



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

NDIA JOINT ARMAMENTS CONFERENCE

Seattle, WA
15 May 2012

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

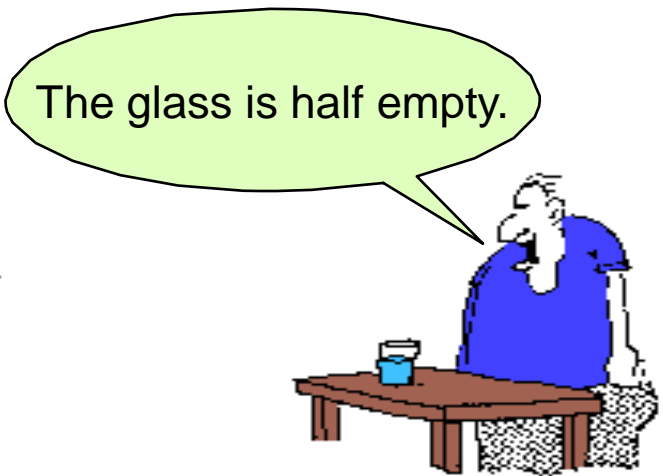
Mr. George W. Solhan, SES

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

Director, Marine Corps S&T



ONR



SYSCOM's/PEO's

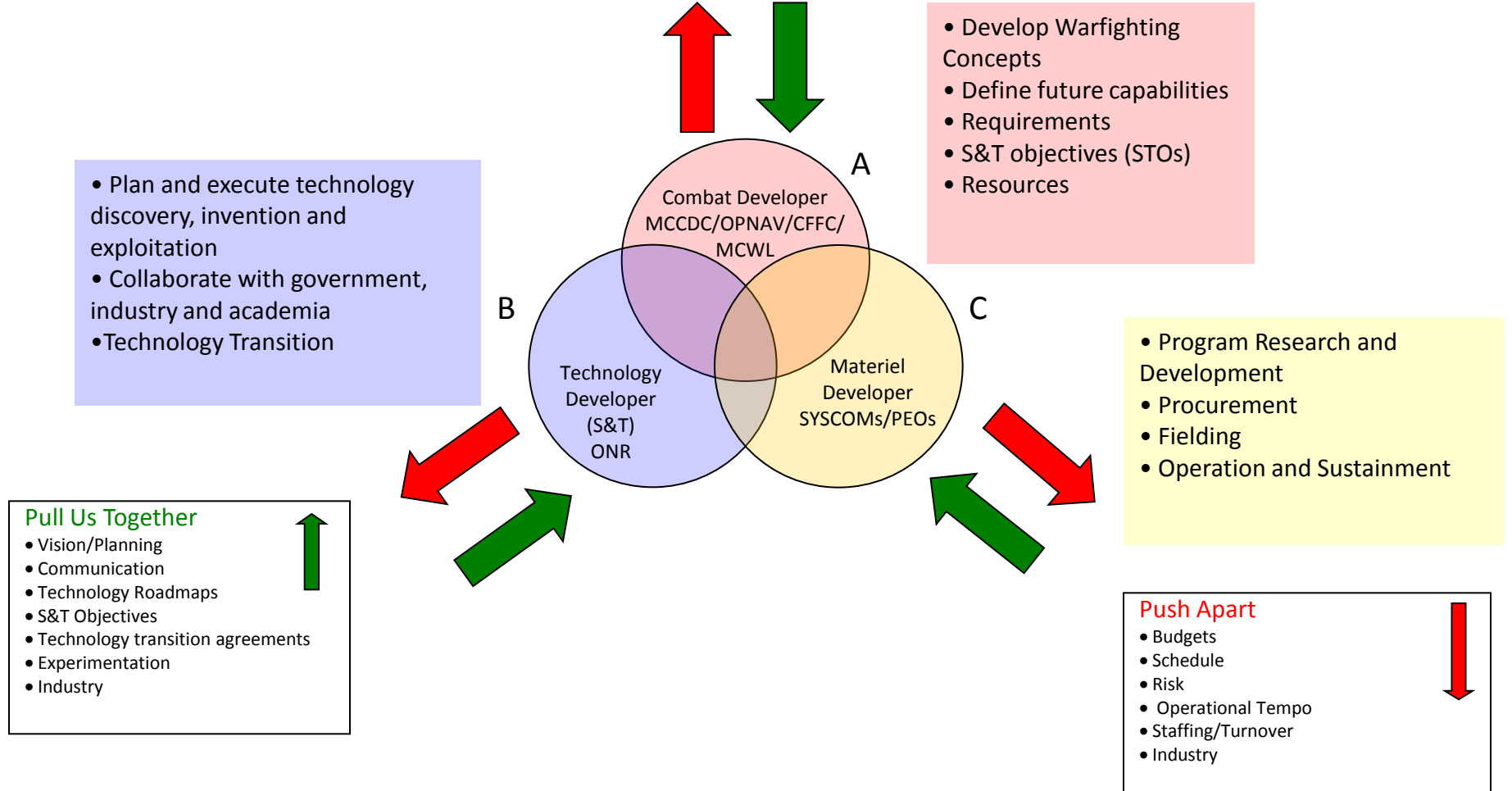


MCCDC/OPNAV



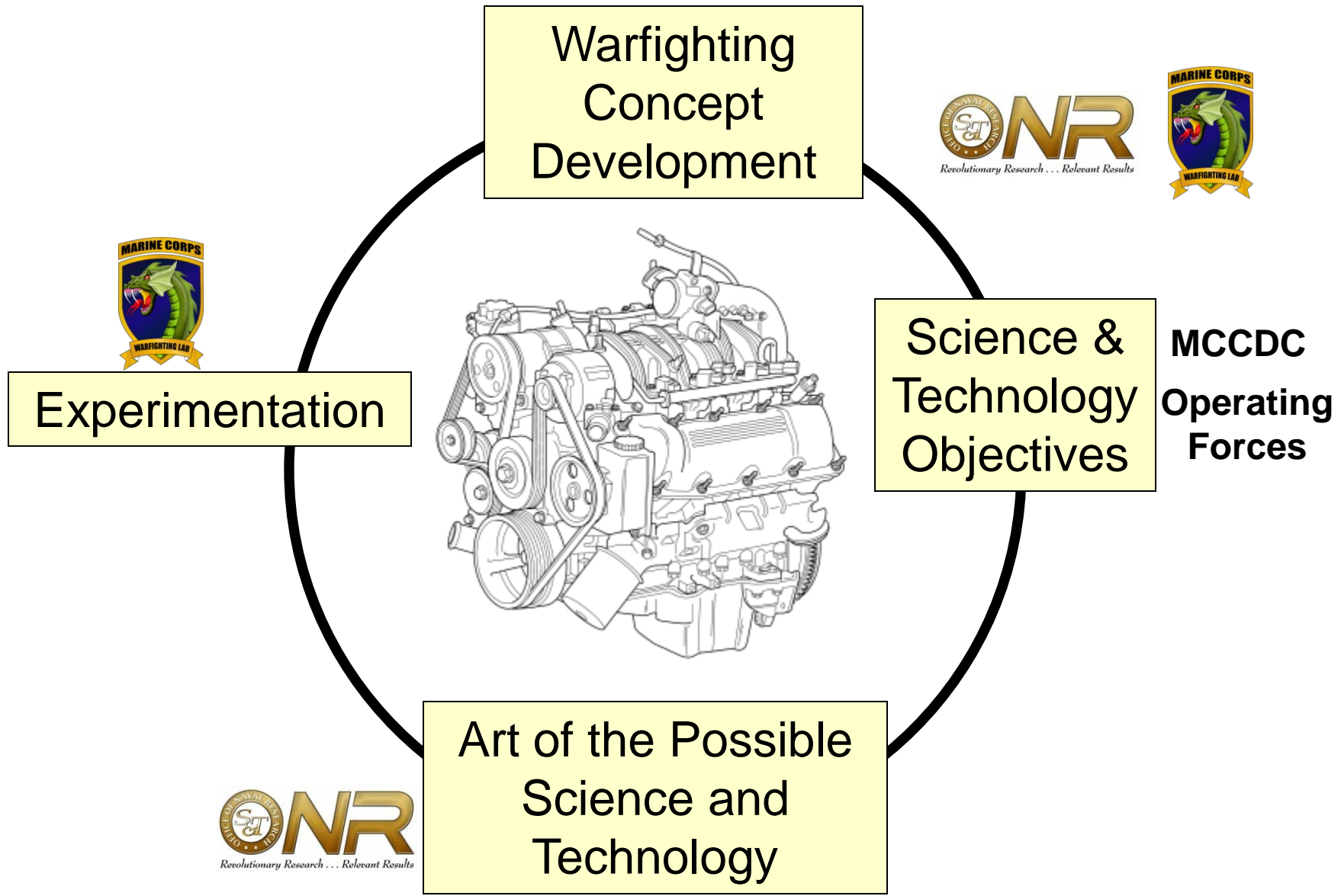
Fleet/MARFOR's

“The Three Circles”

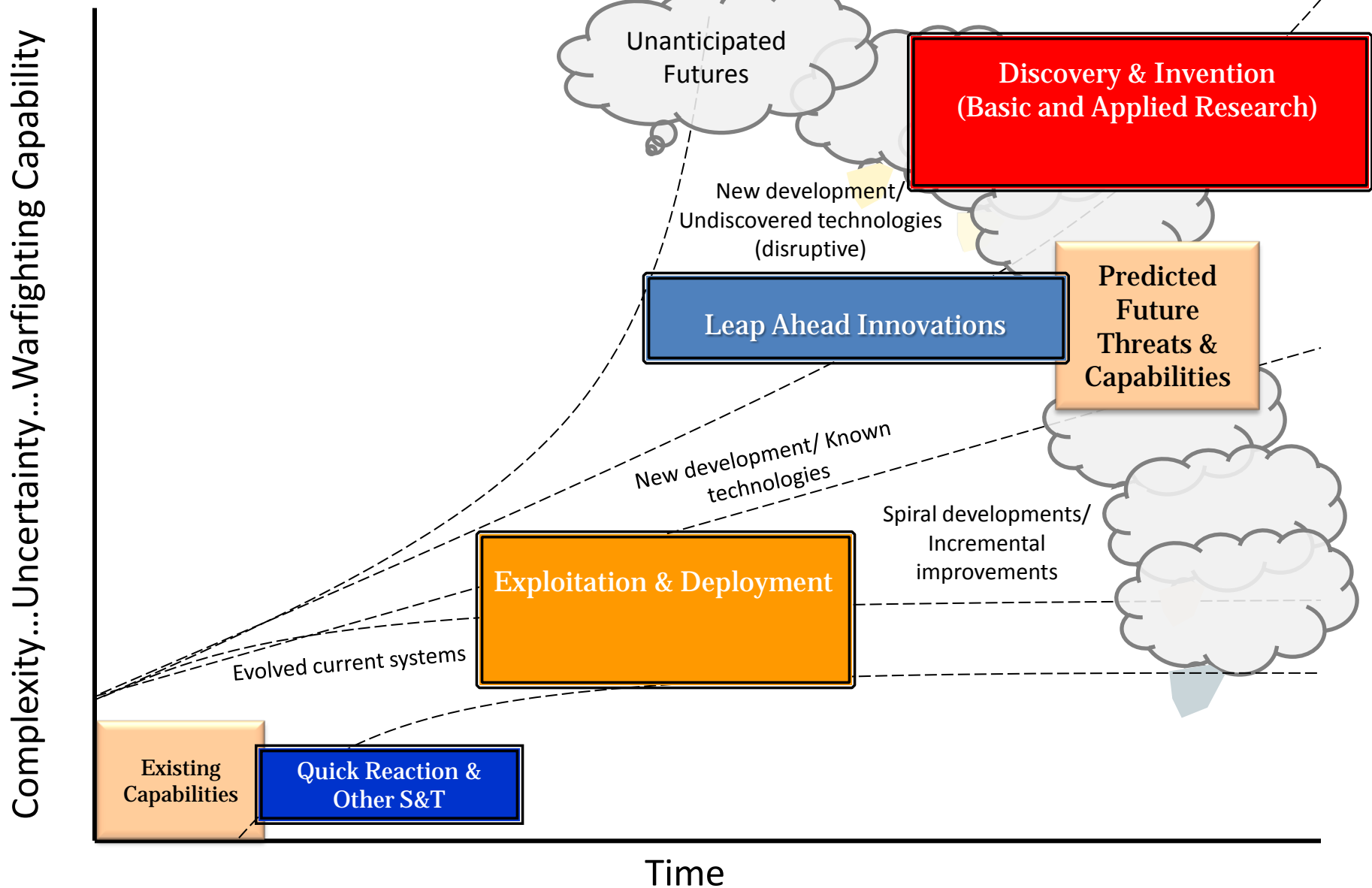


A	Concept	Capability Futures	Gaps	Requirements	
B		Capability Futures	Gaps	Requirements	Technology
C			Requirements	Technology	R&D Production
					Capability

