Joint Armaments Conference

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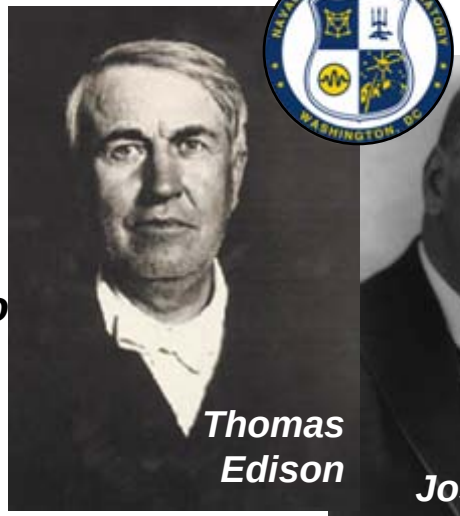
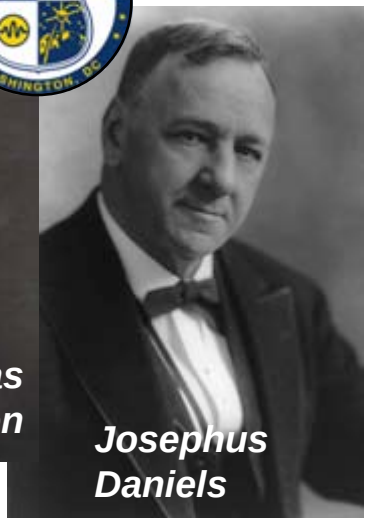
Expeditionary Maneuver Warfare
and
Combating Terrorism (ONR 30)

18 May 2010

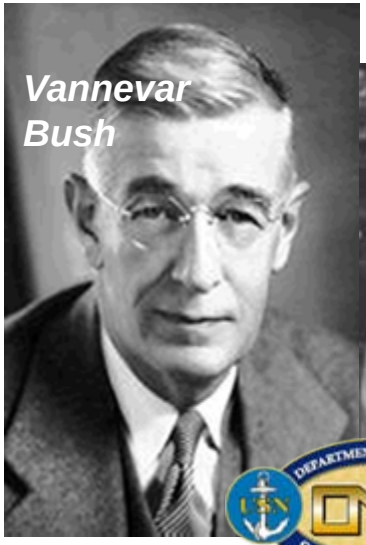
Naval Research: A Statutory Mission

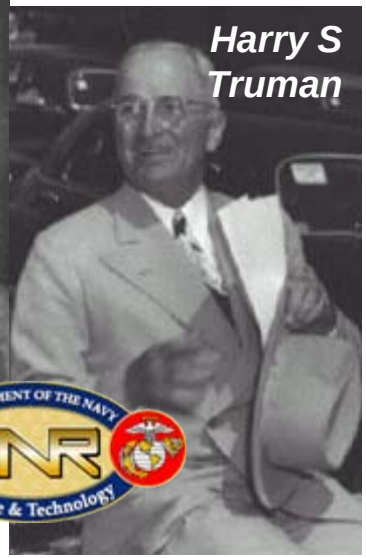
Naval Research Laboratory *(Appropriations Act, 1916)*:
"[Conduct] exploratory and research work…necessary… for the benefit of Government service, including the construction, equipment, and operation of a laboratory…."





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."

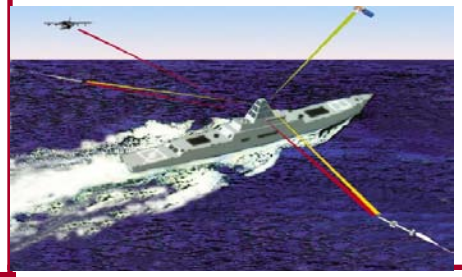
ONR S&T Departments

Code 30

Expeditionary Maneuver Warfare & Combating Terrorism

Code 31

C4ISR



Code 32

Ocean Battlespace Sensing

Code 33

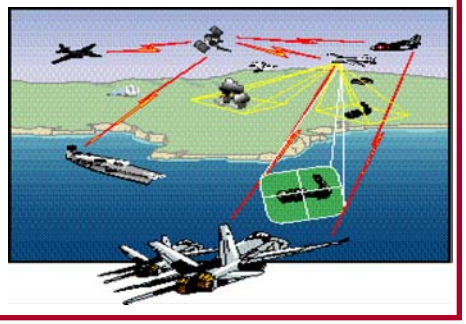
Sea Warfare and Weapons

Code 34

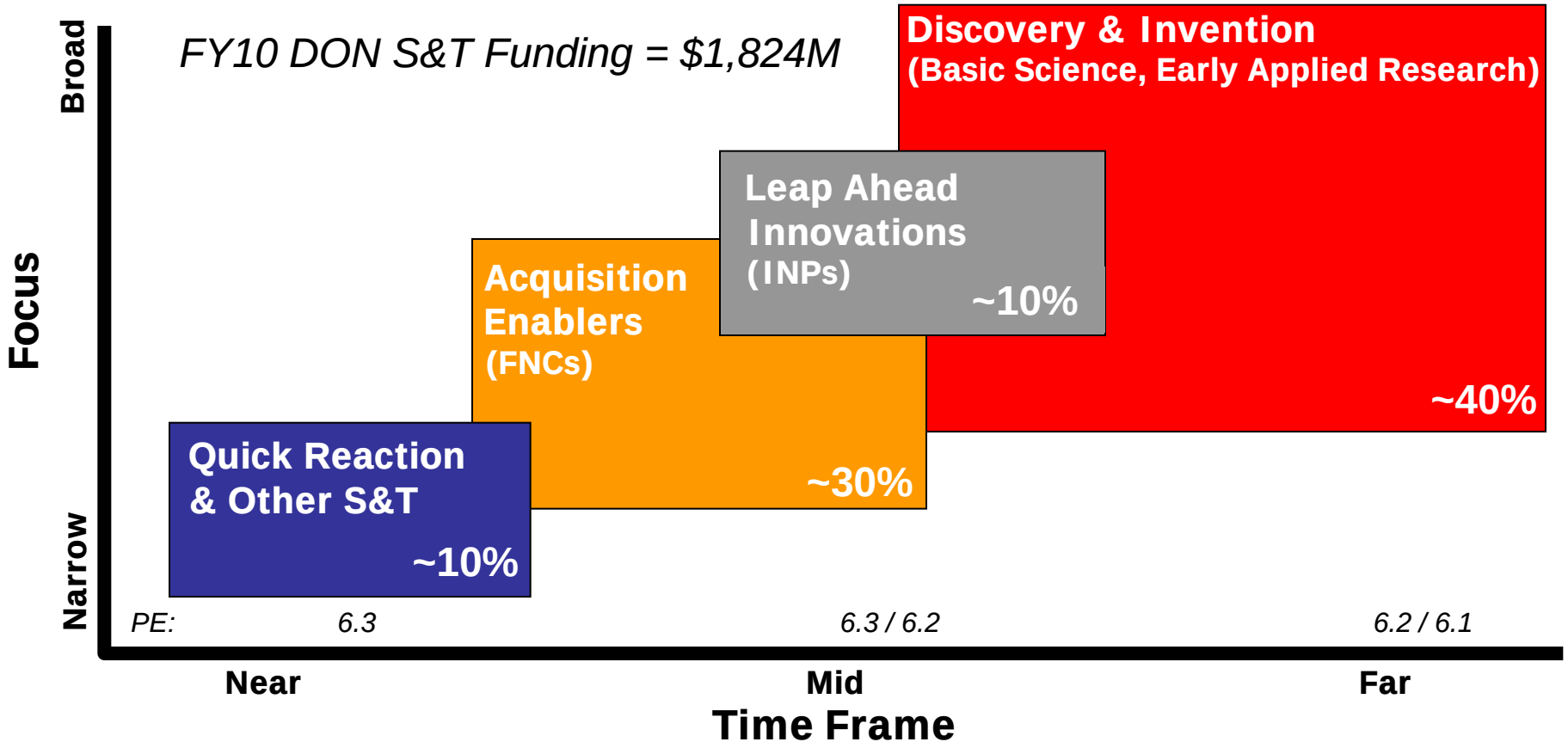
Warfighter Performance

Code 35

Air Warfare and Weapons



S&T Focused on Naval Needs



Quick Reaction (10%)
- Tech Solutions
- Experimentation
- MC S&T (MCWL, JNLW, etc.)

