: Cultural and language proficiency tools**

Develop language and cultural learning packages to support the Marine Corps area specialization program enabling Marines to improve as well as maintain language proficiency while simultaneously expanding their cultural knowledge and effectiveness. Technologies must be flexible and capable of broad application on both military information technology as well as common commercial platforms such as MP3 devices to provide maximum opportunities for their use.

T&E STO-9 maps to following POM 14 gaps:
M.05-08-G2: Tactical tasks
F.05-04-G1: Communicate
I.02-07-G2: Limited HUMINT collection capability
I.02-07-G1: Limited cultural and social information collection capability
F.07-02-G1: Provide qualified CA Marines

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 reachback 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.[51]

-- IW STO-1: Crowd scanning systems

Develop a sensor system capable of identifying individuals of interest that could pose threats. The system should be individually portable capable of full integration into the ensemble of individual Marines through the use of helmet cameras or similar sensors to collect biometrically relevant data and then transmit the data to where it can be assessed in near real time. The system must have a feedback mechanism that will provide an *alert* to the affected Marines. The system is needed specifically to identify any person-of-interest within a crowd, approaching a checkpoint, etc. that requires closer inspection but ideally would be sufficiently portable to be used by patrolling dismounted Marines. Threat detection beyond 30 meters is desirable. Develop the means to integrate the detection and alert system with other ground sensors as part of an integrated tag, track, and locate effort.

IW STO-1 maps to following POM 14 gaps:
I.02-07-G2: Limited HUMINT collection capability
I.03-03-G1: Limited threat personnel identification capability
M.03-05-G1: Inspect/detect personnel/vehicles/explosives

-- IW STO-2: Visual translator system

Develop a technology capable of scanning street signs or other forms of written expression and then providing a near real time translation or graphical depiction.

IW STO-2 maps to following POM 14 gap:
F.05-04-G1: Communicate

-- IW STO-3: Reachback tool for civil military operations

Develop technology that enables engineers specifically to conduct basic troubleshooting for essential services with schematics and diagrams to assist personnel in reconstruction assessment and emergency repairs. Included should be translations of instructions in specific target languages. Goal is to rapidly provide instructions and supporting documentation to permit local construction and engineer organizations to do the work themselves.

IW STO-3 maps to following POM 14 gaps:
L.03-01-G1: Plan and direct logistics operations
F.05-04-G1: Communicate

-- IW STO-4: Indigenous weapons training systems

Develop a deployable, low maintenance, training system to assist Marine Security Force Assistance (SFA) teams with training host nations security forces on host nation's weapons (i.e., AKs and SKS rather than U.S. weapon systems such as M16/M4/M9s). Ensure open architecture that not only permits rapid adaptation to any available weapon system but also protocols that enable technology transfer to partner nations and operation on indigenous display technology.

IW STO-4 maps to following POM 14 gap:
M.04-08-G1: Foreign weapons training

-- IW STO-5: Ship identification and reference tool

Develop a tool that will enable rapid classification of ships and coastal vessels with the ability to rapidly call up schematics and ship blueprints to enable Visit Board Search and Seizure (VBSS) teams to rapidly identify ships and boats by class and then provide a blueprint to guide in the conduct of the search. Develop technology that enables the crew of the parent ship to track the VBSS team's movement within the vessel and enable navigation through the passageways through the use of inertial navigation replacing *pacecounts* or electronic *breadcrumbs*. Ensure compatibility with NORAD/USN Maritime Domain Awareness initiatives.

IW STO-5 maps to following POM 14 gaps:
C.03-03-G1: Situational awareness
M.05-08-G1: Maritime security operations

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.

By capitalizing on technologies already in development, and through a series of new technology development initiatives, substantial progress has been made towards making the Seabasing concept a reality. With the introduction of the Mobile Landing Platform (MLP) into the sea base comes the ability to transfer heavy equipment to and from amphibious and maritime prepositioning ships. Although not yet programmed for introduction to the fleet, innovative, prototype crane systems were developed to quickly and safely move cargo between ships in higher sea states. A new class of ship, the Joint High Speed Vessel (JHSV), under construction along with the planned recapitalization of both non-displacement and displacement landing craft (LCAC-100, LCU-R) greatly increase the capacity and speed of forces and sustainment flowing in to, between, and from the sea base. New technologies, coupled with new operating concepts, provide 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. As an example, much of the technology being fielded or under development gives the sea base a capability to operate *into* sea state 3 (SS-3) conditions. Those technologies need to be enhanced to provide for operations *through* SS-4.

