TACOM

Lethality, Survivability, Mobility and Sustainment for America's Army

Smart Materials and Structures for the Multi-role Future Combat System Ammunition Suite

DARPA/DSO
TIM 2000 & CHAP Kickoff

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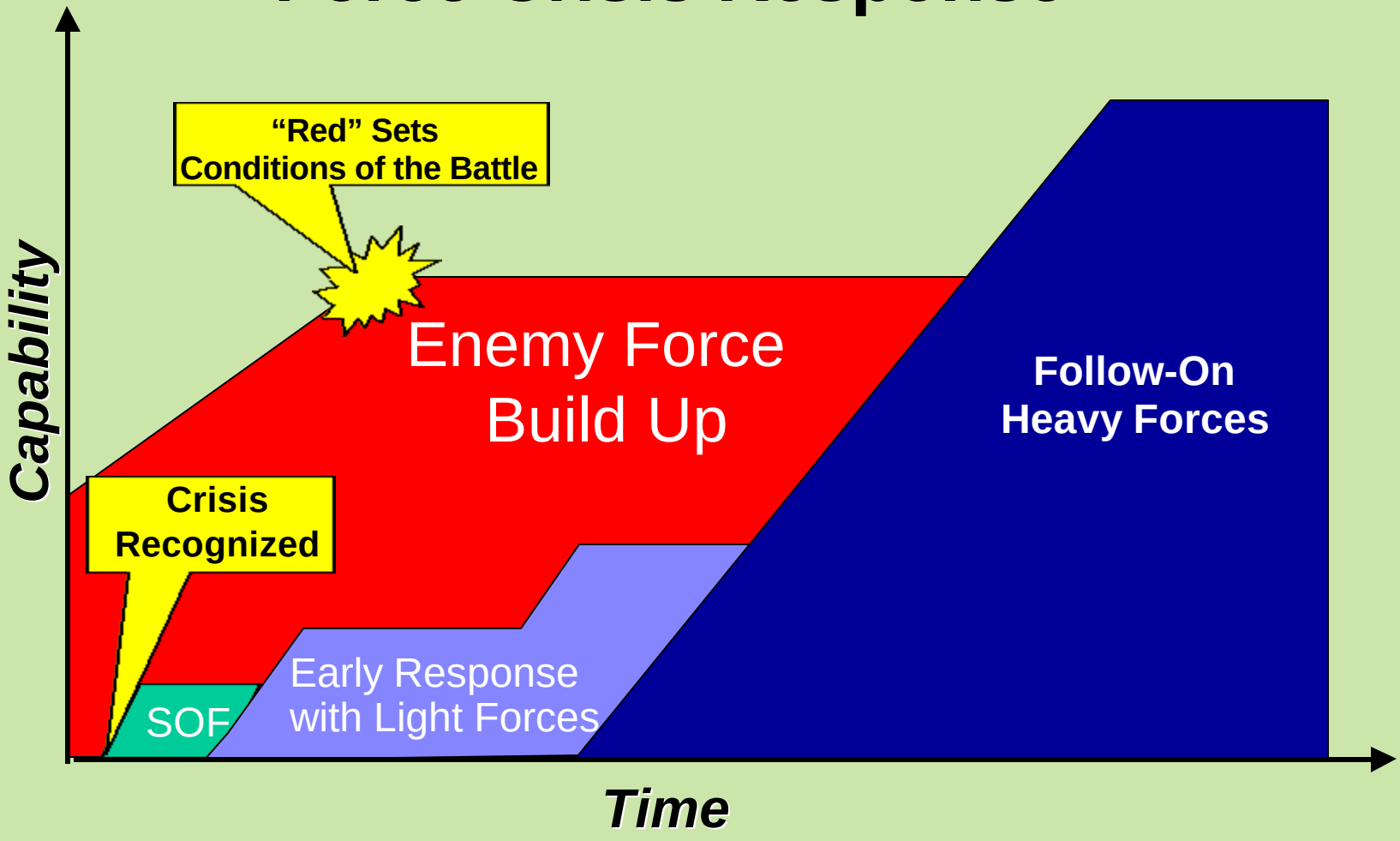
Statement of the Problem

