Program Executive Officer Land Systems

Advanced Technology Investment Plan

2012

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PROGRAM EXECUTIVE OFFICER
LAND SYSTEMS
ADVANCED TECHNOLOGY
INVESTMENT PLAN UPDATE
2012

Executive Summary

This 2012 edition of the Program Executive Officer Land Systems (PEO LS) Advanced Technology Investment Plan (ATIP) provides an update to the Top Technical Issues of PEO LS Programs and has been vetted through the Program Managers to ensure an accurate representation of their highest priority technology needs. This update is consistent with previously published ATIPs and emphasizes our continued commitment to "Focus the Future Faster" by leveraging available Science and Technology (S&T) venues to provide gap closing capabilities to the warfighter.

In order to maximize efficiencies within the S&T enterprise, PEO LS has continued collaboration within the three circles (Concept Developer, S&T Developer, and Material Developer), developed a strong relationship with our Department of the Army counterparts, and implemented the priorities of the Commandant to "Lighten the Marine Air Ground Task Force (MAGTF)" and foster a "Middle Weight Force" capability.

The 2012 ATIP demonstrates our continued focus on concept-aligned, capability-based technology transitions into Programs of Record (PoR) and is designed to foster collaboration, align S&T investments, and support effective technology insertion within PEO LS Programs.

The Marine Corps Program Executive Office, PEO LS is responsible for the management of five Acquisition Category I and II programs which are critical in supporting the warfighter. New programs of note to the PEO this year are the Assault Amphibious Vehicle (AAV), the High Mobility Multipurpose Wheeled Vehicle (HMMWV) and the Amphibious Combat Vehicle (ACV).

This updated ATIP provides the information and tools required to better resolve program specific S&T challenges and ultimately provide state-of-the-art technology to the warfighter.

William E. Taylor
Senior Executive Service
Program Executive Officer Land Systems

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PROGRAM EXECUTIVE OFFICER
LAND SYSTEMS
ADVANCED TECHNOLOGY
INVESTMENT PLAN
2012

Bottom Line Up Front

The enclosed ATIP identifies and prioritizes the Program's Top Technical Issues within PEO LS with the goal of informing, influencing, and aligning S&T investment to resolve program technical issues and support transition of critical capabilities to the warfighter.

Each Program's Top Technical Issues were vetted through the appropriate S&T Representative, Lead Engineer, Deputy Program Manager, and Program Manager to ensure an accurate representation of their highest priority technology needs.

This 2012 edition of the ATIP includes three new programs: the Assault Amphibious Vehicle (AAV), the High Mobility Multipurpose Wheeled Vehicle (HMMWV), and the Amphibious Combat Vehicle (ACV). Additionally, this ATIP includes one new technology focus area in weight reduction and two focus area name revisions. These revisions include "Common Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) Vehicle Architecture" and "Power/Thermal Management" now referred to as "Open Plug and Play Communications Architecture" and "Intelligent Power and Thermal Management."

The PEO LS ATIP employs a repeatable process focused to inform all key stakeholders of Top Technical Issues within PEO LS Programs with the goal of leveraging available S&T venues to "Focus the Future Faster" for the warfighter.

We welcome comments or suggestions to improve the utility of this plan. Please forward any suggestions or comments to Mr. Mike Halloran, PEO LS Director, S&T at michael.d.halloran@usmc.mil.

Michael D. Halloran
Director, Science & Technology
Program Executive Officer Land Systems

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1.00 Introduction

"Focusing the Future Faster…"

PEO LS is celebrating its fifth year since being established in February 2007. As the only Marine Corps Program Executive Office, PEO LS is responsible for the management of multiple Acquisition Category I and II programs that are critical in the support of the warfighter. PEO has had continued success over the last year in identifying potential S&T initiatives for PEO LS platforms as identified in this 2012 ATIP.

This is the third publication of the PEO LS ATIP and builds on previous editions to Identify, Communicate, Align, Engage, Resolve, and Transition gap closing technologies to the warfighter. The "Concept to Capability" process remains the methodology by which this document was developed and provides a focused and repeatable process that aligns S&T investments with High Priority Capability Gaps and Program technology needs.

Engagement within the "3 Circles" remains fundamental in the process. This is a collaborative relationship between the Combat Developer represented through Combat Development and Integration (CD&I) and the Marine Corps Warfighting Lab (MCWL), the S&T Developer represented through the Office of Naval Research (ONR) Code 30 and the Material Developers represented through Marine Corps Systems Command (MCSC) and PEO LS. The 2012 ATIP is the mechanism that "brings it all together" engaging and informing the S&T enterprise within the Department of Defense (DoD), Industry, and Academia.

This ATIP will be adjusted as we move forward and your inputs are encouraged. The intent is for the ATIP to be published annually with updates and associated changes noted appropriately. This will serve to continue to inform the key stakeholders and better assist PEO LS Program managers in resolving their challenging Top Technical Issues.

All comments and suggestions to improve the ATIP are welcome. Please e-mail remarks to Mr. Mike Halloran, PEO LS Director, S&T at michael.d.halloran@usmc.mil.

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2.00 PEO LS Top Technical Issues

> ***"In an era where new technologies are empowering potential enemies – state and non-state actors alike – our military must maintain its technological edge."***
>
> -Leon E. Panetta, U.S. Secretary of Defense, October 11, 2011

Technical Issue to Capability "Roll Up"

The PEO LS S&T Directorate has taken a consistent, deliberate, and focused approach toward assisting the Program Managers (PMs) in answering the top technical challenges of their programs. This "Concept to Capability" approach allows S&T representatives to work through the Top Technical Issues of their programs and apply S&T initiatives that provide potential solutions to their identified challenges.

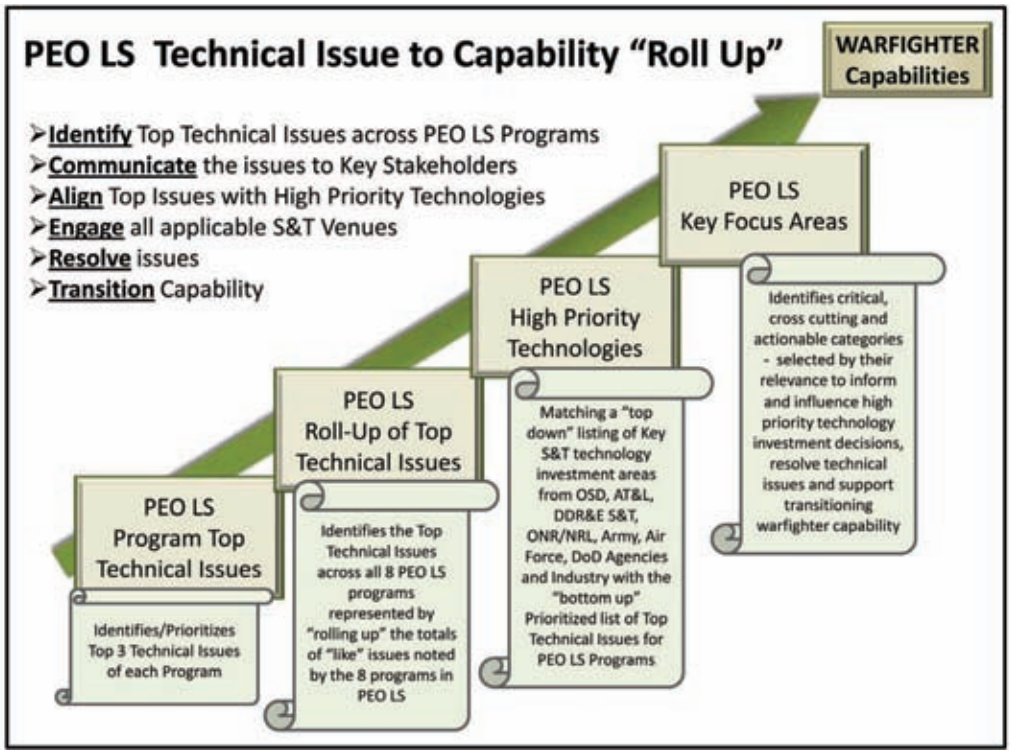


Figure 1 – PEO LS Technical Issue to Capability "Roll Up"

This collaborative approach has proven extremely valuable, not only in identifying individual program technical issues, but also by identifying technology issues common among other PEO LS Programs. By understanding these common technical challenges, PEO LS can align the issues with High Priority Technologies, determine key focus areas and technology investment venues/forums that lead to solutions. Figure 1. illustrates the "Roll Up" of PEO LS technology issues.

Top Technical Issues

The Top Technical Issues of each individual PEO LS Program, vetted through the Program's S&T Representative, Lead Engineer, Deputy PM, and PM for concurrence and prioritization, are identified below, in Figure 2.

PEO LS Program Top Technical Issues	
Program	**Technical Issues**
Amphibious Combat Vehicle (ACV)	Increased Survivability Increased Weight Margin Crew Visibility
Joint Light Tactical Vehicle (JLTV)	Weight/Armor Reliability, Availability, Maintainability (RAM) Modeling and Simulation (M&S) Seat Shock/Vibration
Marine Personnel Carrier (MPC)	Survivability Weight Reduction On-Board and Exportable Power
Logistics Vehicle System Replacement (LVSR)	Fuel Economy Current & Future C4I Integration Demands Increased Survivability
Medium Tactical Vehicle Replacement (MTVR)	Fuel Economy Current & Future C4I Integration Demands Increased Survivability
Common Aviation Command & Control System (CAC2S)	Global Track Manager Database Hardware Infrastructure Design Multiple Interface Formats
Ground/Air Task-Oriented Radar (G/ATOR)	Lowering Manufacturing Costs Transit/Receive (T/R) Module Efficiency GaN Reliability
Lightweight 155mm Howitzer (LW 155)	Modular Artillery Charge (MACS) Compatibility with the M777A2 Howitzer Power Upgrades Thermal Warning Device Reliability
Assault Amphibious Vehicle (AAV)	Survivability Weight/buoyancy management Sustainment/In-service engineering
High Mobility Multipurpose Wheeled Vehicle (HMMWV)	Performance Survivability Reliability/Durability

Figure 2 – PEO LS Program Top Technical Issues

3.00 PEO LS High Priority Technologies

"Our ground combat and tactical vehicle strategy is focused on the right mix of assets, balancing performance, payload, survivability, fuel efficiency, transportability and cost. In particular, the Amphibious Combat Vehicle is important to our ability to conduct surface littoral maneuver and seamlessly project Marine units from sea to land in permissive, uncertain and hostile environments. We remain firmly partnered with the U.S. Army in fielding a Joint Light Tactical Vehicle that lives up to its name while also being affordable."

-General James F. Amos, Commandant of the Marine Corps, November 2, 2011

Once the individual PEO LS Program's technology requirements/issues were identified, analysis was conducted to determine commonality across other PEO LS Program of Records (PoR). The result of this analysis is the PEO LS High Priority Technologies (Figure 3). These High Priority Technologies were then compared and contrasted with the "Top Down" listing of key S&T technology investment areas from the Office of the Secretary of Defense (OSD); Office of the Under Secretary of Defense Acquisition, Technology and Logistics (AT&L); DoD, Director Research and Engineering (DDR&E); Defense Advanced Research Projects Agency (DARPA); ONR/Naval Research Lab (NRL); United States Army (USA), DoD Agencies, and Industry. The priority list of Top PEO LS Program Technology Issues was then mapped to the appropriate technology focus area resulting in the PEO LS "S&T Focus Areas" (see Figure 4).

By Prioritizing the technologies, highlighted in Figure 3 on the following page, the PEO LS S&T Representatives are able to align their technology subject areas with appropriate S&T Venues and "Top Down" technology investment areas. This also informs S&T Stakeholders of how (and where) to invest their S&T dollars to meet PEO LS S&T High Priority Technology Requirements. This cooperative engagement with agencies such as ONR/NRL, MCSC, OSD AT&L, DDR&E, USA Tank Automotive Research, Development and Engineering Center (TARDEC), DARPA, and other services creates a synergistic partnership that helps "Focus the Future Faster" for the warfighter. This partnership is further enhanced by the collaborative engagement between PEO LS S&T Representatives in Program Reviews, S&T conferences, resourcing meetings, Joint Technology Partnership Conferences, S&T Venues, and Technology Process Forums.

