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

ONR
Office of Naval Research
S&T
Revolutionary Research . . . Relevant Results

Expeditionary Maneuver Warfare & Combating Terrorism S&T Department

Code 30

DEVELOPING FUTURE NAVAL COMBAT CAPABILITIES

USMC   USN

SMALL UNIT EXCELLENCE
LETHALITY, SUSTAINMENT, HUMAN PERFORMANCE, AND COMBAT LOAD REDUCTION TECHNOLOGIES FOR NAVAL WARRIORS

MARITIME IRREGULAR WARFARE
NAVAL EXPEDITIONARY COMBAT TECHNOLOGIES FOR COMBATING TERRORISM AND DEFENDING THE HOMELAND

COMBAT TACTICAL VEHICLES
ADVANCED MOBILITY AND ARMOR TECHNOLOGIES FOR ENHANCED MANEUVER AND SURVIVABILITY

DISTRIBUTED OPERATIONS
INTELLIGENCE, SURVEILLANCE, AND C2 TECHNOLOGIES FOR LITTORAL DOMAIN AWARENESS

ONR
OFFICE OF NAVAL RESEARCH

Presented by

George W. Solhan

Deputy Chief of Naval Research for

Expeditionary Maneuver Warfare and

Combating Terrorism S&T Department (ONR 30)

26 February 2007

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…. "

Thomas Edison

Josephus Daniels

Vannevar Bush

Harry S Truman
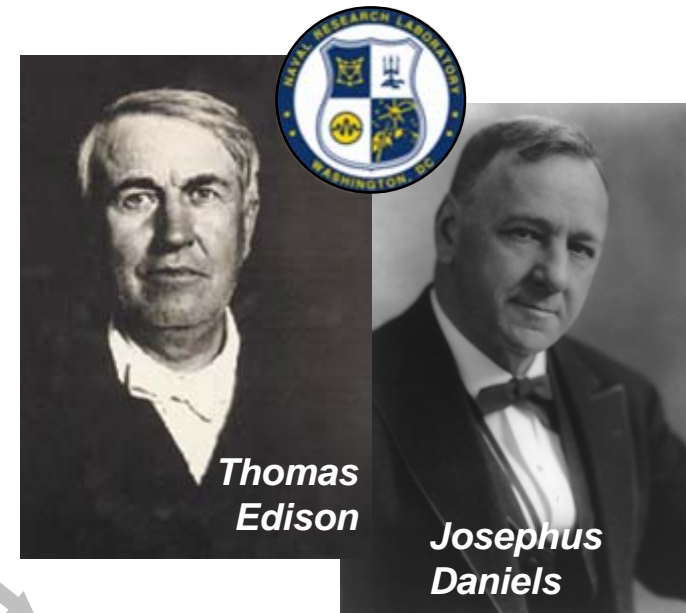
Transitioning S&T *(Defense Authorization Act, 2001)*:
"…manage the Navy's basic, applied, and advanced research to foster transition from science and technology to higher levels of research, development, test, and evaluation."

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)

ONR 30 Mission: Expeditionary Maneuver Warfare and Combating Terrorism
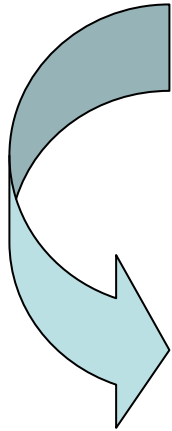
Office of Naval Research *(Public Law 588, 1946)*:

*"… **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.***
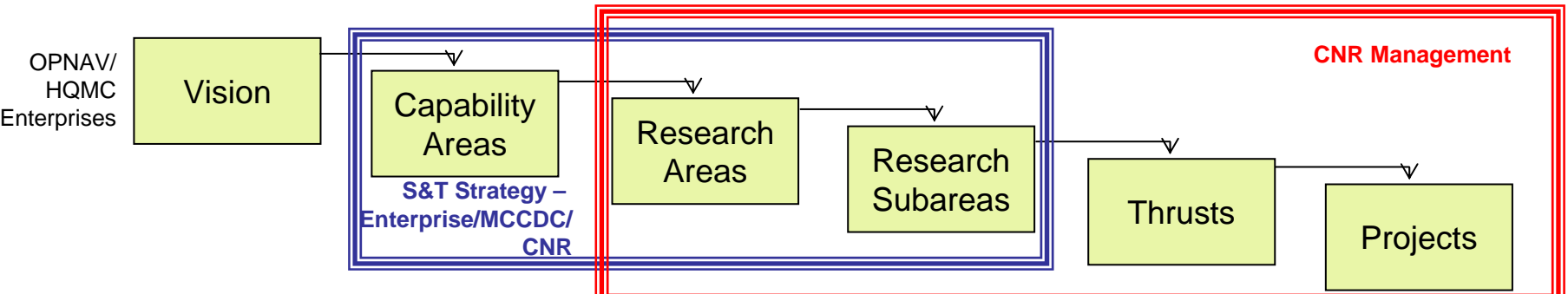

