



**Preparing for the future....  
Never forgetting the past!**

# MARINE CORPS SYSTEMS COMMAND – ADVANCED PLANNING BRIEF TO INDUSTRY

Norfolk, VA  
30 April 2012

**Expeditionary  
Maneuver Warfare  
& Combating Terrorism  
S&T Department**

**Code 30**

DEVELOPING FUTURE NAVAL COMBAT CAPABILITIES

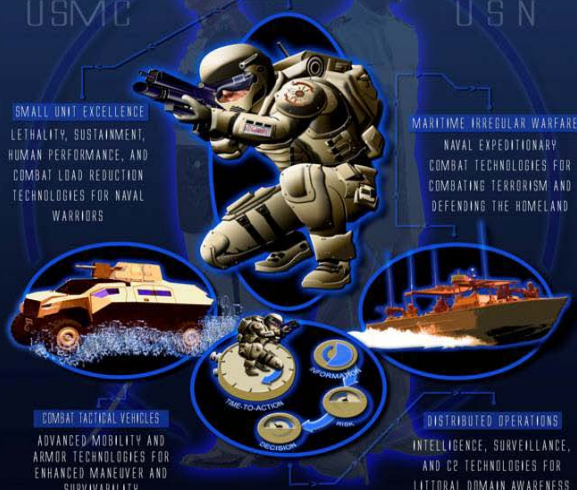
USMC U.S.N.


**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



 OFFICE OF NAVAL RESEARCH

**Mr. George W. Solhan, SES**

Deputy Chief of Naval Research,  
Expeditionary Maneuver Warfare and  
Combating Terrorism S&T

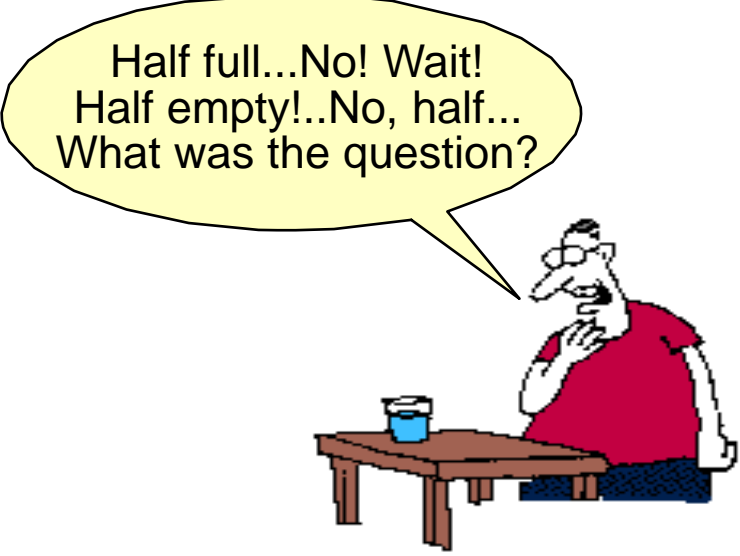
Director, Marine Corps S&T



ONR



SYSCOM

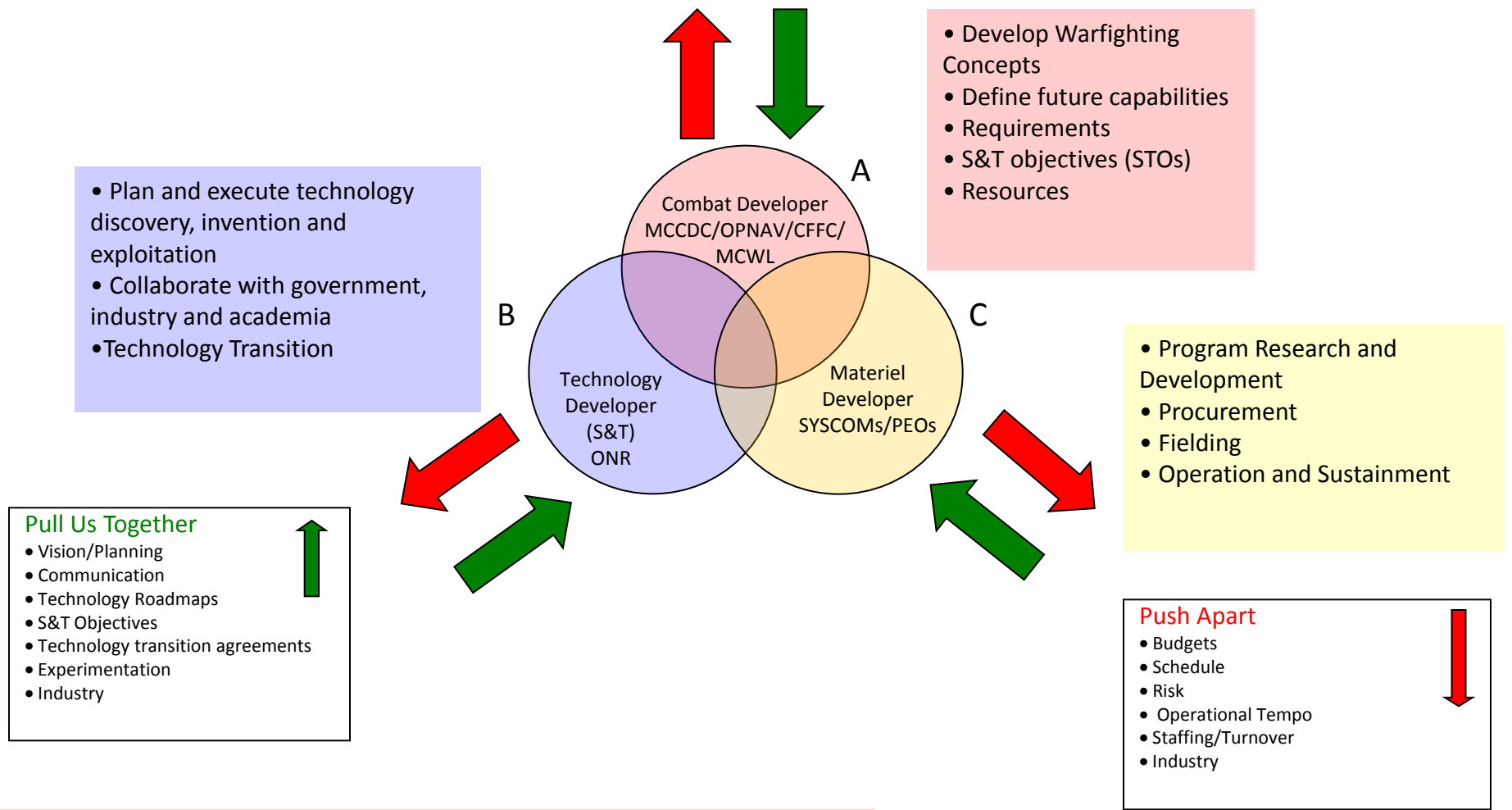


MCCDC/OPNAV



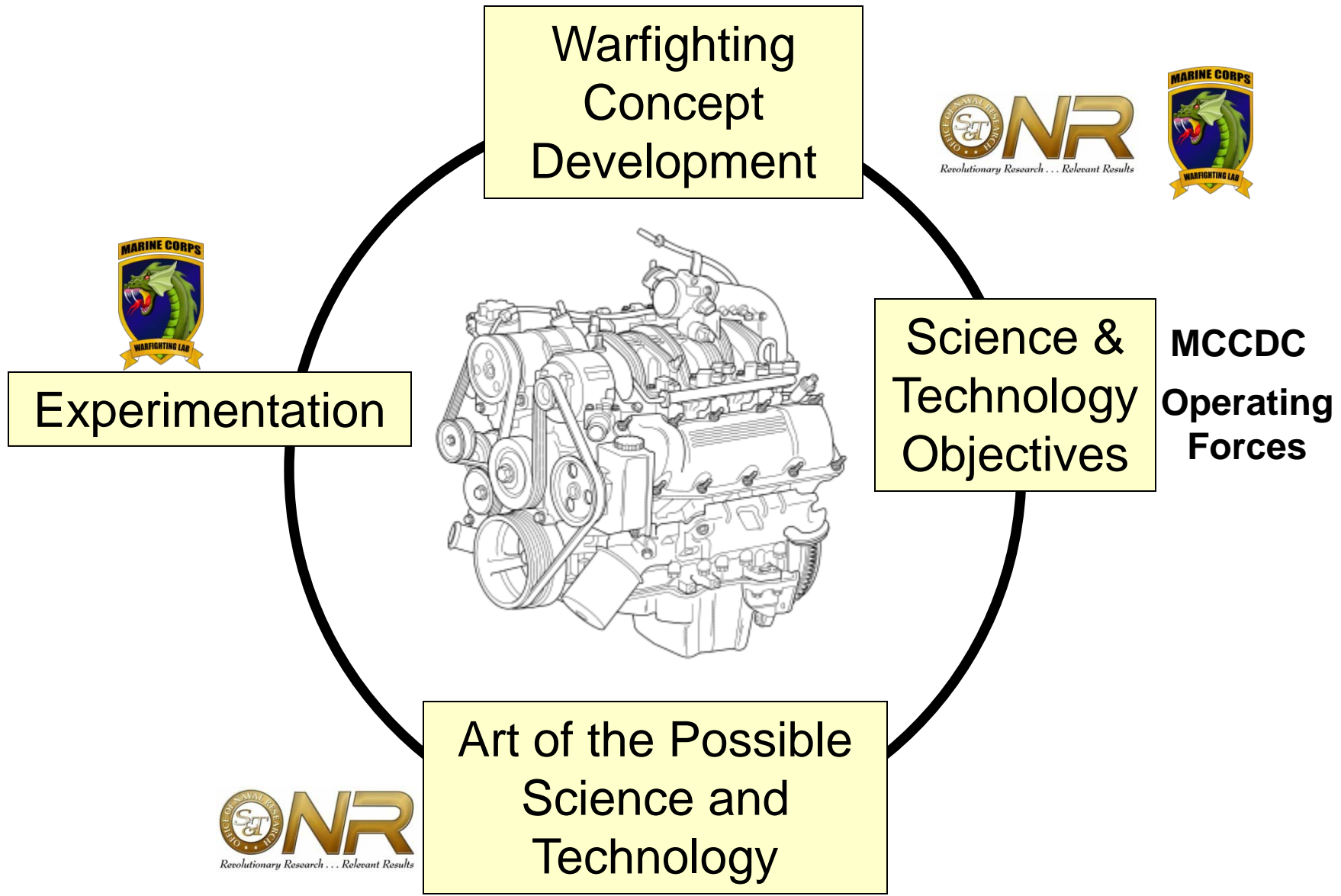
Fleet/MARFOR

# “The Three Circles”



A	Concept	Capability Futures	Gaps	Requirements	
B		Capability Futures	Gaps	Requirements	Technology
C			Requirements	Technology	R&D Production
					Capability