PEO LS High Priority Technologies

Technologies that Reduce Size and Weight:
- Lightweight Materials, Components etc.
- Integrated/Consolidated C4ISR

Technologies that Improve Power Margin:
- Energy Storage
- Batteries (denser/lighter)
- Power Management
- On-Board and Exportable Power

Technologies that Enhance Mobility:
- Suspension
- Axles
- Transmission
- Engine
- Tire Technologies

Technologies that Enhance Fuel Economy :
- Alternative Power Sources
- Alternative Materials
- Fuel Additives
- Tire Technology

Technologies that Enhance Reliability, Availability & Maintainability (RAM):
- Health Monitoring
- Wireless Diagnostic/Prognostics
- Modeling and Simulation Tools to "design-in" Reliability

Technologies that Increase Survivability:
- Lightweight Armor
- Fire Suppression Technologies
- Anti Roll Technologies
- Crash Survivability
- Collision Avoidance
- Blast Resistant Seating
- Seat Belts

Technologies that Enhance Safety:
- Air Conditioning
- Driver and Crew Vision
- Toxic Fume Reduction Technologies
- Noise Reduction Technologies
- Vibration Reduction Technologies

Technologies that Enhance Platform C4ISR Functions:
- Common Data Architecture
- Power/Thermal Management
- Standard Interfaces
- Common Displays

Figure 3 – PEO LS High Priority Technologies

4.00 PEO LS S&T Focus Areas

PEO LS S&T Focus Areas have been developed through the evaluation and identification of High Priority Technologies, driven by the most significant technical challenges of each program. The Focus Areas in 2012 were vetted, scrutinized, and developed in coordination with the S&T Representatives, Lead Engineers, Deputy Program Managers, and the PEO LS Program Managers. The S&T Focus Areas are meant to highlight mission essential, cross-cutting, and actionable areas of focused S&T investment and engagement. These operationally relevant technology focus areas will inform and influence high priority S&T technology investment decisions, resolve technical issues, and support the transition of warfighter capability. These S&T Focus Areas include: Power and Energy, Fuel Efficiency, Survivability and Mobility, Modeling and Simulation, and Fuel Containment/Fire Suppression. New/Updated Focus Areas added in 2012 are Open Plug and Play Communications Architecture, Intelligent Power and Thermal Management, and Weight Reduction.

These new focus areas reflect the significance in communications architecture, the growth in demand for power and thermal management, and the challenge in reducing the size and weight of current and future expeditionary warfighting units.

Figure 4 – PEO LS S&T Focus Areas

S&T Focus Areas

4.1 Power and Energy: Technologies that expand the overall capability of the MAGTF by increasing the availability and capability of battlefield power while decreasing the logistic footprint.

4.2 Fuel Efficiency: Technologies that can enhance vehicle performance and capability while reducing fuel consumption on the battlefield. Gains in this area may also have significant impact on the logistics footprint of the MAGTF.

4.3 Survivability and Mobility: Technologies that increase survivability of both the Marine and the vehicle. These technologies include advanced lightweight armor concepts and upgraded drive and suspension systems.

4.4 Modeling and Simulation: Tools to facilitate a Systems Engineering approach to platform design and evaluates potential design and technology trade-offs for tactical wheeled vehicles. These trade-offs will address performance, payload, crew protection, life cycle costs, survivability, and Reliability, Availability, and Maintainability (RAM).

4.5 Fuel Containment/Fire Suppression: Technologies that safely extinguish internal and external vehicle fires without adversely affecting the crew; preferably a system of systems approach providing fire suppression and/or containment for the vehicle cab, crew, tires, fuel tank, and engine compartment.

4.6 Open Plug and Play Communications Architecture: The development of an affordable, scalable, and interoperable feasible C4ISR for use on legacy platforms. The development of an open source, open architecture for tactical vehicles.

4.7 Intelligent Power and Thermal Management: The development of an integrated system managing power utilization on vehicle platforms in order to improve fuel efficiencies, manages heat properties in the cab and other areas on the platform in order to maintain equipment and crew comfort. An effective power and thermal management system will improve electrical system efficiency and heat rejection.

4.8 Weight Reduction: The development of modular, scalable, and lightweight armor packages tailored to the mission, providing greater flexibility to the Combatant Commander. As well as development of lightweight materials to reduce vehicle weight and increase payload.

Sections 4.1 - 4.8 provide summaries specific to each of these eight areas.

4.1 Power & Energy

"The current and future operating environment requires an expeditionary mind set geared toward increased efficiency and reduced consumption, which will make our forces lighter and faster. We will aggressively pursue innovative solutions to reduce energy demand in our platforms and systems, to increase our self-sufficiency in our sustainment, and reduce our expeditionary foot print on the battlefield. Transforming the way we use energy is essential to rebalance our Corps and prepare it for the future."

-United States Marine Corps Expeditionary Energy Strategy and Implementation Plan, (Washington, DC: CMC, 2011), February 23, 2011

Bottom Line Up Front	
Challenge	
PEO LS has added the directives and processes described in the USMC Expeditionary Energy Strategy and Implementation Plan and Initial Capabilities Document for USMC Expeditionary, Energy, Water, and Waste to its continued focus on Power and Energy. Engaging with Service and Industry partners in an effort to identify capability advances, the PEO LS S&T Directorate continues to identify focused Power and Energy S&T investment opportunities and bring these opportunities to the attention of PEO LS Program Managers for potential application across their portfolios.	
Potential Solutions	
ONR Code 30	On-Board Vehicle Power (OBVP) Fuel Efficient MTVR FNC Modular Vehicle Platform (MVP) Electric Acceleration Assist and Integrated Starter Generator
PEO LS/ONR	Advanced Transmission Technologies Efficient Powertrain Technologies Integrated Power and Propulsion Hybridization and Re-Power
TARDEC	Hybrid Electric Vehicle Experimentation and Assessment Research Program
TARDEC POM 13-17 Programs	Combat Vehicle Auxiliary Power Unit JP-8 Fuel Cell APU System Efficient Powertrain Technologies
SBIRs	Development of small fuel efficient multi-fuel capability engine Vehicle Based Exportable Power Development of High Power Lithium-ion Batteries Variable Speed Alternator Drive Lithium Ion Batteries with Wide Operating Temperature Range Innovative Simulation and Analysis Tool for Vehicle Thermal Management

Potential Solutions

ONR Expeditionary Warfare and Combating Terrorism Department (Code 30) Efforts

On-Board Vehicle Power (OBVP). The MTVR OBVP capability reduces the need for ground forces to carry trailer mounted generator sets that reduce payload and restrict mobility. This MCSC Product Group 15 (PG-15) PM Expeditionary Power Systems (EPS) effort was funded by ONR and includes the following objectives:

- Provide vehicle integrated power source: 120 kW of military grade export power and 21 kW of power on the move
- Allow easy retrofit of existing MTVR vehicle
- Use host vehicle's diesel engine for both mobility and power generation
- Retain MTVR performance

PM EPS expects to have six OBVP MTVR variants available for test and demonstration by the end of Fiscal Year (FY) 12.

Fuel Efficient MTVR FNC. The goals of this effort include increasing fuel efficiency by 15%, extending the range of MTVRs, and reducing the logistics and fuel burden on deployed Marines. This FY 2012 FNC is discussed at length in the Fuel Efficiency Focus Area (Section 4.2).

POM13-08 MTVR Modular Vehicle Platform (MVP)

OPERATIONAL NEED

Objective: Develop open architecture vehicle interfaces to enable modular integration of mobile trauma bay and command and control mission capability sets aboard MTVR platform

Value to Naval Warfighter:

- Flexibility/adaptability in mission planning using a single platform
- Reduced MAGTF logistics footprint
- MVP presents significant capability enhancements across the tactical battle space as gains in these technologies could be leveraged on other tactical vehicles, to include the potential for Autonomous/Robotic application.

Gap # & Title:

POM 13-01 Naval Platform and Systems Total Ownership Cost

POM 13-31 Logistics Support to Distributed Operations

Impact if Not Addressed:

- Distributed Operations will be significantly limited
- Marines will continue to create "homebrew" MTVR mission sets

PROPOSED SOLUTION

The Technology:

- MTVR Open System Architecture and Vehicle Interface
- Mobile Trauma Bay Mission Module
- Mobile Marine Command and Control Mission Module

Similar/Related Projects:

- MTVR On Board Vehicle Power (OBVP) FNC
- Army VICTORY program
- DARPA META program

TRL: Current: 4, Projected at end (FY16) 6

Major goals

- FY13 Subsystem demonstration in SIL
- FY14 Module functionality demonstration on shore net/power
- FY15 Integrate vehicle common interface and test with module
- FY16 Full System Demo/Transition

BUSINESS CASE

Key Metrics:

- Government owned software, architecture, and interface
- 50% reduction in square and cube on seabase
- Up to $53M in cost savings through optimization of mobile network and communications
- Level II Technical Data Package and Technology Demonstrator

Proposed Funding - FY-12 Core

FY12	FY13	FY14	FY15
400K	TBD	TBD	TBD

Partners: PEO LS, Marine Corps Systems Command, Marine Corps Combat Development Command

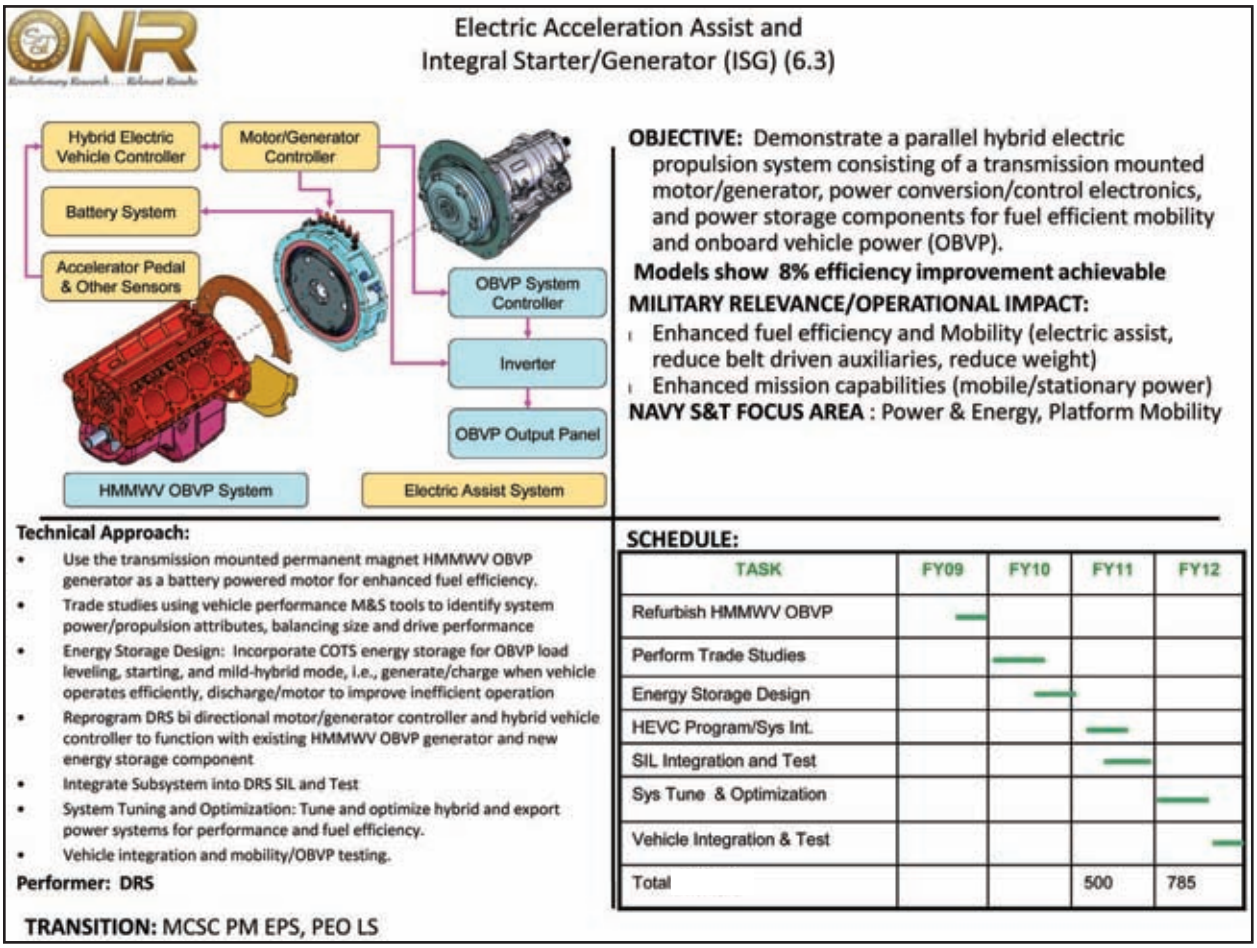
Transition Sponsor: USMC PEO LS, PM-MTVR

ONR POC Contact Info: Mr. Jeff Bradel
703-588-2552, jeff.bradel@navy.mil

MTVR Modular Vehicle Platform (MVP). The capability enhancement that an MTVR equipped with OBVP provides can have synergistic effects across the battle space. In an effort to capitalize on this capability, the PEO LS S&T Directorate submitted a proposed FY14 Enabling Capability (EC) for an MTVR MVP. This effort resulted in MVP being selected as a FY12 Core effort. Goals for FY12 are to identify mission capability improvements as well as S&T investment potential to bring this concept to fruition.

