U.S. ARMY TANK AUTOMOTIVE RESEARCH, DEVELOPMENT AND ENGINEERING CENTER

Advancing Infantry Fighting Vehicle Capabilities

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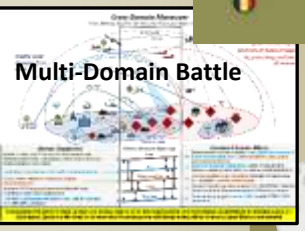
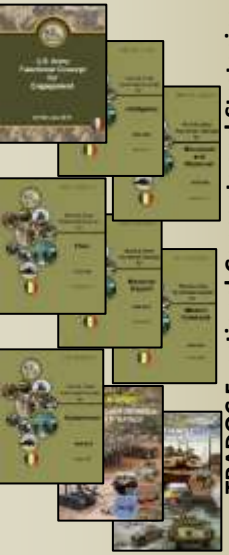
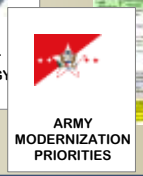
Army Priorities Drive TARDEC's Strategy





TRADOC Functional Concepts and Strategies



TARDEC Strategic Cohort

TARDEC's Strategic Cohort is made up of volunteers who study and internalize all strategic documents coming for TRADOC and National Defense Strategies

Cohorts goals:

- Align TARDEC efforts with the Army's Strategic Guidance
- Influence the Army's Strategic guidance with emerging technology
- Inform the TARDEC workforce

Next Generation Combat Vehicles

Manned Unmanned Teaming

VALUE STREAM 1: Shape the Future Force

VALUE STREAM 2: Support Systems Across the Acquisition Lifecycle

VALUE STREAM 3: Strengthen Foundational Competencies

TARDEC

TARDEC 30 Year Strategy

Modular Power Generation

Electrification

Advanced Ground Vehicle Systems

Survivability – Ground Systems

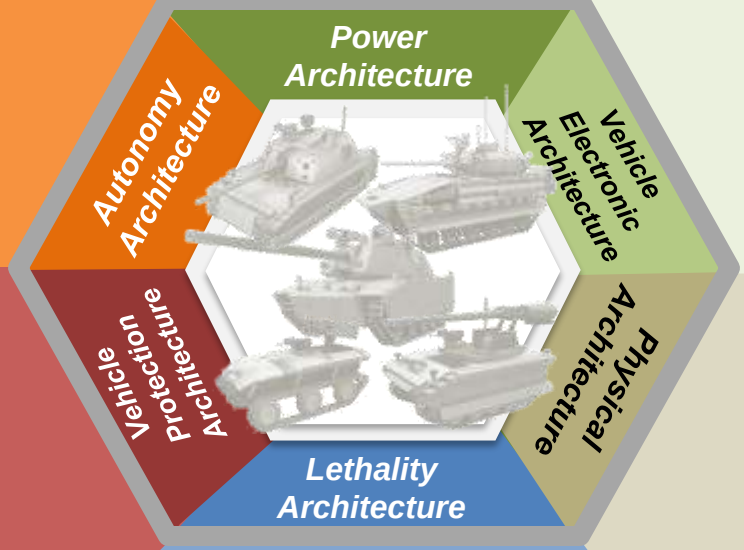
TARDEC's 30 Year Strategy is Built upon Army Priorities and Foundational Strategies to Shape the Future Ground Vehicle Fleet

Next Generation Combat Vehicle Architectures…

- Software architectures
- Autonomous behavior library
- Crew augmentation architecture
  - Augment tasks
  - Decision making via autonomy sensors, situational awareness, critical system operational status, maintenance status, damage assessment status

Provides scalable power generation for
- Communication network
- Electronic hardware
- Platform maneuverability
- Advanced weapons

Provides scalable electronic, power distribution & data architecture for hosting
- On board and network communications
- Sensor integration
- High power/voltage network for advanced weapons, advanced technologies
- Platform system software
- A-kit Interface for other architectures (autonomy, vehicle protection, lethality)
- Soldier machine interface (displays)
- Vehicle System Security



- Modular - Host any active defense capability (APS, active armor, active blast, HFDL)

- Modularity
- Crew accommodations
- Materials & System Lightweighting
- Size/weight (minimize)
- Major subsystems integration

- Directed Energy
- Conventional Kinetics

…are foundational underpinnings to enhance Capabilities for Future Manned & Unmanned Platforms, providing the flexibility to adapt ground vehicles to ever changing environments

Power Architecture: Leading Powertrain Technology Development

Demonstrate increased capability for Combat Vehicles....

