TARDEC 30-YEAR STRATEGY VALUE STREAM ANALYSIS

Revised July 2015

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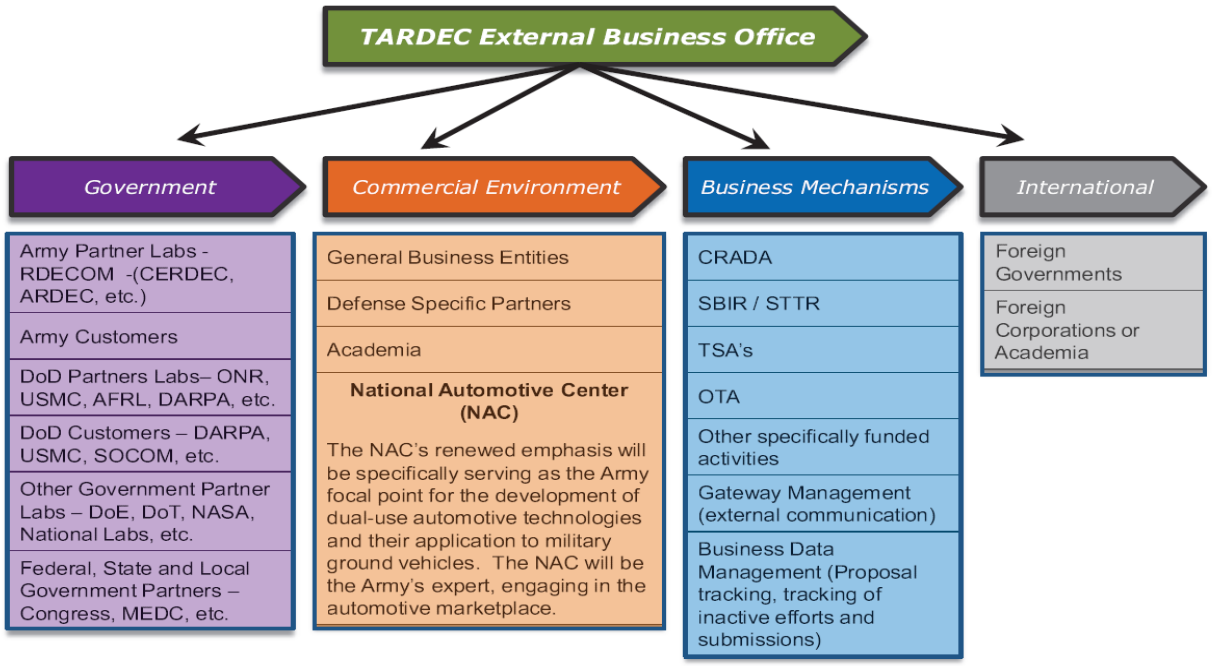

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⇨VALUE STREAM 1 (VS1) *Purposeful investments in leap-ahead technologies and integrated systems to help shape requirements for future programs of record*

VS1 supports TARDEC's stakeholders in the requirements community so that these organizations may better understand the "art of the possible" for future ground vehicles. The organization will shift from focusing on components with a sole focus on broad acquisition needs to system-level demonstrators that can influence requirements for future systems. VS1 Lines of Effort (LoE) will create advanced leap-ahead capabilities for future ground vehicles with an emphasis on maximizing flexibility and adaptability. VS1 is comprised of four LoEs that are focused on the technology areas with the most potential to ensure the enduring value of the future ground vehicle fleet, each of which directly supports Army S&T Priorities.

The four LoEs are:

(1) Autonomy-Enabled Systems;
(2) Ground System Architecture;
(3) Protected Mobility;
(4) Power Density and Energy Efficiency.

The requirements community speaks in terms of capability, not technology. So, TARDEC will focus VS1 efforts on programs called capability demonstrations (CDs). These initiatives are high-level, cross-organizational, integrated demonstrations of new ground system capabilities that are designed to influence the requirements of future programs. They will also inform the requirements community about possible S&T solutions that address newly defined national-level strategy and guidance.

⇨VALUE STREAM 2 (VS2): *Purposeful investments in the development, integration and transition of technologies that address specific PM needs for current ground systems*

VS2 supports TARDEC's partners in the ground system acquisition community through purposeful investments in the development, integration and transition of technologies to meet high-priority needs. VS2 was created to provide a sharper focus on the planning and execution of PM-directed or validated capabilities tailored to very specific, current needs. It focuses on upgrading current platform capabilities to maintain technological superiority, ensures capacity to accommodate new capabilities, and develops a means to understand and mitigate the costs of sustaining each platform. The LoEs that will drive improvements in the Current Force are:

(1) Focused efforts to enhance capability on current programs of record;
(2) Initiatives to improve space, weight, power and cooling parameters in the current ground system fleet; and
(3) Efforts to reduce life-cycle costs in military ground systems.

⇨**VALUE STREAM 3 (VS3):** ***Purposeful investments in TARDEC's engineering enabling capabilities to provide world-class support to internal and external customers***

VS3 provides world-class services and support to the ground system domain, which includes S&T, acquisition and sustainment organizations. VS3 focuses on strategically investing in new or improved engineering-enabling capabilities that provide engineering services and matrix support throughout the vehicle life cycle. The LoEs that will help TARDEC provide world-class engineering services and support are:

(1) Investing in people, facilities and service capabilities that enable advanced engineering services and support;
(2) Improving communication with deployed forces to understand system employment on the battlefield, rapidly providing solutions to deployed units, and expediting repair and replacement of ground systems; and
(3) Leading the Army in secondary item procurement.

Lines of Effort Lines of Effort (LoE's) are strategic thrust areas within each value stream. Collectively the roadmaps for each LoE layout the path to achieve TARDEC's 30 Year Strategy.

Capability Demonstrators (CD's) are high-level, cross-organizational, integrated demonstrations of new ground system capabilities, designed to influence the requirements of future Programs of Record and drive the study of future operational capability. It is how TARDEC communicates with TRADOC in their terms. Focus is on capability, not technology.

Capability Demonstrators identified to date:

- CD 1 – Combat Vehicle Prototype activity (Next Gen Powertrain, Vehicle Architecture, APS/Active Survivability)
- CD 2 – JOEI Modeling Tool, Black Water Treatment/Gray Water reuse, and water quality monitoring.
- CD 3 – Demonstrate an enduring, operationally relevant, air-droppable, mobile protected firepower (MPF) ground vehicle capability.
- CD 4 – Medium/Heavy Duty Tactical Truck Demonstrator, LW Modular Vehicle, ONR Modularity Study.
- CD 5 – Develop unmanned vehicles capable of maneuvering with mounted and dismounted units.
- CD 6 – Achieve ground system integrated 360° situational awareness capability at extended distances from the platform, in order to enhance Soldier safety and ease the Soldier's burden
- CD 7 – Develop robotic technologies and capabilities that expand the operational capabilities of a Brigade Combat Team (air/ground teaming)
- CD 8 – Demonstrate ground vehicle architectures and technologies designed to allow the vehicle to function "as a member of the squad."
- CD 9 – Demonstrate robust ground vehicle architectures and technologies designed to operate offensively and defensively in "dirty", complex and antagonistic electromagnetic and cyber environments (cyber and electronic warfare)

- CD 10 – Demonstrate ground vehicle architectures and technologies designed to assist in the detection, location, identification, compilation, threat assessment, prioritization and neutralization of enemy human, mobile, terrestrial and airborne C4ISR collection assets and sensors (counter C4ISR).
- CD 11 – Demonstrate ground vehicle technologies and architectures designed to provide novel, unconventional and multi-modal mobility applicable to a broad spectrum of environments.
- CD 12 – Develop robotic technologies and capabilities that enable unit resupply and sustainment operations using optionally-manned and unmanned vehicles.

TARDEC Top 3 S&T Initiatives

Combat Vehicle Prototype (CVP) - Focusing technology efforts to position the Army for the next generation combat vehicle

- Provide leap ahead technology enabled capability to the combat vehicle fleet
- Reduce Risk to future combat vehicle program of record
- Inform future combat vehicle requirements
- Sustain advanced concept design teams in the defense industrial base

Autonomy-Enabled Systems - Focusing on:

- Manned-unmanned teaming for mounted and dismounted units
- Coordinated unmanned air and unmanned ground systems operations
- Improved 360 degree vision
- Development of optionally-manned and unmanned vehicles
- Applied robotics for installation and base operations

Modular Active Protection Systems (MAPS) - Focusing on the challenges of transitioning APS with the development of the HW/SW that is designed for safety and enables integration of tailored APS subsystem suites.

- Establishes a common starting point for all APS systems, a common basis for all vehicles
- Enables rapid innovation ability; will enable the Army to adapt in an uncertain future where the enemy and environment is unknown and unknowable
- Creates “Best of Breed” component flexibility, growth capability and competition
- Provides integration of protection from advanced threats at an optimized weight

Ground System Survivability

Jeff Koshko AD GSS

Value Stream One Objectives:

- Advanced Ballistic Protection in support of Combat Vehicle Prototyping (CVP)
- Shaping future Active Protection System (APS) Requirements
- Develop hull structure & weight informed design process for CVP
- Fire Protection
- Advanced Laser Protection for the next Ground Combat Vehicle

- Advanced Blast Mitigation Protection
- C-IED/Mine Payload Development

Value Stream Two Objectives:

- Demonstrating Modular APS on current ground systems
- Align & advance lightweight material S&T projects to needs of Programs of Record (MRAP, JLTV, Bradley, ABRAMS, Stryker, TV)
- Advanced Laser protection for Bradley
- Mechanical Countermine; Fire & Laser Protection;
- Foundational Blast Mitigation Protection for PdM LTV and HTV, M-ATV and PM LAV
- Foundational Ballistic Protection
- Enhance effectiveness of POR Roller against AT threats

Value Stream Three Objectives:

- Develop and grow expertise & capabilities in lightweight material design, analysis and testing for future
- Evolving data, process and tools to enable APS development
- Engineering services/support for fire protection
- Engineering services/support for Ballistic Protection
- Product Manager, Assured Mobility Systems (PdM AMS)Support to legacy Roller Programs

Current GSS Projects

1. **CVP - SURVIVE Integrated Demonstrator-** Design, develop and demonstrate state-of-the-art ballistic/active protection, blast mitigation, and advanced material technologies to influence the next-generation of Infantry Fighting Vehicles.
    a. **Products:**
        i. Ballistic Protection (Armor) - B-Kit and C Kit systems to defeat kinetic and chemical energy threats.
        ii. Hull, Frame, Body, Cab (Blast) - Advanced active and passive soldier protection technologies; defined blast load subsystem interactions.
        iii. Hull, Frame, Body, Cab (Structure) – Advanced, affordable vehicle structure.
        iv. APS Concept - Modular APS Framework and Architecture – “Best of Breed” Soft-Kill & Hard-Kill APS
        v. Modeling - High fidelity system-level vehicle models capable of modeling events with complex materials
    b. **Payoffs**
        i. Improved overall vehicle survivability with net weight decrease
        ii. >4X Underbelly Blast Performance
        iii. 10-15% Survivability Weight Reduction
        iv. 10% Overall Reduction in structure weight
        v. Active Protection System (APS) concept for stressing chemical energy threats

vi. Modular, lightweight armors that defeat battlefield threats while maintaining system level performance metrics
vii. Increased capability to survive larger (higher Net Explosive Weight) blast events w/ reduced Soldier incapacitations for no additional weight
viii. Improved Army vehicle development, integration, and analytical tools
ix. Modular, lightweight armors that defeat future battlefield threats while maintaining system level performance metrics

2. **CVP Armor Program–**Purpose is to leverage investments in combat vehicle armor, develop, mature and integrate lightweight base, add-on, and electrified armors. Advance and test Pulse Power system to enable electrified armors. Mature advanced armors into solutions while maintaining performance, decreasing weight and maintaining cost.
   a. **Products:**
      i. Lightweight B-Kit and C-Kit Armor packages
      ii. Mature electrified armor concepts into robust armor systems
      iii. Compact, high energy density pulse power supply for Electrified Armors
   b. **Payoffs:**
      i. Lightweight armors that will defeat current and future battlefield threats while maintaining system level performance metrics
      ii. Improved mobility, fuel economy, and decreased logistics due to lighter weight armor systems
      iii. Enhanced system level performance that may be tailored to complement other advanced survivability technologies (active blast, APS, etc.) and will function as stand-alone protection

3. **Foundational Armor Program –** Purpose is to leverage current armor mechanisms, with new materials and design approaches to achieve a 10% weight reduction in integrated vehicle armor protection. Also, to develop, integrate, and transition (TRL 6+) B-kit and C-kit armor systems to combat vehicle PMs and OEMs

   a. **Challenges and Risks**
      i. Traditional armor material combinations are too heavy, or costly, to meet system weight or cost goals
      ii. Advanced materials and integration schemes have not previously been subjected to MIL-810 testing
      iii. The combined environmental/vibration effects to the advanced materials and integration schemes are unknown
      iv. Currently working threat allocation between Active Protection and armor to ensure all threats and requirements are being addressed
      v. Hybridized armor scheme (B-kit and C-kit in a single package) may require a change in requirements for times when the system is removed

   b. **Payoff:** 10% reduction in integrated vehicle armor wt. (~1.5 tons over baseline)

4. **Advanced Armor Program –** The purpose is to promote development of armor defeat mechanisms and achieve a 15%+ reduction (~2.25 tons savings over baseline) in integrated vehicle armor weight, and to drive the development of non-traditional armor systems taking advantage of multiple defeat mechanisms.

    a. **Challenges and Risks**
        i. Advanced material combinations that are too heavy, or costly, to meet system weight or cost goals.
        ii. High voltage safety issues in use/maintenance of Electromagnetic (EM) Armor systems, posing potential hazards to the Warfighter.
        iii. Integrating armor and sensors into a single system has never been matured beyond a laboratory level.