# Creative Engine for Combat Development



Warfighting  
Concept  
Development



Science & Technology  
Objectives

MCCDC  
Operating  
Forces

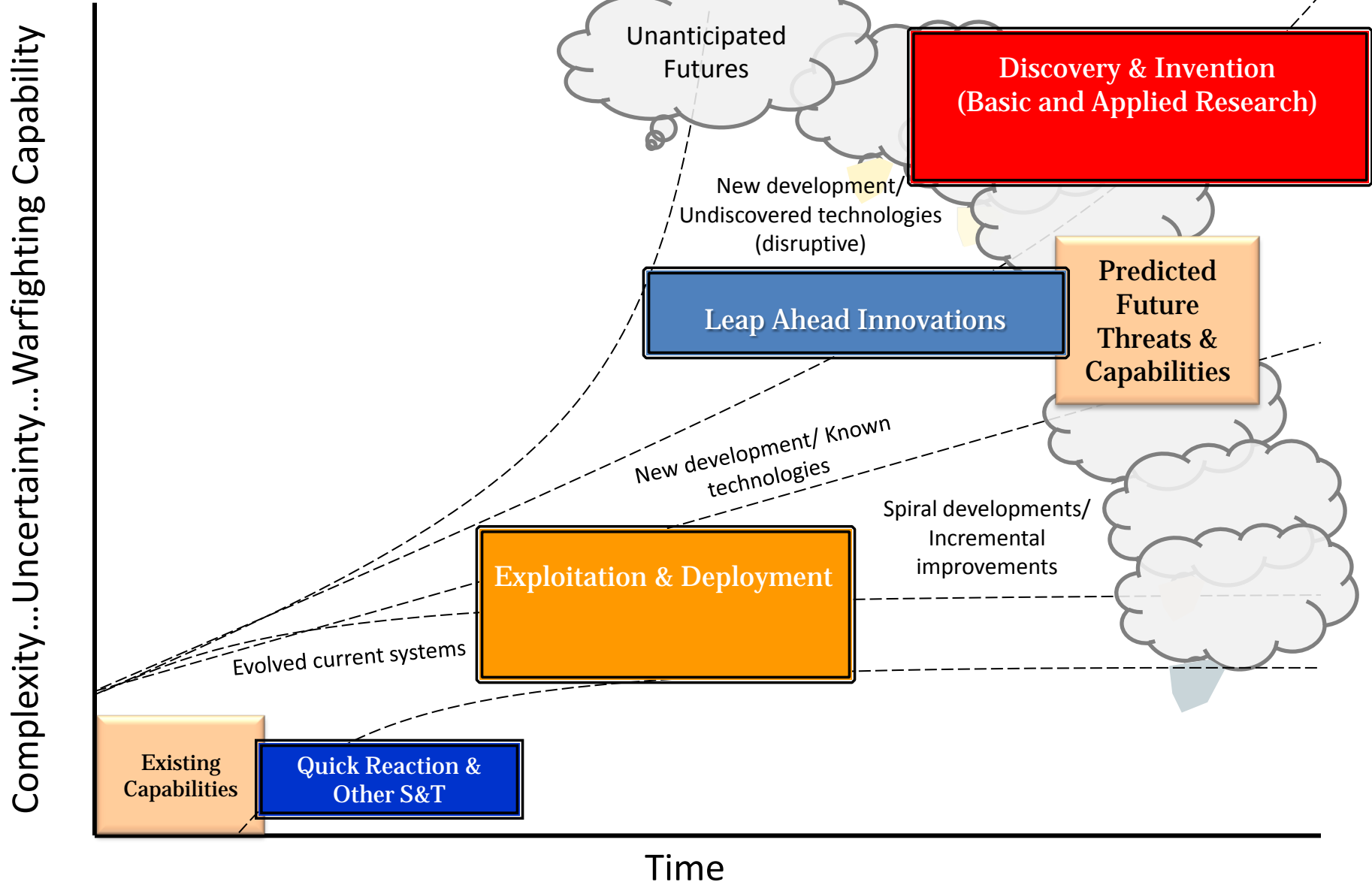
Experimentation



Art of the Possible  
Science and  
Technology

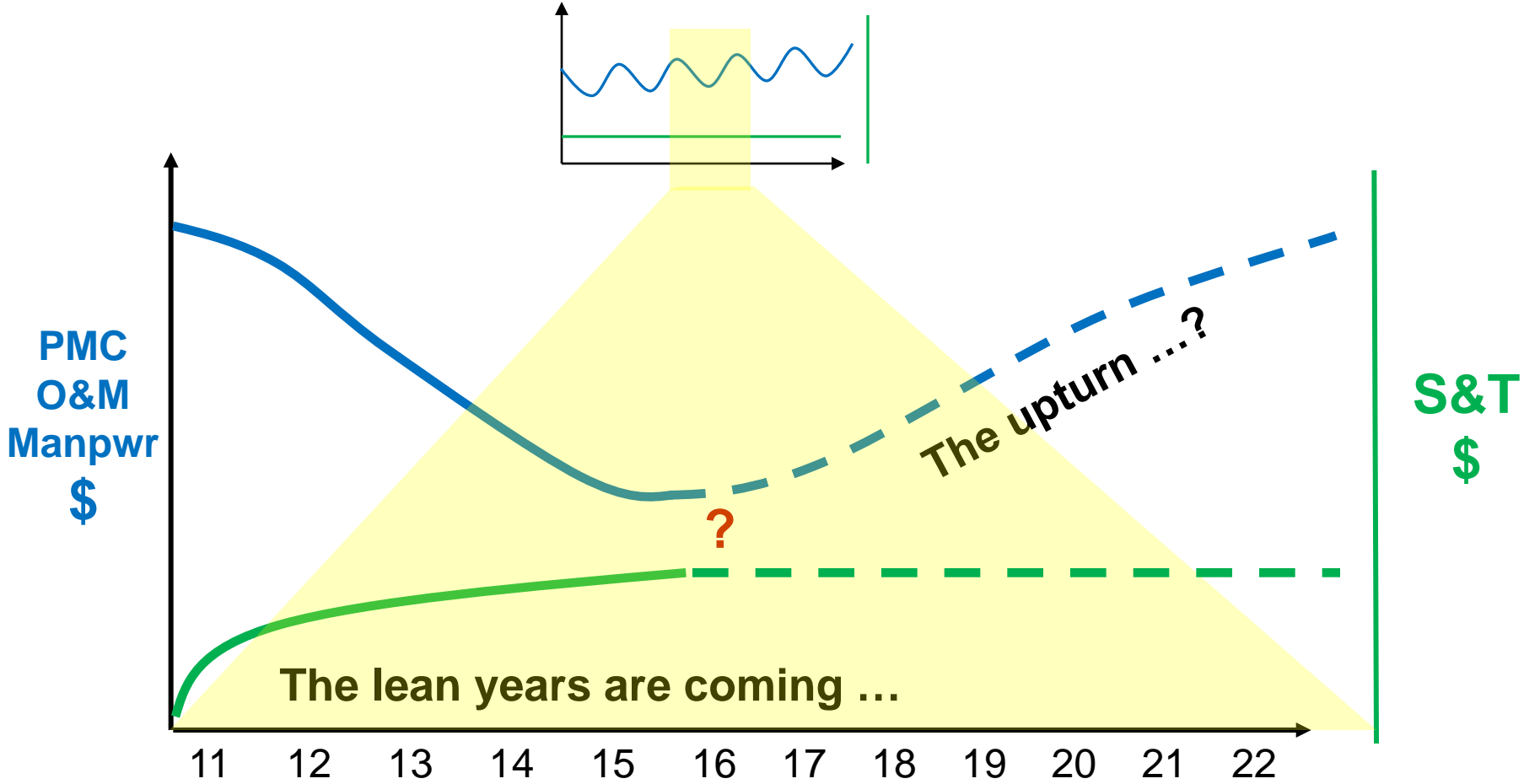


# Portfolio Alignment with Futures



# S&T Opportunity

“When you have no money, **THINK**”



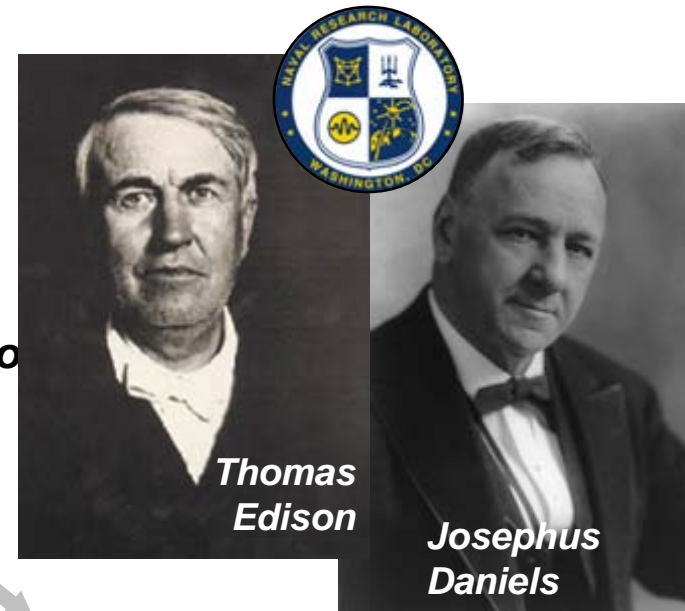
- When procurement funding is plentiful, S&T/Exp is important
- Shape the nature of the buy When procurement funding is scarce, S&T/Exp is more important
- Mitigate Risk with the Creative Engine – Know What is Possible... and When
- Shape future capability – be prepared to take advantage of opportunities when the upturn comes



# Naval Research: A Statutory Mission

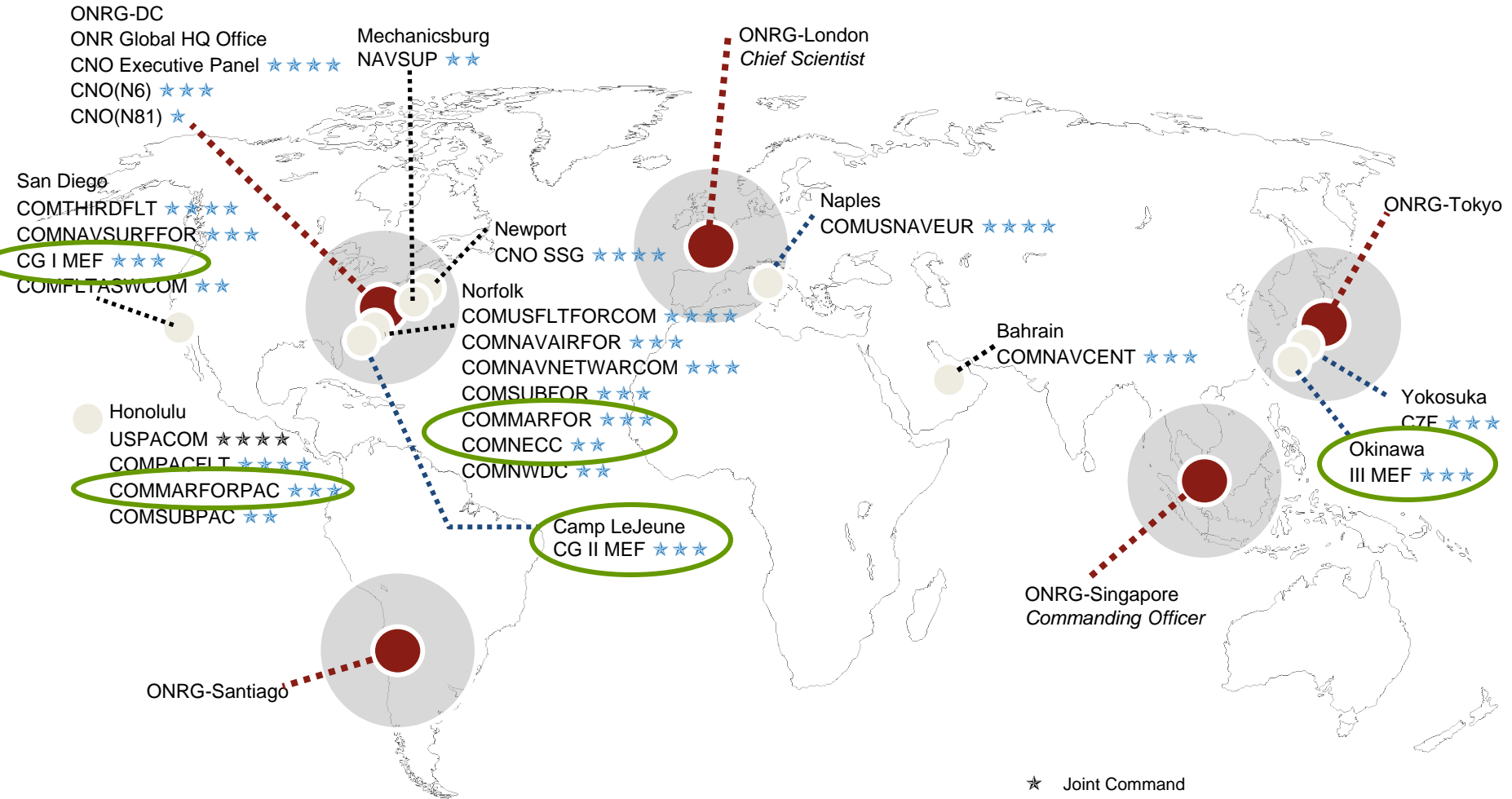
Naval Research Laboratory (Appropriations Act, 1916):  
“**[Conduct] exploratory and research work...necessary... for the benefit of Government service, including the construction, equipment, and operation of a laboratory....**”