Operational Impact/Benefit to the Warfighter:

- Leverages the flexibility MTVR with OBVP offers today's warfighter as a current PoR "enhanced" with modular capability sets
- Provides the commander flexibility and adaptability in mission packages using a single self-loading platform for many different types of missions
- Reduces the number of vehicles required in theater
- Reduces the force's maintenance burden
- Reduces MAGTF footprint



Electric Acceleration Assist and Integrated Starter Generator. Enable electric acceleration assist, onboard power generation, and elimination of vehicle starter motor, alternator, and battery.

Goal:

- Enhanced fuel efficiency

Operational Impact/Benefit to the Warfighter:

- Enhanced fuel efficiency and mobility
- Enhanced Mission Capability for both mobile and stationary power

PEO LS/ONR Efforts

PEO LS S&T continues its close partnership with ONR and tracks the following efforts:

- Advanced Transmission Technologies
- Efficient Powertrain Technologies
- Integrated Power and Propulsion
- Hybridization and Re-Power

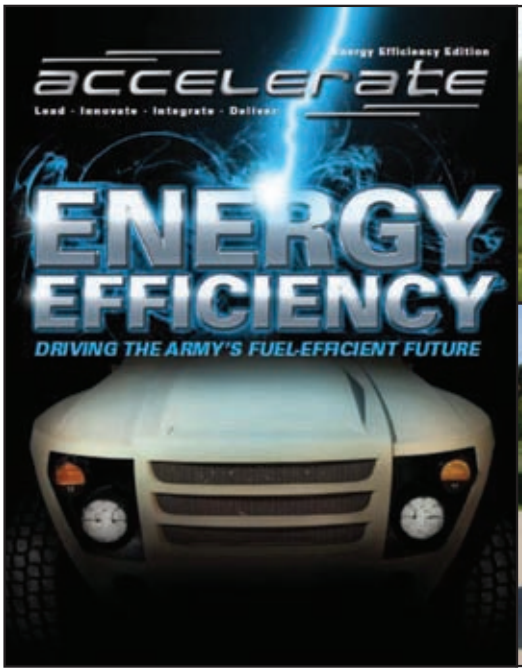
TARDEC Efforts Include

Hybrid Electric Vehicle Experimentation and Assessment (HEVEA). The objective of the HEVEA program is to improve fuel efficiency and enhance export power capability of the existing tactical vehicles through the addition of an advanced diesel engine technology, advanced power dense generator, and hybrid electric drive including regenerative braking.

Goal:

The objectives of the HEVEA program relating to PEO LS efforts include:

- Integrate lighter, higher-powered, JP-8 compliant Cummins ISL engines into the MTVR chassis and maximize common intake, exhaust, and cooling system components of the standard MTVR
- Hybridize OBVP MTVR: Enhance ONR developed MTVR OBVP vehicle through incorporation of a capacitor-based energy storage system (capacitors, energy storage controller) to generate energy during deceleration or idle periods, reducing engine and fuel demands during acceleration
- Support fuel efficiency of United States Marine Corps (USMC) standard MTVR platform, the MTVR OBVP package, and the Hybrid OBVP package
- Develop an advanced Lightweight Synchronous Generator for use on diesel electric military vehicles to provide high power density for export and mobile power
- Develop the next generation electric traction system designed specifically to enhance mobility for an off-road military vehicle at increased efficiencies
- Pursue advanced Tactical Wheeled Vehicle (TWV) power distribution architecture to meet future vehicle propulsion, stationary and on the move power and energy demands



- HEVEA efforts include:
  - Standard testing procedure and methodology for testing HEV's
  - Analytical tools for both assessment and evaluation
  - Established credible/quantifiable data of HEV vice conventional vehicles (fuel economy and reliability)
  - Developed M&S methods

Operational Impact/Benefit to the Warfighter:

- Enhance future tactical vehicle mobility through Engineering and Analysis of HEV platforms
- Support vehicle acquisition strategies with quantifiable and relevant HEV test data and lessons learned

TARDEC POM 13-17 Programs

PEO LS S&T works closely with TARDEC in support of several Power and Energy initiatives. Examples include:

Combat Vehicle Auxiliary Power Unit (APU)

Goal:

- Develop power dense heavy fuel engines for APU applications
- Integrate successful engine programs into platform specific APUs
- Transition successful APU development programs into Abrams, Bradley, Stryker vehicle platforms

Operational Impact/Benefit to the Warfighter:

- Enable engine-off operations such as mounted surveillance for long durations
- Reduce acoustic signature compared to main engine idle
- Reduce fuel consumption in combat vehicles by running APU instead of the main engine
- Reduce maintenance costs for combat vehicle main engine by reducing operating hours
- Increase reliability of high power dense APU systems
- Increase auxiliary power available on combat vehicles
- Expand expertise in small engine and noise control arenas

JP-8 Fuel Cell APU System

Goal:

- Provide quiet, continuous, non-primary electrical power for extended engine-off operation with reduced acoustic and thermal signatures in a ground-breaking fuel cell based auxiliary power unit.

Operational Impact/Benefit to the Warfighter:

- Provide low signature, non-primary vehicle power generation for C4ISR and auxiliary systems (engine off)
- Increase the Warfighter's survivability and lethality through decreased signature during extended silent watch missions
- Increase overall vehicle fuel efficiency to reduce fuel logistics burden
- Provide power for Soldier equipment during transport and overwatch mission scenarios

Efficient Powertrain Technologies

Goal:

- Develop an efficient, reliable powertrain that will dramatically improve the energy productivity of existing military ground vehicle engine-transmission while using less space, improving vehicle mobility and fuel consumption, and reducing thermal load.

Operational Impact/Benefit to the Warfighter:

- More efficient powertrain operating on a wide range of military grade fuels, with reduced heat rejection and improved "energy productivity" specifically for military vehicle applications [Energy Productivity in U.S. Army Weapon Systems, Memorandum dated 7 January 2009]
- Powertrains with increased electrical power generation capabilities for meeting future power demands while improving vehicle mobility and silent watch requirements
- Improved vehicle performance and durability

PEO LS S&T is monitoring TARDEC Power and Energy Efforts:

- Advanced Propulsion with Integrated Starter Generator (ISG) Research
- Advanced Propulsion with Onboard Vehicle Power
- Battlefield Power Generation
- Power Architecture and Standards
- Condition Based Maintenance Advanced Technologies
- National Automotive Center (NAC) Mobile Computing Applications Platform (MCAP)
- NAC Microgrids
- Pulse Power for Weapon and Survivability System Integration

Small Business Innovation Research (SBIR) Efforts

PEO LS S&T is monitoring the following Army SBIR Efforts:

- **Development of Small Fuel Efficient Multi-Fuel Capability Engine**
- **Vehicle Based Exportable Power**

- **Development of High Power Lithium-ion Batteries**
- **Variable Speed Alternator Drive**
- **Lithium Ion Batteries with Wide Operating Temperature Range**
- **Innovative Simulation and Analysis Tool for Vehicle Thermal Management**

Expeditionary Energy

"We equip our forces today to serve as our nation's premier expeditionary force. Through this strategy, we will establish the Marine Corps as the center of innovation in operational energy efficiency, expeditionary energy systems, and renewable energy technology for the battlefield. We will lead requirements development to inform and guide technology innovation by building a deep understanding of energy challenges and possible solutions. We will reset our processes, injecting expeditionary energy concepts into our requirements and acquisitions decisions. We will collaborate with the leading thinkers and innovators in the U.S. Government, academia, and the commercial world. We will be agile and ready to adapt and deploy new capabilities into our operations."

-General James F. Amos, Commandant of the Marine Corps

In publishing the first USMC Expeditionary Energy Strategy and Implementation Plan, the Commandant of the Marine Corps formally brought Power and Energy issues to the forefront of all USMC Acquisition Programs. The prime directives of this plan: Value Energy in our Material Development and Acquisition; Target Materiel Investments in High-Impact Areas; Focus Technology Innovation on Marine Corps Needs; Lead in Deploying Innovative Energy Solutions; and Sustain Energy Security and Environmental Stewardship. Additionally, the establishment of the Initial Capabilities Document for USMC Expeditionary Energy, Water, and Waste will bring structure and focus to this critical capability arena.

Initial Capabilities Document (ICD) for USMC Expeditionary Energy, Water, and Waste

The ICD for USMC Expeditionary Energy, Water, and Waste seeks to resolve the military problem presented by current and future operational energy, water, and waste logistics requirements and the resulting maneuver limitations and vulnerability to attacks on ever more critical and extended supply lines. The intent is for capabilities identified in this ICD to:

Energy Solutions will reduce threats to convoys.

- Achieve resource self-sufficiency on the battlefield
- Reduce energy demand in platforms and systems
- Reduce the overall footprint in current and future expeditionary operations.

PEO LS supports this game-changing approach to addressing critical Power and Energy issues across all programs, and will continue to address Power and Energy as one of its critical Focus Areas.

Expeditionary Forward Operating Base (ExFOB)

The primary focus of ExFOB demonstrations is to observe and evaluate industry solutions that will enhance Marine Corps self-sufficiency, reduce the energy demand of platforms and systems, and lighten the load of the Marine Corps in current and future expeditionary operations.

PEO LS continues to closely monitor the efforts of the Expeditionary Energy Office to include all ExFOB events. In the summer of 2011 ExFOB IV was held at Camp Wilson, aboard the Marine Corps Air Ground Combat Center Twenty Nine Palms, CA. This ExFOB event included several technologies addressing auxiliary and on-board power system applications on tactical vehicles to include the MTVR.

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4.2 Fuel Efficiency

"Reducing the military's dependence on fuel for power generation could reduce the number of road-bound convoys… Without this solution, personnel loss rates are likely to continue at their current rate. Continued casualty accumulation exhibits potential to jeopardize mission success…"

-Lieutenant General Richard Zilmer, United States Marine Corps

Bottom Line Up Front	
Challenge	
Rising military consumption of energy and fuel is a challenge for the core DoD national security mission. The Department needs to reduce the overall demand for fuel and improve the efficiency of military platforms in order to enhance combat effectiveness and reduce risks and costs for military missions. Department of Defense OPERATIONAL ENERGY STRATEGY May 2011 states the US Marine Corps Energy Vision is "To be the premier self-sufficient expeditionary force, instilled with a warrior ethos that equates the efficient use of vital resources with increased combat effectiveness."	
Potential Solutions	
ONR	Fuel Efficient MTVR Fuel Efficient Ground Vehicle Demonstrator (FED)
ONR / TARDEC	HEVEA Research Program
PEO LS / ONR / TARDEC	Fuel Efficiency Enabling Technologies
TARDEC POM 13-17 Programs	Advanced Lubricants/Fluids Program Technologies to Enable Tactical Fuel Use Efficient Powertrain Technologies
SBIRs	Energy Efficiency Enhancements

Potential Solutions

Fuel Efficient Marine Tactical Vehicle Replacement (MTVR)

"The Marine Corps' medium tactical truck, called the Medium Tactical Vehicle Replacement (MTVR), consumes from 40-60% of all fuel consumed by Marine Corps ground vehicles during assault and sustainment operations."

- United States Marine Corps Tactical Fuel Systems (1998-2010) Study - Tactical Fuel Requirements Analysis, 1998

The Fuel Efficient MTVR initiative, a collaborative effort between PEO LS, ONR Code 30, and MCCDC was selected as a new start FNC for FY12. The goal of this effort is to develop, optimize, integrate, and demonstrate at least 15% fuel efficiency improvement over the existing MTVR across a set of driving cycles representative of likely operational conditions, while maintaining MTVR affordability, current mobility, transportability, and survivability capabilities.

Potential Enabling Technologies	
Advanced Fuel Efficient Engine and Idle Reduction Technologies	• Engine Control System for Efficient Torque/Speed Tracking • Optimize turbo machinery, fuel injection schedule, rail and cylinder pressures, compression ratio, and cylinder geometry for JP-8 non-emissions compliant engine
Electrification and Variable Output Control of Mechanical Auxiliaries	• Variable control and selective on/off • Energy storage and auxiliary power unit
Electric Drive with Regenerative Braking	• Flywheel Mounted Motor/Generator with Energy Storage for Regenerative Braking and Electric Acceleration Assist
High-Efficiency/High-Power Density Advanced Transmission/Integration	• Improved materials and higher temperature lubricants • Software controls algorithms optimization • Increased ratio spread to accommodate high speed engine characteristics • Continuously variable transmission for heavy duty applications

A Technology Transition Agreement between ONR and the Program Manager for MTVR was finalized on 21 November 2011, addressing the specifics of pursuing this potential technology.

