NDIA
Lethality Technologies: 2025 & Beyond

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Army Enduring Challenges

- Greater ***force protection (Soldier, vehicle, base)*** to ensure survivability across all operations
  - Ease ***overburdened*** Soldiers in Small Units
  - Timely ***mission command & tactical intelligence*** to provide situation awareness and communications in <u>all</u> environments
  - Reduce logistic burden of ***storing, transporting, distributing*** and ***retrograde*** of materials
- Create ***operational overmatch*** (enhanced lethality and accuracy)
  - Achieve operational ***maneuverability*** in all environments and at ***high operational tempo***
  - Enable ability to ***operate in CBRNE environment***
  - Enable ***early detection*** *and* ***improved outcomes for Traumatic Brain Injury (TBI) and Post Traumatic Stress Disorder (PTSD)***
  - Improve ***operational energy***
  - Improve ***individual & team training***
- ***Reduce lifecycle cost*** of future Army capabilities

Future Environments

Triple Canopy and Forested

Mega Cities and Subterranean

Large Area Coverage

Caves

Urban and Mixed Populations

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ARL S&T Campaigns

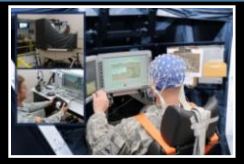
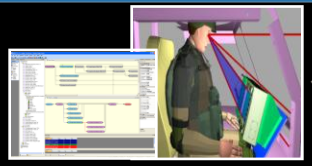
ARL

Extramural Basic Research

Steering and oversight of the systematic study to increase fundamental knowledge and understanding in physical, engineering, environmental, and life sciences related to long-term national security needs.

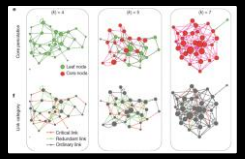
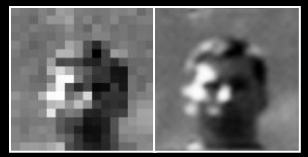
Human Sciences

Fundamental understanding of Warfighter performance enhancement, training aids, and man-machine integration..

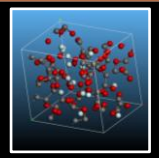
Information Sciences

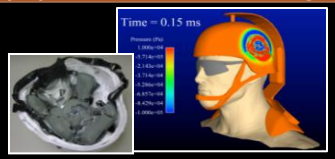
Fundamental understanding of information generation, collection, assurance, distribution, and exploitation.


Sciences for Lethality & Protection

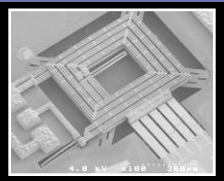
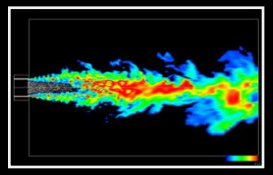
Fundamental understanding of emerging technologies that support weapon systems, protection systems, and injury mechanisms affecting the Warfighter





Sciences for Maneuver

Fundamental understanding of the design, integration, control, and exploitation of highly adaptive platforms in complex environments

Computational Sciences

Fundamental understanding of computer hardware, high efficiency algorithms, and novel mathematical methods.

Materials Research

Fundamental understanding of structural, electronic, photonic, and energy materials & devices.

Assessment and Analysis

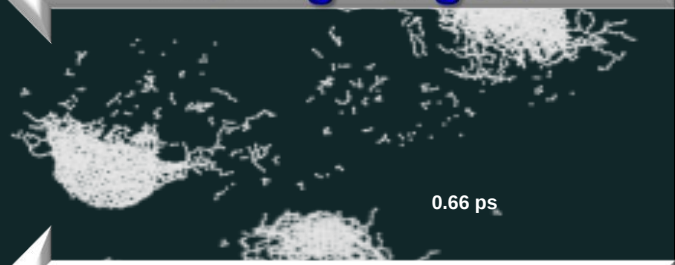
Quantitatively Assess the development and application of analytical tools and methodologies to quantitatively assess the military utility of Army, DoD, and select foreign combat systems.