NOTE: At the end of FY15, the CVP Armor Project will down-select to a single armor development path

Existing Contract Actions FY15:

- Multi-year contract for development and fabrication of pilot scale automated armor manufacturing line - $2.5M
- Pulse power supply component integration - $1.9M
- Ballistic Modeling & Simulation (M&S) code development - $650k
- Materials for prototype armor fabrication with various vendors - $2.4M
- Test and Evaluation Services $625k

Opportunities (FY16-19 New/Competitive, and DME OTA Contracts)

- Armor Material Purchases - $9.6M
- Electronic Component Fabrication and Design - $14.7M
- Modeling and Simulation Development - $3.0M
- Test and Evaluation Services - $2.4M
- Manpower Support - $800k

Gaps and New Opportunities -Advanced Materials Development

- Improved ballistic performance against both direct fire and fragmentation threats
- Increased damage tolerance
- Development of high strain rate material properties
- Improved impact and damage resistance
- Improved Flame, Smoke, and Toxicity performance

Gaps and New Opportunities - Improved Manufacturing Processes

- Significant cost reductions and improved manufacturing methods (e.g. polishing, grinding) of advanced ceramics
- Methods that address seams, corners and other vulnerable areas

Gaps and New Opportunities - Opaque and Transparent Armor

- Significant cost reductions without performance loss
- Decrease in haze; improved luminous transmission
- Improved interlayer material for wide temperature range

Gaps and New Opportunities - Improved Integration Techniques

- Robust integration methods that provide weight reduction, reduce installation time (ease install and removal)
- Incorporation of sensors and mechanisms (actuators, etc.) that allow the armor to adapt and react to its environment

5. **Blast Mitigation/Protection –** Purpose is to mature blast mitigation technologies through product development, integration, and validation. To fully understand blast load paths through vehicle platforms by decomposing the load paths through both technologies and technology interfaces.

   a. **Products:**
      i. Advanced active and passive soldier protection technologies
      ii. Defined blast load technology interactions
      iii. Standards and guidelines for all blast mitigating technologies
      iv. High fidelity system-level vehicle models capable of modeling crash, rollover and blast events with complex materials such as composites

   b. **Payoffs:**
      i. Minimized weight, enhanced soldier protection for ground vehicle systems through advanced technologies and integration strategies
      ii. Improved Army analytical tools
      iii. Documented Standard and Technology Design and Integration Guideline supporting the improvement of survivability, operability, and accommodation of future military vehicles

6. **Exterior Blast Mitigation Technology**

   a. **Purpose**
      i. Prevent catastrophic deformations in the vehicle hull that generate high floor loads resulting in occupant injuries
      ii. Reduce peak flooring accelerations
      iii. Determine evaluation techniques
      iv. Improve GV blast survivability while reducing cost and weight
      v. Control the transfer of momentum to the vehicle cab under various threat loads
      vi. Determine system timeline for detecting/reacting to threat loads
      vii. Provide an electric signal to various blast mitigation measures(technologies) in an effort to reduce injuries to the Soldier
      viii. Reduce lower extremity injuries by controlling loads between vehicle cab and floor

Foundational Technologies	Advanced Technologies
1. Low Deformation Hull	1. Active Floors
2. Monolithic Hull	2. Active Blast Mitigation
3. Foundational Floors	

7. Interior Blast Mitigation Technologies

a. Purpose

i. Develop integrated interior system (seats, restraints, airbags, cargo retention and protective trim) to maximize Warfighter survivability.
ii. Design the interior space from the occupant outward for a system capable of minimizing injuries against underbody threats.
iii. Leverage knowledge gained from previous programs, industry, and emerging technologies
iv. Inform the future requirements process through data accumulated during the maturation of these IBMT projects.
v. Develop data to improve Modeling and Simulation of the effects of blast on interior occupants

Foundational Technologies	Advanced Technologies
1. Foundational Seat	1. Sensing/Active Seat
2. Foundational Restraints	2. Multi-Axis Seat
3. Cargo Retention	3. Active Restraints and Airbags

Program Updates for FY15 - Projects completed
Exteriors – Decoupled Integration of Active Blast Mitigation System (ABMS) - Designed, fabricated, and evaluated a scaled concept of an ABMS decoupled integration which showed a significant reduction in structural accelerations.
Exteriors – Energy Attenuating Floor Concept Performance Band -Executed blast evaluations on Energy Attenuating Floor Concepts to create a flooring concept performance band to be utilized when evaluating future flooring systems.
CAMEL Evaluations & CDR - Project is an occupant centered tactical platform that started from a clean sheet. Components were included because they enhanced occupant accommodation and reduced risk of injury compared to that of the baseline vehicle while maintaining other vehicle performance requirements. Project has just passed CDR and still has upcoming asset testing to conduct. Interiors - Seated Soldier Study - Scanned 310 Soldiers, gear, and seats. These were conducted in multiple standing and seating postures to assess space claim of seated Soldiers. This also led to the development of accommodations models for Soldiers that did not exist previously.
Interiors - Drop Tower Seat Evaluations - Presented an analysis of a limited number of military seats at GVSETS to showcase the spectrum of military seat performance.
Occupant Centric Platform (OCP) – Heavy/Light Platform to PDR - Project included removal and/or reconfiguration of components to enhance occupant accommodation and reduce risk of injury compared to that of the baseline vehicle. Project concluded at PDR.
Program Updates for FY15 - Projects Starting/Ongoing
Interiors – Multi-axis Sensing Seat Concept - Project is to enhance energy absorbing seats to identify occupant size (weight), auto-adjust for the following features: energy absorbing mechanisms, head restraint, lumbar support, and restraint systems. The project will support seat selection for the vehicle to better accommodate/protect occupants
Exteriors – Active Blast Mitigation System (ABMS) - Investigating Active Blast Mitigation System (ABMS) integration concepts to control momentum transfer to a vehicle cab and to learn how to integrate to a combat vehicle.
Exteriors – Adaptive Floors - Developing flooring systems that protect a full range of occupants (5th, 50th, & 95th) over a wide range of threats while accommodating a more space constrained vehicle environment.

Acquisition Strategy – Existing Contract Actions (Awarded)

- Exterior – Underbody and Floor Concept Testing, NATC, $1.2M (FY14)
- Exterior – Dynamic Deflection Instrumentation System, SWRI, $150K (FY14)
- Interior – Foundational Seat Development, SURVICE, $515K (FY14)

Acquisition Strategy–Existing Contract Actions (Awaiting Award)

- Exterior – Reconfigurable Test Asset & Testing, contracting, (FY15)
- Exterior – Foundational Underbody Development, OTA, (FY15)
- Exterior – Foundational Floor Development, OTA, (FY15)
- Exterior Adaptive Floor Development, OTA, (FY15)
- Interior – Advanced Seat Development, OTA, (FY15)
- Exterior – Active Blast Mitigation System, OTA, (FY15)

New Opportunities (FY16-19)

- CVP - Blast Buck Fabrication, $25.85M (OTA, or new competitive Contracts)
- CRADAs and TSA mechanisms will also be used to support this effort.

Gaps and Opportunities

- Blast/Rollover/Crash Mitigation Technologies - Low profile underbody protection solutions for blast events; flooring solutions to mitigate lower extremity injuries and prevent binding of energy absorbing seat mechanism; and Development of energy absorption and robust steering columns to protect the occupant and accommodate an airbag.
- Fire, Smoke, and Toxicity (FST) Technology Testing - Need for fire resistant energy attenuating materials for improved vehicle interior head impact injury protection.
- Impact Abatement for Secondary Effects of Blast - Mechanism and technology development to control or protect against extremity injuries caused by flail of the occupant(s); Development of easy to use solutions for containing gear/cargo/ammo, so they do not become flying projectiles during a blast event and cause harm to the occupants.
- Blast Retrofit Solutions - Development and characterization of blast mats, floor tubs, energy absorbing resettable seats that accommodate 90% of population, hands-free restraint systems, energy absorbing flame retardant material to line vehicle interior to protect head and extremity injuries, decoupled underbody and flooring solutions.
- Improved Manufacturing Processes for Hulls - Cost effective means to produce high performing hulls to protect against blast threats.
- Lightweight Materials for Hulls - Development of lightweight metallic and composite materials or alternative innovative lightweight concepts that are cost effective.
- Central Point Triggering - Development of universal triggering system to trigger all active systems on the vehicle.
- Prototype Fabrication, Repair, Maintenance, Test and Evaluation.

8. **TARDEC Blast Mitigation Program (BMP) and National Defense Industrial Association – Michigan Chapter (NDIA-MI) Cooperative Research and Development Agreement (CRADA)**

    a. Forum for industry to collaborate in a non-competitive environment and exchange information with TARDEC
    b. Objective: Exchange information related to the Blast Mitigation Program Occupant Centric Survivability standards and guidelines development
    c. Topics include: Occupant-Centric Design: Boundary Manikins and Accommodation Models, Occupant-Centric Terms and Philosophy, MIL-STD-XXXX/Guidebook Format/Outline, Modeling and Simulation, Test Procedures, and others

9. **Advanced Countermine Program**
    a. Purpose: Army Elements lack the ability to conduct mounted and dismounted movement and maneuver on and off road, in all terrain conditions where the threat of Anti-Tank (AT) mine and IED engagements exist. This effort will capitalize on small incrementally funded activities to achieve technical capabilities that can ultimately be packaged into a single system adaptable to truck, tracked and robotic platforms.

Supportive Activities:

- Developed the current technology for Program of Record VOIED/CWIED defeat equipment.
- Dismounted C-IED Payload development intended to meet KPP4 for the SMET/DEMS Requirements
- Danish FMS Case provides the opportunity to operate current truck mounted roller systems on a tracked vehicle (M113) for data acquisition.

b. Products:

i. Development of a Test Fixture for Roller Wheel, Suspension and Blade System test and evaluation. FY 15-16
ii. Investigate Blade Technology to eliminate underbody threat from AT Mines and VOIED IED triggers. (FY 16)
iii. Transition Test Fixture lessons learned into existing roller architecture FY 17
iv. Concept Development for Tracked vehicle Mechanical AT Mine/IED Defeat systems. FY 18-19

c. Payoffs:

i. Tracked vehicle high mobility self-protection equipment.
ii. Dismounted Robotic platform C-IED/CTR Mine payload

10. Advanced Countermine / IED Payloads

a. Goals /Purpose

i. Advance Mechanical Countermine/IED test and evaluation capability
ii. Develop next generation Blade technology to eliminate underbody threat from AT Mines and VOIED triggers
iii. Shaping the dismounted soldier Squad Multi-purpose Equipment Transport (SMET) / Dismounted Engineer Mobility System (DEMS) CDD requirements
iv. Explosive hazard threat mitigation for under body blasts
v. Development for tracked vehicle Mechanical AT Mine/IED Defeat systems

b. Challenges and Risks

i. High speed movement on paved surface roadways may cause roller instability or bank flutter.
ii. Operating dismounted C-IED payload in vegetation; grass build up can significantly impact the blades ability to dig.
iii. Test fixture data shows promising results that potentially do not translate into actual subsystem integration.

Note: Mechanical Countermine Team successfully obtained funding from the Joint IED Defeat Organization (JEIDDO) for Dismounted C-IED Payload development

EXISTING CONTRACT ACTIONS FY15:

- Utilize Multi-year contract with Michigan Tech for development and evaluation of mechanical countermine technologies. 350K TARDEC Core Funding
- Combine customer funds with TARDEC dollars to incrementally develop sub component systems for dismounted, tactical and combat vehicles. - $1.48M

OPPORTUNITIES (FY16-19 NEW COMPETITIVE and DME OTA CONTRACTS)

- MCM Team will continue to leverage core funding to pursue additional customer dollars and work with industry partners to meet emerging requirements. $700K TARDEC Core.
- Open for CRADA development

Gaps and New Opportunities

Dismounted Maneuver

- Dismounted Soldiers lack breach lane proofing capability
- Dismounted Soldiers lack route clearance capability on larger robotic platforms

Route Clearance

- PdM Assured Mobility Systems continue to field/support theatre initiatives involving Mechanical Countermine Equipment
- Truck mounted roller equipment lacks the ability to defeat certain “high density” mine threats

Combat Vehicle Protection

- Combat maneuver forces lack high mobility, AT Defeat, self-protection

11. Fire Protection Development, Integration & Evaluation

a. Fire Protection Technology Integration Laboratory (FP TIL)

Establishing integration and test capabilities to evaluate performance of extinguishing component sand agents, including:

i. High-speed concentration analysis
ii. Ballistic fireball simulator
iii. Reconfigurable test enclosure

b. Vehicular Fire Suppression Model

i. Further develop fire suppression model to predict AFES performance:
ii. Flame propagation
iii. Agent dispersion
iv. Fire extinguishment
v. AFES effectiveness
vi. Fire model/ballistic models to predict probability and severity of combat-initiated vehicle fires.

c. Research & Development

Provide a wider choice of technology options to maximize fire survivability and address vulnerabilities Areas of research include:

i. Self-sealing and fire extinguishing fuel tanks
ii. Material flammability, smoke, and toxicity standards

Potential Efforts:

i. External fire protection systems
ii. Environmentally friendly agents
iii. Li-ion battery vulnerability reduction

Acquisition / Engagement Strategy - CRADAs, SIBRs, TSA

Ground System Survivability Lightweight Combat Vehicle S&T Campaign

Dr. Erik Polsen
Material Science Tech Lead

GOAL: An Expeditionary, Scalable & Ready Modern Army

1. Focus S&T investment to maximize the potential of emerging game-changing land power technologies to counter emerging threats.
2. Rapidly deploy, fight, and win whenever and wherever our national interests are threatened.
3. Train and equip the Total Army to rapidly deploy, fight, sustain itself, and win against complex state and non-state threats in austere environments and rugged terrain (The expeditionary mindset).

Value Stream One Objectives:

- LOE2 Develop hull structure & weight informed design process for the Combat Vehicle Prototyping (CVP) program

Value Stream Two Objectives:

- Align and advance LW materials S&T projects to needs of Programs of Record (MRAP, JLTV, GCV, Bradley, ABRAMS, Stryker, Tactical Vehicles…)

Value Stream Three Objectives:

- LOE1 Develop and grow expertise & capabilities in lightweight material design, analysis and testing for future (mobility, blast, structures, power-train & optimization)

Challenge – Vehicle weights have risen in response to new and increasing threats and increasing vehicle protection areas.

1. **Lightweight Combat Vehicle S&T Campaign (LCVSTC)-**In 2013, RDECOM tasked to identify the state-of-the-possible for Abrams & Bradley capabilities**.** To consider 35 & 30 ton packages for 2030+ through material science and technologies to develop an S&T portfolio/plan.

    a. **Data Collection**
        i. Assembled a working group composed of personnel from TRADOC and RDECOM
        ii. Reviewed 131 Army programs that provide weight reduction capabilities
        iii. Considered both direct and secondary weight savings
        iv. Limited technology to TRL 4+ between 2021 and 2030
        v. Developed and hosted a workshop leveraging OGA, industry & academia to fill gaps (July 2014)

    b. **Analysis:**
        i. Worked with TARDEC's Advanced Concepts & Analytics Group to generate weight tapes. Breakdowns were applied to the lowest level available from baseline programs
        ii. Leveraged and defined material and technology weights used in the Next Generation Close Combat Vehicle (NGCCV) Study

    c. **LCVSTC Organizational Recommendations:**
        i. Utilize an existing Army-wide governing body with a Board of Directors (BoD) to ensure purposeful focus on light-weighting Army combat vehicles (CV BoD)
            1. Provide governance and assume lead role in ensuring alignment Army wide
            2. Establish a Cross Organizational Team (COT) to execute the recommendations from the Campaign
            3. Ensure high level engagement in NNMI hubs
        ii. The BoD and COT will publish light-weighting metrics/requirements for research, development and acquisition programs.

iii. Incentivize Program Management Offices (PMOs) to encourage lightweight technology insertion on future and currently-fielded platforms.

d. Design Recommendations:

i. Continue investment in programs like Materials in Extreme Dynamic Environments (MEDE) for creating materials on demand and by providing input to Integrated Computational Materials Engineering (ICME) ballistic material programs.
ii. Immediate and continuing investment in building an Army core competency in design optimization for weight reduction using commercially-available design tools.
iii. Provide and promote the opportunity for using prototype demonstration vehicles and experimental laboratory-demonstrations to drive technology advancement.
iv. Utilize current real-time tools to engage the User on fielding of new technologies and designs.

e. Material Recommendations: (Predominant hurdles in transitioning lightweight materials to combat vehicles do not lie in the materials science research; but rather in the M&S and manufacturing technologies required.)

i. Maintain current research investments, leverage and influence national ICME and Materials Genome Initiative (MGI) programs.
ii. Leverage materials being developed within the automotive industry and Department of Energy Vehicle Technology Office (DoE VTO).
iii. Develop and continue multiple material technology investments to reduce gun barrel weights and recoil loads, while maintaining or improving energy-on-target metrics.
iv. Continue to invest in efforts to consolidate vehicle architecture.
v. Recommendations for specific material investments include continued long term research in advanced metal alloys, ceramics, composites, nano-materials, self-healing /diagnosing materials, multi-functional materials, advanced energetic materials and environmentally acceptable materials.

f. Manufacturing Recommendations:

i. Increase investment in joining and advanced manufacturing technologies for emerging materials through ManTech and other manufacturing avenues where external (industry, OGA, academia) investments fall short.
ii. The Army must become an active voice in the NNMI hubs and provide the requirements of the Army to the consortia as derived from ICME and design optimization programs.