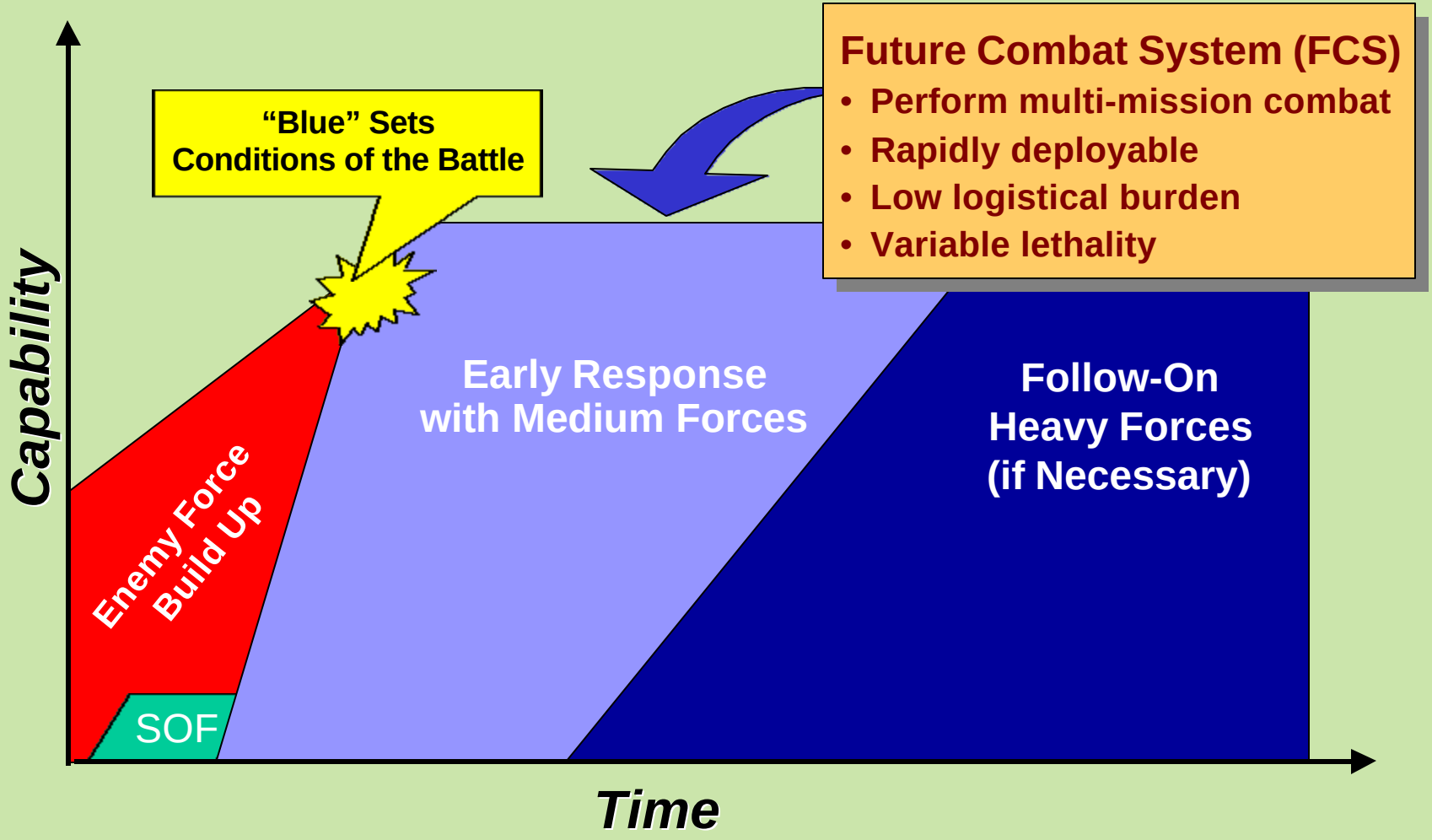
"We must provide early entry forces that can operate jointly, without access to fixed forward bases, but we still need the power to slug it out and win decisively. Today, our heavy forces are too heavy and our light forces lack staying power. We will address those mismatches." -- GEN Shinseki, CSA, 23 June 1999

Today's Challenge: Ground Force Crisis Response



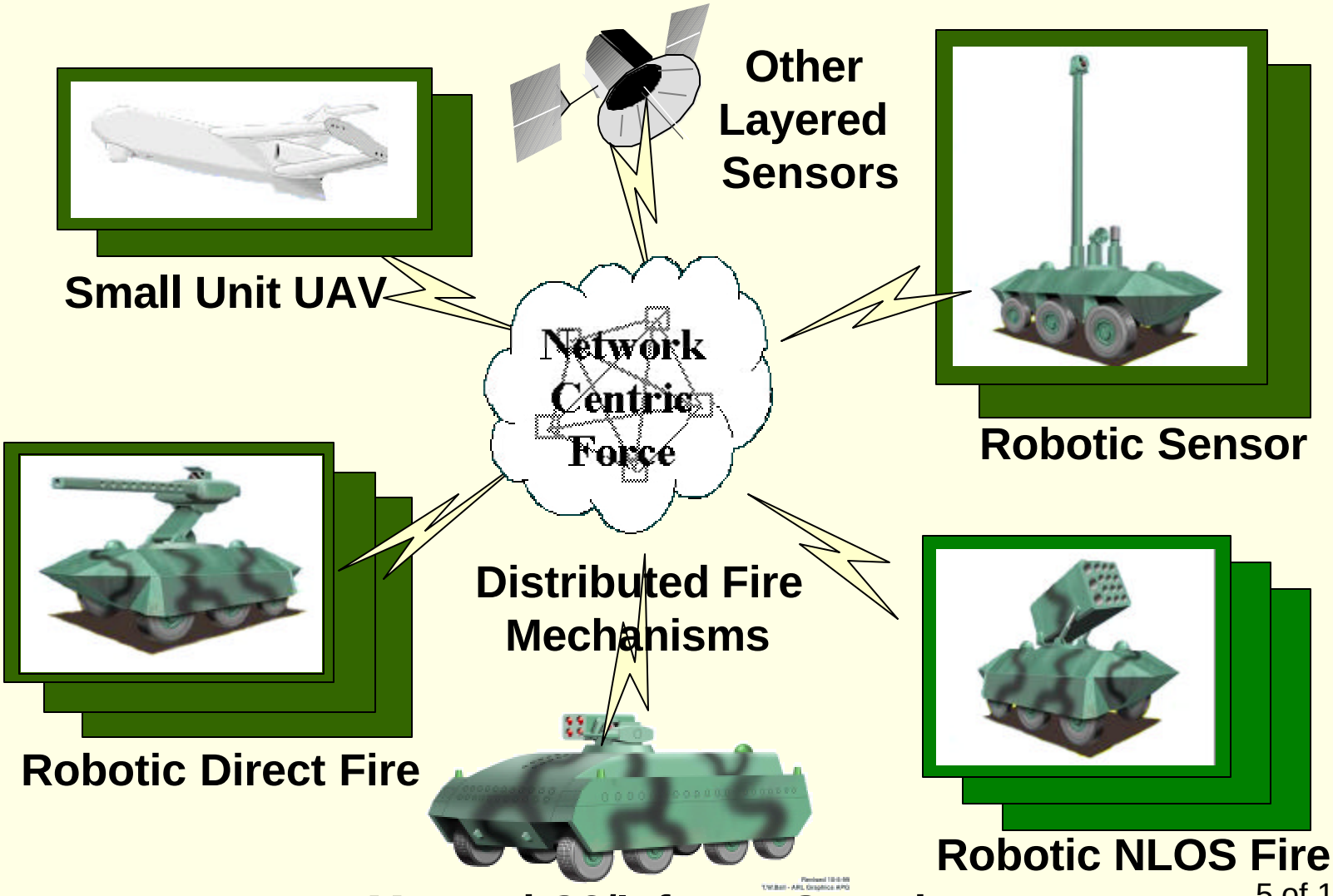
Future Force Deployment Capabilities must mitigate this risk and put the enemy at an early and continuous disadvantage.