Provided in this annex are 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.**

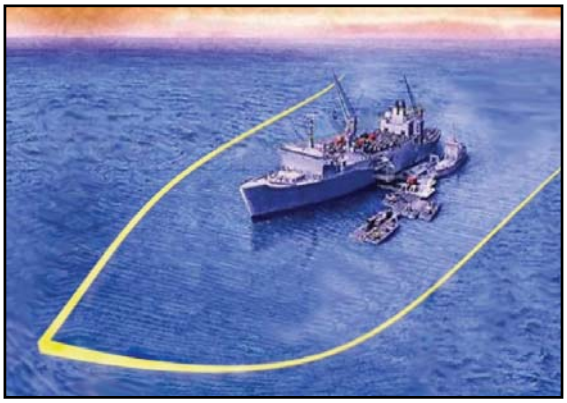
Goal: The overarching goal for the 2011-2012 Marine Corps Seabasing Science and Technology Strategic Plan is to ensure that the various components of the sea base are interoperable (connected), optimized to support force employment in the 2025 operating environment, and operated in the most cost-effective manner possible. Using the CAESR construct outlined above, Marine Corps priorities for Seabasing Science and Technology development are provided below.

Closing the Force

-- 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-2: Reduce sea states



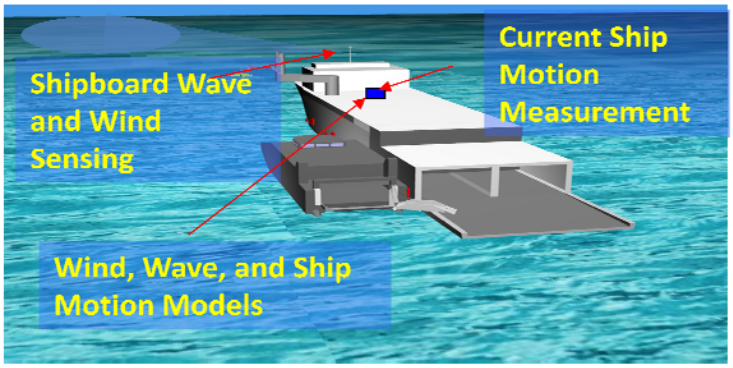
Develop technologies to reduce sea states from SS-4 to SS-2 within the sea base environment in order to facilitate closure for ships and surface connectors delivering forces from an advance- or intermediate staging-base to ships of the sea base.

Assembling the Force

-- 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-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.

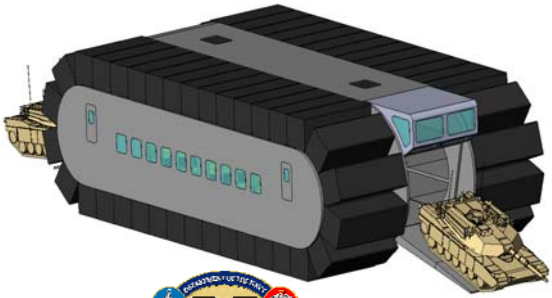
-- SEA-STO-5: Improving equipment stowage factors

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

Employing the Force

-- 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-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.

Sustaining the Force

-- 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-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.
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-- 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-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-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.

Reconstituting the Force.

-- 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.

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-15: Improved ship design tools

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

-- 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.

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* Vision and Strategy 2025 *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.***

1. 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:

(1) Data links and Information/Capability Management Networks
(2) Heavy Lift Replacement (HLR)
(3) Electronic Warfare (EW)
(4) 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 Plan[52] and its own STOs[53] 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.

b. *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: 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-2: Advanced electronic warfare (EW) systems

Develop technologies that are compatible with Marine Corps follow-on Electronic Attack (EA) platforms as the platform requirements are refined. Develop multi-function, transceiver arrays that enable future EW as well as provides adequate bandwidth, SIGINT and ISR and Next Generation Jammer technologies. Software Reprogrammable Payload (SRP) is a single common payload module that is flexible and reconfigurable to support simultaneous missions and applications making maximum use of available bandwidth and ensuring interoperability within joint standards and protocols providing commonality across platforms. Collaborative On-line Reconnaissance Provider Operationally Responsive Attack Link (CORPORAL) is a Joint Capabilities Technology Demonstration that Provides *on-demand* collaborative situational awareness (NTISR) & kinetic and non-kinetic fires to the small unit's target area of interest. It consists of plug-and-play, software reprogrammable, scalable, IP-based, and open-architecture non-kinetic fires solutions and will outpace traditional point solutions, accommodate existing legacy systems, and provide a bridge to future operational systems, enabling machine-to-machine collaboration and coordination.