2. Lightweight Structures

a. Purpose:

i. Demonstrate best practices in cost-conscious, multi-material design for hull/structures to reduce ground vehicle weight
ii. Utilize and evaluate design tools, advanced materials, manufacturing, and assembly technologies to develop a lightweight hull/structure and enhance core competencies.
iii. Support a demonstrator weight savings of ~20-30% over GCV baseline
iv. Evaluate the current technical capability of the material supply chain

b. Products:

i. Lighter subsystem demonstration hull/structure(includes virtual M&S turret and upper/lower hull)
ii. Cost-conscious hull/structure
iii. Tools to support light weighting design and optimization
iv. Design and fabrication of select components for weight reduction

c. Payoff:

i. Lighter weight vehicles
ii. Improved transportability
iii. Increased fuel economy
iv. Increased reliability
v. Increased SWaP-c

Program Updates for 2015
The Request for Information (RFI) on materials, manufacturing technologies, M&S analysis methods/tools, and design options for combat vehicle structures was released and responses were reviewed.
Published LCVSTC Final Report w/Investment Strategy
CV BoD agreed to serve as the governing body
We are leading the operational and cost study of legacy CV systems to begin defining weight trade metrics vehicle. Project concluded at PDR.
Aligned CVP S&T efforts with LCVSTC recommendations
MIL-STD-3040 Welding of Armor Grade Steel (Out for coordination)

Acquisition Strategy - Existing Contract Actions FY15:

- Upper and Lower Hull concepts development OTA acquisition ($3.6M)
- Upper Hull internal TARDEC concept development effort ($712K)
- Internal TARDEC Virtual M&S Turret concept development effort ($102K)
- Holistic Advanced Light weighting Opportunities (HALO) OTA acquisition ($421K - $521K)
    - Internal Light weighting Process Development
    - Identify Potential Lightweight Technology Applications on the PdM Bradley Platform
    - Design and Analysis of at least 1 Lightweight Technology Application
- Computer Aided Design for Fabrication of Advanced Materials (CADFAM) competitive acquisition for design and optimization of new or re-engineered components for fabrication using advanced materials ($335K)

- Adhesives OTA acquisition for development of very high strain rate loading performance of adhesively bonded joints ($266K)

Opportunities (FY15-19 New Competitive and DME OTA Contracts):

- Upper Hull "Challenge" concept development acquisition ($700K)
- Design optimization model & process refinement ($200K)
- Aluminum alloy purchases for welding study ($500K)
- Upper and Lower Hull developmental testing services ($2.3M)
- HALO design and analysis of at least 1 lightweight technology application for the CVP platform ($700K)
- Material purchases ($8-10M)
- Operational & cost analysis model modules for detailed weight metric generation
- Component and/or structure optimization for PM FFV

Gaps and New Opportunities:

- Lightweight advanced materials (e.g., metallic alloys, nano-composites, resin composites, etc.) that meet very high strain rate loading performance
- Lightweight joining techniques that meet very high strain rate loading performance such as blast and ballistic impact
    - Digital imaging correlation for ballistic shock testing of ballistic welds to measure the total response of the material and allow a better understanding and evaluation of weld failure.
    - Characterizing and developing critical design parameters for several classes of adhesive materials
    - Dissimilar material joining techniques, including: Material characterization for dissimilar material combinations that are achievable through FSW is needed for proper M&S activity.
- Novel structural designs or tools that optimize designs that meet very high strain rate loading performance
- Holistic vehicle light-weighting techniques
- Nano-scale devices for Non-Destructive Evaluation (NDE) without compromising material performance
- Multi-scale computational algorithm that can model 3-D weave/braid/stitch composites.
- R&D in tools and process control for localized material property enhancement through micro structural refinement via FSP

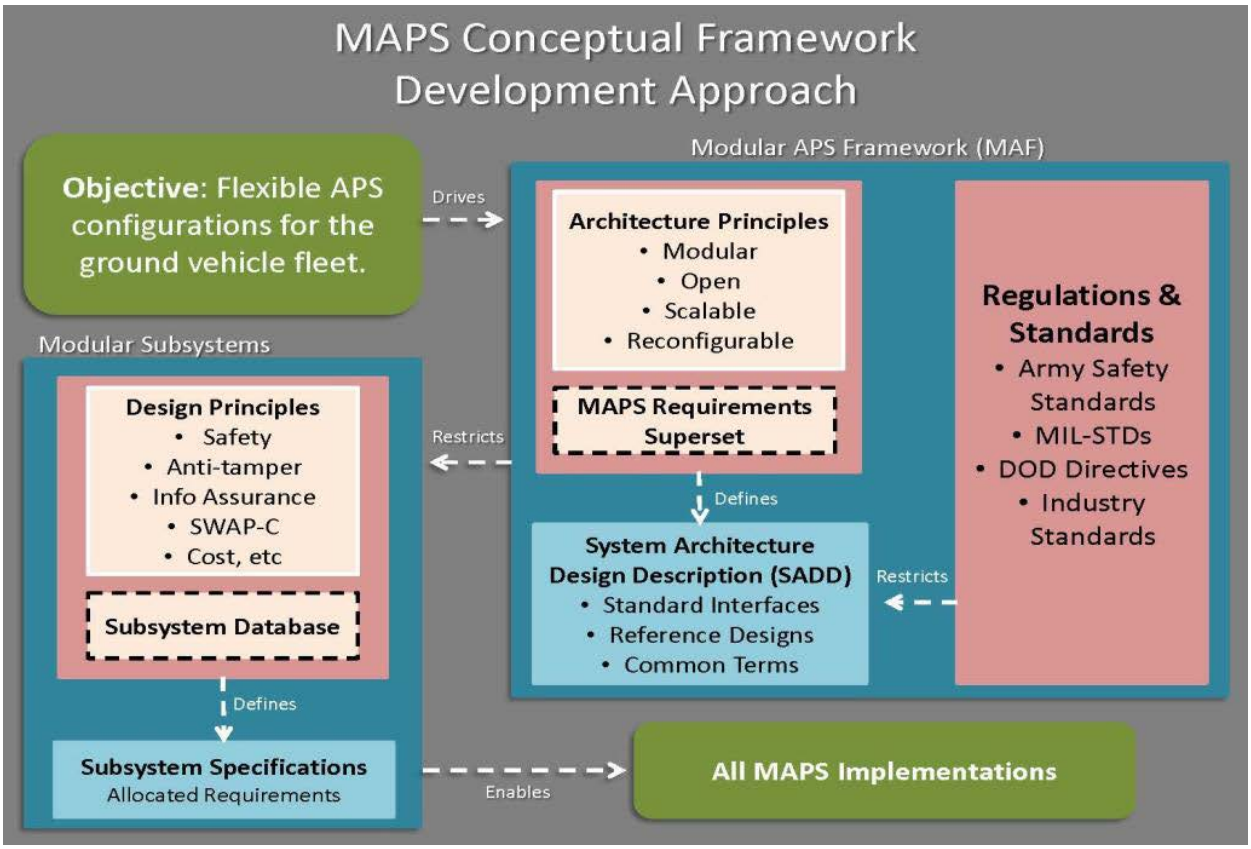
Ground System Survivability
Modular Active Protection Systems

Jeff Koshko
Associate Director GSS

1. **Modular Active Protection Systems (MAPS)**
   a. **Purpose:** Focus on the challenges of transitioning Active Protection Systems (APS) through the development of HW/SW that enables integration of tailored APS subsystem suites, with demonstrated Soft-kill (SK) and Hard-kill (HK) APS that are compliant with a modular approach to defeat Rocket Propelled Grenades, Recoilless Rifles and Anti-Tank Guided Missiles.
   b. **Products:**
      i. Soft-Kill and Hard-Kill Modular APS Demonstrators
      ii. Modular APS Framework (MAF) comprised of APS integration standards (Electrical, Physical, Data Interfaces)
      iii. Modular APS Controller (MAC) that is Configurable for Army Vehicle Fleet and Compliant with Army Safety Standards
      iv. APS Modeling & Simulation and System Integration Lab
         1. End-to-End analysis for transition risk reduction
         2. Hardware-in-the-Loop System Integration Lab
   b. **Payoff:**
      i. Establishes a common starting point, for all APS systems, for all vehicles, to facilitate transition across the fleet
      ii. Enables rapid innovation and the ability to adapt in an uncertain future where the enemy and environment is unknown and unknowable
      iii. Creates “Best of Breed” component flexibility, growth capability and competition
      iv. Provides integration of protection from advanced threats at an optimized weight

2. **MAPS Conceptual Framework (MAF) -**A living document that captures the ideals of the MAF and central medium for dialogue about modular concepts
   a. An architecture that defines common terminology, systems, components, and interfaces
   b. A phased set of standard specifications covering the capabilities needed to integrate MAPS mission equipment /configuration items(CIs), platform applications and interfaces, , including a set of reference designs
   c. Open standard physical and logical interfaces among system and APS components with:
   d. A set of shared communication services
   e. Common and approved hardware and software information assurance (IA) components to enable systems integrators to build security designs that protect and control access to information in compliance with the Army IA regulations

f. Joint Service Weapon Safety Review Board reviewed safety approaches (although each Hardware, Software and Firmware configuration will be approved and certified)



Acquisition Strategy

Existing Contract Actions and Opportunities

- Government-Industry standards body to develop the Modular APS Framework standard specifications(2QFY15: Utilizing OTA Task Request)
- FY15/16: Soft-Kill Demonstration - Update from CERDEC for Cueing Sensors and TARDEC for Soft Kill CM(4QFY15: Utilizing OTA RPPs)
- Subsystem IPTs release competitive RFPs (Sensor and Countermeasure) for Hard-Kill demonstration of MAF/MAC
- Tracking Sensors, and DOTC OTA for RPP from ARDEC for Hard Kill Countermeasures (FY16-19 Utilizing OTA)

Gaps and New Opportunities - The following are opportunities for Industry Engagement currently executing under the Other Transaction Agreement (OTA) 2015 Annual Cycle:

- **Task Request – Government-Industry Standards Body** to develop the Modular APS Framework (MAF) standard specifications. (Source: Tank Automotive Research, Development and Engineering Center (TARDEC))Objectives: Leveraging industry partners' experience to help define the MAF and requirements

a. A Government-Industry standards body will prototype an industry based Modular APS Framework (MAF) open architecture. This body should follow an "adopt-adapt-author" methodology in the effort to move towards establishing a set of common open architectures for use within the vehicle and mission system communities. These prototype architectures will be independent of specific hardware, software or firmware solutions.

b. The MAF standard will be open to support multi-vendor implementation. It is the intent for this standard to be used in future acquisition of active protection system components. Implementation of MAF allows platform systems to share and customize APS suites and to accept future technologies without the need for significant re-design

- OTA Project Opportunities: MAPS Platform Studies and Prototyping, MAPS Electronic Warfare Soft-Kill, Maps Controller Hardware, Maps Controller Software, MAPS Cueing Sensor, MAPS A-Kit Prototyping, MAPS proof of concept Dazzler (eye safe), MAPS Virtual Demonstrators, MAPS compatible directional obscurants & smoke, Data Logger Catcher and Decelerator Capability

FY19 and Beyond:

- Government will maintain configuration control of MAF and MAC
- MAC TDP available to vehicle PMs as a possible foundation to an Active Protection System
- TARDEC Hit Avoidance Lab established to provide assessments of vehicle system integration of MAPS configurations through Verification and Validation(V&V) of Sensor and Countermeasure subsystems

Other Gaps and Opportunities

- Modular APS Framework – Safety, Information Assurance, Centralized vs Distributed, Anti-tamper,
  - Sensors
    i. Passive Technology - Mid-wave IR sensor array development, uncooled PbSe Focal Plane Array (FPA) and Notch exploitation development; Wide angle optical lens development (decrease number of sensors to meet coverage requirement)
    ii. Active Technology -Active Electronically Scanned Array (AESA) cost reduction development; APS concept development to leverage strengths of staring radar technology
    iii. Sensor Fusion -Leverage the “goodness” from multiple technologies to meet APS mission requirements
- Countermeasures
    i. Maturation, miniaturization, effectiveness
        1. Improve probability of defeat for expanded angles and elevations
        2. Reduce and understand “crush-up” phenomenon
        3. Reduce cost (complexity)
        4. Operational Issues (environmental)
    ii. Other Opportunities for Advancement - Develop technologies with minimum collateral damage/low fratricide/focused defeat

Ground Vehicle Power & Mobility

Alfred Grein
Associate Director, GVPM

Value Stream One Objectives: Advanced Combat Engine (ACE) Multi-Cylinder Engine (MCE) provided for the Combat Vehicle Prototyping (CVP) program
Advanced Combat Transmission (ACT), Advanced Powertrain Demonstrator (APD), Advanced Thermal Management System (ATMS), Integrated Starter Generator (ISG), Advanced Li-Ion Modular Batteries (Gen2 6T), Advanced Auxiliary Power Unit (AAPU), External Suspension Unit (ESU), High Capacity Lightweight Track.

Value Stream Two Objectives: Modernization/ECP technology enhancements provided for current Programs of Record (JLTV, Bradley, ABRAMS, Stryker, Tactical Vehicles…)

Value Stream Three Objectives: Component, Sub-system, and System Level Development, Testing, and Analysis conducted in GVPM Propulsion Cells and GSPEL Laboratories.

1. **Advanced Combat Engine (ACE) Multi-Cylinder Engine (MCE)**
   Purpose: Design and develop novel modular, scalable and compact Combat Engines (750 – 1500 hp) to offset increasing combat vehicle weights (armor), increased electrical generation needs (onboard and exportable power), improved fuel economy (cost & range), enhanced mobility (survivability), and reduce cooling system burden (size, heat rejection) in a smaller package (reduce under armor volumes).
   a. **Product(s):**
      i. High Power Density Low Heat Rejection Combat Engines achieving TRL 6 in FY19
      ii. Engine Modeling and Simulation Data
      iii. Engine Performance and Durability Data
      iv. Controls Architecture & Algorithm and Design Specifications
      v. Unlimited & Government Purpose Rights for MCE
   b. **Payoff:**
      i. This engine will provide an order of magnitude in energy efficiency while increasing power density, improving vehicle mobility, reducing fuel consumption and thermal loads.
      ii. Leap-ahead technology in the engine to buy-back vehicle mobility and performance lost due to increasing weights and on-board power demands.
      iii. Advancing technology readiness level of combat specific engine
      iv. The ACE project fits in the area of Traditional R&D to transition an engine to CVP and align the development of the engine technology to schedules for CVP and future combat vehicle applications.

Program Updates for 2015
Advanced Combat Engine program was split into 2 Phases:
Phase 1: To design and build a Single-Cylinder Engine (SCE) 250 hp technology demonstrator as the building block to a family of combat engines

Phase 2: To design and build a Multi-Cylinder Engine (MCE) up to 1500 hp based on the success of the SCE project to build a family of engine concept

Acquisition Strategy-Existing Contract Actions FY15:

- OTA Awarded for 2 x Single Cylinder Engine (SCE) contractors(Achates Power and AVL) Design, build, and demonstrate a 250 hp SCE
- OTA for Multi-Cylinder Engine (MCE) Solicitation closed- March 2015, Contractor TBD

Future Opportunity FY16-19:

- OTA Award for 1 x Multi-Cylinder Engine (MCE) contractor up to $60M - Design, build, and demonstrate a leap-ahead multi-cylinder engine technology to achieve a 750 - 1500 hp advanced combat engine at TRL 6 offering high power density, high efficiency, and low heat rejection

Gaps and New Opportunities

- Combustion Research modeling efforts to optimize efficiency with military grade fuels.
- Thermal barrier coatings for improved heat rejection and durability specific to military engines
    - Develop variable intake valve timing or low compression ratio concepts to reach high brake mean effective pressure limits without exceeding load limits of the engine.
    - Combustion Development - Operate engines in lower air/fuel ratio regimes to minimize air handling systems.
    - Engine Cooling Optimization – Operate engine at highest possible temperature without compromising engine durability.
    - Turbocharger Enhancement – Develop compact multi-stage turbochargers to reduce the amount of charge air cooling required and to increase the pumping efficiency through better heat recovery
    - Increase the engine displacement rate.
        - Higher piston speeds.
        - Possible two-stroke operation.
    - Increase the engine operation pressure, higher brake mean effective pressures.
    - Material Development – High strength lightweight materials need to be incorporated into engine designs to extend engine thermal and mechanical limitations
    - High Temperature Tribology Development – High temperature capable lubricants and corresponding ring and liner material for best tribological match without compromising engine durability

2. Advanced Combat Transmission (ACT)

a. Purpose: Development of a high efficiency cross-drive transmission for a tracked vehicle, mated to an engine while offering greater fuel economy (>10-15%), improved thermal efficiency (>15%), and lower heat rejection (<20%) when compared to legacy systems. The transmission will be designed for use in future combat vehicles and demonstrated in the CVP platform.

b. Product(s):

i. Combat, Cross-Drive Transmission for tracked vehicles achieving TRL6 in FY19
ii. Transmission Modeling and Simulation Data
iii. Transmission Performance and Durability Data
iv. Controls Architecture & Algorithm and Design Specifications
v. Unlimited & Government Purpose Rights for ACT

c. **Payoff:**
i. Higher efficiency transmission will provide a 20% increase in vehicle range equating to savings in fuel usage when compared to legacy transmissions
ii. Increase in power from the engine to the sprocket to improve maneuver responsiveness/dash speed (agility and survivability/hit avoidance
iii. Advance technology readiness level of combat specific transmission
iv. The ACT project fits in the area of Traditional R&D to transition a transmission to CVP and align the development of the engine technology to schedules for CVP and future combat vehicle applications.