Creative Engine for Combat Development

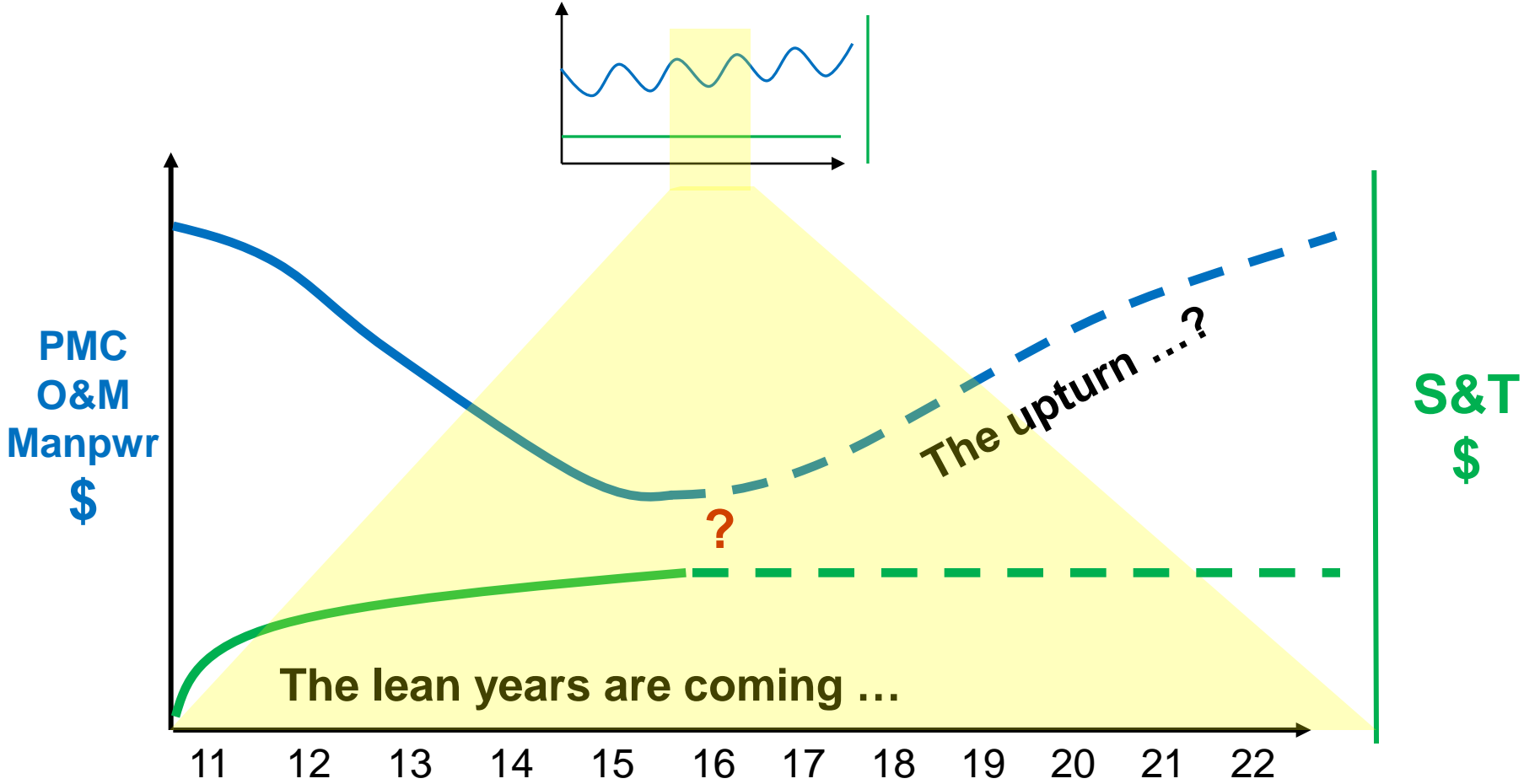


Portfolio Alignment with Futures



S&T Opportunity

“When you have no money, **THINK**”

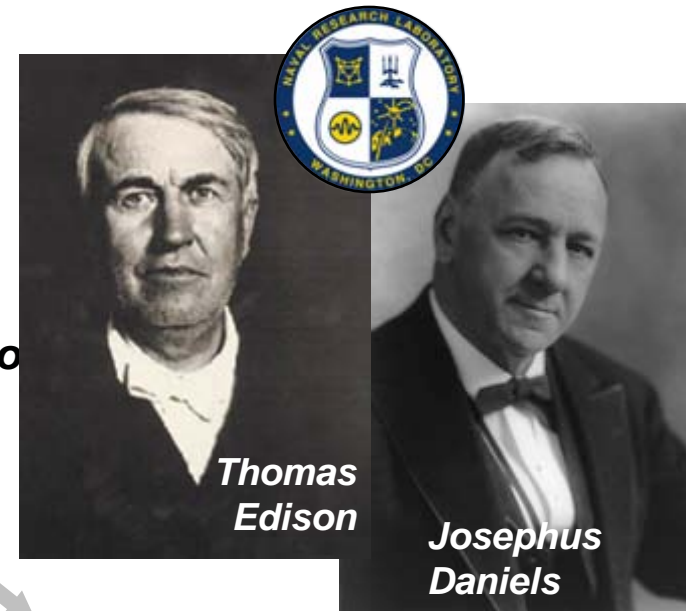


- When procurement funding is plentiful, S&T/Exp is important
- Shape the nature of the buy When procurement funding is scarce, S&T/Exp is more important
- Mitigate Risk with the Creative Engine – Know What is Possible... and When
- Shape future capability – be prepared to take advantage of opportunities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

Naval Research: A Statutory Mission

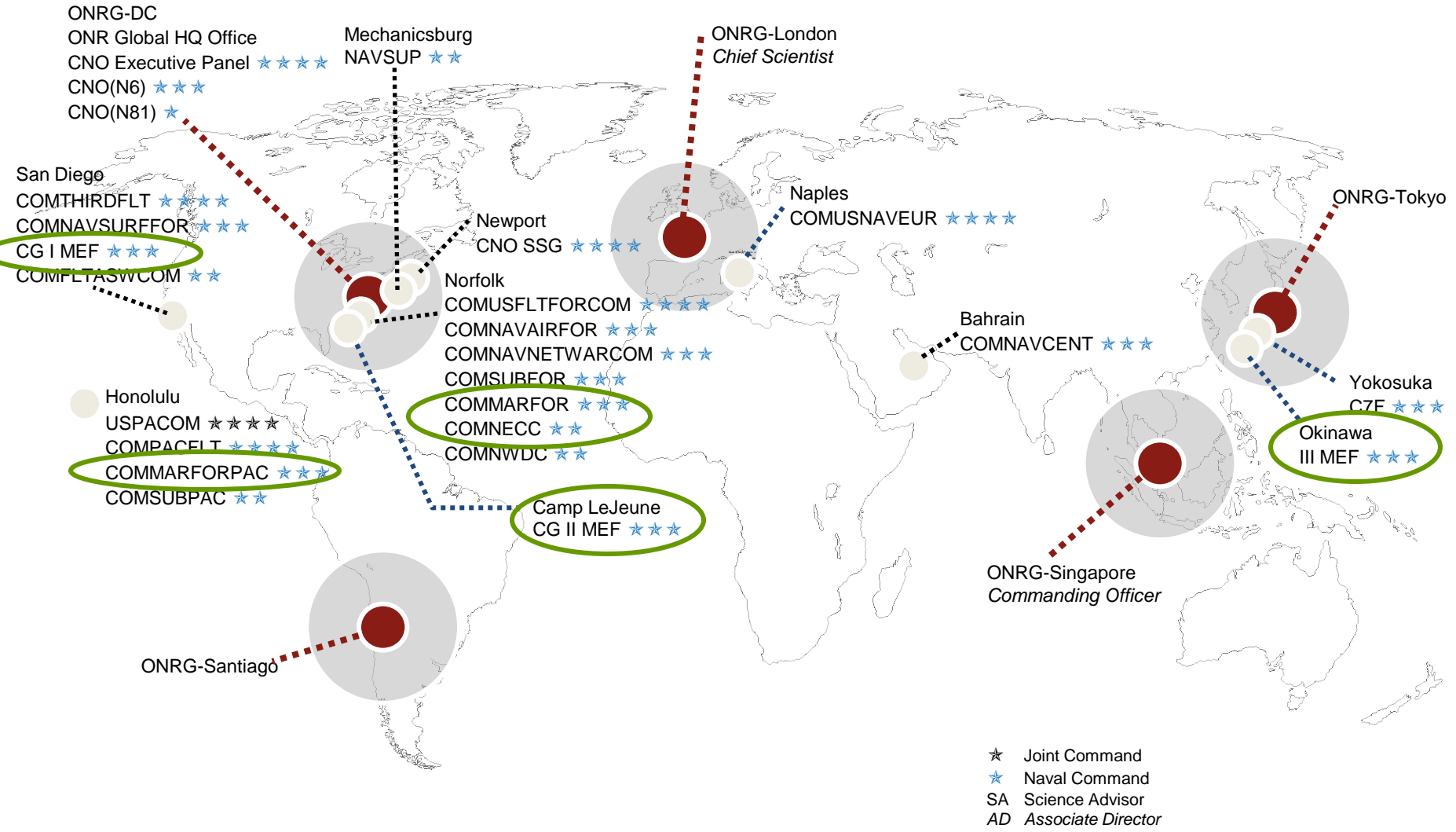
Naval Research Laboratory (Appropriations Act, 1916):
“**[Conduct] exploratory and research work...necessary... for the benefit of Government service, including the construction, equipment, and operation of a laboratory....**”

