The Weapons Technologies Community of Interest (CoI)

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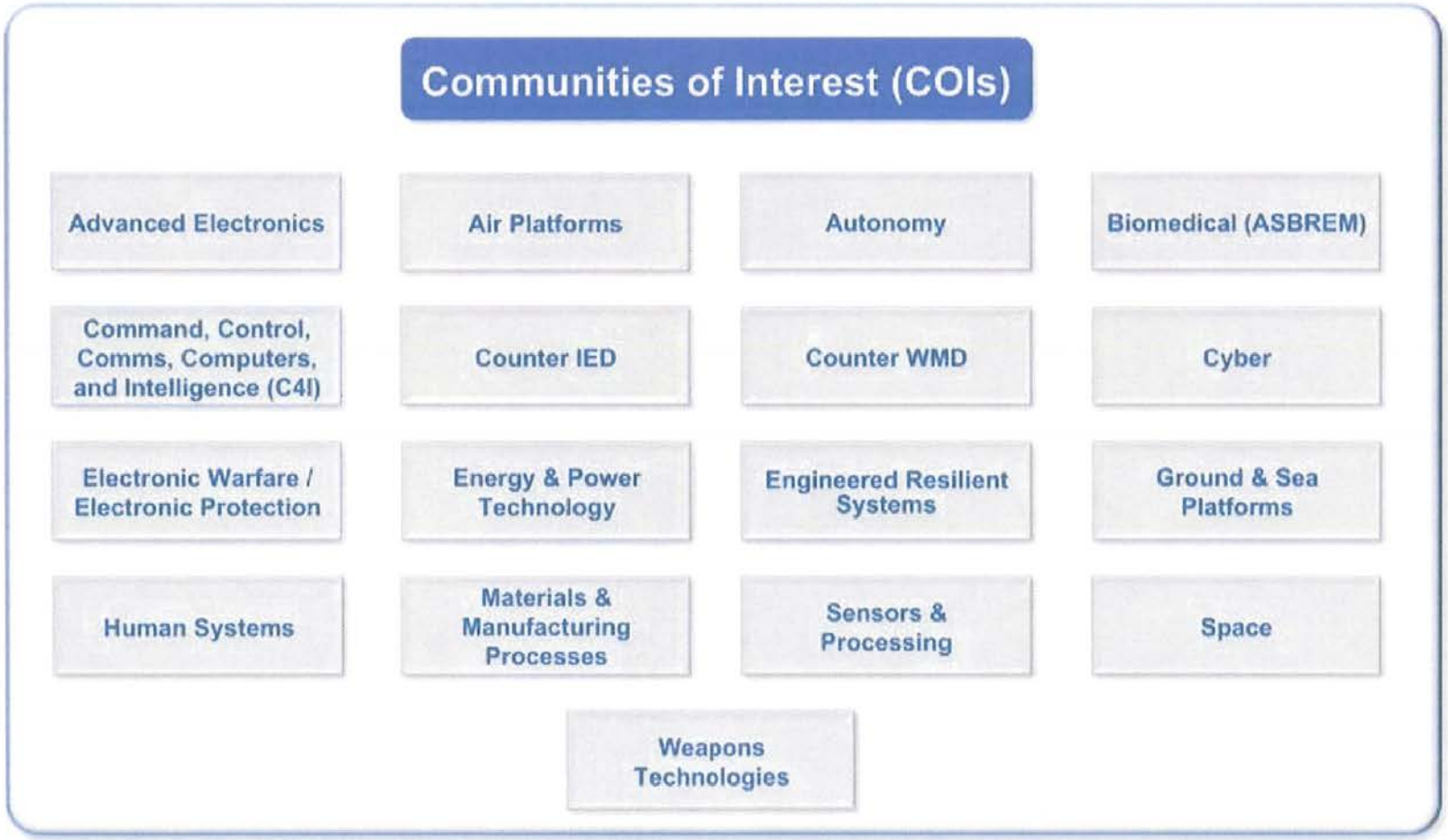
Communities of Interest



~$12B for all COIs covering 6.2 and 6.3 S&T

Weapons Technologies
Initial Comments

- Portfolio Value - ~$1.1 to $1.2B
  - Kinetic/Non-Kinetic Effects - $0.7B/0.4B
- Common themes emerge across components
  - Smaller, lower mass weapons (carriage-constrained)
  - Higher speed and maneuvering capability with reduced signature
  - Denied environments (A2/AD)
  - Extended stand-off / range
  - Denied Distributed-Collaborative-Cooperative (D2C2) engagements (manned/unmanned)
  - Directed energy combined with kinetic effects offers leap ahead
  - Affordable and sustainable - cost-trade favorable

Structure and Scope

Purpose – Conduct R&D to Provide Leap Ahead Tactical and Strategic Offense and Defensive Weapons for Air, Land and Sea Combat

Ordnance
- Performance in extreme environments
- Scalable and lethal effects
- Asymmetric effects

Propulsion
- ICBM/GBSD booster technology
- Tactical missiles and gun-launched projectiles
- Capacity (reduced size/weight/hazards/cost)

Guidance, Navigation & Control and Data Links (GN&C and DL)
- Weapon position, navigation & timing (PNT)
- Networked precision
- High speed guidance

High Energy Lasers (HEL)
- High-power/high-energy laser sources
- Improve laser output power and beam quality
- Mature component technologies – beam control, power, thermal & field demonstrations

RF Weapons (RFW)
- Compact HPM systems (improved SWaP)
- Optimized wave forms for target effects
- Improve source efficiency

Non-Lethal Weapons (NLW)
- Active Denial Technology (smaller, lighter, lower cost)
- Vehicle/vessels stopping at distance
- Characterize trades (effects/risks/system reqs)