- **Moving Targets**
  - Affordable precision kill of moving targets with and without terminal guidance
  - **Robust navigation in GPS challenged environments**
- **Non-lethal Technologies**
  - Technologies from 0 to 1000 m against human targets
- **Full spectrum capability of lethality in the hands of Individual Soldiers**

Small Arms → *Tank-like capabilities*

  - Single munition system for multiple targets: non-lethal, soft, medium, hard, structure
  - Ability to produce large holes in tough walls
  - 0 – 2km defeat of soft targets in defilade
  - 0 – 150% scalable warheads
- **Next generation lethal systems (complex system of systems)**
  - Robotic vehicles to enable new capabilities
  - Insensitive disruptive energetics
  - Throttleable rockets and missiles

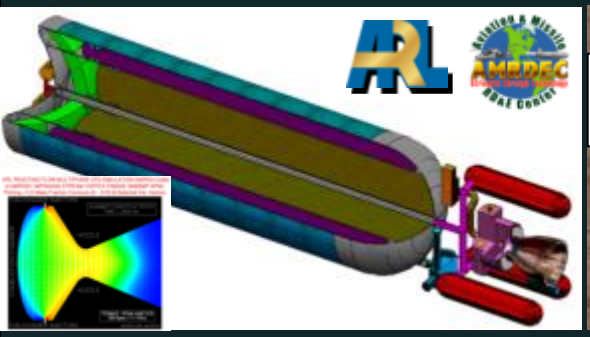
Moving Targets



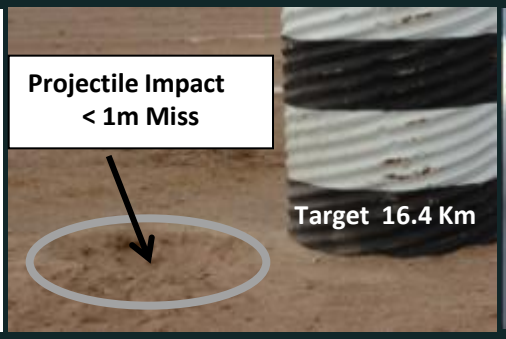
Man-Portable Precision

Structural Bond Energy Release of Nanodiamonds

Throttleable Rockets



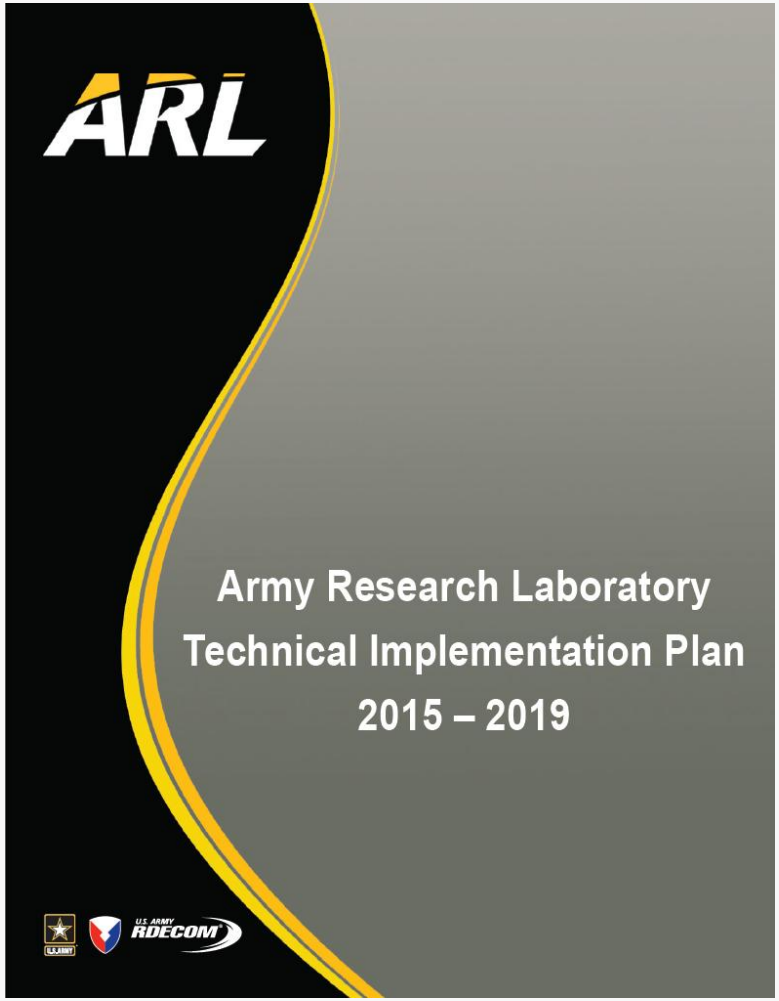
Affordable Precision Demo



Shoulder-Fired Munitions

MOUT

Initiatives



Key Campaign Initiative (KCIs)

