Distributed Operations

2006 Naval Research Advisory Committee
Summer Study Briefing to
The Honorable Delores M. Etter,
Assistant Secretary of the Navy (RD&A)

23 June 2006
SSC San Diego
Focus on text:

**Study Terms of Reference (TOR)**

- **Objective:** “Study the emergent concept of Marine Corps Distributed Operations in order to develop a set of future technology insertions and training opportunities”

- **Specific Taskings:**
  - Compare and contrast required capabilities of Marines conducting DO with those required for conventional operations
  - Determine appropriate options for insertion of technology to support DO and associated training; key upstream investments, technology monitoring, and go/no-go assessment points; and probable time-frames for exploration and implementation
  - Estimate risk associated with particular options and identify potential show-stoppers

Note: Prior to start of NRAC DO Study, DARPA funded a DO Architecture Study. It recommends a set of specific technology programs. To complement the DARPA study, NRAC focused its efforts at a System of Systems level and also made S&T recommendations.
• Consider the rifle squad as a system
• Emphasize enablers for local decision-making consistent with commander’s intent
• Consider enhancement of human performance
• Consider higher-order effects
• Focus on the mid-term (~8 years)
• Do not be constrained by cost
What is Distributed Operations?

- **CMC:** “Distributed Operations is a concept to promote discussion and generate ideas for specific combat development initiatives”

- **MCCDC:** Distributed Operations (DO) will enhance small unit effectiveness and will create an advantage over the enemy through
  - Deliberate use of separation and coordinated interdependent tactical actions
  - Increased access to functional support, including fires
  - Decision-making by those engaged in combat

**NRAC working definition of DO:** Operational approach that enables influence over larger areas through spatially separated small units, empowered to call for and direct fires, and to receive and use real-time and direct ISR.

“Distributed Operations will unleash the combat power of the young Marine”
—LtGen James Mattis, USMC
By-Echelon Capability for Irregular Warfare

Conventional Operations:
- Battalion controls fires, but
- Inappropriately sized for irregular warfare
- Platoon & squad appropriately sized for irregular warfare, but
- Incapable of controlling fires

Distributed Operations:
- Platoon & squad enabled for irregular warfare
- Control of fires
- Communications
- Logistics
- Additional education & training
Developments in Land Warfare

Decision-Making Echelon

- **Higher**
- **Lower**

- **Marine Forces**
- **Joint & Combined Forces**

**Investment Per Warfighter**
- **Less**
- **More**

**Distributed Operations**

**Special Operations**

TOR
- Distributed Operations
- Fact-Finding
- Enabling DO
- Communications
- Logistics
- Education & Training
- Supporting Establishment
- Findings
- Recommendations
- Panel
DO Study…Bottom Line Up Front

- Number of DO-enabled units limited by available communications, fires, logistics, training

- Advanced technology needed to provide enhanced logistics, medical support, training

- Significant implications exist for communications architecture and throughput in the battle space

- Key actions:
  - Establish “DO Marine as System” S&T Program
  - Ensure ASD(NII) architecture and JTRS accommodate DO
  - Evaluate need, feasibility, and means of aging the force
  - Formalize and elevate Marine Expeditionary Rifle Squad “Program” in Corps acquisition
  - Establish “honest broker” for DO network systems engineering
Fact Finding

Marine Corps
- HQMC (X2)
- MCCDC (X3)
- MCSC (X4)
- MCWL (X4)
- I MEF (VTC)
- II MEF (VTC)
- MCAGCC 29 Palms CA
- DO Limited Objective Experiment (LOE)

Army
- PEO Soldier
- Natick Soldier Center (X2)
- Future Force Warrior
- Technical Program Office (FFW TPO)
- Army Science Board 2001
- Objective Force Warrior
- Walter Reed Army
- Institute of Research
- Communications
- Electronics Research
- Development and Engineering Center (CERDEC)
- Army Research Institute
- of Environmental
- Medicine
- Army Medical Research
- and Materiel Command
- (MRMC)

Government (Other)
- ASD(NII) (PDM III Study)
- DARPA
- ONR (X3)
- NSA
- Naval Medical Facility,
- Bethesda MD
- Naval Health Research
- Center, San Diego CA

Other
- Nathaniel Hicks (author
  One Bullet Away)
- Dominic Green (“Career
  Infantry Perspective”)

Commercial
- Boston Dynamics
- OnPoint Technologies
- General Dynamics
- Robotic Systems

Universities
- USC Institute for Creative
  Technologies
- MIT Institute for Soldier
  Nanotechnology
- USC GamePipe
  Laboratory
  (Viterbi School of
  Engineering)
Enabling the Corps for DO