Desired Capability



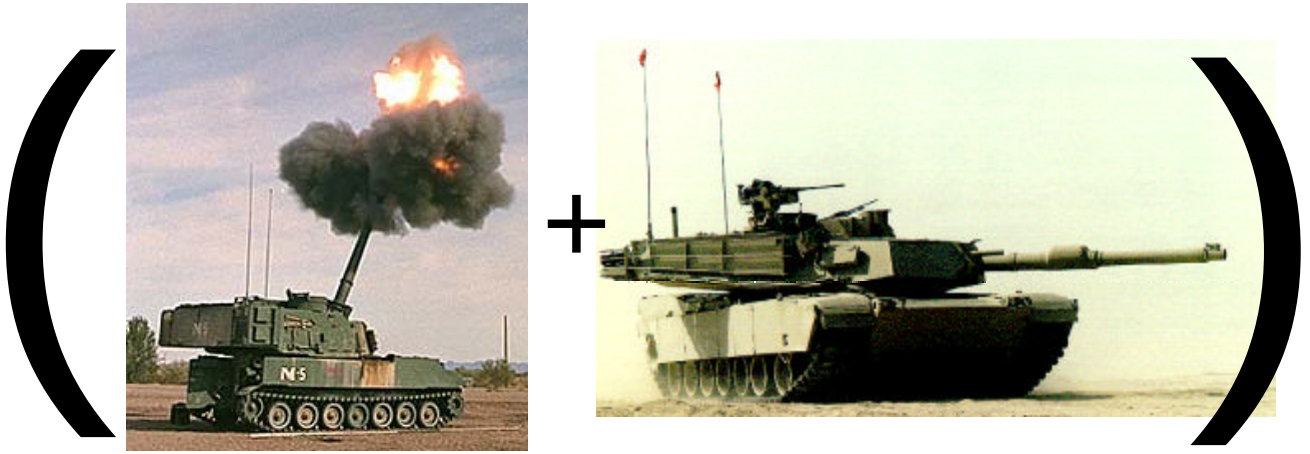
Rapid response highly lethal force capable of winning wars, if necessary!

The Heavy Armored Force will transform into a Network Centric, Distributed System



What makes a notional, multi-mission future combat platform a hard problem?

- Indirect and direct fire functionality in a platform that weighs 20-50 tons less than either legacy system alone



- The drive towards lower weight imposes unique projectile design constraints on *indirect fire projectile* designers

ARD-05 MULTI-ROLE ETC ARMAMENT SYSTEM FOR FCS

Purpose: **Demonstrate a hybrid (direct/indirect fire) cannon armament system for an FCS providing rapid lethal response against the full spectrum of threats.**

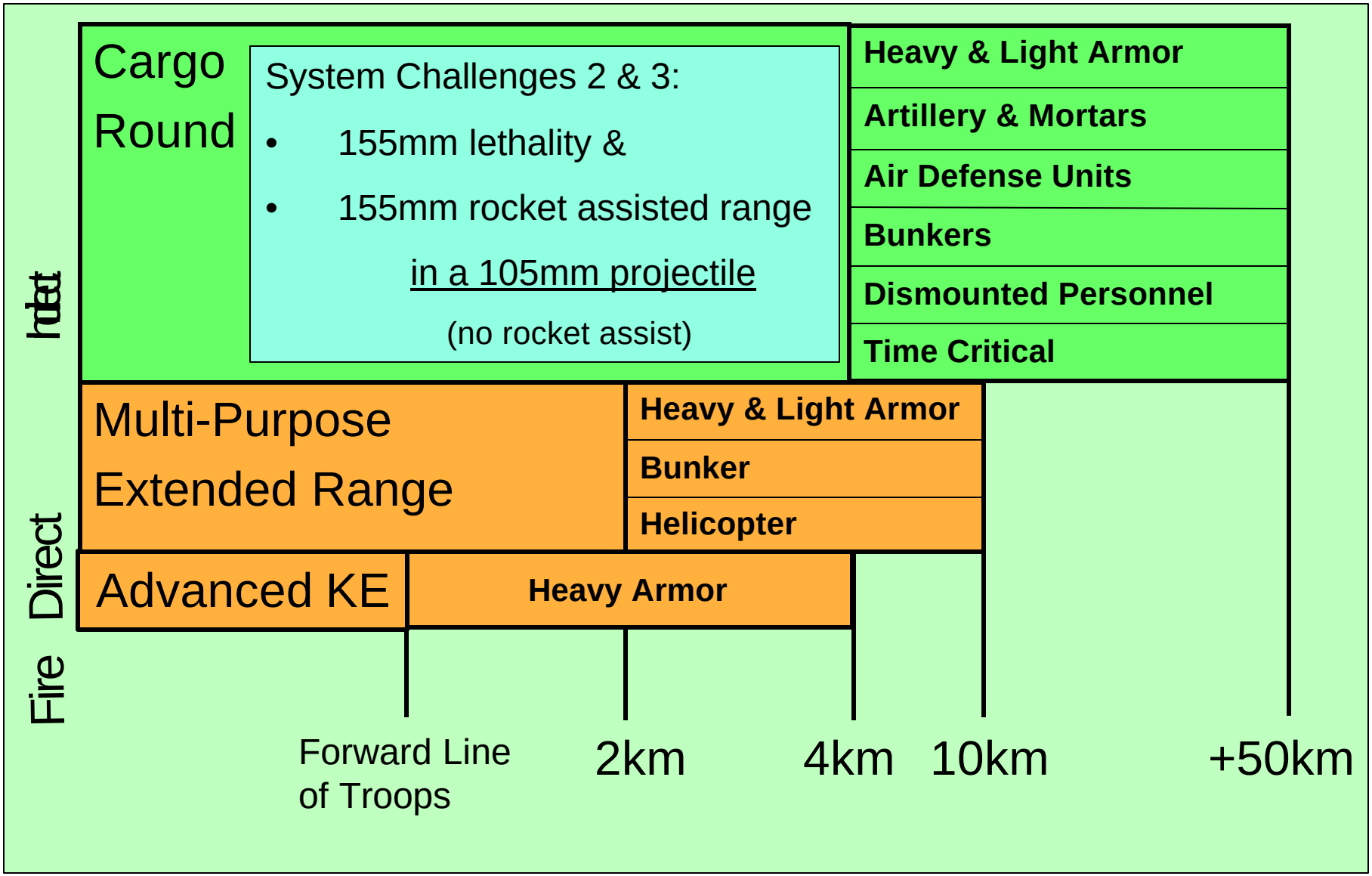
System Challenge #1 - Smooth Bore Barrel