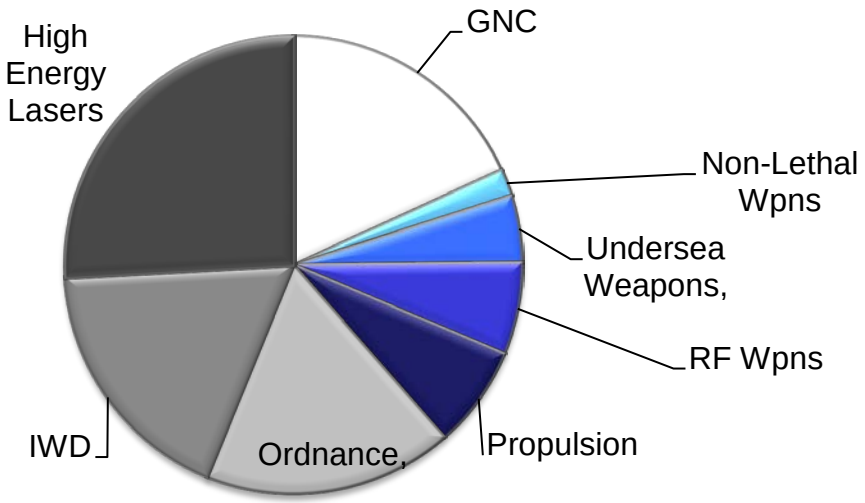
Undersea Weapons
- Torpedo technologies, e.g., warheads, sensors, propulsion, signal processing
- Torpedo countermeasures
- Supercavitating weapon technology

Integrated Weapon Demonstrators (GWD)
- S&T prototyping/transition
- Integrated demonstrations – full ensemble of weapons system technologies needed to achieve effects
- Hypersonics (reported in Air Platforms COI)

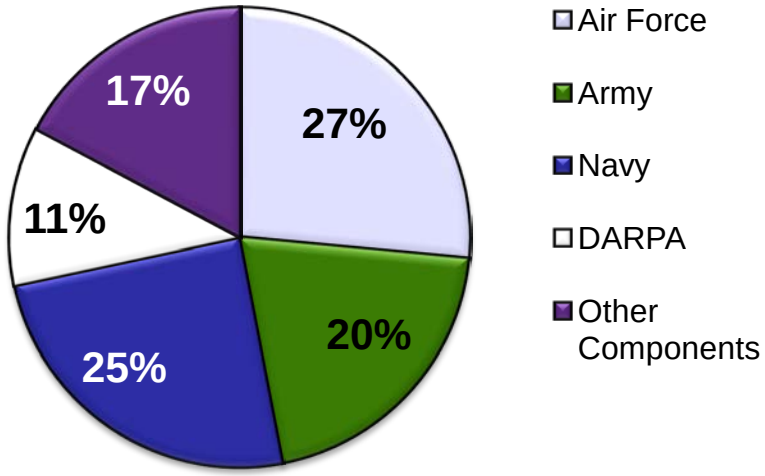
DoD PB16 FY 2016
Weapons Technologies COI