Investment Thrust Areas:	
C4	Logistics
Fires	Manuever
Force Protection	Mine Countermeasures
Human Performance	Maritime Irregular Warfare
Operational Adaptation	
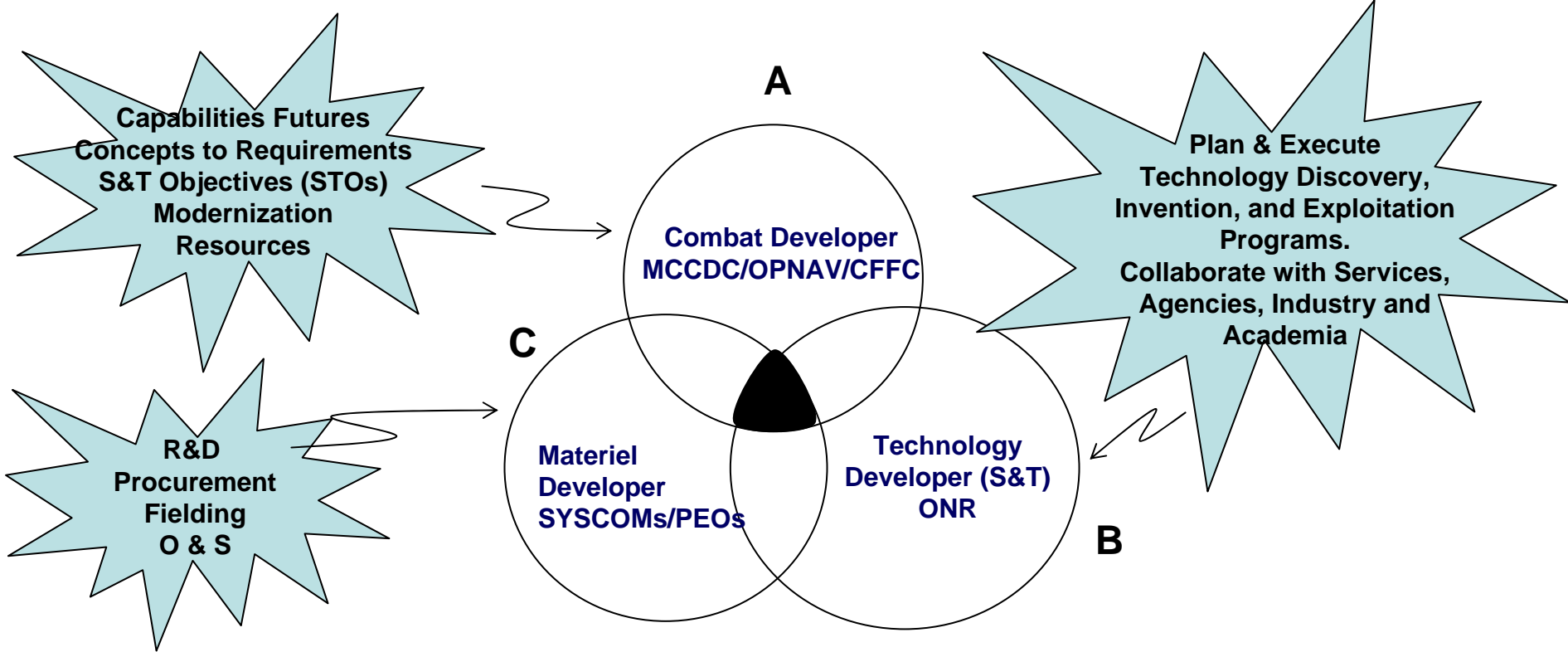
A   Concept ⟶ Capability Futures ⟶ Gaps ⟶ Requirements

B   Capability Futures ⟶ Gaps ⟶ Requirements ⟶ Technology

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

Background

- *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 <u>Defeat</u> Global Terrorism and Work to Prevent Attacks Against Us and Our Friends

- **Work with others** to <u>Defuse</u> Regional Conflicts

- <u>Prevent</u> Our Enemies from Threatening Us, Our Allies, and Our Friends with Weapons of Mass Destruction

- <u>Transform</u> America's National Security Institutions to Meet the Challenges and Opportunities of the 21st Century

National Security Strategy (2002)

National Defense Strategy *(2005)*

National Strategy for Combating Terrorism (2003)

National Strategy for Maritime Security (2005)

National Strategy for Homeland Security (2002)

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*

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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
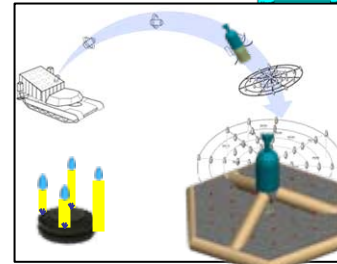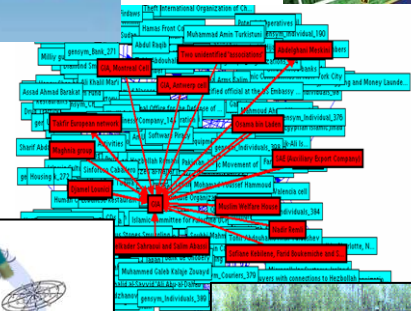
Key Research Topics

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

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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