- **Full-Spectrum Lethality with <u>One</u> Armament Mission Module**
- **Electro Thermal Chemical (ETC) Propulsion**
- **Direct Fire Time of Flight Advantage Retained**
  …But, Indirect and Top Attack Capable...
- **Innovative, Compact Swing Chamber Ammo Handling**
- **Multi-Role, Multi -Mission Family of Munitions**
- **High Stowed Kills via Precision Accuracy**
- **Modular resupply**
- **Lower O&S Costs**

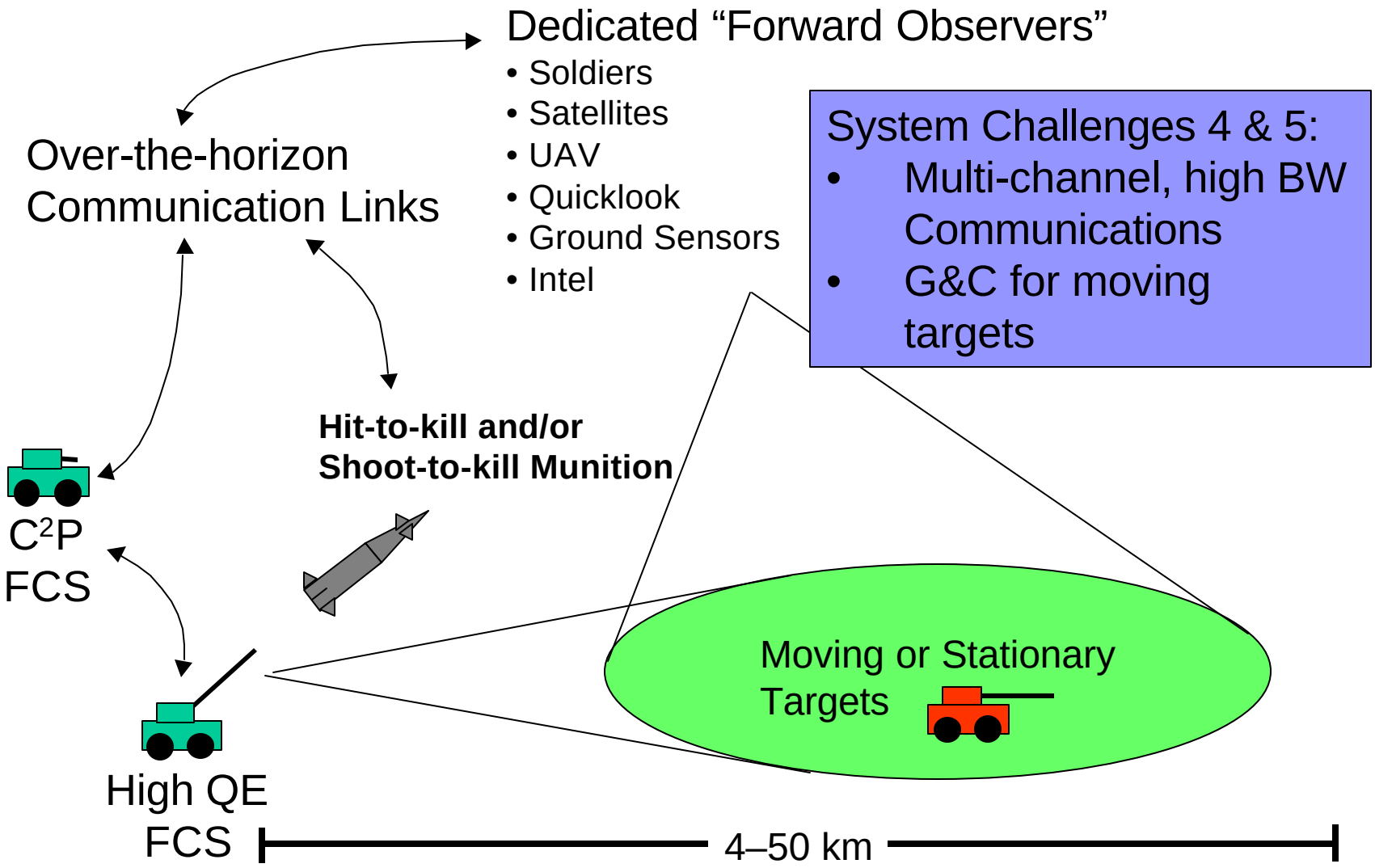
Multiple Capabilities
Multiple Missions
Multiple Threats