Substantive, long-lived, technical programs focused on pursuing scientific discoveries, innovations, and knowledge product transitions that are expected to lead to greatly enhanced capabilities for the operational Army of 2040

Lethality KCIs

- Scalable Lethal Adaptable Weapons Concepts
- Desired Lethal Effects at Standoff Ranges in Constrained Environments
- Disruptive Energetic Materials

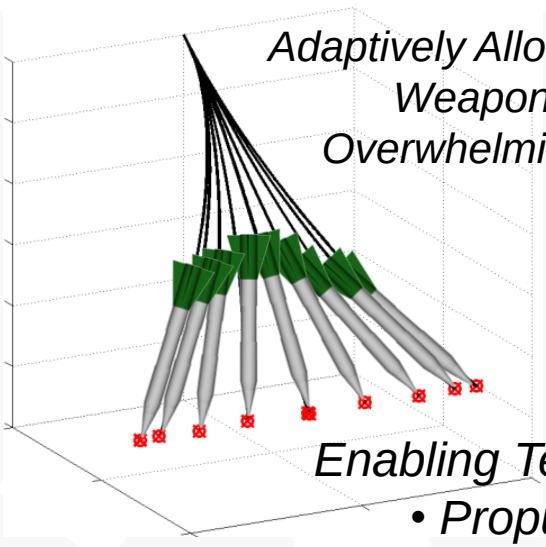
http://www.defenseinnovationmarketplace.mil/resources/ARL_Technical_Implementation_Plan.pdf

Lethality Portfolio Vision/Mission Statement

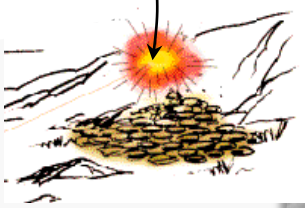
Assured and Instantaneous Delivery of N Lethal Payloads at Extended Ranges through Complex and Denied Environment





