18th Annual SO/LIC Symposium
“Warfare in the Seams: Defense and Industry Partnering in the Long War”

Presented by
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26 February 2007
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.”
Office of Naval Research (ONR) Science and Technology Program

- $2.2 billion budget (of which $600-800M are pre-assigned congressional plus-ups)
- ONR has three primary investment thrusts:
  - **Discovery and Invention** (Basic and applied research) (6.1 & 6.2)
  - **Future Naval Capabilities** (Advanced Technology Demonstrations that are near term programs close to transition to an acquisition program of record) (6.2 & 6.3)
  - **Innovative Naval Prototypes** (high risk, high profile programs that potentially would be ready to transition in 4-8 years) (6.2 & 6.3)
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 preservation of national security…”

Expeditionary Maneuver Warfare and Combating Terrorism (Code 30)
To lead the Department of the Navy’s Science and Technology efforts that develop future combat capabilities for Naval Expeditionary Maneuver Warfare and the Department’s role in Combating Terrorism:

…the exploitation and subsequent application of Science and Technology in order to enhance the ability of the Navy-Marine Corps team to achieve assured access and conduct decisive operations as the naval portion of a joint campaign.

Investment Thrust Areas:

<table>
<thead>
<tr>
<th>C4</th>
<th>Logistics</th>
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<tbody>
<tr>
<td>Fires</td>
<td>Manuever</td>
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<tr>
<td>Force Protection</td>
<td>Mine Countermeasures</td>
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<tr>
<td>Human Performance</td>
<td>Maritime Irregular Warfare</td>
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</table>
A Concept → Capability Futures → Gaps → Requirements

B Capability Futures → Gaps → Requirements → Technology

C Requirements → Technology → R&D/ Production → Capability

Vision

Capability Areas

S&T Strategy – Enterprise/MCCDC/ CNR

Research Areas

Research Subareas

Thruts

Projects

OPNAV/ HQMC

Enterprises

Combat Developer

MCCDC/OPNAV/CFFC

Materiel Developer

SYSCOMs/PEOs

Technology Developer (S&T)

ONR

Plan & Execute Technology Discovery, Invention, and Exploitation Programs. Collaborate with Services, Agencies, Industry and Academia

Plan & Execute Technology Discovery, Invention, and Exploitation Programs. Collaborate with Services, Agencies, Industry and Academia

Capabilities Futures

Concepts to Requirements

S&T Objectives (STOs)

Modernization

Resources

R&D

Procurement

Fielding

O & S
11 Sep 2001: US engaged in Global War on Terror

Sep 2005: ONR Code 30 created, and assigned CbT mission
- Initiated an Executive Leadership Team (ELT) (Department Heads and Directors) and Working Group (Deputies) to review, analyze, and develop recommendations for a coordinated and integrated ONR-wide CbT S&T program
- Conducted coordination meetings with DHS, NECC, USCG, and USMC Distributed Operations representatives to develop appropriate reliance, relevance and ultimately transition

April 2006: ONR CbT Taxonomy approved and CbT portfolio analysis completed

August 2006: Began development of a coordinated and integrated ONR CbT S&T investment strategy
**National & Naval GWOT Strategy/Analysis**

**Strategic Guidance**

**Key Goals**
- Strengthen Alliances to Defeat Global Terrorism and Work to Prevent Attacks Against Us and Our Friends
- Work with others to Defuse Regional Conflicts
- Prevent Our Enemies from Threatening Us, Our Allies, and Our Friends with Weapons of Mass Destruction
- Transform America’s National Security Institutions to Meet the Challenges and Opportunities of the 21st Century

**ONR CbT Capability Areas**
- Global Maritime Domain Awareness
- Operational Adaptation
- Maritime Irregular Warfare

**Naval Guidance**
- NSP
- NOC
- USMC OpCon

**Other Guidance**
- QDR
- FM 3-24 COIN

**External Coordination**
CbT Capability Areas & Enabling Capabilities

**Global Maritime Domain Awareness**
- All Source Collection
- Intelligence & Information Analysis & Fusion
- Netcentric Dissemination
- Persistent, Pervasive, Affordable Surveillance
- Tag, Track, and Locate