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....**”



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.**”

# ONR Global Presence



★ Joint Command  
 ★ Naval Command  
 SA Science Advisor  
 AD Associate Director



# Office of Naval Research

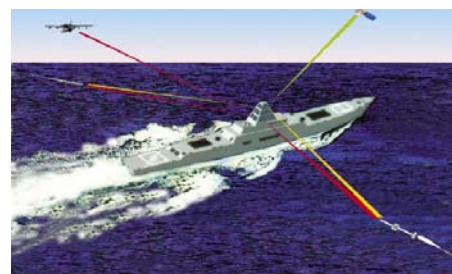
Code 30



Expeditionary Maneuver Warfare & Combating Terrorism

Code 31

C4ISR



Code 32

Ocean Battlespace Sensing



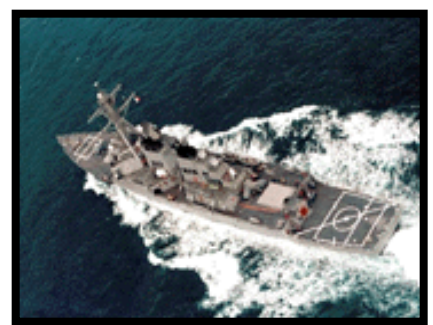
Sea Warfare and Weapons

Warfighter Performance

Air Warfare and Weapons



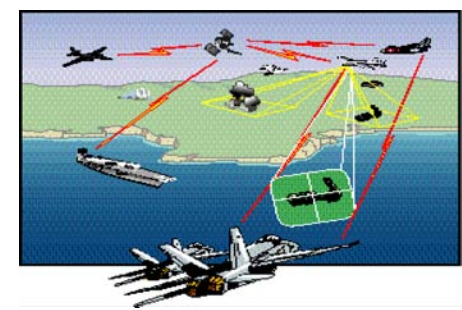
Naval Research Laboratory



Code 33



Code 34

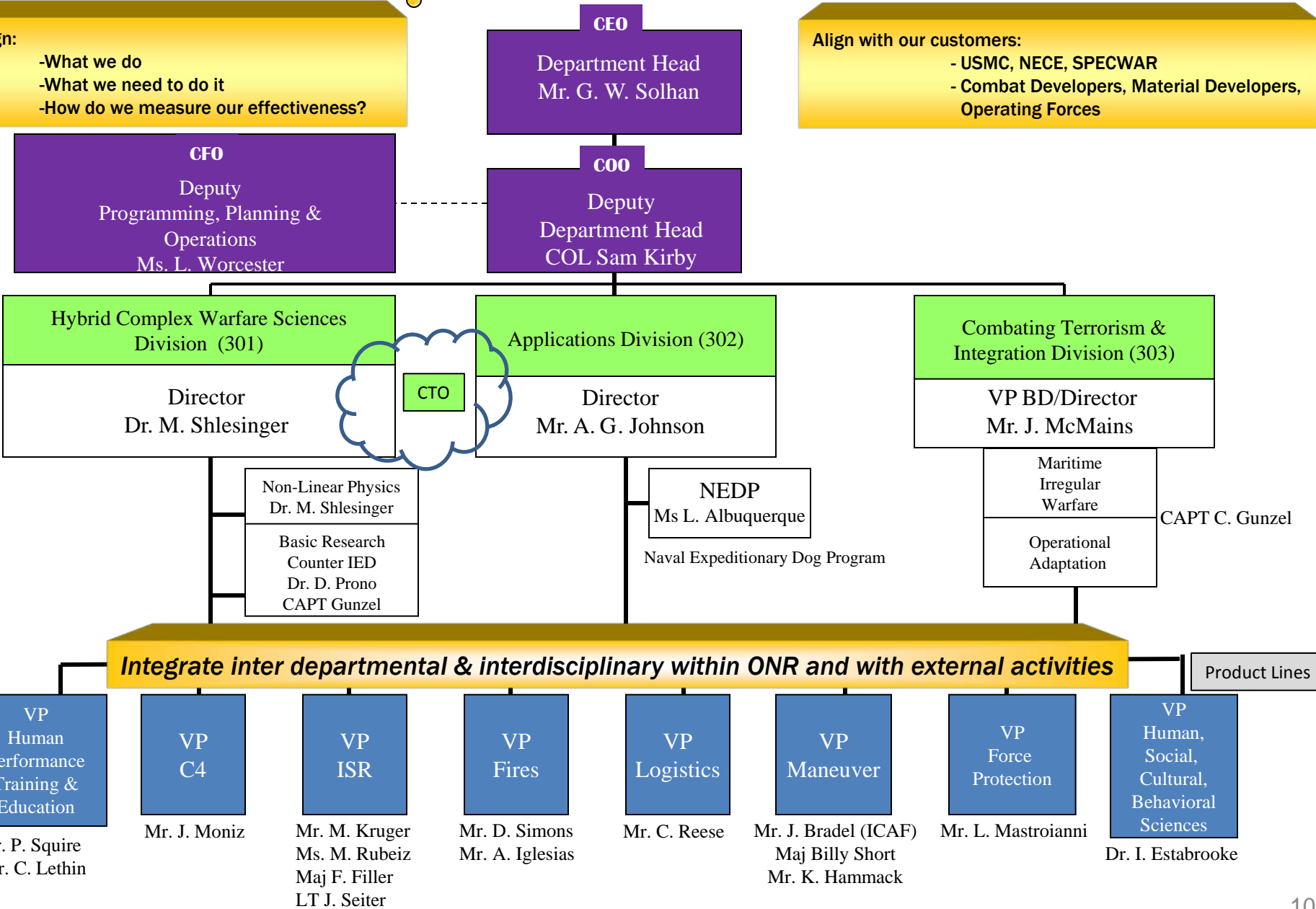


Code 35

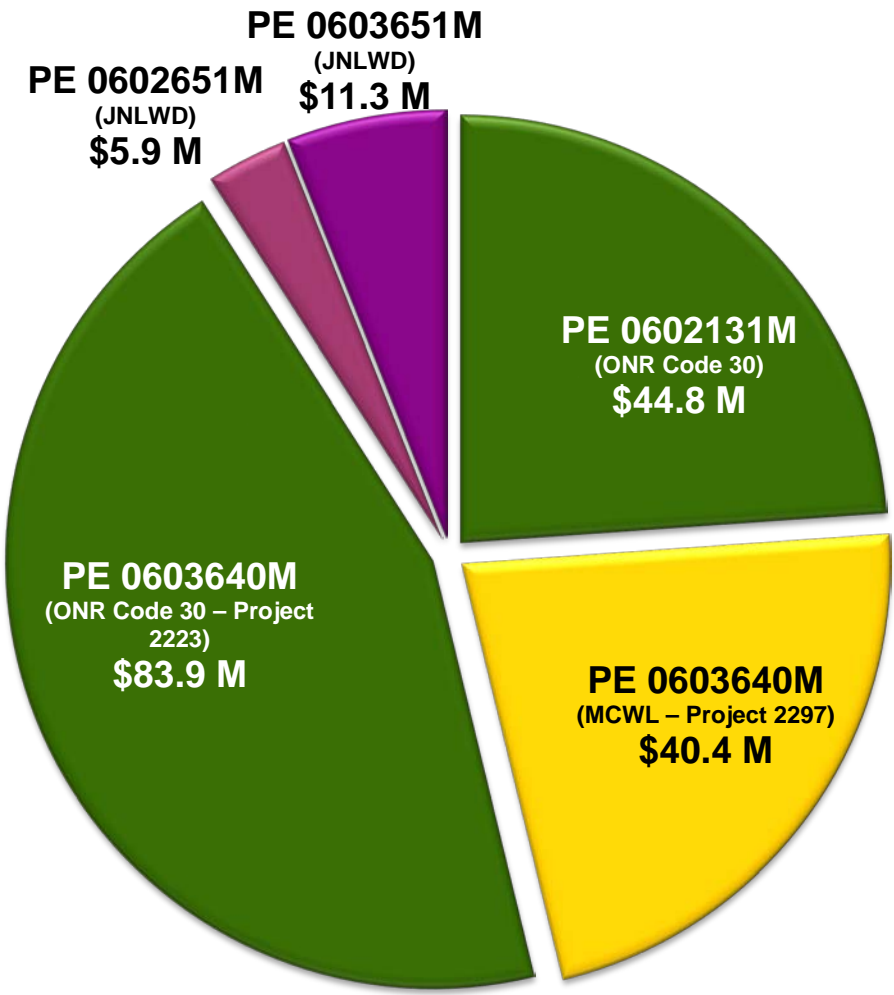
**Focus on the warrior as a system, rather than the platform!**

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

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



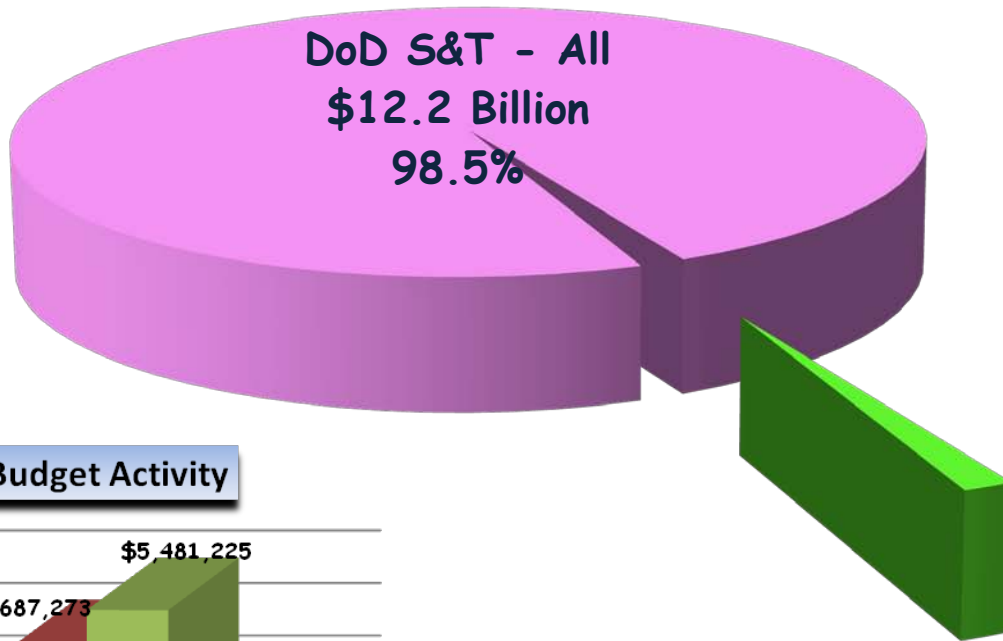
# PBR FY-12 S&T Funding (Total \$186.3M)