Adaptively Allocate Multiple Weapons with Overwhelming effects

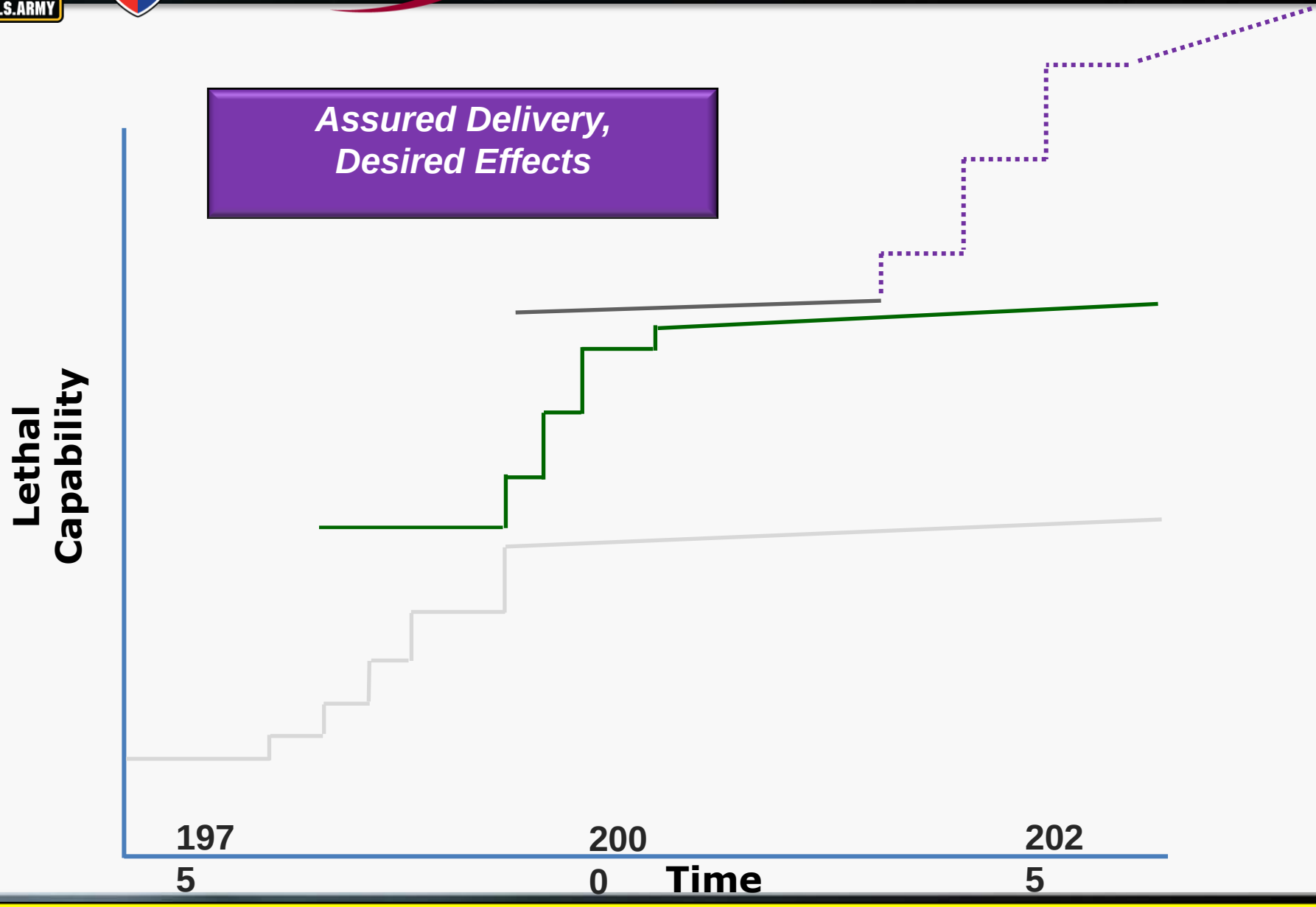


Enabling Technologies

- *Propulsion*
- *Maneuverability*
- *Navigation*
- *Effects*
- *Weapons Engineering*

Affordable

Lethality Over Time



Material and Ballistic Science, Structural/System Design critical for revolutionary lethality

Desired Lethal Effects at Standoff Ranges in **Constrained** Environments

Objectives: To develop the underpinning science and technology for significant enhancements in assured delivery of the lethal payload

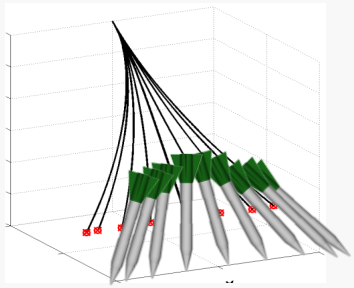
Impact and Relevance:
Assured delivery of munitions on the battlefield more precisely with lower collateral damage and reduced logistics burden

Increase the mission space:
- engagements at extended range
- moving targets
- defilade targets

Complex environment at low cost
- GPS denied
- countermeasures

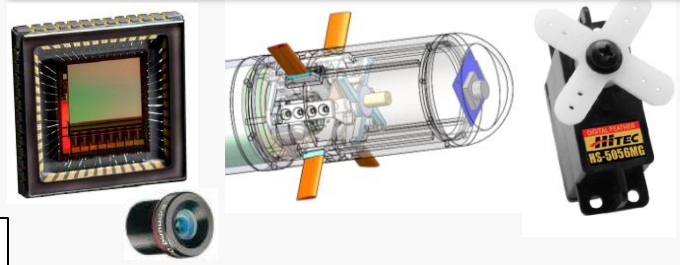
Technical Areas

- Aeromechanics
- Controls
- Maneuverability
- Navigation
- Structures

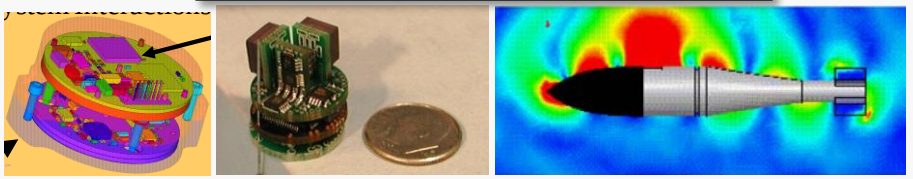


Adaptively Allocate Flight of Multiple Projectiles Based on In-Flight Measurements

Leverage external advancements in processing, measurements, and actuation for navigation and maneuver technologies



