Marine Corps Systems Command - Advanced Planning Brief to Industry

Mr. George Solhan
Deputy Chief of Naval Research,
Expeditionary Maneuver Warfare and Combating Terrorism (ONR 30)
7 April 2010
Naval Research: A Statutory Mission

Naval Research Laboratory (Appropriations Act, 1916):
“[Conduct] exploratory and research work...necessary... for the benefit of Government service, including the construction, equipment, and operation of a laboratory....”

Office of Naval Research (Public Law 588, 1946):
“... plan, foster, and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power, and the reservation of national security.... ”

“...manage the Navy’s basic, applied, and advanced research to foster transition from science and technology to higher levels of research, development, test, and evaluation.”
S&T Focused on Naval Needs

FY10 DON S&T Funding = $1,824M

**Focus**

- **Broad**
  - Quick Reaction & Other S&T (10%)
    - Tech Solutions
    - Experimentation
    - MC S&T (MCWL, JNLW, etc.)
  - Acquisition Enablers (FNCs) (36%)
    - Future Naval Capabilities
    - Warfighter Protection
    - Capable Manpower
    - LO/CLO
  - Leap Ahead Innovations (INPs) (10%)
    - Innovative Naval Prototypes
    - NSPs
    - Swampworks
  - Discovery & Invention (Basic Science, Early Applied Research) (42%)
    - Basic & Early Applied Research
    - National Naval Responsibilities
    - Education Outreach HBCU/MI

**Time Frame**

- **Near**
  - Quick Reaction & Other S&T
- **Mid**
  - Acquisition Enablers
  - Leap Ahead Innovations
- **Far**
  - Discovery & Invention

**PE:** 6.3 6.3 / 6.2 6.2 / 6.1
## ONR S&T Departments

### Code 30
- Expeditionary Maneuver
- Warfare & Combating Terrorism

### Code 31
- C4ISR

### Code 32
- Ocean Battlespace Sensing

### Code 33
- Sea Warfare and Weapons

### Code 34
- Warfighter Performance

### Code 35
- Air Warfare and Weapons
ONR 30 Organization

Expeditionary Maneuver Warfare and Combating Terrorism S&T

Hybrid Complex Warfare Sciences Division (301)
- Basic Research Counter IED

Applications Division (302)
- FITE JCTD

Combating Terrorism & Integration Division (303)
- Maritime Irregular Warfare
- Operational Adaptation + HSCB

FY2011 R2 Activity Areas & ONR Code 30 Thrust Areas

HPT&E Thrust
- Enhanced Physical Readiness
- Mental Resilience & Cognitive Agility
- Expertise Development

C4 Thrust
- Network Centric Warfare - Interoperability
- Over-The-Horizon Comms & Gateways
- Small Unit Technologies

ISR Thrust
- Persistent ISR
- Knowledge Generation
- ISR - C2 (Actionable Intelligence)
- Biometrics
- Tag, Track & Locate

Fires Thrust
- Targeting & Engagement
- Advanced Ammo
- Advanced Weapons

Logistics Thrust
- Asset Visibility
- Logistics Transport
- Operational Self-Sufficiency
- Maintenance Reduction
- Infrastructure

Maneuver Thrust
- Survivability
- Advanced Mobility
- Maneuver Enablers

Force Protection Thrust
- Detection
- Neutralization
- Mitigation

ONR Code 30 Technology Investment Areas – Focused Thrust Level S&T Investments
* HUMAN PERFORMANCE, TRAINING & EDUCATION
Focus on the warrior as a system, rather than the platform!

Align:
- What we do
- What we need to do it
- How do we measure our effectiveness?

Align with our customers:
- USMC, NECE, SPECWAR
- Combat Developers, Material Developers, Operating Forces

Hybrid Complex Warfare Sciences Division (301)
Director
Dr. R. Pohanka
Deputy
Maj B. Short

Applications Division (302)
Director
Mr. A. G. Johnson

Combating Terrorism & Integration Division (303)
Director
Mr. J. McMains

Integrate interdepartmental & interdisciplinary within ONR and with external activities

Human, Social, Cultural, Behavioral Sciences
Dr. I. Estabrooke

Human Performance Training & Education
Dr. R. Stripling

C4
Mr. J. Moniz

ISR
Mr. M. Kruger
Ms. M. Rubeiz
Maj F. Filler

Fires
Mr. D. Simons
Mr. M. Tepaske

Logistics
Mr. C. Anderson

Maneuver
Mr. J. Bradel
Mr. G. Doerrer
Mr. K. Hammack

Force Protection
Mr. L. Mastroianni

Operational Adaptation

Maritime Irregular Warfare

Non-Linear Physics
Dr. M. Shlesinger

Basic Research
Counter IED
Dr. D. Prono
CAPT M. Stoffel

FITE JCTD
Mr. C. Lethin

IDD
Ms. L. Albuquerque

ExFOB
LT V. Cruz

Col T. M. Williams
Deputy Department Head

Ms. L. Albuquerque
ExFOB
LT V. Cruz

Capt Thom Bellamy
Deputy Department Head

Mr. G. W. Solhan
Department Head

Mr. A. G. Johnson
Director

Mr. J. McMains
Director

LT V. Cruz
ExFOB
Fr. R. Blalock
The “The Three Circles”

**Centripetal Forces**
- Vision/Planning
- Communication
- Technology Roadmaps
- S&T Objectives
- Technology transition agreements
- Experimentation

**Centrifugal Forces**
- Budgets
- Schedule
- Risk
- Congress
- Operational Tempo
- Staffing/Turnover
- Industry

<table>
<thead>
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<th>A</th>
<th>Concept</th>
<th>Capability Futures</th>
<th>Gaps</th>
<th>Requirements</th>
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<td>B</td>
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<td>Requirements</td>
<td>Technology</td>
<td>R&amp;D Production</td>
<td>Capability</td>
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Core Membership – key stakeholders

Technology Dev: Mr. George Solhan – Chairman
Executive Sec to EA S&T: Mr. Jim Lasswell
Technology Dev: Mr. Paul Gido - ACNR
Combat Dev: Mr. Len Blasiol
Material Dev: Mr. David Ungar, Mr Mike Halloran
Additional Core: TBD to match charter construct
The glass is half full!

The glass is half empty.

Half full...No! Wait! Half empty!..No, half...
What was the question?

Hey!

Hey!
I ordered a cheeseburger!