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

Operational Adaptation (OA):
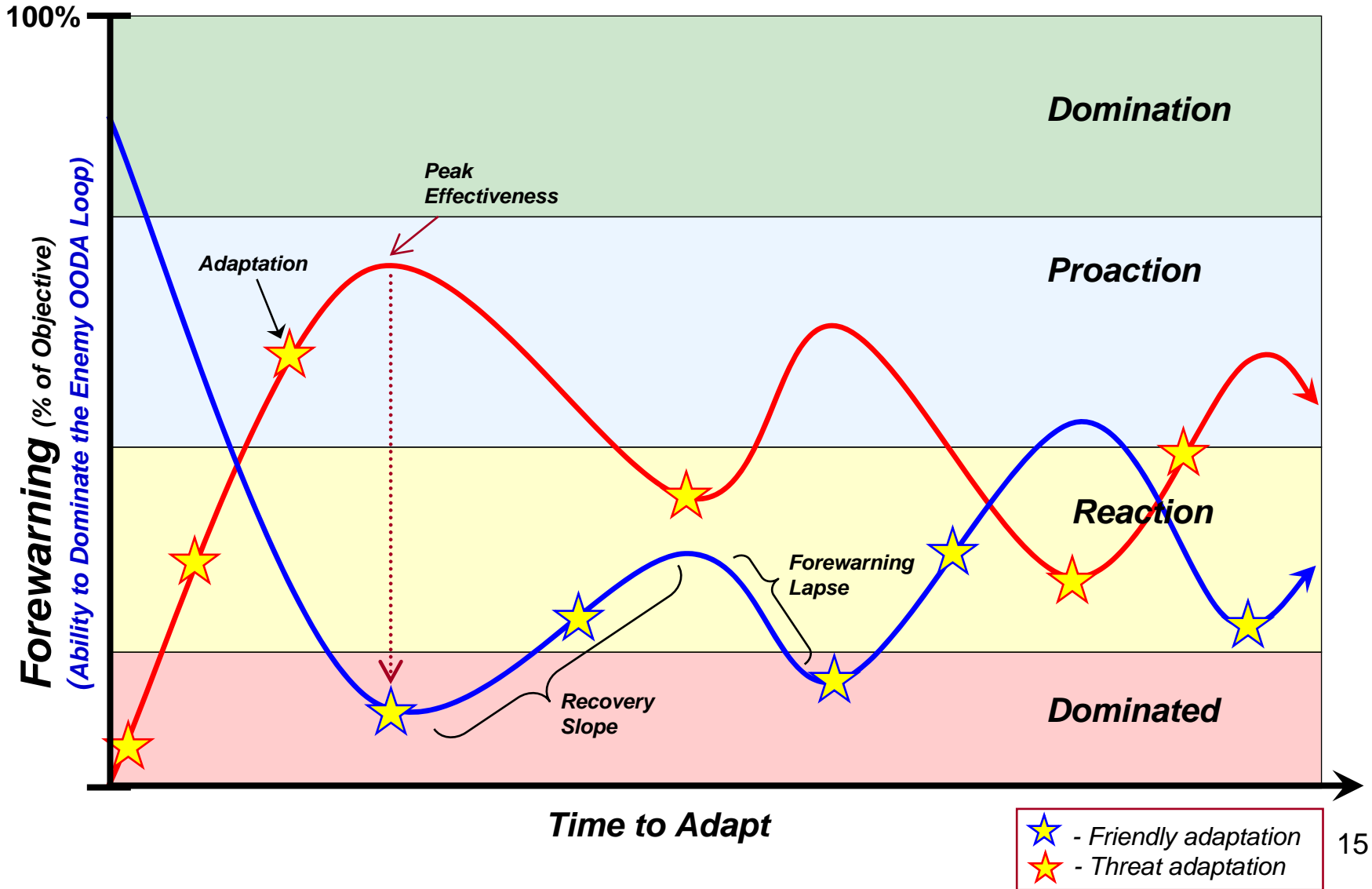## *"The Information Warfare Game Changer"*

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.

****

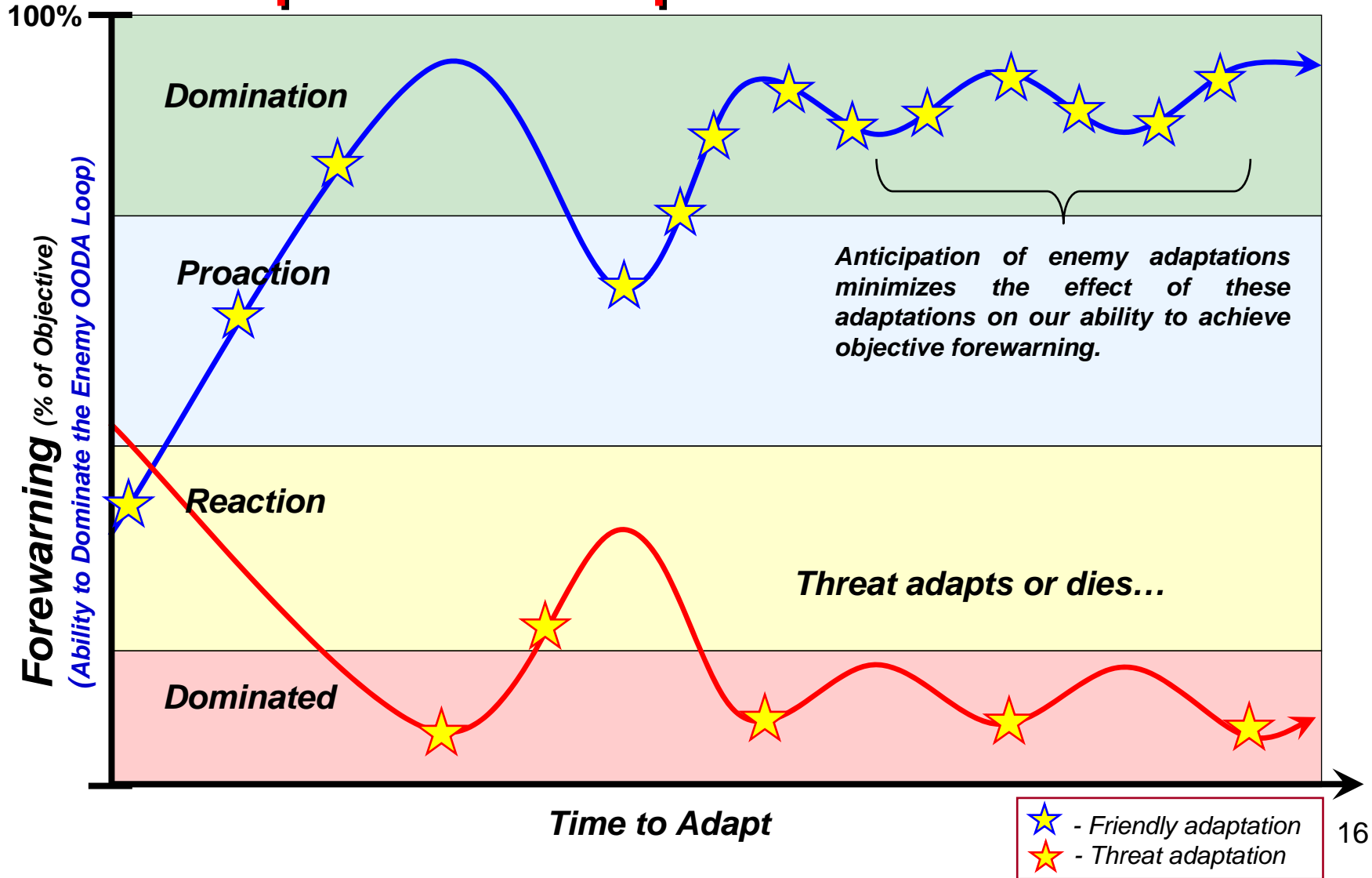# Previous Studies Have Pointed Toward The Need For "Operational Adaptation"