- Communications
- Logistics
- Training

Supporting the Marine Unit for DO

- Mentally
- Physically

Enabling the Marine for DO
## The Marine

<table>
<thead>
<tr>
<th>Mental</th>
<th>Conventional Operations</th>
<th>Distributed Operations</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>• Decision making: centralized and directed</td>
<td>• Decision making: decentralized, consistent with commander’s intent</td>
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<tr>
<td></td>
<td>• Situational awareness (SA) at battalion and higher echelons</td>
<td>• Situational awareness at platoon and squad levels over large area</td>
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<td></td>
<td>• Verbal communications at and below platoon level</td>
<td>• Electronic communications extended below company level</td>
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<td>• Sleep deprivation and physical fatigue degrades decision making skills</td>
<td>• DO CONOPS exacerbates impact</td>
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<thead>
<tr>
<th>Physical</th>
<th>Conventional Operations</th>
<th>Distributed Operations</th>
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<tr>
<td></td>
<td>• Existing equipment loads range from ~60 to 130 pounds per Marine</td>
<td>• Potential increase in equipment, transported over greater distances</td>
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<td></td>
<td>• MREs and water adequate</td>
<td>• MREs potentially insufficient for greater energy expenditure</td>
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The Marine

<table>
<thead>
<tr>
<th>Findings</th>
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</table>
| **Mental** | • Currently squad-level NCOs not trained to execute missions based on commander’s intent  
• Larger assigned operating area and more complex mission requirements increase cognitive workload  
• Array of communications equipment unduly complex  
• Only safe and evidence-based fatigue countermeasures are sleep and caffeine  
• No safe pharmacological cognitive enhancements likely in the foreseeable future  
• Cognitive impairment results quickly from fatigue and nutritional deficit |
| **Physical** | • 86% of Marines exceed recommended load carriage (50 lbs or 1/3 of body weight)  
• First Strike Rations empirically developed to meet nutritional requirements for sustained, intense operations |
# The Marine

## Points of Leverage

<table>
<thead>
<tr>
<th>Mental</th>
<th>Conclusions</th>
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<tbody>
<tr>
<td></td>
<td>• Safe physiological enhancement of cognition unlikely</td>
</tr>
<tr>
<td></td>
<td>• Nutrition and fatigue very significant factors that must be addressed</td>
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<tr>
<td></td>
<td>through logistic support</td>
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<tr>
<td></td>
<td>• Education &amp; Training: primary point of leverage</td>
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<tr>
<td></td>
<td>• Communications: situational awareness and control of fires</td>
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<table>
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<tr>
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<tbody>
<tr>
<td></td>
<td>• Essential to reduce load carriage with attendant impairment of</td>
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<tr>
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<td>combat effectiveness, fatigue &amp; injury:</td>
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<tr>
<td></td>
<td>– Logistics: provide <em>timely and reliable</em> resupply at squad level at</td>
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<td>required frequency to reduce load-carriage of consumables by Marines</td>
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<tr>
<td></td>
<td>– Acquisition: apply system engineering approach to design of small unit</td>
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<td></td>
<td>Table of Equipment (T/E)</td>
</tr>
<tr>
<td></td>
<td>– Materials Science: reduce weight of individual items in T/E</td>
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<tr>
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<td>• Leverage collaborative research (especially Army) in nutritional sciences</td>
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<td>to better understand efficacy and risk of nutritional supplements</td>
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Enabling DO
Necessary Lines of Analysis
Communications
DO Unit Spatial Distribution

Squad Perspective

Platoon Perspective

Line of Sight

TOR
Distributed Operations
Fact-Finding
Enabling DO Communications
Logistics
Education & Training
Supporting Establishment
Findings
Recommendations
Panel
Evolution to DO Comms
Huge Increase in Complexity

Program of Record 2008

Full DO Capability

Required Distance
200 KM

Required Distance
Line of Sight

Required Distance
40 KM

Required Distance
100 KM

Required Distance
20 KM

Required Distance
10 KM

Squad Load*:
21 radios & comm dev
50 lbs of radios
6-12 lbs batteries/day

Platoon Load*:
94 radios & comm dev
275 lbs of radios
30-60 lbs batteries/day

*MCSC data

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*MCSC data
**Significant Impact on Battalion T/E**

Radios per Battalion for Different at Levels of DO Implementation

- **Full DO Battalion ~1220 Radios**
- **Conventional Battalion ~175 Radios**

DO Numbers Assume Currently Available Radios
DO Communications
Recommendations

- Ensure ASD(NII) architecture and JTRS accommodates DO requirements
  - Determine additional requirements for airborne and satcom nodes beyond current plans
  - Determine the communication requirements for DO logistics and medical support
  - Focus on DO network experimentation