COI Sub-Areas

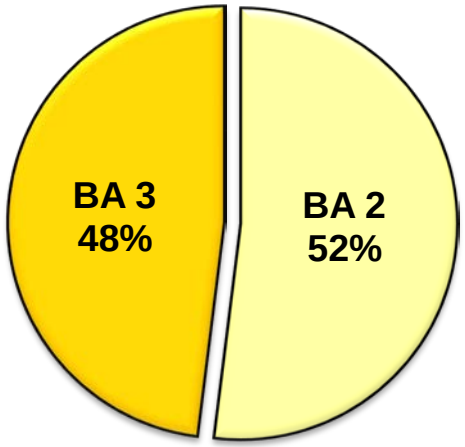
Total = $1,162M



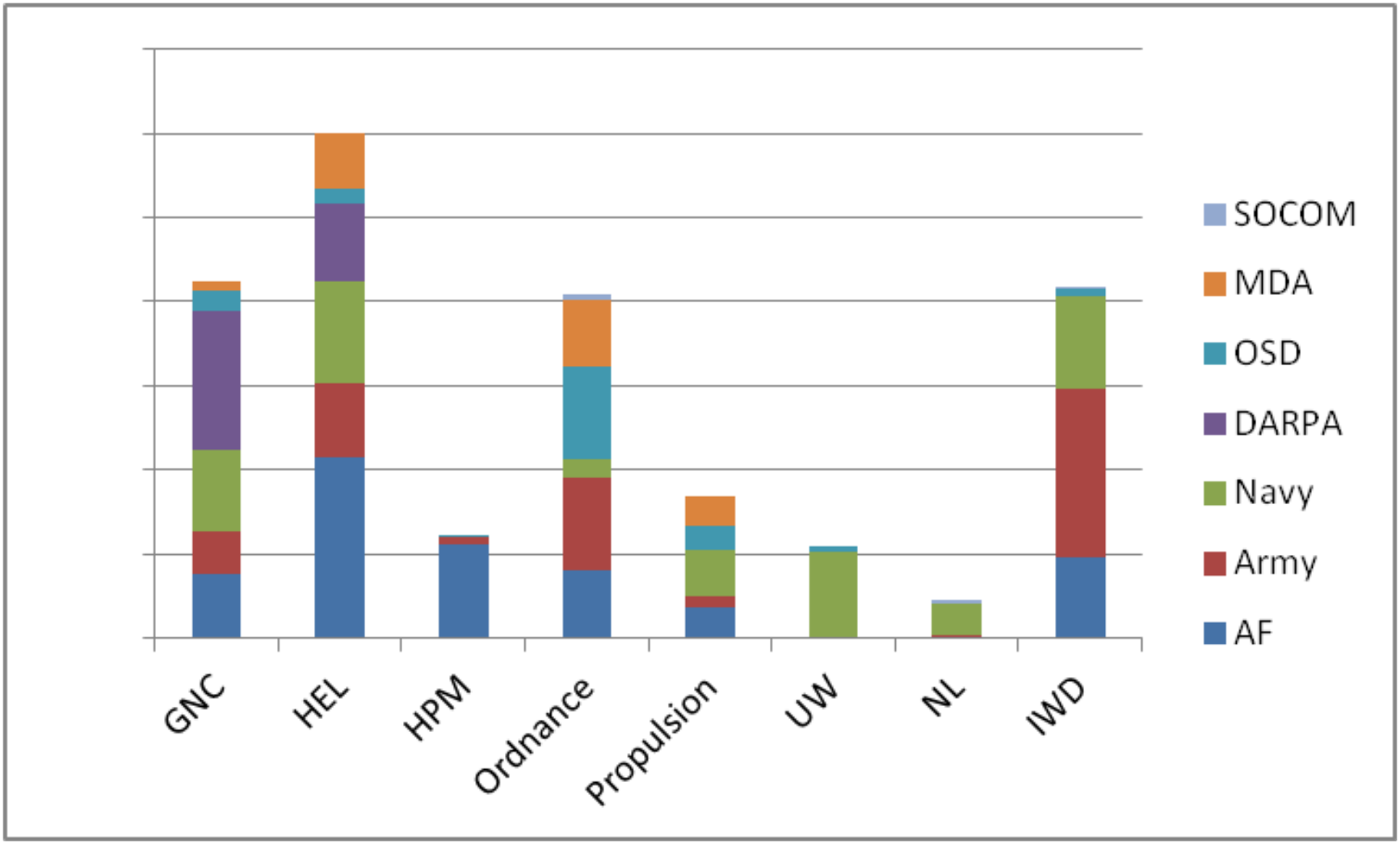
Component Investment



Budget Activity

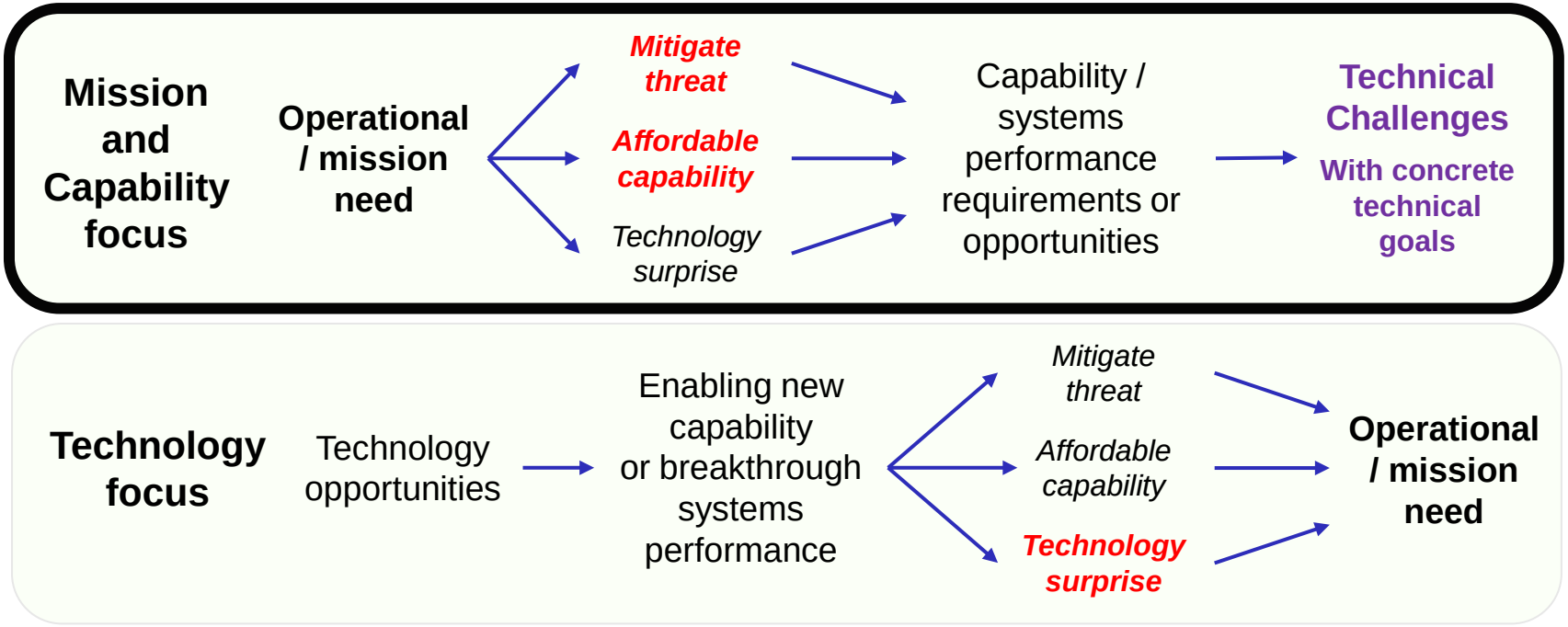


DoD PBR16
Weapons Technologies COI



Roadmap - Technical goal linked to operational/mission need

- **COIs roadmaps should describe the impact of S&T investments in terms of:**
  - Mitigate new and emerging capabilities
  - Affordably enable new or extended capabilities in existing military systems
  - Develop technology surprise through science and engineering
  - Outline major operational or capability needs, or systems performance requirements
  - Describe where we are and where we need to be



Weapons Technologies
Strategic Vision

Current Capabilities Deficient

Standoff Assured Delivery + Desired Effects

Dominant Future Capabilities

Mission Space & Examples

Active defenses against

- **Aircraft**
- **Tactical and Strategic Missiles**
- **Rockets, artillery, mortars**
- **Torpedoes**
- **UAV/UGV/USV/swarms**