**Operational Adaptation**
- Warfighting Decision Superiority
- Commander's Preparation of the Environment
- Information Operations and Related Capabilities
- Battlespace Shaping
- Operational Culture Understanding & Communication
- Mission Gaming and Rehearsal
- Adaptive Thinking and Leader Development

**Maritime Irregular Warfare**
- Ship Disabling Non-Lethal Systems
- Enhanced Maritime Interception Operations
- Expeditionary Security
- Biometrics
- Real-time Forensic Site Exploitation
- Logistics for Distributed Forces
- Extended Small-unit ISR
- Extended Small-unit Engagement
- Enhanced Individual and Small-unit Mobility
- CBRN Defense
- Tactical Comm in Complex Environments

**Counter IED**
- IED Prediction
- IED Prevention
- IED and Mine Detection
- IED and Mine Neutralization
- IED and Mine Effects Mitigation
- Technical and Forensic Exploitation
Asymmetric and Irregular Warfare
(Combating Terrorism)

**Vision:** Enable Naval forces to preempt and defeat adaptive non-conventional threats operating within complex physical and social terrain.

**Objectives**

**ISR:**
- **Unmanned Vehicles:** Intelligent autonomous unmanned vehicles, sensors, and communications
- **Interior/Exterior Imaging:** Rapidly reconstruct and fuse multi-aspect sensor data into 3-D tactical models of building interiors and exteriors
- **Riverine Surveillance:** Common and persistent maritime picture on and below the surface/shore

**Intelligence Analysis:**
- Image and Pattern recognition tools
- Societal, cultural, and behavioral modeling
- Biometrics

**Active and Passive Forensics Tools:**
- Field-portable forensic tools, sensors, and sensor networks; as well as spectrally-coded particulate markers and probes

**Advanced Countermeasures:**
- Dominate EM spectrum
- Predict, detect and neutralize IED’s and P-IED’s
- Deny adversaries the ability to hide among civilian population
- Phase 0 S&T

**Key Research Topics**
- Unmanned Undersea Vehicle Technologies
- Unmanned Air and Ground Vehicles
- Intelligent and Autonomous Systems
- Automated Image Understanding
- Information Processing & Presentation
- Social, Cultural & Behavioral Modeling
- Biometrics
- Nanoscale Electronic Devices and Sensors
- EW Attack
- Counter IED
- Non-Lethal weapons
Irregular Warfare--Defined

“Irregular warfare is a form of warfare that has as its objective the credibility and/or legitimacy of the relevant political authority with the goal of undermining or supporting that authority. Irregular warfare factors indirect approaches, though it may employ the full range of military and other capabilities to seek asymmetric advantages, in order to erode an adversary’s power, influence and will.” (Irregular Warfare Roadmap - QDR)

Detecting and Effecting anonymous irregular threats dispersed throughout the human landscape…”irregular”

versus

Finding and Destroying distinctive conventional formations concentrated on the physical landscape…”traditional”
## Traditional Warfare vs. Irregular Warfare

