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

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.

Study Sponsor Amplifying Guidance

LtGen James N. Mattis, CG MCCDC

- **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**

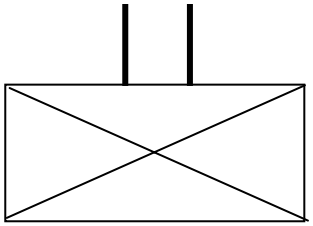
What is Distributed Operations?

- **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

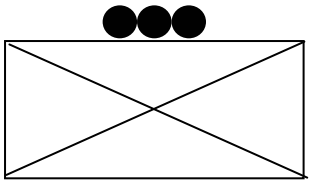


Infantry Battalion

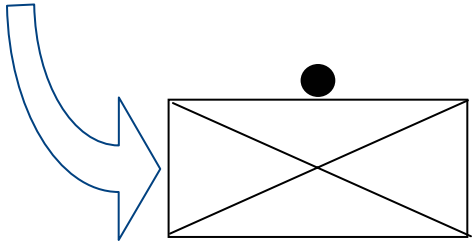
Company

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

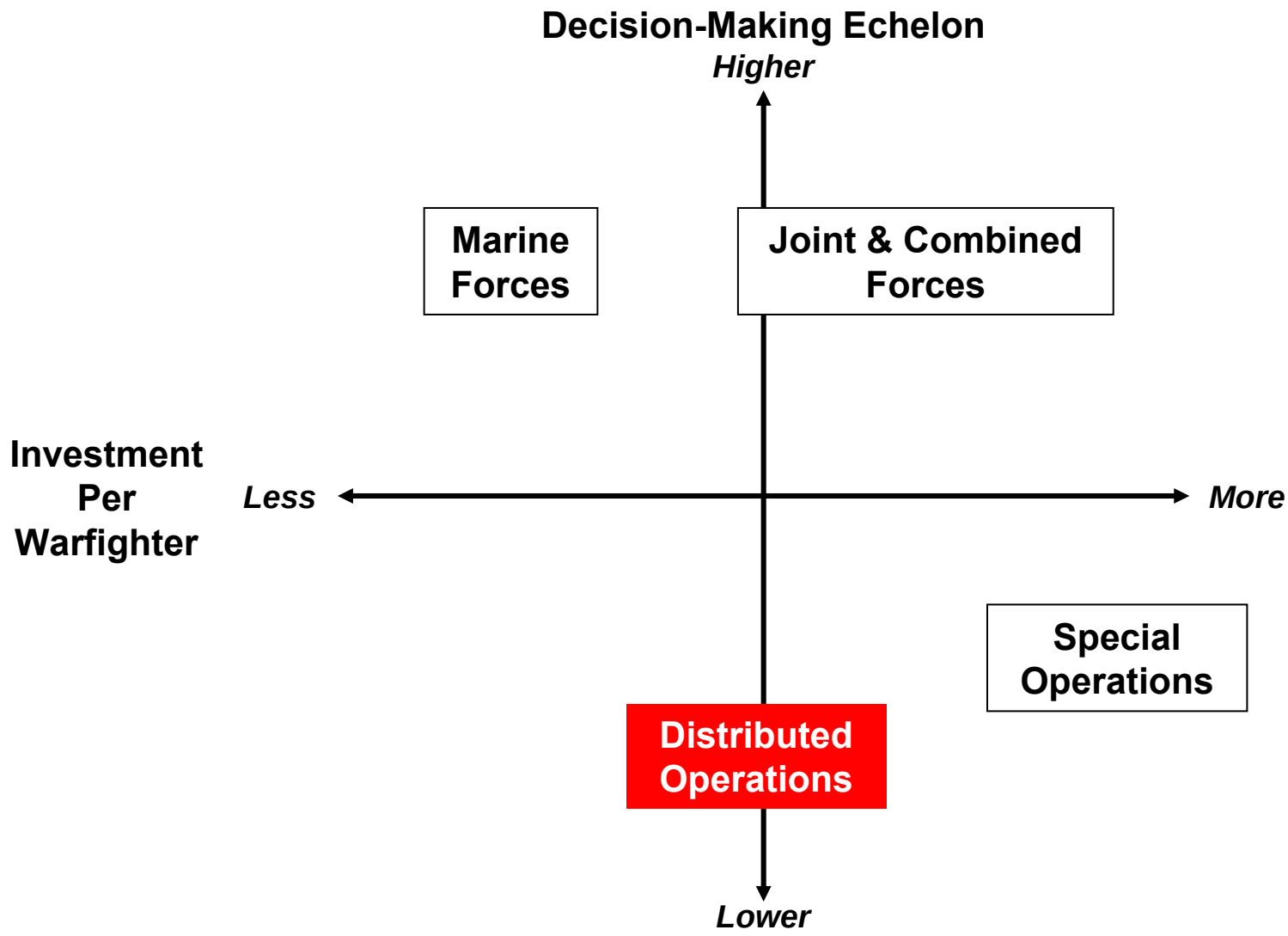


Platoon



Squad

Developments in Land Warfare



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)

Other

- Nathanial Hicks (author *One Bullet Away*)
- Dominic Green ("Career Infantry Perspective")

Commercial

- Boston Dynamics
- OnPoint Technologies