Advanced Combat Engine

160 kW Integrated Starter Generator

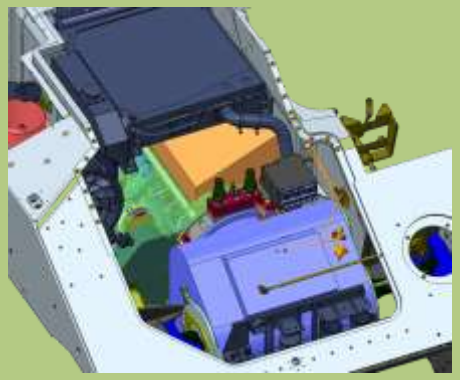
32-speed Advanced Combat Transmission

Advanced Thermal Management System

Gen 2 6T Advanced Modular Li-Ion Batteries

Controls Development

Advanced Powertrain



- Combat Vehicle platforms greater than 45 tons
- Scalable, Modular technologies
- 1.5 - 2X Installed Power Density
- Increased fuel efficiency, 20% ↑ vehicle operating range
- Increase onboard/export power, 160kW

Bradley

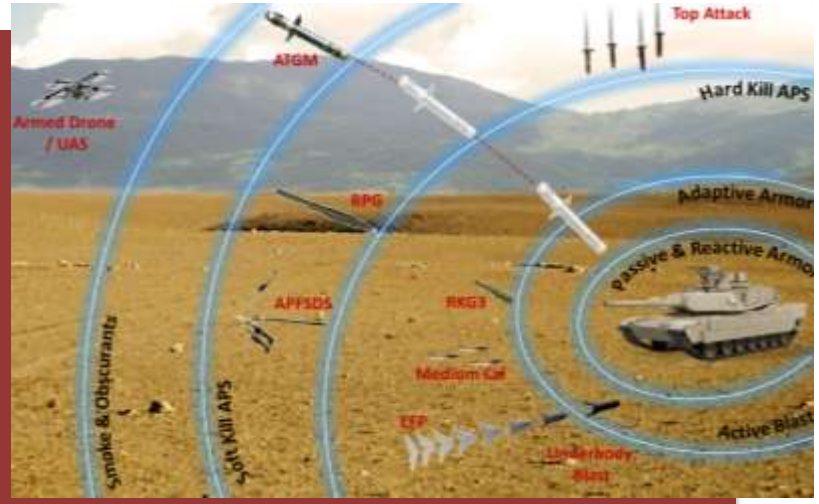
NGCV

PIM

AMPV

Vehicle Protection Architecture: MAPS

Description:
Eliminate barriers associated with the US fielding of Active Protection Systems (APS) through a ***modular and safe architecture*** (Modular Active Controller (MAC) & Modular Active Framework (MAF)) to transition ***tailored capability*** for any platform, while demonstrating state of the art Soft-Kill (SK) and Hard-Kill (HK) threat countermeasures.



Payoff:

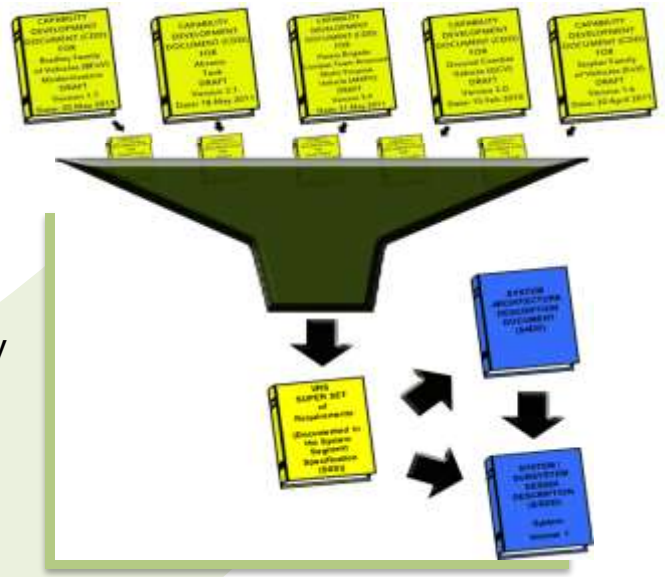
- Situational awareness of shooter location and threat type
- Rapid retaliation via automated weapon system cue with shooter coordinates
- New Tactics, Techniques, and Procedures (TTPs)

Layered Protection Provides Agile Threat Defeat Resiliency

Vehicle Electronic Architecture: VMD

Description:

- Replace 450HP engine and 25kW alternator with a 350HP engine and a 120KW Integrated Starter Generator.
  - Lighter, more fuel efficient powertrain
  - Same mobility performance or better (acceleration)
- Add Smart electrical power management to the platform
- Replace hydraulic loads with power managed, electrically driven loads to increase energy efficiency and boost performance



Payoff:

- Deliver a leap ahead data and power architecture usable on multiple combat vehicles at TRL 6 in FY19
- Demonstrate/prove the value of electrification and thinking smarter rather than thinking bigger
- Provide the “hooks” for energy weapons and combat vehicle electrification
- Supports operating semi-independently and sustain operations for ample duration
- Utilize advanced integrated energy/power management system technologies

Modular and open power enables operating at higher temperatures for greater efficiency

Autonomy Architecture: AGVRA

Current Situation

Fielded, Proprietary (Closed) Robotic Solutions

- Expensive
- Limits Innovation
- Difficult to Upgrade
- Limits Competition

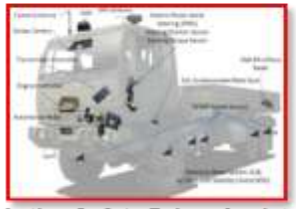
Open Modular Architecture

Modular Software

Standard Interfaces

Future of Army Autonomy

Rapidly build increased capability over time



Active Safety Driver Assist Appliqué Kits

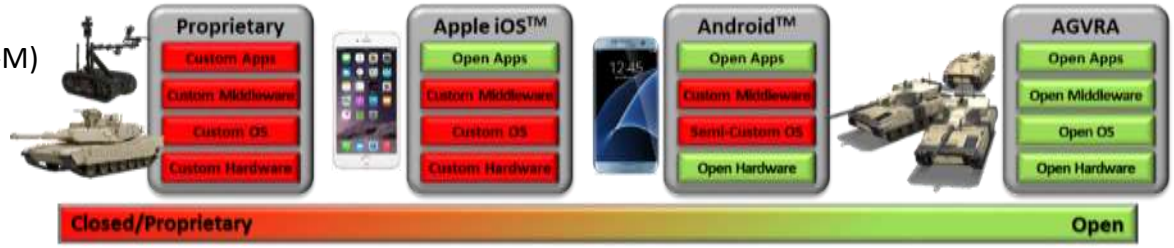
Leader/Follower/ Autonomous Convoy Operations

Manned-Unmanned Teaming

- Enables competition across the life cycle
- Reduces cost and speeds development
- Rapid, cost effective evolution of capability
- Enables Army to take advantage of industry innovation

Government managed Robotics Architecture enables incremental software capability upgrades

- Military library of autonomous behaviors in open, non-proprietary, modular format (ROS-M)
- Interface definition enables integration of payloads across S&T enterprise / Industry
- Autonomous behaviors are not platform specific enabling significant code reuse.