Leverage: ≈ \$100M

Data derived from PBR FY-12

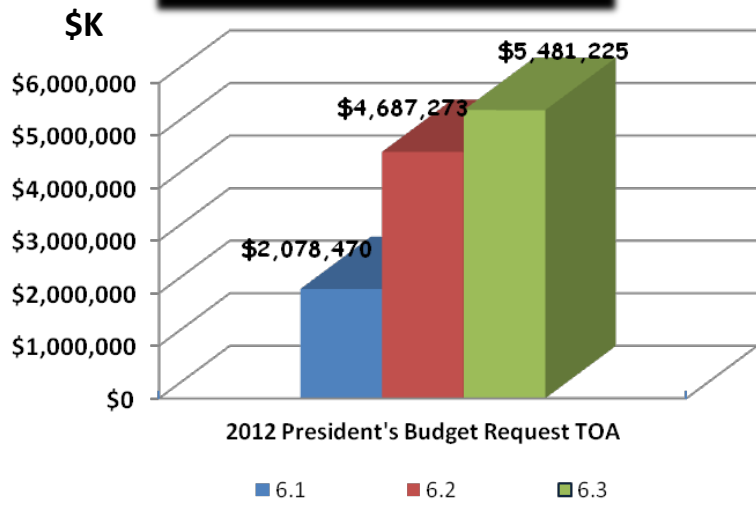
# USMC S&T & DoD S&T FY2012 TOA



**USMC S&T**  
**\$186.3 Million**  
**1.5 % of DoD**  
**S&T TOA**

**Leverage:**  
**Collaborative,**  
**Joint, Cooperative,**  
**In-kind**

**DoD S&T By Budget Activity**





# USMC S&T Is Aligned to the 35<sup>th</sup> CMC's Guidance

*The Marine Corps is America's Expeditionary Force in Readiness — a balanced air-ground-logistics team. We are forward-deployed and forward-engaged: shaping, training, deterring, and responding to all manner of crises and contingencies. We create options and decision space for our Nation's leaders. Alert and ready, we respond to today's crisis, with today's force ... TODAY. Responsive and scalable, we team with other services, allies and interagency partners. We enable and participate in joint and combined operations of any magnitude. **A middleweight force**, we are light enough to get there quickly, but heavy enough to carry the day upon arrival, and capable of operating independent of local infrastructure. **We operate throughout the spectrum of threats — irregular, hybrid, conventional — or the shady areas where they overlap.** Marines are ready to respond whenever the Nation calls ... wherever the President may direct.*



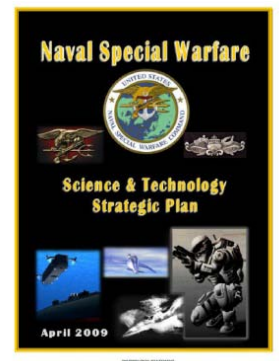
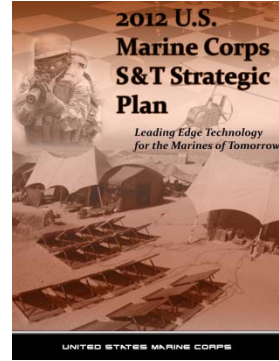
35<sup>TH</sup> COMMANDANT OF THE MARINE CORPS  
COMMANDANT'S PLANNING GUIDANCE

2010

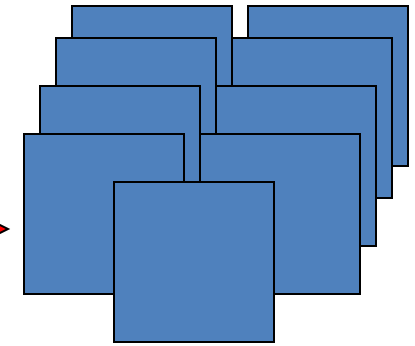
## Priorities of the 35th Commandant of the Marine Corps

- We will **continue to provide the best trained and equipped Marine units to Afghanistan.** This will not change. This remains our top priority!
- We will **rebalance our Corps, posture it for the future and aggressively experiment with and implement new capabilities and organizations.**
- We will **better educate and train our Marines to succeed in distributed operations and increasingly complex environments.**
- We will **keep faith with our Marines, our Sailors and our families.**

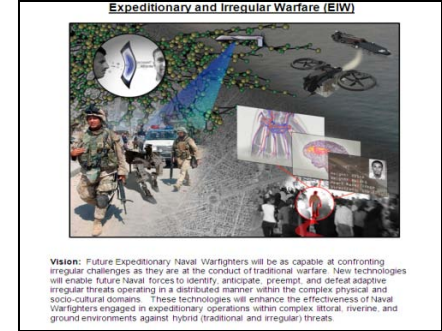
# Science & Technology "Top Down" Guidance



9 Focus Areas



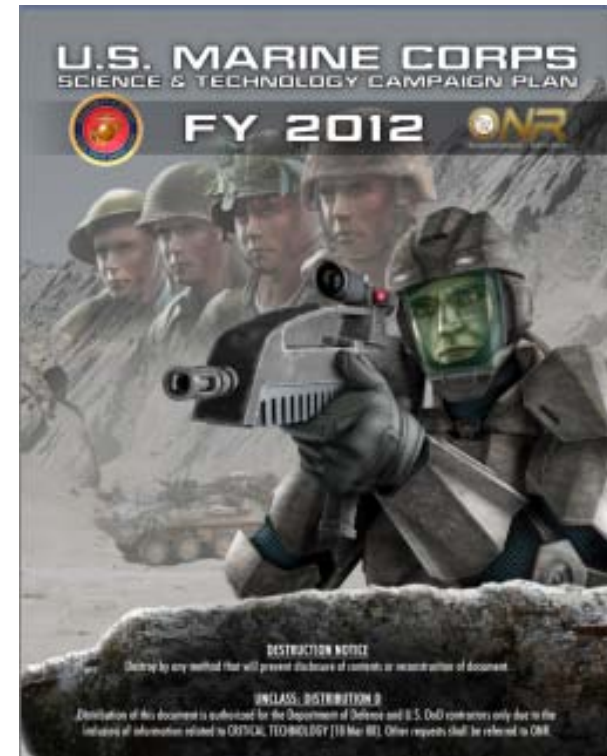
Expeditionary and Irregular Warfare





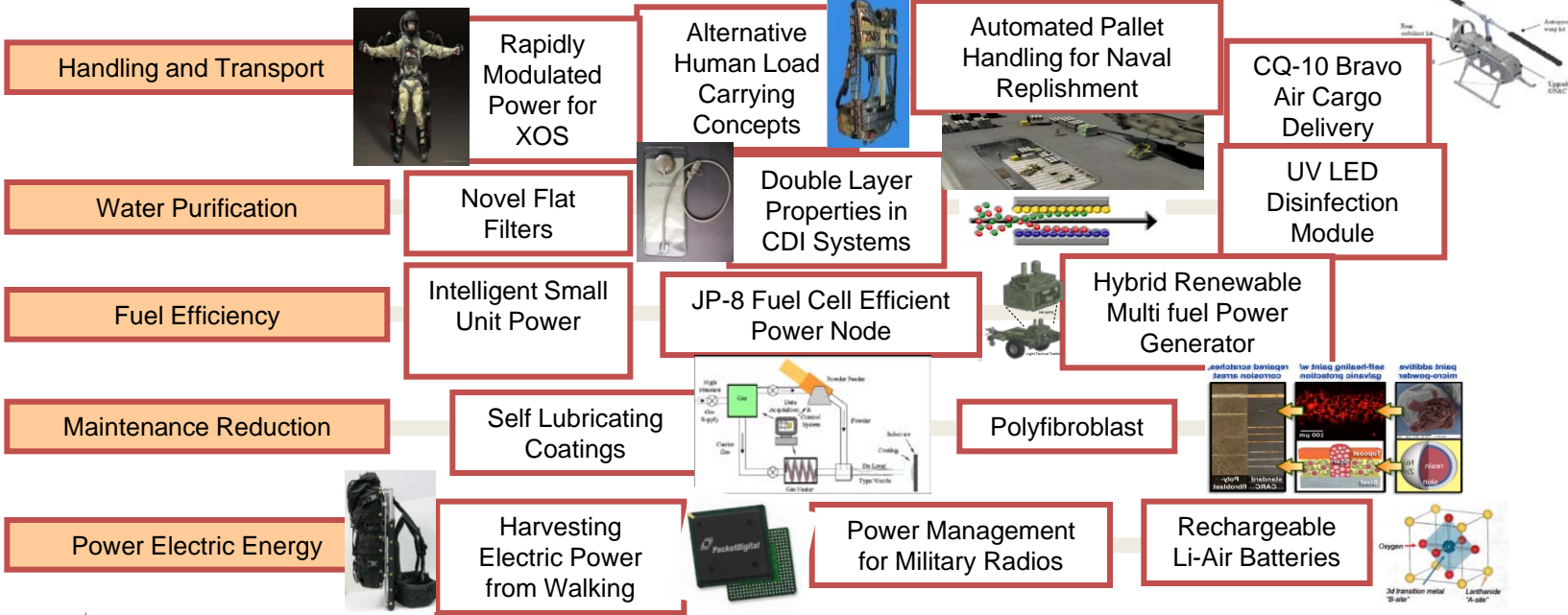
# ONR Code 30 Thrust Alignment

- C4 Thrust
- ISR Thrust
- Fires Thrust
- Maneuver Thrust
- Logistics Thrust
- Force Protection Thrust
- Naval Expeditionary Dog Program
- Human Performance, Training, and Education
- Sciences Addressing Asymmetric Explosive Threats
- Human, Social, Cultural, Behavioral Sciences

