U.S. ARMY RESEARCH, DEVELOPMENT AND ENGINEERING COMMAND

Aviation S&T for the AMTC

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Aviation Development Directorate

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AMRDEC AVIATION S&T

Focus:

- **Discover**, **Mature** and **Demonstrate** technologies that support desired Aviation capabilities
- **Combine technologies** into **capabilities**

Strategies:

- Develop body of technical **knowledge** that supports decisions and develop early versions of **“the system”**
- ADD is **not an** engineer staffing source for existing platforms

AMRDEC AVIATION S&T

Mission

- Manage and conduct basic research (6.1), applied research (6.2), and advanced technology development (6.3)
- Provide one-stop life cycle engineering and scientific support for aviation systems and UAS platforms
- Mature technology to maintain relevance of current fleet
- Develop and mature technologies to support the future fleet

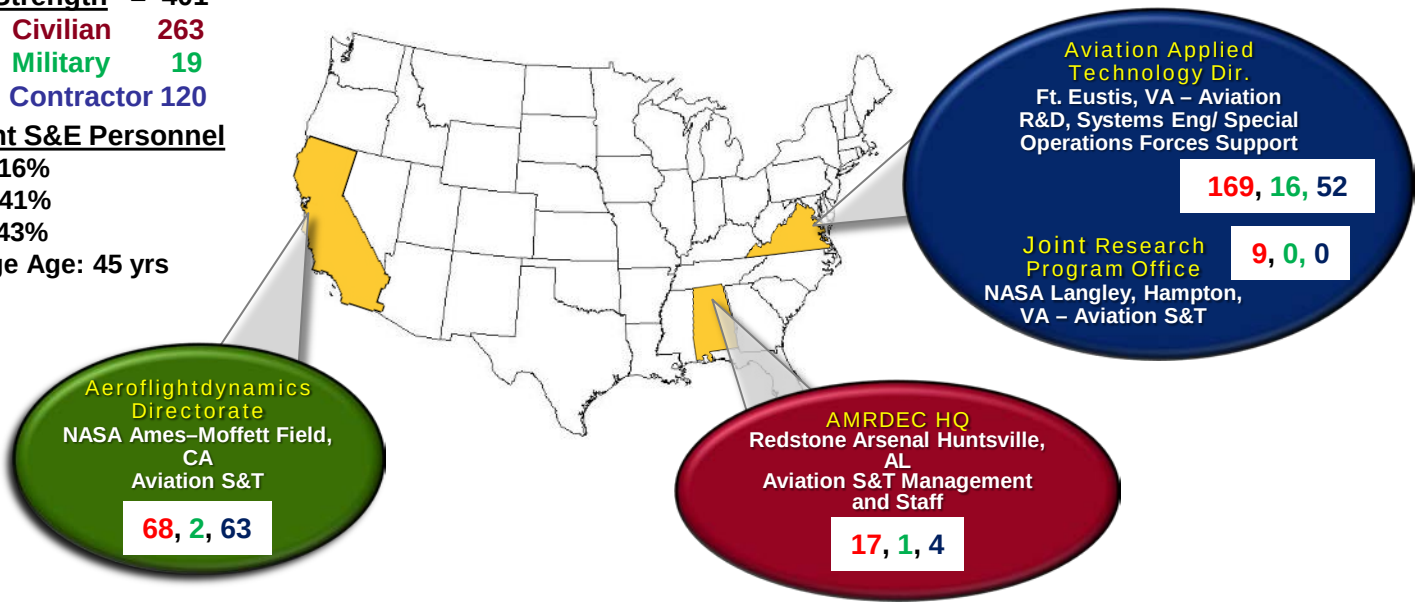
FY16 Strength = 401

60%	Civilian	263
S&T	Military	19
	Contractor	120

Current S&E Personnel

PhD	16%
MS	41%
BS	43%

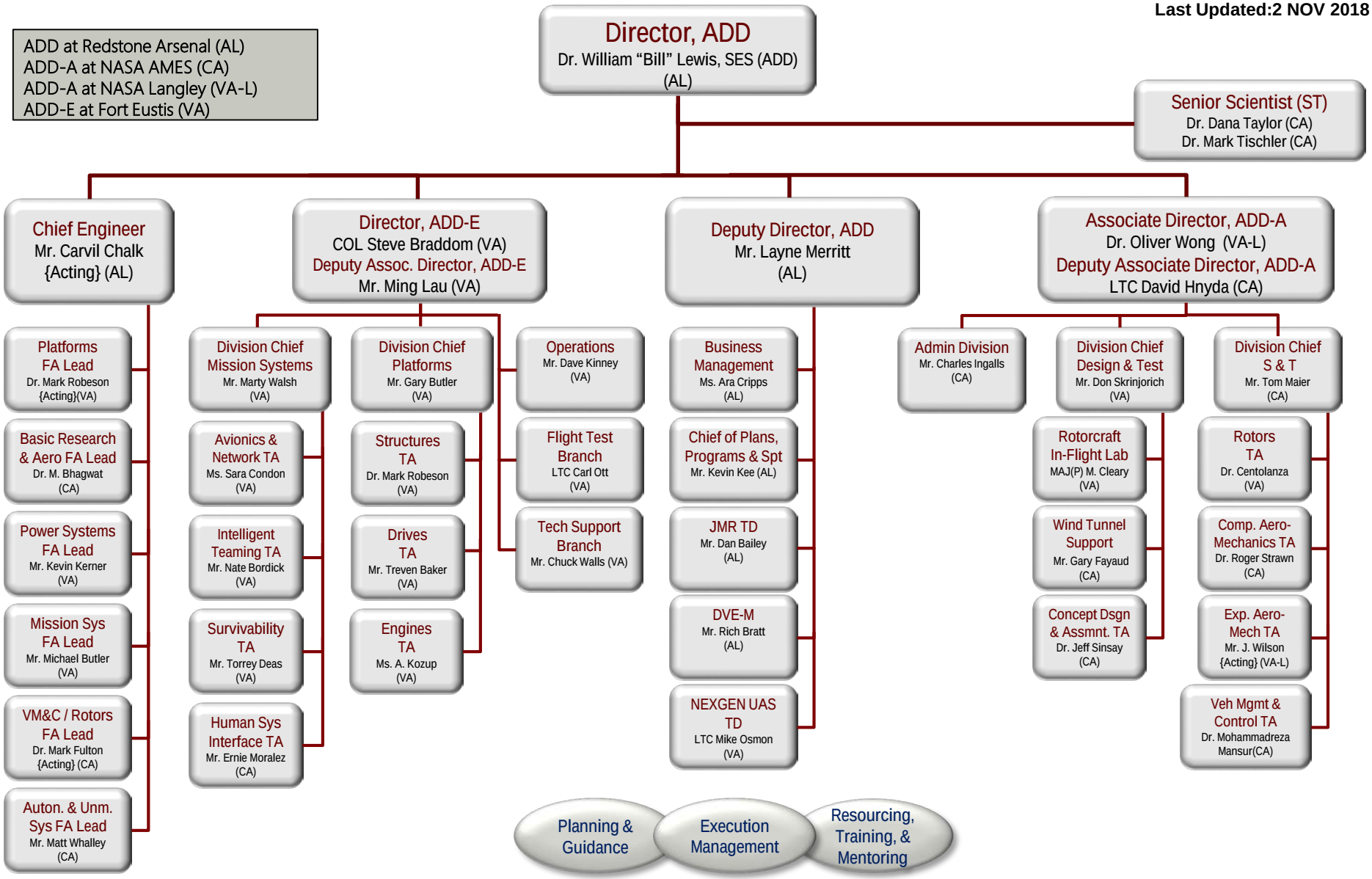
Average Age: 45 yrs



AVIATION DEVELOPMENT DIRECTORATE ORGANIZATION

Last Updated:2 NOV 2018

ADD at Redstone Arsenal (AL)
ADD-A at NASA AMES (CA)
ADD-A at NASA Langley (VA-L)
ADD-E at Fort Eustis (VA)



ADD FACILITIES

Ballistics Test Facility

Ft. Eustis, VA
Component Testing

Countermeasures Test Facility

Ft. Eustis, VA
Signature Characterization of Turbine Engines

Structural Test Facility

Ft. Eustis, VA