- Establish “honest broker” for DO network systems engineering (e.g., MCTSSA)

- Explore surrogate radios compatible with JTRS to reduce the radio load at the small unit level (soon)

- Determine vulnerability to exploitation of frequent, highly networked DO tactical comms
## Logistics

<table>
<thead>
<tr>
<th>Current</th>
<th>DO</th>
<th>Findings</th>
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<tbody>
<tr>
<td><strong>Point of Delivery Systems</strong></td>
<td>Company</td>
<td>Squad</td>
</tr>
<tr>
<td><strong>Logistics Comm Network</strong></td>
<td>GCSS-MC* at Battalion</td>
<td>Squad</td>
</tr>
<tr>
<td><strong>Supplies / Maintenance</strong></td>
<td>Battalion</td>
<td>Order of magnitude change with increased field units</td>
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<tr>
<td></td>
<td></td>
<td>Insufficient surface and air assets to achieve real-time delivery at precision locations over large distances</td>
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<tr>
<td></td>
<td></td>
<td>GCSS-MC does not reach down to squad; real-time sensors for autonomic logistics needed</td>
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<td></td>
<td>Extended missions require more Marine load and/or timely resupply; current equipment reliability, availability, maintainability, durability (RAM-D) challenging for DO</td>
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</table>

**Logistics S&T and modernization must be driven by DO needs**

*Global Combat Support System - Marine Corps*
# Logistics Recommendations

<table>
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<tr>
<th>Point of Delivery Systems</th>
<th>Acquire unmanned systems for air and ground transport to minimize manpower and force protection needs</th>
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<tbody>
<tr>
<td>Logistics Comms Network</td>
<td>Design GCSS-MC architecture to address the platoon- and squad-level requirements</td>
</tr>
<tr>
<td>Supplies / Maintenance</td>
<td>Develop “DO Marine as a System” architecture approach; address RAM-D in future infantry systems</td>
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*Unmanned VTOL to supply and / or medevac*

*Focus on reducing cost and/or developing deliver & return system*

*Unmanned hybrid-electric mule to supply & sustain DO Squad*
“Train for certainty ... educate for uncertainty”

Master Gunnery Sergeant Dominic Green, USMC (Ret.)
Education & Training
Findings

• Distributed Operations approach, training and implementation plan has been completed

• CG MCCDC is dual-hatted as Deputy Commandant for Combat Development & Integration
  – Leads Marine Corps Order-directed Infantry Battalion Enhancement Period Program
    • Designed to fund, man, equip, train, and support DO
Education & Training
Recommendations

• Establish uniform selection criteria and standards for DO leadership across the Marine Corps

• DO requires “brilliance in the basics,” therefore:
  – Increase proficiency levels for specified skills, techniques, procedures
  – Increase formal schools emphasis on DO tactics
  – Improve decision making skills for small unit leaders

• Develop unique training and educational technology to enhance learning for DO platoon and squad leaders

• Update Infantry Training and Readiness Manual syllabus to include
  – Training requirements for designation of platoon and squad leaders for control of fires
  – DO live fire and simulator training support requirements
Impact of DO on Supporting Establishment

TOR
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Fact-Finding
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Panel
## Impact on Infantry Battalion

### Table of Organization

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<th>Education &amp; Training</th>
<th>Supporting</th>
<th>Establishment</th>
<th>Organization</th>
<th>Manpower</th>
<th>Management</th>
<th>Medical</th>
<th>Acquisition</th>
<th>S&amp;T Findings</th>
<th>Recommendations</th>
<th>Panel</th>
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### Findings

- **Logistics**
  - Conventional Operations: 3–4 Company distribution nodes, Internal reallocation / rebalancing, Consolidated processing
  - Distributed Operations: Increased direct delivery sites, Limitations to internal rebalancing, Disaggregated processing
  - Finding: Analysis, supply, and distribution functions likely exceed organic capability in sustained operations

- **Intelligence**
  - Conventional Operations: Fusion at higher echelons, Limited battlespace sensors, Near real time
  - Distributed Operations: Fusion at lower echelons, Increased battlespace sensors, Real time
  - Finding: Intelligence requirements (processing, fusion, dissemination required for DO situational awareness) likely exceed capacity of organic manpower at battalion level

- **Transportation/Mobility/Maintenance**
  - Conventional Operations: Primarily augmented/dismounted, Limited density/limited authority at battalion level (e.g., transport, NVG)
  - Distributed Operations: Primarily organic/mounted (JLTV), Increase in density and authority
  - Finding: Dramatic increases in equipment densities and support required by DO are likely beyond existing organic capability to repair, replace, evacuate
### Infantry Manpower Management