TARDEC/ARDEC
Notional 20T FCV

Multi-role FCS Ammo: Target Sets & Effective Ranges

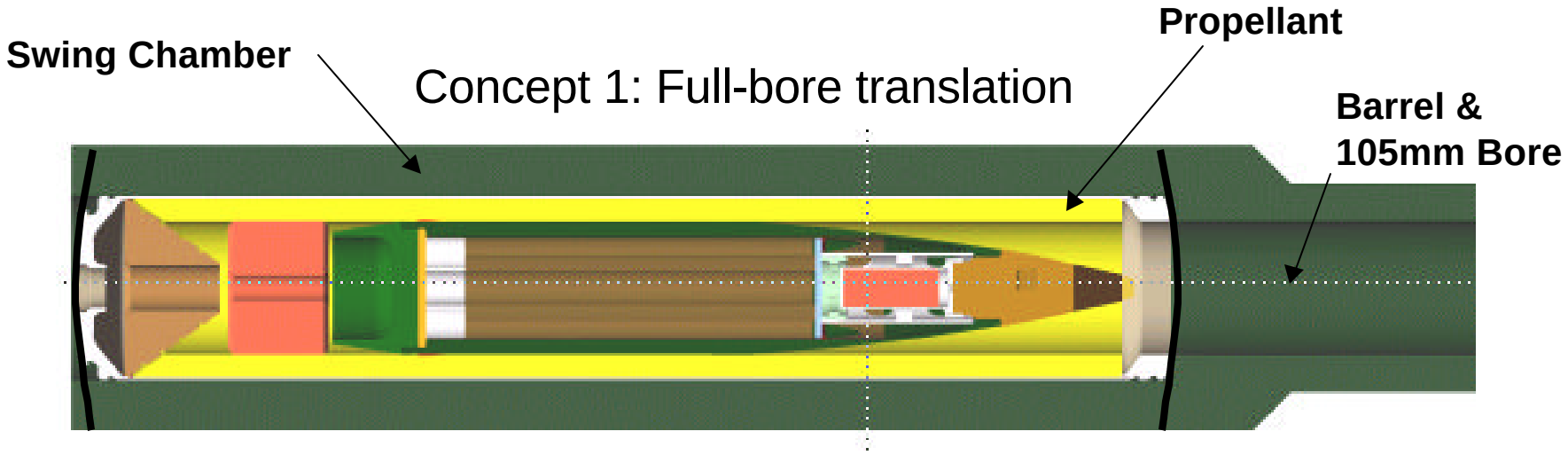


Notional Operational Concept



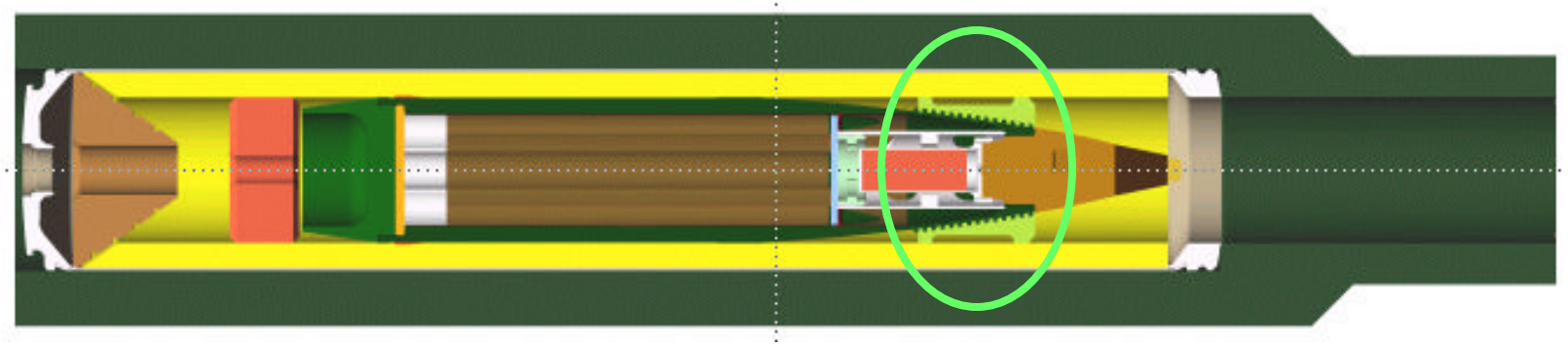
System Challenge #6 – Cased Telescope Cartridge

(Projectile and Propellant together in a “Coke Can”)