ONR

SYSCOM

MCCDC/OPNAV
Fleet/MARFOR
Aligning to Strategic Guidance

SECNAV Priorities
- Taking care of our Sailors, Marines, Civilians, and their Families
- Treating energy in DON as an issue of national security
- Creating acquisitions excellence
- Optimizing unmanned systems

CNO Priorities
- Build the Future Force
- Maintain Warfighting Readiness
- Develop & Support Our Sailors, Civilians and Families

Commandant Guidance
- Achieve victory in the War
- Right-size our Corps
- Provide a fully prepared naval force
- Be most ready when the Nation is least ready
- Improve the quality of life for our Marines and our families
- Rededicate ourselves to our Core Values and warrior ethos
- Posture the Marine Corps for the future

CNR 2010 Priorities
1. Focus on S&T areas that provide the biggest payoff for our future
2. Be innovative in our thinking and business processes
3. Improve our ability to transition S&T into acquisition programs
4. Improve strategic communication and engagement with stakeholders
S&T Priorities

S&T areas with biggest payoff:

- **Autonomous Systems**
- Hypersonics and Directed Energy
- Warfighter Performance
- Information Dominance
- **Expeditionary & Irregular Warfare**
- Total Ownership Costs

- SECNAV High Interest:
  - Power & Energy
  - STEM

1. Focus on S&T areas that provide the biggest payoff for our future
2. Be innovative in our thinking and business processes
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Current state of technology:
Navigation behaviors employing GPS based Route Network Definition Files (RNDF) and costly, multi-modal sensor suites

- Simple behaviors employing rule-based system
- Rule-based systems are not robust enough for complex environments when encountering uncertainty, imprecision, contradiction, and incompleteness
- Typical sensor suite and CPU cost often exceed $250K, bulky, power hungry
  - Limited environmental context and understanding outside of a pre-planned, structured environment
  - Sensor suite and CPU alone render capability un-affordable

S&T challenges:
1. Affordable Logic/Software
2. Affordable Sensor Suites
3. Advanced Autonomy Algorithms

4. Small unit mobility/maneuverability in extremely complex terrain
5. Dense power and energy devices/sources
6. Fuel independence/energy self-sufficiency for extended ranges

DARPA Urban Challenge

Future Tactical System in Unstructured Environments

Advanced perception system and algorithms to reduce number of sensors and to allow operations in unstructured environments
Remote Control Versus Autonomy

Remote Control
Operator continuously, visually controls the platform via tether or radio. UMS takes no initiative.

Tele-operation
Operator, using video or other sensor input either directly controls the platform or assigns incremental goals via tether or radio. In this mode, the UMS may take limited initiative in reaching the assigned incremental goals.

Semi-autonomous
Operator and the UMS cooperatively plan and conduct a mission but still requires varying degrees of Human-Machine Interface.

Fully autonomous
A mode of operation wherein the UMS is expected to accomplish its mission, within a defined scope, without human intervention. Note that a team of UMSs may be fully autonomous while the individual team members may not be due to the needs to coordinate during the execution of team missions.

NIST Special Publication 1011
Autonomy Levels for Unmanned Systems (ALFUS) Framework
Volume I: Terminology
Version 1.1
September 2004
Why Autonomous Behavior is a Hard Problem

Environmental Complexity
Solution ratios on:
• Terrain variation
• Object frequency, density, intent
• Weather
• Mobility constraints
• Communication dependencies

Mission Complexity
• Subtasks, decision
• Organization, collaboration
• Performance
• Situation awareness, knowledge requirements

Machine Intelligence Level
Ability to:
• Reason, Plan, Predict
• Learn from experience, instructions, etc., and adapt to new situations
• Understand the battlespace
• High-level interactions with humans

Human Interaction
• Type of interactions
• Type of operators/users (e.g., workload, skill levels, etc.)
• Frequency, duration, robot initiated interactions
ONR 30 Unmanned Ground Systems
Areas of Interest

Affordable Sensor Suites and Advanced Perception System

Move away from costly multi-modal sensors suites to low-cost vision based sensors

a. Leverage existing machine vision work performed by DARPA and JPL (LAGR Program)
b. Distributed computing networks to process “at-the-sensor” utilizing FPA, DSP, GPU and reduce the computational burden on the CPU
c. More capable and robust texture analysis algorithms (segmentation, texture, signature)
d. Reasoning algorithms to discriminate between objects and apply context to a near-field spatial scene (rock-bush, puddle-hole, door-window)

Advanced Autonomy Algorithms

Move from point-to-point navigation to autonomous behaviors not reliant on GPS

a. Near-field Tactical Path Planner utilizing a Raster World Model including relative and absolute localization (SLAM)
b. Far-field Advanced Path Planner to include platform master state information and environmental traversability
c. Dynamically generated high-level situation awareness model incorporating information not organic to the vehicle such as threat areas, road and terrain connectivity and traversability, and real-time events and intelligence (Ford Sync System™)
d. Advanced autonomy behaviors which integrate bottom-up perception and top-down reasoning to execute doctrinally correct tasks with no human intervention
Human Performance, Training, and Education
Vision for Excellence

Tech Investment Area:
Enhanced Physical Readiness

- Perceive
- Think
- Act
- Nutrition, Physiology, Strength, Endurance, Agility
  - Heat, Cold, Altitude, Humidity, Mission Duration...

Tech Investment Area:
Expertise Development

- Perceive
- Think
- Act
- Knowledge, Skills, Abilities
  - Info Overload, Time Pressure, Mission Performance...

Tech Investment Area:
Mental Resilience & Cognitive Agility Development

- Perceive
- Think
- Act
- Adaptiveness, Emotional Fortitude
  - Rules of Engagement, Moral and Ethical Challenges

DO-enabled training methodologies & technologies
Lightened load of all Warfighters
Increased resilience to extreme and austere environments
Distributed Operations (DO) Small Unit Excellence
Lightened load of all Warfighters
Crisis-based decision making
Marine as a system

Tomorrows Battlespace...
- Non-linear, more complex...often urban
- Difficulty identifying friend or foe
- Enclosed spaces
- Non-combatants including Americans at risk
- Small unit vice force on force
- Responsiveness to threat critical

Conflict Intensity
Impact of Training

• Training today achieves a certain level of proficiency
  – Simulation training can increase rate of proficiency development, enabling greater benefits of live pre-deployment training to be achieved

• During or post-deployment, unused skills deteriorate rapidly
  – Simulation training (synthetic and live) will reduce skill loss by providing training opportunities otherwise not available
**Infantry Immersion Trainer (IIT)**

**TECHNICAL APPROACH:**
- Maximum use of COTS components
- Leverage ONR and Army RDECOM technologies
- Government controlled architecture
- Modular Design
- Incremental improvements
- SESAMS (paintball) weapons with custom lasers
- Projected Avatars on selected walls