- **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

Domination

Proaction

Reaction

Dominated

100%

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

Peak Effectiveness

Adaptation

Recovery Slope

Forewarning Lapse

Time to Adapt

- Friendly adaptation
- Threat adaptation

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Objective Effects of Operational Adaptation…

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

100%

Forewarning *(% of Objective)*
(Ability to Dominate the Enemy OODA Loop)

Domination

Proaction

Reaction

Dominated

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

Threat adapts or dies…

Time to Adapt

★ - *Friendly adaptation*
★ - *Threat adaptation*

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The OODA Loop (Boyd Cycle)
## (The Key to Solving Operational Adaptation)

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.
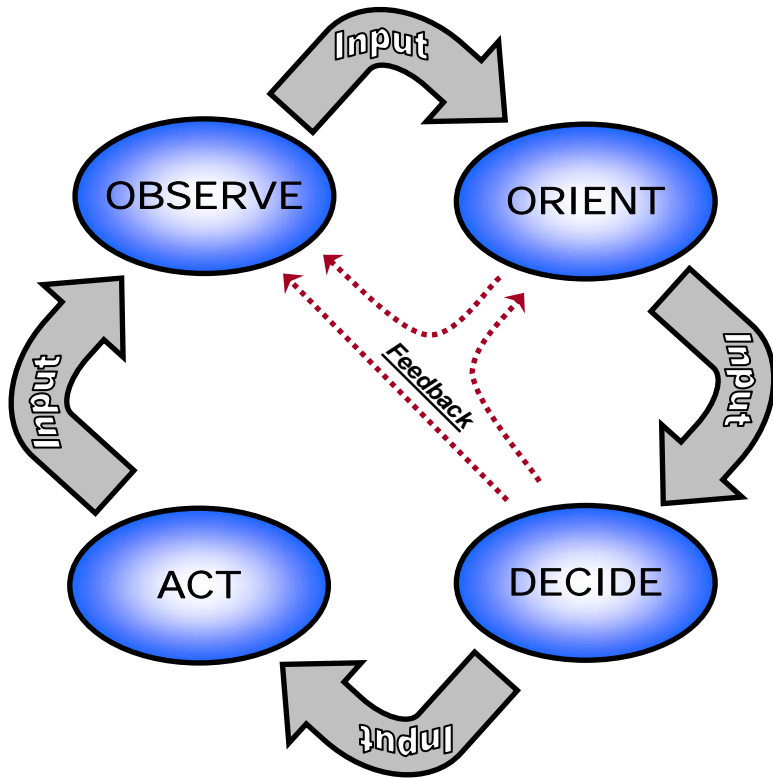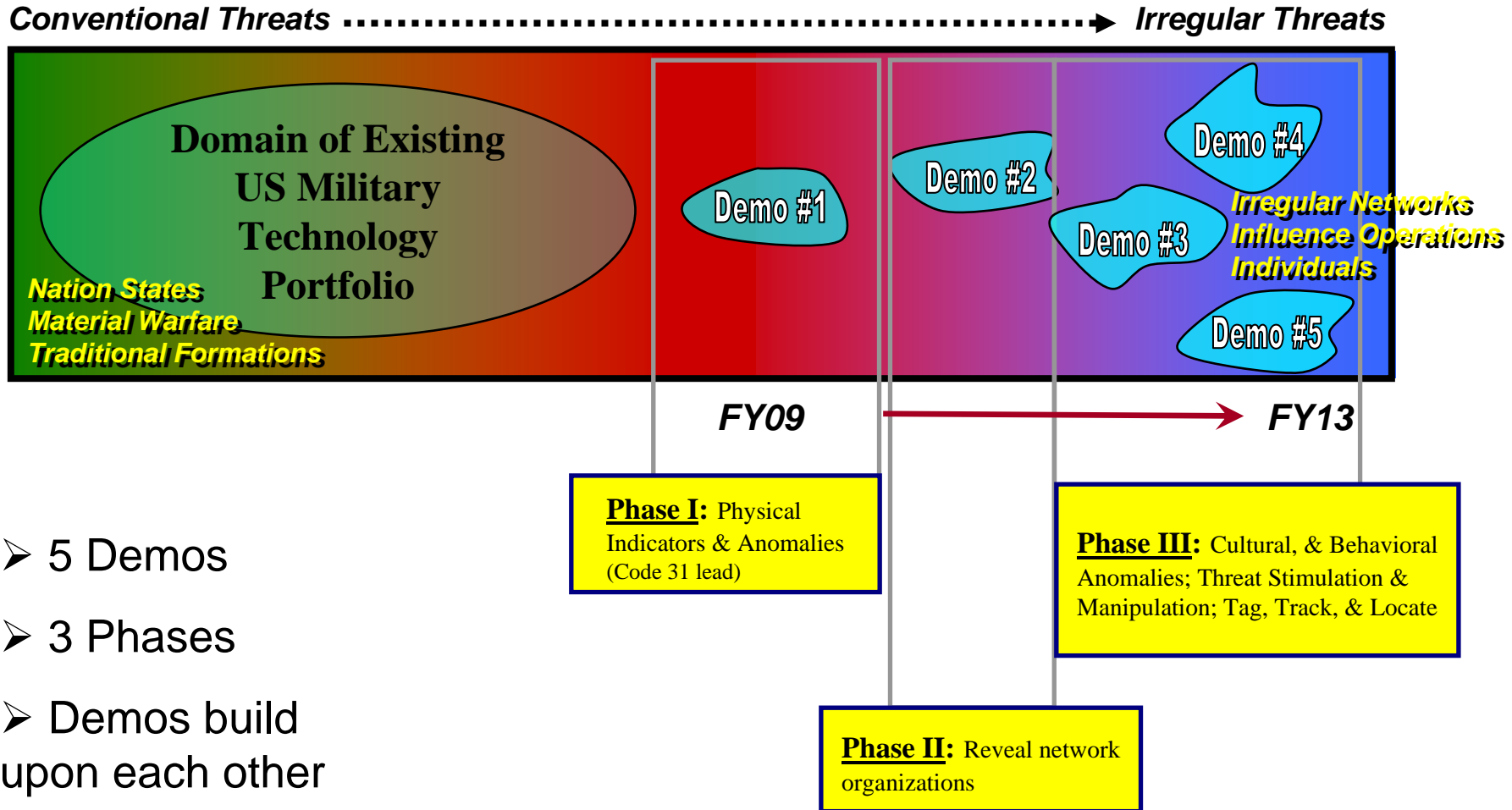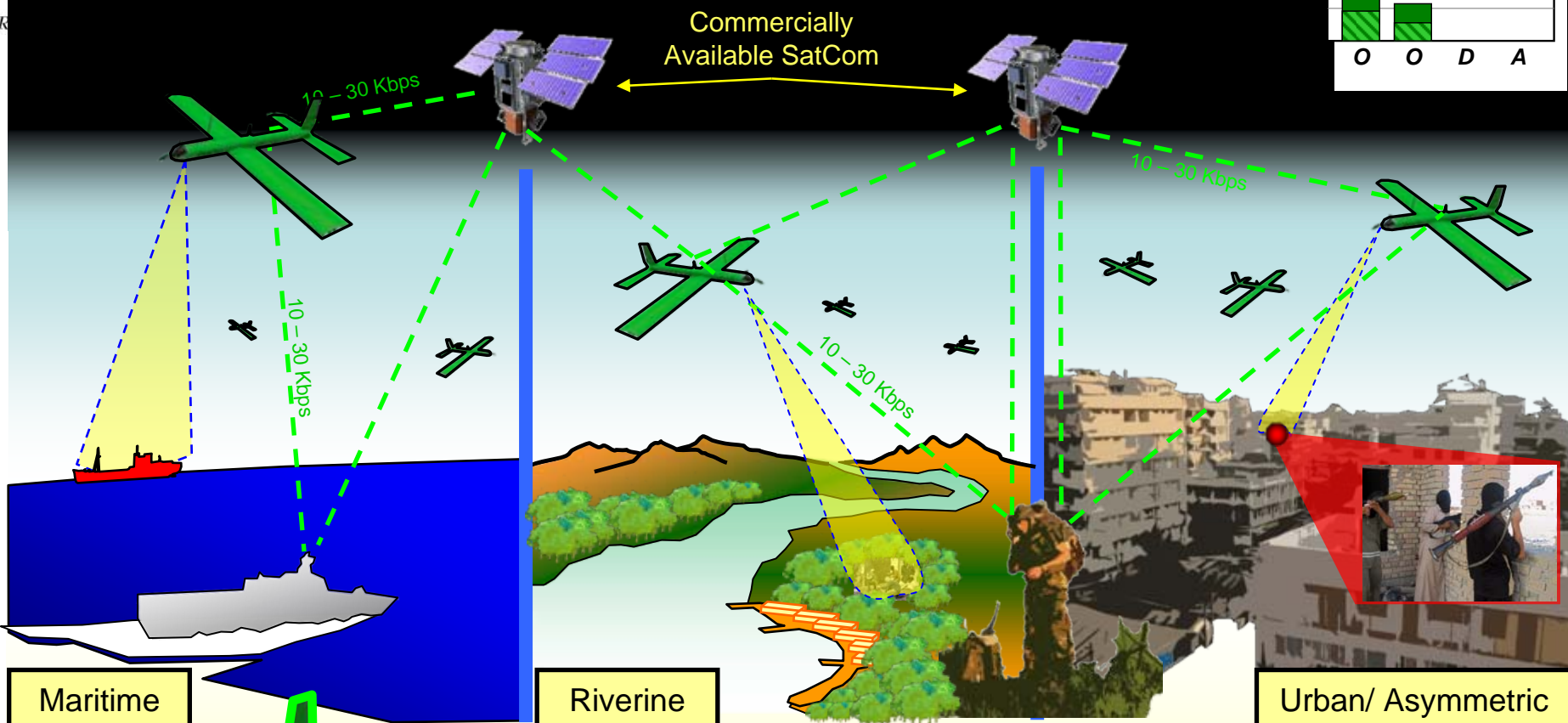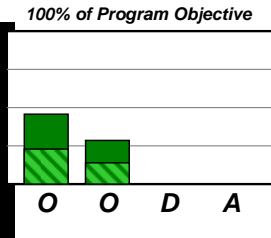