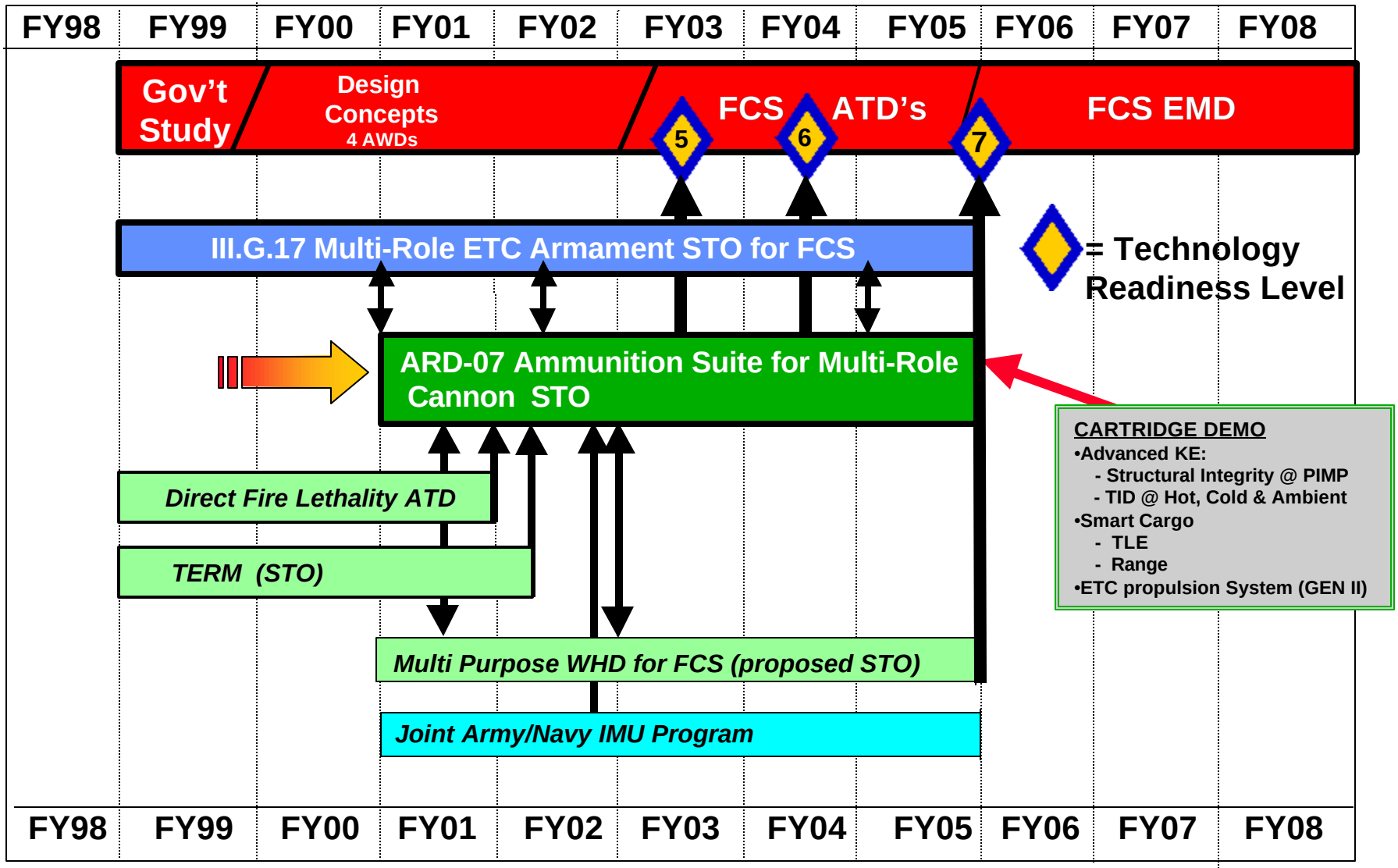


Concept 1: Full-bore translation

Concept 2: Sabot on nose with minimum translation



Ammunition Suite for Multi-Role Cannon



Under the Ammunition Suite for FCS Program, TACOM - ARDEC will explore the feasibility of using Smart Materials & Structures to:

- **Reduce the volume required for the Control Actuation System (CAS)**
  - **More Lethality (SC #2)**
  - **More Communications (SC #4)**
- **Increase the CAS bandwidth**
  - **Hit-to-kill munitions against moving targets (SC #5)**
- **Induce projectile & control surface shape changes, exploit aeroelasticity and introduce high bandwidth control**
  - **Increased range (SC #3)**

While conforming to Smooth Bore and Cased Telescope Constraints

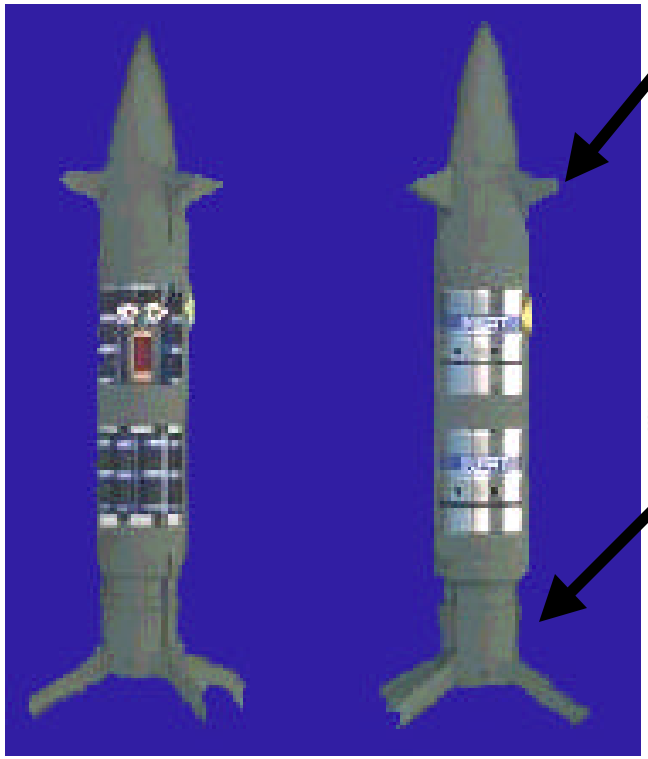
AND

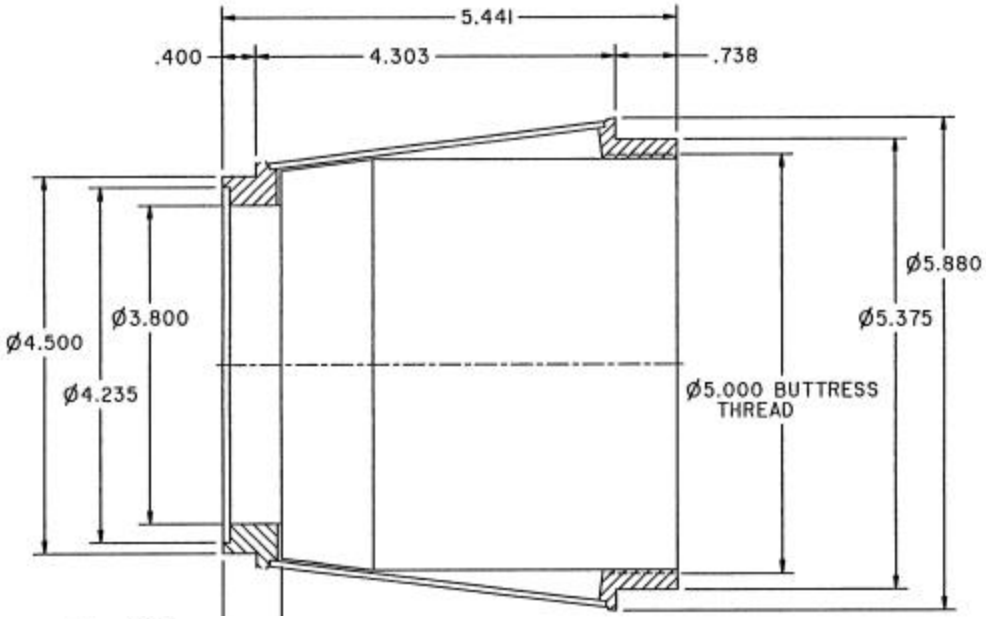
Surviving the Harsh Gun Launch Environment

155mm Artillery Projectile
in Development (PM ARMS)