ONR/TARDEC Efforts

FED
FUEL EFFICIENT GROUND VEHICLE DEMONSTRATOR

Fuel Efficient Ground Vehicle Demonstrator (FED)

The FED was initiated by the Office of the Secretary of Defense to address energy conservation needs highlighted by the Defense Science Board Energy Security Task Force. The overarching goal of the program is to improve military vehicle technology to reduce fuel consumption on the battlefield. This is a collaborative team effort lead by TARDEC and US Army Research Development and Engineering Command. The FED is composed of government and industry Subject Matter Experts (SMEs) evaluating propulsion, drive train, reduced weight, power and integration.

This effort investigates several focus areas that include: (1) Demonstrate a tactical vehicle with significantly greater fuel efficiency while maintaining tactical vehicle capability, (2) Integrate emerging fuel efficient technologies to demonstrate potential capabilities for the next generation of military trucks, and (3) Consider higher risk/higher payoff technologies to attain the most fuel efficient vehicle possible. Sub-working Groups include: System Integration, Operational Changes, Power train/Engine (Hybrid drive, advanced transmissions), Alternative Materials (metallic and non-metallic), Auxiliary Power/Electrical Loads, Fuel/Lubricants, Chassis and Suspension.

FED program objectives include:

- Identifying and assessing new, fuel-efficient vehicle technologies.
- Maintaining tactical vehicle capability while increasing fuel efficiency.

The FED Alpha vehicle (pictured above), is expected to boost fuel economy from approximately 4 MPG to an average of 7.1 MPG on a typical urban patrol mission, using several designed components to achieve efficiencies.

All PEO LS Tactical Vehicle PMs have representation on the FED.

PEO/ONR/TARDEC Efforts

PEO LS is actively engaged with ONR and TARDEC on the following projects under the Code 30 Maneuver portfolio:

Fuel Efficiency Enabling Technologies

Goal:

- Demonstrate technologies that increase fuel efficiency by 20%
- Demonstrate benefit of engine front end accessory drive electrification (electric motor drive vs. belt drive) on candidate MTVR replacement engine
- Reduce risk of future technology insertion by using M&S

Operational Impact/Benefit to the Warfighter:

- Enhance the fuel efficiency of the MTVR.
    - Resulting from this effort could be applicable to other Tactical Ground Vehicle (TGV) programs

TARDEC POM 13-17 Programs

Advanced Lubricants/Fluids Program

Goal:

- Provide innovative petroleum, oil, and lubricants products that:
  - Reduce logistic burden
  - Reduce maintenance requirements
  - Reduce fuel consumption
  - Meet new automotive technology requirements while exceeding future and legacy equipment performance and technical requirements

Operational Impact/Benefit to the Warfighter:

- Reduce sustainment footprint
- Reduce waste products and processing
- Increase equipment reliability and reduce maintenance
- Increase fuel economy to reduce the volume of fuel needed and extend platform range
- Enhance unit resilience in the face of uncertain energy situations
- Contributes to War fighter Outcome

Technologies to Enable Tactical Fuel Use

Goal:

- A variety of fuels are available worldwide and do not meet US specifications, which impacts performance, maintenance, and durability.

Operational Impact/Benefit to the Warfighter:

- Fieldable technologies that will allow use of available fuels with no impacts to performance, maintainability or durability.

Efficient Powertrain Technologies

Goal:

- Develop an efficient, reliable powertrain that will dramatically improve the energy productivity of existing military ground vehicle engine-transmission while using less space, improving vehicle mobility and fuel consumption, and reducing thermal load.

Operational Impact/Benefit to the Warfighter:

- More efficient powertrain operating on a wide range of military grade fuels, with reduced heat rejection and improved “energy productivity” specifically for military vehicle

applications. [Energy Productivity in U.S. Army Weapon Systems, Memorandum dated 7 January 2009]

- Powertrains with increased electrical power generation capabilities for meeting future power demands while improving vehicle mobility and silent watch requirements.
- Improved vehicle performance and durability

SBIR Efforts

- PM MTVR is currently engaged in active SBIR efforts under the category **Engine Efficiency Enhancements**:
  - Diesel engine design resulting in potential increases in both fuel efficiency and low end torque. Combined with other technologies these efforts could represent significant strides in an attempt to reach DoD fuel economy targets.
  - Develop non-trivial retrofit engine technologies that can be adapted to an existing vast base of DoD diesel and gas driven platforms to significantly increase fuel efficiency. This does not require a new engine, rather it upgrades/retrofits to the existing engine (reducing costs).

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4.3 Survivability and Mobility

"We must be able to disperse and concentrate, conduct full spectrum operations across all dimensions (air, land, sea, cyber and the electromagnetic) and provide protected mobility to both dismounted and mounted Marines."

-Statement before the House Armed Services Committee, Subcommittee on Tactical Air and Land Forces, November 16, 2011, of Brigadier General Daniel J. O'Donohue, Director, Capabilities Development Directorate and Brigadier General Frank L. Kelly, Commander, Marine Corps Systems Command and Mr. William E. Taylor, Program Executive Officer Land Systems

Bottom Line Up Front	
Challenge	
Survivability and Mobility are addressed jointly because they are clearly linked. This challenge is to provide increased protection (survivability) while maintaining (or increasing) mobility.	
Potential Solutions - Survivability	
ONR	Advanced Electromagnetic Armor (AEMA) Advanced Requirements for Crew Safety Combat Science and Technology Vehicle (CSTV) Shock Mitigating Seats Energy Absorbing Structures for Blast Mitigation Expeditionary Light Armor Seeding Development High Strength-High Ductility Nano Composites Survivability Analysis of Alternative Tool Trimodal Aluminum
RDECOM / TARDEC	Advanced Combat Vehicle Armor Development (ACVAD) Electro-Magnetic (EM) Armor KE Active Protection System (APS) Kinetic Energy Armor Integration Techniques Laser and High Energy threat Research Low Risk EM Armor Multi Threat Armor Development Multi-Function Armor Occupant Centric Survivability RPG Active Protection (RAP) Sensor Enhanced Armor Tactical Vehicle Armor Development Transparent Armor Vision Protection from Lasers Warfighter Injury Assessment Manikin (WIAMAN)
SBIRs	Mitigation of Blast Injuries Laser Eye Protection Light Weight High Temp Armor Lightweight Self-Sealing Fuel Tanks with Hydraulic Ram Mitigation Lightweight Armor Study Transparent Armor Delamination Study Software for FOA of Effects of Blast & Ballistic Impacts on Vehicles Innovative Manufacturing Research-Forming of Large Light Armor Alloy Modular Anthropomorphic Test Device Modular Light Weight Armor Composite Armor Structural Monitoring (CASM)

Bottom Line Up Front	
Potential Solutions - Survivability Continued	
SBIRs conitinued	Innovative Cost-Effective Lightweight Transparent Armor for Vehicles Low Cost Manufacturing of the Ballistic Resistant Transparent Spinel Windows Nanoinfusion Technology for Low-Cost, Lightweight, Transparent Armor Optically Transparent, Ballistic Protective HybridSil Armor for Combat Vehicles Real Time Damage Monitoring of Composite Vehicle Armor Structure Integrity Using Embedded Sensors Transparent Armor Delamination Phase A Study North Carolina State University – Metallic Foam Armor MTVR Blast Seat Evaluation
Potential Solutions - Mobility	
ONR	Advanced Suspension System – LAV Advanced Propulsion Technologies Electrical Acceleration Assist & Integrated Starter Generator (ISG) Combat Science and Technology Vehicle (CSTV) Infinitely Variable Transmission (IVT) Modular Vehicle Platform (MVP) Vehicle Stability
RDECOM / TARDEC	Advanced Propulsion w/ISG Research Advanced Running Gear Mobility Combat Engine Research Concept Based Maintenance (CBM) Technologies Continuous High Output Engine Research Elastomer Maturation for Increased Track Durability GVPM High Performance Lightweight Track System Next Generation Engine Research
MCWL	Autonomous Mobility Appliqué System (AMAS) JCTD
SBIRs	An Innovative Ultra Lightweight Runflat Technology Passive Adaptive Run-on-Flat (RoF) Tires High Mobility Suspension Technologies Suspension and Track Noise and Vibration Reduction

Potential Solutions

Survivability

Although fire suppression is a subset of survivability, all fire related projects and programs are addressed in the Fire Suppression section 4.5 of the ATIP.

ONR Efforts

Advanced Electromagnetic Armor (AEMA). The AEMA program is developing new defeat mechanisms for efficient lightweight protection concepts and exploring novel under vehicle protection concepts and developing improved vehicle mine blast protection. The goal is to increase survivability against Explosively Formed Penetrators (EFPs)/RPGs and Air to Ground Missiles while reducing power requirements and weight burden.

Advanced Requirements for Crew Safety. The objective of this program is to develop validated, quantitative, medically-based and measurable crew survivability requirements for

the JLTV. This program concentrates on the need to focus on the warfighter vice the platform survivability.

Combat Science and Technology Vehicle (CSTV) Shock Mitigating Seats. This ONR project has the goal of developing seating technology and services to protect the crew against current/emerging vehicle IED/Mine threats and rollover. M&S tools for end-to-end threat to occupant characterization will be developed for evaluation of loads and injury assessments. Included in this project is the development of a test-bed for seat concepts, emphasizing lower leg and multi-directional protection.

Energy Absorbing Structures for Blast Mitigation. This project will explore the development of new energy absorbing structures to improve crew survivability against underbody blast events.

An up-armored LVSR arrives ashore.

Expeditionary Light Armor Seeding Development. By expanding existing ballistic performance design equations, it will be possible to develop properties-based equations for state-of-the-art and emerging ceramic composite armor systems. Possible equation parameters could include ceramic hardness, yield and fracture toughness; and composite yield, elongation, and stiffness.

High Strength-High Ductility Nano Composites. The objective is to develop nanoscale reinforcements, in combination with a dispersion strengthened matrix and coarse grained region that has tailorable plasticity to yield a high strength-high ductility multi-scale nano composite aluminum.

Survivability Analysis of Alternative Tool. The objective is to develop an M&S tool to conduct Analysis of Alternatives (AoA) establishing key survivability performance parameter thresholds for crew casualty and help focus investments for survivability.

Trimodal Aluminum. This is a new mass efficient ballistic armor that simultaneously absorbs energy during dynamic loading while maintaining high strength. Trimodal Aluminum has the potential of offering a light appliqué armor system providing equal protection to fielded heavier appliqué systems at 60% less weight. Efforts such as this enable lighter, more survivable, and maneuverable ground combat vehicles.

RDECOM & TARDEC Efforts

Advanced Combat Vehicle Armor Development (ACVAD). The ACVAD program's purpose is to develop and demonstrate EM armor, multifunctional SE and EA armor with an advanced

electro-magnetic defeat mechanism in an integrated armor package. The armor design/ integration lessons learned will be used in the development of EM, SE and EA armors providing a multi-hit armor system without recharging and meet emerging survivability threats.

Electro-Magnetic (EM) Armor. The EM Armor project purpose is to develop and demonstrate an advance electromagnetic defeat mechanism in an integrated armor package. The products developed from the project will be designed to meet ACVAD threats.

KE Active Protection System (APS). KE APS is focused on developing a guided interceptor, warhead and fusing capability that integrate into an Active Protection System providing capability to defeat Tank-Fired Kinetic Energy Long Rod Threats.

Kinetic Energy Armor Integration Techniques. This project focuses on developing and validating improved techniques and capabilities to integrate and test advanced medium and heavy appliqué armors for combat platforms with the goal of providing improved bolted/bonded joints, closeouts, and grilles for medium and heavy armor.

Laser and High Energy threat Research. The purpose of the project is to determine the impact of short-pulse and high energy lasers on vision and sensor technologies and investigate new the technologies for protection.

Low Risk EM Armor. The Low Risk EM Armor will develop and demonstrate electro-magnetic defeat mechanisms in an integrated armor package. It will utilize COTS components to integrate an electro-magnetic armor on a ground combat system platform.

Multi Threat Armor Development. The goal is to develop and mature lightweight advanced multi-threat B-kit and C-kit armor solutions received from ARL and Industry for transition to PEO CS&CSS vehicles and ensure the B-kit and C-kit armor designs can withstand residual projectiles from various APS technologies. The result will be lighter weight armor solutions allowing for greater vehicle payload and performance and reducing the vehicle's overall visual signature.

Multi-Function Armor. This program will meet the need to develop lower weight, higher performance armor solutions with embedded sensors for real-time health monitoring, signature control and situation awareness. This improved ballistic armor will include embedded health monitoring, antenna and signature control.