- General Dynamics Robotic Systems

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

Universities

- USC Institute for Creative Technologies
- MIT Institute for Soldier Nanotechnology
- USC GamePipe Laboratory (Viterbi School of Engineering)

Enabling the Corps for DO

Supporting the Marine Unit for DO

Mentally

Physically

Enabling the Marine for DO

The Marine

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

The Marine

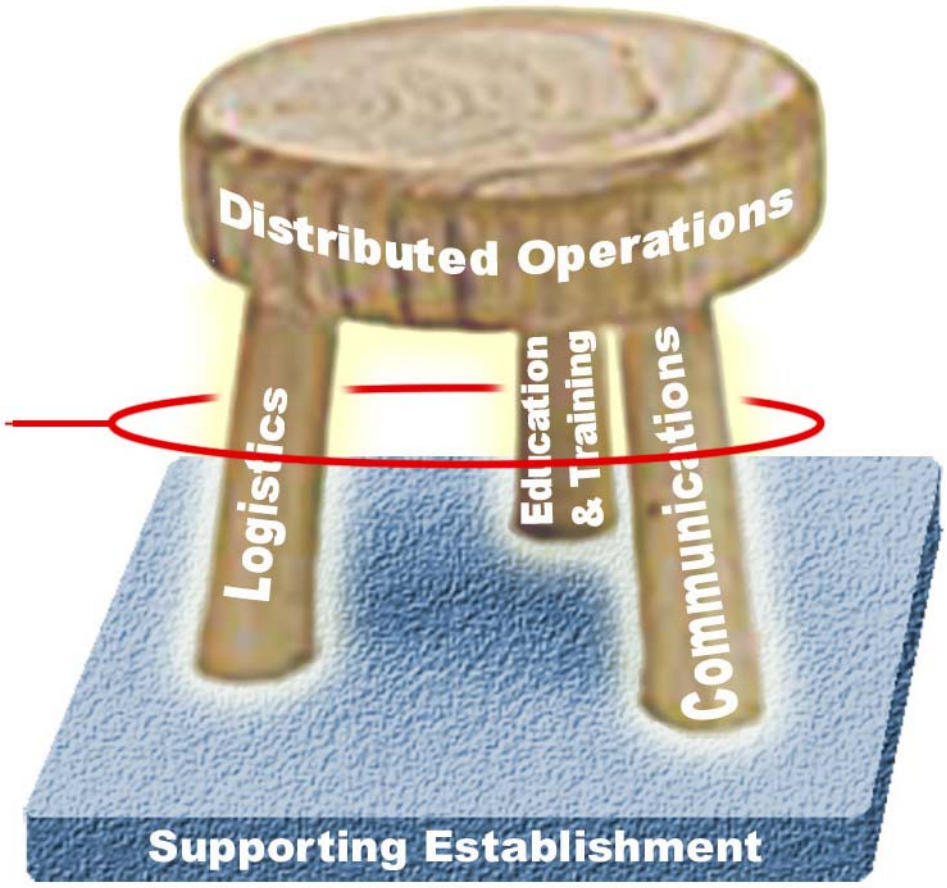
	Findings
Mental	• Currently squad-level NCOs not trained to execute missions based on commander's intent • Larger assigned operating area and more complex mission requirements increase cognitive workload • Array of communications equipment unduly complex • Only safe and evidence-based fatigue countermeasures 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