Rotor- Blade Test Fixture and Structures Backstop for Loads/Fatigue Testing

14-by-22 Foot Subsonic Tunnel

NASA Langley, VA
Helicopter Aerodynamics, Performance and Configurations

National Full-Scale Aerodynamics Complex

Moffett Field, CA
Advanced Testing of Full Scale Rotorcraft

Large Rotor Test Apparatus

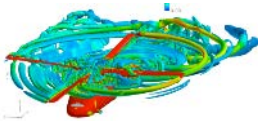
Moffett Field, CA
Full Scale Rotorcraft Component Testing

Tiltrotor Test Rig

Moffett Field, CA
Full Scale Tilt-Rotor Testing

S&T FOCUS AREAS

PLATFORMS



- Structures
- Concept Design & Assessment

MISSION SYSTEMS

- Survivability
- Avionics & Networks

VEHICLE MANAGEMENT & CONTROL AND ROTORS

- Rotors
- Vehicle Management & Control

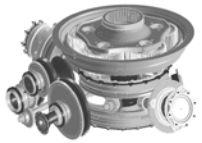
AUTONOMOUS AND UNMANNED SYSTEMS

- Autonomy & Teaming
- Human System Interface

MAJOR PROGRAM AREAS

- Joint Multi-Role Technology Demonstration
- Degraded Visual Environment – Mitigation
- Next Generation UAS Technology Demonstration
- Future Attack-Reconnaissance Aircraft Competitive Prototype

POWER



- Engines & Other Power Sources
- Drives

BASIC RESEARCH

- Computational Aeromechanics
- Experimental Aeromechanics

S&T FOCUS AREAS

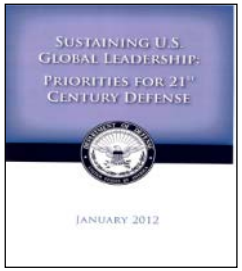
- ADD S&T efforts aligned to the CSA Priorities – Future Vertical Lift
- Expertise focused on core aviation technologies: aeromechanics, sustainment, power systems, autonomy, platforms, rotors, survivability, and vehicle control
- Major Programs support the FVL Cross-Functional Team Lines of Effort
  - FLRAA
  - FARA
  - Advanced UAS
  - MOSA

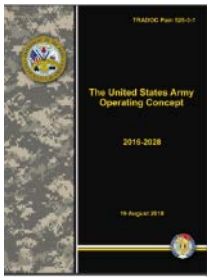
Innovative Workforce & Leading Edge Efforts