<table>
<thead>
<tr>
<th>OBJECTIVES:</th>
<th>Accomplishments and Plans:</th>
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<tr>
<td>• Develop a prototype mixed reality system for highly effective Home Station MOUT training prior to Mojave Viper.</td>
<td>• Over 10,000 Marines, Soldiers, and Allies trained</td>
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<td>• Inoculate Marines to the sights, smells, sounds, and chaos of urban battle.</td>
<td>• Smaller scale system for Human Factors research-Gruntworks Research for Infantry Integration Testing (GRIIT) facility at Stafford, VA in use by PM MERS</td>
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<td>• Demonstrate and experiment with new technologies</td>
<td>• Improvements to I MEF IIT:</td>
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<td></td>
<td>• Improved Call for Fire Software</td>
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<td>• Improvements to Avatars (virtual characters); lasers; and improved instructor control</td>
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<td>• ONR Software to be used at JIEDDO funded I MEF IIT Phase 2, II MEF, and III MEF facilities</td>
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<td>• Continued improvements under ONR Technical leadership as part of the FITE JCTD</td>
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ONR S&T enables Sailors and Marines!

- S&T in support of Expeditionary Maneuver Warfare (continued primary importance to both Navy and Marine Corps)
- S&T in support of Combating Terrorism – aka Maritime/Irregular Warfare (MIRWAR), GWOT, Long War, etc. (rapidly growing emphasis in both Navy and Marine Corps)
- Survive and Win
- Be more lethal
- Expand their area of influence
- Be flexible in all phases of warfare
- Move between kinetic and non-kinetic tactics
- Predict actions of Irregular enemies
- Generate combat power operationally/tactically
- Operational Adaptation in new paradigm of Hybrid Complex Warfare
Back-Up
Marine forces of the future will be significantly more agile, lethal, mobile and survivable. Technologies will be developed to increase the warfighting capabilities and effectiveness of the Marine Corps Air Ground Task Force (MAGTF) with emphasis on improving survivability, providing enhanced maneuver, and providing maneuver enabler systems in Distributed Operations and Irregular / Asymmetric Warfare.

**Technology Investment Areas**

**Survivability**
- MVR STO-2: Advanced materials and survivability technologies to enhance the performance and survivability of combat vehicles
- MVR STO-8: Vehicle design for Marine Survivability and Usability
- FP STO-4: Active protection system for vehicles against rocket propelled grenades (deleted in new S&T plan)

**Advanced Mobility**
- MVR STO-1: Advanced power plants, drive trains, and suspensions
- MVR STO-2: Advanced materials and survivability technologies to enhance the performance and survivability of combat vehicles

**Maneuver Enablers**
- MVR STO-3: Augmented cognition for combat vehicle crews and operators of maneuver systems
- MVR STO-5: Marine performance enhancements
- MVR STO-6/NSW MVR 09-15: Advanced robotic systems for ground combat

**PROJECTS**

- **Survivability**
  - Lightweight Armor Materials (D&I)
  - CSTV Tri-Modal Aluminum (FNC)
  - Advanced Electromagnetic Armor (D&I and E&D)
  - AEMA (EPS) (FNC)
  - Advanced Requirements for Crew Safety (D&I)
  - Advanced Ceramic Composites (Plus-Up)
  - CSTV Shock Mitigating Seats (D&I and E&D)
  - INL Survivability (Plus-Up)
  - Active Protection System for LAV (E&D)

- **Advanced Mobility**
  - Vehicle Stability (D&I)
  - Hybridization and Re-Power (E&D)
  - Military Driving Cycle Assessment (E&D)
  - Integrated Power & Propulsion (E&D)
  - Fuel Efficiency Enabling Technologies w/ TARDEC (E&D)
  - Advanced LAV Suspension System (FNC)
  - Electronic Acceleration Assist and Integral Starter / Generator System (E&D)
  - On-Board Vehicle Power Systems Development (Plus-Up)

- **NECE/NSW STOs**
  - Advanced Interfaces and Ground Controls (D&I)
  - MAGTF Situational Awareness (Plus-Up)
  - Small Unit Mobility Enhancement Technologies (SUMET) (D&I and E&D)
  - Naval Expeditionary Overwatch (NEO)

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- **DEPUTY**
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  - 703.696.2833
  - keith.hammack@navy.mil

- **TDA LEAD**
  - Mr. Greg Doerrer
  - 703.696.5991
  - gregory.doerrer@navy.mil

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**KEY**
- Plus-up
- Other
- FNC
- D&I
- E&D

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* = Transition

**REVISED:** 02JUN09
## Survivability Technology Investment Area Roadmap

### Technology Domain

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<th>Technology Domain</th>
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<td>Armor Materials</td>
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<td>Active / Pulsed Power Protection</td>
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### Armor Materials

- Nano-Aluminum Cryomilling (STTR)
- CSTV Tri-Modal Aluminum (EMW-FY09-04)
- Advanced Ceramic Composites
- INL Survivability
- Lightweight Armor Materials
- APS for LAV
- PM LAV & JLTV
- To 6.3 Integrated Armor Solutions

### Active / Pulsed Power Protection

- Advanced Electromagnetic Armor (AEMA)
- Active RPG Defense (STK-FY05-01)
- Electromagnetic Non-Explosive Reactive Armor
- PM LAV
- PM AAV
- PM MRAP
- Advanced Protection Systems

### Crew Protection

- CSTV Shock Mitigating Seats
- PM LAV
- PM MT
- PM JLTV
- Advanced Requirements for Crew Safety (Joint w/FP)
- To 6.3 Integrated Armor Solutions

### Studies and Trades

- JLTV NATC Whole System Trade Study
- JLTV NATC Tech Demo Vehicle
- TWV Survivability ATO
- Armored Patrol Vehicle
- Survivability Enhancements
- Advanced Blast Mitigation
- Integrated Armor Solutions
To provide tomorrow’s naval expeditionary warfighters with the precise information they need, when they need it, under all conditions with emphasis on small units in complex, hybrid warfare environments.