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



Office of Naval Research

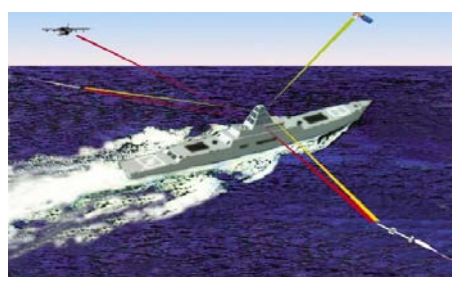
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Expeditionary Maneuver Warfare and Combating Terrorism

Code 31

C4ISR



Code 32

Ocean Battlespace Sensing



Sea Warfare and Weapons

Warfighter Performance

Air Warfare and Weapons



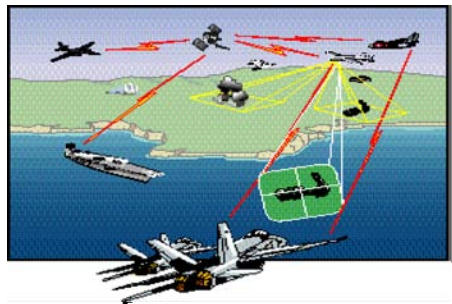
Naval Research Laboratory



Code 33



Code 34

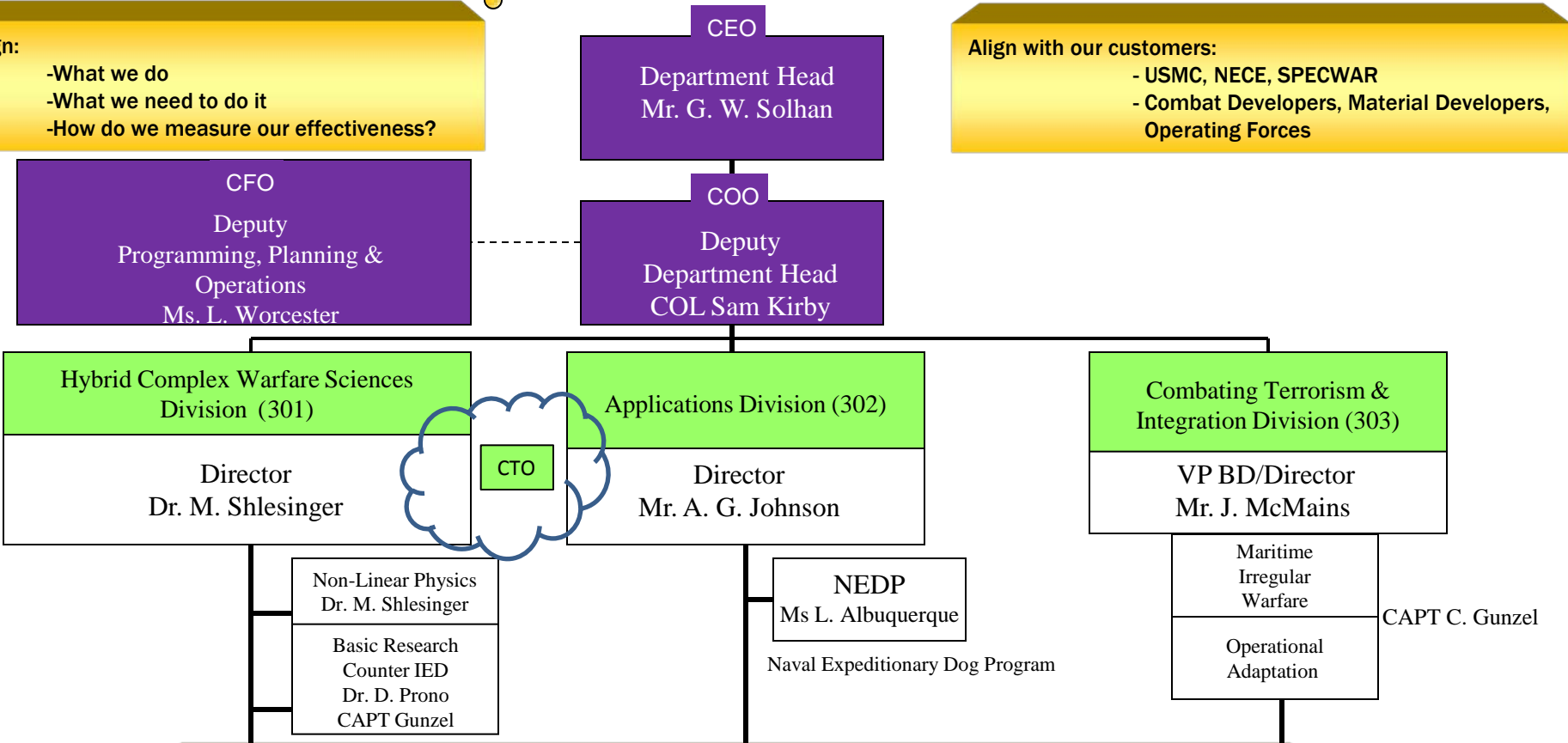


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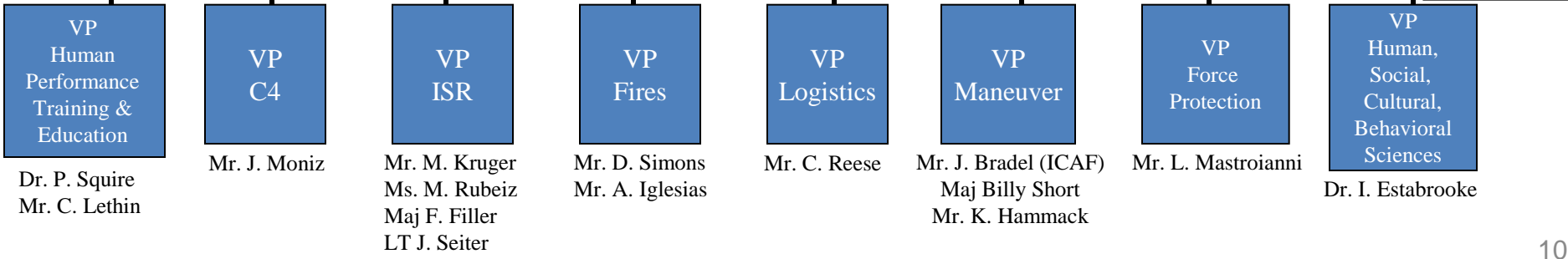
Focus on the warrior as a system, rather than the platform!

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

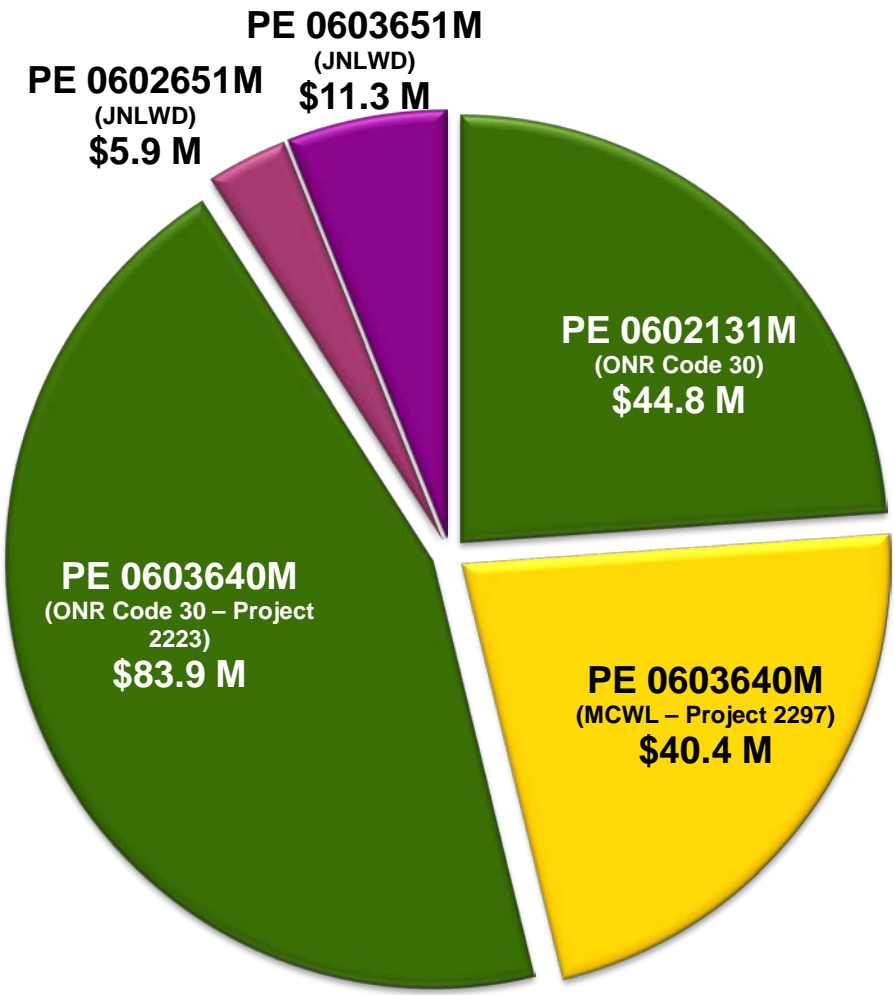
Align with our customers:
 - USMC, NECE, SPECWAR
 - Combat Developers, Material Developers, Operating Forces



Integrate inter departmental & interdisciplinary within ONR and with external activities



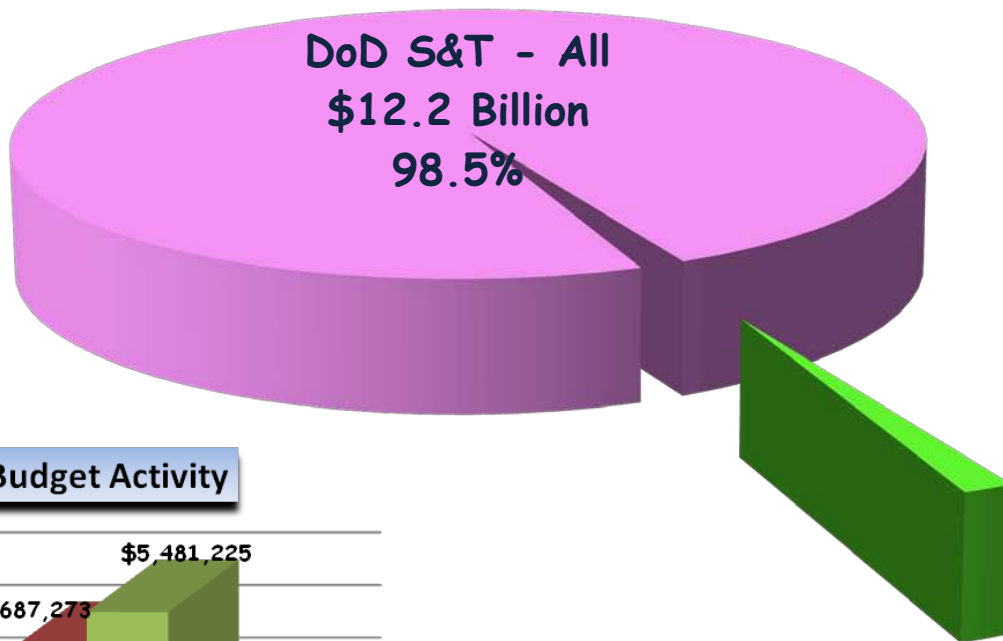
PBR FY-12 S&T Funding (Total \$186.3M)