Occupant Centric Survivability. The goal is to approach occupant protection from a system level and leverage defense, automotive/race industry & medical community knowledge to integrate IED/mine protection, PPE, crash and rollover protection. Continue development of M&S capability to predict and reconstruct mine/IED/crash events.

RPG Active Protection (RAP). The purpose of RAP is the Active Protection concept developed to current user requirements and matured to TRL 6, with focus on RPGs. The system will be developed to open architecture standards (communication protocols, processors and displays), for the user developed APS requirements.

Sensor Enhanced Armor. This project will implement various ways to assess the health of the armor over the life of the vehicle. The Sensors will provide real-time armor data.

Tactical Vehicle Armor Development. This project will develop opaque armors for the defeat of direct fire, IED, shape charge jet threats and APS residuals.

Transparent Armor. The project purpose is to research and develop technologies and processes to improve the performance and environmental stability of transparent armor laminates, refine ATPD 2352 to improve the quality of transparent armor and the development of products which improve rock-strike and delamination resistance.

Vision Protection from Lasers. The purpose of this project is to develop sensor and vision protection from lasers.

Warfighter Injury Assessment Manikin (WIAMAN). WIAMan is a collaborative effort to create a Warrior-representative test dummy and associated biomedically-validated injury assessment tools for use in live-fire test & evaluation and vehicle development efforts.

DARPA Efforts

DARPA Armor Challenge. Many small companies are developing new armor concepts and products but lack the required resources to initiate full-scale armor development programs. In order to ensure ideas are not overlooked, DARPA has initiated the "Armor Challenge" program to concentrate on inventors and small organizations in efforts to identify revolutionary and promising new armor systems for military vehicles and personnel. While not a full development program, Armor Challenge reimburses qualified participants for the costs of manufacturing initial test articles. The program evaluates participants based on ballistic test results at qualified testing facilities during periodic "shoot-offs" and assesses the cost effectiveness of armor designs. Armor Challenge then considers successful armor designs for follow-on testing or potential armor development programs.

Survivability SBIR Efforts

- **Mitigation of Blast Injuries**
- **Laser Eye Protection**
- **Light Weight High Temp Armor**
- **Lightweight Self-Sealing Fuel Tanks with Hydraulic Ram Mitigation**
- **Lightweight Armor Study**
- **Transparent Armor Delamination Study**
- **Software for FOA of Effects of Blast & Ballistic Impacts on Vehicles**
- **Innovative Manufacturing Research-Forming of Large Light Armor Alloy**
- **Modular Anthropomorphic Test Device**
- **Modular Light Weight Armor**

- **Composite Armor Structural Monitoring (CASM)**
- **Innovative Cost-Effective Lightweight Transparent Armor for Vehicles**
- **Low Cost Manufacturing of the Ballistic Resistant Transparent Spinel Windows**
- **Nanoinfusion Technology for Low-Cost, Lightweight, Transparent Armor**
- **Optically Transparent, Ballistic Protective HybridSil Armor for Combat Vehicles**
- **Real Time Damage Monitoring of Composite Vehicle Armor Structure Integrity Using Embedded Sensors**
- **Transparent Armor Delamination Phase A study**
- **North Carolina State University – Metallic Foam Armor**
- **MTVR Blast Seat Evaluation –** This is an STTR evaluation of energy absorbing seats specifically for the MTVR.

"To move swiftly, strike vigorously, and secure all the fruits of victory is the secret of successful war."

-Lieutenant General Thomas "Stonewall" Jackson, CSA

Mobility

Vehicle Mobility will likely benefit from the Fuel Efficiency, Modeling and Simulation, and Weight Reduction S&T Focus Areas.

ONR Efforts

Advanced Suspension System – LAV. This project will develop a fully operational ride-height adjustable advanced suspension system to be installed and tested on a Light Armored Vehicle replacing the current passive LAV suspension. The goal is to reduce absorbed power at the driver's seat by 30% for all anticipated vehicle weight conditions.

Advanced Propulsion Technologies. The purpose is to investigate and develop advanced propulsion components to achieve improved system efficiency including electric and Hybrid

Electric, and other non-conventional propulsion architectures for manned and unmanned combat vehicles, either wheeled or tracked and other alternative forms of mobility.

Combat Science and Technology Vehicle (CSTV) Infinitely Variable Transmission (IVT). The Objective is to demonstrate an operationally suitable IVT for tactical wheeled military vehicles. The CSTV IVT has the potential of improving fuel economy and reducing gross weight of the vehicle.

Modular Vehicle Platform (MVP). Demonstrate a single self-loading platform (i.e. Medium Tactical Vehicle Replacement) with mobile modular combat capabilities (i.e. weapons, command and control, trauma bay), housed in standard containers (i.e. CONEX shipping container).

Vehicle Stability. Efforts in this area include development of a stability control technology suitable for integration into the tactical vehicle fleet, reducing the tendency of vehicle rollovers. Results of these S&T contributions will include: reduced vehicle rollover tendencies, increased vehicle stability, enhanced vehicle safety, and improved ride quality.

RDECOM / TARDEC Efforts

Advanced Propulsion w/ISG Research. The purpose of this program is to investigate and demonstrate advanced propulsion technologies, develop in-house capability to test, analyze an advance integrated hybrid and mild hybrid systems in vehicle platforms.

Advanced Running Gear Mobility. This project takes a systems approach to research running gear system improvements for legacy and future combat and tactical vehicles to reduce weight, improve durability, survivability, and reliability. An active suspension system will be developed offering energy regeneration based on vehicle movement, real-time prognostic/diagnostic tools, and increased durability. Additional goals include, increased survivability through improved mine blast and fire resistance, reduced track and suspension system life cycle costs through longer lasting materials, greater off road performance, greater roll stability, and lower interior hull shock/vibration.

Combat Engine Research. The purpose of this program is to investigate and validate novel high power density low heat rejection fuel efficient engine design concepts to meet mobility need of future combat engine vehicles.

Concept Based Maintenance (CBM) Technologies. The purpose is to develop, integrate, and demonstrate CBM algorithms, data acquisitions, storage and transfer capabilities, as well as vehicle management agents. This will have the potential for improving operational readiness through platform health status reporting and predictive failures.

Continuous High Output Engine Research. The project's purpose is to continue R&D activity on high speed engines and implement design change improvements identified during exploratory development phases to increase specific output. The best engine candidates will be identified for further advanced development for next generation diesel engines.

Elastomer Maturation for Increased Track Durability. The purpose of this project is to develop improved thermoset components that improve track system durability and reliability and reduce life cycle costs. Track system life improvement goal is 50%.

GVPM High Performance Lightweight Track System. The purpose of this project is deliver a robust, survivable lightweight track system with a 20 to 25% improvement in durability for a 45 ton class vehicle with growth potential for future ground vehicles program.

Next Generation Engine Research. The purpose of this project is to combine high speed combustion, closed loop control, oil cooled, low heat rejection engine research efforts for development of a high power density diesel engine with operating characteristics enabling propulsion system power densities greater than 10 Net Hp/ cu. ft. of system installation volume.

Operating in the harshest of environments, mobility continues to be a challenge for Marine Corps vehicles.

"We are light enough to get there quickly, but heavy enough to carry the day upon arrival."

-General James F. Amos, Commandant of the Marine Corps, February 8, 2011,
Marine Memorial Club, San Francisco, CA

MCWL Efforts

Autonomous Mobility Appliqué System (AMAS) JCTD. This effort provides scalable autonomy in a single material solution, agnostic of tactical platform. The autonomy kit would provide scalable autonomy ranging from Driver Assist functionality through autonomous behaviors. The Vehicle By-wire kit would provide the actuation and interface for the Autonomy kit's capabilities.

Mobility SBIR Efforts

- **An Innovative Ultra Lightweight Runflat Technology**
- **Passive Adaptive Run-on-Flat (RoF) Tires**
- **High Mobility Suspension Technologies**
- **Suspension and Track Noise and Vibration Reduction**

4.4 Modeling and Simulation

Bottom Line Up Front	
Challenge	
As resources tighten in the Department of Defense but performance demands for tactical vehicles increase, a ground tactical vehicle modeling and simulation "systems engineering" suite of tools that will enable M&S based development, acquisition, and lifecycle management is required. The objective of this focus area is to develop a model to address top priority program technical issues and provide a fully integrated, "turn-key" system that can be operated by Government personnel (without additional support) and eventually be expanded to support all tactical wheeled vehicles within the United States Marine Corps (USMC).	
Potential Solutions	
PEO LS / MCSC	MPC JLTV Systems Engineering Toolkit
ONR	Military Driving Cycle Composite Armor Modeling and Optimization Human Surrogate Development Improved Survivability Modeling and Injury Prediction Correlation to ORCA Modeling and Simulation of Advanced Armor Systems Novel Ceramic Armor Configuration Modeling
SBIR	Mitigation of Blast Injuries through M&S Innovative manufacturing research on forming of large light armor alloy sections resistant to blast and penetration. Linguistic Geometry Based Predictive Technology for Simulation and Training
TARDEC	DADS, Nato Reference Mobility Model GT Power, Star, Multi-Service Electro-Optics Signature Nastran, nCode Fatigue LS-DYNA, Mathmatical Dynmaic Models Cooling System Evaluation Tool Armor Durability Simulation Hit Avoidance SIL Ground Systems Survivability Head Impact Protection SIL Multi-Axis Blast Simulator Threat Oriented Survivability Optimization Model Lightweight Armor Evaluation Process Linear Impact Sled WIAMan Warrior Injury Manikin and Assessment Framework

Potential Solutions

PEO LS is actively engaged with ONR, MCSC, US Army (RDECOM-TARDEC), DARPA and various Industry partners and other agencies to address the Marine Corps' M&S challenges. To date, M&S efforts for Tactical Wheeled Vehicles have not been fully integrated to provide a "total systems" approach. Previous M&S work with a "Systems Engineering" focus includes:

Marine Personnel Carrier (MPC) Vehicle Performance Generation Tool. A suite of interactive systems engineering tools to support decision makers in defining vehicle specifications. The requirements optimization process allows multiple vehicle subsystems to be varied concurrently while assessing differing vehicle performance attributes, such as power train performance, vehicle dynamics, human factors and transportability.

JLTV Systems Engineering Toolkit (Penn State University). Developing common M&S requirements for an acquisition model for JLTV. Developing a Systems Engineering Toolkit for the JLTV program allowed for the exploration of vehicle performance parameters versus vehicle acquisition cost and weight.

FACTS (Flexible AC Transmission Systems) Power network modeling and simulation. These are M&S tools to model this new power transfer, controllability, and stability technology. A new technology based on power electronics -- offers an opportunity to enhance controllability, stability, and power transfer capability of AC transmission systems.

ONR Efforts

Military Driving Cycle. Utilizes a subset of logistics data from the Embedded Platform Logistics System to characterize the terrain and system state of Marine Corps vehicles during high fuel consuming operational scenarios. This effort concluded in FY11 but follow on work will be driven by the Fuel Efficient MTVR FNC.

Composite Armor Modeling and Optimization. This is an ongoing effort with Battelle Institute funded through FY14. The objective of this program is to develop advanced analytical models and designing tools for innovative composite structures for armored vehicles to protect against antitank landmines and Improvised Explosive Devices (IEDs).

Human Surrogate Development. ONR and JHU APL effort to develop state-of-the-art human surrogates to understand how the brain is affected by blast trauma, and to discover novel ways to protect warriors from debilitating Traumatic Brain Injury.

Improved Survivability Modeling and Injury Prediction Correlation to ORCA. This is an FY13 new start designed to review the ORCA blast module in order to determine which changes and additions should be made to improve and expand its capabilities.

Modeling and Simulation of Advanced Armor Systems. This is an FY13 new start program and may align well with the active RDECOM effort to build more accurate predictive modeling and simulation tools focused models (i.e., ceramic crack propagation). This will address the need to define attainable model/simulation goals and would have value to designers/integrators of armor materials systems.

Novel Ceramic Armor Configuration Modeling. This is an FY13 new start that will develop and apply a novel concept to measure penetrator induced shock loads in ceramic armor.