Acquisition Enablers (36%)
- Future Naval Capabilities
- Warfighter Protection
- Capable Manpower
- LO/CLO

Leap-Ahead Innovations (12%)
- Innovative Naval Prototypes
- NSPs
- Swampworks

Discovery & Invention (42%)
- Basic & Early Applied Research
- National Naval Responsibilities
- Education Outreach HBCU/MI

ONR 30 Organization

Expeditionary Maneuver Warfare and Combating Terrorism S&T

Human, Social, Cultural, and Behavioral Sciences (HSCB)

Hybrid Complex Warfare Sciences Division (301)

- Basic Research
- Counter IED

Applications Division (302)

- FITE JCTD

Combating Terrorism & Integration Division (303)

- Maritime Irregular Warfare
- Operational Adaptation + HSCB

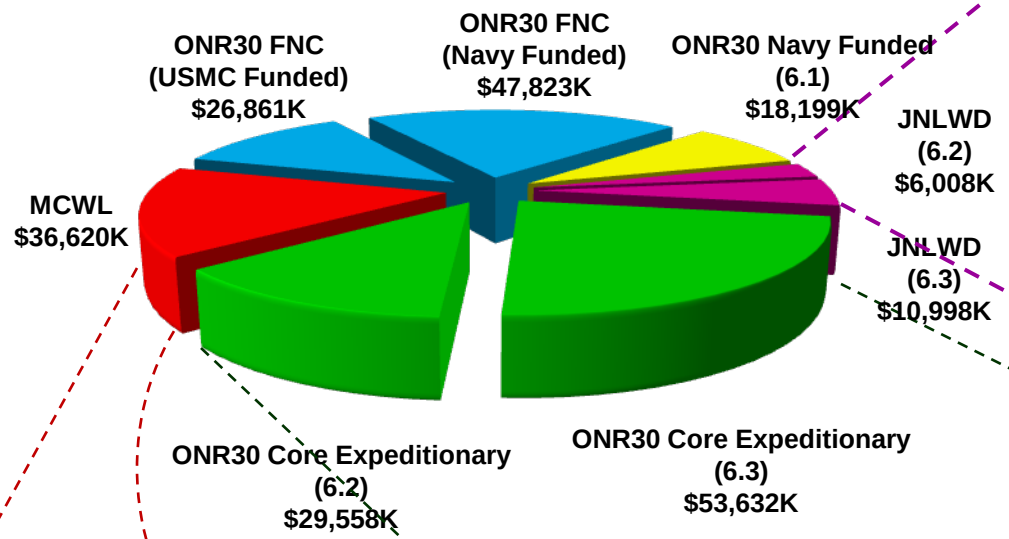
FY2011 R2 Activity Areas & ONR Code 30 Thrust Areas

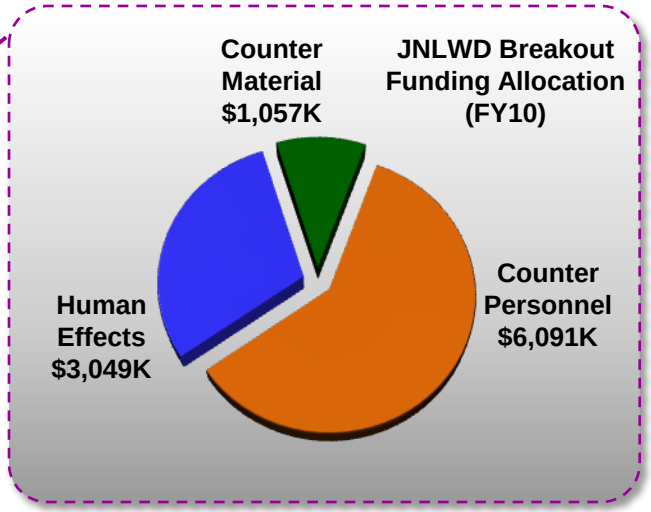
HPT&E* Thrust	C4 Thrust	ISR Thrust	Fires Thrust	Logistics Thrust	Maneuver Thrust	Force Protection Thrust
✓ Enhanced Physical Readiness	✓ Network Centric Warfare -Interoperability	✓ Persistent ISR	✓ Targeting & Engagement	✓ Asset Visibility	✓ Survivability	✓ Detection
✓ Mental Resilience & Cognitive Agility	✓ Over-The-Horizon Comms & Gateways	✓ Knowledge Generation	✓ Advanced Ammo	✓ Logistics Transport	✓ Advanced Mobility	✓ Neutralization
✓ Expertise Development	✓ Small Unit Technologies	✓ ISR - C2 (Actionable Intelligence)	✓ Advanced Weapons	✓ Operational Self-Sufficiency	✓ Maneuver Enablers	✓ Mitigation
		✓ Biometrics		✓ Maintenance Reduction		
		✓ Tag, Track & Locate		✓ Infrastructure		

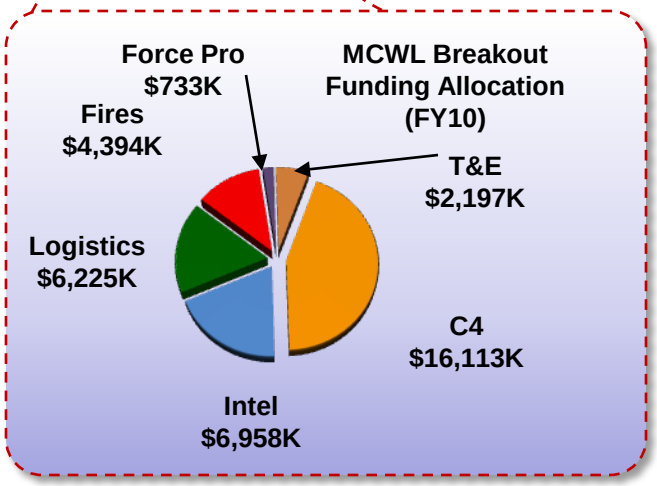
ONR Code 30 Technology Investment Areas – Focused Thrust Level S&T Investments

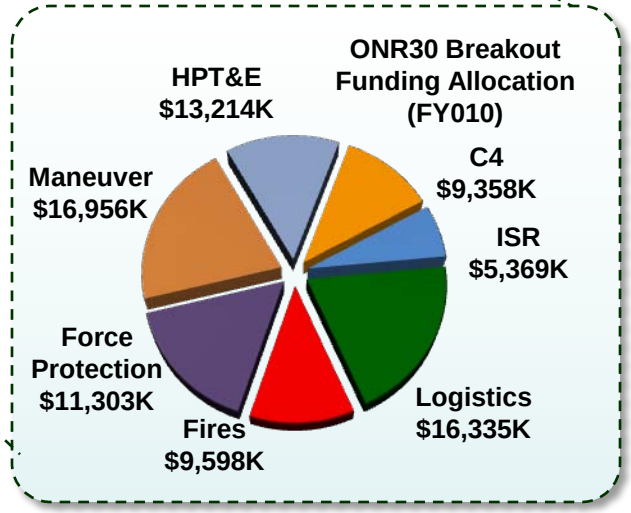
* HUMAN PERFORMANCE, TRAINING & EDUCATION