Army Aviation S&T: Resilient and Adaptable to the Changing Environment

WHAT INFORMS THE PORTFOLIO

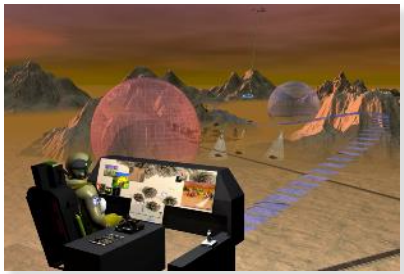
1. CSA Priorities & CFT Initiatives
2. Stakeholder capability needs and technology objectives (PEO, TRADOC, COCOMs, AMCOM, etc.)
3. Aviation S&T Strategic Plan (2018)
4. Army S&T priorities (ASAALT DASA(RT))
5. DoD priorities (OSD)
6. Future Outlooks (TRADOC)
7. Warfighter Outcomes / Wargaming Exercises
8. Future aviation requirements (JMR TD, FARA, FLRAA, AUAS, MOSA)

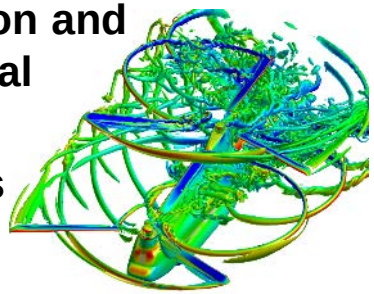


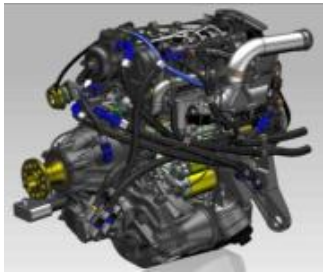


STRATEGIC GOALS

- Provide air vehicles and technologies for battlefield persistence and rapid response
- Implement open systems architectures
- Develop air-launched effects to conduct mission sets using modular payloads
- Demonstrate autonomy and cooperative teaming using autonomous decision-making in heterogeneous formations
- Shape the human-system interfaces to enable mission command from a battlestation with reduced cognitive demands
- Explore novel power generation, storage, and distribution technologies
- Dominate complex environments through navigation and airspace management for teams operating in natural clutter and high-density airspace
- Reduce fielding timelines and lower technical risks
- Sculpt the government workforce to respond with adaptability and agility while retaining core competencies







Army Aviation S&T: Informing the Future – Supporting the Present

FUTURE ATTACK RECONNAISSANCE AIRCRAFT (FARA)

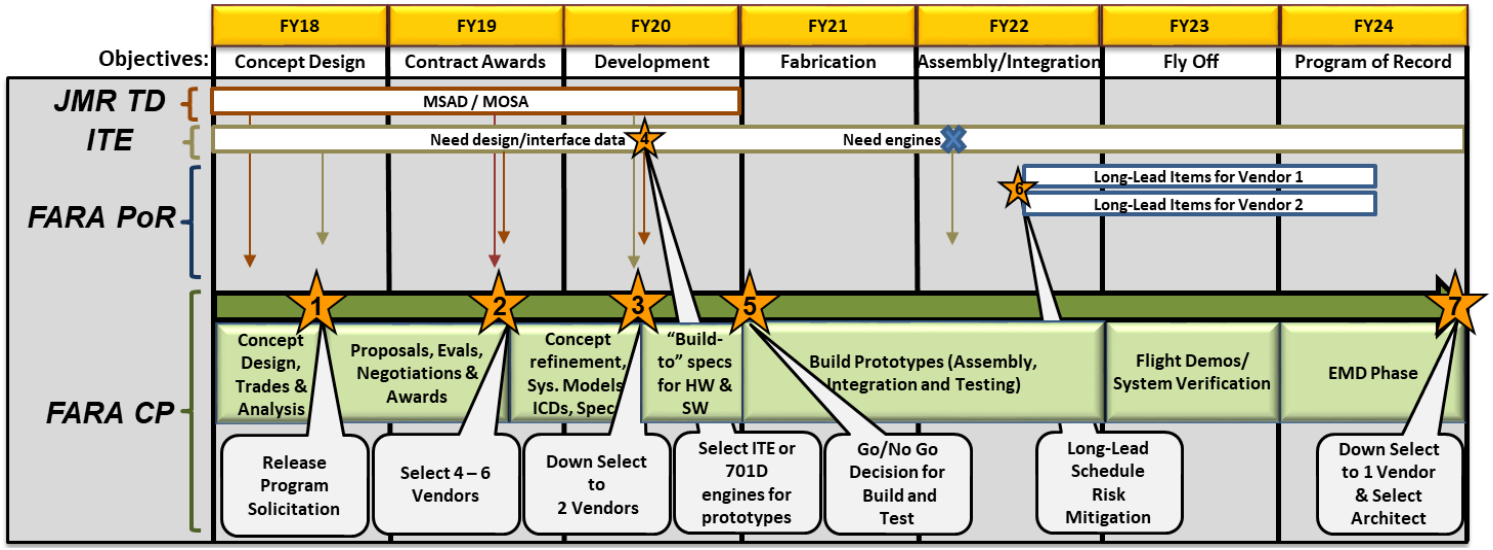
Description:

- Optionally piloted, close combat reconnaissance and lethality designed to operate in large scale combat operations in complex and degraded environments

Strategy/Approach:

- Streamlined competitive prototyping effort executed outside of DoD 5000.02 using 6.4 RDT&E funding
- Minimal requirements (Size, Improved Turbine Engine, 20mm Weapon); **maximum trade space**
- Other Transaction Authority for Prototyping (OTAP); Fixed Price; Statement of Objectives
- Draft Solicitation released 22 Jun 2018
- Industry Day held 28 Jun 2018
- Solicitation release 24 Sep 2018 (planned)
- Execution similar to Joint Multi-Role Technology Demonstration (JMR TD):
  - Lean staffing w/ judicious use of control measures and decision points
  - Industry given latitude to be innovative within trade space
  - Minimizing scope for follow-on acquisition program
- Transition to Program of Record for full system qualification and production

	Decision Point	
1	3Q FY18	Approve Acquisition Strategy and release of Program Solicitation using Other Transaction Program Agreements
2	3Q FY19	Select 4 – 6 vendors to begin development
3	2Q FY20	Down select to two (2) vendors and commit to ITE or 701D engines for flight demos
5	1Q FY21	Go/No go decision to proceed with building prototypes for flight demo and fly off competition
7	4Q FY24	Down select to one (1) vendor to complete Engineering, Manufacturing and Design (EMD) and prepare for production



JOINT MULTI-ROLE TECHNOLOGY DEMONSTRATOR (JMR TD) – BELL

Video

FUTURE LONG-RANGE ASSAULT AIRCRAFT & MOSA

Purpose:

Demonstrate transformational vertical lift capabilities to prepare the DoD for decisions regarding the replacement of the current vertical lift fleet

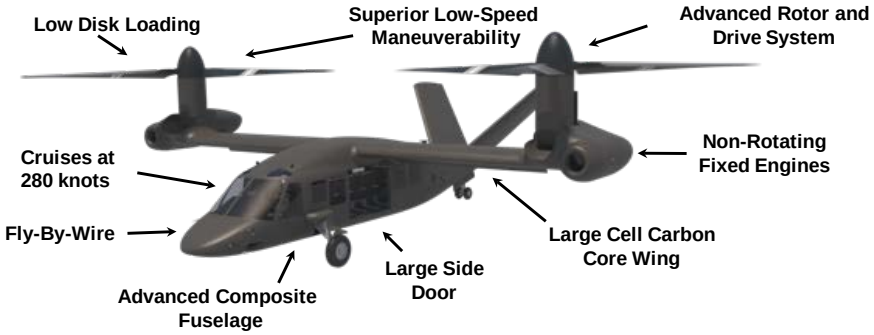
Scope:

- Design, build, and fly two demonstrator aircraft (not prototypes)
- Sub-system technology demonstrations and system integration analyzes
- Increasingly complex architecture demonstrations

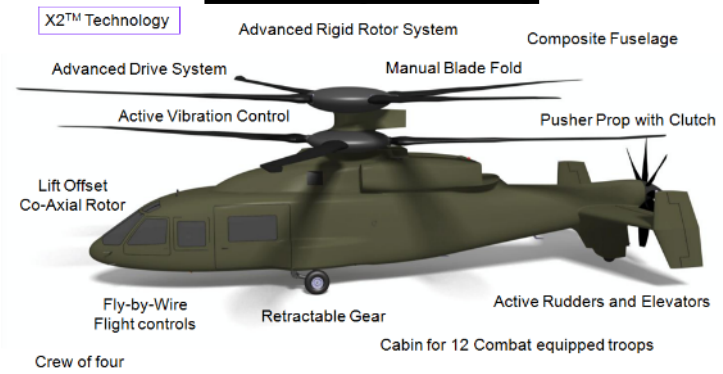
Outcomes:

- System-level demonstrations of advanced rotorcraft configurations that satisfy Future Vertical Lift (FVL) performance goals
- New component and manufacturing technologies
- Standards and tools for open architectures
- Advanced Modeling & Simulation tools and aircraft design capabilities
- Technology roadmaps, cost analysis and technical risk assessments to inform FVL acquisition and funding

Bell Helicopter



Sikorsky-Boeing



JMR MISSION SYSTEMS ARCHITECTURE DEMO (MSAD)

- Effective Acquisition
  - Competitive Opportunities
  - Reduced Vendor Lock
  - Increased Affordability
- Efficient Integration
  - Reduced Time to Field
- Improved Capabilities
  - Portable / Reusable
  - Interoperable
  - Upgradeable / Resilient
  - Planned Variability
- Efficient Qualification
  - Safe/Secure

Purpose:

Investigate/Mature processes, tools and standards necessary to specify, analyze, design, implement and qualify a Mission Systems Architecture in support of emerging FVL PoR that meets Army business goals

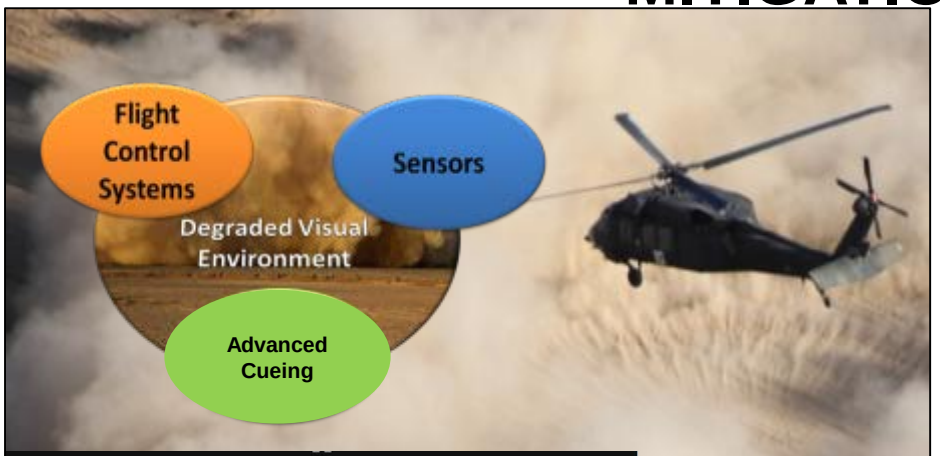
Approach:

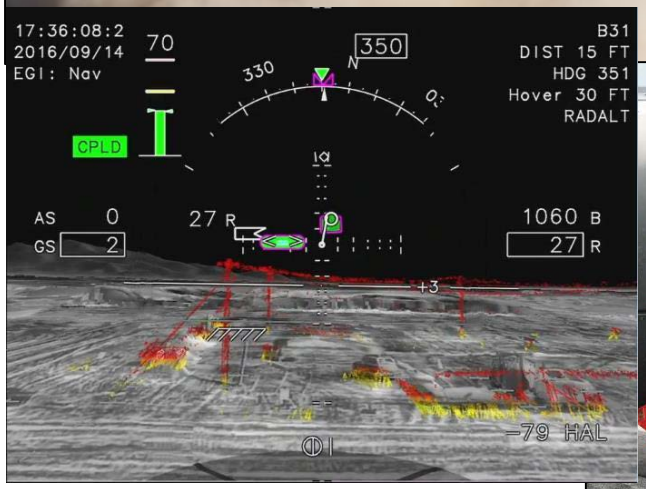
- Leverage or develop the standards and tools necessary to successfully implement a mission systems architecture
- Execute a series of increasingly complex demos - Learn by doing

Focus Areas:

- Implementation of Open Systems Architectures (OSA)
  - Joint Common Architecture (JCA)
  - FACE™ Technical Standard
  - Hardware Open Systems Technologies (HOST)
- Application of Model Based Engineering (MBE)
  - Model-based specification/acquisition
- Execution of an Architecture Centric Virtual Integration Process (ACVIP)
  - Predictive performance assessment

DEGRADED VISUAL ENVIRONMENT - MITIGATION





Purpose:

- Enable pilots to fly in all environmental conditions
  - Smoke/Smog, Sand/Dust, Fog/Rain/Clouds/Snow
- 360º situational awareness (SA)
- Low-latency Local Imagery shared between cooperating aircraft
- Multi-function Sensors – terrain avoidance and threat detection

Scope:

- Technical assessment of system performance and maturity
- Cost and developmental risk assessment
- Demonstrated integration of multi-function sensors, advanced flight controls, and pilot cueing
- Ready for incorporation with autonomy efforts

Outcomes:

- Execute combat rotorcraft operations in degraded visual environments and adverse environmental conditions
- Increased survivability & operational effectiveness of
- Safety
- Exploiting Adverse Environments for Tactical Advantage

DEGRADED VISUAL ENVIRONMENT MITIGATION (DVE-M)

Video

AUTONOMY

Purpose:
Develop and Demonstrate the integration of autonomous functions that enhance crew performance and enable unmanned systems to operate independent from and interdependent with real-time human input

Scope:
Enable crew to execute role of mission manager
Demonstrate Adaptive Flight Controls and Autonomous Onboard Systems
Assess Capability of Autonomous Agents for Awareness of Location, Mission, Capability, and Alternatives
Develop Criteria for Prioritizing and Assessing Adaptive Behaviors

Outcomes:
Reduced Crew Cognitive Workload
Adaptable, Self-Reconfiguring groups of Autonomous Systems