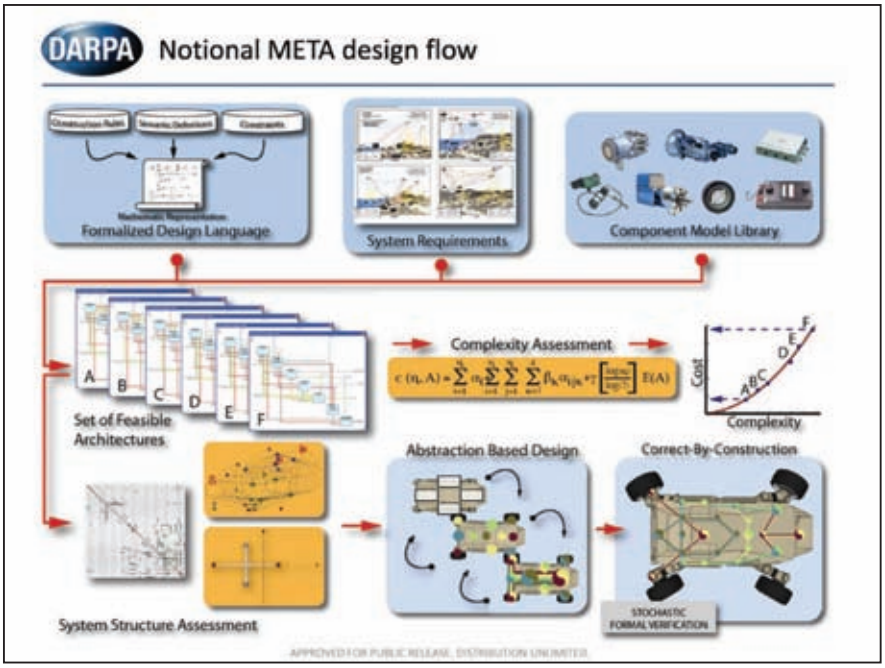
DARPA Efforts

DARPA Advanced Vehicle Make (AVM). The AVM effort is a portfolio of programs addressing revolutionary approaches to the design, verification and manufacturing of complex defense systems and vehicles. The portfolio consists of three primary programs: META, Instant Foundry Adaptive through Bits (IFAB) and Fast Adaptable Next-Generation Ground Vehicle (FANG).

The META program is meant to dramatically improve the existing systems engineering, integration, and testing process for defense systems. META is not predicated on one particular alternative approach, metric, technique or tool. However, in a broad sense, it aims to develop model-based design methods for cyber-physical systems far more complex and heterogeneous than those to which such methods are applied today.

The top-level technical objectives of the META program are as follows:

- Develop a practical, observable metric of complexity for cyber-physical systems to enable cyber-vs-physical implementation trades and to improve parametrization of cost and schedule;
- Develop a quantitative metric of adaptability associated with a given system architecture support trade-offs between adaptability, complexity, performance, cost, schedule, risk, and other system attributes;
- Develop a structured design flow employing hierarchical abstraction and model-based composition of electromechanical and software components;
- Develop a component and manufacturing model library for a given airborne or ground vehicle systems domain through extensive characterization of desirable and spurious interactions, dynamics, and properties of all constituent components down to the numbered part level; develop context models to reflect various operational environments;
- Develop a verification flow that generates probabilistic "certificates of correctness" for the entire cyber-physical system based on stochastic formal methods, scaling linearly with problem size;
- Apply the above framework and toolset to design, manufacture, integrate, and verify a ground vehicle of substantial complexity 5X faster than with a conventional design/build/test approach.



TARDEC Efforts

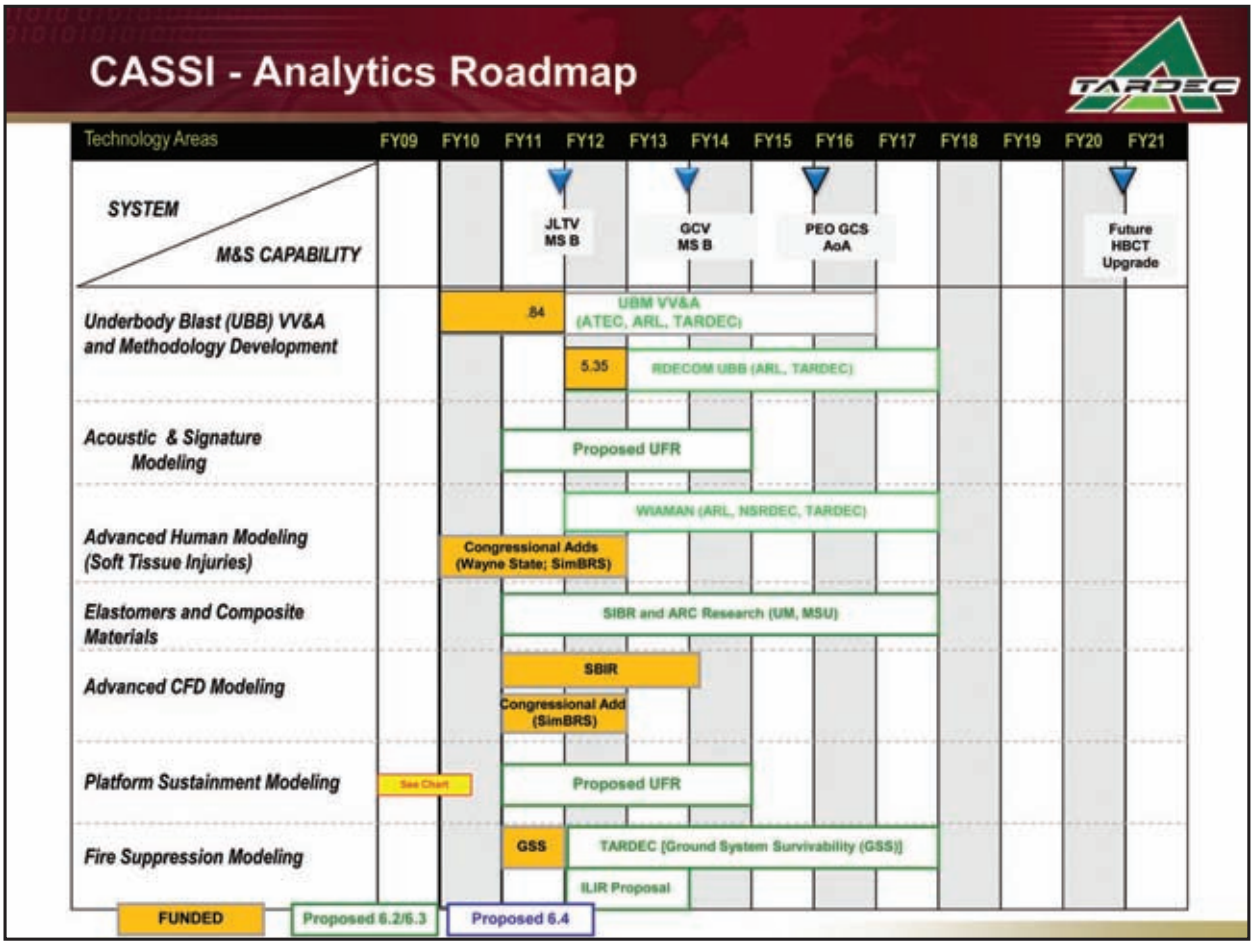


Figure 5-CASSi Analytics Plan

TARDEC has a number of M&S efforts within the Concepts, Analysis, Systems, Simulations, and Integrations (CASSI) program that include:

DADS, Nato Reference Mobility Model - Multi-body Vehicle Dynamics

- Automotive Performance and Mobility Prediction

GT Power, Star, Multi-Service Electro-Optics Signature - Computational Fluid Dynamics

- Thermal and Aerodynamic Analysis

Nastran, nCode Fatigue - Durability, Stress & Fatigue

LS-DYNA, Mathmatical Dynmaic Models - Predictive Analysis of Blast Events

- Finite Element Analysis
- Structural integrity analysis in a blast event

Cooling System Evaluation Tool. M&S and test and evaluation efforts seek to understand the component and system-level impacts of advanced heat-rejecting materials and cooling.

Armor Durability Simulation. Provide the armor technology development community with a computational toolbox for determination of durability and environmental performance of advanced passive/reactive armor designs.

Hit Avoidance SIL. A tool to aid in the development and integration of Hit Avoidance Systems for ground-based combat vehicles.

Ground Systems Survivability Head Impact Protection SIL. Reduce the injuries to head, neck and spine of occupants in a mine/improvised explosive device, crash, and rollover events.

- Head impact protection test rig
- Test methodology and standards
- Finite element models

Multi-Axis Blast Simulator. Intended to reduce the ground system vehicle occupant injuries and develop occupant protection technologies.

- Test rig and laboratory
- Test methodology and standards
- Finite element models

Threat Oriented Survivability Optimization Model. Advanced and innovative capability to perform system level trades using a mathematical assessment of traditional and nontraditional survivability technologies.

- Optimization software
- Survivability metrics
- Streamlining of concept definition

Lightweight Armor Evaluation Process. Support current and future armor needs by providing vendors with a process by which their solutions can be analyzed by the government at the coupon size level. This will also provide the government a common testing reference.

Linear Impact Sled. Creates infrastructure, physical and virtual tools, and other technologies for enhanced occupant protection in ground vehicles.

SBIR Effort

- **Mitigation of Blast Injuries through M&S.** The objective of this topic is to investigate the effect of non-centerline IED/mine blast on crew survivability and to develop a physics-based model that will assist in the design of safety components devised to mitigate injuries sustained by individuals riding in tactical wheeled vehicles.

- **Innovative manufacturing research on forming of large light armor alloy sections resistant to blast and penetration.** Further we will utilize high fidelity modeling and simulation to determine the armor's effectiveness against penetration and blast before testing is required.
- **Linguistic Geometry Based Predictive Technology for Simulation and Training.** This effort will apply Linguistic Geometry technology to enhance predictive technology for tactical training simulations

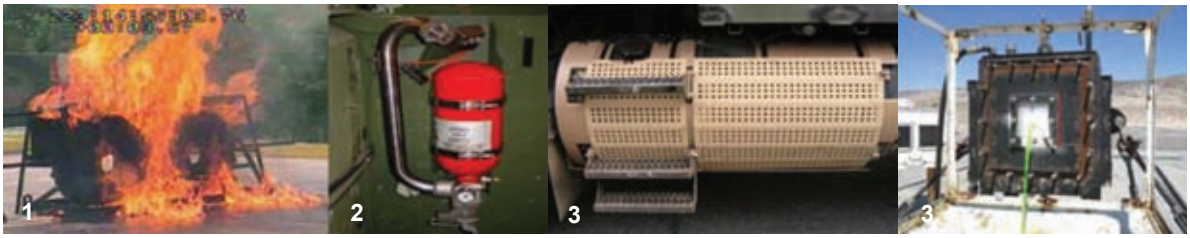
4.5 Fuel Containment/Fire Suppression

Bottom Line Up Front	
Challenge	
Tactical Ground Vehicle fires continue to pose a significant threat to our warfighters. Loss of life, critical cargo, and vehicle platforms presents Commanders with significant challenges in executing their mission. Providing suitable fuel containment, fire detection and extinguishing capabilities presents a critical challenge to vehicle programs given space/weight/performance limitations as well as factors such as cost and levels of survivability required.	
Potential Solutions	
PEO LS	MTVR Fire Suppression LVSR Fire Suppression Fuel Tank Protection Systems (ONR SwampWorks)
TARDEC	Fire Protection Research Advanced Fire Protection R&D Fire Protection SIL Simulations of Actual Military Ground Vehicle AFES System Design
SBIRs / STTRs	Modular Lightweight External Fuel Tank System (SBIR) Lightweight self-sealing Fuel Tank with Hydraulic Ram Mitigation (SBIR) Mitigation of Fuel Tank Explosions and Fires from IED Blasts (STTR) Mitigation of Fuel Tank Explosion and Fires Using a Hybrid Electrochemical Oxygen Extraction and Explosion Suppression Foam System (STTR)

Potential Solutions

PEO LS S&T representatives continue to work with ONR, TARDEC, MCSC, Naval Innovation Laboratory (NaIL), other Government Agencies, Industry and Academia in investigating areas such as:

- Dry Bay Fire Mitigation Technologies
- Powder Panels
- Self Healing Polyurea
- Self-Sealing Tanks
- Tire Fire Suppression Technologies
- Engine and Crew Compartment Suppression Systems



(1) Fire Suppression, (2) Self Healing Polyurea and (3) Powder Panel Testing.

These and other potential technology solutions are being considered to address crew and vehicle survivability.

MTVR Fire Suppression

UNCLASSIFIED

Medium Tactical Vehicle Replacement (MTVR) Fire Suppression System (FSS) Status

Fuel Tank Fire Protection

Fire Extinguishing Capability

Uses Powder Panel Technology

Program Description

- The MTVR replaced the aging M809/M939 series 5-ton trucks with state-of-the-art commercial automotive technology beginning in 2001. The MTVR cargo truck has a 7.1-ton off road and 15-ton on road payload, and a 22-year service life. MTVR Variants include the Dump, Wrecker, and Tractor (5th Wheel). There is a high level of commonality across the family of vehicles.
- The MTVR Armor System (MAS) provides complete 360-degree protection as well as overhead and underbody protection for the crew compartment. The MAS is a permanent modification to the vehicle and includes an upgraded front suspension and cab rebuild. The kit includes a removable personnel carrier (with ballistic glass), air conditioning system, and machine gun mount. All vehicles in theater include MAS armor.