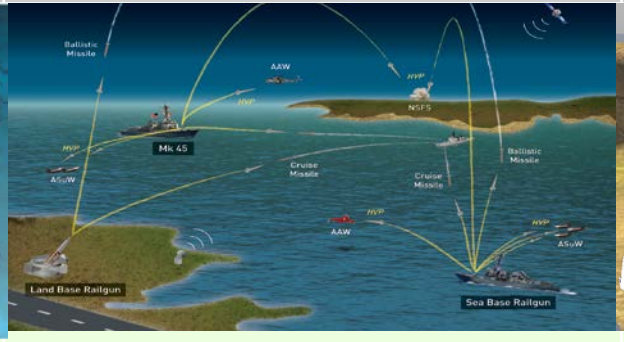
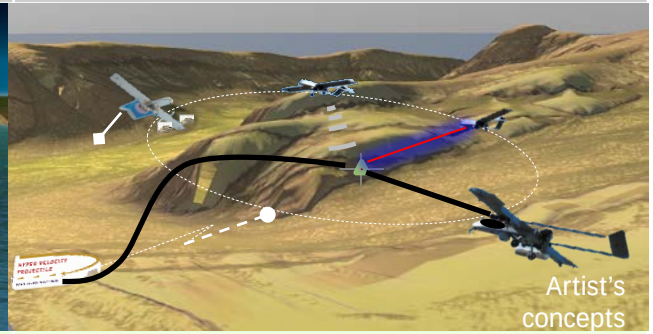
Attack

- **Area targets**
- **Point targets**
- **Mobile Targets - Land/Sea/Undersea/Air**
- **New threats – swarms, UAV/UGV/USV**
- **Networks/Systems of Systems**

Kinetic and Non-Kinetic / Lethal and Non-Lethal effects

Goal: Gain back overmatch and offset - affordably

Weapons Enabling Technologies

Near Term (2020)	Mid Term (2030)	Far Term (2040)
High Speed, Highly Maneuverable, Extended Range Weapons with Selectable Output	**Integrated Kinetic and Non-Kinetic Effects**	**Integrated Kinetic and Non-Kinetics Weapons in a Denied Distributed Collaborative Cooperative (DC2) Environment**
		
• Omnisonic Flight and Navigation • Adaptive Control and Estimation Techniques • Higher Energy within IM Constraints for propulsion and effects	• Integrated System-of-Systems Techniques w/ predictive effects • DE devices/systems to enable denial, disruption and destruction • Hypervelocity (Rail gun) launchers	• Extreme energy materials with energy coupling • Increased energy DE devices • Coordinated swarms with autonomous behaviors • Switchable Non-lethal to lethal effects

Weapons S&T Value

S&T core competencies support RDT&E and life cycle

Legacy	Rapid Acquisition	Planned Acquisition	Future Acquisition
• Small , Medium Large Caliber Ammo • Javelin, Hellfire, TOW • Mortar/Artillery • GPB (500/1000/2000) • SDB • Demolition • MK-48; MK54 • Harpoon • Evolved Sea Sparrow • SM-3	• MOP Tech Demo & QRC • FLM-MK-82 • APMI • EOD Shaped Charge • XM395	• Hard Target Munition • LRASM • AIM9x • JAGM • 25mm XM25 • Anti-Torpedo Torpedo • MK48 Sonar Upgrade • MK50 Conversion • SM-6 • Heated and Mobile Munitions Employing Rockets (HAMMER) / Agent Defeat Penetrator (ADP)	• High Speed Strike Weapon • SMART Ammo • Long Range Precision Fires • Hyper Velocity Projectile (HVP) • Railgun • GBU-X/AGM-X • Next Gen Land Attack Weapon • Next Gen Surface Weapons • MSDM, SSW, SACM

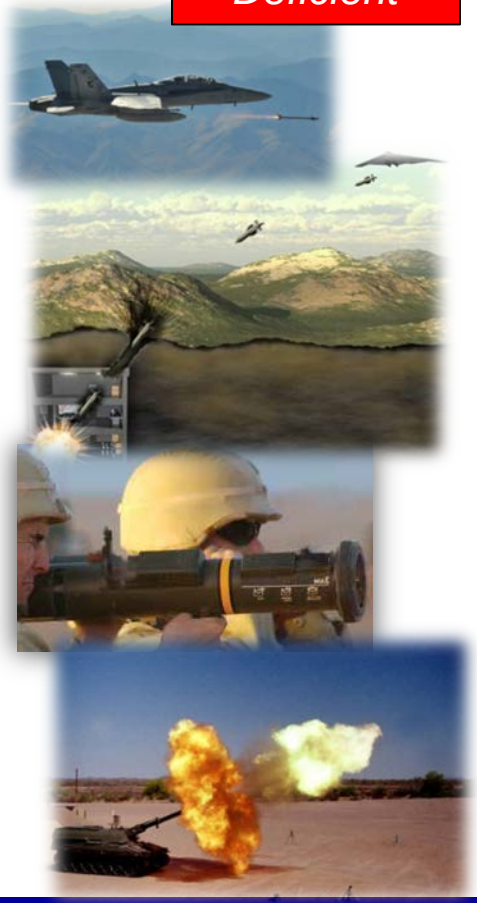
Weapons S&T addressing diversity and pace of change in threat targets - sheer numbers, area denial, mobility, soft- / hard-kill challenges, & cost-trades

Ordnance Strategic Vision

Current Capabilities Deficient

Survivability + Capacity + Effectiveness

Dominant Future Capabilities



- **Performance in Extreme Environments**
  - Survivable
  - Insensitive Munitions Hazards
- **Scalable and Lethal Effects**
  - Enhanced Performance for Limited Volumes
  - Multi-effects / multi-mission
  - Prescribed and Tailored Effects
  - Distributed, Collaborative and Collective Effects
- **Asymmetric and Cross-Domain**
  - Kinetic Effects on Hypersonic Platforms
  - Disruptive Energetics
  - Access Denial

Goal: Ordnance S&T for Affordable, Mitigating, and Surprise Weapon Capabilities

Ordnance Sub-Area
Grand Challenge Areas

Ordnance sub-Area

- **Performance in Extreme Environments**: (*delivery and target interaction*) Reliably function under severe conditions: temperature, vibration, and acceleration loading. Ensure Insensitive Munitions and fuze reliability.