**RECENT TRANSITIONS**

Conformal Antennas 6.2 (D&I)
- Transitioned to CERDEC

System Integration Environment
- Transitioned to MAGTF C2
- Transitioned to MACCS-X
- Transitioned to MCSC (DARPA DTN)

M2C2 (Plus-up)
- Transitioned to MCSC
- 2d MEB

**OVER-THE-HORIZON COMMUNICATIONS/GATEWAYS**

USMC/NECC/NSW C2 STO-1: Converged services networks with assured, robust communications linking all echelons of the MAGTF

USMC/NECC/NSW C2 STO-2: Multilevel information security and assurance

USMC/NECC/NSW C2 STO-3: Intelligent network monitoring, maintenance, and mobility

USMC/NECC/NSW C2 STO-4: Improved situational awareness for warfighters at all echelons

**NETWORK CENTRIC WARFARE / INTEROPERABILITY**

USMC/NECC/NSW C2 STO-1: Converged services networks with assured, robust communications linking all echelons of the MAGTF

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**TECHNOLOGY INVESTMENT AREA**

**PROJECTS**

Adaptive Networks 6.2 (D&I)

System Integration Environment (E&D)

DTCN EC (FNC)

Agile Coalition Environment and TEMPO (Plus-Up)

Signal Distribution (D&I)

NON-LINE OF SIGHT COMMS Tech (D&I)

FSO COMMS TECH (D&I)

TACTICAL RF SYSTEMS (E&D)

Advanced HF Communications (E&D)

SATCOM OTM Int/Demo (E&D)

Software Reprogrammable Payload (E&D)

Low-Cost SATCOM Antennas (FNC)

MOBILE MODULAR COMMAND & CONTROL-NETWORK MGMT TOOLS (M2C2) (Plus-Up)

Agile Coalition Environment and TEMPO (Plus-Up)

Conformal Antennas 6.2 (D&I)

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MOBILE MODULAR COMMAND & CONTROL-NETWORK MGMT TOOLS (M2C2) (Plus-Up)

Agile Coalition Environment and TEMPO (Plus-Up)
To provide tomorrow's naval expeditionary warfighters with the precise information they need, when they need it, under all conditions with emphasis on small units in complex, hybrid warfare environments.

USMC/NECC/NSW C2 STO-1: Converged services networks with assured, robust communications linking all echelons of the MAGTF
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USMC/NECC/NSW C2 STO-3: Intelligent network monitoring, maintenance, and mobility
USMC/NECC/NSW C2 STO-4: Improved situational awareness for warfighters at all echelons
USMC/NECC/NSW C2 STO-5: Blue Force Tracking/ PLI/ Combat ID*
USMC C2 STO-6/NSW STO-10: Collaborative Planning and Synchronized Execution

* Funding planned in FY11

Jul09v12
Discovers and develops technologies to provide decisive, unrivaled new capabilities for, or to improve the performance of Navy and Marine Corps warfighters in the areas of Fires; with particular focus on Distributed Operations and Asymmetric/Irregular Warfare; to include Naval Expeditionary and other weapons, munitions, fuzes, ballistics, propulsion, weapons systems control and guidance, enhanced accuracy, tailored lethality including non-lethal alternatives, enhanced targeting (to include detection, locating, identification, designation, and tracking), directed energy, and lightweight components; and to avoid technological surprise.

**Fires**

**Technology Investment Areas**

**Recent Transitions**

- **Improved Fire Control System (FNC)**
  - Transitioned to PM Infantry Weapons Systems

- **Lightweight Mortar System (FNC)**
  - Transitioned to PM Mortars & PM Infantry Weapons Systems

- **Advanced Fires Coordination Technology**
  - Transitioned to PM MAGTF C2

- **Advanced Gun Barrel Technology**
  - Transitioned to PEO-IWS3c

- **MEMS Safe & Arm**
  - Transitioned to PM Ammo

**Projects**

- **Improved Fire Control System (IFCS)**
- **Distributed Operations Precision Engagement (DOPE)**
- **Non-Magnetic Azimuth Sensing (NMAS)**
- **Integrated Day/Night Sight Technology (IDNST)**
- **Micro-Pulse Laser Designation**
- **MEMS Inertial Sensors (UC Irvine)**
- **Flight Controlled Mortar**
- **Precision Engagement Technologies (PET)**

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Discovers and develops technologies to provide decisive, unrivaled new capabilities for, or to improve the performance of Navy and Marine Corps warfighters in the areas of Fires; with particular focus on Distributed Operations and Asymmetric/Irregular Warfare; to include Naval Expeditionary and other weapons, munitions, fuzes, ballistics, propulsion, weapons systems control and guidance, enhanced accuracy, tailored lethality including non-lethal alternatives, enhanced targeting (to include detection, locating, identification, designation, and tracking), directed energy, and lightweight components; and to avoid technological surprise.

**TECHNOLOGY INVESTMENT AREAS**

**PROJECTS**

**ADVANCED AMMUNITION**

USMC Fires STO-4: More capable, lighter weight ammunition across the spectrum of lethality, with increased reliability, range, precision, and safety

USMC Fires STO-5: Improved propellants and energetic materials

USMC Fires STO-6: Increased capabilities and reduced weight of all ground combat weapons systems

**HIGH PERFORMANCE ALLOYS FOR WEAPONS APPLICATIONS**

NSW Fires 09-11: Measured-Effect Munitions

NSW Fires 09-12: Clandestine Structure Penetration

NSW Fires 09-18: Advanced Weapons and Propellant Technologies

**CASELESS AMMUNITION**

**REVOLUTIONARY TARGET EFFECTS**

**TACTICAL URBAN STRIKE WARHEAD (TUSW)**

**1901 A IGNITION SAFETY DEVICE**

**81mm EXTENDED RANGE MORTAR AMMUNITION (ERMA)**

**MEMS MORTAR S&A**
ONR 30 FIRES S&T Roadmap (1 of 2)
ONR 30 FIRES S&T Roadmap (2 of 2)

Technology Investment Area

Advanced Ammunition
- Fuzing
- Warheads
- Flight Controls
- Propulsion
- Advanced Weapons
- Materials

Advanced Ammunition

Fuzing

Warheads

Flight Controls

Propulsion

Advanced Weapons

Materials

ONR 30 FIRES S&T Roadmap (2 of 2)

- MEMS Fuze Safe & Arm
- MEMS Mortar S&A
- 1901 A Initiation Safety Device
- Caseless Ammunition
- Tactical Urban Strike Warhead
- Trajectory Shaped Mortar Munition Studies
- Revolutionary Target Effects
- Precision Urban Mortar Attack
- Flight Controlled Mortar
- 81mm Extended Range Mortar Ammunition
- High Performance Alloys for Weapons Applications

Timeline:
- '06 '07 '08 '09 '10 '11 '12 '13 '14 '15

Legend:
- = Product
- = Transition

Knowledge Product:
- JSSAP LW Small Arms Technologies Program

Programs:
- PM AMMO
- PM AAS
- PM IW
- PM IW & PM FSS

T = Transition
Expeditionary Warfighters that are physically, mentally, emotionally, and cognitively ready to deploy anywhere in the world on short notice, to serve within their team, or take on leadership roles as needed, and to complete their mission efficiently and effectively under any extremes of condition.