Advanced computational and experimental tools



Complex Targets

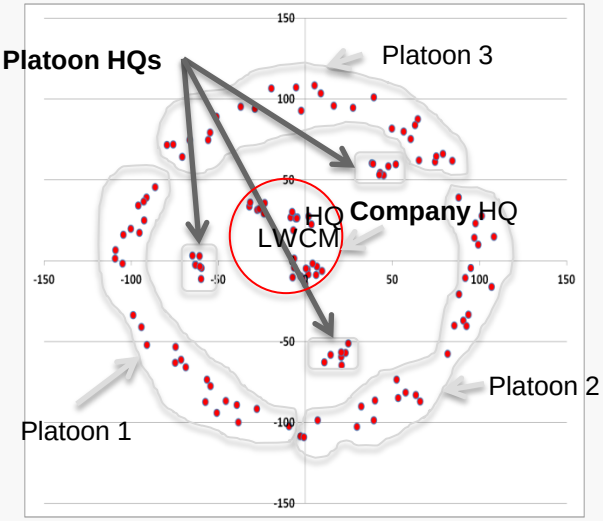
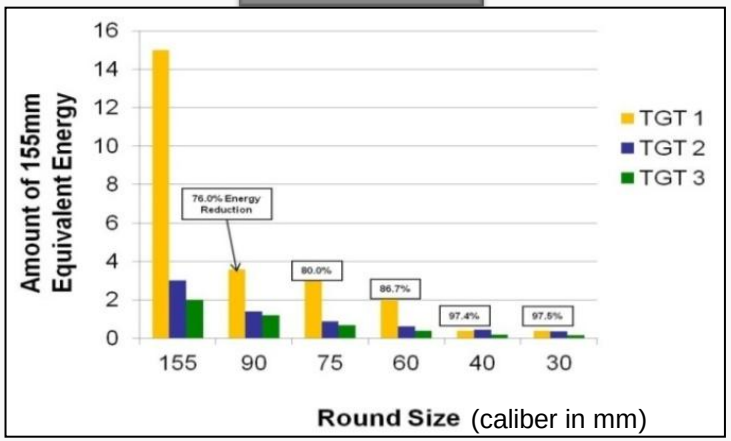


Image courtesy of U.S. Army ARDEC

- round #'s 1-3 (Armor lethal mechanism)
- round #'s 4-6 (Armor lethal mechanism)
- round #'s 7-9 (Armor lethal mechanism)
- round #'s 10-11 (Defilade lethal mechanism)
- round # 12 (Soft vehicle lethal mechanism)

ANALYSIS



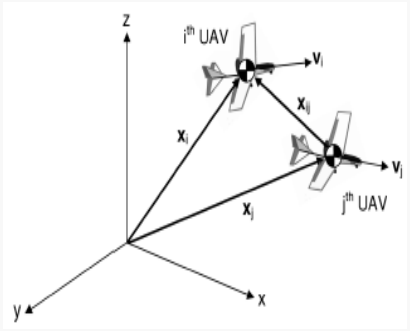
Effectiveness studies suggest efficiencies, increased performance, widened engagement space of modular/swarming lethality

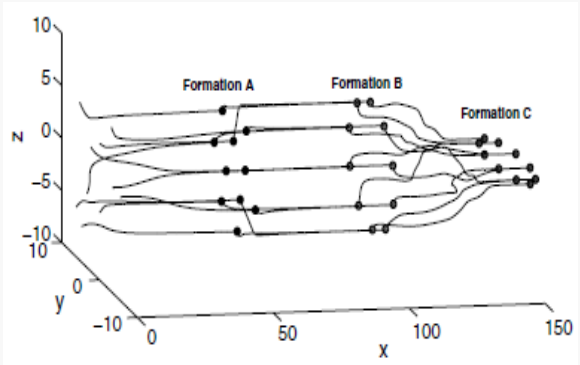
How to deliver?
- low cost
- reliable (GPS denied, …)

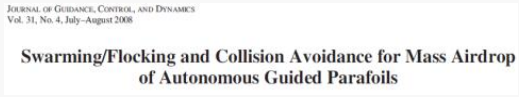
Seek understanding for wide classes of land warfare missions