- **Scalable and Lethal Effects**: Affordable reduced size, increased carry capacity and carriage distance of delivery platforms, and multi-effect technologies that secure the capability of reduced-size delivery platforms. Provide affordable target prosecution.
  - **Enhanced Performance for Limited Volumes**
  - **Multi-effects / multi-mission**
  - **Prescribed and Tailored Effects**
  - **Distributed, Collaborative and Collective Effects**

- **Asymmetric and Cross-Domain Effects:** Provide ordnance capabilities to enable surprise weapons; Ensure robust/daunting output, functionally defeat targets, and KE effects with DTRA to deny all CBRNE and WMD.
  - **Kinetic Effects on Hypersonic Platforms**
  - **Disruptive Energetics**
  - **Access Denial**
  - **Asymmetric Solutions**

Capability Deficiency/Gap Focused Technical Challenges – Ordnance

		Deficiency / Gap							
Grand Challenge Area	**Gaps and Shortfalls**	**A2AD / LR Precision Strike**	**C-UAS / Subsonic Cruise Missiles**	**Counter Air-Air**	**Long Range Precision Fires**	**Area Attack Air Interdiction**	**Counter HDBT**	**Anti-Surface Warfare (ASuW)**	**Strategic Deterrent (ICBM/ SLBM)**
1	**Survivable / Environment**	Temperature Shock		Shock	Temperature	IM	Loads IM		
2, 3	**Reduced Size /Longer range**	Smaller	25% less than SOTA	Smaller	50% less than SOTA at equal lethality	Form Fit	Smaller More Capable		
2, 3	**Volume Constraints**			50% of legacy length		Lethal Radius	Weapon Carrier		
2	**Collaborative Mission**	2+ blast-frag					Multi-Strike		
2	**Multi-Effects / Mission Flexibility**	Many modes HOB,Contact		Hit to Kill Close Miss		Many modes HOB Contact			
1	**Reliable & Stable at Long-Term**	Thermal cycling. Aging		Thermal cycling. Aging		< 1% non-function			

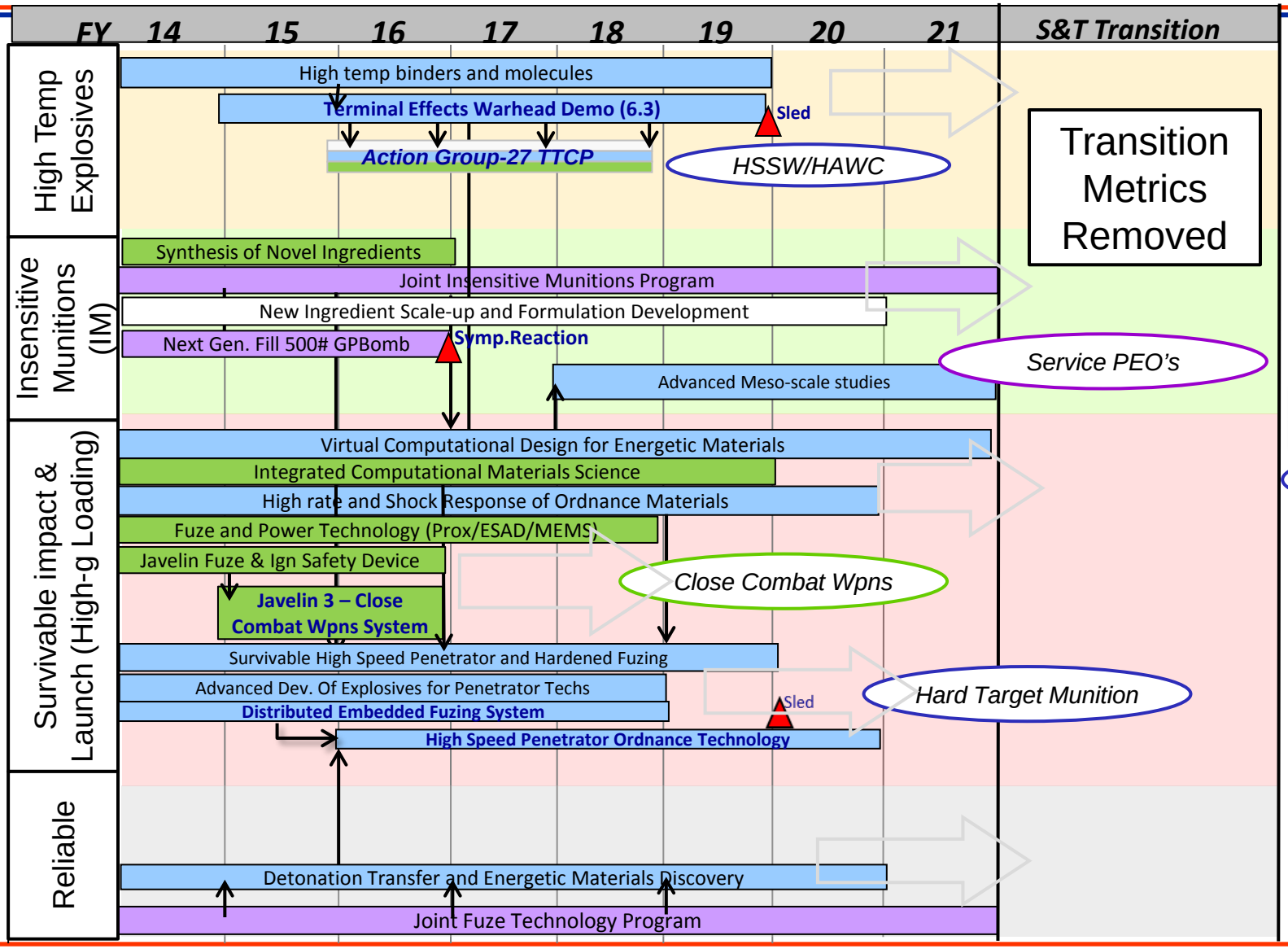
1 – Extreme Environments, 2 – Scalable and Lethal, 3 - Asymmetric