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

Enabling DO
Necessary Lines of Analysis

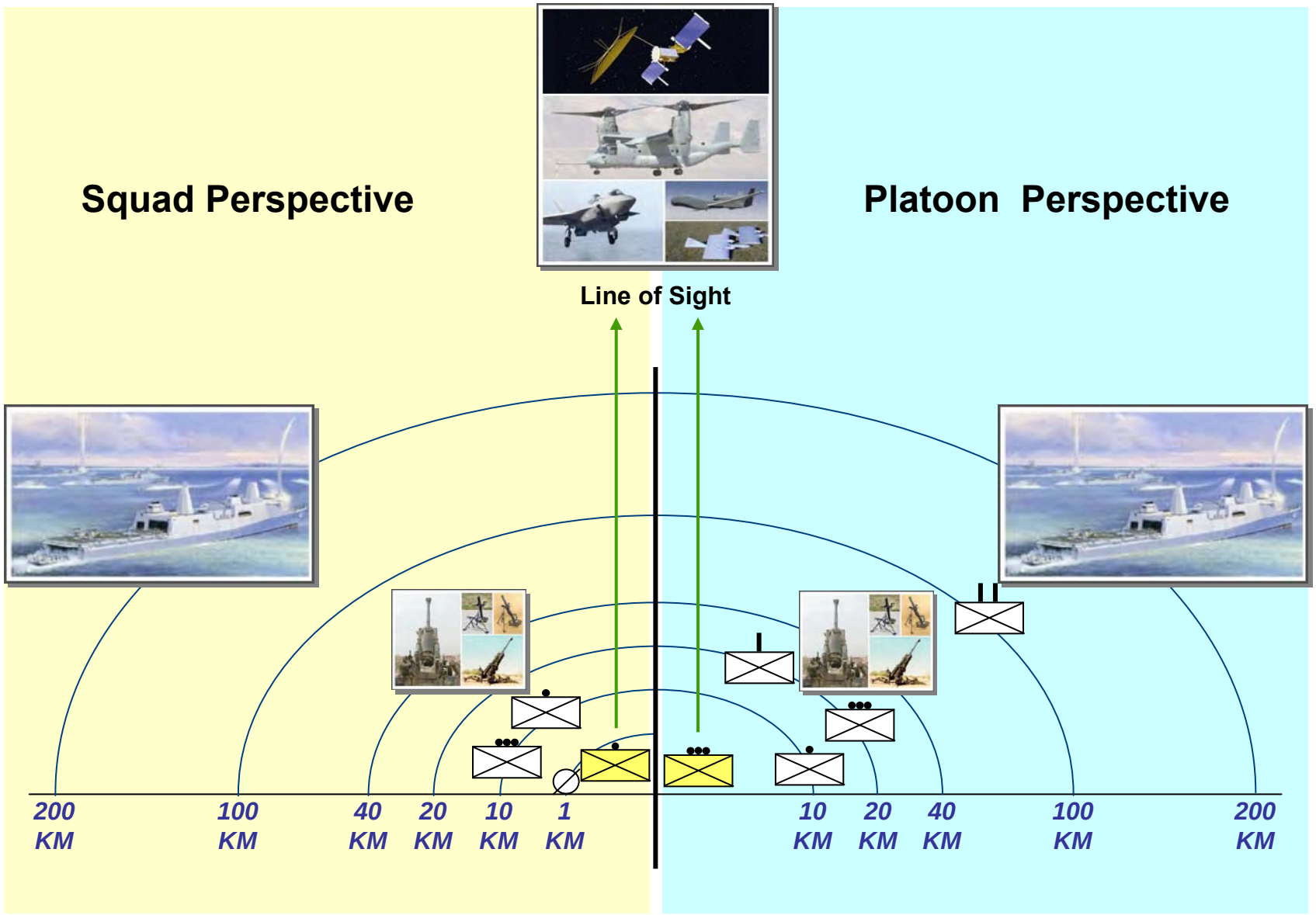
Potential Show Stoppers



Communications

DO Unit Spatial Distribution