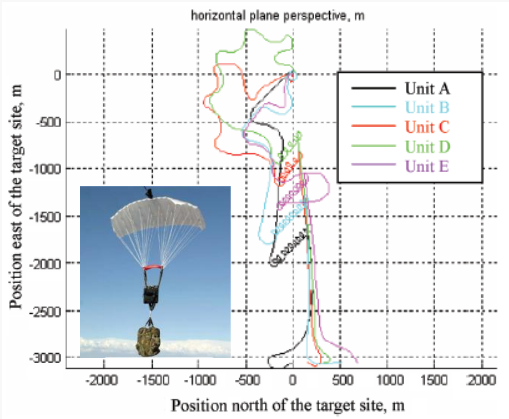
Delivery Concepts Parent-Child

Background/Past Work

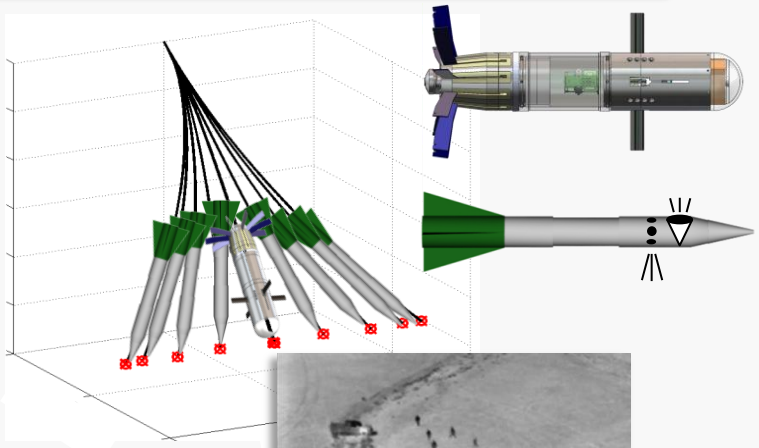








DELIVER MODULES THROUGH PARENT-CHILD CONCEPT



Parent Projectile Equipped with Higher Performance Components Guides to Target

Child Projectile(s) Equipped with Simpler Components Maneuvers Off Parent Projectile

Efficient, low-cost extended range delivery of reduced size lethal payload against complex target layout in countered environments for land warfare missions

- caliber-agnostic (direct/indirect)
- stationary/moving air and ground targets
- tight distribution to critical points of hard targets
- tailored distribution to light vehicles and distributed personnel

Strategy

Long-Term Roadmap and Key Technologies

	FY14 – FY23	FY24 – FY33	FY34 – FY43
MANEUVERABILITY	spin-stabilized projectile maneuvers high maneuverability airframe unstable & enhanced lifting surface/deployment	optimally morphing airframes variable thrusters / vector control extremely high-G, aerodynamic control	hybrid variable-thruster arrays and aerodynamic control force/moment arrays for arbitrary three-dimensional acceleration profiles
NAVIGATION	image-based navigation (IBN): simple targets IBN: realistic ground vehicle, personnel, urban targets radiofrequency (RF): data-linking, GPS inertial measurement unit (IMU): heuristics IBN: realistic air targets with high speed or high maneuverability	IBN: countermeasures IBN: multispectral network-based RF data-linking miniature high-G, high-dynamics, low power spot detectors miniature rangers high accuracy IMU arrays flash LIDAR	multiple in-flight / high speed communications hybrid sensor navigators

ASSURED DELIVERY

- HIGHER GS
- SMALLER CALIBER
- LOWER COST
- EXTREME ACCURACY
- MORE COMPLEX ENVIRONMENT
- FASTER DYNAMICS (MACH, SPIN RATE, TIME-OF-FLIGHT)

External Advancements in Performance and SWaP/C of:
- Processors (GPUs, …) → algorithms
- Measurements (IMUs, RF antenna / receiver, imagers / optics, …)
- Actuation Technologies

Objectives:

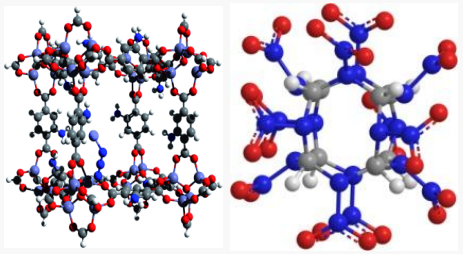
Research in energetic materials expected to offer revolutionary advancement in soldier lethality and long range precision fires.

Impact and Relevance:

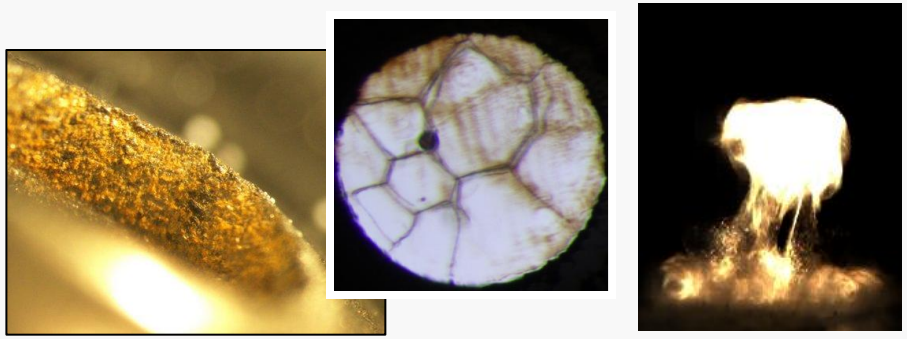
- Understanding of new class of energetics with high-energy density
  - 30% Improvement in Performance Characteristics over Conventional Energetics
  - 5-10 x Improvement in Performance Characteristics over Conventional Energetics with extended solids
  - Identification of methods to release energy on desired timeframe
- Single Munition systems for multiple target types in order to empower Individual Soldiers with full spectrum capability
- Creation of next generation lethal systems
- 0-150% scalable warheads

Technical Areas

- Disruptive Ingredients
  - Chemical Synthesis
  - Mechanochemical Synthesis
- Disruptive Technologies
  - Explosives, propellants
- Enabling Technologies
  - M&S, diagnostics & characterization

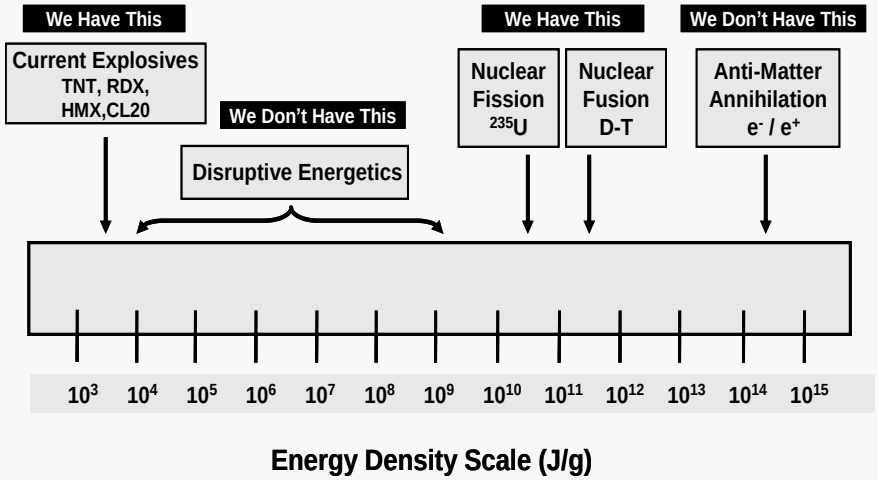


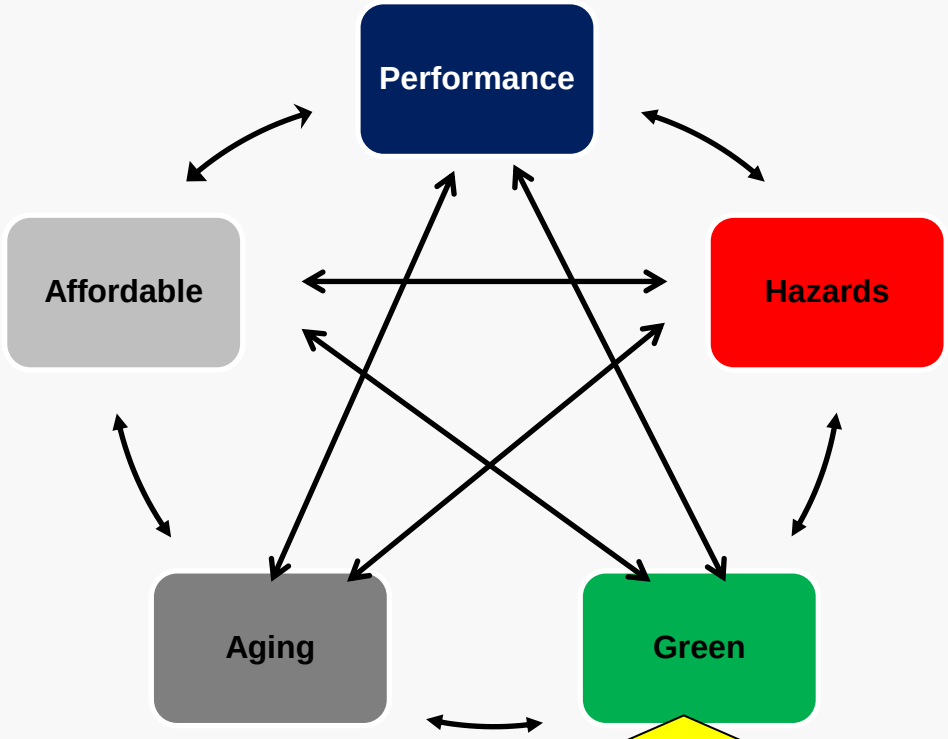
Synthesis of New CHNO Molecules



High Pressure Synthesis and Scale-up of Extended Solids

Create new classes of higher energy and power materials for use in propulsion and effects concepts.