DUAL LIFT / AUTONOMY

Video

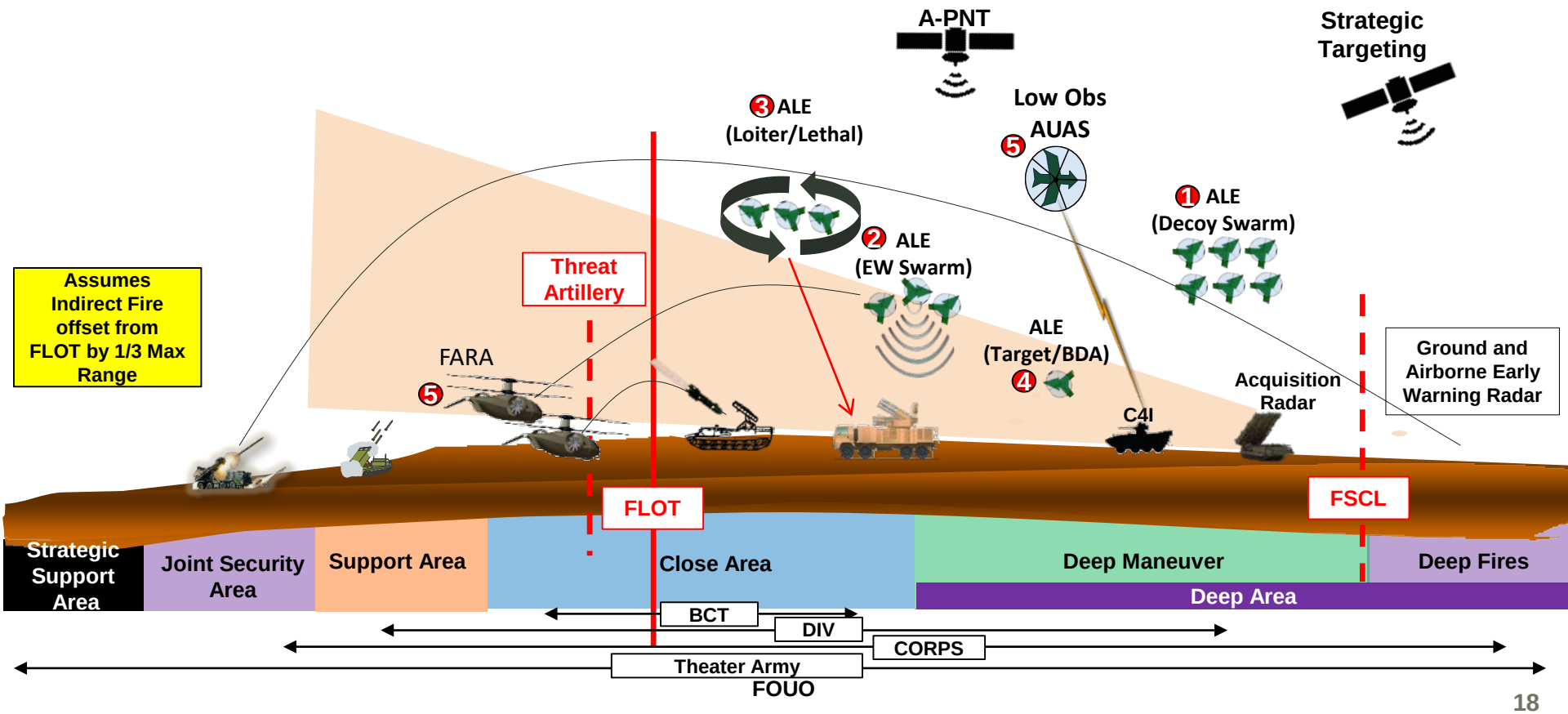
ADVANCED TEAMING

"Advanced teaming is the symbiotic effort of manned rotary wing and fixed wing aircraft, unmanned aircraft systems, ground vehicles, and air launched effects (ALE) to accomplish the full range of multi-domain operational missions with enhanced and distributed situational awareness, greater lethality, and improved survivability."

- TCM-FVL, FVL CFT

Layered Breaching

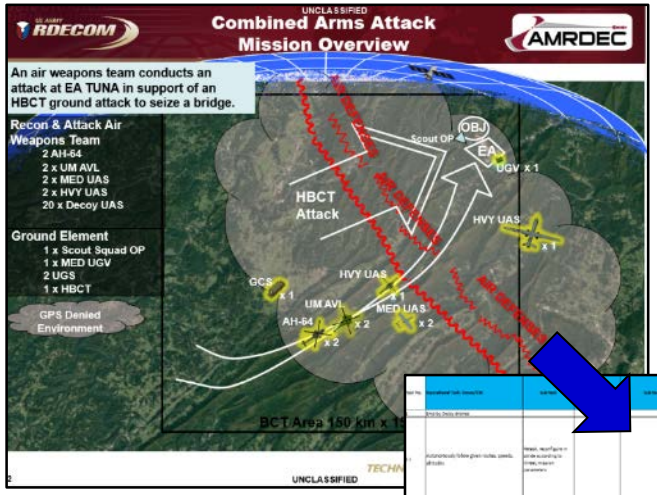
1. Decoy stimulates IADS signature
2. EW conducts stand-in jamming
3. Lethal destroys prioritized targets
4. Optical provides BDA
5. RSTA, Kinetic/Non-Kinetic Attack



FOUO

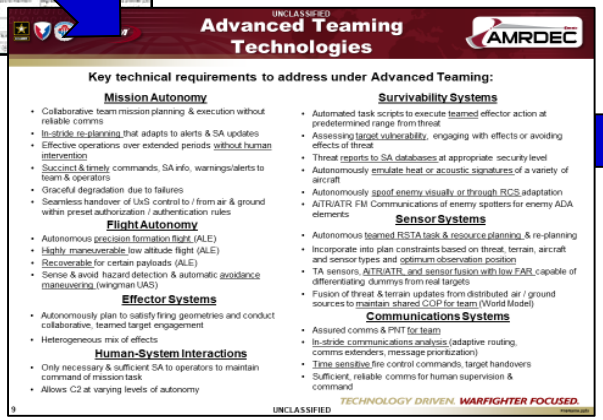
TECH DEVELOPMENT APPROACH

Define & Decompose CONOPS

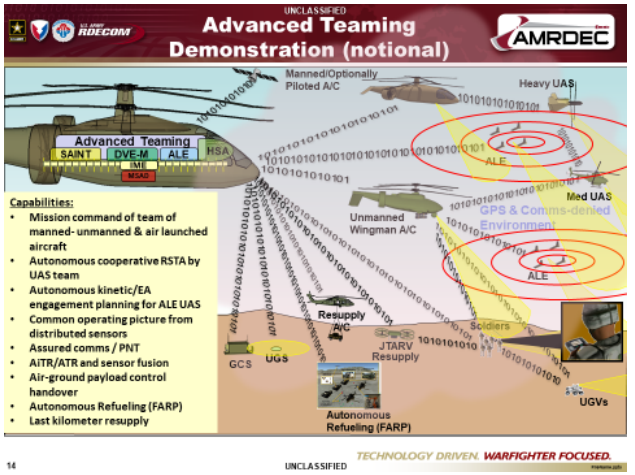


Assess Operational Capabilities and Technology Gaps

Prioritize Advanced Teaming Technology Investment Areas



Demonstrate Integrated Capabilities



Develop Enabling Technologies

Mission Sets

- Decoy / EW
- Recon
- Surveillance
- Target Acquisition
- Mission Command
- Attack
- E/W & Protection
- CASEVAC
- MEDEVAC
- Resupply