Dominated
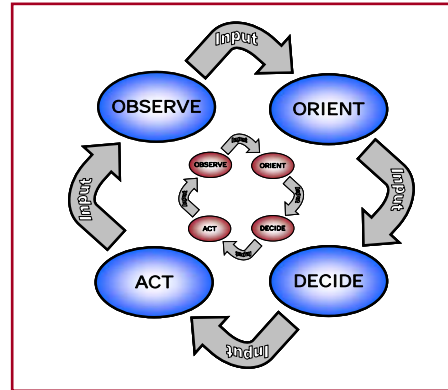
Reactive
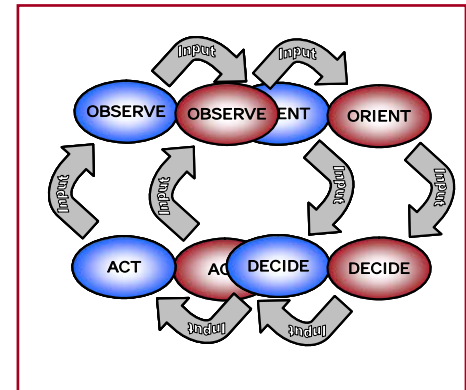
Proactive
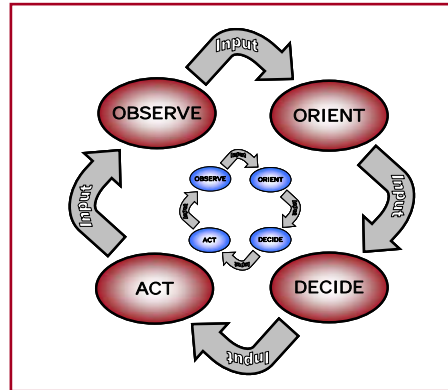
Domination of all domains
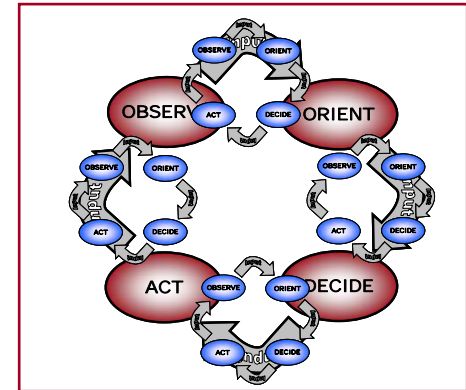
Demo 1 – Phase 2: Affordable Persistent Pervasive Surveillance
(Wide Areas up to 200 nm² - Open Ocean, Littoral, Rivers & Urban)

100% of Program Objective

O O D A

Commercially Available SatCom

10 – 30 Kbps

10 – 30 Kbps

10 – 30 Kbps

10 – 30 Kbps

Maritime

Riverine

Urban/ Asymmetric
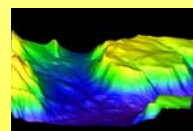
Urban and Terrain Imaging

GPS

GIS Geodata
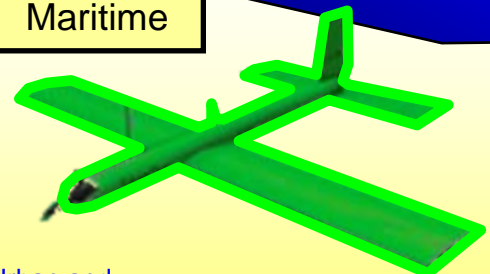
Methodology:

- **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**
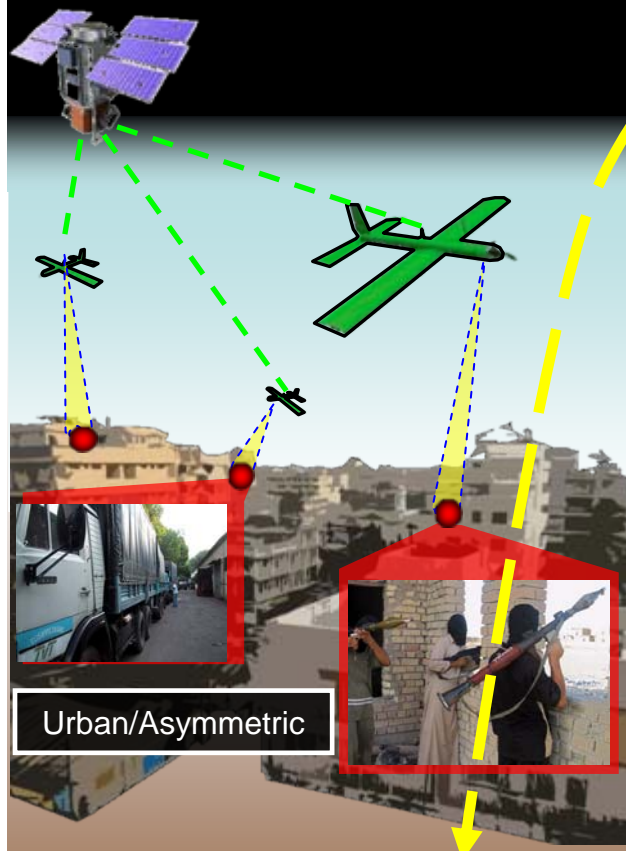- **Low bandwidth, over the horizon datalinks**
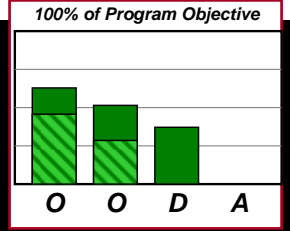
Demo 2: Near Real-Time Forensics and Social Network Mapping