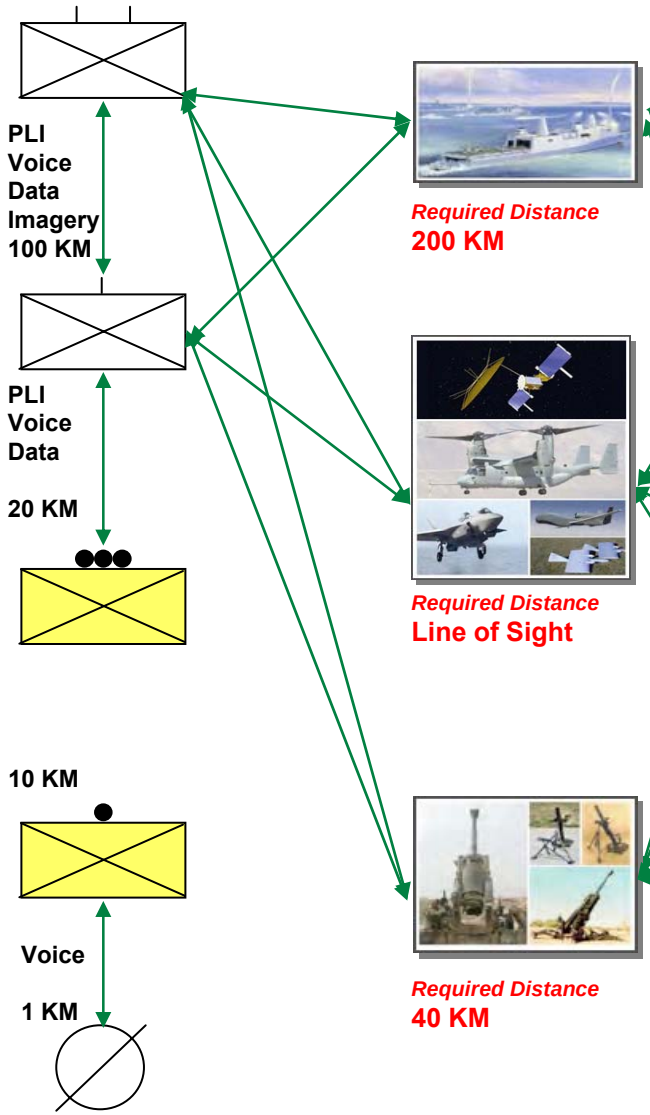
- TOR
- Distributed Operations
- Fact-Finding
- Enabling DO
- **Communications**
- Logistics
- Education & Training
- Supporting Establishment
- Findings
- Recommendations
- Panel