IOC (vehicle): 4QFY99 FOC: Dec 09(O) / Jun 10(T) AAO: 10,139

FSS Status

- Status: MTVR armored vehicles include fuel tank fire protection kits. Armored and unarmored vehicles have hand held fire extinguishers mounted inside the cab. There are currently no automatic fire suppression systems in MTVRs.

- Ongoing efforts:
  1) Leveraging LVSR automatic fire suppression system study. Intent to develop common system with LVSR.
  2) Submitted POM-12 initiative for funding fire suppression upgrades for all vehicles per agreement with MCDDC.
  3) Coordinating efforts with MCCDC, MCSC, and other vehicle PMs.

UNCLASSIFIED

UNCLASSIFIED

LOGISTICS VEHICLE SYSTEM REPLACEMENT (LVSR) Fire Suppression System (FSS) Status

Program Description

The Logistics Vehicle System Replacement (LVSR) will replace the current Marine Corps heavy-tactical wheeled vehicle, the Logistics Vehicle System (LVS). As the Marine Corps' heavy-tactical distribution system, the LVSR Cargo variant will transport bulk liquids (fuel and water); ammunition; standardized containers; bulk, breakbulk, palletized cargo, and bridging equipment. The LVSR Wrecker variant will perform heavy wrecker/recovery missions, while the LVSR Tractor variant will tow heavy engineer equipment and combat vehicles with the M870A2 40 ton Medium Heavy Equipment Trailer (MHET).

IOC: 3QFY09 FOC: FY13 AAO: 1699

FSS Status

- Status: Current LVSR fire protection consists of hand held fire extinguisher inside crew cab. Currently no automatic fire suppression systems.

- Ongoing efforts:
  1) Working with OEM (Oshkosh Corp) to develop automatic fire suppression system for crew compartment, engine compartment, and exterior tires (2 front cab axles).
  2) Working with Oshkosh to design fuel tank fire protection kit (similar to MTVR kit).
  3) Submitted POM-12 initiative for funding fire suppression upgrades for all vehicles per agreement with MCDDC.
  4) Coordinating efforts with MCCDC, MCSC, and other vehicle PMs.

UNCLASSIFIED

ONR SwampWorks

PEO LS S&T has teamed with the MCSC Program Manager for Materials, System Engineering, Interoperability, Architecture and Technology (SIAT) and ONR SwampWorks in an effort to address Fuel Tank Protection Systems for Tactical Vehicles. This effort seeks to develop a new class of integrated fuel tank protection for combat vehicles. This will encompass a singular coating technology that (1) self-seals upon small arms ballistic threats / impacts, (2) self-protects against pool-fire threats, and (3) provides fire suppression for IED and EFP events. The intent of this effort is to develop a military specification and qualify potential permanently self-sealing coatings for Tactical Vehicles to be used on current and future vehicle fuel tanks as stand-alone protection against ballistic threats.

TARDEC Efforts

PEO LS S&T continues its work with TARDEC to investigate technology enhancements for Fire Protection. Current TARDEC efforts include:

Fire Protection Research

Goal:

- Provide new platforms and legacy vehicle modernization programs with improved fire protection technologies to increase warrior and system survivability against current and emerging battlefield threats.

Operational Impact/Benefit to the Warfighter:

- Tolerant fuel container designs which reduce the likelihood of catastrophic loss of crew and system
- Robust fire suppression systems with latest agents and improved reaction time to battlefield threats
- Ability to predict performance of crew AFES to reduce risk and the need for system testing

Advanced Fire Protection R&D

Goal:

- Provide new platforms and legacy vehicle modernization programs with improved damage mitigation techniques to protect against current and emerging fire threats.

Operational Impact/Benefit to the Warfighter:

- Reduced probability of crew incapacitation and vehicle kills from fire and fragment threats
- Damage tolerant fuel containers that reduce likelihood of catastrophic vehicle fires
- Reduced potential for injury from fire by-products
- Capability to validate system-level AFES performance

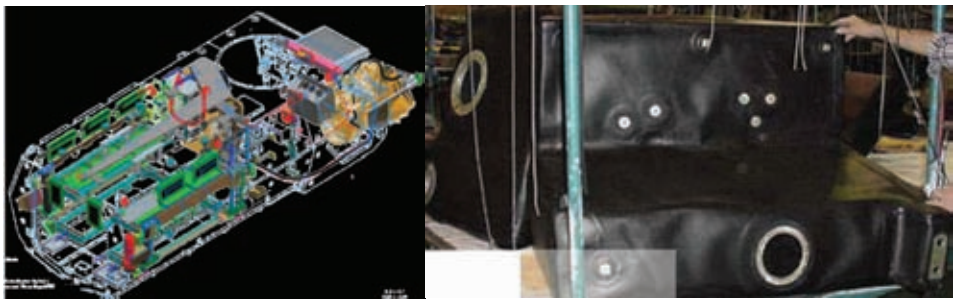
Fire Protection Research to Support Convoy Operations

Goal:

- Provide fire protection solutions currently available to customers for Ground Combat Vehicle modernization and retrofit programs. Perform basic research and develop system specifications for survivable fuel tanks and materials which increase Soldier and system survivability while providing vehicle design flexibility.

Operational Impact/Benefit to the Warfighter:

- Reduced implementation and life-cycle costs for tactical vehicle fire protection
- M&S tools for optimization of ground vehicle design and analysis



TARDEC M&S and Fuel Tank Fire Protection Tests

Fire Protection SIL

Goal:

- The Fire Protection Laboratory will provide in-house integration and evaluation of fire protection system technologies. The in-house M&S capability will allow prediction of fire extinguishing system performance and compare multiple configurations.

Operational Impact/Benefit to the Warfighter:

- Reduced integration and test costs while improving response to customers
- Enhanced ability to develop and transfer innovations to vehicle PMs and the field with potentially life-saving technologies

Simulations of Actual Military Ground Vehicle AFES System Design

Goal:

- Provide fire protection solutions currently available to customers for Ground Combat Vehicle modernization and retrofit programs. Perform basic research and develop system specifications for survivable fuel tanks and materials which increase soldier and system survivability while providing vehicle design flexibility.

Operational Impact/Benefit to the Warfighter:

- Reduced implementation and life-cycle costs for tactical vehicle fire protection
- M&S tools for optimization of Ground Vehicle design and analysis

SBIR and STTR Efforts

The competing requirements of ballistic protection, fuel containment, and vehicle weight present a significant engineering challenge for Marine TGVs. PEO LS S&T representatives are continuing to monitor the following SBIR and STTR efforts:

- **Modular Lightweight External Fuel Tank System (SBIR)**
- **Lightweight self-sealing Fuel Tank with Hydraulic Ram Mitigation (SBIR)**
- **Mitigation of Fuel Tank Explosions and Fires from IED Blasts. (STTR)**
- **Mitigation of Fuel Tank Explosion and Fires Using a Hybrid Electrochemical Oxygen Extraction and Explosion Suppression Foam system (STTR)**

Technologies and capabilities identified as a result of these efforts can potentially have application across the PEO LS portfolio.

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4.6 Open Plug and Play Commmunication Architecture

Bottom Line Up Front	
Challenge	
Operating force demand for more complex and more capable Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) is driving a need to develop an open source, open architecture based specification for tactical vehicles that allows plug and play mission capabilities. The demand signal from the operational forces is very clear as articulated in Urgent Universal Need Statements (UUNS), Deliberate Universal Need Statements (D-UNS), and a myriad of field modifications to vehicle platforms to achieve better C4ISR capabilities and more functionality and tactical agility for existing platforms. The MAGTF's ability to provide network capabilities and adequate force protection is dependent on a more organized approach to vehicle platform based C4ISR capabilities. The key to increased capability with dwindling resources is a common architecture and standards for all tactical vehicles. The specification for a common C4ISR architecture must be affordable, scalable, and operationally feasible for use on legacy platforms.	
Potential Solutions	
PEO LS / ONR / MCSC / RDECOM / TARDEC / NSWC	NUCLEUS MVP JLTV MRAP and M-ATV
TARDEC	VICTORY Architecture Development and Standard Maturation. Plug-n-Play Architectures for Ground Vehicles. Open Framework for Legacy Integration. Vehicle Electronics Architecture SIL. Deterministic High Speed Data Bus. Soldier System Fusion. VICTORY Standards maturation. SWAP-C Reductions. Power Architecture and Standards. Hi/Low Temperature Power Electronics.
SBIR	OTM HF Antenna performed by Astron Wireless Ka/Ku OTM Satellite Communications performed by NanoSonic, Inc.

Potential Solutions

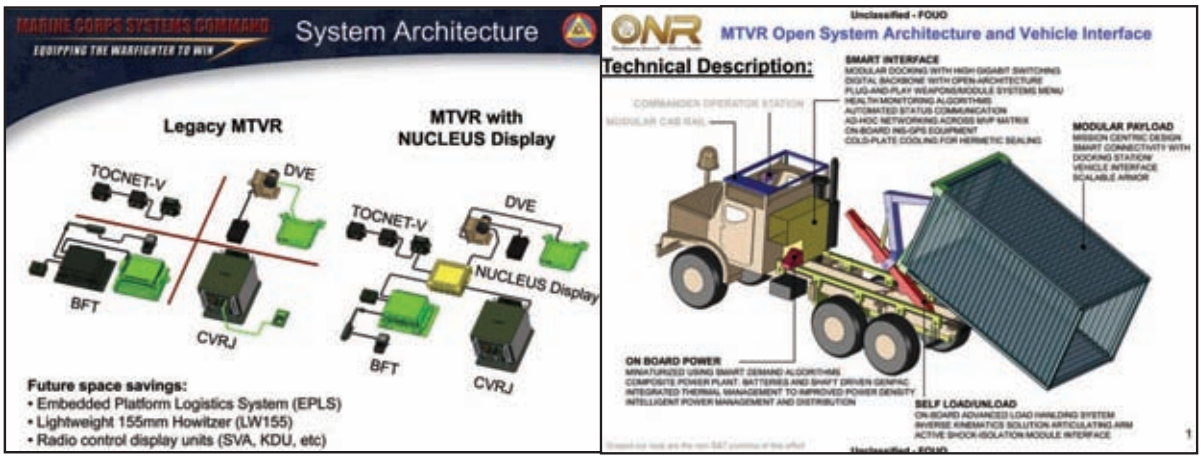
PEO LS Efforts

PEO LS is engaged with Office of Naval Research (ONR), Marine Corps Systems Command (MCSC), US Army Research, Development, and Engineering Command (RDECOM) Automotive Research, Development and Engineering Center (TARDEC), Naval Surface Warfare Center (NSWC) Dahlgren as well as various industry partners and other agencies to address the Marine Corps' vehicle C4ISR challenges. To date, there have been several disparate efforts to develop C4ISR solutions for USMC vehicles, but the effort has lacks consolidated requirements is subject to, rapid technological change and frequently involves a stove-pipe approach to platform design. Previous and ongoing work toward a common vehicle C4ISR architecture includes:

Networked User Control of Locally Embedded and Unique Systems (NUCLEUS). MCSC Systems Engineering, Interoperability, Architecture, and Technology (SIAT) sponsored an effort by NSWC Dahlgren and Space and Naval Warfare Systems Command (SPAWAR) San Diego to rapidly develop a common display for the Marine Tactical Vehicle Replacement (MTVR).

MTVR Cab before (numerous bolt-on applications) and after (consolidated display) application of prototype NUCLEUS technologies

Modular Vehicle Platform (MVP). The intent of this ONR 30 Manuever Thrust effort is to develop modular functionality for a common C4 architecture with vehicle wide power and thermal management to allow plug-n-play mission modules for current and planned vehicles. Based on user demand, the need to lighten the MAGTF load and the applicability of modularity across the MAGTF, ONR 30 has established a core program for MVP in FY12. This effort will refine the technology requirements behind an MVP capability to drive future investment through the FNC program, ONR core or other funding methods.



This is an example of MVP technologies being considered for the MVP FNC by the Office of Naval Research

TARDEC Efforts

Vehicular Integration C4ISR/EW Interoperability (VICTORY). TARDEC and RDECOM sponsored, multiyear effort to develop and demonstrate a joint specification for a common digital backbone that includes a suite of interactive systems engineering tools to support decision makers in defining vehicle specifications. The requirements optimization process allows multiple vehicle subsystems to be varied concurrently while assessing differing vehicle performance attributes, such as power train performance, vehicle dynamics, human factors, and transportability.