**Enhanced Physical Readiness**

Med STO 2: Human Performance Enhancement Capabilities

Med STO 3: Fatigue Management

Med STO 7: Warfighter Physiology

Med STO 8: Physical Readiness Conditioning and Nutrition Monitoring

**Mental Toughness & Cognitive Agility**

T&E STO-2: Learning OPFOR

T&E STO-6: High Fidelity Virtual Environment

T&E STO-8: Non-Kinetic Effects Simulation

T&E STO-9: Squad Immersive Training Environment Enablers

**Technology Investment Areas**

- **Enhanced Physical Readiness**
- **Mental Toughness & Cognitive Agility**

**Recent Transitions**

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- **Framework Diagram**

**Projects**

- Assessment, Development & Validation of PT Regimens (D&I)
- Biomarkers of Heat Stress and Resilience (D&I)
- Enhanced Warfighter Psycho-physical Performance (E&D)
- Physical Conditioning Impacts on Combat Readiness (E&D)
- Increasing Sensitivity of the Human Eye (YIP)
- Simulation Tool for Lightening the Load of Warfighters (STTR)
- Trainable Automated Forces (TAF)(D&I)
- Vehicle Common Adaptive Display (E&D)
- Unmanned Ground Vehicles MMI (Man-Machine Interface) (E&D)
- Real-time Adaptive Training Environment (E&D)
- Closed-Loop Real-Time Neurophysi-Driven Simulation-Based Training System (SBIR)
- Development of Low-cost Augmented Reality Head Mounted Display (STTR)
- Technology for Assessing the Resilience of Training to Stressful Conditions (ONR-Global)

**Key**

- D&I
- E&D
- Cong
- FNC
- other

**RECENT TRANSITIONS**

- **Infantry Immersive Trainer (IIT)**
  - ONR prototype, transitioned directly to MEF

- **Gruntworks Research for Infantry Integration Testing (GRIT)**
  - ONR prototype, transitioned directly to PM Marine Expeditionary Rifle Squad

- **Automatic Performance Evaluation and Lessons Learned (APELL)**
  - ONR prototype, transitioned directly to PM Training System (PM TRASYS)

- **VIDEO FLASHLIGHT (D&I)**
  - Fielded to USMC ranges as Tactical Video Capture System (TVCS)

- **Multi-platform Operational Team Training Immersive Virtual Environment**
  - Transition to:
    - TRASYS DVTE
    - TBS
    - IOC
    - EWS
    - EWTG-LANT and PAC for JTAC sustainment training

- **AAV Turret Trainer**
  - ONR prototype, directly to series production; currently fielded as an USMC training simulator.
Expeditionary Warfighters that are physically, mentally, emotionally, and cognitively ready to deploy anywhere in the world on short notice, to serve within their team, or take on leadership roles as needed, and to complete their mission efficiently and effectively under any extremes of condition.

**Technology Investment Areas**

**Expertise Development**

- **T&E STO-1**: Warfighter Cognition
- **T&E STO-2**: Learning OPFOR
- **T&E STO-3**: Physics Based Library for Battlefield Effects
- **T&E STO-4**: Warrior Training
- **T&E STO-5**: Experiential Learning Technologies and Pedagogy
- **T&E STO-6**: High Fidelity Virtual Environment
- **T&E STO-7**: Automated Performance Assessment
- **T&E STO-8**: Non-Kinetic Effects Simulation
- **T&E STO-9**: Squad Immersive Training Environment Enablers
- **T&E STO-10**: Live Virtual Constructive Training Environment Enablers

**PROJECTS CONTINUED**

- Neuroadaptive Language Training (D&I)
- Mobile Field Technologies for Assessing SA (D&I)
- INSITE (D&I)
- Measuring Performance Using Human Movement Tracks (D&I)
- Neural Control of Actions in Context (D&I)
- Brain Dynamics of Coordinated Teams (D&I)
- Adaptive Perceptual Training (D&I)
- Smart Tutoring System (D&I)
- Perceptually-informed Virtual Environment (STTR)
- Physiological-based Tools for Virtual Environment (STTR)
- Live Fire Virtual Sniper/Counter Sniper Training System (SBIR)
- ImmersSci for Training & Mission Rehearsal (PDB 709)
- MURI: A Multi-scale, Multi-Modal Investigation of Spatial Learning (SBIR)
- IMPACTS (SBIR)
- Mobile Brain Imaging (BRC)
- Objective Live-Training Infantry Performance Metrics for Automated After Action Review (SBIR)
- Integrated System for Language Education Training (FNC)
- Behavioral, Analysis & Synthesis Intelligent Training (FNC)
- Next Generation Expeditionary Warfare Intelligent Train (FNC)
Enhance situational awareness and understanding to enable real time tactical decision making for Distributed Operations and provide proactive and predictive capabilities for Asymmetric and Irregular Warfare.

**Intel STO-2**: Provide quality tactical sensing

**Intel STO-3**: Ensure mission-focused situational awareness in urban environments

**Intel STO-4**: Enhance tag, track, and locate (TTL), biometric, and chemical, biological, radiological, nuclear, and explosive (CBERNE) detection capabilities

**Intel STO-6**: Translate data to combat information at the point of collection

**Intel STO-7**: Provide actionable intelligence to tactical units

**Intel STO-8**: Deny enemy use of communications and networks

**Intel STO-9**: Enhance situational awareness and understanding to enable real time tactical decision making for Distributed Operations and provide proactive and predictive capabilities for Asymmetric and Irregular Warfare.

**Recent Transitions**

- **SIGINT VISUALIZATION (FNC)**
  - Transitioned to MCSC

- **MASINT CORE (FNC)**
  - Transitioned to MCSC

- **EA ANTENNA (FNC)**
  - Transitioned to MCSC

- **TACTICAL LITTORAL SENSING (FNC)**
  - Transitioned to NAVSEA

- **RF Emitter ID AND GEOLOCATION (FNC)**
  - Transitioned to MCSC

- **AUTOMATED PATTERN RECOGNITION (FNC)**
  - Transitioned to MCSC

- **DISTRIBUTED TACTICAL INTEL DATABASE (FNC)**
  - Transitioned to MCSC

- **REMOTE SENSOR FUSION CARD (FNC)**
  - Transitioned to MCSC

**Knowledge Generation**

**Intel STO-1**: Enable smart sensor field planning and management

**Intel STO-4**: Enhance tag, track, and locate (TTL), biometric, and chemical, biological, radiological, nuclear, and explosive (CBERNE) detection capabilities