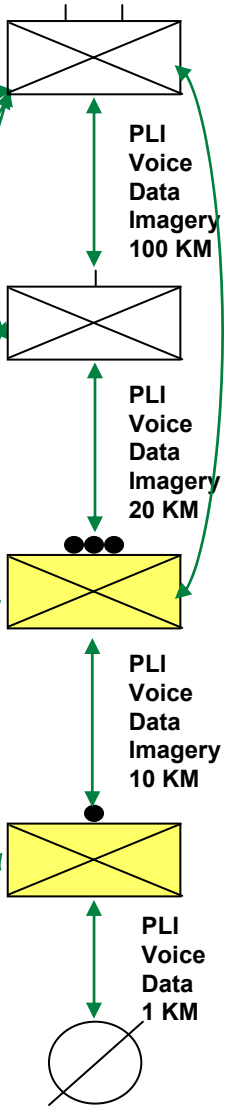
Evolution to DO Comms

Huge Increase in Complexity

Program of Record 2008



Full DO Capability



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

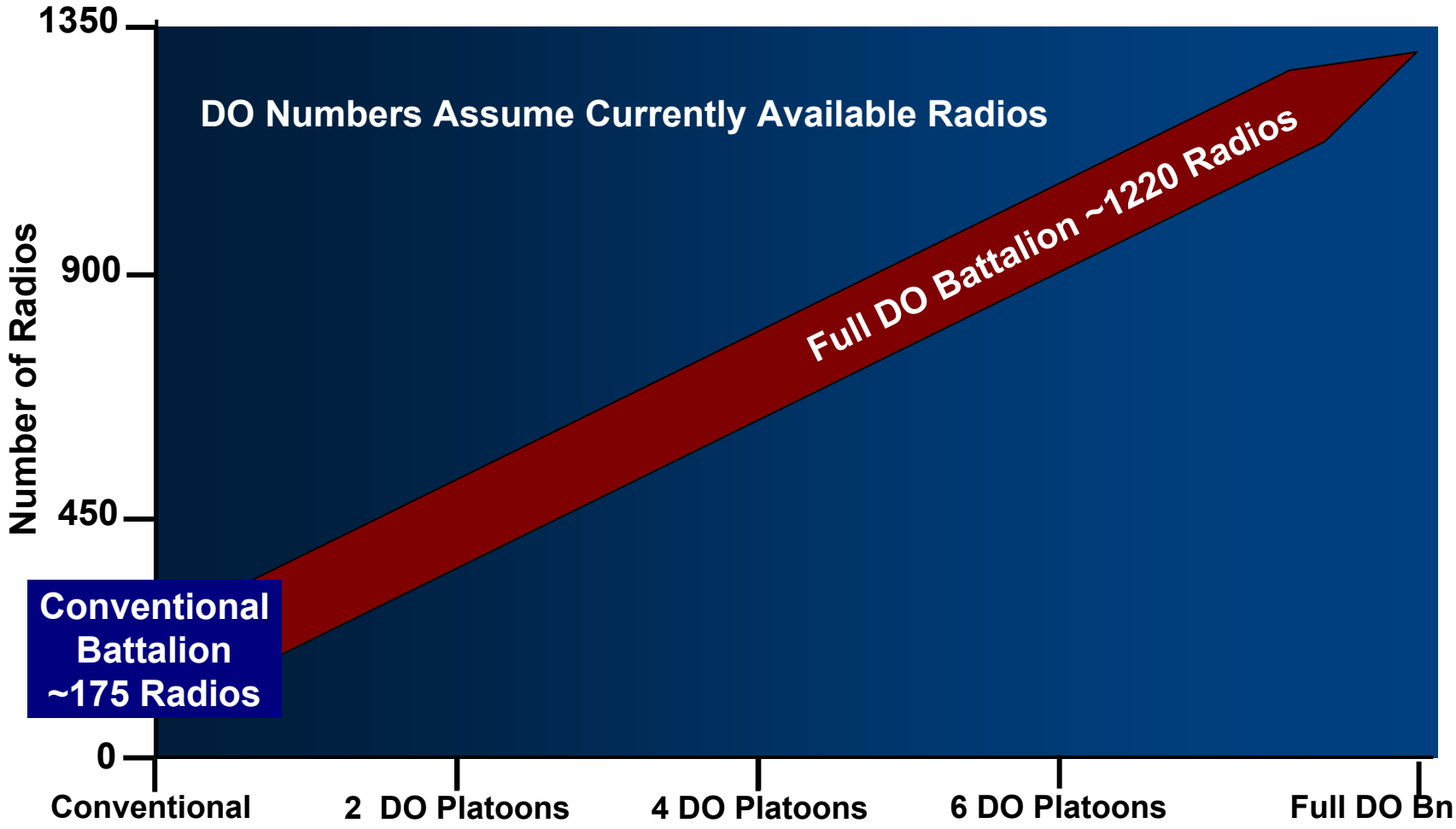
Squad Load*:
21 radios & comm dev
50 lbs of radios
6-12 lbs batteries/day

*MCSC data

Significant Impact on Battalion T/E

- TOR
- Distributed Operations
- Fact-Finding
- Enabling DO
- **Communications**
- Logistics
- Education & Training
- Supporting Establishment
- Findings
- Recommendations
- Panel