<table>
<thead>
<tr>
<th>TOR Distributed Operations Fact-Finding Enabling DO Communications Logistics Education &amp; Training Supporting Establishment Organization Manpower Management Medical Acquisition S&amp;T Findings Recommendations Panel</th>
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| Recruitment | Conventional Operations: Infantry GCT requirement unchanged for years | Distributed Operations: Potentially higher GCT requirement |
| Accession | Minimal screening for critical cultural and decision-making skills | Increased screening for critical cultural and decision-making skills |
| Assignment | | Findings:  
  • Future infantry responsibilities will be commensurate with advanced-skill MOSs  
  • Increased technological requirements/educational demands of DO units requires much earlier unit staffing to T/O (consistent with IBEPP)  
  • The increased excellence required by infantry in NCO/SNCO ranks in DO will require refresher training after B billet assignments |
| Retention | Incentives < overall force Time in Grade for promotions > overall force | Incentives should increase Time in Grade for promotions should be comparable |
# Medical Support

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<tr>
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<th>Conventional Operations</th>
<th>Distributed Operations</th>
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<tbody>
<tr>
<td><strong>Survivability</strong></td>
<td>Findings:</td>
<td>Findings:</td>
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<tr>
<td></td>
<td>• Body armor (IBA) effective, but extremities vulnerable, mobility impaired; contributes to fatigue</td>
<td>• Protective eyewear considered unacceptable by riflemen and consumer eyewear is substituted. No eyewear worn ~ 1/3 of the time</td>
</tr>
<tr>
<td><strong>Combat Casualty Care</strong></td>
<td>First medical responder a Corpsman at platoon level</td>
<td>First responder probably a rifleman at squad level</td>
</tr>
<tr>
<td></td>
<td>Findings:</td>
<td>Findings: Currently Corpsman trains 3 Marines per squad in Combat Lifesaving Skills; insufficient for DO.</td>
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<tr>
<td></td>
<td>Within “Golden Hour”</td>
<td>May exceed “Golden Hour”</td>
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<tr>
<td><strong>CASEVAC</strong></td>
<td>Findings:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• CASEVAC provided primarily with tactical helicopters</td>
<td></td>
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<tr>
<td></td>
<td>• Air and ground platforms are not optimized to support DO</td>
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<tr>
<td><strong>Casualty Tracking</strong></td>
<td>Coordinated through echelons of medical care</td>
<td>Becomes inherently more complex</td>
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<td>Finding: Increased complexity in DO environment requires enhanced casualty tracking technology</td>
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## Organization, Manpower, Medical

### Recommendations

| Organization | • Revise Infantry Battalion T/O to support increased demands in support functions required by DO  
|             | • Use LOE-3 to begin to develop requirements for these changes |
| Manpower    | • Evaluate GCT stratification of Infantry occupational field to determine if DO will require changes to the MOS Manual  
|             | • Screen for critical decision-making ability and identify cultural skills during accession  
|             | • Incentivize to reduce MOS migration detrimental to retaining experience in Infantry field  
|             | • Evaluate extending current enlistment period |
| Medical     | • ONR partner with Army on nanotechnology solutions for body armor  
|             | • NHRC test and evaluate eyewear meeting combatants requirements  
|             | • All riflemen complete the Combat Lifesaver Course  
|             | • Use Tactical Medical Logistics system to model coordinated network of care facilities connected by transportation assets for DO |
T/E (System of Systems) Acquisition

Rifle Squad (Possibly Reinforced)

Individual Marine’s Load: Personal Protective Gear + Weapons/Optics + Food/Water
Sum of Unallocated Individual Loads Available for Squad Use

- Tradeoffs among mass, cost, and utility are necessary to optimally equip Rifle Squad
  - At level of individual Marine
  - At level of Rifle Squad
- “Commodity Market” model has proven effective in other complex system tradeoff contexts
  - Spacecraft development
Acquisition
An Enabling Organizational Change

• Marine Expeditionary Rifle Squad "Program"
  – Excellent conceptual basis for System of Systems engineering
  – Not currently a program of record
  – At PM level not empowered to enforce mass constraints, nor effect mass, cost, utility tradeoffs
  – At PM level not empowered to coordinate “commodity market” approach

• Marine Expeditionary Rifle Squad Program
  – Excellent conceptual basis for System of Systems engineering
  – Empower to enforce mass constraints, nor effect mass, cost, utility tradeoffs
  – Empower to coordinate “commodity market” approach

Commander, Marine Corps Systems Command

Product Groups

Programs

Institutional Issues

Findings

Recommendations

Actions

Panel Members

TO Distributed Operations
Fact-Finding Enabling DO Communications Logistics Education & Training Supporting
Establishment Organization Manpower Management Medical Acquisition S&T Findings Recommendations Panel

Product Groups

Programs

Infantry Weapons Systems

PM Infantry Weapons

PM Marine Expeditionary Rifle Squad

PM Optics & Non-Lethal Systems

PM Combat Infantry Equip.