Performance in Extreme Environments – *Challenge Area 1*

Technologies

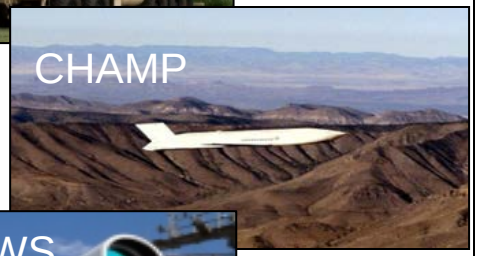
High Temperature Explosives and Binders	Insensitive Munitions Hazards	High-G Loading	Reliability
• High temp energetic crystals • High temp binders • Maintain blast and/or brisance capability • Affordable and available sources	• 6 Hazards, Levels 3-5 reaction response required • Insensitive crystals and binder systems • Frag mitigation and passive protection • Venting without mass /volume increases • Improved M&S for sub-detonative response	• Up to several ten's of thousands g boosted penetrators • Survivable explosives and fuzing • Defeat high strength concrete and advanced targets • System launch; gun and rail	• SECDEF Policy on Cluster Munitions requiring <1% UXO • High fidelity M&S of initiation systems and energetic response • Long-term stable materials

Performance in Extreme Environments Roadmap



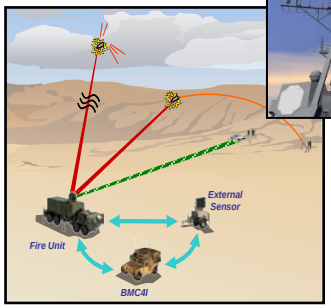
Directed Energy (HEL and RFW) Strategic Vision

Technology Development → *Power + SWAP + Efficiency + Effectiveness* → **Technology**



- **High Energy Lasers**
  - Higher energy, efficient laser sources
  - Advanced beam control with higher throughput and atmospheric compensation
  - Reduced system size and weight
- **Higher Power RF Weapons**
  - Pulsed power sources with high-peak power waveforms and high pulse repetition
  - Compact, efficient micro /millimeter-wave sources with pulse repetition rates
  - Improved antennas
  - Reduced system size and weight

- ***Affordable—Low Cost Per Kill***
- ***Depth of Magazine***
- ***Low collateral damage***
- **Precision Application of Energy at the Speed of Light**
- **Graduated Response for Non-Lethal Effects**