Program Updates for 2015
Advanced Combat Transmission (ACT) program is part of the OTA RPP3 solicitation closed on March 16, 2015.
ACT proposals have been received by the Government and are under evaluation. Contract Award is expected 4QFY15

Acquisition Strategy
Existing Contract Actions FY15:

- OTA Award for 1 contractor, planned for 4QFY15 to Design, build, and demonstrate a leap-ahead technology to achieve an advanced combat transmission (ACT) at TRL 6 offering high efficiency and greater mechanical ratio spread for tracked combat vehicles

Gaps and New Opportunities

- High efficiency longitudinal transmissions for wheeled vehicles
- Use of improved component materials and higher temperature lubricants to reduce space claim and heat burden.
- Ultra high capacity launch clutch for tactical transmissions.
- Multi-K factor torque converter design.
- Infinitely variable transmission technologies
- High gear ratio & efficient steering systems for cross-drive transmissions.

3. **Advanced Powertrain Demonstrator (APD)**
a. **Purpose:** Design, develop and test leap-ahead technologies and integrate into an automotive subsystem demonstrator to meet the demands of the next generation infantry fighting vehicle.
b. **Products:** TRL 6 Components to be integrated into subsystem
i. High Power Density Low Heat rejection Advanced Combat Engine (ACE)
ii. 160kW ISG and power electronics
iii. Advanced Combat Transmission (ACT)
iv. Advanced Thermal Management System (ATMS)
v. Advanced Modular Battery (AMB; Gen II 6T Li-Ion)

vi. Component and subsystem specifications

b. Payoff:

i. 1.5x improved installed system power density
ii. 20% less cooling demand
iii. 25% Increase subsystem fuel efficiency
iv. 10x increase of electrical power generation
v. Improve mobility of platform to meet or exceed requirements (e.g. Top Speed, Speed on Grade, Range, Acceleration)

Acquisition Strategy - Existing Contract Actions - FY15:

- OTA Solicitation March 2015, Contractor TBD

4. Advanced Thermal Management System (ATMS)

a. Purpose: Design, develop and demonstrate Advanced Cooling Components (ACC) that will be incorporated into the ATMS for cooling the powertrain and auxiliary systems on the Advanced Powertrain Demonstrator (APD). This Project seeks to advance the state of the art in military thermal technology by creating and validating designs to push the limits of cooling components. Leap-ahead technology in cooling components will also buy-back vehicle mobility and performance lost due to increasing vehicle weights and on-board electrical power demands.

b. Products:

i. Efficient Fan System with intelligent drive that adjusts cooling based on demand
ii. Compact, highly effective Heat Exchanger (HEX)
iii. Component Modeling and Simulation Data
iv. Component Performance and Durability Data.
v. Government Purpose rights for Patents, Design Specifications and full Tech Data Package.

c. Payoff:

i. Improved fuel efficiency target of 10%.
ii. Improved platform mobility, including: 8% increase in top speed, 5% increase in speed on grade, 5% increase in acceleration.
iii. Increased heat transfer.
iv. Flexibility in form factor (10% less volume).
v. Lighter weight (10%)

Acquisition Strategy - Existing Contract Actions - FY15:

- OTA Solicitation closed March 2015, Contractor TBD
- Fan Drive Durability Testing (WD#05), Fan Drive ManTech (WD#06), Intelligent Fan Drive Controls Testing (WD#07).
- Bradley Vehicle Performance and Fuel Economy Testing with Efficient PTO Optimized Efficient Fan Drive (RIF)
- Efficient Fan Geometry Testing (SBIR).

5. **Integrated Starter Generator (ISG)**
   a. **Purpose:**
      i. Address onboard electrical power needs of Army combat vehicles (Stryker/CVP).
      ii. Current vehicle alternators provide 10-20kW; inline generators under will provide 160kW of high voltage electrical power.
      iii. Buy back power margin, allow for future capability growth.
      iv. Increase efficiency (save fuel), augment mobility, and allow export power.
      v. Increase power electronics high temperature capability.
   b. **Products:**
      i. Verified 160 kW and 120 kW ISGs & controls for Combat Vehicles.
      ii. High power generator and electrified auxiliary systems demonstration to include test methods, reports and analysis of high voltage OBVP and components, with the Advanced Powertrain Demonstrator
      iii. Validated Model of OBVP components and systems (with GSEAA).
      iv. Specifications, ICDs, and evaluation of TRL.
   c. **Payoff:**
      i. 30% increase in electrical power over the CVP Baseline with minimum integration impact.
      ii. Improved Operational Energy efficiency and mobility gains.
      iii. Achieving Integration of safe high voltage OBVP (100-160kW) capability on Stryker and CVP Advanced Powertrain Demonstrator.
      iv. Validated strategy for Intelligent Engine Start/Stop – Electrified systems available without engine running.
      v. Core technology to enable future grid connectivity.

Program Updates for 2015
Completed Initial Modeling of Stryker powertrain combining mechanical, electrical and cooling models. Baseline APOP Stryker and SIL Testing ongoing.
Planned Integration and Testing of APOP ISG components into Baseline Stryker and SIL to commence in FY15 with completion in early FY16.
Initial documentation of ISG System Requirements completed.

Acquisition Strategy - Existing Contract Actions

- **FY13:** APOP Stryker SIL Integration; ALION/GDLS
- **FY13 – FY15:** APOP Stryker Vehicle System Integration, Development Support & Testing; GDLS
- **FY15:** Competitive contract for 85C capable Inverter for risk mitigation of SiC CVP Inverter, Closed March 2015 Contractor / Funding TBD

Future Opportunities FY16 – FY19

- FY16 Generator modifications for 105C operation (L3COM / Funding TBD)
- FY16 Generator Controller Development contract (Open / Funding TBD)
- FY17 Surrogate SIL Development (funding TBD)
  - Generator modification based on results of component test (L3COM)
  - Generator Controller modifications based on results from environmental testing

- FY18 Generator and Generator Controller integration into Advanced Powertrain Demonstrator (Funding TBD)
- FY19 Test Support for Advanced Powertrain Demonstration (Funding TBD)

Gaps and New Opportunities

- Silicon inverter device coolant inlet temperature to 105C
- Thermodynamic aids to achieve 105C with Silicon devices
- Auxiliary Component Electrification – Fan drives, pumps, etc.
- Future Advanced Mobility Capabilities Development – Start/Stop, Burst Power, Silent Mobility

6. Advanced Li-Ion Modular Batteries (Gen2 6T)

a. Purpose: Apply recent advances in Lithium-ion based anode, cathode, electrolyte and separator battery materials to electrode, cell, and pack designs to:

i. Double the energy density for the Gen 1 6T Lithium-Ion Battery from 80Whr/kg to >160Whr/kg AND
ii. Increase power density for Gen1 6T Li-ion battery by 50%.

b. Products:

i. AdvLi-ion battery materials for evaluation and demo.
ii. Gen 2 6T Lithium-Ion battery performance specifications and interface control documents

c. Payoff:

i. Maximization of both power and energy density (Resulting in 3X silent watch duration).
ii. Reduced Weight: (2 PbA 6T batteries (160lbs) replaced by 1 Gen2 6T battery (40 lbs)) (120lbs saved per pair of batteries replaced)
iii. Reduced Volume (single Li-ion battery replaced two PbA batteries)
iv. Reduced Logistics & Sustainment Burden; Increased Cycle Life (3-5X improvement in cycle life duration)
v. Decreased recharge time from ~10hr to 1hr (increase operational application and availability).

Program Updates for 2015
AMB has undergone a requirements development process to ensure battery requirements necessary to support TARDEC's CVP program and demonstrators are captured.
The solicitation for the development of Gen 2 6T lithium ion batteries has been released and is in the source selection phase.
A draft specification for Gen 1 6T lithium ion batteries is being released to industry for comment.

Acquisition Strategy - Existing Contract Actions

- Development of prototype Gen 2 6T battery cells to demonstrate material performance; ALION/Navitas; $350K.
- Development of prototype Gen 2 6T battery packs for demonstration material performance; ALION/Navitas; $630K

Future Opportunities - FY15 OTA:

- Solicitation for 2nd generation 6T development, delivery, and testing;$7.3M Closed: target award date of June 2015

7. **Advanced Auxiliary Power**
   a. **Purpose:** Provide electrical power for ground vehicle main engine off operations. Develop a compact, scalable Auxiliary Power Unit (APU) to provide sufficient power while meeting space and weight requirements
   b. **Products:**
      i. Scalable, heavy fueled engine integrated into an APU with 45kW electric output
      ii. APU performance specifications, Interface Control Documents (ICD), and noise package Technical Data Package (TDP)
      iii. APU is a complete integrated system with controls, generator, cooling, mounting, noise mitigation, etc.
   c. **Payoff:** A second vehicle power source will provide the following:
      i. More available power
      ii. Reduced vehicle maintenance costs (via main engine off operations)
      iii. Fuel savings
      iv. Reduced audible noise

The scalable engine developed has potential use in UAVs, Special Operations vehicles, UGVs, and APUs that require the use of JP-8 and DF-2 fuels.

Program Updates for 2015
Awarded contract to L3Com Combat Propulsion Systems to begin design work on 25kW and 45kW APU variants
Began APU design in 1QFY15. As a result, shifted APU development schedule to the left 10 months
Developed thermal models of APU cooling system optimized for low parasitic losses and reduced audible noise

Acquisition Strategy - Existing Contracts

- APU contract was awarded to L3Com Combat Propulsion Systems, utilizing the Robotics Technology Consortium (RTC), OTA.
- Scalable Engine development contract awarded to SAIC; L3Com CPS is subcontractor:
  - Utilized traditional FAR contract through Omnibus.
  - Two heavy fuel engine variants; effort continues to May 2016
  - Small military utility vehicle, UAV, UGV, smaller APU all need power source.
  - Noise, vibration, and harshness development contract awarded to Keweenaw Research Center of Michigan Technological University.

Future Opportunities

- FY16 SBIR program (A152-098) to develop variable energy ignition (spark) system for heavy fuel rotary engine. $150K phase I request for proposal due June 24, 2015. $1M phase II follow on if successful

- FY17 ManTech program focusing on rotary engine's trochoid housing to reduce manufacturing cost and bring manufacturing capability to US companies $4M program beginning in January 2017 is proposed. (Focus will be on coating and grinding technique of trochoid housing)

8. External Suspension Unit (ESU) Demonstrator

a. Purpose: Develop an External Suspension system to increase vehicle performance; provide vehicle designers with flexibility for complex hull shaping while buying back internal hull volume.
ESU upgrade to alleviate effects of increasing GVW, such as degraded mobility and reduced ground clearance while providing for weight growth and optional height management with adaptive damping.

b. Products:

i. Vehicle performance and durability testing of an ESU to demonstrate a TRL 6.
ii. Integration of ride height and adaptive damping capabilities.

c. Payoff:

i. Suspension system which can accommodate for weight growth.
ii. Increased off-road mobility and vehicle performance through height management and adaptive damping.
   - Capable of up to 30% higher off-road speeds over severe terrain vs. passive systems.
   - Variable height control allows for transportation and blast mitigation.
iii. Enables "tuning" of the spring and damping characteristics; this provides for ride quality adjustability and optimization for weight and terrain.
iv. ~40 cu. ft. increase in exterior and interior hull volume over torsion bar system, allowing for more blast survivable underbody hull shaping.
v. 20% reduction in system weight over current torsion bar system

Program Updates for 2015
Contract awarded to Horstman, Inc through competitive process.
Aligned with TARDEC SE and TARGET processes.
Finalized requirements through systems engineering processes.
Conducting trade study and analysis to determine final suspension configuration (on-arm, in-arm, etc).
Initial design ideations began April 2015.
ESU will be designed with an integrated height management and adaptive damping capability.

Acquisition Strategy - Existing Contracts

- FY14 ESU Base effort: Horstman (12 months), $1M for base effort – Awarded Design analyses to identify cost and performance trade-offs to optimally meet specified design requirements.
- FY14 ESU Option 1: Horstman (18 months), $1M – Awarded Fabricating prototype components for preliminary laboratory testing to include spring and damper characterization, functionality, performance, and durability. Three complete prototype units will be manufactured for testing.

- FY16 ESU Option 2: Horstman (18 months), $1.8M - Fabrication of a vehicle set of ESUs for Limited Durability (Proof of Principle) on-vehicle system suspension test at YPG.

Future Opportunities FY18

- ESU Fabrication: (18 months), $1.5M - (1 set) - Fabrication of a production set of ESUs for Qualification on-vehicle system suspension test at YPG.

9. High Capacity Lightweight Track Demonstrator

a. Purpose:

i. Reduce track weight through improved track system designs.
ii. Increase track system durability through advanced elastomer materials.

b. Products:

i. Lightweight, high capacity track system for a Combat Vehicle application.
ii. On vehicle durability and performance testing to demonstrate TRL

c. Payoff:

i. Buyback of SWAP-C: Decreased track weight by 10%.
ii. Increased track system durability from 2,100 miles to 3,000 miles.
iii. Flush back track design reduces vehicle rolling resistance, will improve overall fuel efficiency.
iv. Decrease vibration by 15%, improved ride quality, less warfighter fatigue.
v. Bolt-less ground pad design will reduce track system maintenance.

Program Updates for 2015
Contract awarded to GDLS (prime) Diehl Land Systems (sub) through OTA.
Finalized requirements through systems engineering processes.
Conducted weight reduction and durability improvement trade study.
Initial lightweight designs have begun (March 2015).
In-house designs and contractor based designs occurring simultaneously.

Acquisition Strategy - Existing Contracts FY14:

- Base effort – OTA / Limited Competition – GDLS/Diehl (12 months), $700K – Awarded - Weight reduction/durability improvement trade study development of advanced elastomer compounds capable of increased durability
- FY15: Work Directive – GDLS/Diehl (12 months),
  - $1M; Elastomer compound maturation & lab testing
  - Initial designs for lightweight track system; One interchangeable with current T-158LL, one non-interchangeable

Future Opportunities

- FY16: Work Directive – GDLS/Diehl (12 months), $1.0M; Fabrication of prototypes for on vehicle Proof of Principle testing / Design iteration based on YPG testing.
- FY17: Work Directive – GDLS/Diehl (12 months), $1.1M; Fabrication of prototypes for Limited Durability (Proof of Principle) testing – (2 Sets) / Design iteration based on YPG testing.