FY10 Marine Corps Funding Allocation

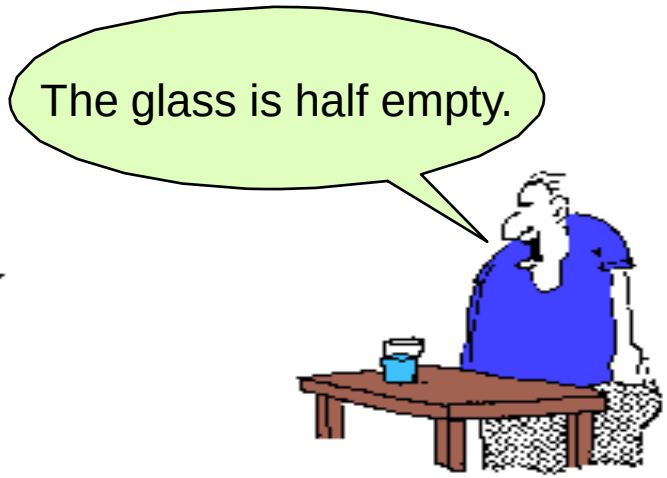








ONR



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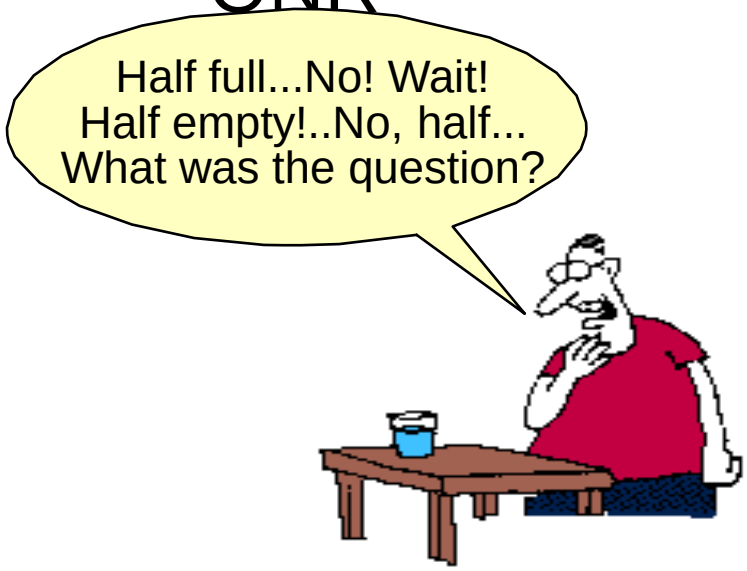


MCCDC/OPNAV

Fleet/MARFOR

Distributed Operations Defined

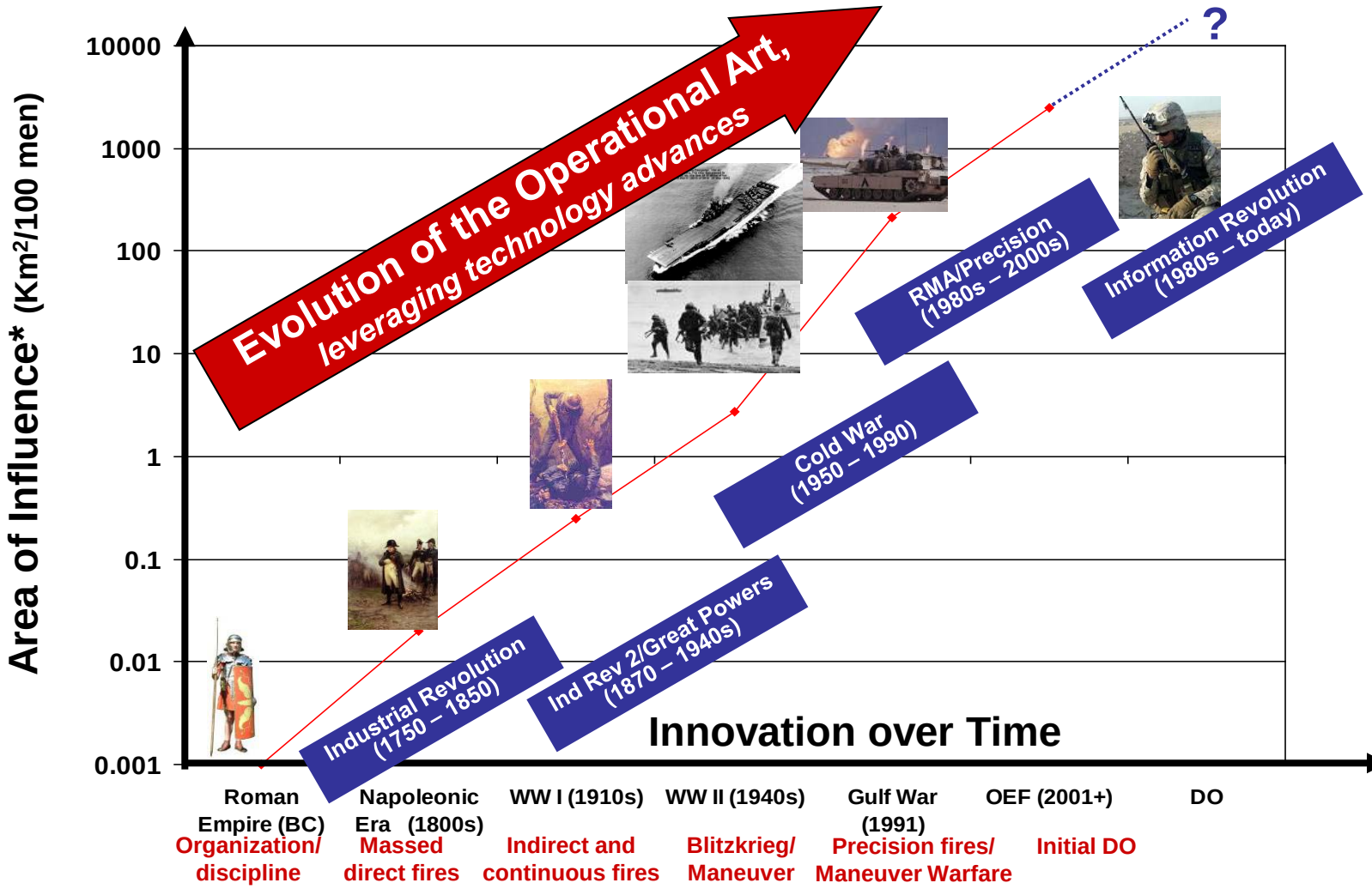
"Distributed operations describe an operational approach that creates an advantage over an adversary through **the deliberate use of separate, coordinated and interdependent actions.** Distributed operations are **enabled by improved access to functional support, as well as by enhanced combat capabilities at tactical levels.** Distributed operations are essentially a form of maneuver warfare in all domains and dimensions." ***-- Major Combat Operations Joint Operating Concept***

"Distributed operations is a technique applied to an appropriate situation wherein **units are separated beyond the limits of mutual support.** Distributed Operations are **practiced by general purpose forces, operating with deliberate dispersion, where necessary** and tactically prudent, and **decentralized decision-making** consistent with the commander's intent to achieve advantages over an enemy in time and space..." ***-- Marine Corps Ops in Complex & Distributed Environments*** ***(concept paper)***