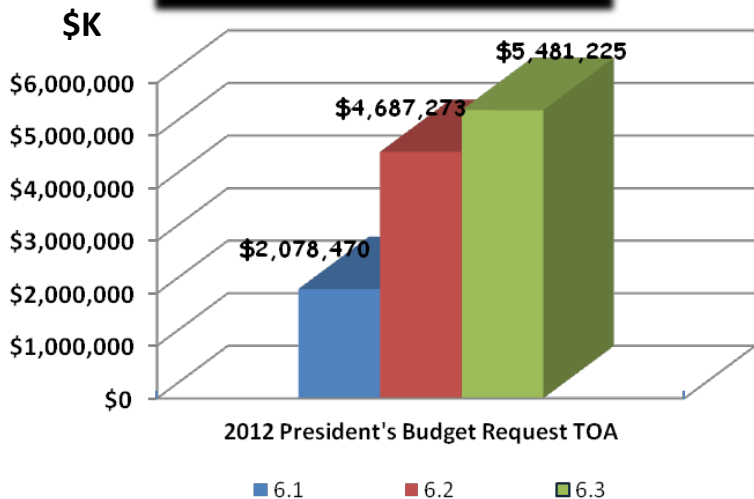
Leverage: ≈ \$100M

Data derived from PBR FY-12

USMC S&T & DoD S&T FY2012 TOA



DoD S&T By Budget Activity

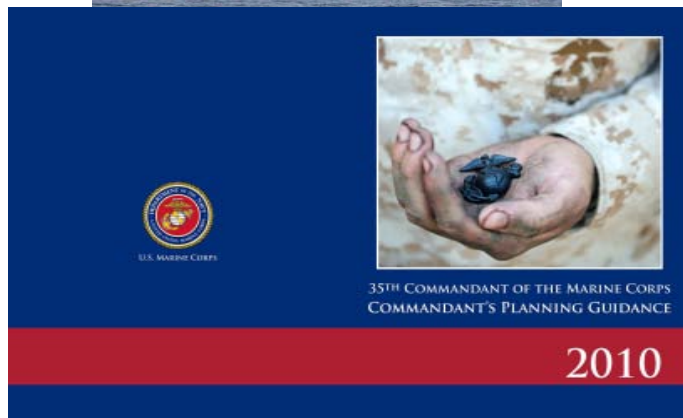


USMC S&T
\$186.3 Million
1.5 % of DoD
S&T TOA

Leverage:
Collaborative,
Joint, Cooperative,
In-kind

USMC S&T is Aligned to the 35th CMC's Guidance

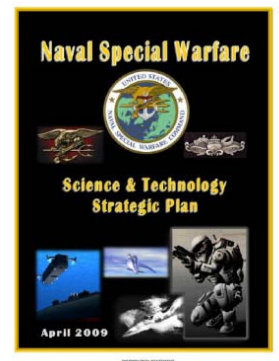
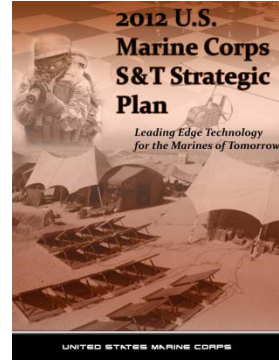
*The Marine Corps is America's Expeditionary Force in Readiness — a balanced air-ground-logistics team. We are forward-deployed and forward-engaged: shaping, training, deterring, and responding to all manner of crises and contingencies. We create options and decision space for our Nation's leaders. Alert 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.*



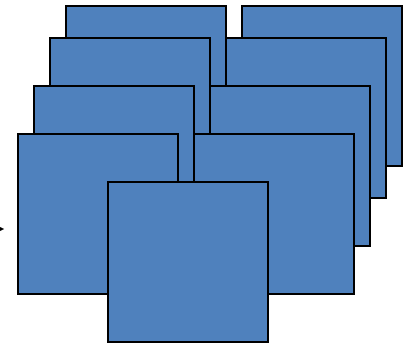
Priorities of the 35th Commandant of the Marine Corps

- 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

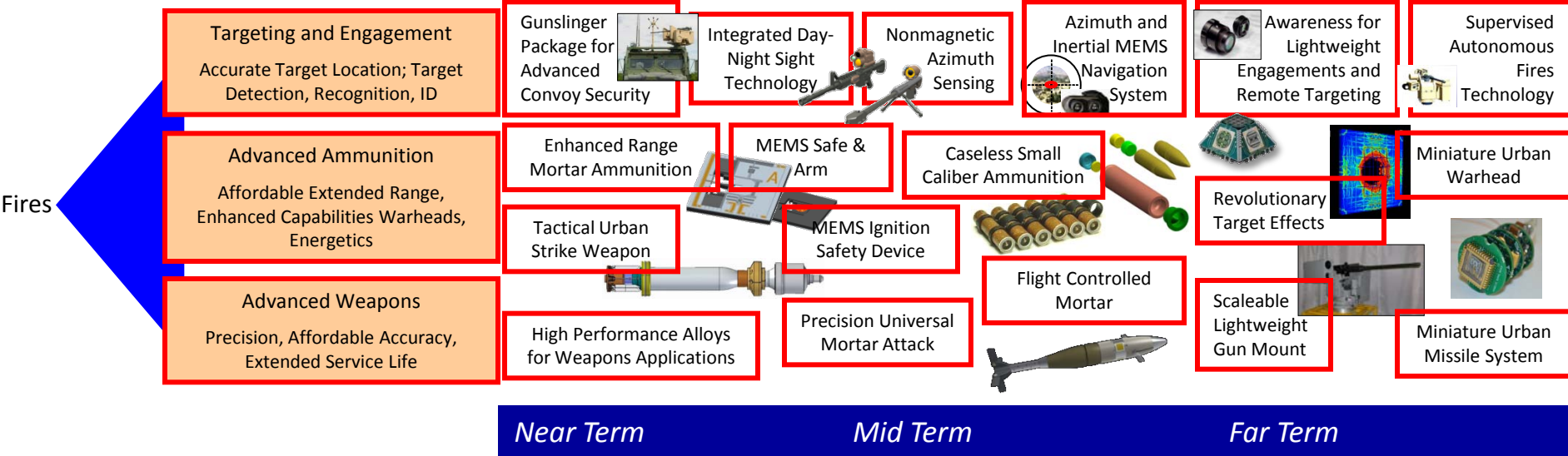


Expeditionary and Irregular Warfare



“Whitman’s Sampler”

Technology Investment Areas



ONR 30 Vision for Fires



Unconventional Warfare: Irregular – Asymmetric – Hybrid

Distributed Operations – Enhanced Company Operations – Enhanced MAGTF Operations

Targeting and Engagement Technology Investment Area



Current Capability:
Conventional targeting and engagement systems for direct and indirect fires

- End-state:**
- All-encompassing targeting and engagement capabilities
 - Enabling “Fires as a Commodity” to individual warfighters
 - Against unconventional threats
 - Across the full range of military operations and operational environments

Fires as a Commodity

- Netted:**
- Shared Situational Awareness throughout sensor-to-shooter chain
 - Ability to mass fires

Advanced Ammunition and Energetics TIA



Current Capability:
Conventional munitions for direct and indirect fires

- End-state:**
- Improved lethality and dominance of the individual warfighter throughout his area of influence
 - Through advanced warhead, propulsion, and ammunition technologies
 - Enabling engagement of the enemy from greater distances with tailorable effects
 - Enabling “Fires as a Commodity”



- Reliable
- Accurate
- Lethal (Scalable)
- Responsive

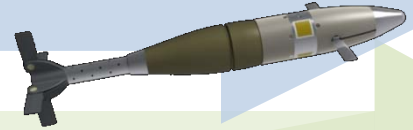


Advanced Weapons TIA



Current Capability:
Conventional weaponry for direct and indirect fires

- End-state:**
- Improved weapons systems
 - Enabling “Fires as a Commodity” against diverse unconventional 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



- Flexible
- Inorganic
- Bomb Damage Assessable
- Logistically Supportable
- “Lighten the Load”



Current Capability: Conventional munitions, explosives, and propellants for direct and indirect fire capability			
FY	Desired Capability	S&T Challenge	S&T Solution
Near Term FY12-FY16	<ul style="list-style-type: none"> - Affordable extended range fires for battalions - Enable defeat of all targets in urban terrain and other complex types of terrain - Improve munitions reliability and first round Probability of Kill (PK) - Reduce weight and logistics burden of ammunition 	<ul style="list-style-type: none"> - Develop advanced propellant technologies that increase impulse within existing 81mm and 120mm mortar maximum operating pressures - Develop predictive capability to understand and optimize the synergistic effects of superimposed and sequenced kill mechanisms in novel warhead designs - Apply high reliability commercial silicon based MEMS technology to weapons initiation trains for improved SWAP and reliability - Develop structural high ignition temperature propellants and associated initiation mechanisms impervious to normal weapon environments, eliminating the need for a conventional cartridge case 	<ul style="list-style-type: none"> - High nitrogen propellants and new propellant formulations/granulations - Physics-based models coupled with hydrocodes that predict combined performance of conventional defeat mechanisms including linear explosively formed penetrators, shaped charges, rigid body penetrators, high explosives, shock focusing, and fragments - Miniature MEMS based low-energy reactive bridges, novel primary explosives/propellants, and safe-arm technologies - HMX based high ignition temperature propellant, using commercial structural resins as PNP binder replacement
Mid Term FY17-FY21	<ul style="list-style-type: none"> - Affordable extended range fires for companies - Defeat of targets behind walls (both combatants and doubly protected items) - Insensitive primary explosives, propellants, and fuzes for advanced warheads - Maintain or improve existing warhead and propulsion capabilities at reduced size and weight 	<ul style="list-style-type: none"> - Develop advanced propellant technologies for the 60mm mortar - Develop advanced warheads and fuzes that delay detonation until the penetrator enters the protected space - Develop high output energetics with low sensitivity - Increase explosive yield by an order of magnitude and propellant total impulse 	<ul style="list-style-type: none"> - High nitrogen propellants and new propellant formulations - Physics based modeling and optimization of advanced penetrating warheads, combining multiple effects (ie, Munroe, Misznay-Schardin, spall, etc) - Porous chromium oxide matrices that control the ignition and detonation of high output explosives combined with advanced nano-circuits for reduced explosive sensitivity - Nanodiamond and PolyCO structural bond energy release with densities ranging from 104-108 J/g; Tungsten-impregnated conventional propellants

. . . Continued

FY	Desired Capability	S&T Challenge	S&T Solution
Far Term FY22-FY26	<ul style="list-style-type: none"> - Affordable extended range fires for individual warfighters - Scalable warhead effects for shoulder launched missiles and mortars 	<ul style="list-style-type: none"> - Develop propulsion technologies that can be used to extend the range of guided bullets - Develop warhead configurations allowing variable and tailorable output 	<ul style="list-style-type: none"> - Nano-materials for propellant with significant advantages in propulsion output - Unique configurations of MEMS based fuzing, variable output explosives, and advanced kill mechanism combinations
<p>Endstate: 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 and reducing life cycle costs</p>			

Integrated Day-Night Sight Technology (IDNST)