OPERATIONAL TECHNOLOGY REQUIREMENTS

Key subsystems technology requirements to demonstrate Advanced Teaming

Mission Autonomy

- Collaborative team mission planning & execution without reliable comms
- In-stride re-planning that adapts to alerts & SA updates
- Effective operations over extended periods without human intervention
- Succinct & timely commands, SA info, warnings/alerts to team & operators
- Graceful degradation due to failures
- Seamless handover of UxS control to / from air & ground within preset authorization / authentication rules

Flight Autonomy

- Autonomous precision formation flight
- Highly maneuverable low altitude flight
- Recoverable for certain payloads
- Sense & avoid hazard detection & automatic avoidance maneuvering

Effector Systems

- Autonomously plan to satisfy firing geometries and conduct collaborative, teamed target engagement
- Heterogeneous mix of effects

Human-System Interactions

- Only necessary & sufficient SA to operators to maintain command of mission task
- Allows C2 at varying levels of autonomy

Survivability Systems

- Automated task scripts to execute teamed effector action at predetermined range from threat
- Assessing target vulnerability, engaging with effects or avoiding effects of threat
- Threat reports to SA databases at appropriate security level
- Autonomously emulate heat or acoustic signatures of a variety of aircraft
- Autonomously spoof enemy visually or through RCS adaptation
- AiTR/ATR FM Communications of enemy spotters for enemy ADA elements