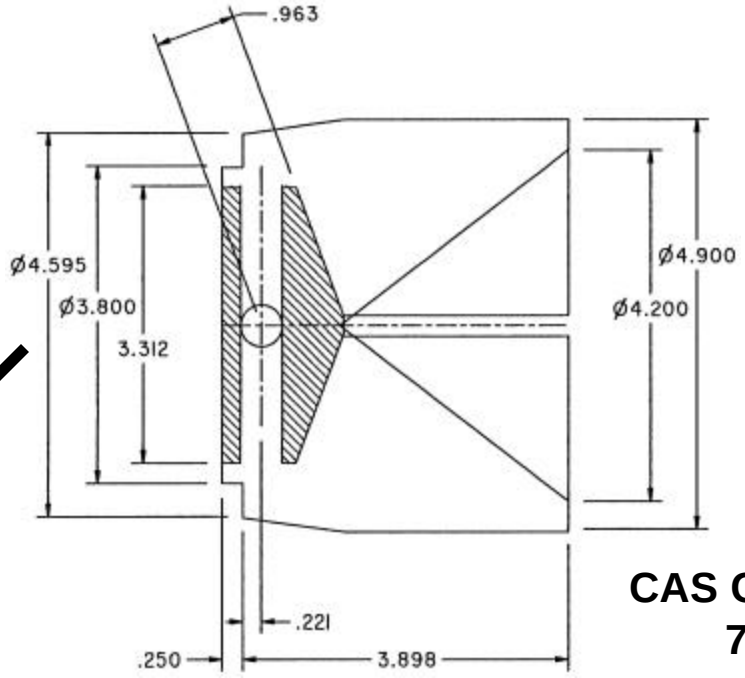
Length = 1 meter Range = 28-47km

Weight = 106 lbs





CAS Section
123.5 in^3

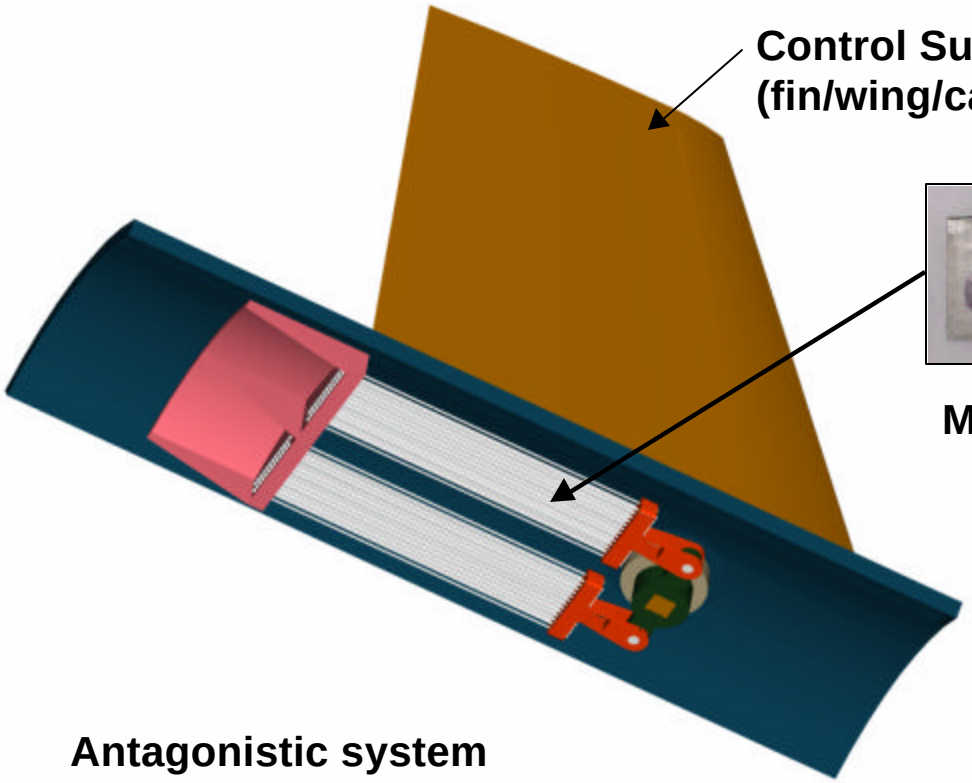


Total: 202 in^3

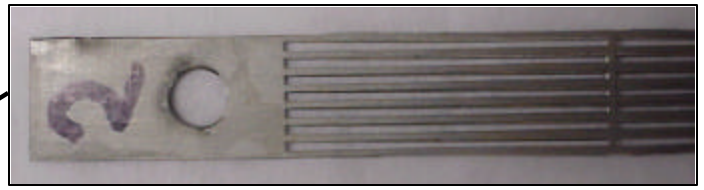
CAS Core Section
78.22 in^3

Example SBIR Concept

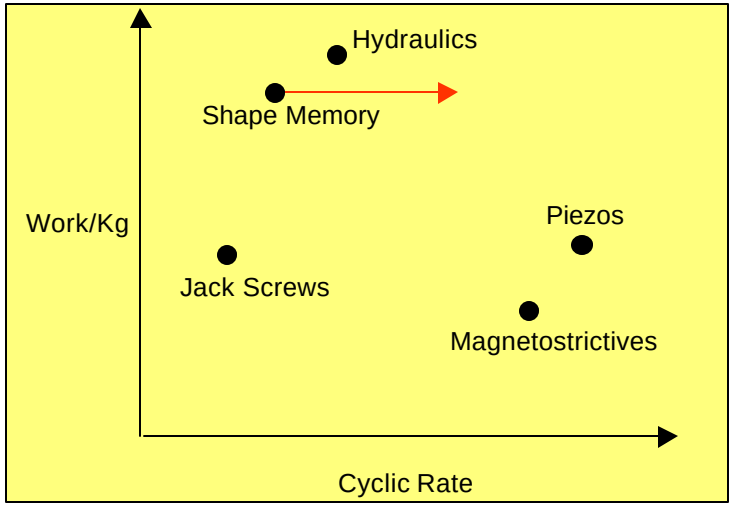
(Mide' Corp)