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

**Global Intel Sources**

- → Timeline → +

Attack Occurs

100% of Program Objective

| O | O | D | A |

Urban/Asymmetric

Surveillance & Global Intelligence Info Databased

Attack Analyzed Using Database Info
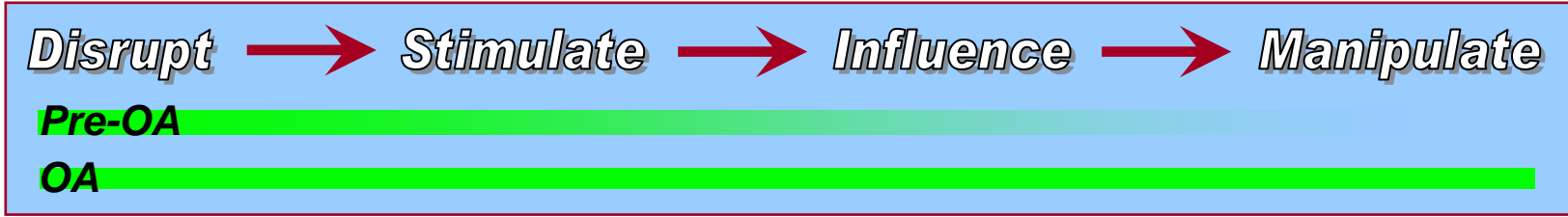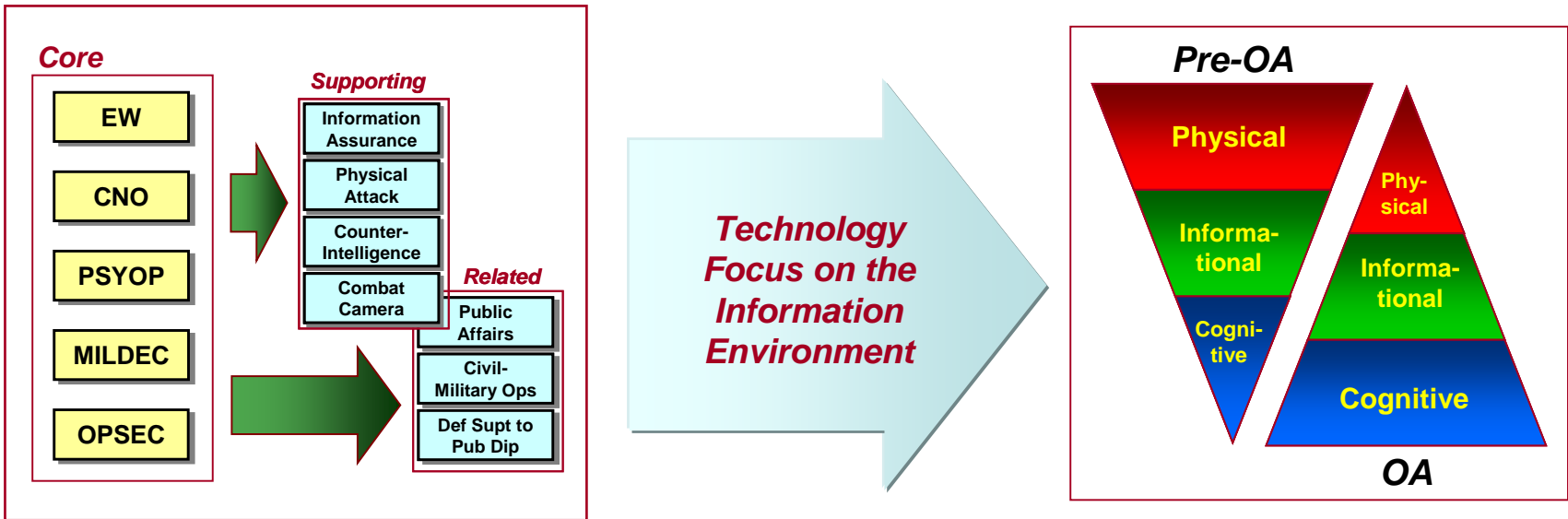
Methodology:
- **All-source intelligence fusion;**
- **social network mapping; persistent, pervasive surveillance; multi-spectral collection and analysis; and automated tracking of entities**

Activity network mapped within minutes
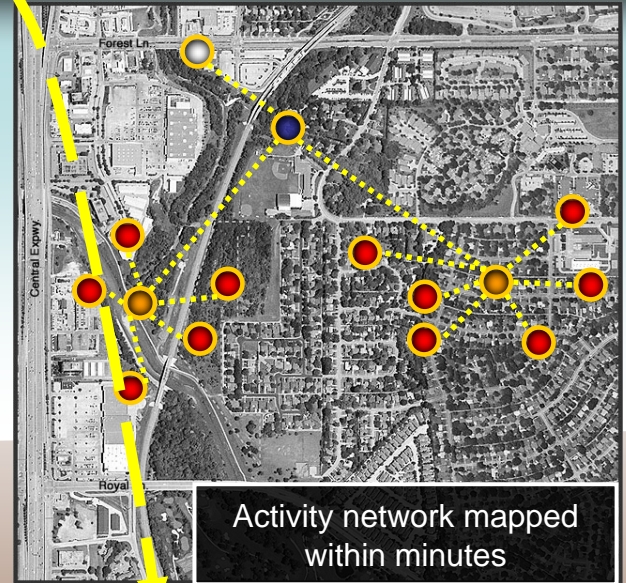
- **Analysis Algorithms Define Network(s) in Near Real-Time Using Surveillance, Intel & Attack Info**
- **Enemy Network Rapidly Identified**

Information Operations Evolution (Demo 5)

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.