- FY18: Work Directive – GDLS/Diehl (12 months), $1.2M; Final design iteration of track system; Fabrication of production representative components for Qualification testing – (2 Sets)
- FY19: Work Directive – GDLS/Diehl (12 months), $0.4M; Test qualification field support / final report.

10. AC Dynamometer Procurement

a. **Purpose:** Replace tandem DC dynamometers with up to 3 new AC dynamometers.
b. **Products:**
   i. Up to 3 new AC dynamometers installed in the TARDEC Propulsion Systems Laboratory.
   ii. Dynamometers could range from 700HP to 2000HP.
   iii. Data acquisition capability to support the new dynamometers.
   iv. Training for Government personnel
c. **Payoff:**
   i. Ability to do transient testing of engines.
   ii. More realistic load testing.
   iii. Support controls development
   iv. Facilitate modernization of military engines.

Acquisition Strategy FY15

- Competitive Solicitation to be issued in May 2015.

Vehicle Electronics & Architecture

Chris Ostrowski
Associate Director, VEA

Value Stream One Objectives: Reference architecture that includes power and data instantiated in system designs. To enable these capabilities, TARDEC is developing the standards for common, open architecture (Data, Electrical, and Physical).

- Autonomy-Enabled Systems
- Ground System Architecture
- Protected Mobility
- Power, Density & Energy Efficiency

Value Stream Two Objectives: Lead for MRAP Digital Backbone; support Capability Set Integration

Value Stream Three Objectives: Provide engineering services for PEO customers and internal to TARDEC such as MAPS

VEA Deliverables to CVP - Transition Products include: software, hardware, ICDs, and performance specifications.

- TRL 5 Components, Power, Data & Vehicle. Systems in a SIL.
- TRL 6 Components, Fully Integrated, Power, Data & Vehicle Systems, in a vehicle.

Power Architecture	Data Architecture
USG Open Software	USG Open Software
Interface Control Documents	Interface Control Documents
Converters, Inverters, Switches	Video Network
Silicon Carbide	
Vehicle Systems Control Software	**System Design**
USG Open Software	System Design Document
Interface Control Documents	Common Power and Network Design
Increase Fuel Efficiency	SE Documentation (Sys ML)

1. **VEA Research SIL (VRS)**
   a. **Purpose:** The Army faces considerable challenges when integrating electronics on ground vehicles, compounded by the need to reduce cost and redundancy across multiple platforms. The VRS project will create a complete reference architecture to address the power, Vetronics, and C4ISR integration challenges facing the modernization of the ground vehicle domain. This architecture and the associated will support experimentation with future architectural concepts and implementations. This effort also includes the Power Management Technologies for the VRS project.
   b. **Product(s):** The primary customers are PEO GCS. In addition to various architectural design transitions throughout the project the following will transition when the SIL is FMC (TRL 5).
      i. Vehicle Electronics & Architecture Research SIL
      ii. HV and LV power electronics
      iii. Vetronics, C4ISR integrated components
      iv. Documented DoD AF Architecture Products
      v. DREN Interface to other RDEC SILs
   c. **Payoff:**
      i. Addresses significant SWAP challenges.
      ii. Supports four out of the five TARDEC cultural identities by providing facilities, knowledge, and experience.

Program Updates for 2015
VRS has completed PDR; with CDR planned in Oct 2015
System Architecture Design Document (SADD) is in development
Fully embraced Model Based System Design utilizing the Artisan Modeler tool
Taken delivery and tested in our GVPM labs our 1st Gen SiC based 15 kW DC/DC converter; Buck mode only 600V to 28 VDC; Designed to operate at 70 C ambient and 70 C inlet cooling; Plans are to gain lessons learned from testing this device and then competitively procure a bidirectional device that meets all of our requirements.
System Integration Technology Hanger (SITH) aka the physical lab space has seen many improvements; EMI chamber is operational; High Voltage Bus Duct has been designed and installed; Space for VECTOR SIL has been allocated; parts ordered; initial bench set.

Acquisition Strategy

- Existing: Engineering Services to date - $10.5M

Future Opportunities

- Hardware purchases, Test Equipment
- Network analyzers (Ethernet and CAN), oscilloscopes, etc; Total $35K
- Hardware purchases, System Components
- Video switches, Network adapters, displays, video/audio data recorded, video encoders, cameras, etc; Total $110K
- Test Service Agreement for use of the EMI chamber
- Test Service Agreement to test high power components

2. **VICTORY Enabled Company TransfORmation**
   a. **Purpose:** Transition and Demonstrate TARDEC's Vehicle Integration for C4ISR/EW Interoperability (VICTORY) investment from its current TRL 4 Lab Components to TRL 6 vehicle systems. This will reduce the risks for PMs by providing an accredited Information Assurance (IA) solution.
   b. **Product(s):**
      i. Vehicle Integration Package (specifications and drawings)
      ii. VICTORY Standards demonstrated at TRL 6
      iii. Accredited VICTORY IA solution (TRL 6)
      iv. System Infrastructure Software (TRL 6)
      v. Vehicle Video Sensor Bus (V2SB) (TRL 6)
      vi. VICTORY Components Competitive Prototypes (TRL 6)
   c. **Payoff:**
      i. Provides the capability to Network the Force, Execute Network Operations, and Mission Command.
      ii. TARDEC will develop and demonstrate future Ground Vehicle Electronics and Software Architecture based upon VICTORY.
      iii. This project serves to shape near term vehicle architectures and as a risk reduction effort in support of PEO CS&CSS and PEO GCS by reducing the risk of applying a digital vehicle architecture, IA, VICTORY, and a modular software infrastructure.
      iv. A primary goal of VECTOR is to develop a modular and adaptable architecture, common interfaces and components that can be applied across multiple ground vehicle platforms quickly.

Program Updates for 2015
VECTOR has completed SNR, SRR, SFR; with PDR/CDR planned in May 2015
Initial one wire diagrams complete for all three vehicle designs
We have possession of all three vehicles
Test site has been determined to be Grayling in Sept 2015

Acquisition Strategy - Existing Contracts - Engineering Services to date - $6.5M

Future Opportunities-None - All items will have been bought and integration started
VICTORY Standards Maturation

a. **Purpose:** Maintain, develop, and adopt future capabilities to continue to enhance the Vehicular Integration for C4ISR/EW Interoperability (VICTORY) Specifications. Enhance existing Systems Integration Lab (SIL) capabilities to perform Validation and Verification for the updated Standards. Continue to provide new capabilities that can be added to Military Ground Vehicle platforms as a part of ARFORGEN block upgrades or Modernizations.
b. **Product(s):**
    i. VICTORY Architecture A2VICTORY Standard 1.6
    ii. VICTORY SIL Continuous Updates
    iii. VICTORY Validation and Verification Test Results Ongoing
    iv. VICTORY Certification Test Facility
    v. VICTORY Interoperability Test Results Ongoing
    vi. VICTORY Independent Verification Testing Ongoing
c. **Payoff:**
    i. Provides the capability to Network the Force, Execute Network Operations, and Mission Command
    ii. TARDEC will continue to support VICTORY Standards and update VICTORY SIL (Maintaining our customer base)
    iii. Positions TARDEC to be a preferred source for GV Life Cycle Engineering by having the VICTORY SIL certified to serve as a Government VICTORY Certification Test Facility which will lead to additional revenue through test service agreements with suppliers and MOAs with Program Offices.
    iv. A primary goal of VICTORY is to develop a **modular** and **adaptable** architecture, **common** interfaces, and software modules that can be applied across multiple ground vehicle platforms.
    v. Strategic Arena/Traditional R&D: Shape VICTORY Standard Specification requirements that will transition to PEO GCS in FY-17 to support Abrams, Bradley, and Stryker ECP Programs.

Program Updates for 2015
TARDEC made tough decision to divest itself of investment in this project starting in FY16.
PMs and PEOs will continue VICTORY Standards Organization and the VICTORY requirement will endure future vehicle designs

VICTORY Enabled Components Needed

- 24 port Rugged Ethernet Switch (C1 Switch) with built-in Cross Domain Guard
- Vehicle Intercom (G2 Intercom, G3 Voice Radio, G4 Single Instance Audio Data Source, G5 Streaming Audio Data Source)
- Firewall (D9 Network Firewall, D8 Intrusion Detection and Prevention)
- Shot Detection or Other Threat Sensors (J1 Threat Detection and Reporting Service)
- GPS Receiver (A1 Timing, A2 Position, O1 GPS Receiver)
- INS (A2 Position, A3 Orientation, A4 Direction of Travel)
- Remote Weapon Station (R1 RWS)
- Power System (Q1 Power Distribution)
- Processor (E1 Shared Processing Unit)

- Router (C2 Router)
- CAN to Ethernet Bridge (P1 Automotive)

TARDEC Tested VICTORY Components - *https://software.forge.mil/sf/projects/victory*

Acquisition Strategy

- Existing: Engineering Services to date - $1.2M
- Future Opportunities: Test Service Agreements to test VICTORY Components; Use of Govt software for FREE

3. **VS2 - MRAP Integrated Bridge –** The MRAP Integrated Bridge (IB) provides a means to more effectively and efficiently integrate C4ISR systems onto the MRAP Ley Leader Vehicle (KLV) while enhancing operational capability for the soldier. The IB is a scalable intra-vehicle system that integrates Command & Control, Communications, Situational Awareness, Lethality, Electronic Warfare, and vehicle systems within the platform and routes system information to a centralized display for enhanced system management.

Existing Contract

- Engineering Services to date – $9.0M

Future Opportunities - Purchase of individual components in prototype quantities:

- Smart Display Unit: Quantity 10; Unit Price $14K
- Ethernet Switch Unit (x 2): Quantity 10; Unit Price $3.25K
- Power Control Unit: Quantity 10; Unit Price $7K
- Communications Interface Unit: Quantity 10; Unit Price $2K
- Power Distribution Unit: Quantity 10; Unit Price $2.5K
- Battery Monitoring Unit: Quantity 10; Unit Price $3K
- Video Routing/Processing Unit: Quantity 10; Unit Price $15K
- Power Management Interface Unit: Quantity 10; Unit Price $4.5
- Power & Data Cabling: Quantity 10; Unit Price $27K
- Brackets & Mounts: Quantity 10; Unit Price $4.5K

4. **VS3 - VEA Engineering Services -** VEA Provides numerous personnel both Government and contractors to PEO GCS and PEO CS & CSS
   - **a.** Personnel who are direct site located within PM offices
   - **b.** Develop Information Support Plans for PMs
   - **c.** Develop Assessment and Authorization/Risk Management Framework(RMF) documentation for PMs
   - **d.** Field Service Reps both CONUS and OCONUS
   - **e.** Perform Army Interoperability Test Certification support

Existing Contract

- Engineering Services contract with DCS

Future Opportunities

- We will be soliciting a new multi-year Task Order under the new TS3 contract

Force Projection Technology

Douglas C. Hedberg
Deputy Associate Director, FPT

The Mission of the Force Projection Technology (FPT) group includes: Serving as the DoD responsible agent for all ground fuels and lubricants specifications, acting as DOD Lead Lab for Ground Water Supply and Wastewater Treatment, and as the National Depository Authority for the US Army on Military Load Classification.

FPT supports all three Value Streams of the 30-year strategy:

- Fuels and Lubricants
- Fuel Handling & Quality Surveillance Equipment
- Water Purification, Handling, & Quality Equipment
- Combat Engineer & Material Handling Equipment
- Military Bridging (LOE 1.3)

Operational Vulnerability:

- 70-80% of resupply weight in theater consists of fuel and water.
- 18% of US casualties in OIF and OEF related to ground resupply.
- Threat to Installation Energy Supplies.

Army Top Challenges:

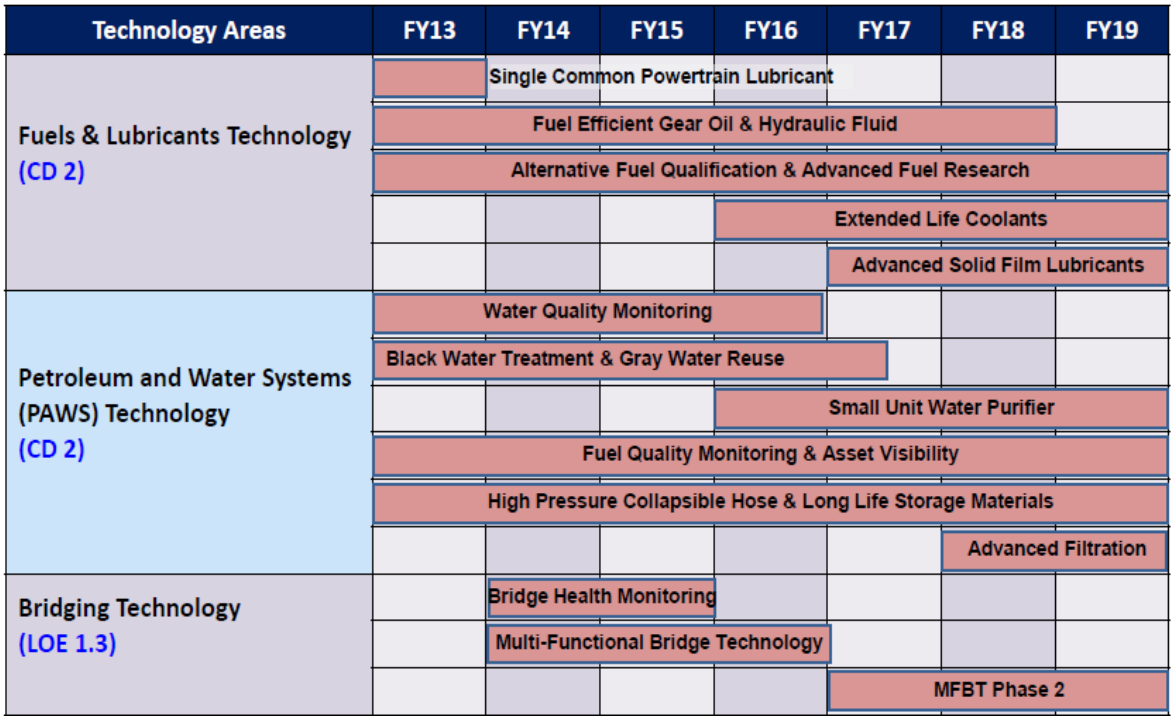
- 4. Reduce logistic burden of storing, transporting, distributing and retrograde of materials
- 8. Improve operational energy

Force Projection Technology (FPT) Gaps

- High pressure (740 psi) collapsible hose + coupling assembly
- For reverse osmosis systems, raw water pre-treatment that will produce a feed water of equivalent quality as membrane systems, but with the simplicity and robustness of media and cartridge filtration
- Affordable composite material manufacturing techniques
- Real time measurement of all water quality parameters in EPA primary and secondary drinking water standards
- For composite materials in bridging structures, understand repair-ability & long-term effects of the environment, multi-material joining of dissimilar materials

- Technology to enable rapid load engagement for MHE
- Highly energy-efficient, specialized lubricants and surfaces that enable service-free components (e.g., synergy between the lubricant and surfaces)
- Pigment technology for solid film lubricants
- Accurate volumetric fluid measurement for collapsible fabric storage tanks
- Long-life, lightweight materials for collapsible fabric storage tanks
- New bio-inspired approaches to wastewater treatment to reduce system volume and energy requirements, and provide more robust operation
- Polymeric additive that is soluble in fuel to suppress mist fires & enable fire resistant fuel
- Means to capture the mechanical energy imposed on modular bridging components and convert to electrical power to operate structural health equipment.