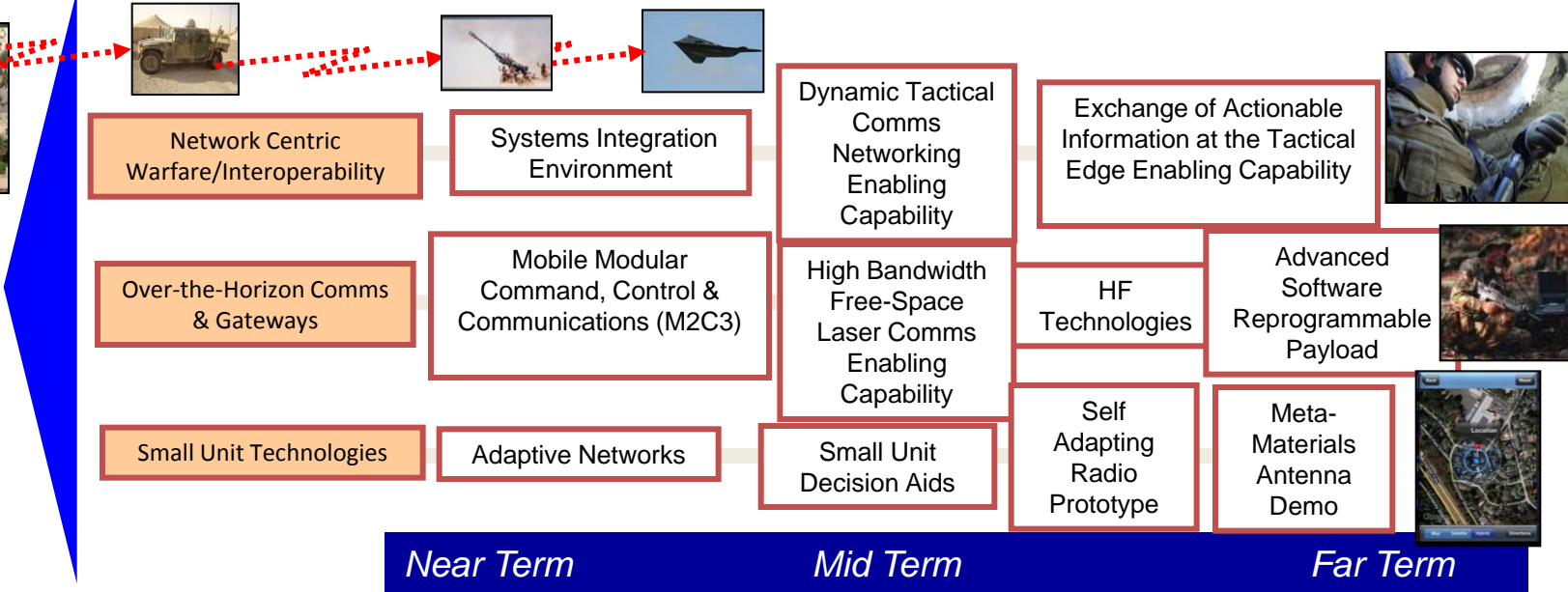


# Expeditionary Maneuver "Whitman's Sampler"

## Logistics

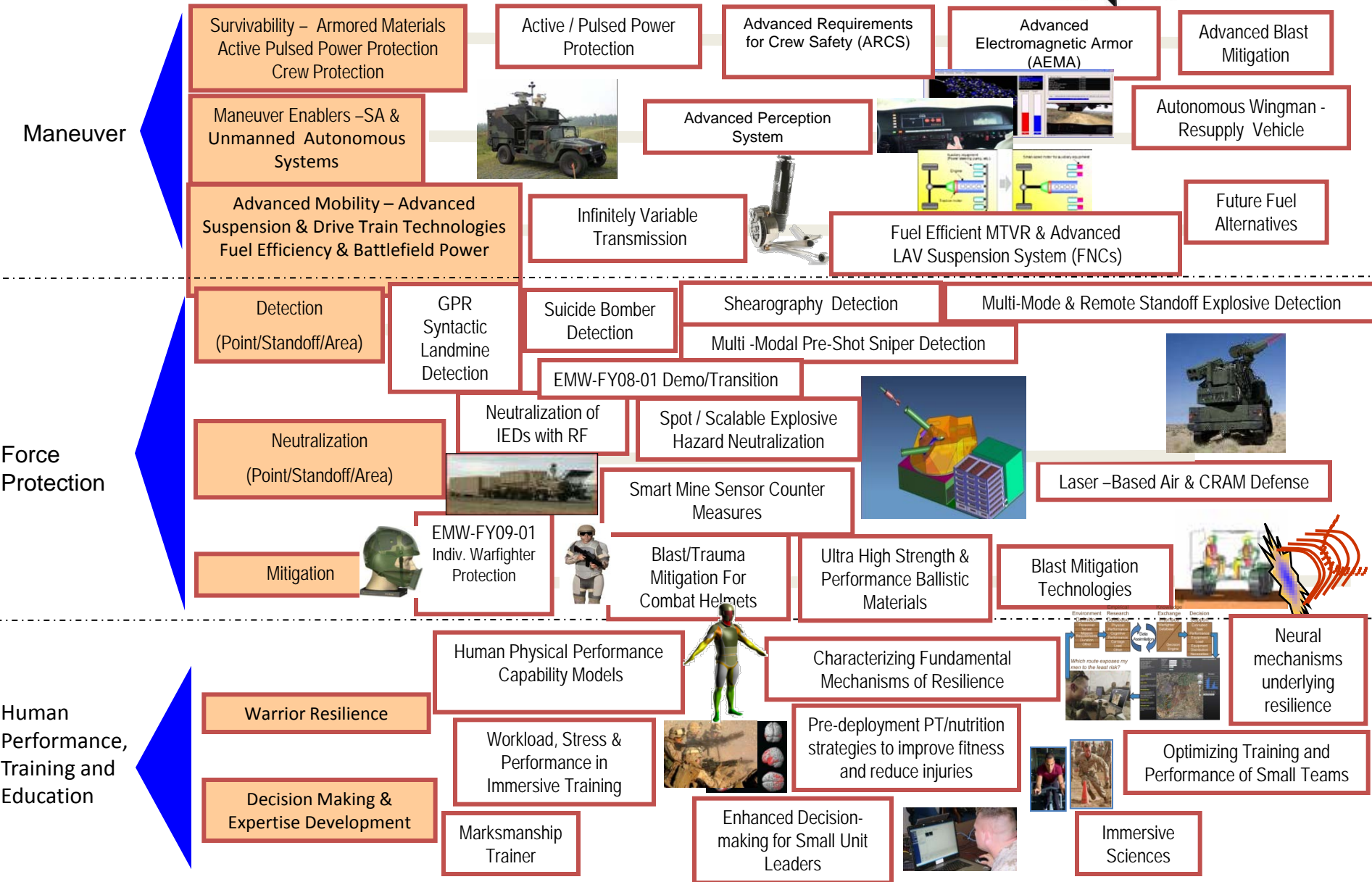
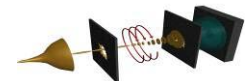


## Command, Control, Communications, and Computers (C4)





# Expeditionary Maneuver "Whitman's Sampler"



Near Term

Mid Term

Far Term



## Targeting and Engagement TIA – Willful Intent

<b>Current Capability:</b>			
<ul style="list-style-type: none"> <li>Conventional targeting and engagement systems for direct and indirect fire capability</li> </ul>			
<b>FY</b>	<b>Desired Capability</b>	<b>S&amp;T Challenge</b>	<b>S&amp;T Solution</b>
<b>Near Term FY11- FY15</b>	<ul style="list-style-type: none"> <li>Accurate target location for dismounted warfighters, at standoff distances, in all terrain and weather conditions, including urban and mountainous with cloud cover</li> <li>Light-weight, low cost target detection, recognition, and identification out to effective ranges of small arms and crew served weapons in day, night, and all weather conditions</li> <li>Coordinated threat response with remote weapons stations</li> </ul>	<ul style="list-style-type: none"> <li>MEMS based gyro compassing using high-Q (~500k) silicon based disc resonating gyros with Angle Random Walk of 0.004 deg/rt hr and Bias Stability of 0.04 deg/hr, resulting in an azimuth accuracy of 4 mils achievable in 4 minutes through MEMS scale wafer trimming and high vacuum packaging</li> <li>Lower SWIR dark current to increase signal to noise ratio through novel ROIC design, extending identification range and eliminate the need for a thermal electric cooler for an integrated SWIR/LWIR imager by implementing non-uniformity correction algorithms across the operational temperature range for lightweight, low power targeting and observation systems</li> <li>Integrated stabilization, data fusion, compression algorithms, frequency hopping techniques, advanced communication protocols, and object oriented GUI software for networked sensors and remote weapon systems onto multiple platforms</li> </ul>	<ul style="list-style-type: none"> <li>Hemispherical resonator gyro, micro-electromechanical system (MEMS) tuning fork gyro, MEMS silicon based disc resonator gyro, accelerometers, and electronic components packaged in complete inertial measurement units (IMU)</li> <li>Integrated Vis-NIR-SWIR-LWIR sensors in a single focal plane array</li> <li>Boomerang and CROWS II integrated via 4CE software hosed on Tough-book computers and multiple systems networked via the PRC-117G radio</li> </ul>
<b>Mid Term FY16- FY20</b>	<ul style="list-style-type: none"> <li>Handheld inertial navigation targeting in all environment and weather conditions, including GPS-denied</li> <li>Lightweight, day/night wide FOV target acquisition for individual dismounted warfighters</li> <li>Self defense, precision engagement, and escalation of force from unmanned ground and surface platforms</li> </ul>	<ul style="list-style-type: none"> <li>MEMS based inertial navigation using high-Q (~1M) disc resonating gyros with Angle Random Walk of 0.001 deg/rt hr and Bias Stability of 0.01 deg/hr, resulting in an azimuth accuracy of 1 mils achievable in 60 seconds through MEMS scale wafer trimming and high vacuum packaging of MEMS based gyros, and through integration of MEMS based accelerometers</li> <li>Fabricate Gradient Index lenses from low density polymers with optical transparency (90+%) and sufficient dispersion (Abbe# 30-90) by varying polymer optical properties and the refractive index (<math>\Delta n=0.2</math>) to create an optical lens element with a 75% weight reduction while increasing the number of resolvable pixels by 50%</li> <li>Accurate identification and simulation of kill-chain functions that can be optimally served by semi-autonomous systems for self-defense and precision engagement, reducing dependency on RF links</li> </ul>	<ul style="list-style-type: none"> <li>MEMS quartz based disc resonator gyro, MEMS 5 deg. of freedom spinning mass gyro, electronic components, accelerometers, and position tracking in a complete inertial navigation system</li> <li>Miniaturized GRIN lens and other imaging technologies to provide enhanced SWAP and FOV</li> <li>Unreal Development Kit (UDK) based M&amp;S, virtual simulations, electro-optic based target detection and video tracking algorithms, RWS gunner logic/behavior programming, an autonomy kit, object detection/classification algorithms, and world model of the Advanced Perception System (APS) from the Small Unit Mobility Enhancement Technologies (SUMET) program</li> </ul>

## Targeting and Engagement TIA – Willful Intent Continued

. . . Continued

<p><b>Far Term</b> FY21- FY25</p>	<ul style="list-style-type: none"> <li>• 10m target location error (TLE) at standoff distances, accounting for all sources of error, including azimuth, self location, vertical angle, range, and meteorological effects</li> <li>• Remotely deployed tags with delivery and activation system to mark targets of interest at near to extended stand-off distances</li> <li>• Automatic target detection, recognition, identification, tracking, and hand-off capability at stand-off distances in dismounted targeting systems</li> <li>• Miniaturized, inertial-based, autonomous navigation of munitions for GPS-denied environments and no available laser designation</li> <li>• Lightweight, day/night, wide Field of View (FOV) target acquisition for crew served weapons</li> </ul>	<ul style="list-style-type: none"> <li>• Develop technologies for enhanced vertical self location accuracy; and ability to receive, manage, and transmit locally-generated meteorological messages integrated with local ground sensors to compensate the theoretical targeting solution</li> <li>• Develop miniaturized marking technology (delivery survivable) suitable over extended ranges</li> <li>• Develop real-time, sensor data fusion, automatic target recognition and processing power system, in a dismounted package</li> <li>• Develop affordable, high-shock, and thermally resistant, MEMS inertial navigation, guidance, and control technologies</li> <li>• Develop Graduated Index of Refraction (GRIN) lenses coupled to curved FPA</li> </ul>	<ul style="list-style-type: none"> <li>• Angle of arrival of GPS M-code or other reference signal to determine accurate vertical self location; and meteorological data collection and targeting compensation algorithms for onboard targeting system computing and hand-off</li> <li>• MEMS based inertial navigation technologies for assisted projectile markers having adequate power for signal transmission and observer-initiated activation (by laser, RF, or other means)</li> <li>• Pattern recognition algorithms using IR, active illuminated SWIR, or other sensor arrays against classification libraries of target types; and identification and mitigation of processing limitations</li> <li>• MEMS based inertial navigation, advanced material composition, ultra-high Q and ultra-high dynamic range or inertial components having micro level angle random walk (ARW) and simplified control scheme</li> <li>• Combined GRIN lens, curved FPA, and advanced signal processing on crew served weapons to provide day-night target acquisition</li> </ul>
<p><b>Endstate:</b></p> <ul style="list-style-type: none"> <li>• All-encompassing targeting and engagement capabilities, enabling responsive and flexible "Fires as a Commodity" to individual warfighters, netted for shared situational awareness throughout the sensor-to-shooter chain, providing precision fires and massed fires ability, against unconventional and hybrid threats across the full range of military operations and environments.</li> </ul>			