**Intel STO-5**: Expose enemy networks, and anticipate and influence their behavior

**Intel STO-7**: Provide actionable intelligence to tactical units

**Technology Investment Area**

- **ISR - C2 (ACTIONABLE INTELLIGENCE)**
  - Intel STO-3: Ensure mission-focused situational awareness in urban environments
  - Intel STO-7: Provide actionable intelligence to tactical units
  - Intel STO-8: Deny enemy use of communications and networks

- **BIOMETRICS**
  - Intel STO-3: Ensure mission-focused situational awareness in urban environments
  - Intel STO-4: Enhance tag, track, and locate (TTL), biometric, and chemical, biological, radiological, nuclear, and explosive (CBERNE) detection capabilities

- **TAG, TRACK, AND LOCATE (TTL)**
  - Intel STO-4: Enhance tag, track, and locate (TTL), biometric, and chemical, biological, radiological, nuclear, and explosive (CBERNE) detection capabilities
  - Intel STO-7: Provide actionable intelligence to tactical units
Enhance situational awareness and understanding to enable real time tactical decision making for Distributed Operations and provide proactive and predictive capabilities for Asymmetric and Irregular Warfare.

**Intel STO-2:** Provide quality tactical sensing

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**Recent Transitions**

- **SIGINT VISUALIZATION (FNC)**
  Transitioned to MCSC

- **MASINT CORE (FNC)**
  Transitioned to MCSC

- **EA ANTENNA (FNC)**
  Transitioned to MCSC

- **TACTICAL LITTORAL SENSING (FNC)**
  Transitioned to NAVSEA

- **RF EMITTER ID AND GEOLOCATION (FNC)**
  Transitioned to NAVSEA

- **AUTOMATED PATTERN RECOGNITION (FNC)**
  Transitioned to MCSC

- **DISTRIBUTED TACTICAL INTEL DATABASE (FNC)**
  Transitioned to MCSC

- **REMOTE SENSOR FUSION CARD (FNC)**
  Transitioned to MCSC

**Recent Transitions**

- **TYPE 3 WITNESS MATERIALS (6.1)**

- **NANO TECHNOLOGY ENABLED SENSOR FIELDS (D&I)**

- **TAG, TRACK AND LOCATE TECHNOLOGIES (D&I)**

- **SMART DISTRIBUTED SENSOR FIELDS (6.1)**

- **AGILE TACTICAL SENSOR NET (E&D)**

- **IDENTITY DOMINANCE ENABLED BY INTEGRATED BIOMETRIC / TTL CAPABILITY (E&D)**

- **SENSORS FOR AUDIO SURVEILLANCE (E&D)**

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Enhance situational awareness and understanding to enable real time tactical decision making for Distributed Operations and provide proactive and predictive capabilities for Asymmetric and Irregular Warfare.

**Intel STO 1**: Enable smart sensor field planning and management

**Intel STO-4**: Enhance tag, track, and locate (TTL), biometric, and chemical, biological, radiological, nuclear, and explosive (CBERNE) detection capabilities

**Intel STO-5**: Expose enemy networks, and anticipate and influence their behavior

**Intel STO-7**: Provide actionable intelligence to tactical units
INTELLIGENCE, SURVEILLANCE & RECONNAISSANCE

Enhance situational awareness and understanding to enable real time tactical decision making for Distributed Operations and provide proactive and predictive capabilities for Asymmetric and Irregular Warfare.

Intel STO-3: Ensure mission-focused situational awareness in urban environments

Intel STO-7: Provide actionable intelligence to tactical units

Intel STO-8: Deny enemy use of communications and networks

TECHNOLOGY INVESTMENT AREA

ISR - C2 (ACTIONABLE INTELLIGENCE)

- ADVANCED TACTICAL SENSOR TECH (D&I)
- TACTICAL NET & DCGS INTEGRATION (LTSN)
- HUMAN TO SENSOR FIELD INTERFACE (SMART DATA PULL) (LTSN)
- WARFIGHTER AS A SENSOR (E&D)
- OA PROOF OF CONCEPT DEMONSTRATIONS (E&D)
- OA ENTERPRISE SERVICES

PROJECT

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RECENT TRANSITIONS
SIGINT VISUALIZATION (FNC)
Transitioned to MCSC

MASINT CORE (FNC)
Transitioned to MCSC

EA ANTENNA (FNC)
Transitioned to MCSC

TACTICAL LITTORAL SENSING (FNC)
Transitioned to NAVSEA

RF Emitter ID and GEOLOCATION (FNC)
Transitioned to MCSC

AUTOMATED PATTERN RECOGNITION (FNC)
Transitioned to MCSC

DISTRIBUTED TACTICAL INTEL DATABASE (FNC)
Transitioned to MCSC

REMOTE SENSOR FUSION CARD (FNC)
Transitioned to MCSC

KEY
D&I  E&D  FNC  Other  Cong
Enhance situational awareness and understanding to enable real-time tactical decision making for Distributed Operations and provide proactive and predictive capabilities for Asymmetric and Irregular Warfare.

**Intel STO-3:** Ensure mission-focused situational awareness in urban environments

**Intel STO-4:** Enhance tag, track, and locate (TTL), biometric, and chemical, biological, radiological, nuclear, and explosive (CBERNE) detection capabilities

**Intel STO-4:** Enhance tag, track, and locate (TTL), biometric, and chemical, biological, radiological, nuclear, and explosive (CBERNE) detection capabilities

**Intel STO-7:** Provide actionable intelligence to tactical units

**TAG, TRACK, AND LOCATE (TTL)**

**PROJECT**

- **ISOLATING AND LOCATING SPEAKERS IN CLUTTER (STTR Phase II)**
- **SMART ALGORITHMS FOR TACTICAL SENSORS (LTSN)**
- **AGILE SENSORS (GWOT TPS)**
- **AUTOMATED CLASSIFICATION USING SOFT BIOMETRICS (SBIR Phase II)**
- **Tracking w Hard and Soft Biometrics**
- **TAG, TRACK AND LOCATE TECHNOLOGIES (D&I)**
- **TAG, TRACK AND LOCATE DEMONSTRATIONS (E&D)**
- **DEGRADE TAGGANTS (SBIR Phase II)**
- **BINARY MULTI-STATE OPTICAL TAGGANT (STTR Phase II)**
- **Deployment Technologies**
- **Contextual Meaning of Presence**
- **TTL to Network Analysis**
- **Contextual Meaning of Presence**
ISR S&T Road Map

WITH ENDING PROGRAMS

Technology Investment Area

PERSISTENT INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR)