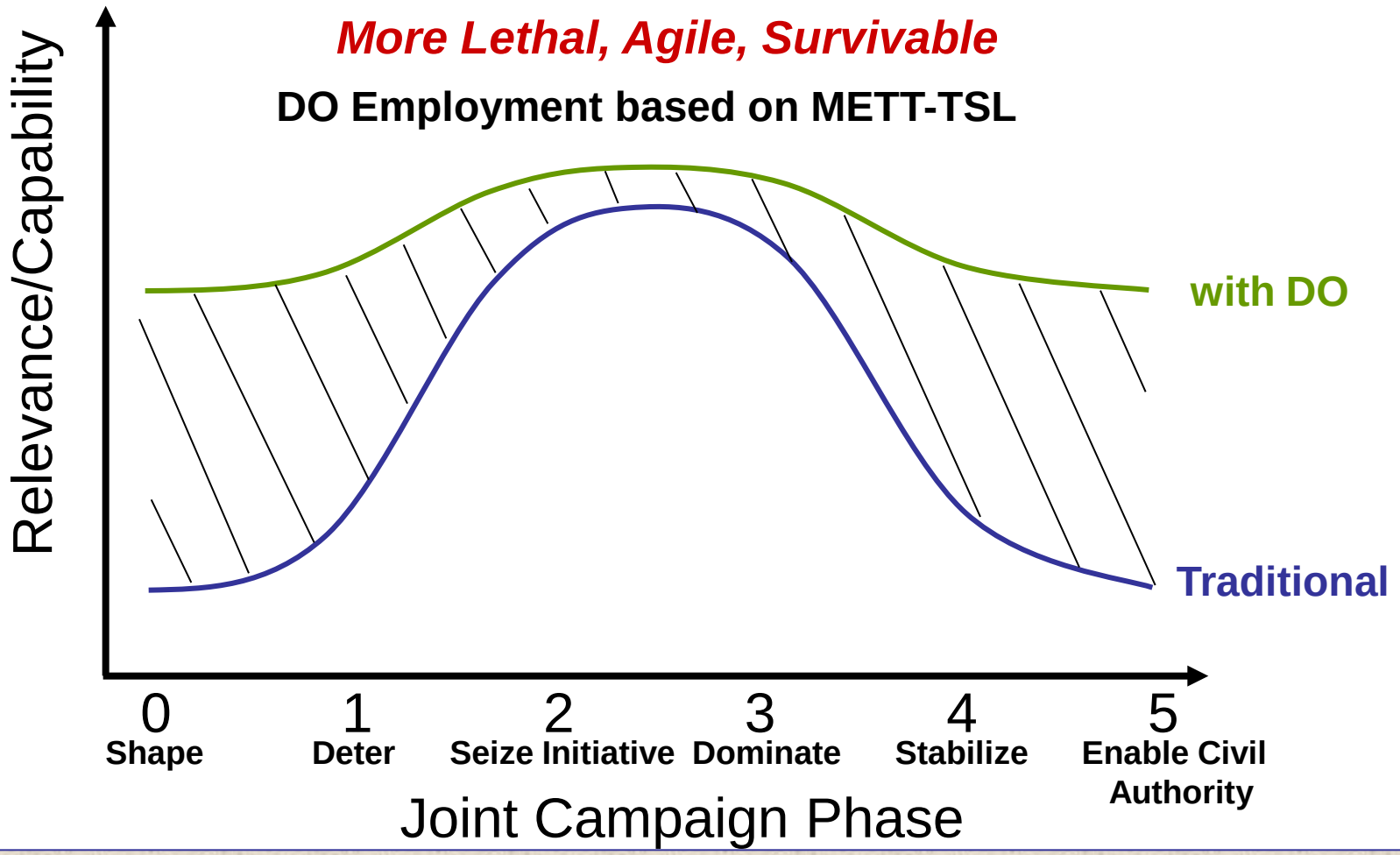
"[The] Navy's current operating environment drives us to adopt **distributed, networked operations** as our overarching global Navy concept. [This concept] takes advantage of the Navy's persistent forward posture to support active, layered defenses while placing the Navy-Marine Corps team in a unique position to conduct the shaping operations needed to assure friends and allies, and dissuade or deter potential regional, transnational, or global competitors." ***-- Navy Strategic Plan, 2006***

Technology Transforms Operational Art

DO is the next logical step in a historical progression toward increased dispersion.



DO Relevance in Joint Operations



"Armies do not win wars by means of a few bodies of super-soldiers but by the quality of their standard units"

Field Marshall Sir William Slim

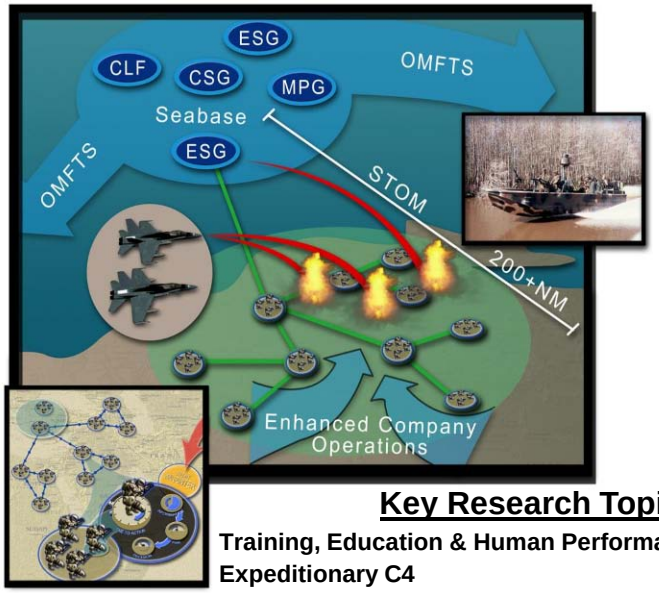
Distributed Operations
Vision & Objectives

Vision

Enable dispersed small units to dominate an extended battlespace through advanced warfighter training, assured network connectivity, enhanced situational awareness, and guaranteed access to logistics and fire support.

Objectives

1. **Warfighter Preparation:**
   - 1.1 Optimized physical readiness and enhanced cognitive performance
   - 1.2 Immersive, synthetic systems for training and education
2. **Command & Control:**
   - 2.1 Robust communications networks
   - 2.2 Enhanced small-unit situational awareness through intelligence and alert dissemination
   - 2.3 Small unit blue force tracking systems
3. **Logistics:**
   - 3.1 Automated logistics planning and monitoring
   - 3.2 Sustained demand reduction
   - 3.3 Logistics delivery
4. **Mobility:**
   - 4.1 Individual mobility & combat load reduction
   - 4.2 Small-unit mobility
5. **Lethality and Survivability:**
   - 5.1 Enhanced organic small-unit weapons effects
   - 5.2 Enhanced small-unit surveillance and reconnaissance



Key Research Topics

- Training, Education & Human Performance
- Expeditionary C4
- Communications and Networks
- Expeditionary Logistics
- Expeditionary Firepower
- Precision Strike
- Expeditionary ISR
- Unmanned Air and Ground Vehicles
- Special Warfare / EOD
- Land Mine Countermeasures
- Expeditionary Maneuver/ Individual Mobility

Fires as a Commodity

Technology Investment Areas (TIA):

- Targeting and Engagement
- Advanced Ammunition
- Advanced Weapons

Netted:

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

Reliable

Accurate

Lethal (Scalable)