<table>
<thead>
<tr>
<th></th>
<th>Traditional Warfare</th>
<th>Irregular Warfare</th>
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<tbody>
<tr>
<td>1</td>
<td>The center of gravity is often the adversary’s military forces and political leadership</td>
<td>The center of gravity is usually the indigenous population</td>
</tr>
<tr>
<td>2</td>
<td>Influencing the physical terrain is key.</td>
<td>Influencing the social &amp; cultural terrain is key</td>
</tr>
<tr>
<td>3</td>
<td>Conducted by regular forces of nation states that are separate and distinct from the civilian population</td>
<td>Often conducted by irregular forces of state or non-state networks that are embedded (not distinct) from the civilian population</td>
</tr>
<tr>
<td>4</td>
<td><strong>Focused kinetic effects -- Physical</strong></td>
<td><strong>Distributed non-kinetic effects -- Psychological</strong></td>
</tr>
<tr>
<td>5</td>
<td>Symmetrical – less opportunity to adapt forces and material</td>
<td>Asymmetrical – more opportunity to adapt forces and material</td>
</tr>
<tr>
<td>6</td>
<td>Focus on the kinetic destruction of the adversaries warfighting material from stand-off distances</td>
<td>Focus on the non-kinetic influence of local and regional populations requiring face-to-face interaction.</td>
</tr>
<tr>
<td>7</td>
<td><strong>Tactical competence</strong> is critical</td>
<td><strong>Cultural and tactical competence</strong> is critical</td>
</tr>
<tr>
<td>8</td>
<td>Threat forces and relationships easily templated</td>
<td>Threat forces and relationships difficult to template</td>
</tr>
<tr>
<td>9</td>
<td><strong>d i M e</strong> (Diplomatic, Information, Military, &amp; Economic with emphasis on the Military)</td>
<td><strong>D I m E – High interagency</strong> (Emphasis on Diplomatic, Information, and Economic)</td>
</tr>
<tr>
<td>10</td>
<td><strong>Metrics of success are easily defined</strong></td>
<td><strong>Metrics of success are not easily defined</strong></td>
</tr>
<tr>
<td>11</td>
<td>Proven technological advantage</td>
<td>Advanced technology advantage remains unproven as benefactor to irregular warfare</td>
</tr>
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Operational Adaptation (OA): “The Information Warfare Game Changer”
Operational Adaptation

**Definition:** (OA) The development and sustainment of a tempo of operations and a rhythm of adaptation and decision superiority that is beyond an adversary’s ability.

*******
Previous Studies Have Pointed Toward The Need For “Operational Adaptation”

• June 2001 Institute for Defense Analysis study: “New Perspectives on Effects-Based Operations”

• Key attributes of Effects Based Operations:
  – Focus on decision superiority (not just precision engagement or targeting)
  – Applicable in peace and war
  – Look beyond the direct, immediate first-order effects
  – Adaptation at the operational level occurs in a disciplined process
  – Include all elements of national power (economic, political, etc)

• Game Changer
  – “Victory is gained through a tempo or rhythm of adaptation that is beyond the other side’s ability to achieve or sustain.” FM 3-24
Current Situation...The Adaptation Dance

- Domestic
- Proaction
- Reaction
- Domination

Adaptation
Forewarning (% of Objective)
(Proactivity to Dominate the Enemy OODA Loop)

Time to Adapt

- Friendly adaptation
- Threat adaptation
Anticipation of enemy adaptations minimizes the effect of these adaptations on our ability to achieve objective forewarning.

**Forewarning Objectives:**
- Tactical – Hours
- Operational – Days
- Strategic – Weeks

**Objective Effects of Operational Adaptation…**

- **Domination**
- **Proaction**
- **Reaction**
- **Dominated**

**Time to Adapt**

- Friendly adaptation
- Threat adaptation

**Threat adapts or dies…**

Anticipation of enemy adaptations minimizes the effect of these adaptations on our ability to achieve objective forewarning.
The Observe, Orient, Decide, Act (OODA) Loop provides a standard description of decision making cycles that is widely understood and accepted throughout the U.S. military. It was developed by Colonel John (Richard) Boyd (January 23, 1927–March 9, 1997) who was a United States Air Force fighter pilot and military strategist of the late 20th century whose theories have been highly influential in the military and in business.

Four Activity Components

1. Observe – collect, store, and access raw (but relevant) data and information related to one’s environment, situation, objective, opposition, etc. This activity includes observation of the effects of one’s own actions or inactions.