Force Projection S&T Roadmap



1. **Fuel Efficient Gear Oils (FEGO)**
   a. **Purpose:** Develop new fuel efficient gear oils
   b. **Products:**
      i. Federal Test Method & apparatus to measure axle efficiency (called out in SAE J2360)
      ii. New performance based specification (SAE J2360)
   c. **Payoff:**
      i. 2-4% increase in fuel economy with no equipment modification

ii. Reduce wear, thus lessen logistics and maintenance burden
iii. Achieve OE ICD goals for fuel reduction

FEGO – Updates for FY2015
Axle efficiency test stand fabrication has been completed. All three axles (LTV, MTV, HTV) to be evaluated are on hand.
Mapping LTV axle for speed and torque data on-going. Completed HTV and MTV maps. This data will be used in developing test methodology.
Completed survey of axle technology (ratios, size, loads, etc) used in Army system particularly across LTV, MTV, and HTV.
Gathering information to conduct survey for axle efficient lubricants.
Requirements to ensure FEGO is compatible with limited slip differentials and transfer cases has been added to the project scope

EXISTING CONTRACT ACTIONS FY13-14:

- Work directive Southwest Research Institute (SwRI), TARDEC Fuels &Lubricants Research Facility (TFLRF), $700K
    - Market research for advanced technology
    - Test methodology and apparatus to measure axle efficiency

OPPORTUNITIES FY15-18:

- Engagement with axle and gear manufacturers on test methodology through the Lubricant Review Institute (LRI) Gear Oil Review Committee
- Multiple work directives to TFLRF
    - Complete development of axle efficiency test procedure
    - Establish pass/fail criteria for an extended oil life test
    - Develop apparatus and procedure to evaluate the compatibility of FEGO in transfer cases and limited slip differentials
- Provide candidate products for evaluation
- Provide qualified products for procurement by DLA under revised performance specification (SAE J2360)

2. **Black Water Treatment & Gray Water Reuse**
    a. **Purpose:** To develop and integrate multiple technologies to produce compact, mobile, energy-efficient systems capable of rapid start-up that can treat black water to discharge standards and treat gray water to non-potable reuse standards
    b. **Products:**
        i. A stand-alone black water treatment system
        ii. A gray water reuse system
        iii. DOTLMPF analysis at SLB STO-D (formerly TeCD 4a), will inform requirements
    c. **Payoff:**
        i. Reduces convoys and dollars required to provide potable water (for non-potable uses)potentially providing an order of magnitude cost savings for Army water logistics support
        ii. Reducing convoys saves more soldiers' lives
        iii. Supports OE & Base Camp ICD and Force Provider CPD

BWTGWR - Updates for FY2015
Possible extension of program into FY17 to conduct in-house testing and evaluation of alternative technologies.
Based on responses to the RFI, the Comparative Industry Demo was restructured and no longer requires a single field event. Site visits may occur.
Frontier, Terragon and Raytheon developed systems completed and delivered for Government performance testing. Additional funding added to each R&D contract for extended on-site support for SLB STO-D (formerly TeCD4a) demonstration of systems in FY15.

Existing Contracts - FY15-FY16

- Frontier Environmental Technology, LLC, Blackwater treatment system based on modified activated sludge technology, $1.03M
- Terragon Environmental Technologies, Inc., Blackwater treatment system based on electrochemical technology $1.2M
- Cambrian Innovation, Inc., Blackwater treatment system based on bioelectric & fuel cell technology, $1M
- NASA-Ames Research Center, Gray water (GW) treatment based on forward osmosis technology, $750K
- Raytheon UTD Inc., GW treatment system based on ultra-filtration technology, $1.12M

Future Opportunities FY15-19

- Network Integration Evaluation (NIE) 16.1 Demo (SEP 15)
- Transition to PdM PAWS or PdM FSS program of record in FY19

3. Water Quality Monitoring

a. Purpose: To enable rapid contaminant detection and process verification for mobile water treatment and supply systems.

b. Products:

i. Prototype Inline automated monitor measuring water quality parameters (low cost, common, adaptable)
ii. Prototype toxin and pathogen detection devices
iii. Demonstration of Smart Sensor capability
- Automates recording & expedited reporting
- Alarms for Quality and Malfunctions

c. Payoff:

i. Reduces Army convoys:
- Solves Capability Gap for long-term tactical water purification skilled man power for equipment complexity
- Improves efficiency of water production

ii. Protects Soldier Health through improved process monitoring

WQM - Updates for FY2015
Based on responses to the RFI, the Comparative Industry Demo was restructured and no longer requires a single field event. Site visits may occur.
In-house evaluation of how two COTS multi-parameter sondes (probes) work with Army water systems bought in 2014.
TARDEC is partnering with Army Corps of Engineers to complete an integration package (sonde and data collection & transmission) that can accept a variety of COTS sensor heads.
Just completed the two Phase I SBIRs for real-time inline wastewater monitoring (phase II TBD).

Acquisition Strategy
Existing Contracts FY15-16:

- SBIR, Two Phase I Awards of $0.1M to Giner and Luna for Real-time inline wastewater monitoring
- ARO Grant, UCLA, $0.514M - Cyst assay using cell-phone camera

Future Opportunities - FY 16:

- Provide COTS sensors for pH, turbidity, conductivity, temperature, chlorine, dissolved oxygen, chemical oxygen demand, and total organic carbon for Army integration

4. **Small Unit Water Purifier (SUWP)**
   a. **Purpose:** Develop a system that produces 30 gallons per hour.
   b. **Products:**
      i. Lightweight, energy efficient high pressure pump incorporating energy recovery
      ii. Advanced, simple, robust pretreatment that produces membrane quality feed water
      iii. New system design integrating advanced components and state of the art reverse osmosis
      iv. Draft detailed specification and drawing package
   c. **Payoff:**
      i. Fills the Petroleum and Water CBA Gap # 22: develop a man-portable water system
      ii. Reduces the distribution footprint and waste associated with bottled water.
      iii. Reduces soldier risk, one USMC study reported one casualty per every 50 fuel and water convoys in Afghanistan.
      iv. Technologies will be transitioned to PM PAWS.

Acquisition Strategy
Existing Contracts

- DoD Small Business Innovation research (SBIR) FY2015.1 Topic A15-089 –Advanced, Robust, and Simple Pretreatment to Reverse Osmosis.

Opportunities FY 16-19

- Procurement and evaluation of COTS and emerging:
  - Pretreatment
  - RO membranes
  - Lightweight components
  - Power sources
  - Intake systems
  - Disinfection technologies
  - Pumps and energy recovery devices
- Design system in-house with a combination of advanced and COTS components

5. **Fuel Quality Surveillance (FQS)**
   a. **Purpose:**

i. Develop technologies to enable fuels quality surveillance in minutes.
ii. Investigate: Light obscuration, high speed imaging, light scattering, and ultrasound for contaminant detection; and Near Infrared Spectrometry for the portable fuel analyzer.

b. Products:

i. Prototype sensors with corresponding algorithms based on TARDEC's library of fuels for each fuel sensor technology
ii. Develop Acceptable fuel property limits

c. Payoff:

i. Instrumentation will be incorporated into the Army Petroleum Test Kit
ii. Gives a fast moving Army the ability to test captured fuel in minutes.
iii. Increases number of properties that can be checked at the point of issue.
iv. In-line and real time fuels monitoring for several PM-PAWS systems.

Fuel Quality Surveillance (FQS)Updates for FY2015
Published Tri-Service POL Users Group position paper on the use of Particle Counting Test Method for Quality Surveillance of Aviation Turbine Fuels. This will amend Table 1 of MIL-STD-3004 in include particle counting limits.
Eliminated Corrosion Inhibitor/Lubricity Improver additive detection from the scope of the project.

Existing Contract Actions - FY15-19

- All technologies are being developed under SBIR efforts.
- Integration of developed technologies into Petroleum Test Kit.
- Source sought for ruggedized particle counter calibrated to ISO-11171.

6. Multi-Functional Bridging Technology (MFBT) Phase 1

a. Purpose: Develop a single bridge system which can be reconfigured for use in all Bridging missions; enable User to adapt to any condition encountered at a gap site.

b. Products:

i. Evaluation of applicability of composites, advanced materials for bridging applications
ii. High strength, lightweight, scalable bridge components

c. Payoff:

i. Single, common bridging solution consisting of compact, generic, agile gap crossing equipment adaptable to multiple bridging missions, gap lengths, load levels

Multi-Functional Bridging Technology (MFBT) Updates for FY2015
Project now slated to run through FY16. $1.5M funding allocated for FY16. FY15 funding reduced to $1M
Several design updates made to the system: 1. Initial launch mechanism, launch/ retrieval concept developed

2. Changes made to bridge/ launch beam design and bridge/ launch beam joint design to account for heavier vehicle loads, improve compatibility with launch mechanism design 3. Initial design work performed on intermediate supports to enable spans longer than 50m to be bridged.
Start of Advanced Material Evaluation (previously slated for mid-FY14) pushed back to FY15.
Design team has concerns about the ability to manufacture load cartridges (bridge reinforcement) from 100% composite materials, and is looking at conventional materials to alleviate the manufacturing issue.

MFBT - Existing Contract Actions – FY15-19

- Assembly and test support for durability testing of the existing Advanced Modular Composite Bridge prototype (assess durability of composite joints) – planned FY15 award
- FY16 - Contract(s) for composite design/ manufacturing consulting, component demonstrators, est. $800k
- FY17 - Test support for demonstrators, est. $700k

Ground Vehicle Robotics

Jim Parker
Associate Director, GVR

Value Stream One Objectives: The Ground Vehicle Robotics (GVR) group provides support for value stream one objectives by shaping requirements for future programs of record for Autonomy Enabled Systems.

Value Stream Two Objectives: The Ground Vehicle Robotics (GVR) group provides support for value stream two by providing autonomy-enabled system support to PM's for existing ground vehicle systems.

Autonomous Ground Vehicle Capability Demonstrations – GVR supports the following Capability Demonstrations:

- CD 5 – Develop unmanned vehicles capable of maneuvering with mounted and dismounted units.
- CD 6 – Achieve ground system integrated 360° situational awareness capability at extended distances from the platform, in order to enhance Soldier safety and ease the Soldier's burden.
- CD 7 – Develop robotic technologies and capabilities that expand the operational capabilities of a Brigade Combat Team (air/ground teaming)
- CD 12 – Develop robotic technologies and capabilities that enable unit resupply and sustainment operations using optionally-manned and unmanned vehicles.
- CD 12 – Develop robotic technologies and capabilities that enable unit resupply and sustainment operations using optionally-manned and unmanned vehicles.

- CD 17 - Develop and demonstrate an improved and optimized distribution system that integrates new and emerging technologies across the full spectrum of operational and tactical supply movement operations.

1. **Autonomous Ground Resupply (CD17)**
   - **a.** Autonomous Maturation of JCTD
   - **b.** Autonomous Ground Resupply
     - i. Transition JCTD architecture from "Fail Safe" to "Fail Mission Capable" while building in reliability and redundancy.(FY16-20)
     - ii. Develop software-centric behaviors with discrete "app."-like modules. (FY16-20)
   - **c.** Autonomous Ground Tactical Resupply.
     - i. Architecture Harmonization - Standardize RTK Architecture to enable cross program utilization of software, scaling and commonality amongst developers. (FY16,17)
     - ii. Autonomous Behavior Development – Implement behaviors to enable a complete point to point tactical resupply mission. (FY15-19)
       1. Significant improvement in speed, localization, path planning and re-path planning. (FY17,17)
       2. Tactically relevant speed, enhanced OD/OA, and teaming behaviors (FY18, 19).

Existing Contracts:
- Lockheed Martin ($5.0M FY 15—AMAS Maturation)
- DCS Corporation ($2.625M FY 15—Tactical Resupply)
- U of M Dearborn Robotic Institute (300k FY15 Architecture)

Opportunities and Areas of Investment:
- o High Speed, Off- road Robotic Mobility
- o Common Interfaces and Architecture
- o Joint Developed Robotics Software Library (Apps)

Gaps That Industry Can Help Fill:
- o Autonomous Testing Methodologies and Procedures
- o Negative obstacles both open and occluded
- o Bodies of water detection and fording determination
- o Environmentally tolerant sensor, switches, and CPU hardware.
- o High Vertical Resolution LIDAR
- o Cyber and Physical Security

2. **ground Degraded Visual Environment (gDVE/CD6)**

Existing Contracts:
- DCS Corporation (FY15 1,158k service support contractor)

Opportunities and Areas of Investment:
- o High speed video transport bus

- Augmented reality
- 360 Situational Awareness (SA)
- Driving Aids and User interface

Gaps That Industry Can Help Fill:

- High resolution military displays
- DVE Testing Methodologies and Procedures
- Head Up displays
  - Sensor Fusion
  - High speed video transport bus

3. Extending the Reach of the Warfighter through Robotics (ERWR/CD7)

Existing Contracts:

- National Robotics Engineering Center (NREC) – $1.48M

Opportunities and Areas of Investment:

- Possible DME opportunities in FY16
  - Long-distance communications (beyond line of sight)
  - Technology to mitigate problems associated with latency
  - Mission enabling payloads that a modular robotic system can integrate or utilize to expand its mission profile.

Gaps That Industry Can Help Fill:

- Demonstrate unmanned systems performing useful missions for the warfighter.

4. Applied Robotics for Installations & Base Operations (ARIBO)

a. Purpose: ARIBO is a strategic initiative to accelerate the adoption and use of intelligent ground vehicle systems for military and commercial applications utilizing a systems approach to link technology with real-world operational settings for use and experimentation in semi-controlled environments.

b. Products:

i. National and collaborative network of federal, state, and local government and commercial partners developing, deploying, and sustaining autonomy-enabled technologies with thoughtful policy and doctrine.
ii. Standardized data collection tools and methodologies to inform DoD ground robotic requirements, development, technology investments, and procurement decisions supported with agent-based behavior modeling.
iii. Optionally-manned systems consisting of base platform + B-kit + A-kit leveraging and validating AMAS and DSAT solutions.
iv. Open architecture small robotic research platform with broad dual-use applicability, especially for industrial hygiene-type applications.

c. Payoff:

i. Increased reliability of robotic technologies.
ii. Increased socialization and living experimentation of robotic technology to produce trust and confidence of autonomous vehicles.
iii. Standard data for informed policy decisions and systems design.

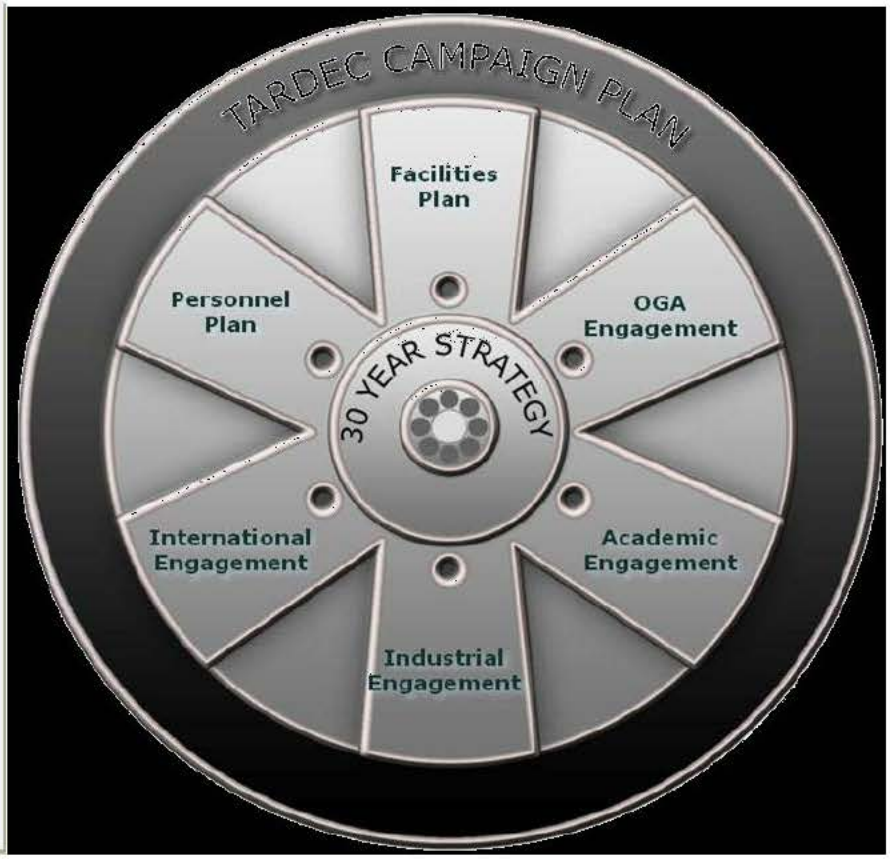
iv. Inter-agency partnership, collaboration, and decision making
v. Provides a living laboratory for TARDEC smart/intelligent systems development and shaping formal TRADOC requirements.
vi. Enables disruptive innovation and technology transition approach by addressing immediate installation needs in a manner which influences and enables future program development and fielding.