-- AVN STO-3: 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 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-4: Command and control (C2) data fusion and networking

Develop technologies to support data fusion to improve sensor tracking of tactical aircraft and UASs as well as the fusing of data from the various ground and intelligence system employed by the MAGTF. The most significant challenge for Aviation C2 is the quest for data fusion. The requirement statement in the Common Aviation Command and Control System (CAC2S) Capability Production Document (CPD) describes data fusion as fusing data from real time sensors/ near real time Tactical Digital Information Links (TADILs) and non-real time data components to deliver an adaptive situational display. Develop a robust data network established with common databases that push near-real time updates to C2 operators and aircraft. Overcome security and IA requirements with multiple data standards and security levels. Develop a single system that can interface with both current ground C2 and intelligence systems and has communication channels with adequate capacity to transmit and receive terabytes worth of data.

-- AVN STO-5: 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-6: Group 4 (Tier III) unmanned aircraft systems (UAS)

Develop an expeditionary, all-weather, high endurance, multi-mission UAS capable of operating from austere locations and providing networked, interoperable systems to enhance the MAGTF and Joint Force Commander's battle-space awareness. 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.

-- AVN STO-7: **Advanced multi-function EW transceiver**

Leverage Next Generation Jammer (NGJ) technologies to develop capabilities compatible with Marine Corps follow-on EW concepts (i.e. system-of-systems distributed EW, including low observable systems) as the system requirements are refined. Multi-function transceiver arrays potentially enables future EW as well as increasing bandwidth access, SIGINT and ISR capabilities.

-- AVN STO-8: Ground based C2 and surveillance systems

The concept of active aperture array is critically dependent on the availability of compact and minimum weight, low consumption and high reliability Transmit/Receive

(T/R) modules. Develop technologies that provide the thermal margins required to meet mission radar performance for the T/R modules using of state of the art, air-cooled technology. Develop manufacturing techniques that can produce high quality, micro-miniature RF circuits (T/R modules) that are not susceptible to stress and cracking during production. Develop technologies that support the calibration of an ambient air-cooled Active Electronically Scanned Array (AESA).

-- AVN STO-9: 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-10: Scalable, light weight, interference cancellation system and adaptive/cognitive radio technologies for both co-situated RF emitters and RF saturated environments to eliminate VHF, UHF, SATCOM RF interference between multiple radio and electronic attack systems.

Develop low-cost interference cancellation technologies and adaptive/cognitive radio systems to enable assured communications and information distribution for emerging platforms and systems as well as technology transition for legacy platforms that suffer communications degradation with multiple communications systems or jamming.

-- AVN STO-11: 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-12: 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, over round-trip distances with a threshold of

150 nautical miles and an objective of 900 nautical miles, reducing the number of ground transport delivered items

-- AVN STO-13: 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-14: 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-15: 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-16: Advanced rotor/prop technologies for performance across wider envelope[54]

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/91.5º F. OEF and other potential deployment locations require lift well beyond this ambient

pressure/temperature. Develop 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.

-- AVN STO-17: 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) 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-18: 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-19: Cost effective mass memory (terabytes)

Develop 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 with airborne and shipboard environmental conditions. 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 denied.

-- 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: **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-22: 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-23: Lightweight De-ice/Anti-ice capability for aircraft

Develop technologies to provide a lightweight all de-ice/anti-ice capability for both rotor blades and fuselage that reduces both weight and electrical power requirements. Current de-ice/anti-ice capabilities are heavy due to power requirements for heating and wiring.

-- AVN STO-24: **Variable-speed air refueling drogue**

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

-- AVN STO-25: 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 helicopters[55] for the delivery of logistics support with reduced risk to manned aircraft is also desired.

ANNEX C: Naval Medicine and Human Performance

Naval Medicine supports and enhances the expeditionary warfare capability of the United States Marine Corps through the development and rapid adoption of relevant enabling technologies. Recognized and anticipated technology capability gaps are identified not only through the systematic, ongoing warfighter's review of recent and current Marine Corps operations, but also through strategic future planning designed to fully support the *Commandant's Marine Corps Vision & Strategy 2025;* a vision of an unparalleled expeditionary warfighting force that is fast, lightweight and lethal. Naval Medicine science and technology (S&T) research in support of that vision will complement (not duplicate) the medical research efforts of the other Services, those supporting the militaries of other nations, and those conducted within the private sector. In addition, medical S&T initiatives will be designed for full integration into the USMC S&T Strategic Plan.