2. Orient – analyze the results of one’s observation activities in order to achieve understanding of the situation or in order to uncover gaps in one’s observations.

3. Decide – incorporate one’s understanding of the situation to develop appropriate courses of action (COAs), analyze competing COAs, predict 2nd- and 3rd-order effects, and select the combination of actions (and inactions) that will achieve the most favorable effect(s). This activity may uncover additional gaps in one’s observation and orientation activities.

4. Act – execute the actions selected during the previous activity.
The OODA Loop (Boyd Cycle)

The Observe, Orient, Decide, Act (OODA) Loop provides a standard description of decision making cycles that is widely understood and accepted throughout the U.S. military.

OBSERVE

ORIENT

ACT

DECIDE

Feedback

Domination of all domains

Dominated

Reactive

Proactive
Proposed S&T Plan: Road to Operational Adaptation

Technology Effectiveness Spectrum

Conventional Threats .......................................................... Irregular Threats

- Domain of Existing US Military Technology Portfolio
- Nation States
  - Material Warfare
  - Traditional Formations

- FY09
  - Demo #1: Physical Indicators & Anomalies (Code 31 lead)

- FY13
  - Demo #4
  - Demo #5
  - Irregular Networks: Influence Operations
  - Individuals

- Phase I: Cultural & Behavioral Anomalies; Threat Stimulation & Manipulation; Tag, Track, & Locate
- Phase II: Reveal network organizations
- Phase III: Demos build upon each other

- 5 Demos
- 3 Phases
Demo 1 – Phase 2: Affordable Persistent Pervasive Surveillance
(Wide Areas up to 200 nm² - Open Ocean, Littoral, Rivers & Urban)

Methodology:
- Stealthy, long range, and high endurance UAVs for “eyes in the sky” - deployable from ocean and remote locations
- Inexpensive, low power consumption surveillance payloads
- Panoramic, wide-aperture optical sensors with 3-D imaging
- Data processing for minimization of transmitted data using physical indicators and anomalies
- Low bandwidth, over the horizon datalinks
Demo 2: Near Real-Time Forensics and Social Network Mapping

(Attack forensics and potential forewarning of seconds prior to attack)

Global Intel Sources

Timeline

Attack Occurs

Attack Analyzed Using Database Info

Methodology:
- All-source intelligence fusion;
- Social network mapping;
- Persistent, pervasive surveillance;
- Multi-spectral collection and analysis;
- Automated tracking of entities

- Analysis Algorithms Define Network(s) in Near Real-Time Using Surveillance, Intel & Attack Info
- Enemy Network Rapidly Identified

Consumer

100% of Program Objective
Information Operations are the integrated employment of electronic warfare (EW), computer network operations (CNO), psychological operations (PSYOP), military deception (MILDEC), and operations security (OPSEC), in concert with specified supporting and related capabilities, to influence, disrupt, corrupt or usurp adversarial human and automated decision making while protecting our own.

**Technology Focus on the Information Environment**

**Disrupt** ➔ **Stimulate** ➔ **Influence** ➔ **Manipulate**

**Pre-OA** ➔ **OA**
Distributed Operations (DO)

“Maneuver Warfare is the shift from quantitative characteristics of warfare – mass and volume – to qualitative factors of speed, stealth, precision, and sustainability”

“Distributed Operations constitutes a form of Maneuver Warfare. The essence of this concept lies in the capacity for coordinated action by highly capable units, dispersed throughout the breadth and depth of the battlespace, ordered and connected within an operational design focused on a common aim.”
**Vision:** Enable dispersed small units to dominate extended battlespace through advanced warfighter training, unambiguous situational awareness, robust communications and sense and respond logistics.