Advanced Sensors & Signal Processing

Networked Sensor Fields

- Yeast Based Detection
- Semiconductor Nanocrystal Synthesis
- Novel Concepts in Molecular Recognition
- Novel IR Nanophosphores
- ZnO Based Nanophosphores for TTL
- TTL Technologies (D&I)
- TTL Demonstrations (E&D)
- Identity Dominance Enabled by Bio/TTL Capability (E&D)
- Automated Entity Classification w/ Soft Biometrics (SBIR)
- Adv Optics Hyper Spectral Sensor (SBIR)
- TTL (GWOT TPS)
- Binary Multi-StateTaggant (STTR)
- Zeolite Thin films & Nanoparticles (YIP)
- Degrade Taggant (SBIR)
- Materials for Sensing (6.1)
- Adv Tactical Sensor Tech (D&I)
- Craft Integrated Electronics Suite (Cong)
- Autonomous Control of K-9 (YIP CORE $)
- Agile Sensors (GWOT TPS)
- Detect and ID Facilities (TUS)
- RF Modeling of Composite Building Material (SBIR)
- Sensing Through Walls (TUS)
- Networked Sensing Systems (6.1)
- Smart Distributed Sensor Fields (6.1)
- Automated Tactical Platform & Sensor Planning and Management (LTSN)
- Smart Algorithms for Tactical Sensors (LTSN)
- Service Oriented Sensor Network (LTSN)
- Communications Enhancement for Tactical Sensors (GWOT TPS)
## ISR S&T Road Map

**Technology Investment Area**

**PERSISTENT INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR)**

### Advanced Sensors & Signal Processing

- **Type 3 Witness Materials (6.1)**
- **Nanotechnology Enabled Sensors (D&I)**
- **TTL Technologies (D&I)**
- **TTL Demonstrations (E&D)**
- **Identity Dominance Enabled by Bio/TTL Capability (E&D)**
- **Automated Entity Classification w/ Soft Biometrics (SBIR)**
- **Adv Optics Hyper Spectral Sensors (SBIR)**
- **TTL (GWOT TPS)**
- **Binary Multi-StateTaggant (STTR)**
- **Zeoite Thin films & Nanoparticles (YIP)**
- **Degrade Taggant (SBIR)**
- **Materials for Sensing (6.1)**
- **Advanced Tactical Sensor Tech (D&I)**
- **Craft Integrated Electronics Suite (Cong)**
- **Agile Sensors (GWOT TPS)**
- **Detect and ID Facilities (TUS)**
- **RF Modeling of Composite Building Material (SBIR)**
- **Sensing Through Walls (TUS)**
- **Distributed Wireless Image Sensing (6.1)**
- **Smart Distributed Sensor Fields (6.1)**
- **Automated Tactical Platform & Sensor Planning and Management (LTSN)**
- **Smart Algorithms for Tactical Sensors (LTSN)**
- **Service Oriented Sensor Network (LTSN)**
- **Communications Enhancement for Tactical Sensors (GWOT TPS)**

### Networked Sensor Fields

**KEY**

- *D&I*
- *E&D*
- *FNC*
- *Other*
- *Cong*
ISR S&T Road Map (cont)

Technology Investment Area

ISR - C2 (ACTIONABLE INTELLIGENCE)

Warfighter as a Sensor

Automated Indications & Warnings & Knowledge Subscription

OA FNC Enablers (E&D) (31)

OA Enterprise Services (AIEPS)

OA Proof of Concept Demonstrations (E&D)

Advanced Tactical Sensor Tech (D&I)

Warfighter as a Sensor (E&D)

DCGS Data Backbone

Tactical Net and DCGS Integration (LTSN)

Core Enterprise Services

OA Enterprise Services (AIEPS)

Human to Sensor Interface (LTSN)

KEY

D&I  E&D  FNC  Other  Cong

50
ISR S&T Road Map (cont)

Technology Investment Area

BIOMETRICS

Feature Identification

Smart Algorithms for Tactical Sensor Nets (LTSN)
Identity Dominance Enabled by Bio/TTL Capability (E&D)
Speakers in Clutter (STTR)
Automated Entity Classification w/Soft Biometrics (SBIR)
Agile Sensors (GWOT TPS)
Marines of the future will benefit from a precisely tailored level of logistic sustainment from seabased platforms to rapidly maneuvering forces ashore. Logistic planning, delivery and recovery systems of the future will be more responsive and flexible, enabling Marines to out-pace rapidly changing operational scenarios. Likewise, delivered logistic commodities will provide more operational value per unit weight, enhancing combat unit self sufficiency and maneuverability. Finally, operational units will benefit from technologies that maximize equipment readiness by minimizing both down-time and maintenance requirements.

**Recent Transitions**

**Info-Sensors for Vehicle Health Reporting**
Transitional from Core funding to Sense and Respond Logistics EC

**Harvesting Power from Walking**
Small business formed to market power harvesting backpack invention from ONR Basic Research

**POET Seabased Logistic Transport Model**
MCDC personnel trained to use simulation tool.

**Operational Self-Sufficiency**

**USMC Log STO-4:** Enhanced Self-Sufficiency for Fuel
**USMC Log STO-5:** Enhanced Self-Sufficiency for Water
**USMC Log STO-6:** Enhanced Self-Sufficiency for Electric Power

**ASSET VISIBILITY**

**USMC Log STO-1:** Logistic Commodity inventory/Tracking

**LOGISTICS TRANSPORT**

**USMC Log STO-2:** Air Cargo Delivery
**USMC Log STO-3:** Dismounted Transport

**Possible Start in FY 2011**

- **Mono Tiltrotor Flight Dynamics & Controls**
- **Seabased Small Payload Delivery System**
- **Emergency Air Cargo Delivery**
- **CQ-10 "B" Cargo UAV System**
- **Alt. Human Load Carrying Concepts**
- **Portable Fuel Analysis Tech.**
- **Dual Stage Water Purification**
- **Small Scale Fluid Particle Separator**
- **Double Layer Properties for CDI Systems**
- **Direct JP-8 Advanced Cell Dev.**
- **Lightweight Elec. Energy for Dismounted ...**
- **High Perf. Ceramic Anodes for SOFC**
- **High Energy Electrochemical Capacitor**
- **Carbon Nanofoam Cathode for Metal-Air Batteries**
- **Mediator-Enhanced Poly. Electrolyte Supercapacitor**
- **Pseudocapacitor Based on NIO Nanostructures**
- **Lightwt. Multi-Fuel Thermoelectric Battery Charger**
- **Personal Power Network**
- **Harvesting Power from Walking**
- **High Power Zinc-Air Battery**
- **Integrating "POWERSAGE" into a C4I Device**
- **Hybrid Capacitor Supercell**
Marines of the future will benefit from a precisely tailored level of logistic sustainment from seabased platforms to rapidly maneuvering forces ashore. Logistic planning, delivery and recovery systems of the future will be more responsive and flexible, enabling Marines to out-pace rapidly changing operational scenarios. Likewise, delivered logistic commodities will provide more operational value per unit weight, enhancing combat unit self sufficiency and maneuverability. Finally, operational units will benefit from technologies that maximize equipment readiness by minimizing both down-time and maintenance requirements.