Individual Weapon Sight

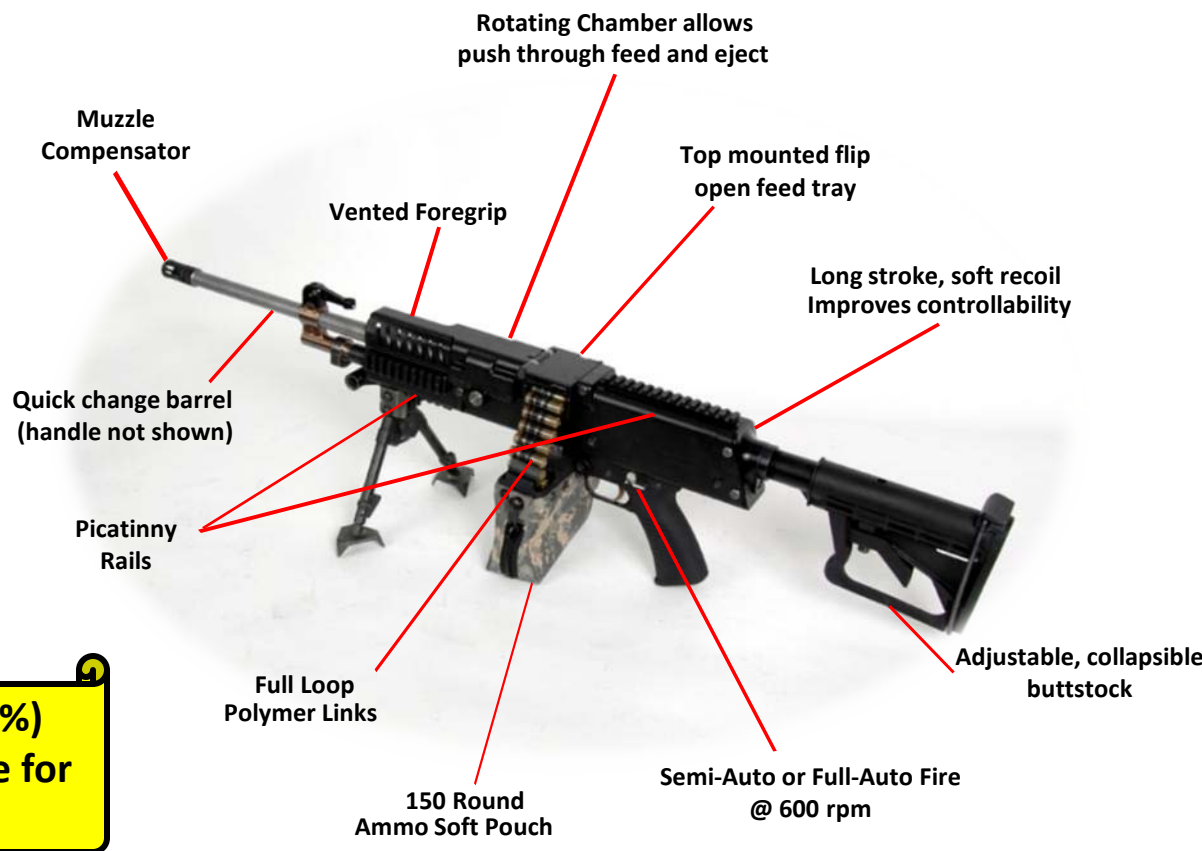
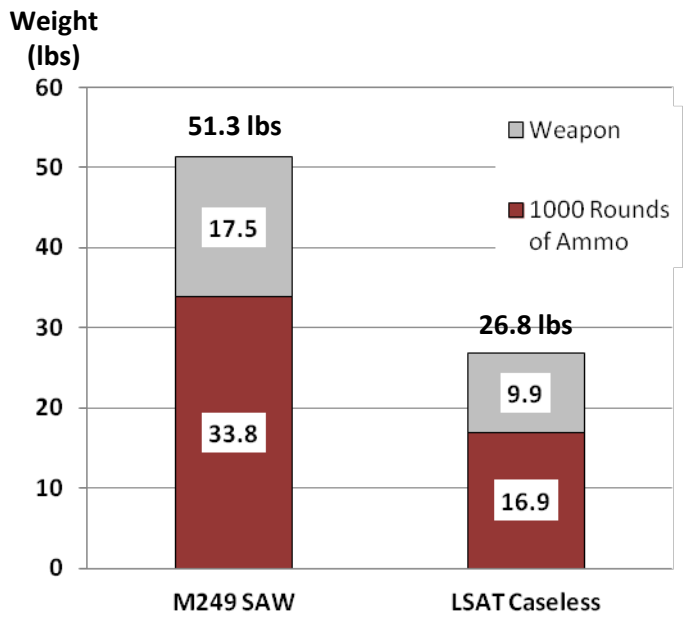


Crew Served
Sight Concept

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

Precision Universal Mortar Attack (PUMA)

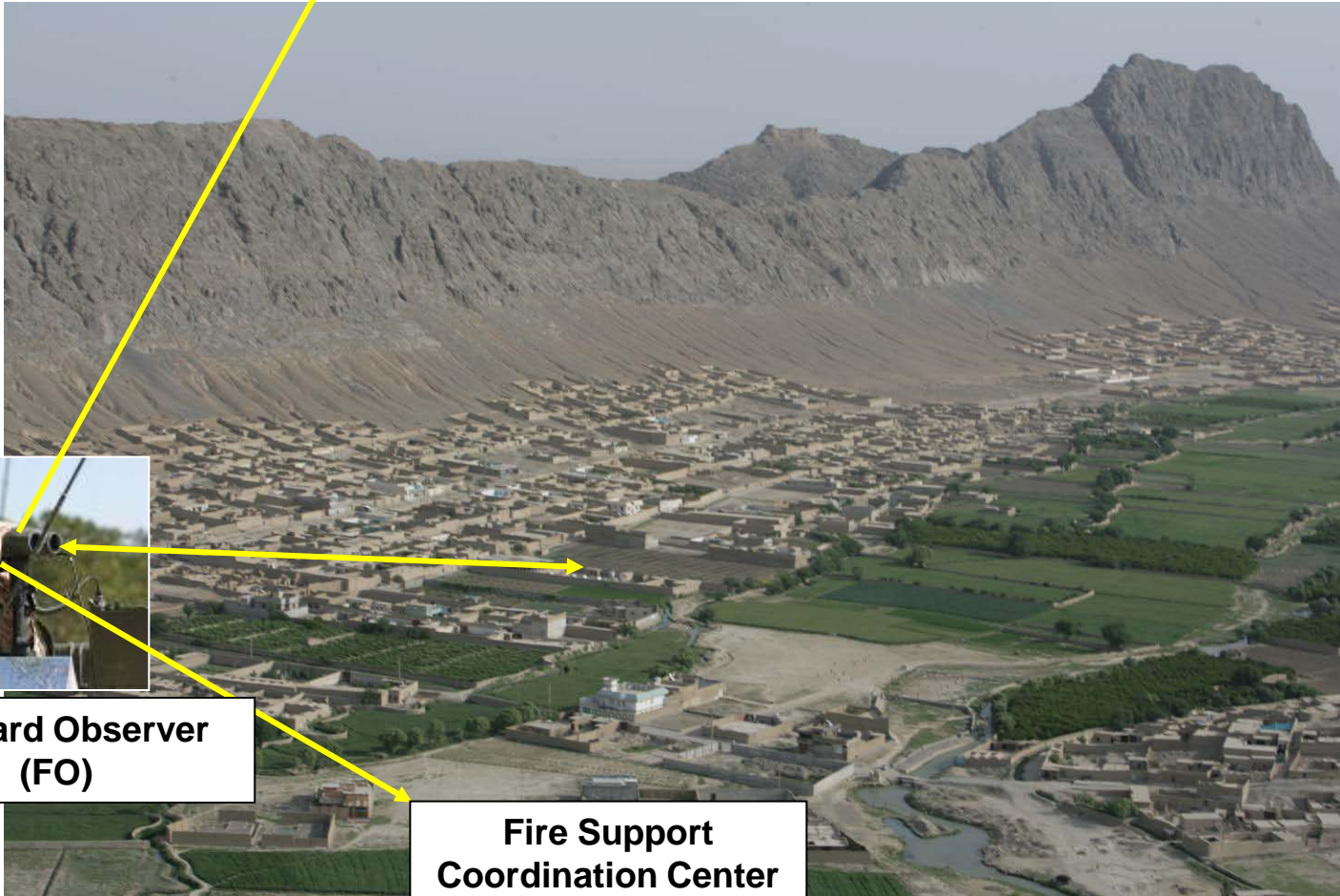
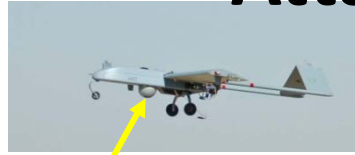


Providing an affordable, mid-range, high precision mortar capability for the Marine Corps 120mm rifled mortar Expeditionary Fire Support System (EFSS), enabling vertical attack angle to enhance lethality.

The EFSS Family of Munitions includes:

- M1101 round, now fielded, accurate at short ranges (up to 6 km)
- Precision Extended Range Munition (PERM), in acquisition process; to provide precision at long ranges (12-16 km or greater)
- PUMA will provide precision at medium ranges (6 – 12 km)

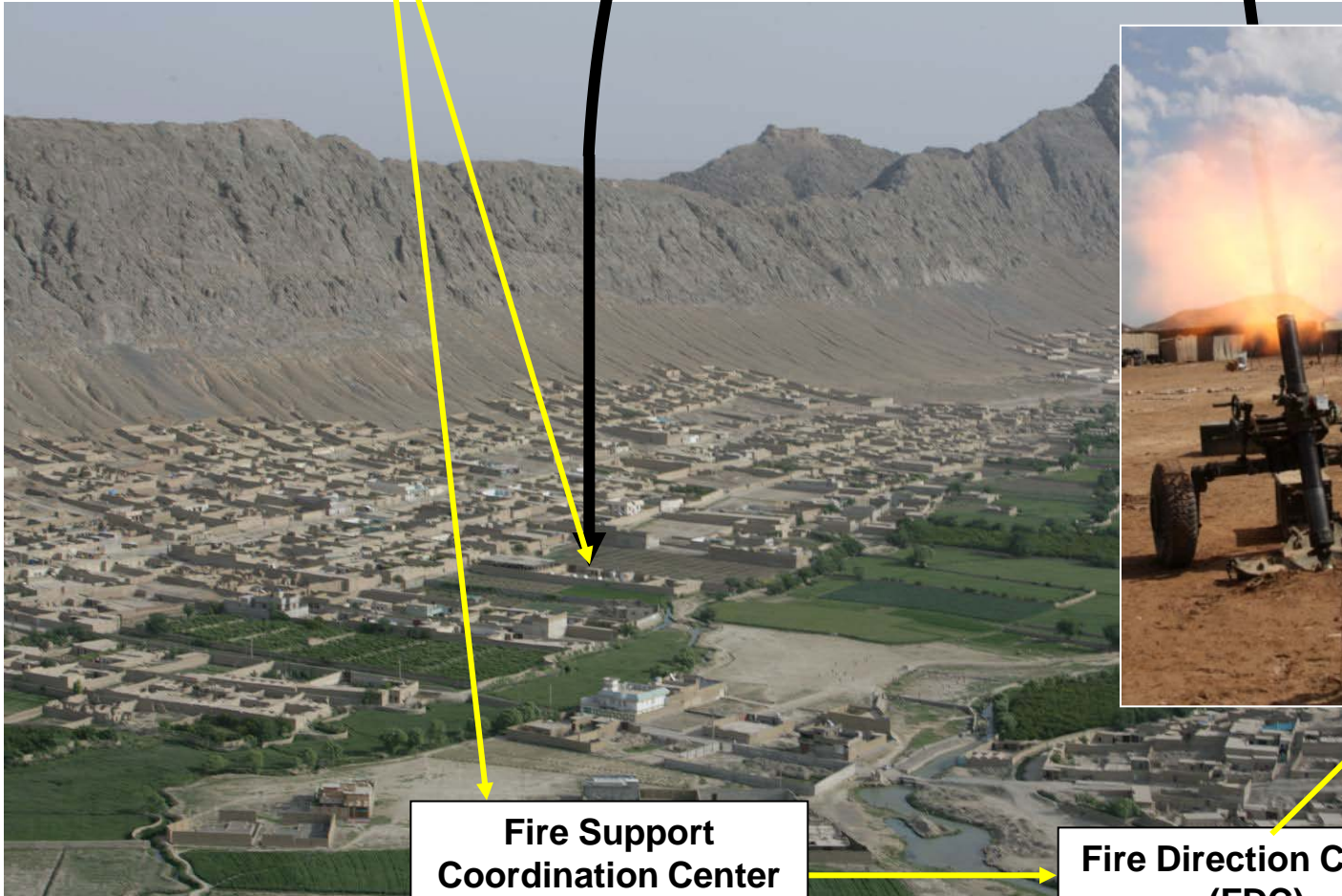
Precision Universal Mortar Attack (PUMA)