Office of Chief Scientist (OCS)

Ravi Thyagarajan, Ph. D.
Deputy Chief Scientist, OC

Mission of the Office of Chief Scientist (OCS)

The OCS sets the research direction for TARDEC, to leverage research through other Government agencies, industry and academia, and to nurture and develop TARDEC's scientific and engineering talent.



Objectives:

Value Stream One – Shape Requirements for Future Programs of Record

- LOE1: M&S Framework for Autonomy-Enabled Systems
- LOE3: Off-road Mobility (Next-Gen NATO Reference Mobility Model NRMM)
- LOE2: Modularity Ground Vehicle Architecture
- LOE3: Underbody Blast Methodology and Protection

Value Stream Two – Develop New Capabilities for Current Ground Systems

- LOE1: Align Basic Research Efforts to ground systems gaps/needs

Value Stream Three – Provide Engineering Support and Services

- LOE1: Computational M&S development of new and emerging M&S capabilities (autonomy, mobility, blast, structures, thermal/signature, power-train & optimization)

TARDEC OCS Top 3 Initiatives

1. **Next-Generation NATO Reference Mobility Model (NRMM) -** Leading technology efforts across NATO to predict mobility world-wide for military ground vehicles, focusing on:
    - **a.** Off-road mobility (vehicle, vehicle-terrain and terrain)
    - **b.** 7 tech areas (Requirements, Methodology, Stochastics, Autonomy, Tools, Inputs/Outputs, Benchmarking)
    - **c.** 27 members from 11 nations, several industry partners (BAE, LM) and academic partners (MIT, Wisconsin, Illinois, Michigan)

2. **M&S Framework for Autonomy-Enabled Systems -** Focusing on:
    - **a.** Model-based Development of Mobility vs. Latency vs. Autonomy Relation
    - **b.** Three different tech areas (Platform Mobility, Communication, Autonomy)
    - **c.** Sensor and Perception Algorithms
    - **d.** Analysis and Mitigation of Delays/latencies
    - **e.** Physics-based dynamics solvers with different levels of fidelity

3. **Automotive Research Center (ARC) -** Focusing on open-literature basic research:
    - **a.** Dynamics and Control of Vehicles
    - **b.** Human-Centered Modeling and Simulation
    - **c.** High-Performance Structures and Materials
    - **d.** Advanced and Hybrid Powertrains
    - **e.** Vehicle System Integration, Optimization and Robustness

Acquisition Strategy - Existing Contracts

- M&S Research - ARC (Automotive Research Center) ~$2.5M
- Academic Research Centers – CVRC (MSU), SIMBRS (Miss State), FAJRI(Oakland) ~$2.1M
- Contractor support (Technical Writers, Researchers) ~$0.7M
- Innovation/Other Projects (Oakland, MIT, JPL, VDSC, CDI, P&M) ~$0.6M
- FY14 SBIR/STTR contracts managed by TARDEC ($21.8M)
- FY13 Rapid Innovation Fund (RIF) managed by TARDEC ($1.86M, University of Wisconsin)

Future Opportunities

- Focused Advanced Technology Demonstration seed projects up to $0.5M (FY15)
- Innovation Projects (TARDEC associates partnered with Industry) up to $0.45M(FY16)
- SBIR/STTR Projects for Phase 1 and Phase 2, $20-30M
- FY15.2 SBIR Topics will be posted in April-May 2015
- FY16.1 SBIR Topics will be posted in Nov-Dec 2015
- STTR Topics TBD, check SBIR/STTR Solicitations website

- FY15 RIF BAA Release in FedBizOpps on Apr 1, 2015; white papers due Jun 1,2015; and Full proposals due Dec 1, 2015
- One full-time post-doctoral position of 1 year duration (starting in FY15) to perform onsite research in the area of Autonomy-Enabled Vehicle Mobility applicable to large vehicles operating at high speeds
- Two part-time Sabbaticals (Faculty, Principal Scientists) working onsite in TARDEC, on following focus areas (FY15)
    - Cognitive Modeling for autonomy-enabled systems
    - Fundamental science of Verification and Validation (V&V) for autonomy-enabled systems
    - Materials and Joining research for Light-weighting
    - Computational Behavior Modeling
    - Other research areas that address TARDEC key strategic needs/gaps
- 4-6 internships (FY16 summer) of 10-12 weeks working in TARDEC labs with experienced mentors on all TARDEC technical research areas. (Announcement in Jan/Feb 2016)
- Access to past research products, and participate in setting new research direction – as Industry Quad Principal in ARC partnerships.
- Ability to get critical fundamental research needs addressed by Army Research Laboratory (ARL) and Army Research Office (ARO) in their Research Formulation meetings
- Industry Access to DoD High Performance Computing (HPC) resources for collaboration projects with TARDEC
- Industry and TARDEC Joint proposal submissions, e.g. to
    - DARPA (e.g., GXVT, 'Squad X Core Technologies', 'Communicating with Computers', etc)
    - DOE (e.g., Composites NNMI hub)
    - American Lightweight Materials Manufacturing Innovation Institute (ALMMII)
        - ARPA-E
        - ONR
        - MANTECH, etc.

Technical Planning and Management

Andrew Yee
Acting Associate Director, TPM

Value Stream One Objective: LOE1 Develop Systems Engineering Methods and expertise to support mission scenario analysis

Value Stream Two Objectives: LOE1 Develop Systems Engineering Methods and expertise to support Programs of Record (MRAP, JLTV, GCV, Bradley, ABRAMS, AMPV, TVs…)

Value Stream Three Objectives: VS3-LOE1 Develop Systems Engineering Methods and expertise for future (mobility, blast, structures, thermal, power-train &optimization)

Program Updates for 2015
Awarded $275K funding for continued Requirements Support for CVP Program working in conjunction with Government Personnel.
Awarded $150K funding for continued System Architecture Development Support for CVP Program working in conjunction with Government Personnel.
Awarded $400K funding for continued RAM and Quality Engineering Support for Current Programs working in conjunction with Government Personnel.
Awarded $1.6M funding for continued Systems Engineering Support for Science and Technology (S&T) Projects and CVP working in conjunction with Government Personnel.
Awarded $60K to GDLS for Light Weighting Effort
Awarded $250K to REL for Development Of Bi-Metallic Squeeze Castings Which Will Produce Lighter-Weight Components In Support Of The Light Weight Vehicle Structures

Acquisition Strategy - Existing Contracts FY15

- CVP Requirements Support Pool: BAH (12 months), $275K for continued support – Requirements Analysis and Traceability to align CVP System Requirements with S&T Project Development.
- CVP System Architecture Support Pool : DCS (12 months), $150K for continued support
  - Sys/Architecture Development to support upcoming CVP System Functional Review.
  - RAM and Quality Support: Wyle, $400K for continued support.
  - S&T Project Systems Engineering Lead Support and Technical Planning and Management Process Development: SAIC, BAH - $1.6M for continued support.
- SBIR:
  - **TempInc (Phase 1)** - $100K: Forming of steels used in underbody blast events by utilizing heat and electromagnetic fields, which should allow forming of harder/thicker steels.
  - **Century (Phase 2)** - $1M: Developing friction materials for Metal Matrix Composite (MMC) brake drums which have been previously developed. Current materials do not generate enough heat/friction on the drums, which has a negative effect on stopping/slowing.
  - **NexGen (Phase 2)** - $1M: Developing a process to lower the manufacturing cost of composite/metallic armor solutions.

Gaps and New Opportunities

- FY15: ORSA – Operational Research System Analysis – Expertise and Execution Support.
- FY16 and Beyond: Rapid Competitively Awarded Contracting Mechanisms to Quickly Meet New Customer Demand Signals and Surge Demand for Technical Planning and Management Support In These Competency Areas:
  - Requirements Engineering
  - Risk Management
  - System Architecture Development
  - Systems Engineering Lead
  - RAM Engineering
  - Quality Engineering
  - Logistics Engineering

Systems Engineering – Analytics

Sudhakar Arepally
Associate Director, Analytics

Value Stream One Objective: LOE1 Computational M&S support provided for the Combat Vehicle Prototyping (CVP) program

Value Stream Two Objectives: LOE1 Computational M&S support provided for Programs of Record (MRAP, JLTV, GCV, Bradley, ABRAMS, Stryker, Tactical Vehicles…)

Value Stream Three Objectives: VS3-LOE1 Develop Systems Engineering Methods and expertise for future (mobility, blast, structures, thermal, power-train & optimization)

Program Status for FY15 – Baseline: Analytics's M&S investments are significant and the knowledge is available for use to industry.

Vehicle dynamics – chassis and suspension models	High strain rate material characterization and models	OCP-TECD knowledge (validation data, models, reports)
Power-Train/Electrical coupling model	Fast-algorithm for thermal analysis on dense mesh	Vertical drop tower model
Reduced Order models	Stochastic modeling approach	Soil and threat models
Off-road mobility models	ATD models	PPE model

Updates for FY2015
TARDEC visited BAE M&S group in Sterling Heights, MI , and conducted an all-day Technical Exchange meeting; decided to meet regularly (bi-monthly or quarterly) to exchange technical knowledge to establish Verification, Validation (V&V) of computational modeling and simulation under a CRADA mechanism.
Developed plans to establish Light-weighting Optimization Center at Altair Engineering.
Contracted Dassault Systems to train TARDEC analysts in advanced finite element methods in composites and Noise, Vibration and Harshness (NVH).
Engaged with Wayne State University to discuss topics in Systems Engineering architecture and utility of Trade Space tools in the framework.
Engaged with Detroit Engineered Products, Inc. on several occasions to get familiar with MeshWorks software and to explore partnership opportunities.
Three in-house contractors (M&S analysts) were offered government positions.
Virtual Proving Ground for robotic platform project start was shifted to the right by two quarters in FY15.
Systems behavior, trade-space & stochastic modeling project to populate systems engineering tool (ISEF or other) was shifted to the right by two quarters in FY15.

Acquisition Strategy - (Opportunities for industry to collaborate through the programs)

- Future partnering opportunities (CRADA/TSA etc.) – Off-road mobility, light-weight materials, underbody blast, trade-space and stochastic modeling, computational systems behavior modeling, operational effectiveness/capability, vehicle robotics M&S (Tele-Ops - Shared-control – Full autonomy), multi-disciplinary optimization
- Include ongoing contracts (awards already in place) – SoarTech, ASA Corp., SURVICE, Computational Dynamics Inc.; SimBRS, ALION,, ALTAIR, ESI, LSTC, ETA, TASS, Humanetics, Beta CAE, CD-Adapco, Gamma Tech., MSC, Siemens (Abaqus, iSight, RecurDyn), LMS, PHM, MathWorks, PTC, Mechanical Simulation Corp., nCode
- Service contract requirements (All your service needs like people, materials etc.)

Gaps and New Opportunities -

- Virtual Proving Ground for robotic/autonomy platforms M&S
- Computational System Behavior (probabilistic M&S throughout Life Cycle)
- Operational Assessment/Effectiveness M&S
- Light-weighting and multi-disciplinary optimization M&S
- Trade-space, META or Reduced Order tool development/enhancement M&S
- Reduce logistic burden (fuel and water usage) M&S

TARDEC Software Engineering Center (SEC)

Mark Slominski
Associate Director, SEC

Value Stream One Objective: Software and Information Systems Security Engineering Support (ISSE) to VECTOR, VRS, GVR, MAPS.

Value Stream Two Objectives: Software support provided for Programs of Record (MRAP, ABRAMS, Stryker). Lead software development, ISSE, and sustainment efforts for the MRAP Integrated Bridge (IB).

Value Stream Three Objectives: Post production Software Support (PPSS) to Abrams M1A1 ED, DSESTS, PQAS, M1200 Armored Knight. ISSE Support to PEO CS-CSS.

TARDEC SEC Key Functions/Capabilities - Software Development, Information Systems Security Engineering (ISSE), Software Integration & Test, Software Acquisition Support to PM's, Lifecycle Software Support, and Continuous Process Improvement.

Software & Information Systems Security Skills

Software Skills required to support the TARDEC 30-Year Strategy	**Information Sys/Sec. Skills required to support the TARDEC 30-Year Strategy**
Software Acquisition Managers * (* Typically restricted to Government personnel) (# denotes work which can be performed by govt. or contractors)	System Security Engineering - Discover Stakeholder Requirements - Define Solution Security Requirements. - Architect Security Solution - Design Security Solution - Implement Security Solution
- Software Eng. Technical SMEs# - Software Project Engineering# - Software Architecture# - Software Process Improvement#	Technical Management - Planning and oversight for executing engineering efforts - Inject security concerns (risk items) at appropriate stages
- Software Developers# - Software Test Engineers# - Product & Process Quality	Assessment and Authorization/Risk Management Framework (RMF)

- Assurance (PPQA) Engineers# - Software Lab Tool Support#	
- Software Assurance Specialist# - Software Safety Specialist# - Software Configuration Management (CM) Engineering#	U.S. Government Information Assurance Related Policies and Issues

Acquisition Strategy:

- Value Stream #1 Contractor Engineering Services will be obtained primarily through new TACOM Omnibus
- Value Stream #3 Contractor Engineering Services will be obtained primarily through existing vehicle prime contractors

Resource Plan (Work-Years) to support the TARDEC 30-Year Strategy

Value Stream / FY	FY15	FY16	FY17	FY18	FY19	FY20
VS#1 Contractor	17	13	5	20	20	17
VS#3 Contractor	36	37	38	39	39	38
Total Contractor	53	50	43	59	59	55

Center for Systems Integration

John J. Schmitz
Associate Director, CSI Engineered Solutions

The mission of the CSI is to develop, fabricate and integrate advanced solutions into current and future ground systems. The Core Competencies of the CSI include: Ground Systems Integration, Prototyping, Systems Engineering, Reverse Engineering, Drawings, Technical Manuals, Watercraft Systems Integration, and Bridge Design.