Responsive

Flexible

Inorganic

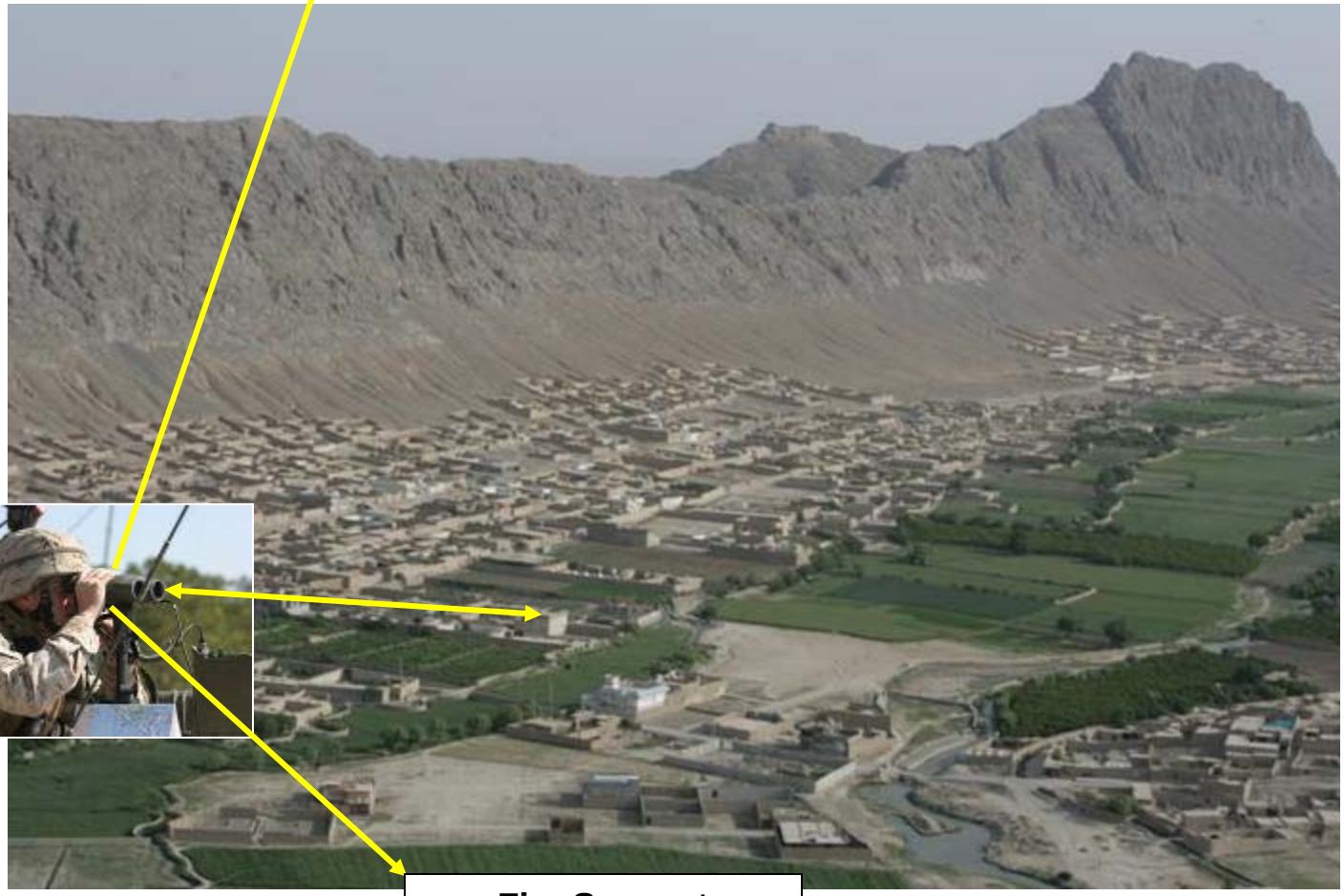
Bomb Damage Assessable

Logistically Supportable

“Lighten the Load”

Targeting and Engagement TIA

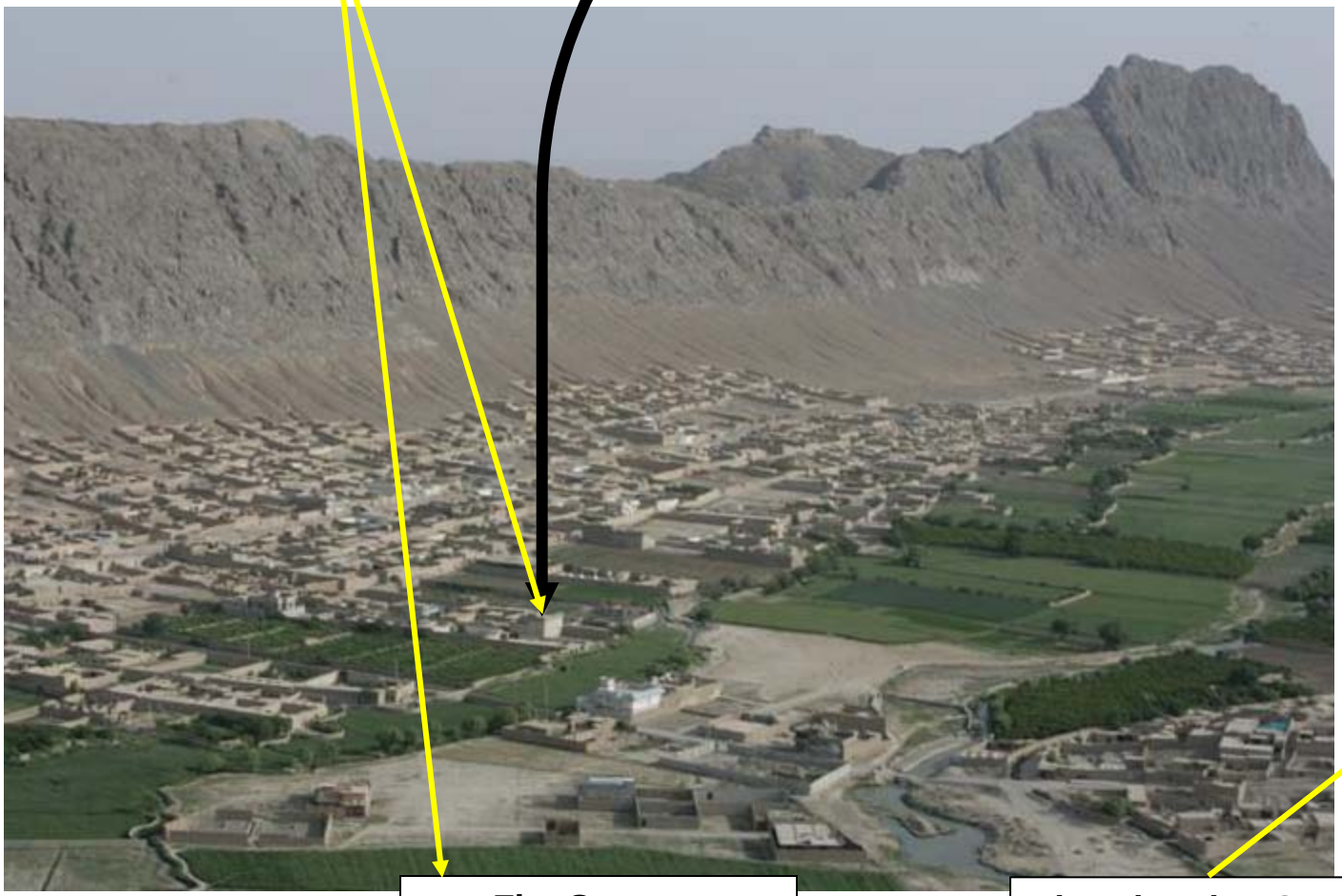
Precision Urban Mortar Attack (PUMA)

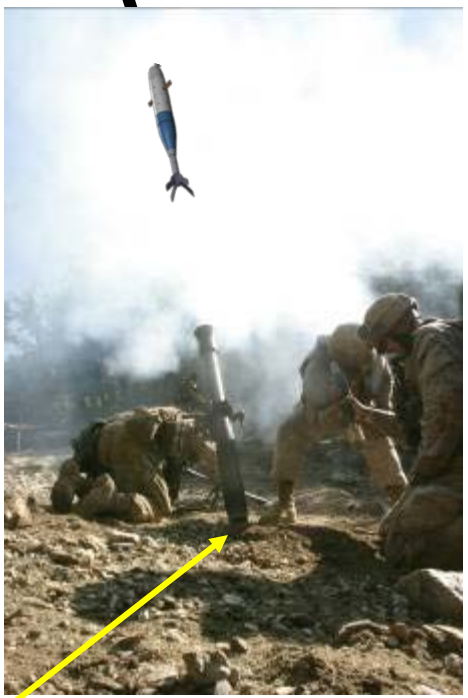


Fire Support Coordination Center (FSCC)

Targeting and Engagement TIA

Precision Urban Mortar Attack (PUMA)



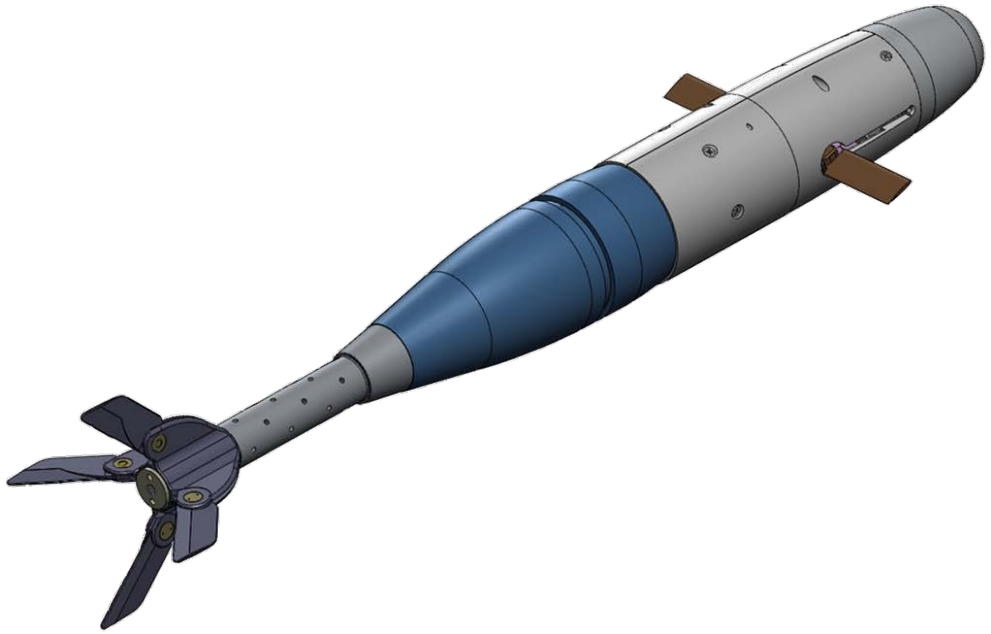


Fire Support Coordination Center (FSCC)