Commander, Marine Corps Systems Command

Marine Expeditionary Rifle Squad

PM Infantry Weapons

PM Combat Infantry Equip.

PM Optics & Non-Lethal Systems
Specific Marine Corps S&T
Top Level View

• ONR PRESBUD FY06 ~$1.8B
  – Marine Corps is ~$99M (5.6% of ONR budget))
    • ONR Code 30: ~$62M; MCWL: ~$37M

• Panel Observation 1
  – Very small percentage allocated to S&T underpinning of Expeditionary Maneuver Warfare Applications

• Panel Observation 2
  – Establishment of Code 30 at ONR affords Corps opportunity for strategic leverage and focus
  – With DO as transformational initiative, will be important for Code 30 to prioritize investment in support
  – Based on Panel experience, sub-critical investment unlikely to produce leap-ahead capability or achieve significant leverage

• Recommendations
  – Effective leverage of other Services (especially Army), DARPA S&T is essential
  – Code 30 investment should be focused on fewer, more significant, high-priority investments
Specific Marine Corps S&T Recommendations

“DO Marine as a System” S&T Program
- Create comprehensive system architecture studies to define technology needs
  - Determine ONR/MCWL S&T Funds focused on DO Marine
  - Assure that this is ≥ $50M/yr
- Leverage and complement the DARPA/USMC DO Technology Program

Comms (C2 STO-1; C2 STO-4; Marine Corps S&T Strategic Plan, Sept. 2005)
- Airborne relays on manned and unmanned platforms (opportunistic and dedicated)
- Surrogate software defined radios and networks

Training & Education (HPT&E STO-1–4)
- Simulation-based scenarios for decision making; comms education; control of fires; training for squad “Corpsman”

Logistics (Log STO-2,3; MVR STO-6)
- Unmanned VTOL and unmanned “Mule” (for each DO squad)
- Low-cost parafoil, recoverable with mule or VTOL UAV
- Real-time autonomic supply sensors and network

Medical (FP STO-1)
- Improved body armor through nanotechnology as co-investment with Army at MIT/SNI
- Remote wireless monitoring device to assess shock
- Continue development of reconstitutable intravenous hemostatic solutions
Top-Level Findings

• Number of DO-enabled units limited by available communications, fires, logistics, training

• DO will require significant resources
  – DO will require advanced technology to provide needed training, logistics, medical support
  – DO has significant implications for communications equipment, architecture, and throughput in the battle space
  – DO may require aging the Force
Top-Level Recommendations

• ASN (RD&A) and CMC direct CNR, VCNR to establish “DO Marine as System” S&T Program

• CG MCCDC ensure ASD(NII) architecture and JTRS accommodate DO requirements

• DC M&RA evaluate need, feasibility, and means of aging the Force

• COMMARCORSYSCOM establish “honest broker” for DO network systems engineering (e.g., MCTSSA)

• COMMARCORSYSCOM formalize and elevate MERS in acquisition structure
Panel Membership

Dr. John C. Sommerer   
Chair   
Johns Hopkins Applied Physics Laboratory

BGen James M. Feigley, USMC (Ret.)   
Vice Chair   
NRAC Associate

Dr. A. Michael Andrews II   
L-3 Communications

Dr. Fernando “Frank” L. Fernandez   
Consultant

MajGen Paul Fratarangelo,   
USMC (Ret.)   
NRAC Associate

Dr. Valerie J. Gawron   
Army Science Board   
General Dynamics

VADM E. R. Kohn, USN (Ret.)   
NRAC Associate

Dr. William A. Neal, MD   
West Virginia University

Mr. Norman Polmar   
U.S. Naval Institute

RADM John T. Tozzi, USCG (Ret.)   
L-3 Communications

Dr. Christopher B. Wallace   
Army Science Board   
Northrop Grumman

LtGen James N. Mattis, USMC   
Panel Sponsor   
Commanding General, Marine Corps Combat Development Command (MCCDC)

Dr. George Akst   
Senior Analyst, MCCDC

Mr. Stephen L. Cabrian   
Executive Secretary   
MCCDC

Mr. Roy V. Toliver   
Executive Secretary   
MCCDC
Questions?