**Forward Observer
(FO)**

**Fire Support
Coordination Center
(FSCC)**

Precision Universal Mortar Attack (PUMA)



**Fire Support
Coordination Center
(FSCC)**

**Fire Direction Center
(FDC)**

Non-magnetic Azimuth Sensing (NMAS)



Will nearly eliminate Target Location Error (TLE) enabling use of a wider choice of precision munitions with reduced probability of collateral damage.

Levels of S&T investments:

- Basic Research (phenomenology)
- Applied Research (feasibility)
- Advanced Technology Development (utility)

Design and fabricate ultra-high resolution MEMS vibratory gyroscopes

Achieve azimuth accuracy of 4 mils in four minutes with MEMS tuning fork gyros and disc resonating gyros

Develop high-Q silicon based disc resonating gyro and MEMS based inertial measurement unit (IMU) components (accelerometers, electronics, software)

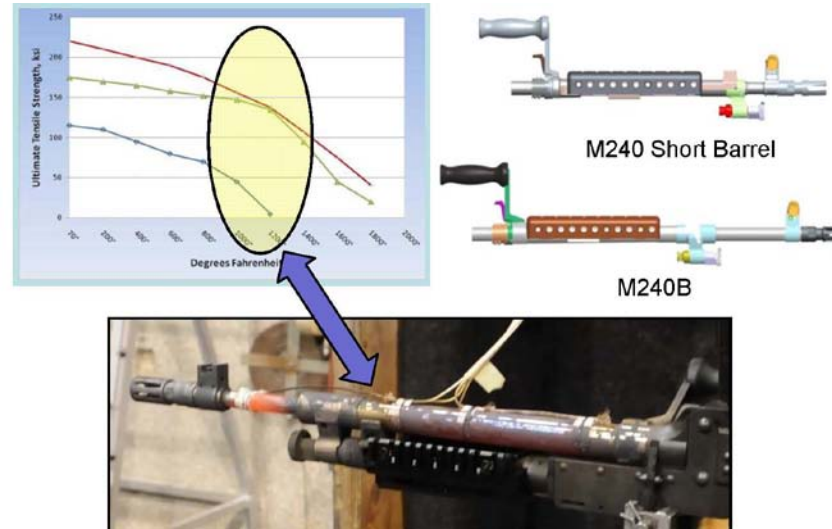
Azimuth and Inertial Micro-electromechanical (MEMS) Navigation System (AIM)



Future Naval Capability Program, will provide low cost precision inertial navigation systems for:

- Very accurate handheld targeting systems
- Low cost shoulder launched missiles and munitions
- Robotic and Unmanned Aerial Systems (UAS) navigation

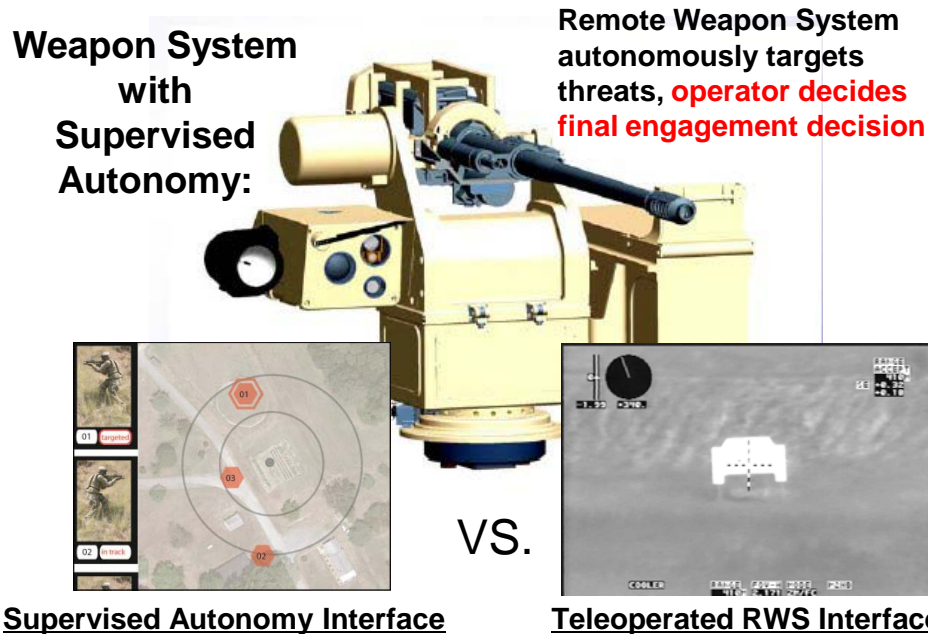
High Performance Alloys for Weapons Applications (HPAWA)



Prototyping 7.62mm machinegun barrels from super alloys to:

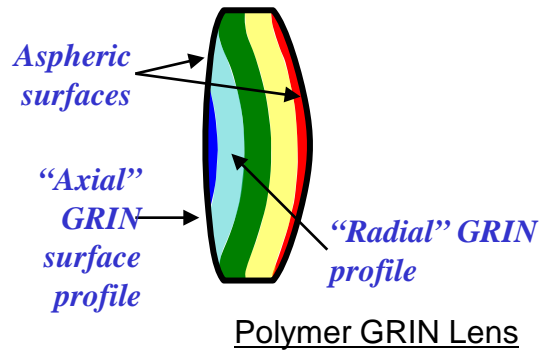
- Withstand the high firing temperatures, pressures, and erosive environments
- “Lighten the Load” by eliminating spare barrel
- Increase lethality by eliminating gun barrel changes during firing events
- Improved service life and reduced life-cycle cost

Supervised Autonomous Fires Technology (SAF-T)



- Machines outperform warfighters in well-defined, repetitive tasks.
- If the engagement chain of a teleoperated (TO) remote weapon system can be decomposed into primarily well-defined processes, then there exists a reassignment of tasks for which a supervised autonomous (SA) system shall outperform a TO system;
- As determined by established measures of performance such as P_D , P_H , and time-to-engage.

Awareness for Lowlight Engagements and Remote Targeting (ALERT)

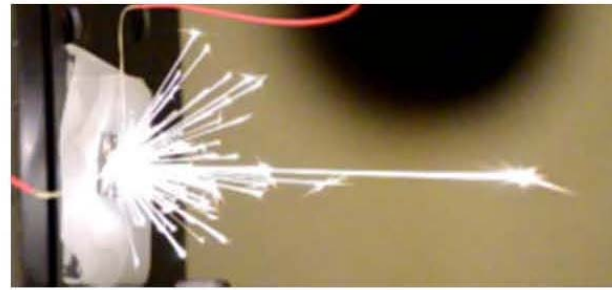


- GRIN Mass: **7.5 x less**
- GRIN Volume: **3.5 x less**

- Providing ultra lightweight, highly tailorable optical lens packages having substantially increased fields of view.
- If a 50mm aperture gradient index lens of sufficient optical transparency (<90%) and dispersion (Abbe Number 30-90) can be fabricated, then by varying the refractive index as a function of both axial and radial position within the lens, multi-element optical systems could reduce their weight by 75% while increasing the number of resolvable pixels by 50%.

Hypothesis

Micro-electromechanical (MEMS) Ignition Safety Device (ISD)

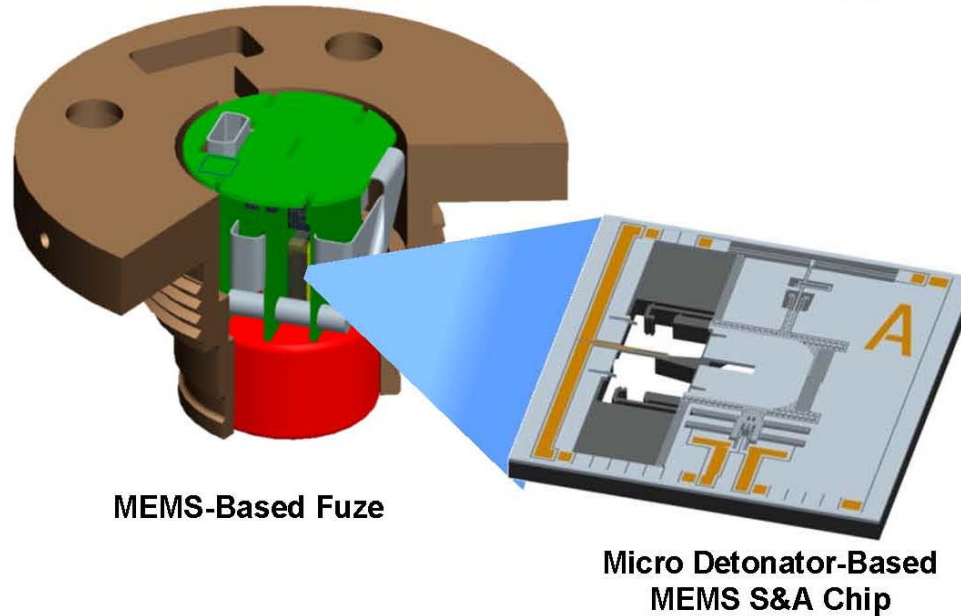


- Providing low cost and low SWAP propulsion ignition safety devices compliant with MIL-STD 1901A: Safety Criteria for Munition Rocket and Missile Motor Ignition Systems.
- If BKNO₃ ignition by an exploding silicon semiconductor bridge is related to:
 - Bridge dimensions
 - Formulation and amount of intermetallic and thermite based reactive materials
 - Bridge surface shape
 - The size of air gaps between reactive materials and pyrotechnic

Hypothesis

Then by maximizing both the amount of bridge silicon and reactive material that function at input energies of about 1 mJ and fit within a MEMS device, an affordable MEMS ISD can be developed.