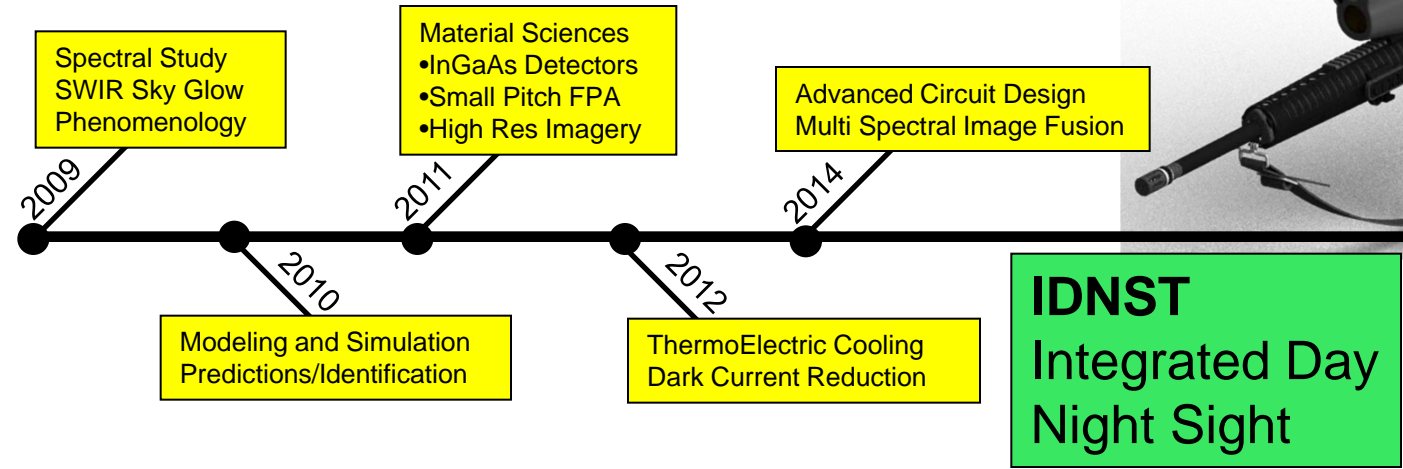
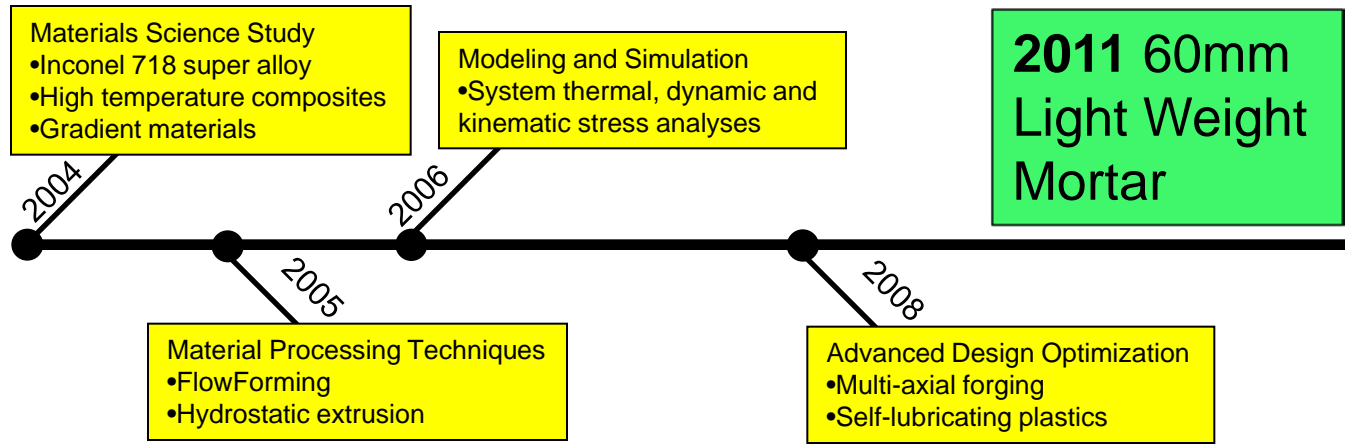
## Advanced Ammunition TIA – Willful Intent

Current Capability: Conventional munitions for direct and indirect fire capability			
FY	Desired Capability	S&T Challenge	S&T Solution
<b>Near Term</b> FY11- FY15	<ul style="list-style-type: none"> <li>Affordable extended range fires for battalions</li> <li>Enable defeat of all targets in urban terrain and other complex types of terrain</li> <li>Improve munition reliability and first round Probability of Kill (PK)</li> <li>Reduce weight and logistics burden of ammunition</li> </ul>	<ul style="list-style-type: none"> <li>Develop advanced propellant technologies that increase impulse within existing 81 mm mortar maximum operating pressure</li> <li>Develop predictive capability to understand and optimize the synergistic effects of superimposed and sequenced kill mechanisms in novel warhead designs</li> <li>Apply high reliability commercial silicon based MEMS technology to weapons initiation trains for improved SWAP and reliability</li> <li>Develop structural high ignition temperature propellants and associated initiation mechanisms impervious to normal weapon environments, eliminating the need for a conventional cartridge case</li> </ul>	<ul style="list-style-type: none"> <li>High nitrogen propellants and new propellant formulations/granulations</li> <li>DoE atomic level models coupled with Eulerian and Lagrangian hydrocodes that predict combined performance of conventional kill mechanisms including linear explosively formed penetrators, shaped charges, rigid body penetrators, high explosives, and fragments</li> <li>Miniature MEMS based low-energy reactive bridges, novel primary explosives/propellants, and safe-arm technologies</li> <li>HMX based high ignition temperature propellant, using commercial structural resins as PNP binder replacement</li> </ul>
<b>Mid Term</b> FY16- FY20	<ul style="list-style-type: none"> <li>Affordable extended range fires for companies</li> <li>Defeat of targets behind walls (both combatants and doubly protected items)</li> <li>Insensitive primary explosives and fuzes for advanced warheads</li> </ul>	<ul style="list-style-type: none"> <li>Develop advanced propellant technologies for the 60 mm mortar</li> <li>Develop advanced warheads and fuzes that delay detonation until the penetrator enters the protected space</li> <li>Develop high output explosives with low sensitivity</li> </ul>	<ul style="list-style-type: none"> <li>High nitrogen propellants and new propellant formulations</li> <li>Physics based modeling and optimization of advanced penetrating warheads, combining multiple effects (i.e. Munroe, Misznay-Schardin, spall, etc)</li> <li>Porous chromium oxide matrices that control the ignition and detonation of high output explosives combined with advanced nano-circuits for reduced explosive sensitivity</li> </ul>
<b>Far Term</b> FY21- FY25	<ul style="list-style-type: none"> <li>Affordable extended range fires for individual warfighters</li> <li>Scalable warhead effects for shoulder launched missiles and mortars</li> </ul>	<ul style="list-style-type: none"> <li>Develop propulsion technologies that can be used to extend the range of guided bullets</li> <li>Develop warhead configurations allowing variable and tailorable output</li> </ul>	<ul style="list-style-type: none"> <li>Nano-materials for propellant with significant advantages in propulsion output</li> <li>Unique configurations of MEMS based fuzing, variable output explosives, and advanced kill mechanism combinations</li> </ul>
<b>Endstate:</b>			
<ul style="list-style-type: none"> <li>Improved lethality and dominance of the individual Warfighter within his area of influence through advanced warhead, propulsion, and ammunition technologies, enabling engagement of the enemy from greater distances, with tailorable effects, improved reliability, reduced collateral damage, while lightening the load.</li> </ul>			

## Advanced Weapons TIA – Willful Intent

<b>Current Capability:</b>			
<ul style="list-style-type: none"> <li>Conventional weaponry for direct and indirect fire capability</li> </ul>			
<b>FY</b>	<b>Desired Capability</b>	<b>S&amp;T Challenge</b>	<b>S&amp;T Solution</b>
<b>Near Term FY11- FY15</b>	<ul style="list-style-type: none"> <li>Precision fires for battalions</li> <li>Reduce the weight of weapon systems and components</li> <li>Extend the service life of weapon systems</li> </ul>	<ul style="list-style-type: none"> <li>Develop for 81mm mortar a low cost, highly integrated, miniaturized guidance, navigation, and control system providing 5 meter CEP precision</li> <li>Demonstrate the utility of reducing combat load by increasing warfighter "kills-per-kilogram"</li> <li>Economically design and apply superalloys to weapon systems in order to minimize erosion, extend service life, reduce weight, and enhance high temperature performance</li> </ul>	<ul style="list-style-type: none"> <li>Low cost canard actuation system, MEMS based fuzing, extended range propellants, abbreviated guidance laws, SASM GPS, terminal seeker based guidance, and tail kit for the M821/M889 81mm mortar munitions</li> <li>Caseless ammunition small caliber weapons technologies</li> <li>Flow-forming small bore, thick walled, lightweight gun barrels out of superalloys such as L605, Rene 41, Stellite 21, Inconel 718, etc.</li> </ul>
<b>Mid Term FY16- FY20</b>	<ul style="list-style-type: none"> <li>Precision fires for companies</li> <li>Improved life cycle performance for small arms (reduced barrel erosion, improved operational performance)</li> <li>Affordable fires accuracy and lethality against small tactical platforms from small manned tactical platforms</li> <li>Cover tagging of enemy vehicles and combatants</li> </ul>	<ul style="list-style-type: none"> <li>Develop a miniature guidance, navigation, and control system for a 60mm mortar</li> <li>Develop new materials and materials production techniques to provide consistent high weapon performance</li> <li>Develop a remotely operated, stabilized weapon station mount of less than 200 lbs</li> <li>Develop tag dispersion techniques that provide more than 95% coverage of all targets within 25m diameter from 2 km standoff range</li> </ul>	<ul style="list-style-type: none"> <li>Flow-form processing, super alloys, and advanced composite materials</li> <li>Integration of micro-pulsed laser designator, integrated day-night optics, lightweight minor caliber weapons, and low cost missiles</li> <li>Airburst warhead for 81mm mortar with infrared reflective and other unique signature tagging technologies</li> </ul>
<b>Far Term FY21- FY25</b>	<ul style="list-style-type: none"> <li>Precision fires for the individual warfighter</li> <li>Nonlethal engagement capability</li> </ul>	<ul style="list-style-type: none"> <li>Develop low cost, ruggedized, miniature 6 DOF navigation grade inertial system</li> <li>Develop inexpensive non-lethal weapons effects and munitions, in coordination with Joint Non-lethal Weapons Directorate (JNLWD)</li> </ul>	<ul style="list-style-type: none"> <li>Gun hardened , miniature MEMS based INS</li> <li>Directed energy, electromagnetic pulse generators, variable density projectiles, and phaser technologies</li> </ul>
<b>Endstate:</b>			
<ul style="list-style-type: none"> <li>Lightweight, reliable, accurate weapons systems, enabling organic and inorganic scalable lethality Fires as a Commodity, against diverse unconventional and hybrid threats, with the ability to escalate from non-lethal to lethal force from ground, air, and naval platforms, across the full range of military operations.</li> </ul>			