Fire Direction Center (FDC)

Targeting and Engagement TIA

- **Flight Controlled Mortar (FCMortar):**
  - **Guidance kit for 81mm mortar system, for precision engagement of targets in deep defilade**
  - **Flight trajectory shaping, miniature guidance and control components**



Targeting and Engagement TIA

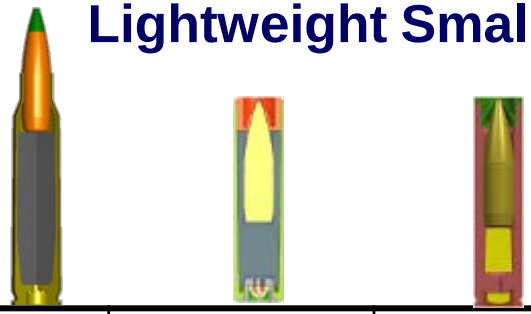
- **Non-magnetic Azimuth Sensing (NMAS):**
  - Handheld azimuth sensor for targeting, to 1 mil accuracy
  - System accuracy in operational environments
- **Eye-safe Laser Designation (ESLD):**
  - Handheld, eye-safe laser designator and seeker for covert targeting and engagement
  - Detector responsivity at eye-safe wavelength

Targeting and Engagement TIA

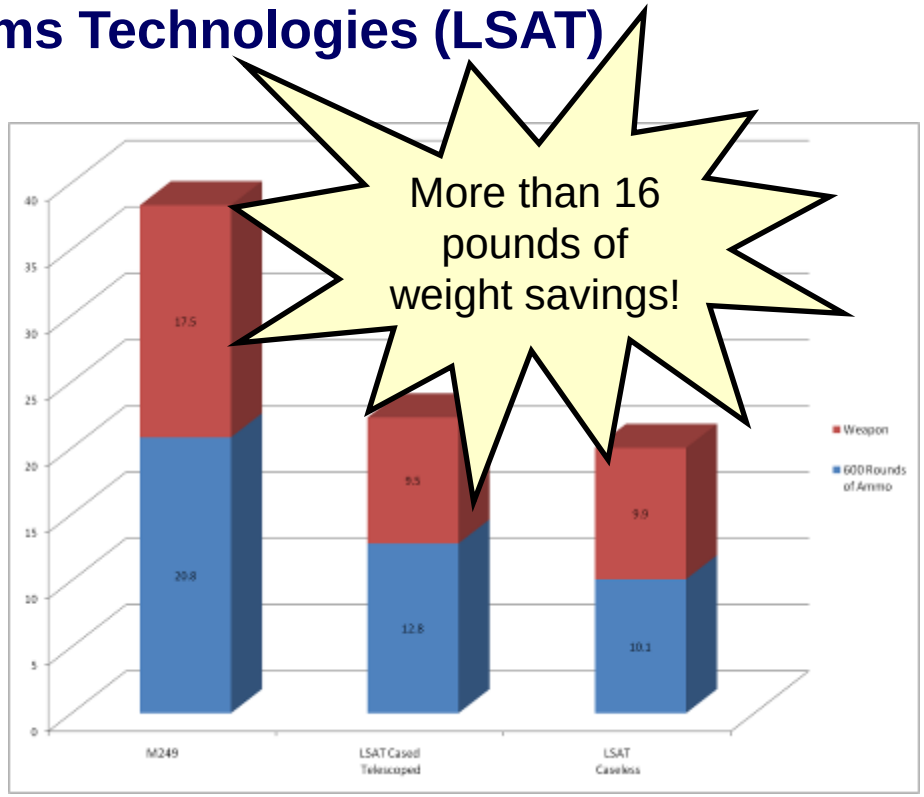
- **Integrated Day-Night Sight Technology (IDNST):**
  - **Integrated Vis-NIR-SWIR-LWIR optics in a single sight package; version for individual weapons, version for crew served weapons**
  - **Seek, acquire, track, observe, and engage targets to weapons' maximum effective ranges, under all light levels, through smokes and aerosols**
  - **Electromagnetic spectrum integration in a lightweight system**
  - **Lighten the load: reduce size, weight, and power**

Advanced Ammunition TIA

Lightweight Small Arms Technologies (LSAT)



	M855	Cased Telescoped	Caseless
Volume (cu in)	0.247	0.215	0.152
Percent Volume Reduction	----	**13%**	**38%**
Weight (grains) Including link	220	130.6	105.1
Percent Weight Reduction	----	**41%**	**51%**



Light Machine Gun (Comparable to M249 SAW)

5.56mm Case Telescoped

5.56mm Caseless

Advanced Ammunition TIA

- **Extended Range Mortar Ammunition (ERMA):**
  - **Increase range of the 81mm mortar by changing propellant formulation and granulation**
  - **Propellant formulations, interior ballistics, insensitive munitions**
- **Physics Based Modeling of Novel Warhead Designs:**
  - **Optimize initiation, explosives, materials, and shapes phenomenologies for warheads designed for specific effects on a variety of material targets**
  - **Computational/modeling capabilities of National Laboratories**
- **Micro-electromechanical Systems (MEMS):**
  - **Mortar Safety and Arming, ignition safety device**
  - **MEMS energetics**

Advanced Weapons TIA

- **High Performance Alloys for Weapons Applications (HPAWA):**
  - **Lighten the Load**
  - **Durability/Reliability**
  - **Cost Avoidance**
  - **Flowformed, lightweight, Cobalt Alloy machine gun barrels able to withstand high firing temperatures**
  - **Alloy characterization and fabrication**