Goal: New Class of Weapon

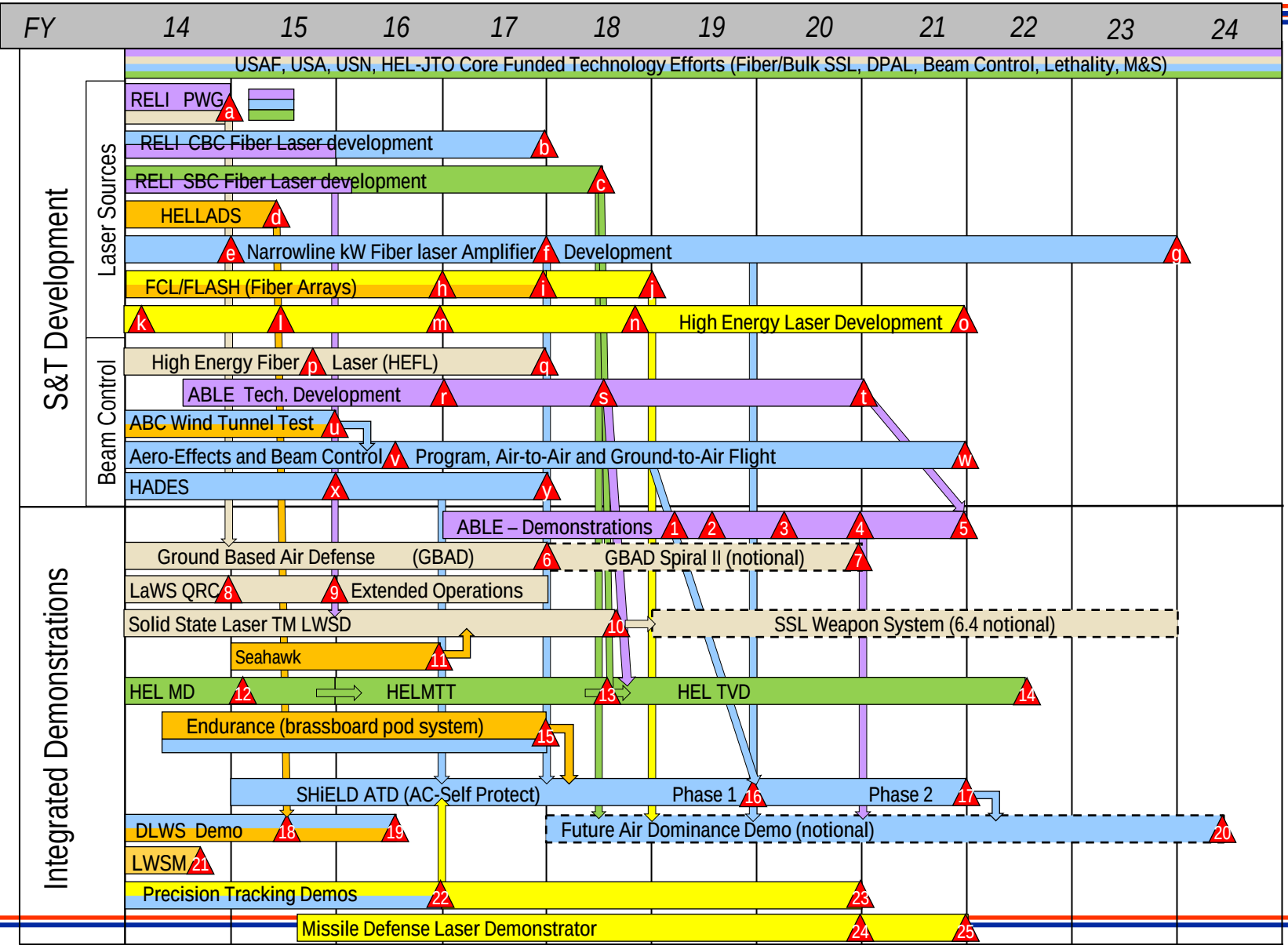
High Energy Lasers

Mission Area Capability

Technical Challenges

	Counter UAS	Aircraft Defense against EO-IR AAM	Aircraft Defense against MANPADS	Aircraft Defense against SAM	Counter RAM	Airborne Boost Phase BMD	Counter Cruise Missile	Vehicle/ Vessel Stopping
Effective Power **Disrupt Destroy**	Small kWs Disrupt Destroy	Small KWs	Small kWs	Med kWs	Med kws Tech available – need to demo in field	Large kWs Need times more power	Large k@ Need 2times more power kWs	Small kW at short range Completely range dependent
System SWAP	Light Tactical Vehicles	Pod-sized; Large Aircraft	Large Aircraft	Pod-sized; Large Aircraft	Ground Tactical & Combat	SWAP decrease by ~5x	Pod-sized; Large Aircraft	Large Aircraft/Ship/ Ground Based
Beam Propagation	Short range	Short/mid range	Short range	Atmosphere challenging	Short/mid range	Range challenging	Range	Atmosphere challenging
Acquisition, Tracking, Pointing	mrad	mrad	mrad	mrad	mrad	Long range - decrease ~order of magnitude	mrad	mrad
Target Effects	***Need full spectrum data base for all targets***							

DoD HEL S&T Roadmap



Integrated Weapon Demonstrators Strategic Vision

Current Capabilities Deficient

Standoff Assured Delivery + Desired Effects

Dominant Future Capabilities

Mission Space & Examples

- **Defensive/Counter-**
  - **IADS**
  - **RAM, UAS**
  - **Tactical and Strategic Missiles**
  - **Torpedoes**
- **Offensive/Attack**
  - **Area Effects**
  - **Mobile Targets**
  - **Air-Air**
  - **Hardened Targets**
  - **Weaponized UAVs**
  - **ASW, ASuW**

Goal: Gain back overmatch and offset - affordably

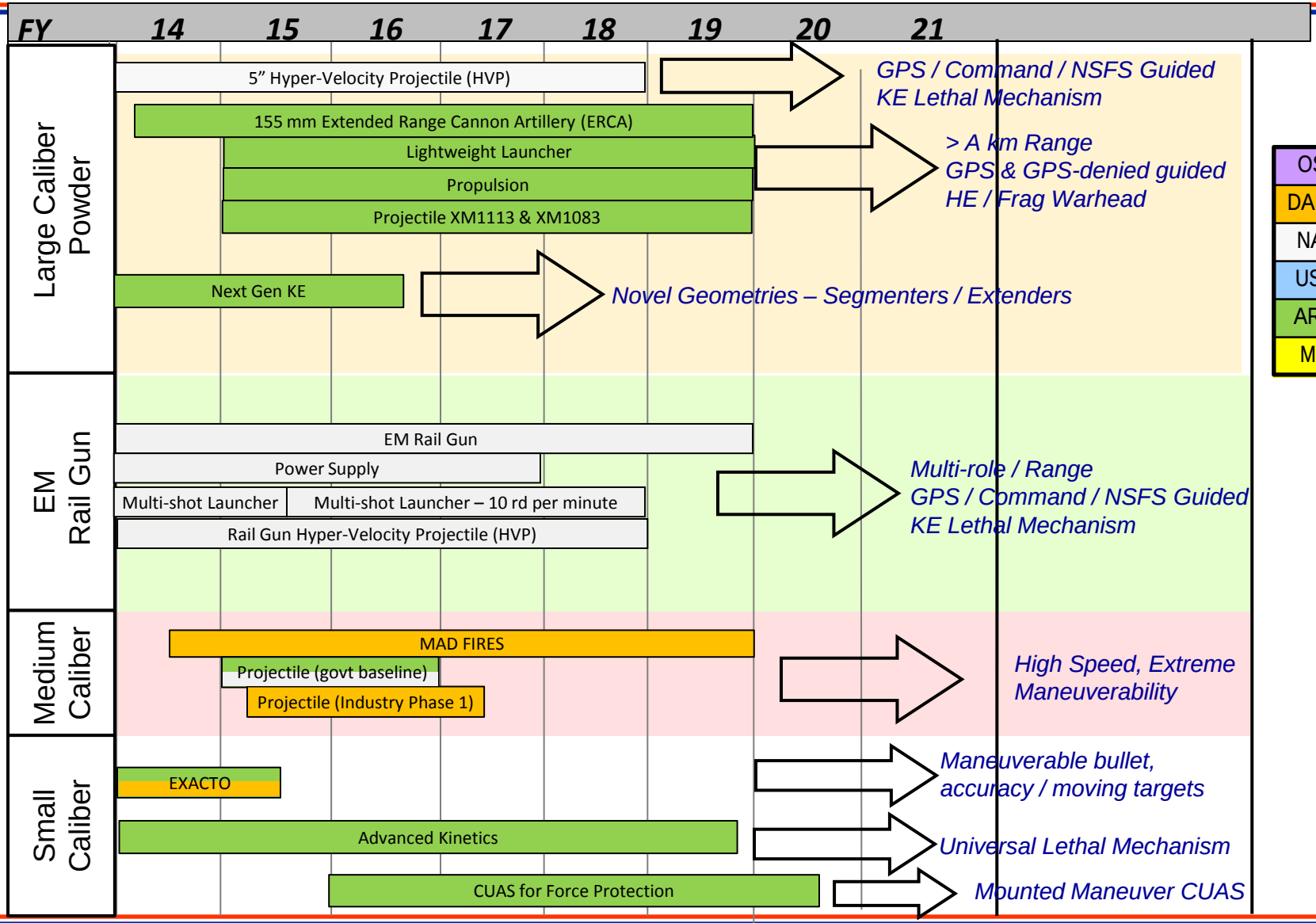
Integrated Weapon Demonstrators Technical Challenges