# Done for you lately... or Modernization?



# **Alignment: Demand Signal/Technology Demand Signal**

**“Lightening the Load”**

## Lightening the Load

- Integrated Day Night Sight Technology (IDNST)
- Lightweight Individual Modular Body Armor (LiMBR)
- Lightweight Expeditionary Power (conversion, storage distribution)
- Advanced Lightweight Mortars, Machine Gun Barrels
- Cased-telescoped/Caseless ammo
- Energy Efficient Vehicles, On-Board Vehicle Power
- Advance Lightweight Vehicle Armor Technologies
- Enhanced Technologies for Optimization of Warfighter Load (ETOWL)





# Average Personal Infantry Combat Load

**LWH**  
Light Weight Helmet:  
\$260  
3.45 lbs  
**Helmet Cover:**  
\$15.35  
0.15 lbs  
**Dog Tags**  
\$8  
0.1 lbs

**OTV**  
Outer Tactical Vest:  
\$638  
8.4 lbs

**E-SAPI**  
Enhanced Small Arms  
Protective Insertsx2:  
\$1140  
10.9 lbs

**Side-SAPI**  
Side Small Arms  
Protective Inserts  
Prototype:  
\$600  
6 lbs

**Magazine with  
Ammunition x6:**  
\$115.86  
6.3 lbs

**Utilities:**  
\$68.65  
2.97 lbs

**Undershirt:**  
\$3.50 ea  
0.18 lbs

**Socks:**  
\$3  
0.16 lbs

**Underwear:**  
\$2.50  
0.25 lbs

**Utility Belt:**  
\$5.90  
0.3 lbs

**MPB**  
Multi-Purpose Bayonet:  
\$38.53  
1.3 lbs



**Balistic Eye Wear:**  
\$78  
0.15 lbs

**Ear Plugs:**  
With Case  
\$7.54  
0.1 lbs

**Hydration System  
with Water:**  
\$45.37  
6.3 lbs

**M16 A4:**  
\$1200  
7.9 lbs

**Pouches:**  
\$75  
1.9 lbs

**G940 Green Smoke  
Grenade x2:**  
\$94.10  
4.0 lbs

**G8811 Frag  
Grenade x2:**  
\$85.02  
4.0 lbs

**Gloves:**  
\$19.50  
0.33 lbs

**Knee and  
Elbow Pads:**  
\$31.05  
1.0 lbs

**ILBE**  
Individual Load  
Bearing Equipment:  
\$415  
10.5 lbs

**MRE**  
Meal Ready to Eat x3:  
\$20.58  
3.9 lbs

**ICB**  
Infantry Combat  
Boot:  
\$90  
4 lbs

**Combat Assault  
Sling:**  
\$27  
0.42 lbs

**IFAK**  
Individual First Aid Kit:  
\$68  
1.0 lbs

**Total: \$5015.45  
93.96 lbs**





# “Lightening the Load” Operational Constraints

- Tenants of Expeditionary Warfare
  - The Nature of War
    - **Friction and Uncertainty**
  - The Theory of War
    - **Speed and Focus**
    - **Surprise and Boldness**
    - **Creation and Exploitation of Opportunity**
  - Preparing for War
    - **Professionalism**
    - **Training and Education**
  - The Conduct of War
    - **Commander’s Intent**
- Distributed Operations (DO)
  - “Distributed Operations describes an operating approach that seeks to create an advantage over an adversary — spatial, temporal, and psychological — through the intentional use of dispersion and independent, small-unit tactical actions, **which are enabled by increased access to functional support.**”  
*from A Concept for Distributed Operations (4/25/2005)*
- **Seminal issue**
  - Mission vs. Capability trade space
    - Develops an inherent “tension” between the small unit leader and higher command
      - Immediate utility vs. Contingency/Operational flexibility

**“A common mistake is to base the fighting load on the gear and supplies necessary to meet every contingency.” MCRP 3-02A**

# Integrated Day-Night Sight Technology (IDNST)

Individual Weapon Sight

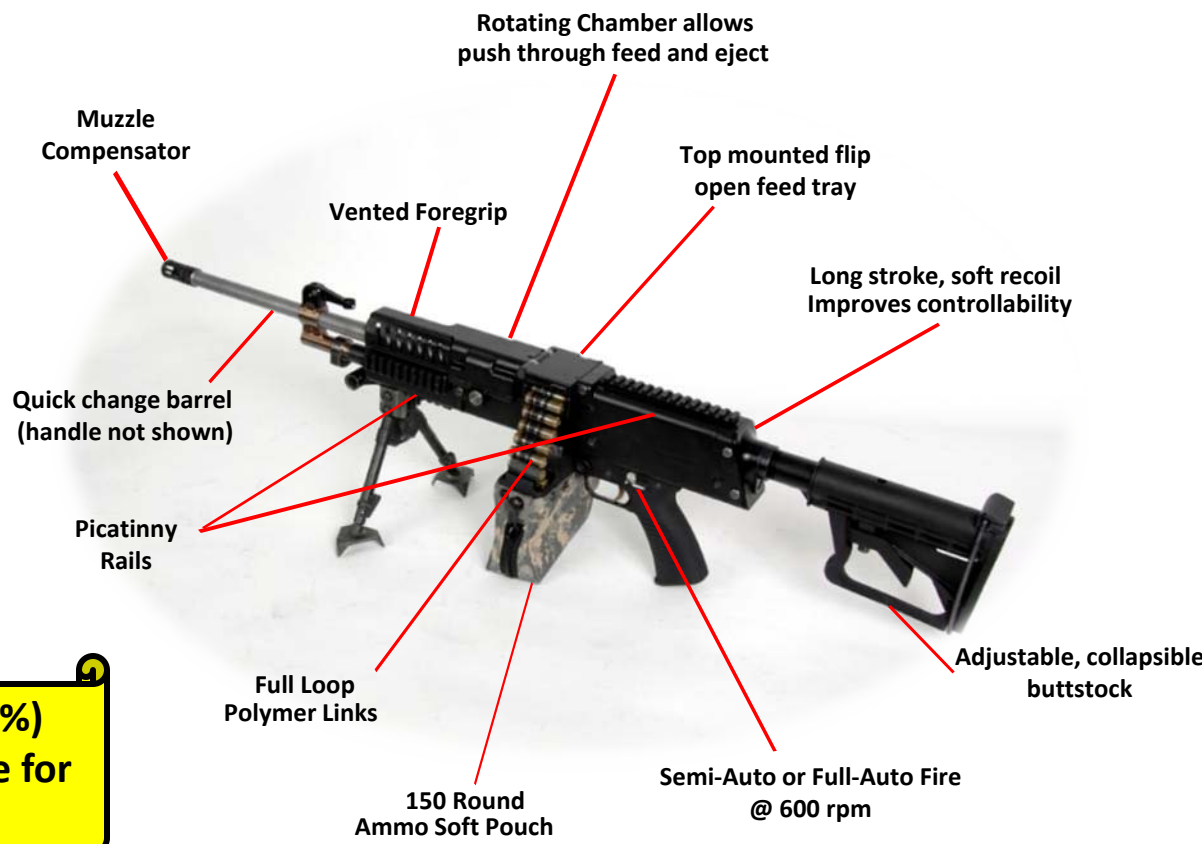
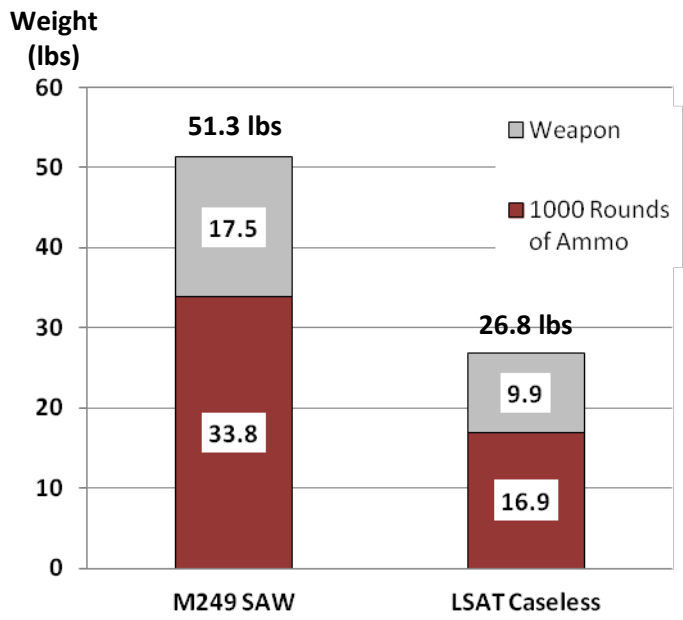


Crew Served  
Sight Concept

Combining Short Wave Infrared (SWIR) and Long Wave Infrared (LWIR) imagers, to provide enhanced target detection & identification capabilities

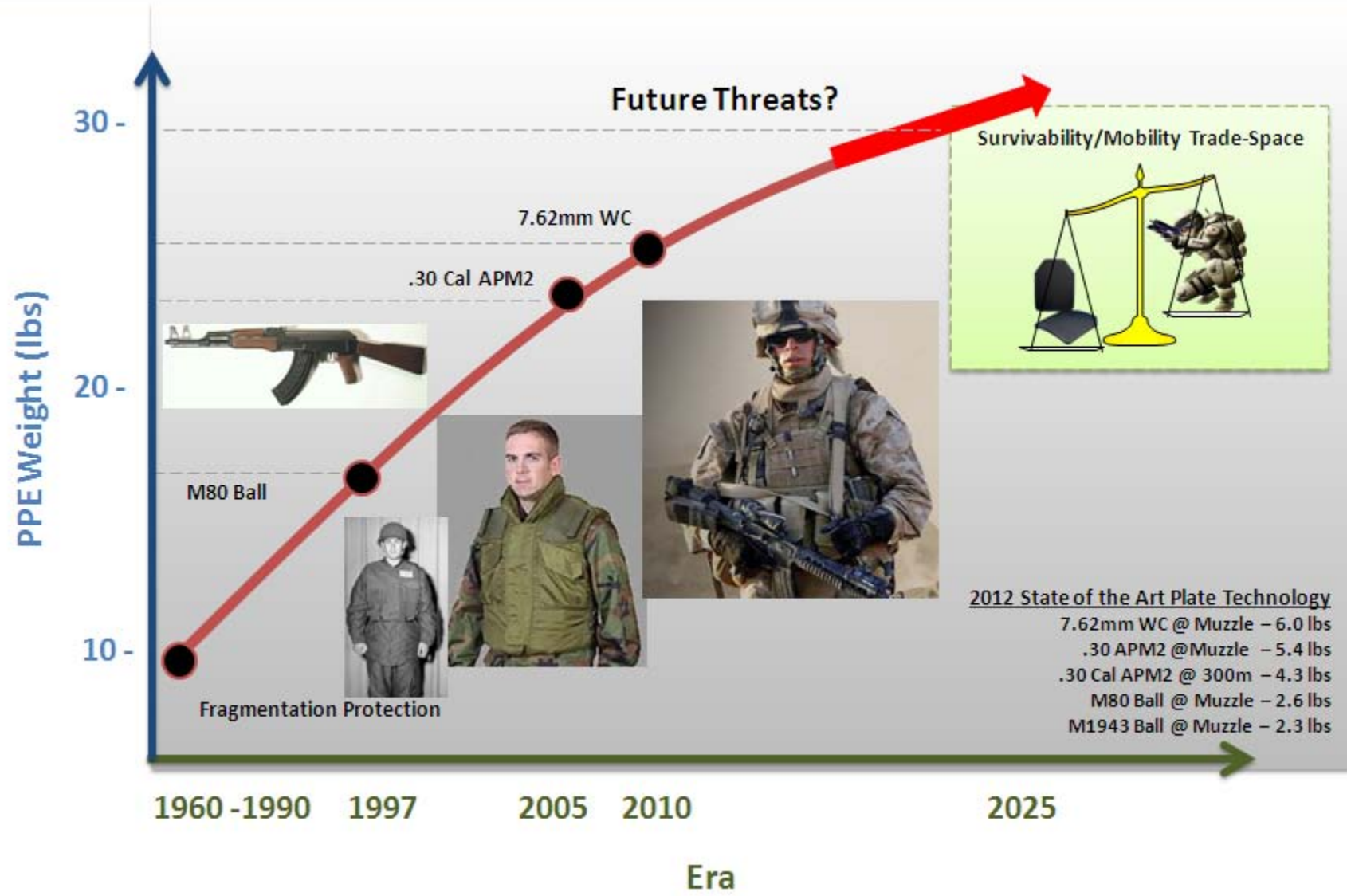
- Compared to current thermal imagers and Image Intensified (I2) sights:
  - Lower weight ; individual weapons sight 2 lb versus 3.4 lb, crew served weapons sight 3.3 lbs versus 12.1 lbs
- Enhanced target identification out to maximum effective ranges of the weapons:
  - From day through starlight
  - Will image through haze, fog, smokes, through thermal crossovers, and behind glass
  - Will detect camouflage clothing and netting against foliage
- Crew-served sights will be developed for Joint Early User Evals in FY14 followed by Individual sight demos in FY15.