Radios per Battalion for Different at Levels of DO Implementation



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

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

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

*Global Combat Support System - Marine Corps

Logistics
Recommendations

	Recommendations
Point of Delivery Systems	Acquire unmanned systems for air and ground transport to minimize manpower and force protection needs
Logistics Comms Network	Design GCSS-MC architecture to address the platoon- and squad-level requirements
Supplies / Maintenance	Develop "DO Marine as a System" architecture approach; address RAM-D in future infantry systems

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

Education & Training

Conventional vs. Distributed Operations

- **Training for conventional operations focuses on basic elements needed for military success:**
  - **Leadership, warfighting, MOS proficiency**

- **DO builds on the above and adds**
  - **Concentration on critical thinking and decision-making by small unit leader**
  - **Substantial technical and professional training in**
    - **C2ISR**
    - **Control of fires**
    - **Cultural awareness**
    - **Logistics**

"Train for certainty ... educate for uncertainty"

Master Gunnery Sergeant Dominic Green, USMC (Ret.)

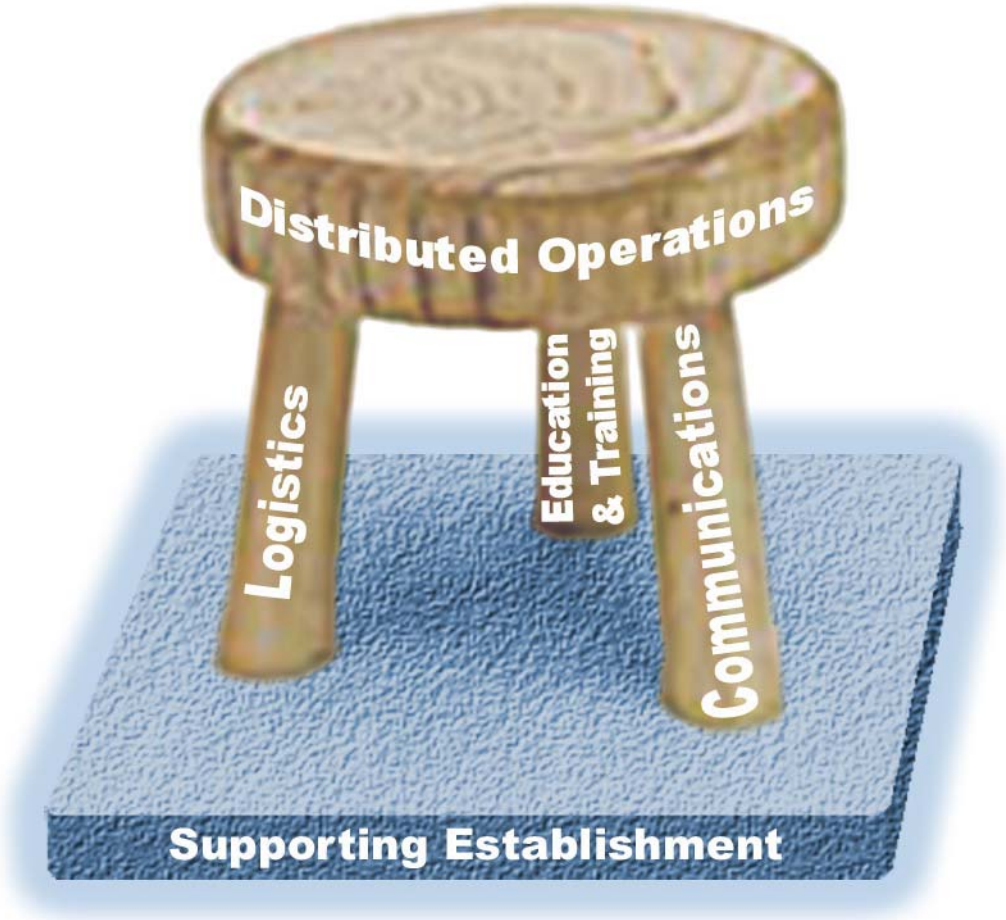
Education & Training
Findings

- **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



Impact on Infantry Battalion
Table of Organization

	Conventional Operations	Distributed Operations
Logistics	3–4 Company distribution nodes Internal reallocation / rebalancing Consolidated processing	Increased direct delivery sites Limitations to internal rebalancing Disaggregated processing
	Finding: Analysis, supply, and distribution functions likely exceed organic capability in sustained operations	
Intelligence	Fusion at higher echelons Limited battlespace sensors Near real time	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	Primarily augmented/dismounted Limited density/limited authority at battalion level (e.g., transport, NVG)	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