**Objectives**

**Training**
- Enhancement of Physical and Cognitive Performance
- Simulation – based scenarios for enhanced training
- Rapid assimilation of cultural environments

**Communications**
- Robust Command and Control networks
- Airborne relays on manned and unmanned platforms

**Logistics**
- Rapid re-supply and medical evacuation whenever possible
- Real–time automatic supply sensors and network
- Optimize medical self-sufficiency

**Fires**
- Integrate firepower of distributed ground, offshore, and air assets
- Blue Force Tracking down to the individual

**Survivability**
- Warfighter stealth technology
- Warfighter exoskeleton technology

**Maneuver**
- Adaptable and survivable tactical mobility systems to enhance operational tempo and extend range of vehicles and soldiers
- Advanced materials to reduce combat load

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**Key Research Topics**

Training, Education & Human Performance
- Expeditionary C4
- Communications and Networks
- Expeditionary Logistics
- Expeditionary Firepower
- Precision Strike
- Expeditionary ISR
- Unmanned Air and Ground Vehicles
- Special Warfare / EOD
- Land Mine Countermeasures
- Expeditionary Maneuver/ Individual Mobility
Decreasing the Marine’s Load

Yesterday’s & Today’s Marine – Overloaded!

1960s

No Change

Today

Treat the Marine as a system – Focus on the entire individual

~Make smart tradeoffs between performance & weight~

Improvements in:

- Combat Load
- Ergonomics
- Nutrition
- Physiologic Performance (Endurance, Strength)
- Fatigue Management
- Protection

Tomorrow’s Marine: Optimized for Combat Endurance

Equals improvements in a Marine’s load-bearing capability
Human Performance, Training & Education (HPT&E) 6.2 Investment

**TECHNICAL APPROACH:**
- Operational metric assessment, ID baseline performance level, scenario design & validation study
- Develop foundational learning theories extended to complex tasks for a range of expertise levels, training mitigation strategies triggered by neurophysiological markers of learning, cognition & expertise, & principles of expertise development on a continuum of novice to expert
- Develop training mitigation strategies triggered by behavioral and neurophysiological markers of learning, cognition and expertise
- Design and develop principles of expertise development on a continuum of novice to expert learning framework for both individual and team training
- Build task-specific models of expertise development in dismounted and mounted task environments; Develop simulation based automated diagnostic assessment of Knowledge, Skills, Abilities & Potentials (KSA&Ps) to drive HPT&E systems

**OBJECTIVE:**
- Optimize individual & team performance using a range of solutions, scaleable across all leadership levels & echelons in complex combat environments (e.g., DO).
- Provide fundamental KSAs for a complete Warfighter in any combat situation via methods that generate & maintain combat effectiveness (e.g., basic skills acquisition, consolidation in scenario-based training, situation-targeted education)
- Continual assessment and diagnosis of individual and team capabilities and potentials
- Develop physically realistic models for combat performance simulation & evaluation
- Delineate neural mechanisms differentiating transition of learner from novice to expert

**PAYOFF:**
- Enhanced combat capabilities at individual and small unit level
- Significant increases in training efficiency, completion, and effectiveness rates per unit time for individuals and small unit leaders in both real and virtual/augmented environments
- Enhanced training via tailored and real-time closed-loop training systems that are based on neuro-cognitive and psychologically-driven instructional strategies developed
- Ensure a small, yet potent fighting force by realizing the full potential of each Marine via efficient, targeted assessment and selection methods
- Enhanced team cognition and combat effectiveness capability
- Enhanced Warfighter capability to effectively/efficiently Observe, Orient, Decide, and Act during complex, stressful combat conditions
- Support USMC S&T Master Plan and STOs
The Ultimate Customer – The Warfighter!
Caveat: Real Customer: SYSCOMs, PEOs, DRPMs

**HOT Buttons:**
1. Survivability
2. Reduce Combat Load
3. Small Unit Excellence
4. Fuel Efficiency
5. Light weight portable power sources
6. “Transparent” Urban Structures
7. Modular, Scaleable Weapons
8. CIED, MCM, CRAM
9. Operational Adaptation
10. Infantry combat load reduction
QUESTIONS?