MEMS Mortar Safety and Arming (S&A)



MEMS-Based Fuze

Micro Detonator-Based
MEMS S&A Chip

- Providing miniaturized fuze capabilities for a wide variety of munitions, compliant with MIL-STD 1316: Safety Criteria for Fuze Design.
- Objective
- To demonstrate utility of a MEMS based fuze that fits into the current M821 and M889 81mm mortar fuze booster cavity, incorporating environmental locks, command arm, and command initiation.

The Ultimate Customer – The Warfighter!

ONR S&T enables Sailors and Marines!

- S&T in support of Expeditionary Maneuver Warfare (continued primary importance to both Navy and Marine Corps)
- S&T in support of Combating Terrorism – aka Maritime/Irregular Warfare (MIRWAR), GWOT, Long War, etc. (rapidly growing emphasis in both Navy and Marine Corps)
- Be more lethal; be more resilient, be pro-active (not reactive)
- Expand Small Unit area of influence & support logistically
- Be flexible in all phases of warfare (ROMO)
- Move between kinetic and non-kinetic tactics
- Predict actions of Irregular enemies
- Operational Adaptation in paradigm of Hybrid Complex Warfare
- Lighten the Load
- More Energy Efficient
- Autonomous systems for the “Grunt”
- Survive and Win

Questions/Comments?

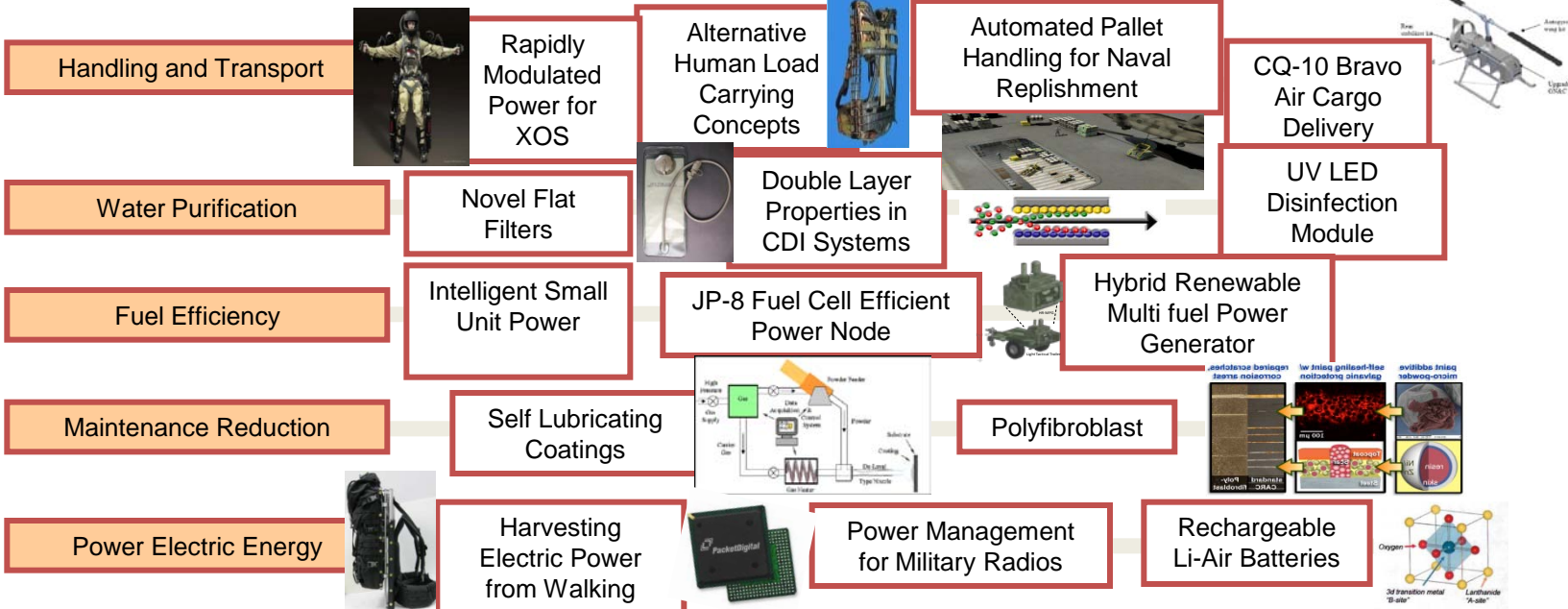
Visit us at:

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

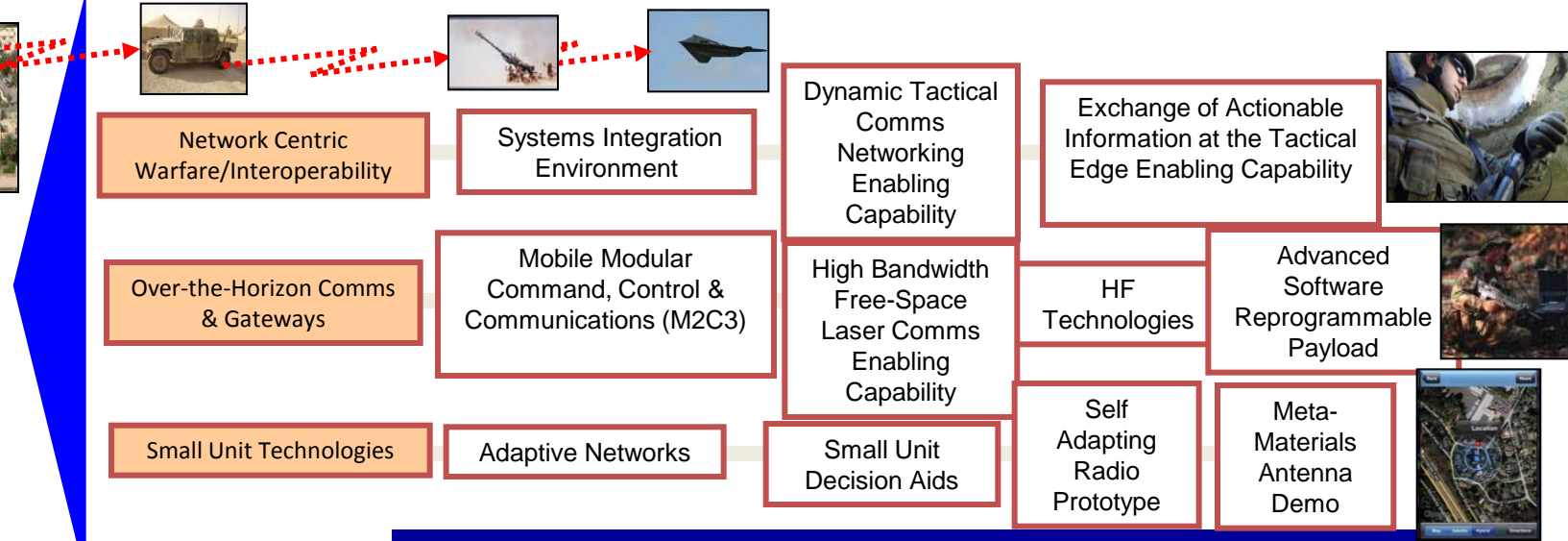
Backup

Expeditionary Maneuver "Whitman's Sampler"

Logistics

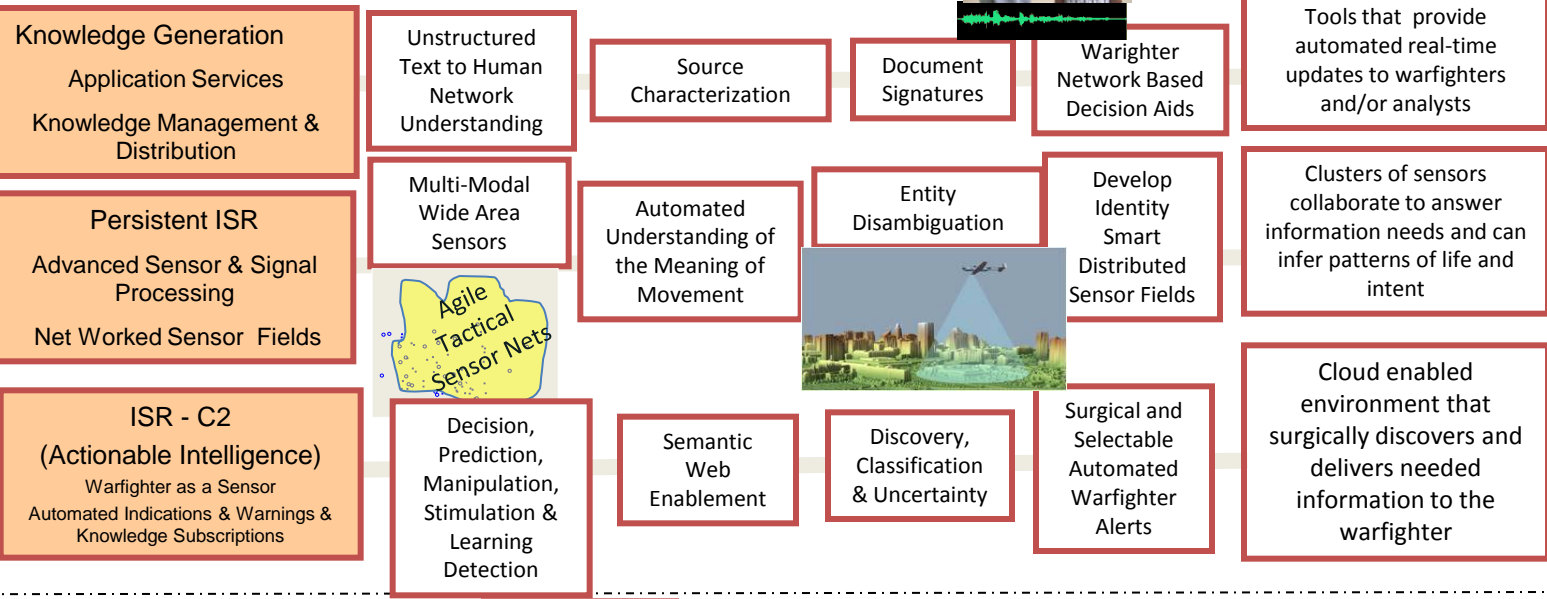


Command, Control, Communications, and Computers (C4)

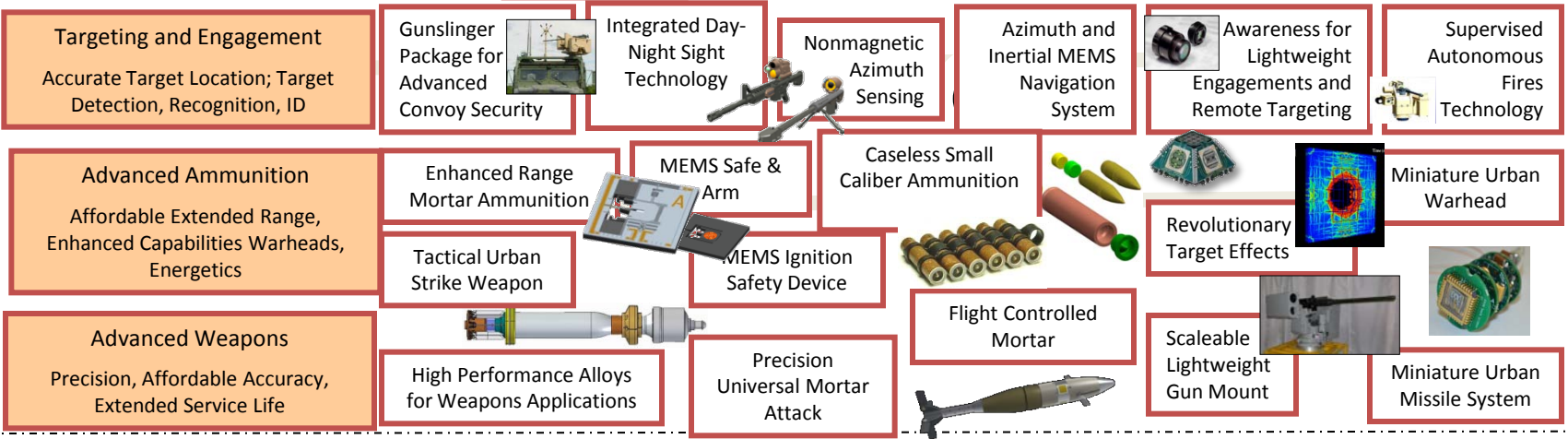


Expeditionary Maneuver “Whitman’s Sampler”