Antagonistic system embedded in projectile wall



Micro-channel SMA increase BW



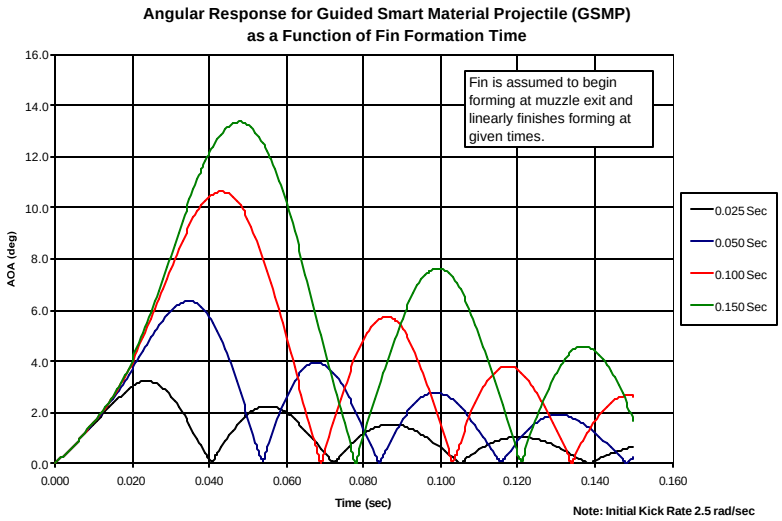
In addition to expanding on traditional CAS, whole bodies of aerodynamic research are open to exploitation with smart structures and materials

+ Increase altitude through lower supersonic drag
    - Active boat tailing & thinner control surfaces
+ Increase range in subsonic glide
    - Projectile body shape (ellipse/camber)
    - Control surface shape (active camber)
    - Decrease trim drag (eliminate hinge pivot)
    - Exploit unsteady aero-elasticity (resonance for plunging)
+ Increase stability (body shape changes to move center of pressure)
+ Increase control actuation system bandwidth
    - Stabilize unstable projectile

DARPA and the Army Research Office have been developing active control applications of Smart Materials and Structures over the last six years…

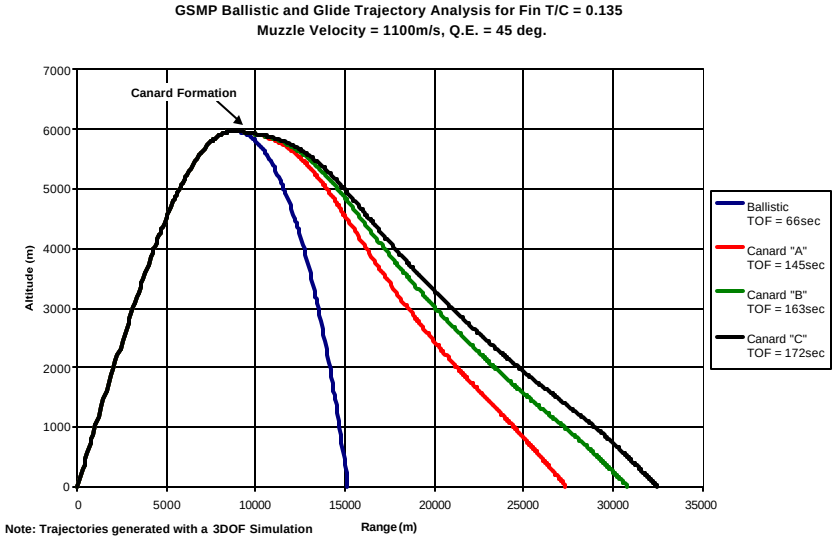
Application	Technology Readiness Level
Rotorcraft – Active Twist Blades (fiber & tube twist) & (tabs)	Level 6 - Mach scale hover test of integrated blades
Vortex Wake Control (vortex tabs on control planes)	Level 6 - NSWC Carderock 36” Water Tunnel
Smart Wing (structure morphing w/ tubes & wires)	Level 6 - Scale F/A 18 Wings at NASA wind tunnels
Smart Skin (self and radiated noise cancellation)	Level 4 - LM ATC Lab Test
Smart Panel (structure acoustic & vibration isolation)	Level 3 - ¼ scale lab prototypes

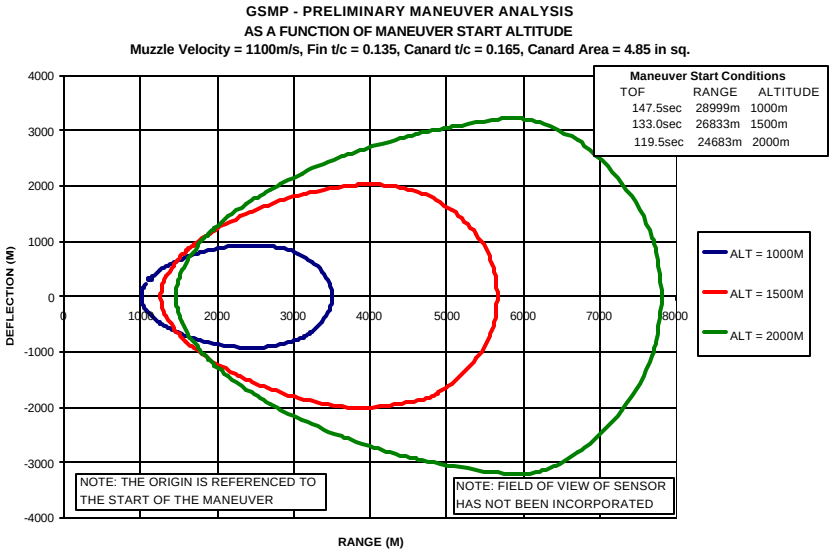
Generation of the Baseline “Design Space”



	Canards	Wings	Fins
Lift	X	X	X
Stability	X	N/A	Baseline
Maneuver	X	X	X

Analysis output: Moments to generate _____ with _____ at _____ location on round





Work done by TACOM-ARDEC Aeroballistics Team

Simplified Schedule