Core

- EW
- CNO
- PSYOP
- MILDEC
- OPSEC

Supporting

- Information Assurance
- Physical Attack
- Counter-Intelligence
- Combat Camera

Related

- Public Affairs
- Civil-Military Ops
- Def Supt to Pub Dip

Technology Focus on the Information Environment

Pre-OA

- Physical
- Informa-tional
- Cogni-tive

OA

- Phy-sical
- Informa-tional
- Cognitive

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"*
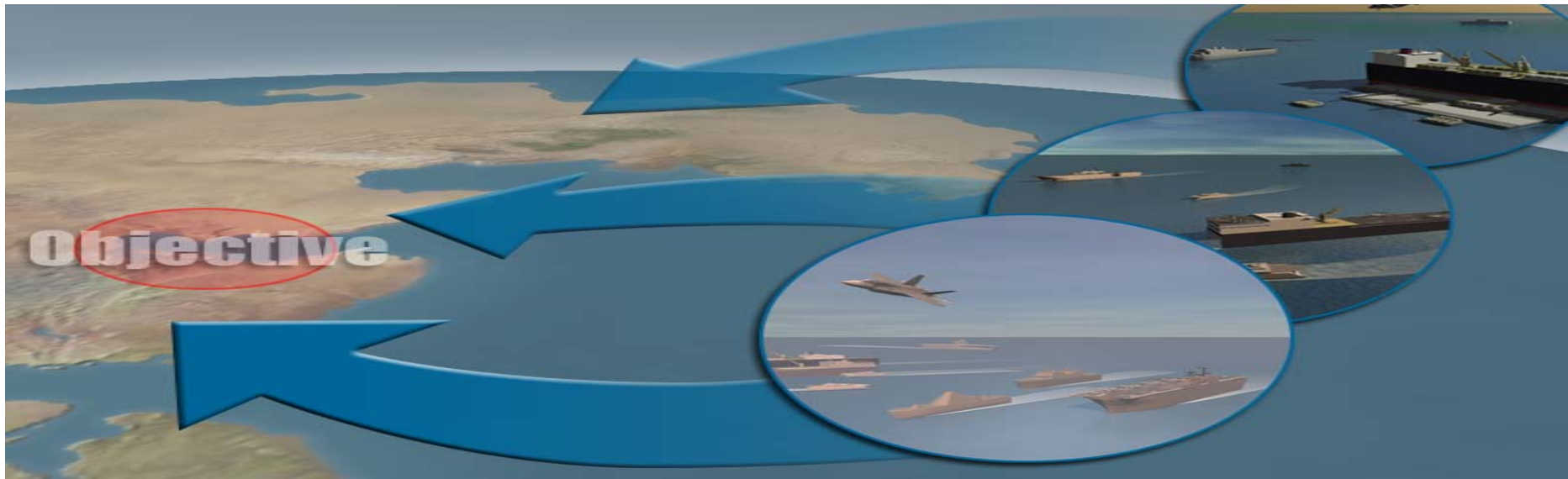
*"**Distributed Operations** constitutes a form of Maneuver Warfare. The essence of this concept lies in the capacity for coordinated action by highly capable units, dispersed throughout the breadth and depth of the battlespace, ordered and **connected** within an operational design focused on a common aim."*

Distributed Operations

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
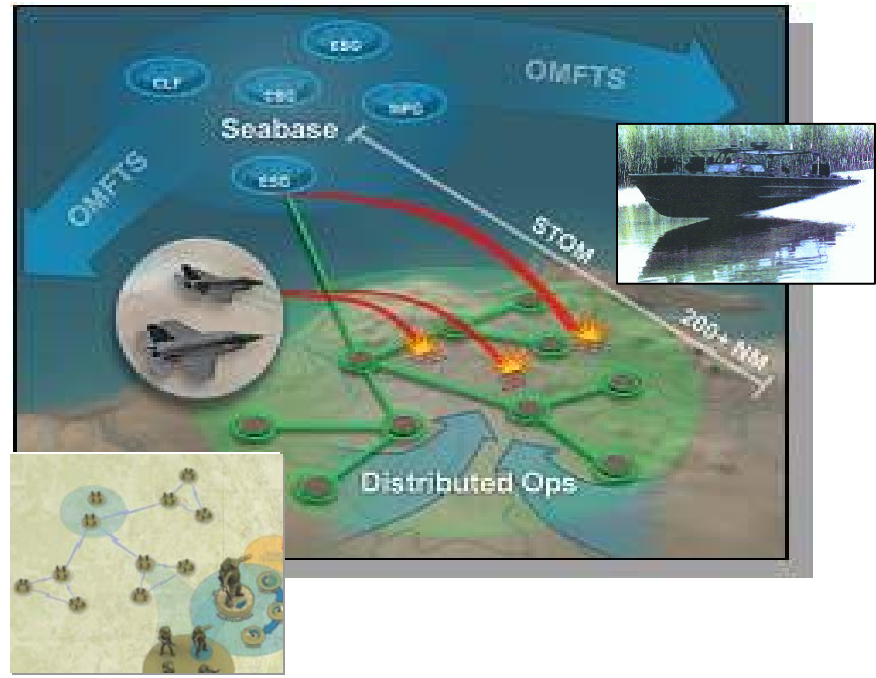
Key Research Topics

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

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Decreasing the Marine's Load

Yesterday's & Today's Marine – Overloaded!

1960s   Today

No Change

Tomorrow's Marine: Optimized for Combat Endurance

Treat the Marine as a system – Focus on the entire individual
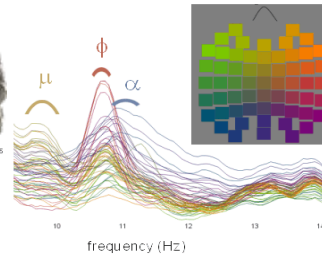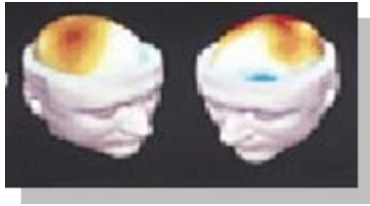
~Make smart tradeoffs between performance & weight~

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

Equals improvements in a Marine's load-bearing capability

Human Performance, Training & Education (HPT&E) 6.2 Investment

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

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

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?