TARDEC's autonomy investments focus on improving unmanned ground maneuver and integrating mission payloads on while continuously engaging the user in operational experiments / assessments

Better Buying Power Focus Areas:

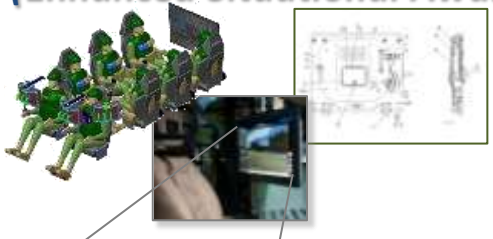
- ☑ **Achieve Affordable Programs**
  Software code reuse from previous programs, increased capability w/o vendor lock
- ☑ **Control Costs Throughout the Product Lifecycle**
  Architecture enables reduced safety certification timeline reduced w/ M&S approach, mitigates obsolescence in rapidly evolving field
- ☑ **Incentivize Productivity & Innovation in Industry/Gov't**
  Government managed software architecture enables industry to innovate around different RAS behaviors inviting broader industry participation.
- ☐ Eliminate Unproductive Processes and Bureaucracy
- ☑ **Promote Effective Competition**
  Competition ensures module level upgrades incorporate best of breed behaviors throughout the lifecycle
- ☐ Improve Tradecraft in Acquisition of Services
- ☐ Improve the Professionalism of the Total Acquisition Workforce

Industry Partners for AGVRA Development

MIT Lincoln Laboratory · SwRI · dcs corp · NAMC · APL

Mission Enabling Technologies - Demonstrator

Effective Distributed Operation (Enhanced Situational Awareness)

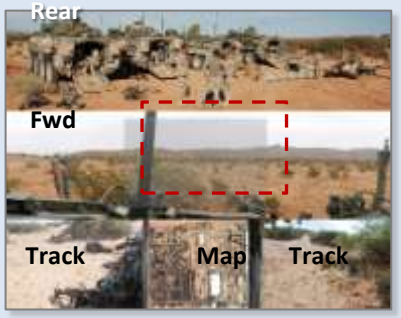


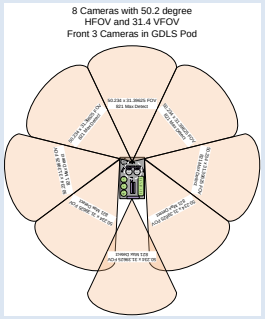
Real-Time Situational Awareness
- Crew Workstations
- Squad Tablets
- Enhanced Virtual Window

Real Time Mission Planning
- Common Operating Picture (COP)
- Virtual Sand Table ("Madden Draw")

Platoon Voice & Data Network
- Vehicle to Vehicle
- Vehicle to Soldier (NETT Warrior)

Closed Hatch (Indirect) Driving



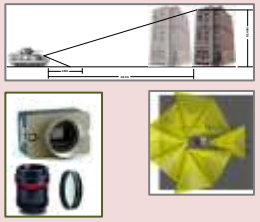


Indirect Driver Vision
- 150° Stereo Forward Cameras (Depth Perception)
- 2x Flank/Track Cameras (Close Quarters Movement)
- Rear Camera

MET-D Bradley Vehicles

Closed Hatch Target Detection

Extended Target Detection: GMTI Radar
- Auto detect & track vehicles & personnel
- > 2x optical detect range

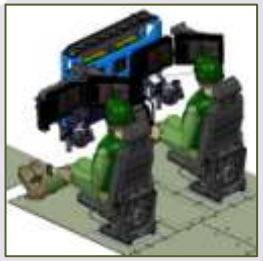


Enhanced 360 SA
- Visual
- Audio Cueing
- Proximity Warning

NLOS Target Detection: Integrated UAS
- Host vehicle integration (launch, land, C2)
- On-Demand 3D Area Surveillance

Unmanned/Remote Turret
- Modified/remote Bradley Turret
- Evaluate TTPs and technologies that enable closed hatch ops

Reduced Crew Task Load



Autonomous Driving
- Drive by Wire
- Supervised Waypoint Navigation
- Shared Route Following (formation)

Allows Crew to Prioritize Other Tasks

Two-Person Crew-station Design
- Ground up workstation design coupled w/ task automation
- Working testbed (SIL) to test and incorporate Soldier feedback

It's All About the Warfighter

Delivering Warfighter Readiness