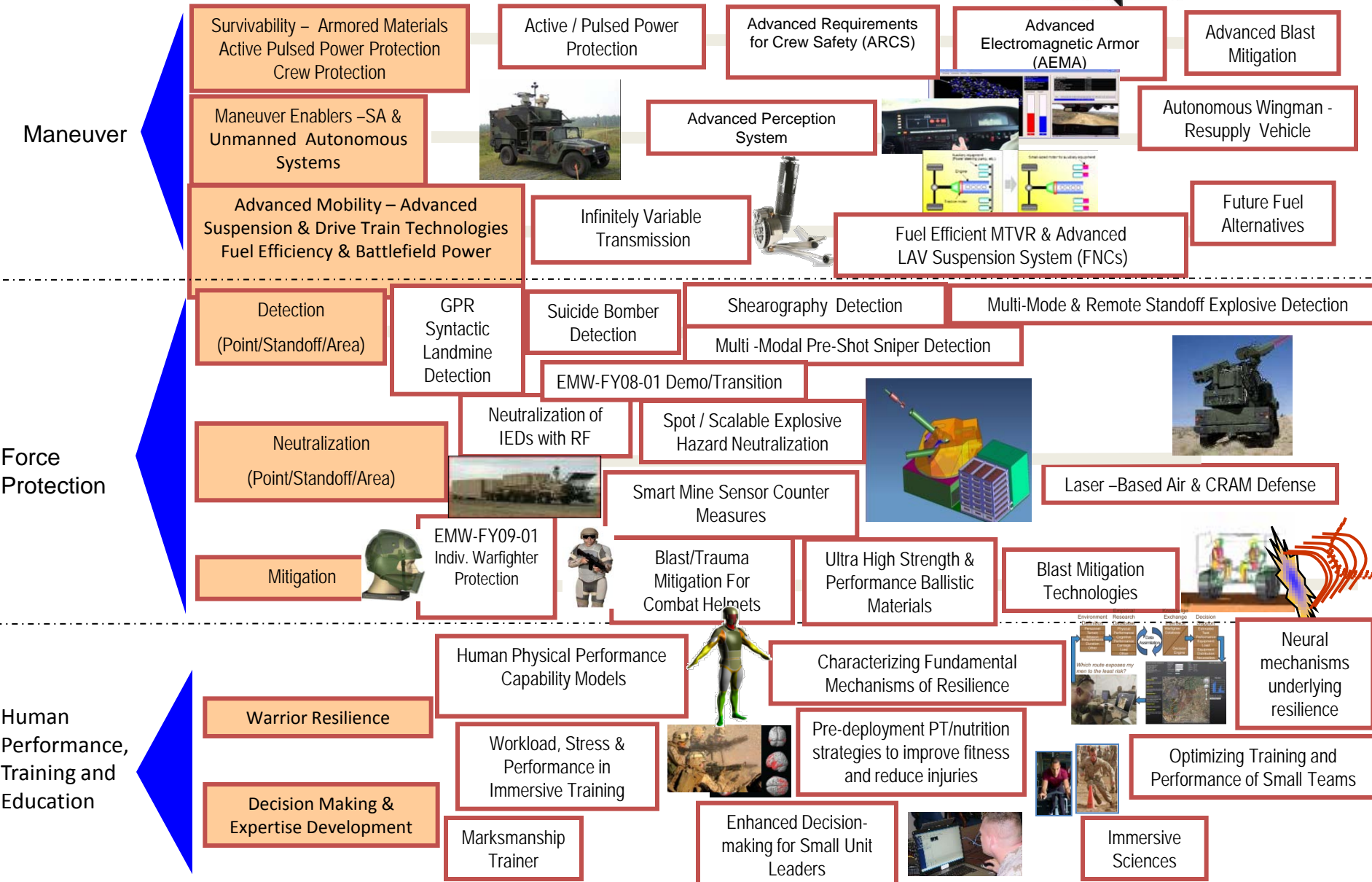
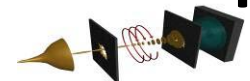
Intelligence, Surveillance & Reconnaissance (ISR)



Firepower



Expeditionary Maneuver “Whitman’s Sampler”



Targeting and Engagement TIA – Willful Intent

Current Capability:

- Conventional targeting and engagement systems for direct and indirect fire capability

FY	Desired Capability	S&T Challenge	S&T Solution
Near Term FY12-FY16	<ul style="list-style-type: none"> - Accurate target location for dismounted warfighters, at standoff distances, in all terrain and weather conditions, including urban and mountainous with cloud cover - Lightweight, 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 	<ul style="list-style-type: none"> - Achieve 4mil azimuth accuracy with light-weight, non-magnetic north finding sensors - Integrate sensor technologies into light-weight targeting and observation systems 	<ul style="list-style-type: none"> - 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) - Integrated SWIR-LWIR sensors in a single focal plane array
Mid Term FY17-FY21	<ul style="list-style-type: none"> - Handheld inertial navigation targeting in all environment and weather conditions, including GPS-denied - 10m target location error (TLE) at standoff distances, accounting for all sources of error, including azimuth, self location, vertical angle, range, and meteorological effects - Remotely deployed tags with delivery and activation system to mark targets of interest at near to extended stand-off distances - Lightweight, day/night, wide Field of View (FOV) target acquisition for crew served weapons 	<ul style="list-style-type: none"> - Achieve 1mil azimuth and 1mil vertical angle accuracy with handheld, inertial navigation targeting systems - 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 - Develop miniaturized marking technology (delivery survivable) suitable over extended ranges - Develop Graduated Index of Refraction (GRIN) lenses coupled to curved FPA 	<ul style="list-style-type: none"> - 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 - 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 - 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) - Combined GRIN lens, curved FPA, and advanced signal processing on crew served weapons to provide day-night target acquisition - Integrated Vis-NIR-SWIR-LWIR sensors in a single focal plane array

Targeting and Engagement TIA – Willful Intent

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FY	Desired Capability	S&T Challenge	S&T Solution
Far Term FY22-FY26	<ul style="list-style-type: none"> - Miniaturized, inertial-based, autonomous navigation of munitions for GPS-denied environments and no available laser designation - Lightweight, day/night wide FOV target acquisition for individual dismounted warfighters 	<ul style="list-style-type: none"> - Develop affordable, high-shock, and thermally resistant, MEMS inertial navigation, guidance, and control technologies - Develop nano- and doping-technologies for small sights, for individual weapons 	<ul style="list-style-type: none"> - 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 - Miniaturized GRIN lens, curved focal plane array to provide small sight - Null latency targeting and C2 technologies, autonomous on-board target recognition algorithms.

Endstate: 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.

Advanced Weapons TIA – Willful Intent

Current Capability:

- Conventional weaponry for direct and indirect fire capability

FY	Desired Capability	S&T Challenge	S&T Solution
Near Term FY12-FY16	<ul style="list-style-type: none"> - Precision fires for battalions - Reduce the weight of weapons systems, components, and ammunition - Extend the service life of weapons systems - Reduced operator burden for remote weapons stations - Reduce weapons spectral signatures 	<ul style="list-style-type: none"> - Develop a low cost, lightweight, low-power, guidance, navigation, and control system for a 81mm and 120mm mortar with trajectory shaping for engagements in complex terrain and less than 10 meter CEP precision - Demonstrate the utility of reducing combat load by increasing warfighter “kills-per-kilogram” - Economically design and apply superalloys to weapon systems in order to minimize erosion, extend service life, reduce weight, and enhance high temperature performance - Identify and automate engagement tasks that can be performed effectively and safely - Develop coatings and/or materials that absorb or reflect light at selective wavelengths for application to weapon system components 	<ul style="list-style-type: none"> - 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 and M934 120mm mortar munitions - Caseless ammunition small caliber weapons technologies - Flowforming small bore, thick walled, lightweight gun barrels out of superalloys such as L605, Rene 41, Stellite 21, Inconel 718, etc - Leverage consumer 3D graphical engines (ie, Unity game engine) to develop tools for M&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 - Suitable pigments, dyes, and polymers

Advanced Weapons TIA – Willful Intent

FY	Desired Capability	S&T Challenge	S&T Solution
Mid Term FY17-FY21	<ul style="list-style-type: none"> - Precision fires for companies - Improved life cycle performance for small arms (reduced barrel erosion, improved operational performance) - Affordable fires accuracy and lethality against small tactical platforms from small manned tactical platforms - Covert tagging of enemy vehicles and combatants - Automatic target detection, recognition, identification, tracking, and hand-off capability at stand-off distances in dismounted targeting systems 	<ul style="list-style-type: none"> - Develop a miniature guidance, navigation, and control system for a 60mm mortar - Develop new materials and materials production techniques to provide consistent high weapon performance - Develop a remotely operated, stabilized weapon station mount of less than 200 lbs - Develop tag dispersion techniques that provide more than 95% coverage of all targets within 25m diameter from 2 km standoff range - Develop real-time, sensor data fusion, automatic target recognition and processing power system, in a dismounted package 	<ul style="list-style-type: none"> - Micro CAS and low cost SAL seeker - Flow-form processing, super alloys, and advanced composite materials - Integration of micro-pulsed laser designator, integrated day-night optics, lightweight minor caliber weapons, and low cost missiles - Airburst warhead for 81mm mortar with infrared reflective and other unique signature tagging technologies - 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
Far Term FY22-FY26	<ul style="list-style-type: none"> - Precision fires for the individual warfighter - High velocity launch for kinetic kill projectiles to defeat future armor - Non-lethal engagement capability - Precision engagement and escalation of force from unmanned ground, air, and surface platforms 	<ul style="list-style-type: none"> - Low-cost, accurate, fire-and-forget, low SWaP missile subsystem technologies - Increase projectile velocities beyond chemical property limits of current propellants to velocities in excess of 4 km/s - Develop inexpensive non-lethal weapons effects and munitions, in coordination with Joint Non-lethal Weapons Directorate (JNLWD) - Develop wireless lethal effectors for safe and legally permissible employment from unmanned platforms 	<ul style="list-style-type: none"> - Silicon-based MEMS INS - Combustion light gas gun using hydrogen and oxygen for propulsion - Directed energy, electromagnetic pulse generators, variable density projectiles, and phaser technologies - Null latency targeting and C2 technologies, autonomous on-board target recognition algorithms

Endstate: 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.