LSAT Cost Comparison

- **Cost to Replace Army and Marine Corps M249 SAW, M4, and M16:**

  $1,300,000,000

- **Cost of M1 Main Battle Tank:**

  $5,000,000 each

  Total: $31,400,000,000

- **Cost of F-22 Raptor:**

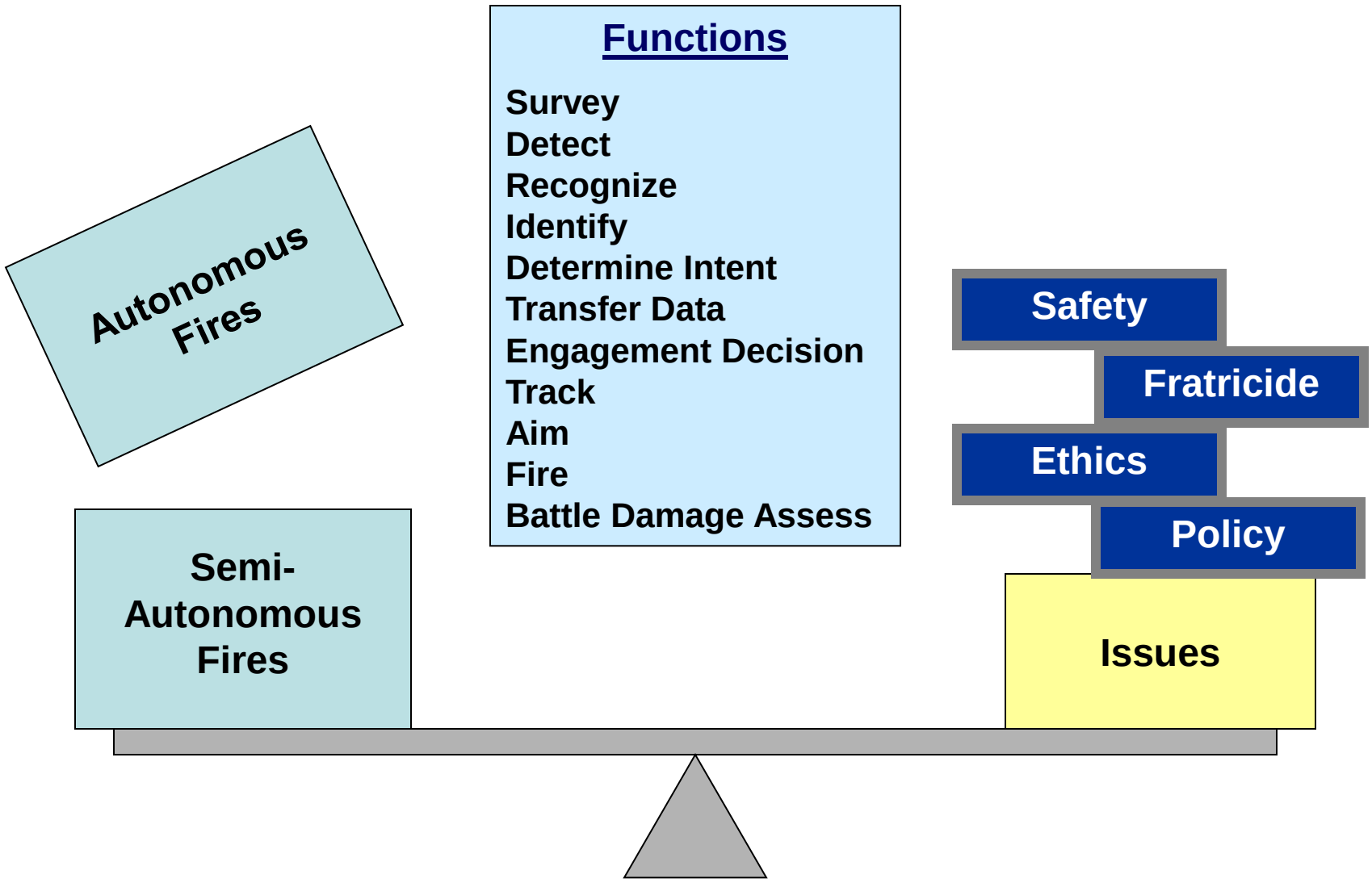
  $143,000,000 each

  Total: $19,600,000,000

All costs are estimated

Advanced Weapons TIA

Autonomous Fires Systems



The Ultimate Customer – The Warfighter!

ONR S&T enables Sailors and Marines!

- S&T in support of Expeditionary Maneuver Warfare
- Distributed Operations (Enhanced MAGTF Operations (EMO)/Enhanced Company Operations (ECO)
- Survive and Win
- Be more lethal
- Expand Small Unit area of influence
- Be flexible in all phases of warfare
- Move between kinetic and non-kinetic tactics
- Generate combat power operationally/tactically

Questions?

Back-Up


EXPEDITIONARY MANEUVER WARFARE
& COMBATING TERRORISM S&T DEPARTMENT

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 **FY10-FY15**	- Precision fires for battalions - Accurate target location - Eye-safe, light weight, low-power target designation - Threat detection, recognition, and identification out to effective ranges of small arms and crew served weapons	- Develop a miniature guidance, navigation, and control system for a 81mm mortar - Develop miniature azimuth sensors with 1mil accuracy - Develop low power eye safe laser designator technologies - Develop advanced Focal Plane Arrays (FPA), having miniature displays, applying scene enhancement technologies	- GPS and terminal seeker based guidance kit and tail kit for the M821/M889 81mm mortar munitions - Miniature Micro-electromechanical Systems (MEMS) based inertial azimuth sensors - Micro pulsed laser range finder and pulse integrating seeker technologies and algorithms - Integrated Vis-NIR-SWIR-LWIR optics in a single sight package through the Future Naval Capability (FNC) program
Mid Term **FY15-FY18**	- Precision fires for companies - Remotely deployed tags to mark hostile vehicles and combatants - Day and night wide Field of View (FOV) target acquisition for crew served weapons	- Develop a miniature guidance, navigation, and control system for a 60mm mortar - Develop rapidly dispersed aerosols or MEMS to attack to targets - Develop Graduated Index of Refraction (GRIN) lenses coupled to curved FPA	- GPS and terminal seeker based guidance kit and tail kit for the M720/M888 60 mm Mortar - Flight controlled mortar delivering aerosol/MEMS tags on designated standoff site - Combine GRIN lens, curved FPA, and advanced signal processing on Crew served weapons to provide day/night target acquisition
Far Term **FY18-FY22**	- Precision fires for the individual warfighter - Day and night wide FOV target acquisition for individual dismounted warfighters	- Develop guidance, navigation, and control technologies to flight correct small caliber projectiles - Develop nano- and doping-technologies for small sights, for individual weapons	- Micro-thrusters and MEMS based GNC for minor caliber and small arms ammunition - Miniaturized GRIN lens, curved focal plane array to provide small sight

Endstate: Advanced 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 Ammunition TIA Willful Intent

Current Capability:

- Conventional munitions for direct and indirect fire capability

FY	Desired Capability	S&T Challenge	S&T Solution
Near Term **FY10-FY15**	- 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 (P_K) - Reduce weight and logistics burden of ammunition	- Develop advanced propellant technologies for the 81mm mortar - Develop novel warhead technologies that combine kill mechanisms for various target sets - Improve the reliability and output of safe-arm and ignition devices - Reduce small caliber ammunition weight by 50% and volume by 40%	- High nitrogen propellants and new propellant formulations - Combine conventional kill mechanisms including linear explosively formed penetrators, a shaped charge, a unitary penetrator, high explosive, and fragments in a single warhead - Miniature MEMS based low-energy reactive bridges and safe-arm technologies - High ignition temperature propellant, PNP binder replacement, and improved primer technologies for advanced caseless small caliber ammunition
Mid Term **FY15-FY18**	- Extended range fires for companies - Defeat of targets behind walls (both combatants and doubly protected items) - Insensitive primary explosives and fuzes for advanced warheads	- Develop advanced propellant technologies for the 60 mm mortar - Develop advanced warheads and fuzes that delay detonation until the penetrator enters the protected space - Develop high output explosives with low sensitivity	- High nitrogen propellants and new propellant formulations - Physics based modeling and optimization of advanced penetrating warheads, combining multiple effects (i.e. 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
Far Term **FY18-FY22**	- Extended range fires for individual warfighters - Scalable warhead effects for shoulder launched missiles and mortars	- Develop propulsion technologies for extending range for guided projectiles - Develop warhead configurations enabling scalable lethality	- Nano-materials for propellant with significant advantages in propulsion output - Unique configurations of MEMS based fuzing, variable output explosives, and advanced kill mechanism combinations

Endstate: Improved lethality (scalable) and dominance of the individual Warfighter within his area of influence through advanced warhead, propulsion, and ammunition technologies, supporting Fires as a Commodity.

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 **FY10-FY15**	- Reduce the weight of weapon systems and components - Extend the service life of weapon systems - Coordinated threat response with remote weapons stations	- Develop new manufacturing processes that improve characteristics of materials used in weapon systems - Develop an integrated tactical network of threat detection sensors and remote weapons systems on moving vehicles - Demonstrate the utility of reducing combat load by increasing warfighter “kills-per-kilogram”	- High performance alloys and novel manufacturing methods - Acoustic sensors, advanced radios, and stabilized remotely operated weapon stations - Caseless ammunition small caliber weapons technologies
Mid Term **FY15-FY18**	- 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	- 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	- 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
Far Term **FY18-FY22**	- High velocity launch for kinetic kill projectiles to defeat future armor systems - Non-lethal fires - Precision engagement and escalation of force from unmanned ground, air, and surface platforms	- 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 corrdination with Joint Non-lethal Weapons Directorate (JNLWD) - Develop wireless lethal effectors for safe and legally permissible employment from unmanned platforms	- 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.

FIRES

Discovers and develops technologies to provide decisive, unrivaled new capabilities for, or to improve the performance of Navy and Marine Corps warfighters in the areas of Fires; with particular focus on Distributed Operations and Asymmetric/Irregular Warfare; to include Naval Expeditionary and other weapons, munitions, fuzes, ballistics, propulsion, weapons systems control and guidance, enhanced accuracy, tailored lethality including non-lethal alternatives, enhanced targeting (to include detection, locating, identification, designation, and tracking), directed energy, and lightweight components; and to avoid technological surprise.