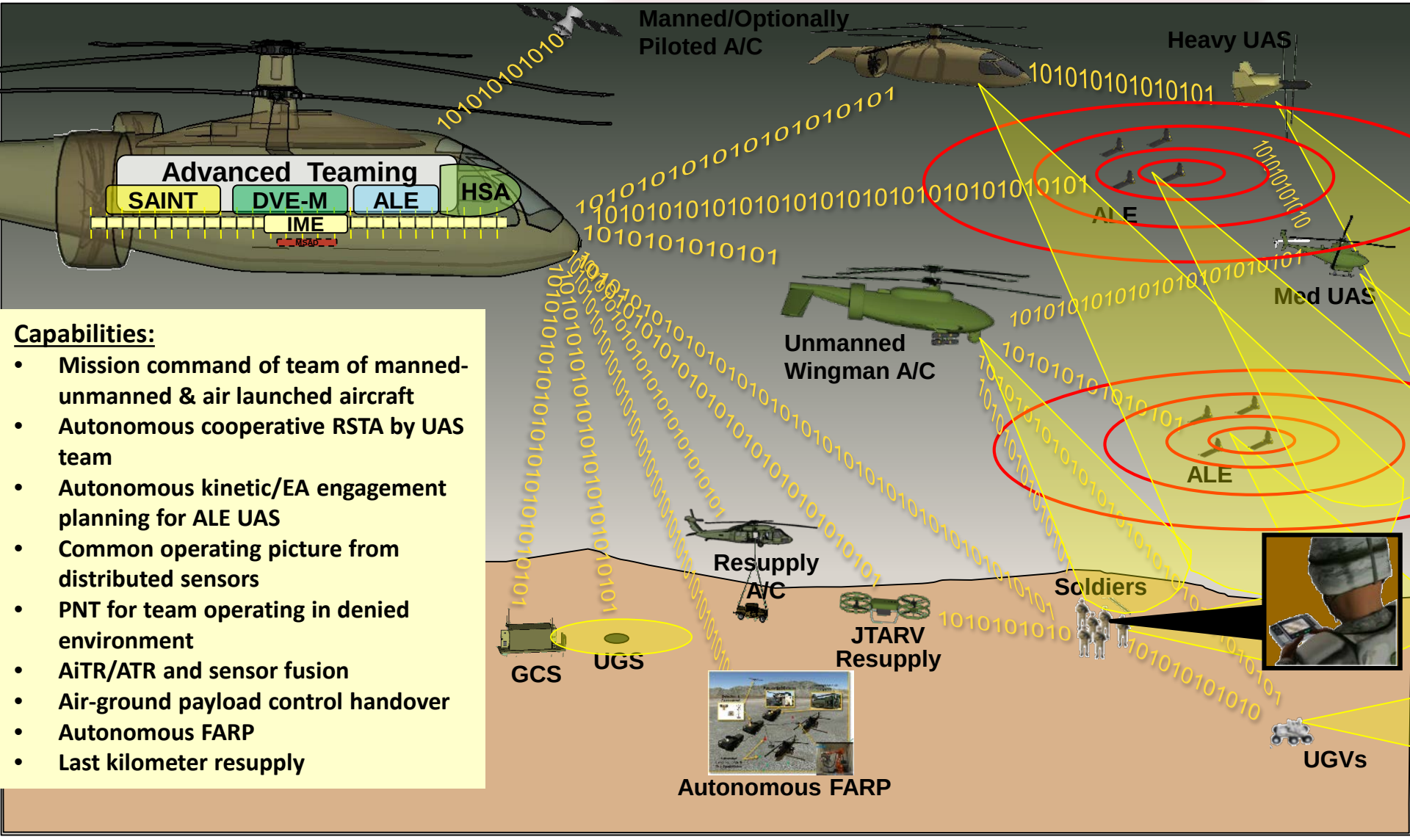
Sensor Systems

- Autonomous teamed RSTA task & resource planning & re-planning
- Incorporate into plan, constraints based on threat, terrain, aircraft and sensor types and optimum observation position
- TA sensors, AiTR/ATR, and sensor fusion with low FAR capable of differentiating dummies from real targets
- Fusion of threat & terrain updates from distributed air / ground sources to maintain shared COP for team (World Model)

Communications Systems

- Assured comms & PNT for team
- In-stride communications analysis (adaptive routing, comms extenders, message prioritization)
- Time sensitive fire control commands, target handovers
- Sufficient, reliable information for human supervision & command

MISSION SYSTEMS INTEGRATED TECH DEMO (FY23)



Capabilities:

- Mission command of team of manned-unmanned & air launched aircraft
- Autonomous cooperative RSTA by UAS team
- Autonomous kinetic/EA engagement planning for ALE UAS
- Common operating picture from distributed sensors
- PNT for team operating in denied environment
- AiTR/ATR and sensor fusion
- Air-ground payload control handover
- Autonomous FARP
- Last kilometer resupply

FOUNDATIONAL ENABLERS

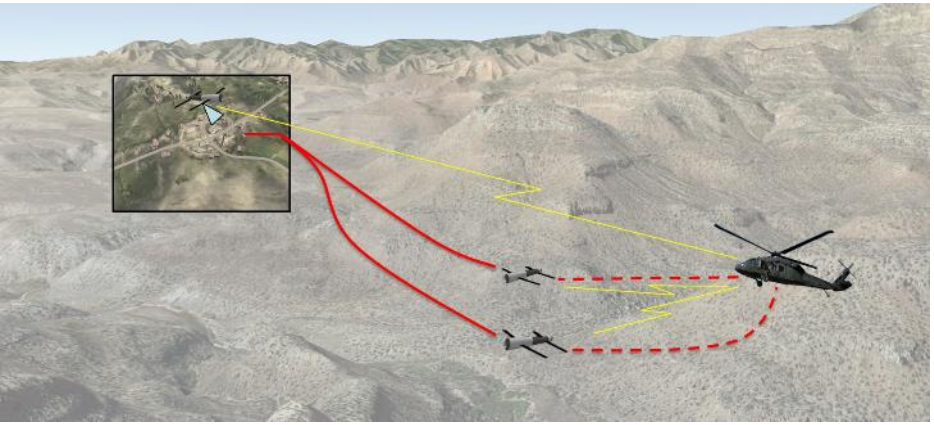
Key foundational enablers required to develop Advanced Teaming:

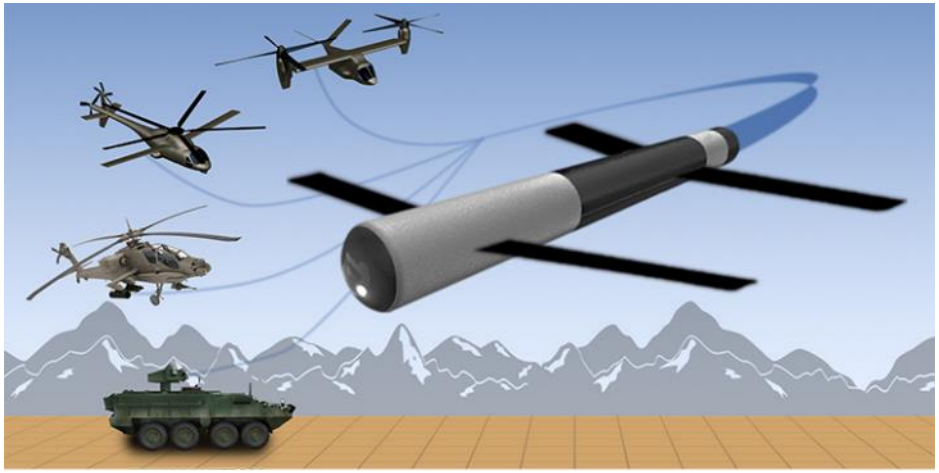
- **Mission Systems development & integration approach**
  - **Based on Joint Common Architectures Strategy**
  - **Ensures subsystems integration & interoperability**
  - **Explores a framework for safety & security certification**
- **Modeling & Simulation approach integrated into T&E**
  - **For independent Government evaluation of vendor autonomy products**
  - **For risk reduction through system of systems simulations**

Foundational enablers

- **Provide approaches to a sustainable life cycle acquisition process**
- **Enable vendor-neutral ability to extend capabilities**
- **Offer accelerated paths to certification of and upgrades to autonomy technologies**
- **Inform V&V approach for autonomous, adaptive systems**

AIR LAUNCHED EFFECTS





- Air Launched at Low-altitude and High-speed
- Range of greater than 35km
- Loitering on the Objective
- Multiple Effects
  - Electronic Warfare
  - Surveillance
  - Route Reconnaissance
  - Decoy and Countermeasures
  - Target Acquisition & Designation


ADD
Aviation Development Directorate