Value Stream Support - CSI supports all 3 TARDEC Value Streams through

- S&T funded projects and demonstrators
- PM funded development and integration efforts
- TARDEC's capability to develop and integrate emerging capability demonstrations. *(VS3 – LoE1 – KO8 (3.1.8))*

The business model contains these four components:

- Customer reimbursable organization: PEOs (Ground Combat Systems, Combat Service & Combat Service Support, Land Systems), REF, SOCOM, and RDECOM
- CSI collaborates with RDECs for specialized capabilities, industry for surge capability and depots for production
- Contracts are primarily 4464 for materials and services
- 119 Government and 35 Contractor Personnel

Past / Recent Products and Innovations:	
Capability Set-13/14	HMMWV Blast Cab
HMMWV & MRAP Egress Trainers	Fuel & Water Distribution & Treatment Equipment
Line of Communication Bridge	Army Watercraft Upgrades
Caiman EFP Kit Integration	ROBODEX
Robotic Deployment System	ET-REMADE
RPG Defeat for MRAP FOV	Reconfigurable Firebox
Overhead Wire Mitigation Kits	HUSK HET A1 Armor Cab
Add-On Armor Kits	

Key Capabilities:

Project Management	**Creo/CAD 3D Modeling**	**Finite Element Analysis (FEA)**	**Mechanical & Electronic Eng. Design**
Multi-Axis CNC Turning/Milling	**Water Jets with chamfering capability**	**Technical Data Package Development**	**112,000 sq. ft. Facility/16 Integration Bays**
Laser Cutting	**Robotic Welding**	**Circuit Board Design & Mfg.**	**Direct Metal Deposition Machine**

Program Updates for 2015
Awarded "Blue Collar" Contract to Arbeit, LLC for welders, machinists, material handler, heavy vehicle mechanics and electronics technicians (November 2014)
Awarded Technical Writer, Illustrator Contract to Addon Services, LLC (September 2014)
Acquired Direct-Metal Deposition Capability

Acquisition Strategy - Existing Contracts:

- "Blue Collar" Contract for welders, machinists, material handler, heavy vehicle mechanics and electronics technicians. (Arbeit, LLC)
- Technical Writer/Illustrator Contract. (Addon Services, LLC)
- "White Collar" Contract for mechanical automotive design engineers and experienced, technical CAD operators. (GSE)
- "Professional Services" Contract for automotive design engineers and experienced, technical CAD operators. (Primus)
- Project Scheduler, Logistician. (Unified Business Technologies)

Future Opportunities:

- Project-specific material and services purchased regularly using a 4464 or Government Purchase Card.
- Next Blue Collar Contract anticipated in 2017.

New Capabilities in FY15

The DMD system is a laser-based, additive fabrication technology which combines five common manufacturing technologies together (lasers, CAD, computer-aided manufacturing (CAM), sensors and powder metallurgy) to repair and rebuild worn/damaged components that are

difficult to weld. This additive metal technology also reconfigures parts to accommodate design changes, improving efficiency and reducing lead time.

Specifications:

- 4 kW LASER
- 5-axis + 2-axis tilting-rotary table
- Inert chamber for working with Titanium
- Over 2 cubic feet of work area
- Multi-Material Manufacturing

Benefits:

- Adds additional metal to a 3D surface using a 5-axis motion system.
- Narrows heat affected zone, resulting in reduced microstructure modifications.
- Offers a wide variety of material capability, including steels, stainless steel and titanium alloys, among others.

Physical Simulation & Test (PS&T)

Mark Brudnak
Associate Director, PS&T

Value Stream One Objectives:

- KO 1.1.1: Simulated Autonomy Program
- KO 1.1.1: Latency in Tele-operations Kiosk
- KO 1.1.3: T&E Management of AMAS field experiments
- KO 1.2.2: Provide the M&S environment for the VEA SILS
- KO 1.3.2: Provide durability evaluations of force protection technologies.

Value Stream Two Objectives:

- LOE 2.1: Execute durability tests on technologies targeted toward PORS.
- LOE 2.1: Execute performance tests on technologies targeted toward PORS.
- LOE 2.1: Provide T&E management personnel to support POR modernization such as ECPs, reset, tech insertion and rapid response.

Value Stream Three Objectives:

- KO 3.1.2: TARDEC Virtual Experiment Capability.
- KO 3.1.3: Suspension Characterization Unit
- KO 3.1.3: Vehicle Characterization Lab Hydraulics Distribution system
- KO 3.1.7: ISO 17025 training and experience qualifications.
- KO 3.2.3: Provide rapid durability testing for kits developed in support of field needs.
- LOE 3.3: Provide testing services to PMs and PEOs to assess quality of spares and to qualify second sources for parts production.

Capability Demonstrators:

- CD 1: Provide T&E Management and Planning services to the base program and to particular technologies.
- CD 6: Provide simulation environment for the human-in-the-loop

Test and Evaluation Program Support

- Test Planning (TEMP)
- Risk Mitigation
- DT/OT
- Performance, RAM & Live Fire Testing
- Testability
- TRL Assessment
- T&E Efficiencies

PS&T Capabilities & Services		
Vehicle Testing	**Terrain Measurement**	**Mass Properties**
Terrain Measurement	**Heavy Vibration**	**Vehicle Testing**
Cab and Payload Testing	**Mass Properties**	**Cab and Payload Testing**
4 Person Vehicle Simulator	**Suspension Properties Light Vibration**	**Tire/Runflat & Road Wheel Testing**
Turret Evaluation	**Damper Properties**	**Heavy Vibration**
Seat Assessment	**Motion Capture**	**Driving Simulator**

1. **TARDEC Virtual Experiment Capability (TVEC)**
   a. **Purpose:** Create purposeful engagement with ARCIC and other Army partners participating in the development of the Early Synthetic Prototyping (ESP) program.
   b. **Products:**
      i. Drop-in M&S representations of TARDEC technologies and demonstrators for use in the ESP environments.
      ii. Pilot 1: Represent the NGCCV platform in an ESP experiment.
      iii. Pilot 2: Represent the Squad Centric Mounted Maneuver concept in an ESP experiment.
   c. **Payoff:**
      i. Provides a tangible means to get technology concepts and ideas into the hands of soldiers.
      ii. Provides a means to obtain a large volume of data on soldier use of technology.
      iii. Provides a means to capture emergent tactics as grown over time by soldier players.
      iv. Provides the means to perform in-house experiments using low-cost computers.

2. **Simulated Autonomy**
   a. **Purpose:** Create a means to explore and assess the effectiveness of autonomous ground systems in combat roles as compared to the performance of traditional manned forces.
   b. **Products:**
      i. Scenarios and force constructs for autonomous ground systems.
      ii. Prototyped Soldier Machine Interfaces for autonomous systems control.

iii. TVEC-based virtual experiments to compare manned vs. unmanned performance.

c. **Payoff:** Controlled experimental results which indicate relative performance of manned vs. unmanned ground systems in combat.

Program Updates for 2015
Awarded contract to Add-on Services for the installation of a hydraulic distribution system in the Vehicle Characterization Lab (VCL).
Awarded contract to MTS Systems Corporation for the refurbishment of a Suspension Test Fixture (STF).
Took delivery of a track testing machine from Onodi Tool & Engineering.
Rolling Resistance, Force and Moment tire Characterization system – Camber Ridge i. Two Instrumentation Configurations: *Six Beam Kinematic Configuration* *Monolithic Spoke Configuration* ii. Dual Sensitivity Measurement *Large Scale Loads – Strain Gage Approach* *High Sensitivity Loads – Capacitance Gage Approach*
Quarter Car fixture for component characterization and durability testing – Rose-A-Lee

Acquisition Strategy - Existing Contracts

- Simulation Support and Integration contract: DCS Corporation
- Test & Evaluation Services: SURVICE Inc.
- Test Surge IDIQ: Link Engineering Co.
- Rolling Resistance Force and Moment Measurement: Camber Ridge
- Environmental covers: Russells Technical Products
- SPIDER Compliance Lateral Longitudinal & Steer modification: SEA, Ltd.

Future Opportunities FY15/16

- ISO 17025 process support
- Technician surge support

Gaps and New Opportunities

- Design for Automotive Reliability in Test (DART)
- Working with ATEC
- Work with ATEC to determine how best to use laboratory testing in their evaluations.
- We may need expertise with respect to reliability modeling and assessment.
- Autonomous Systems Virtual Proving Ground
- Currently in planning & requirements stage.
- Models, methods, processes will need to be established under this effort.

RDECOM Integrated Systems Engineering Framework (ISEF)

Lisa Graf, Program Manager, ISEF

The goal of ISEF is to provide the means to manage SE knowledge in an integrated manner throughout the system lifecycle. It provides the right information to the right stakeholders in the right context at the right time and enables decisions to be made with confidence.

TARDEC's Systems Engineering and Integration Directorate:

- Provides SE Subject Matter Expertise and Personnel to Programs
- Manages SE Knowledge Throughout the System Lifecycle with ISEF
- Ties S&T to POR's for Improved Investment Planning, Integration and Transition

The ISEF supports the Integrated System Lifecycle Knowledge Framework by enabling investment & portfolio planning to align technology/solutions to platforms & capabilities across all Value Streams. It is a common environment that provides an integrated, traceable systems engineering analysis capability throughout the life cycle of a program. It provides an essential supporting structure and an iterative collaborative environment for all stakeholders, practitioners and decision makers to proactively engage in and facilitate decision making.

ISEF Value Proposition

- **Improve quality of SE execution**
  - Confidence in decisions
  - Accelerated delivery of data and information
  - Traceability to requirements compliance
  - Adaptability, commonality, modularity of architectures
  - Clarity in reducing Risk
- **Increased level of knowledge integration**
  - Insights from connected data, visualizations and rollups
  - Reduction in perception of complexity
  - Focused knowledge, channeled to the appropriate stakeholders
  - Ability to anticipate and understand life-cycle ripple effects early
- **Increased efficiency and speed to market**
  - Enable seamless, lean business processes
  - Increased level of enterprise collaboration
- **Stretch limited resources**
  - Capture & leverage subject-matter expert knowledge as patterns
  - Broaden reach of each individual through recursive methods
  - Reduce enterprise software expenditures
- **Government owned Intellectual Property**
  - Government control that can be easily tailored to Government needs
  - Continuous access to cutting edge COTS & GOTS tools
  - Framework for government, industry and academic collaboration
  - Means to more easily leverage other method and tool innovations

Acquisition Strategy:

- Work continues on developing new ISEF Capabilities utilizing the AMCOM Express contract W31P4Q-05-A-0031/0034
- Work is often viable on contracts with SE deliverables language.

Program Updates for 2015
CRADA was signed with Systems Process Incorporated (SPI), to commercialize and market ISEF. *TARDEC will receive 40% of all software royalties back from the CRADA.*
A Rapid Innovation Fund (RIF) contract was awarded for FY15-FY16 work for new ISEF capabilities.

ISEF Industry Opportunities - *There are three main opportunities for Industry to partner with ISEF:*

- If you have a contract with the U.S. Government, ISEF is available for your use.
  - This saves contractors cost of doing business by allowing use of USG SE tools.
  - Promotes customer/partner collaboration by utilizing the same SE tools for data transfer.
- ISEF still has capability needs/gaps. There may be business potential if your company can fulfill these gaps through partnership or existing tools.
- ISEF has a CRADA partner. If your tools integrate to ISEF, the CRADA partner may choose to explore partnerships to market your tools as part of their commercial suite.

Gaps and New Opportunities - *Still needed for a full ISEF capability:*

- Executive Dashboards (initial in FY15 – final in FY16)
- Tie to Capability Needs Assessment (CNA) database
- Lessons Learned generalized tool
- Global ISEF search engine and Discussion Management panel (like social media)
- ISEF Blog Spot for users to openly collaborate and exchange ideas
- TARDEC Development System (TDS) definition and integration
- Value Stream Tool and Design Assurance Tool
- 3D Viewer for M&S outputs and CAD data
- Failure Mode and Effects Analysis (FMEA) capability
- Registry Editor (Administrative Tool)

Combat Vehicle Prototype (CVP)

Todd Thomas, PM CVP

How to Stay Up-To-Date On CVP

- Federal Business Opportunities - FedBizOpps (https://www.fbo.gov/)
- ACC-WRN ProcNet Link for - Combat Vehicle Program (https://contracting.tacom.army.mil/research/cvp-ipt/cvp-ipt.htm)

The CVP team will focus technology efforts to position the Army for the next generation combat vehicle by: providing leap ahead technology capabilities to the combat vehicle fleet; reducing risk to future combat vehicle program(s) of record (POR); informing future combat vehicle

requirements; and collaborating with defense industrial base concept design teams. CVP will deliver, by Fiscal Year 2019 (FY19), technologies and subsystems at a technology readiness level (TRL) of six, or higher.

Value Stream One Objectives: CVP directly influences future requirements through the demonstration of Leap Ahead ground vehicle capabilities across specific Power & Mobility, Survivability, and Electronic Architecture (Power & Data) technologies.

Value Stream Two Objectives: CVP intentionally develops flexible, scalable, and modular technologies in order to additionally align with current ground systems and transition new capabilities in support of Modernization activities.

Value Stream Three Objectives: CVP specifically leverages the expertise of TARDEC's engineering services and support organizations by facilitating the creation and utilization of common engineering and programmatic processes across CVP projects.

OPPORTUNITIES FY15-19: Integrated Product Teams (IPT) are the forum to connect PM, Combat Vehicle (CV) OEMs, Army Science and Technology (S&T) resources, and CVP Technology Industry Partners

- CVP & Industry S&T Collaboration IPTs
  - Provides system integrators with early understanding and knowledge of Army S&T projects.
  - Provides a forum to connect CV OEMs - system Integrators and industry technology developers
  - Provides opportunities for information sharing and a feedback loop on technology development.
- Industry Leveraging CVP S&T Projects
  - Enables prioritization and complementary investment of industry R&D
  - Increases opportunities for technology transition to Combat Vehicle PORs.
- Clean Sheet Concept - National Advance Mobility Consortium (http://www.namconsortium.org/)
- Engineering Service Support
  - System Engineers – 9 WYs
  - Master Scheduler – 1 WY

Defense Mobility Enterprise (DME, VRA, OTA)

Mr. James Biga
Director, Vehicle and Robotics Alliance Program Office

Overarching Agreement Mechanism: **10 U.S.C. 2371 Section 845 Other Transaction**

The Defense Mobility Enterprise (DME) is comprised of two components:

- The Vehicle and Robotics Alliance – A Network of Participating Government Organizations: Government Labs / R&D Centers / Program Offices, and VRA Program Office (VRA PO).
- National Advanced Mobility Consortium, Inc. (NAMC) (http://www.namconsortium.org) Non-Profit 501(c) 3 Organization Industry / Academia / NPO; and its Consortium Management Firm (CMF).

Goals and Objectives

1. Enable greater visibility into warfighter needs;
2. Provide Government greater insight into what's technologically feasible;
3. Engage non-traditional companies for innovation and technological solutions;
4. Facilitate teaming among traditional and non-traditional defense companies;
5. Provide ready access to Government resources, as needed;
6. Execute business and contractual processes to simplify and accelerate getting technology development projects under contract;
7. Support the Government's efforts to advance interoperability, open architecture, and other vehicle-related technology standards.

Defense Mobility Enterprise	Annual Cycle FY15 FY16 Schedule
Publish Annual Plan to GOV and NAMC	19 DEC 2014
White Papers Due from NAMC Members	23 JAN 2015
White Paper Evaluations Due from GOV	20 FEB 2015
RPP* published to NAMC members	26 FEB 2015
Proposals due from NAMC members	03 APR 2015
GOV Evaluations due	01 MAY 2015 **
Estimated awards	JUNE 2015 and beyond **

Dates are considered "Best Estimates" which may change periodically.
** RPP = Request for Project Proposal*
*** Actual date becomes project dependent at this stage.*

DME - Basket Provision

- A NAMC proposal is placed in an electronic basket for a period of three (3) years from the RPP closing date when a proposal (rated better than poor) is not initially selected for award. (If a proposal selected for award is not funded within nine (9) months from the RPP closing date, the proposal will be placed in the electronic basket)

- To maintain acquisition integrity - Proposals placed in the basket will maintain rankings as specified by the source selection evaluation team for a period of nine (9) months from the RPP closing date. (After this period it will become available to all VRA customers under equal ranking)
- Exception to the 9 month rule – Proposals can be selected from the basket out of the ranked order prior to 9 months provided that the selecting customer is from a different service or business unit (Division level) organization than the source selection team organization.

Important Websites

- Public site www.DefenseMobility.org
  - Application process, capabilities paragraph on NAMC members

- NAMC Members-Only https://NAMConsortium.org
  - Request for Project Proposal (RPP) Information, Award Announcements, Meeting Proceedings, Basket Quad Charts

- BIDS Website Portal https://BIDS.acqcenter.com
  - Industry whitepaper and proposal submissions, government evaluations, basis of selections.

- END -