	Conventional Operations	Distributed Operations
Recruitment	Infantry GCT requirement unchanged for years	Potentially higher GCT requirement
Accession	Minimal screening for critical cultural and decision-making skills	Increased screening for critical cultural and decision-making skills
Assignment	Long pre-deployment flow	Shorter, earlier pre-deployment flow
	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

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

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

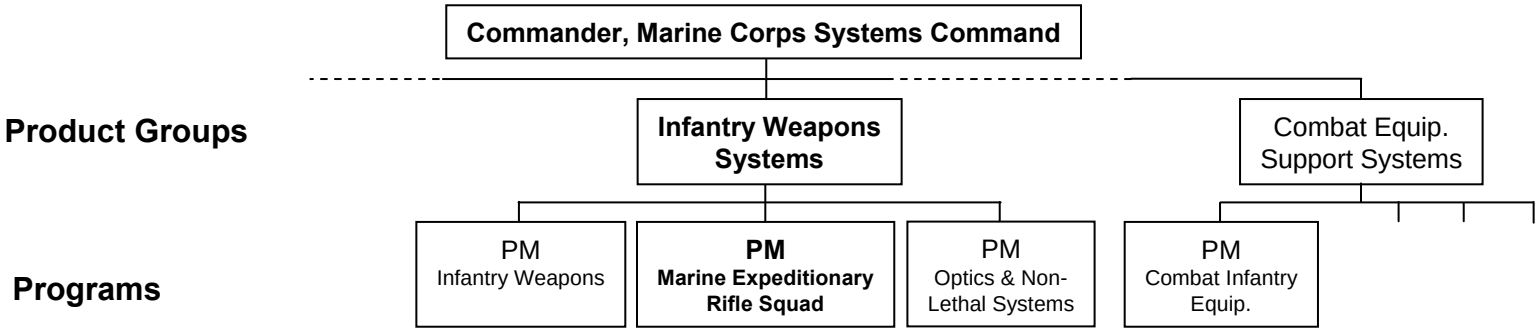
Rifle Squad (Possibly Reinforced)

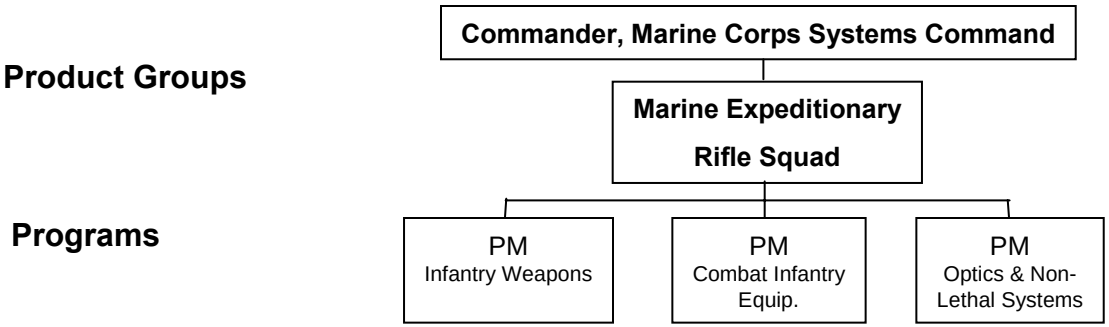
Individual Marine's Load: Personal Protective Gear + Weapons/Optics + Food/Water
Sum of Unallocated Individual Loads Available for Squad Use

- **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

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?

- TOR
- Distributed Operations
- Fact-Finding
- Enabling DO
- Communications
- Logistics
- Education & Training
- Institutional Issues
- Findings
- Recommendations
- Actions
- Panel