<u>The Vision:</u> Using the Marine Corps Vision and Strategy 2025, Naval Medicine technologies will support and realize operational concepts focused on defeating Hybrid threats and challenges, enhancing the MAGTF's flexibility, agility, and adaptability, enabling Marines to quickly analyze, clearly decide, and decisively act, thus increasing the ability of the rifle company to conduct the full range of missions. Medical technologies will clearly demonstrate support for one or more of the following operational imperatives:

- ***Seabasing***
- ***Persistent forward presence and engagement***
- ***Agile and adaptable forces***
- ***Remaining multi-capable across the range of military operations (ROMO)***

<u>Goal</u>: 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 capabilities

Develop technologies to improve immediate point of injury (first responder) care, enhance life-saving forward resuscitative care, ensure appropriate theater hospitalization and optimize en route evacuation care to definitive tertiary care for casualties of the future battlefield.

-- Med STO-2: Human performance enhancement capabilities

Leverage existing and/or create new technologies to reduce warfighter fatigue, optimize human-systems integration, enhance warfighter sensory, cognitive, and motor capabilities, enhance mental resilience to stress, improve warfighter learning, communication, and decision-making skills, enhance physiological capability and maintain warfighter abilities in austere or stressing environments to provide a healthy and fit force.

-- Med STO-3: Fatigue management

Develop technologies that enable both the individual and the commander to detect when a Marine is becoming fatigued to the point where it affects cognitive functioning, decision making ability, or other aspects of operational performance. Detection capability must be specific to the individual and adaptable to operational field ensembles for dismounted operations. Develop the capability for a commander to safely and effectively manage sleep as he would food, fuel, ammunition, or other essential logistical supplies. This capability may include pharmacological agents for initiating/maintaining sleep provided their effects are immediately reversible in response to changing tactical requirements.

-- Med STO-4: Patient movement capabilities

Create technology solutions and innovations to improve patient movement, i.e., casualty evacuation (CASEVAC) and medical evacuation (MEDEVAC) both within the joint theatre of operations as well as evacuation to a definitive source of care outside of theatre. Develop light weight stretchers and the means to reduce the number of dismounted Marines that are required to rapidly transport a non-ambulatory Marine.

-- Med STO-5: Health surveillance, intelligence, and preventive medicine capabilities

Develop technologies and systems to improve comprehensive health surveillance at all echelons of care, quickly share medical intelligence from all relevant sources, and provide a full-spectrum of preventive medicine services.

-- Med STO-6: Medical logistics and infrastructure support capabilities

Improve existing systems and technologies, while developing new technical innovations that accurately plan for future medical logistics operations, optimize current joint medical logistics operations and develop sustainable health service support to current and future joint force operations.

-- Med STO-7: Warfighter physiology[56]

Develop technologies that will identify Marines' responses to prolonged combat stress by assessing multiple interdisciplinary indicators such as psychological, physiological, endocrinological, or immunological factors simultaneously. The technologies would be able to provide the information quickly and unobtrusively so that the effects of stress that may influence combat effectiveness, such as mental or physical fatigue, can be quickly identified and mitigated.

-- Med STO-8: Physical readiness conditioning and nutrition monitoring[57]

Develop solutions that would assist Marines in monitoring exercise intensity, frequency, duration, recovery, and/or specific physiological indicators of aerobic training to prevent over-or under-training. Solutions should increase self-awareness by assessing physiological indicators, physical activity, and/or fuel (food) usage. This will enable Marines to maximize their physical training by knowing what foods are optimal for recovery, when to increase exercise intensity, frequency, duration, or increase recovery (by resting or decreasing training volume).