Ingredients → *Formulations* →

Enabling Technologies →

Propulsion and effects concepts

Disruptive Energetics and Propulsion Technologies

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	FY14 – FY23	FY24 – FY33	FY34 – FY43
Disruptive Ingredients	C,H,N,O w/ 30% Energy gain; Poly-CO, poly-N2 Nano-Diamond	Extended Solids, Organometallics	Metal Organics, Metal Clusters, Coulomb Explosives, Metallic Hydrogen, Spin Isomers, Fermi Liquids
Disruptive Technologies	Gun, Explosives & Propellant Formulations	High Pressure Scale-Up; Gun Propulsion	Muzzle Pressure Management; Composite Rocket Propulsion
Enabling Technologies	Experimental Miniaturization	Quantum Modeling	Multi-Scale Modeling; Advanced Mathematical Theorems & Data Analysis

Objectives: Conduct S&T to provide the Soldier with lethal overmatch across the full range of calibers for both direct and indirect fire weapons

Technical Areas

- Enhanced Lethality & Warhead Mechanisms
- Enabling Technology for Kinetic Energy Lethal Mechanisms
- Scalable Effects
- System Effectiveness

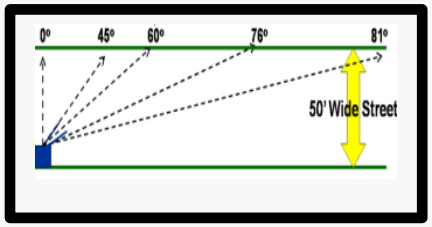
Investigating concepts to create a man-sized hole in double-reinforced concrete (single shot)

Impact and Relevance:

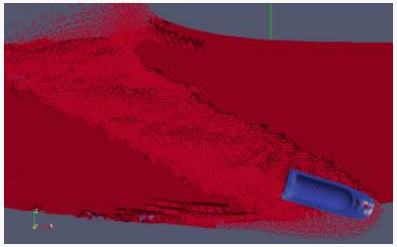
New gun and missile technologies will be realized to deliver increased energy at range with lower SWAP

New lethal mechanisms capable of defeating the toughest targets at:

-Redistributed energy
-Reduced caliber
-Reduced missile size



Probability of high obliquity impact increases quickly in urban scenarios



Perforate walls at obliquity while maintaining air bust capability

Scalable Lethal Adaptable Weapons Long-Term Roadmap

	FY14 – FY23	FY24 – FY33	FY34 – FY43
Overwhelming Lethality	*Significantly More Capability in Current Weapons* *Significantly More Capability in Modified Weapons E+* *New and Better Lethal Mechanism*	**New and different Threats** *New High Energy Cannons E++* • *Grow in Breath and Level of target sets* • *Blur the line between traditional Medium and Large Cal*	*More Direct Methods of Shutting down Humans (both reversible and non-reversible)* *Very Different Approaches to Lethal Mechanisms* • *New styles of weapons and munitions*
Underpinning Science	*Penetration Mechanics, Fracture and Failure of Materials, Material Science, Understanding of Environmental and Toxicology Effects of Materials, Deep Understanding of how the Body works*		
Relevance	*Identification of Opportunity, Definition of Technical Goals and Achievement, Business Case*		

Maintain Significant Overmatch for Army Systems

Lethality S&T Strategy
Critical Research Areas

- Launcher
  - Higher energy containment structures
  - High rate of Fire
  - Reduced platform loading
- Propulsion
  - Muzzle pressure management
  - Temperature compensated
  - Higher energy (disruptive energetics)
  - Hybrid rocket propulsion
- Flight and guidance
  - Omnisonic flight
  - Image based (non GPS and not easily countered)
  - Unobtrusive control mechanisms to include fuzing
- Terminal Effects
  - Modular and Scalable
  - Novel penetrators
  - Higher energy output (disruptive energetics)
  - Directed Energy
- Materials
  - Higher strength, lighter materials