Kinetic Effects

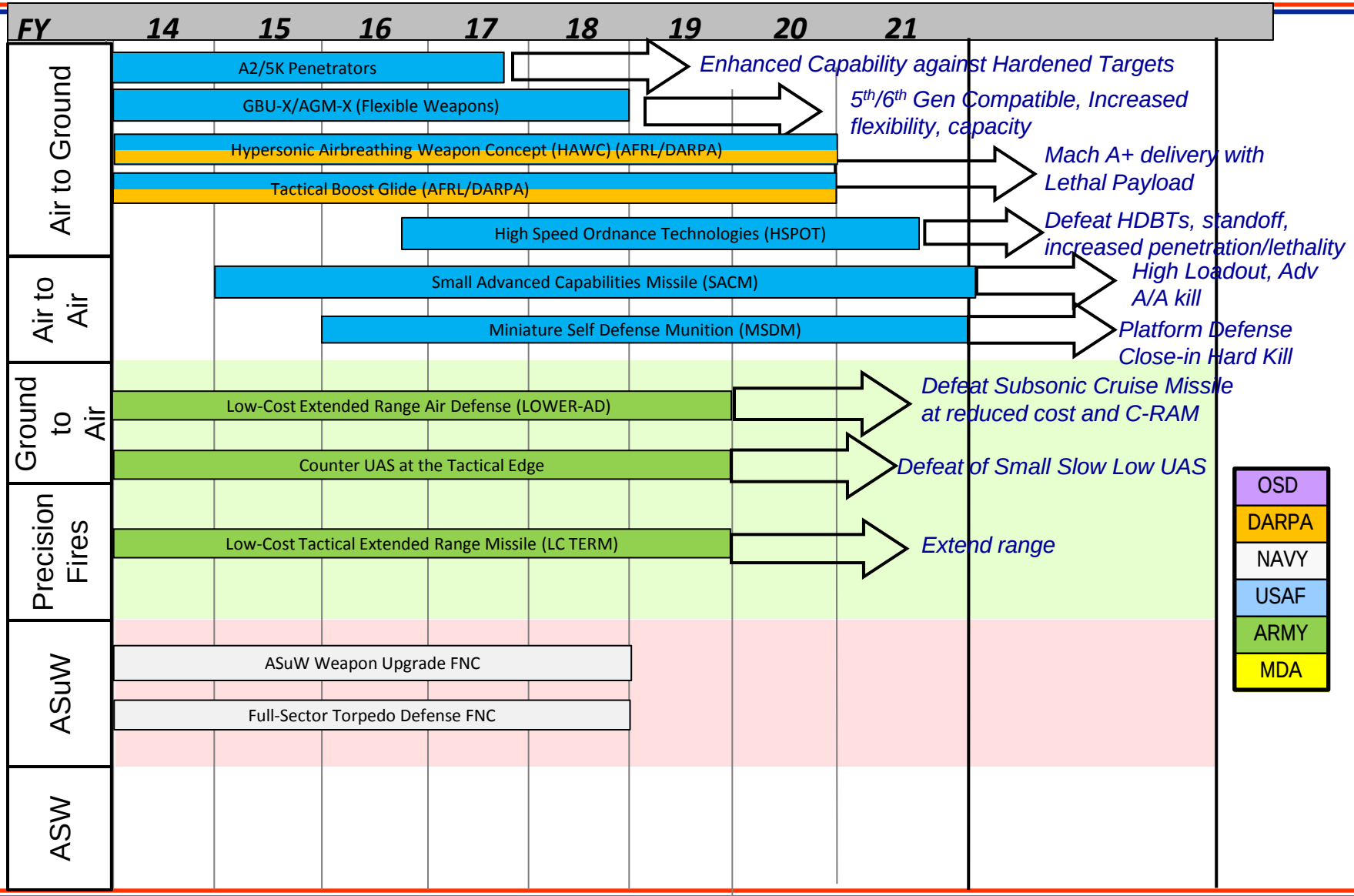
Guns	Missiles

• Higher energy (velocity, mass)
• Maneuverability
• High-repetition rate of fire
• Materials (extend life, higher strength)
• Thermal loads and management
• Power generation, storage, and conversion
• End-to-end high fidelity models
  • Interior, aero, and structural dynamics to handle complex flows and loads
	• Range
	• Speed
	• Maneuverability
	• Volume constraints (launcher / effector)
	• Lower cost multi-mode seekers
	• Loiter, data links
	• End-to-end high fidelity models
	  • Aero and structural dynamics to handle complex flows and loads

Integrated Weapon Demonstrators Guns



Integrated Weapon Demonstrators
Missiles & Undersea Weapons



Focus Going Forward

- Weapon Technologies that Provide Offset Capability
  - » High speed, highly maneuverability, low signature
  - » Some level of autonomy through manned/unmanned teaming
  - » Machine learning navigation

Engagement Opportunities with Industry

- Army Open Campus
- Component BAAs (Army, AF, Navy, DARPA)
- Weapons Technology IRAD and Innovation Review (Spring 2017)
- Attend Industry IRAD Reviews

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Questions