-- Med STO-9: **Stress resistance, resilience, and recovery**[58]

Marines must be physically and mentally resilient to endure and overcome the challenges of current and future operational environments. Marines must have the skills and tools to be resilient, adaptive, and able to operate in situations where they are exposed to complex, ambiguous, and stressful situations for extended periods of time. Additionally, better diagnostic and treatment capabilities are needed for Marines with injuries, including Post Traumatic Stress Disorder (PTSD).[59] Develop multidisciplinary science that improves understanding of the relationship between stress, resistance (persistence of normal function despite stress), resilience (very rapid return to normal function after stress), and recovery from stress-related impairments. Develop scientific products and technologies to enhance Marines' resilience in these demanding operational environments, enable them to maintain high performance levels, enable more efficient identification and diagnosis of impending stress-related conditions, and facilitate rapid recovery from stress-related impairments. Develop tools and technologies, to include but not limited to neurocognitive measures, to effectively and efficiently evaluate factors that predict stress resistance, resilience, and impairment. The objective is to develop additional understanding of the causes, indicators, and effects of stress-related injuries in order to prevent, diagnose, treat, and rehabilitate combat and operational stress related conditions.

[1] Army Science & Technology Master Plan 2007 of Mar 2007.
[2] Col Terry L. Bruning "Report of Marine Corps Participation at 2009 ABCA Armies Science and Technology Workgroup (1~BCA S&T WG) Meeting: dated 15 April 2009 w/First Endorsement of Director, Command, Control, Communications and Computers, Headquarters, US Marine Corps Director, Command, Control, Communications dated 20 Apr 2009.
[3] Office of Naval Research SORM, ONRINST 5430.16A page 3-14
[4] Mattis, Lieutenant General J.N., Excerpted from Commanding General's (MCCDC) Command and Control (C2) Intent, 11 April 2006.
[5] UNS for "Satellite Gap" 2003
[6] UNS for "MEF Level Targeting UAV" 2004.
[7] UNS for "Small Unit Space Transport and Insertion Capability" Jul 2002.
[8] Rhodes, LtGen J.E. Rhodes and Holder, RADM G.S. "A Concept for Future Naval Mine Countermeasures in Littoral Power Projection," 1 May 1998 pg. 4.
[9] COMMANDANT OF THE MARINE CORPS POLICY MEMORANDUM 2-02 "INCREASED WARFIGHTING CAPABILITY THROUGH REDUCED FOSSIL FUEL BURDEN", page 2.
[10] Naval Operations Concept 2010, page 57.
[11] USMC "MAGTF Mine Countermeasures Master Plan" Aug 2004, Appendices E & F and CO, Engineer Center of Excellence 1000 over CO dtd 11 Mar 09.
[12] USMC "MAGTF Mine Countermeasures Master Plan" Aug 2004, Appendices E & F.
[13] UNS for "Exoskeleton" Aug 2004.
[14] Distributed Operations Architecture Study, 26 Mar 2007, pg. 12.
[15]There are a number of promising high and directed energy technologies of interest to the Marine Corps to include Electromagnetic Pulse (EMP) Hardening; DC and AC LINAC-Driven Charged Particle Beam (CPB); Directional Acoustic Weaponry; and, Pulsed and CW Terahertz High Power Microwave (HPM) and Millimeter Wave Weapons Technologies.
[16] Force Application Functional Concept, 5 March 2004, pg. 13.
[17]Marine Corps Vision & Strategy 2025, June 2008, pg. 21
[18]Marine Corps Vision & Strategy 2025 Implementation Planning Guidance, December 2008, pg. 13
[19] Urgent UNS for "Vehicle Stopping," the "Portable Vehicle Arresting Barrier" ORD, USMC NLW Strategy, and USMC NLW Annual NL Requirements.
[20] Following Urgent UNS documents refer: "Non-Lethal Tube Launched Munition (VENOM)," "Long Range Non-Kinetic Non-Lethal Weapons," "Laser Dazzlers," "Untethered Non-Lethal Weapons Capability," and "Long Range Acoustic Devices." In addition, the Mission Payload Module (MPM) CDD, DRAFT Escalation of Force (EoF) ICD, and Joint Non-Lethal Weapons Directorate CBA consistently reflect these standards of need.
[21] USMC NLW Strategy dated 2005.
[22] UNS for "Gunship Advanced Combined Arms Weapon Suite" dated May 02.
[23] 35th Commandant's Planning Guidance, 2010.
[24] United States Marine Corps Expeditionary Energy Strategy and Implementation Plan, 2011.
[25] Initial Capabilities Document for United States Marine Corps Expeditionary Energy, Water, and Waste.
[26] Commandant's Planning Guidance 2010, pg. 9.; Commandant of the Marine Corps 2011 Report to the House Armed Services Committee on the Posture of the United States Marine Corps, pg. 16.
[27] Marine Corps Vision and Strategy 2025, June 2008, pg. 2.
[28] The Training and Education Command Science and Technology Working Group (STWG) identifies, reviews, and addresses TECOM S&T requirements and challenges; facilitates communication and coordination between TECOM stakeholders and the S&T Community; and serves as an advisory group to CG, TECOM on matters pertaining to T&E related S&T.
[29] MAGTF Training Simulations Division (MTSD), TECOM identifies, develops, and coordinates the integration of MAGTF training modeling and simulation requirements and sponsors non-standard ground virtual and constructive training simulations to provide accredited training systems to the Total Force.
[30] Range and Training Area Management Division (RTAM), TECOM is the Marine Corps Executive Agent for range and training area management, including management of training airspace.
[31] Ground Training Division (GTD), TECOM conducts occupational and training analysis, publishes service training policies and directives, validates and maintains individual/collective training standards for common skills