# Caseless Small Caliber Ammunition



**24.5 pounds of weight savings (48%) and 40% reduction in ammo volume for the M249 SAW gunner**

# Historical Weight Increases in Personal Protection



30 -

Future Threats?

Survivability/Mobility Trade-Space



7.62mm WC

.30 Cal APM2



M80 Ball



Fragmentation Protection



20 -

10 -

1960 -1990

1997

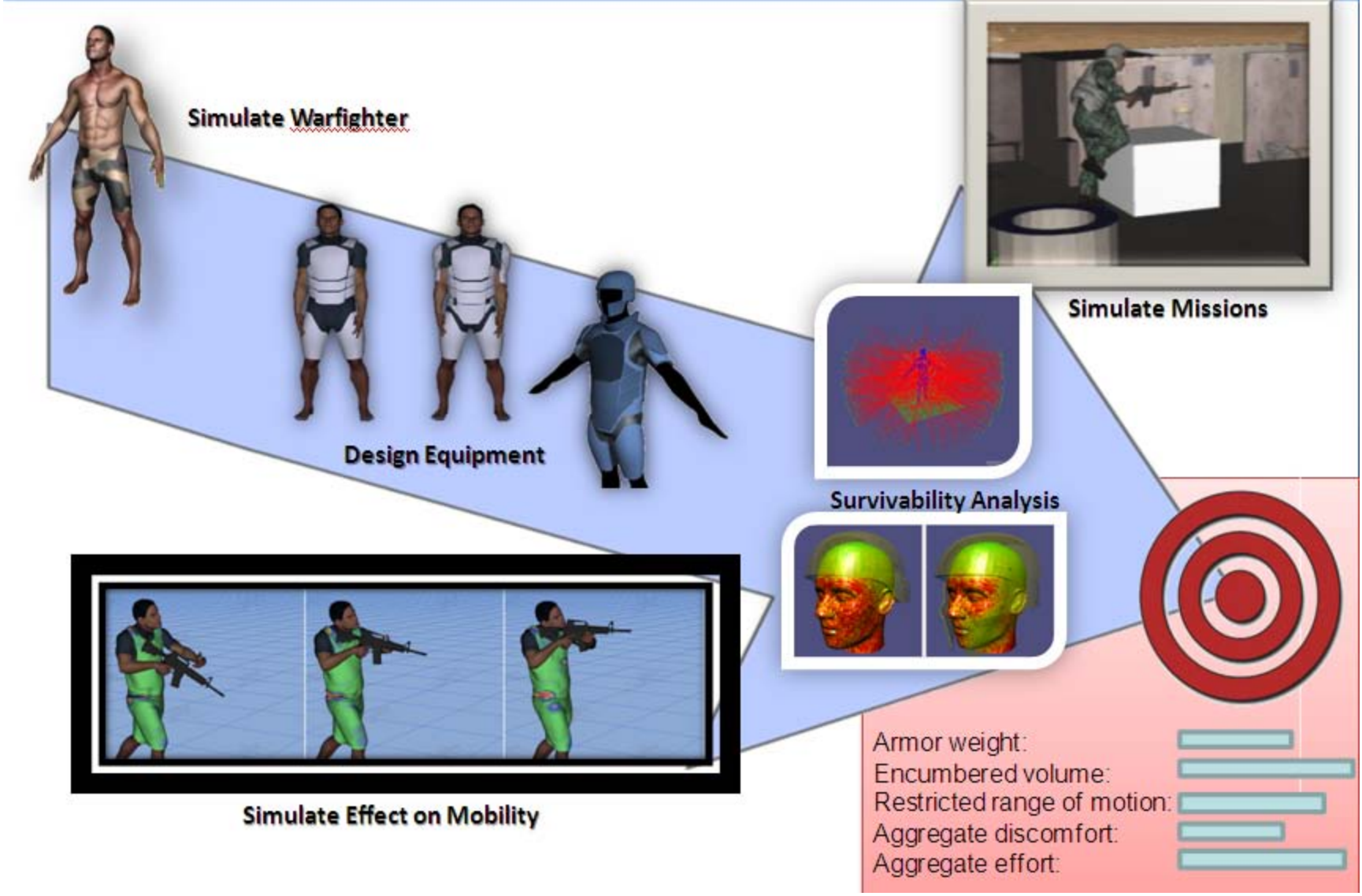
2005

2010

2025

Era

# Operational Effectiveness & Mobility vs. Survivability





# Expeditionary Power Systems

- **PowerSage** (Packet Digital LLC)

- Intelligent Power Management Integrated Circuit
- Replaces a traditional voltage regulator (ubiquitous electronic component)
- Adjusts circuit-level voltage supply based on real-time component power demand
- Potential to greatly reduce power consumption in nearly any electronic device
- Demonstrated 67% reduction in power consumption of a Motorola soldier radio
  - Equates to a 12 lb reduction per Marine in batteries carried on a 4-day mission
  - Lowers noise and waste-heat, enabling further weight reductions via smaller heat sinks



- **High- $\eta$  Flexible PV** (NRL and MicroLink Inc)

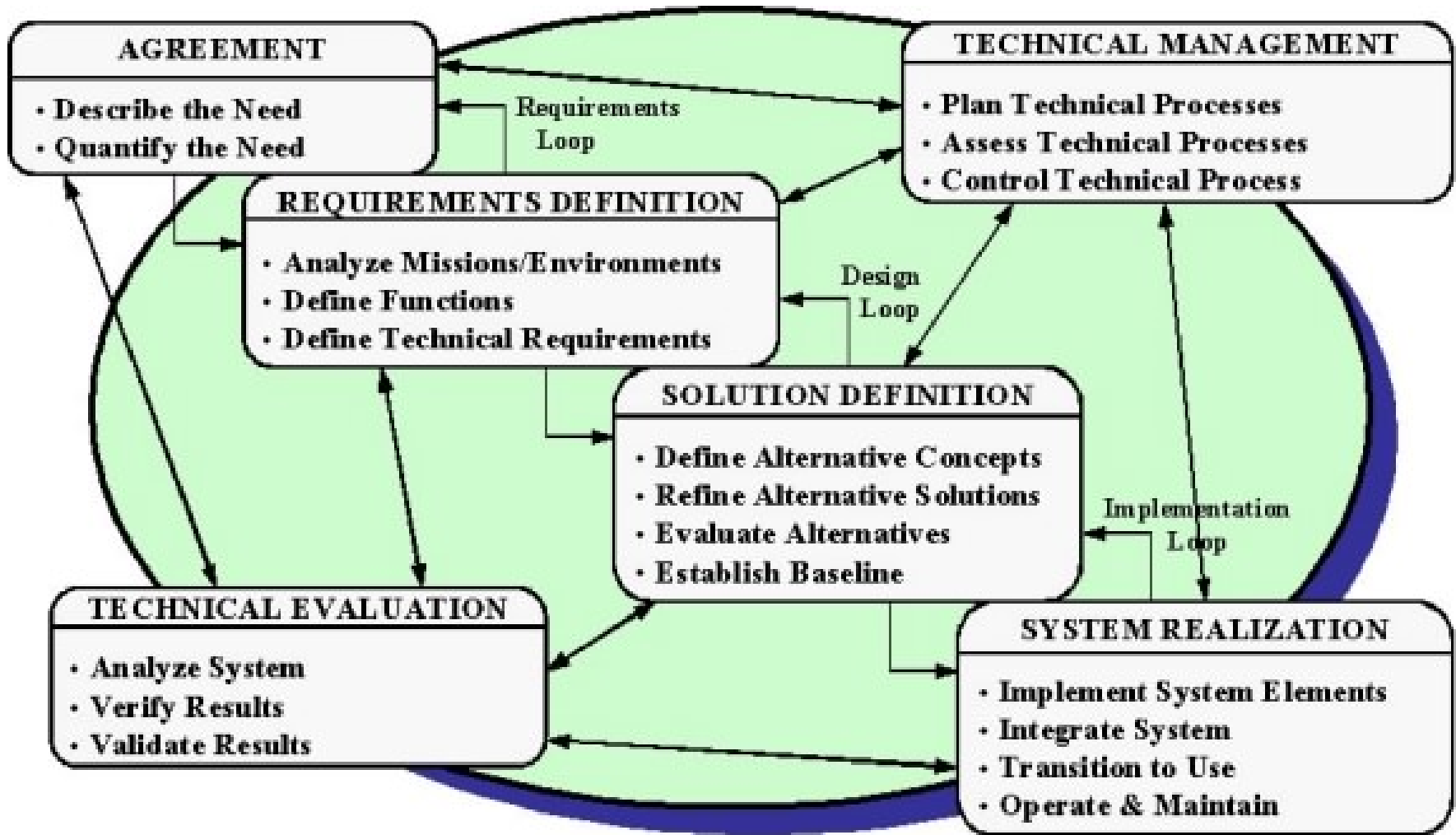
- High-efficiency, thin-film, multi-junction, flexible solar cells
- Technology enabled by Epitaxial Lift-Off manufacturing process
- 3x-10x more output than current flex PV technology (eg. SPACES)
- Enables warfighter to reduce number of spare batteries carried





# Systems Engineering Approach to LL

- \* Are we treating the Marine Infantryman as a system?
- \*\* Should weight (and other mobility enablers) be an independent variable?



# “Lightening the Load”

## Final Thoughts and Way Forward

- Combat load is “controlled” but not optimized for LL considerations
  - Biased for contingency/risk mitigation
- Conventional vs. Light infantry tasking/demands
  - Functionally different for good reasons
  - What is the “break point” for light infantry ops?
  - Squad based capability/combat load
    - » Have we developed this metric?
- Requirements drive S&T investment
  - LL concerns are stated anecdotally and lack a systems approach
    - » S&T like everything else is resource constrained; where is the largest opportunity for ROI?
  - METT-TSL approach supported with decision aids/tools to visualize/articulate/compare/examine combat load options will balance mission and load considerations.

# Efforts in Support of the Marine Corps



# Questions/Comments?

**Visit us at:**

<http://www.onr.navy.mil/home/Science-Technology/Departments/Code-30.aspx>