KEY:	Other	FNC	D&I	E&D	Plus-Up

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RECENT TRANSITIONS

IMPROVED FIRE CONTROL SYSTEM (FNC)
TRANSITIONED TO PM INFANTRY WEAPONS SYSTEMS

LIGHTWEIGHT MORTAR SYSTEM (FNC)
TRANSITIONED TO PM MORTARS & PM INFANTRY WEAPONS SYSTEMS

ADVANCED FIRES COORDINATION TECHNOLOGY
TRANSITIONED TO PM MAGTF C2

ADVANCED GUN BARREL TECHNOLOGY
TRANSITIONED TO PEO-IWS3c

MEMS SAFE & ARM
TRANSITIONED TO PM AMMO

TECHNOLOGY INVESTMENT AREAS

TARGETING & ENGAGEMENT

USMC Fires STO-1: Targeting technologies for faster, more precise engagements, while simplifying fire control tasks

USMC Fires STO-2: Integrated lightweight day-night optics

USMC Fires STO-3: Engagement damage assessments

USMC Fires STO-4: More capable, lighter weight ammunition across the spectrum of lethality, with increased reliability, range, precision, and safety

USMC Fires STO-6: Increased capabilities and reduced weight of all ground combat weapons systems

USMC Fires STO-7: Technologies that utilize the electromagnetic spectrum to detect, exploit and target adversary systems, equipment, or individuals

NECE Fires STO-6: Lightweight day-night optics

NSW Fires 09-7: Lightweight, All Weather, Precision Targeting Technologies

NSW Fires 09-9: Lightweight Day-Night Weapons Optics

NSW Fires 09-13: Munitions Terminal Guidance for NSW Applications

NSW Fires 09-16: Highly Responsive Loitering Munitions/Weaponized UAS

NSW Fires 09-18: Advanced Weapons and Propellant Technologies

PROJECTS

- IMPROVED FIRE CONTROL SYSTEM (IFCS)
- DISTRIBUTED OPERATIONS PRECISION ENGAGEMENT (DOPE)
- NON-MAGNETIC AZIMUTH SENSING (NMAS)
- INTEGRATED DAY/NIGHT SIGHT TECHNOLOGY (IDNST)
- MICRO-PULSE LASER DESIGNATION
- MEMS INERTIAL SENSORS (UC IRVINE)
- FLIGHT CONTROLLED MORTAR
- PRECISION ENGAGEMENT TECHNOLOGIES (PET)

FIRES

Discovers and develops technologies to provide decisive, unrivaled new capabilities for, or to improve the performance of Navy and Marine Corps warfighters in the areas of Fires; with particular focus on Distributed Operations and Asymmetric/Irregular Warfare; to include Naval Expeditionary and other weapons, munitions, fuzes, ballistics, propulsion, weapons systems control and guidance, enhanced accuracy, tailored lethality including non-lethal alternatives, enhanced targeting (to include detection, locating, identification, designation, and tracking), directed energy, and lightweight components; and to avoid technological surprise.

KEY:	Other	FNC	D&I	E&D	Plus-Up

TECHNOLOGY INVESTMENT AREAS	PROJECTS
ADVANCED AMMUNITION	TACTICAL URBAN STRIKE WARHEAD (TUSW) 81mm EXTENDED RANGE MORTAR AMMUNITION (ERMA) CASELESS AMMUNITION 1901 A IGNITION SAFETY DEVICE REVOLUTIONARY TARGET EFFECTS MEMS MORTAR S&A

USMC Fires STO-4: More capable, lighter weight ammunition across the spectrum of lethality, with increased reliability, range, precision, and safety

USMC Fires STO-5: Improved propellants and energetic materials

USMC Fires STO-6: Increased capabilities and reduced weight of all ground combat weapons systems

NSW Fires 09-11: Measured-Effect Munitions

NSW Fires 09-12: Clandestine Structure Penetration

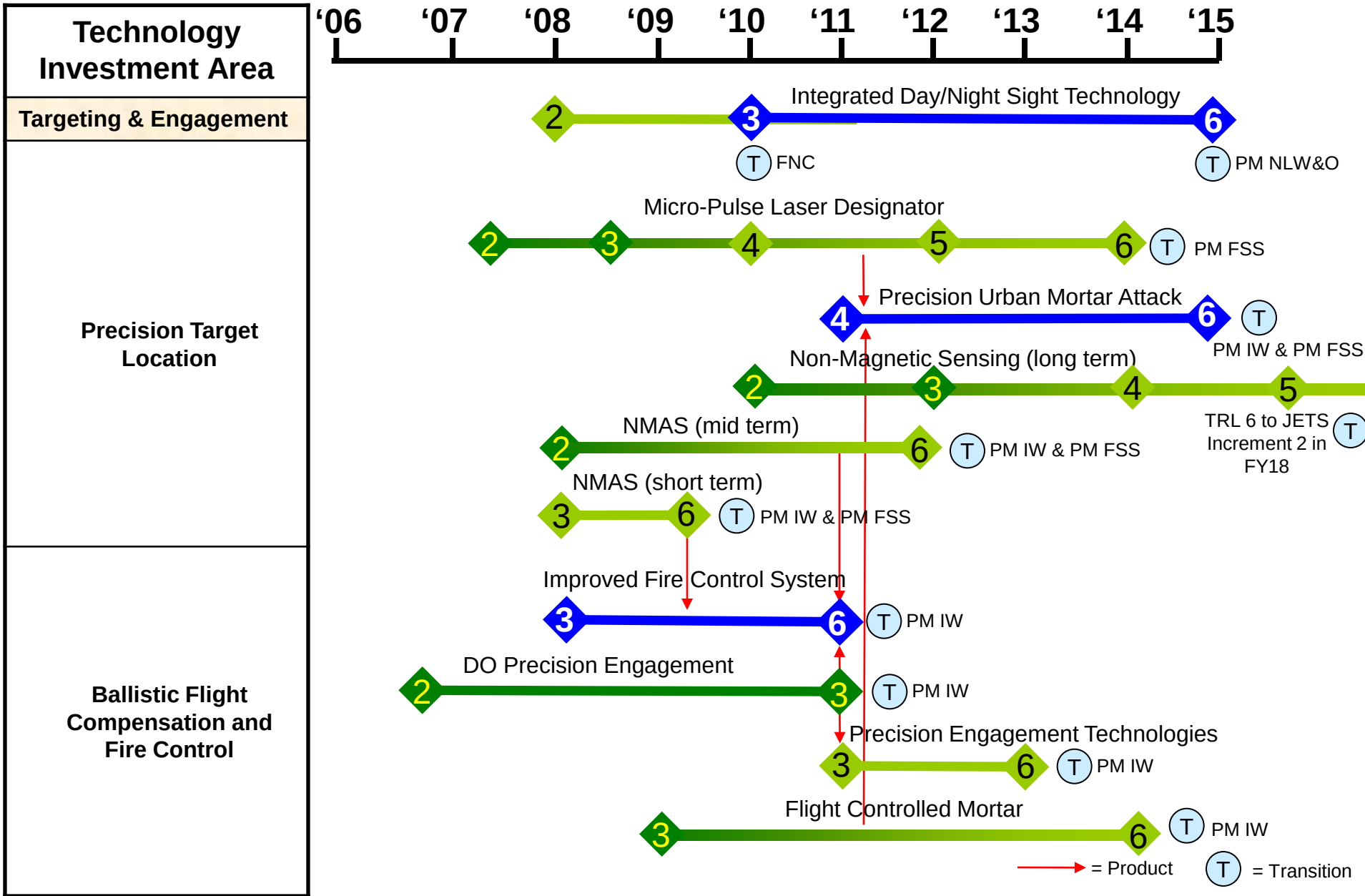
NSW Fires 09-18: Advanced Weapons and Propellant Technologies

ADVANCED WEAPONS	HIGH PERFORMANCE ALLOYS FOR WEAPONS APPLICATIONS

USMC Fires STO-6: Increased capabilities and reduced weight of all ground combat weapons systems

NSW Fires 09-18: Advanced Weapons and Propellant Technologies

ONR 30 FIRES S&T Roadmap (1 of 2)



ONR 30 FIRES S&T Roadmap (2 of 2)