along with C2/ground occupational fields and provides service oversight and training support for unit and formal school training management in order to ensure Marines meet the challenges of present and future operational environments.

[32] As the Marine Corps Culture and Language Center of Excellence, the Center of Advanced Culture Learning (CAOCL), TECOM ensures Marines are equipped with operationally relevant regional, culture, and language knowledge to allow them to plan and operate successfully in the joint and combined expeditionary environment: In any region of the world, in current and potential operating conditions, targeting persistent and emerging threats and opportunities.

[33] The College of Distance Education and Training (CDET), TECOM designs, develops, delivers, evaluates, manages, and resources distance learning products and programs across the Marine Corps training and education continuum in order to increase operational readiness.

[34] The Command and Control Training and Education Center of Excellence (C2TECOE), TECOM, serves as the central Marine Corps agency for C2 training and education issues within the DOTMLPF process in order to synchronize the art and science of MAGTF C2 training and education requirements from the individual Marine through all levels of MAGTF commanders and their staffs and is the higher headquarters for the MAGTF Integrated System Training Centers.

[35] Marine Corps University (MCU), TECOM develops, delivers, and evaluates professional military education and training through resident and nonresident programs to prepare leaders to meet the challenges of the national security environment; preserves, promotes, and displays the history and heritage of the Marine Corps.

[36] Commandant's Planning Guidance 2010, pg. 9.

[37] Marine Corps Vision & Strategy 2025, June 2008, pg. 14.

[38] Marine Corps Vision & Strategy 2025, June 2008, pg. 14.

[39] Marine Corps Small Unit Decision-making Workshop Outbrief dated 12 January 2011 defined cognitive skills as the skills involved with the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses. Relational skills are defined as the ability to understand, motivate, and communicate with other people.

[40] Marine Corps Vision & Strategy 2025, June 2008, pg. 21.

[41] Squad Immersive Training Environment Initial Capabilities Document, 7 April, 2010.

[42]Commandant's Planning Guidance 2010, pg. 12.

[43] Commandant of the Marine Corps 2011 Report to the House Armed Services Committee on the Posture of the United States Marine Corps, pg. 17.

[44] Commandant's Planning Guidance 2010, pg. 13.

[45] Marine Corps Vision & Strategy 2025, June 2008, pg. 15. Squad Immersive Training Environment Initial Capabilities Document, 7 April, 2010.

[46] United States Marine Corps Training and Education Command Modeling and Simulation Master Plan 2010.

[47] United States Marine Corps Training and Education Command Modeling and Simulation Master Plan 2010; Live Virtual Constructive Training Environment Initial Capabilities Document, 30 July 2010.

[48]Marine Corps Vision & Strategy 2025, June 2008, pg. 15-16.

[49] Commandant's Planning Guidance 2010, pg. 5; Marine Corps Vision & Strategy 2025, June 2008, pg. 6.

[50] Marine Corps Vision & Strategy 2025, June 2008, pg. 10.

[51] Marine Corps Vision & Strategy 2025, June 2008, pg. 23.

[52] Naval Aviation Enterprise Science & Technology Strategic Plan, 1 July 2006.

[53] Naval Aviation Enterprise Science & Technology Objectives, April 2008.

[54] Director, CDD "Letter of Interest in Continuation of the Joint Heavy Lift (JHL) Concept of Refinement and Solution Development," 22 June 2007.

[55] Marine Corps Vision & Strategy 2025, June 2008, pg. 22.

[56] Marine Corps Vision & Strategy 2025, June 2008, pg. 14.

[57] Marine Corps Vision & Strategy 2025, June 2008, pg. 14.

[58] Commandant's Planning Guidance 2010, pg. 12.

[59] Commandant's Planning Guidance 2010, pg. 10.

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