### KEY

<table>
<thead>
<tr>
<th>FNC-EC</th>
<th>Plus-up</th>
<th>OTHER</th>
<th>D&amp;I</th>
<th>E&amp;D</th>
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### LOGISTICS

Marines of the future will benefit from a precisely tailored level of logistic sustainment from seabased platforms to rapidly maneuvering forces ashore. Logistic planning, delivery and recovery systems of the future will be more responsive and flexible, enabling Marines to out-pace rapidly changing operational scenarios. Likewise, delivered logistic commodities will provide more operational value per unit weight, enhancing combat unit self sufficiency and maneuverability. Finally, operational units will benefit from technologies that maximize equipment readiness by minimizing both down-time and maintenance requirements.

### MAINTENANCE REDUCTION

USMC Log STO-7: Materials for Reduced Maintenance

### TEMPORARY INFRASTRUCTURE

USMC Log STO-8: Temporary Mobile Infrastructure

### CASUALTY EVACUATION

USMC Log STO-9: Improved Life Support for Casualties at Point of Injury through Evacuation

### SELF LUBRICATING COATINGS/ALLOYS

### POLYFIBROBLAST SELF-HEALING COATING

### MULTIFUNCTIONAL SMART COATING STACK-UP

### SELF LUBRICATING COATINGS/ALLOYS

### ALL ORGANIC CORROSION RESISTANT PRIMERS

### ADV. IN-FIELD MFG OF MOD. COMP. BRIDGES

### COMPOSITE JOINT ASSAULT BRIDGE TECH DEMO

### ONR Code 34 investment only
Asset Visibility
Technology Investment Area

TIA: Asset Visibility

USMC STO 1: Logistic Commodity Inventory/Tracking

SAW & Chipless RFID

Hierarchical Active & Passive RFID

Autonomous Container Inventory

= Technology Readiness Level
## Logistics Transport Technology Investment Area

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<tr>
<td>USMC STO-2: Air Cargo Delivery</td>
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<td>USMC STO-3: Dismounted Transport</td>
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- **POET Seabased Log Simulation 6.3)**: 6
- **CQ 10"B" (Autogyro)**: 5
- **Emergency Air Cargo Delivery**: 7
- **Seabased Small Payload Sys**: 7
- **Mono Tiltrotor**: 5
- **Deep Sustainment UAS (Innovative Naval Prototype)**: 7
- **Alternative Human Load Carrying Concepts (6.3)**: 3

= Technology Readiness Level
Operational Self-Sufficiency
Technology Investment Area

<table>
<thead>
<tr>
<th>TIA: Operational Self Sufficiency</th>
<th>’08</th>
<th>’09</th>
<th>’10</th>
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<tbody>
<tr>
<td>USMC STO 4: Enhanced self sufficiency for fuel</td>
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<td>Chlorine Resistant Membranes</td>
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<td>Small Scale Fluid Particle Separator</td>
<td>7</td>
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<td>Portable Fuel Analysis (6.3)</td>
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<td>EUWP (Plus-up)</td>
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| USMC STO 5: Enhanced self sufficiency for water | | | | | | | | |
| Dual Stage Water Purifier (Plus-up) | 5 | | | | | | | |
| High Performance Ceramic | 3 | | | | | | | |
| Anodes for SOFC (6.1) | 2 | | | | | | | |
| Direct JP-8 Advanced Cell Dev. (6.2) | 2 | | | | | | | |
| Water Purification Research (6.1 & 6.2) | 7 | | | | | | | |
| Electrochemical Capacitor Research (6.1 & Assorted 6.2) | 2 | | | | | | | |
| Light-weight Multi-fuel Thermoelectric Battery Charger (6.3) | 4 | | | | | | | |
| Advanced Fuel to Electric Conversion (6.2) | 2 | | | | | | | |

| USMC STO 6: Enhanced self sufficiency for electric energy | | | | | | | | |
| High Power Zinc-Air Batteries (Plus-up) | 3 | | | | | | | |
| Personal Power Network (6.2) | 2 | | | | | | | |
| High Performance Ceramic | 3 | | | | | | | |
| Applied Research for Advanced Metal-Air Batteries (6.2) | 2 | | | | | | | |
| Electrochemical Capacitor Research | 2 | | | | | | | |
| Advanced Fuel to Electric Conversion (6.3) | 4 | | | | | | | |
| Advanced Fuel to Electric Conversion (6.2) | 2 | | | | | | | |
| Hybrid Capacitor Super Cell (Plus-up) | 7 | | | | | | | |
| "Powersage" Integration (Plus-up) | 7 | | | | | | | |
| Squad Power Network | 7 | | | | | | | |
| "Lighten the Load EC Product" |  | | | | | | | |

3 = Technology Readiness Level
<table>
<thead>
<tr>
<th>TIA: Maintenance Reduction</th>
<th>'08</th>
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<tr>
<td>USMC STO-7: Materials for reduced maintenance</td>
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**USMC Equipment Maintenance Study**
- Self Lubricating Coatings (D&I)
- Materials for Prevention of Wear (D&I)
- Smart Coating Stack-up (D&I)
- Polyfibroblast Coating (D&I)
- All Organic Corrosion Resistant Primers (D&I)

**Materials for Prevention of Wear (E&D)**
- Polyfibroblast Coating (D&I)

**Materials for Prevention of Corrosion (E&D)**

= Technology Readiness Level
Temporary Infrastructure Technology Investment Area

TIA: Temporary Infrastructure

USMC STO 1: Temporary Mobile Infrastructure

- Composite Joint Assault Bridge (6.3) - Technology Readiness Level 5
- Modular Composite Structures (6.3) - Technology Readiness Level 7
- Advanced Concepts for Mobile Infrastructure (6.3) - Technology Readiness Level 5

= Technology Readiness Level
Casualty Evacuation
Technology Investment Area

TIA: Casualty Evacuation

USMC STO 9: Improve life-support for casualties at point of injury through evacuation

‘08 ‘09 ‘10 ‘11 ‘12 ‘13 ‘14 ‘15

Mod & Sim for CASEVAC UAV (Study)

= Technology Readiness Level