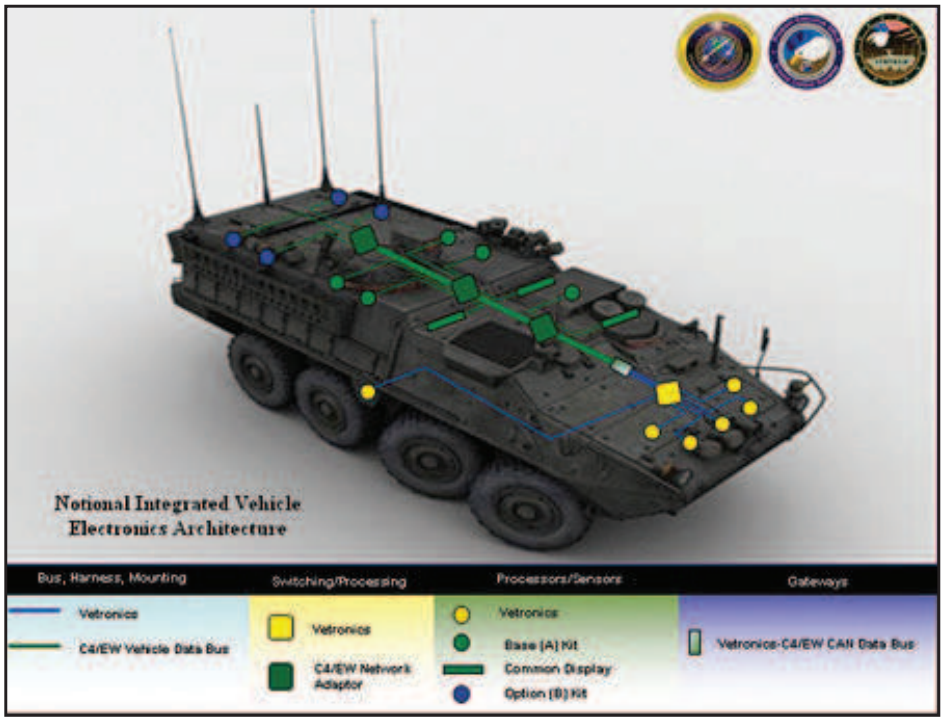


Figure 6 – Notional VICTORY Architecture

Architecture Development and Standard Maturation. Develop and adopt VICTORY specifications. Develop a System Integration Lab (SIL) reconfiguration package to perform validation and verification for the standards.

Plug-n-Play Architectures for Ground Vehicles. Define Plug-n-Play for Military Ground Vehicles and assess the feasibility of implementation. Develop, integrate, and demonstrate a Plug-n-Play capability for a Military Ground Vehicle in a System Integration Lab (SIL) environment.

Open Framework for Legacy Integration. Providing open framework for interfacing legacy sensors and components using small pervasive computing devices. Embedded Computing Resources SWAP-C Reduction. This effort is intended to reduce SWAP-C of onboard electrical and electronic components.

Vehicle Electronics Architecture SIL. This is an open architecture SIL with the ability to test any piece of hardware to verify its compatibility with an open architecture and VICTORY compliant system (see Figure 7 on the following page).

Deterministic High Speed Data Bus. The purpose of this effort is to develop the next generation deterministic high speed data bus for ground vehicle platforms to meet the needs of real-time applications for weapons systems and vehicle controls.

Soldier System Fusion. Increased soldier-vehicle system cohesion to provide unprecedented Soldier situational awareness. Planning and control of manned and unmanned systems.

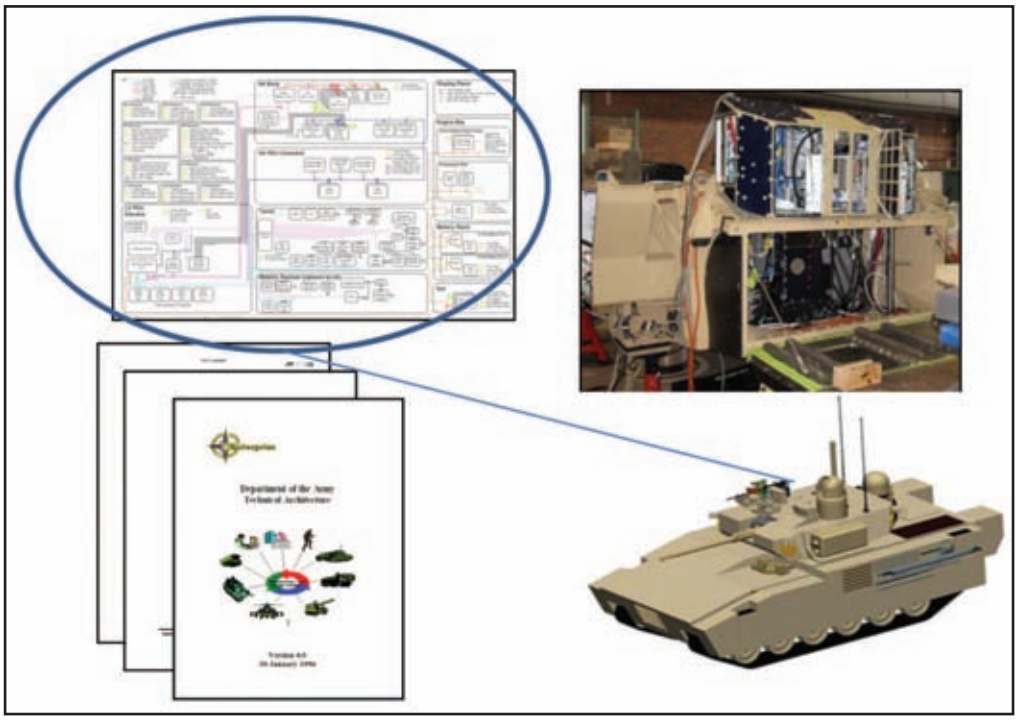


Figure 7 - Vehicle Architecture Program

VICTORY Standards maturation. Continue to mature and maintain the VICTORY specification and architecture. The effort will also mature and maintain a SIL reconfiguration package to perform verification and validation of the specification.

SWAP-C Reductions. Reduces SWAP-C of onboard electrical and electronic components.

Power Architecture and Standards. Update and develop voltage standards and electrical power architectures to provide common standards and interfaces to new start programs and modernizations efforts.

Hi/Low Temperature Power Electronics. Smaller size and weight for power electronics in order to operate at high temperatures without failure. Reduce burden on propulsion cooling, enabling better mobility, more payload and less integration work for future systems.

SBIR Efforts

- **OTM HF Antenna** performed by Astron Wireless
- **Ka/Ku OTM Satellite Communications** performed by NanoSonic, Inc.

4.7 Intelligent Power and Thermal Management

Bottom Line Up Front	
Challenge	
Critical to meeting the demand for C4ISR capabilities on tactical vehicles is intelligent power and thermal management. The objective of this focus area is to develop an integrated system that manages power utilization on vehicle platforms in order to improve fuel efficiencies and manage heat properties in the cab and other areas on the platform to maintain equipment and crew comfort. Effective power/thermal management systems will improve electrical system efficiency and improve heat rejection by linking power/thermal management strategies into a single onboard architecture. The likelihood of the demand for more capable suites of C4ISR, and electronic warfare devices and applications aboard USMC tactical vehicles will continue to increase resulting in power and heat loads that exceed platform capabilities. Advanced power/thermal management tools are a critical step in the development of efficient and reliable vehicle platforms.	
Potential Solutions	
PEO LS / ONR / MCSC / US Army (RDECOM-TARDEC)	MPC Vehicle Performance Generation Tool Integrated Vehicle Thermal Management Modular Vehicle Platform
TARDEC	Thermal Management Systems Development Program Cooling System Evaluation Tool Onboard Vehicle Management, Microgrid, and Hybridization Auxiliary Power Power and Thermal Management Technologies for the Vehicle Electronics Architecture Systems Integration Laboratory Efficient Powertrain Systems Integration
JNLWP	Compact, Low Mass, and Very Low Maintenance Thermal Management System for High Power Directed Energy Systems
SBIR	Innovative Simulation and Analysis Tool for Vehicle Thermal Management Application of Spot Cooling Technologies for the Thermal Management at the Source

Potential Solutions

PEO LS is engaged with ONR, MCSC, US Army (RDECOM-TARDEC), as well as various Industry partners and other agencies to address the Marine Corps' power/thermal management challenges. Some of these efforts include:

MPC Vehicle Performance Generation Tool. A suite of interactive systems engineering tools to support decision makers in defining vehicle specifications. The requirements optimization process allows multiple vehicle subsystems to be varied concurrently while assessing differing vehicle performance attributes, such as powertrain performance, thermal management, vehicle dynamics, human factors and transportability.

Integrated Vehicle Thermal Management. This is a commercially focused effort at the National Renewable Energy laboratory that looks at combining thermal management systems in vehicles with partial or completely electric power trains.

Modular Vehicle Platform. A key aspect of the ONR 30 MVP effort will be developing or exploiting integrated power and thermal management technologies in order to synchronize power and thermal management across automotive, hotel, and modular payload.

TARDEC Efforts

Thermal Management Systems Development Program. This is a $16 million program scheduled to complete by FY18 with several TRL6 technologies. It's purpose is to develop the ability to communicate and control remote loads from a central computer and to provide an opportunity to optimize electrical power usage system-wide. Algorithms to balance power draw from multiple sources, including batteries, alternators, ultracapacitors and fuel cells, and have produced overall system efficiency improvements in the range of 20% in simulations.

Cooling System Evaluation Tool. M&S and test and evaluation efforts seek to understand the component- and system-level impacts of advanced heat-rejecting materials and cooling.

Onboard Vehicle Management, Microgrid, and Hybridization. Provide an on-vehicle demonstration of the next step beyond current planned modernizations to show additional ways to increase fuel efficiency, mobility, and commonality. Provides a means to enable operational energy on-vehicle.

Auxiliary Power. TARDEC has several efforts looking at auxiliary power for silent watch operations in tactical vehicles. These technologies included JP-8 based fuel cells, ultra high power energy storage, and OBVP solutions.

Power and Thermal Management Technologies for the Vehicle Electronics Architecture Systems Integration Laboratory (VEA SIL). Provides an open architecture VEA SIL capable of testing any piece of hardware to verify its compatibility with an open architecture and is VICTORY compliant. The SIL will have the ability to configure multiple vehicle electronics implementations quickly in order to provide valuable data to PM offices and Original Equipment Manufacturers (OEMs). It will centralize the Army's approach to integrating electronics on ground vehicles, saving cost and reducing redundant efforts across multiple programs.

Joint Non-Lethal Weapons Program Efforts

Compact, Low Mass, and Very Low Maintenance Thermal Management System for High Power Directed Energy Systems. The successful demonstration of the proposed research and development will significantly improve performance and reliability of current and next generation high-capacity, high-rate thermal management system technologies and systems for both military and commercial applications. Additionally, the proposed concept may also be used in space nuclear power and energy conversion related applications.

SBIR Efforts

- **Innovative Simulation and Analysis Tool for Vehicle Thermal Management**
- **Application of Spot Cooling Technologies for the Thermal Management at the Source**

4.8 Weight Reduction

"We are currently developing a plan for reducing the size and weight of Marine Expeditionary Units, Marine Expeditionary Brigades so that they can begin to fit within likely lift constraints."

-General James F. Amos, Commandant of the Marine Corps, February 8, 2011

Bottom Line Up Front	
Challenge	
The challenge in this focus area is to meet the Commandant's Directive to "Lighten the MAGTF" while maintaining combat effectiveness, survivability, and mobility requirements.	
Potential Solutions	
ONR	Fuel Efficient MTVR (FNC 12) Expeditionary Light Armor Seeding Development Advanced Concepts for Fuel Efficiency Efficient Powertrain Technologies Integration (Partnering with TARDEC)
TARDEC	Alternative Fuels & Petroleum, Oil & Lubricants Hybrid Vehicle Testing Program Next Generation Engine Research Efficient Powertrain Technologies Integration (Partnering with ONR)
SBIR	Modular Lightweight External Fuel Tank System (PEO LS SBIR)
Other	Integrated Starter Generator (ISG) that reduces up to 300 pounds per vehicle Fuel efficiency programs will reduce the fuel required to be transported

Potential Solutions

PEO LS is engaged with ONR, MCSC, RDECOM, TARDEC, NSWC Dahlgren as well as various industry partners, small businesses (SBIRs) and other agencies to address the Marine Corps' vehicle weight reduction challenge.

"We're too heavy. We've got to get light."

-Brigadier General Frank Kelley, Commanding General, Marine Corps Systems Command, September 29, 2010

"We need to get lighter, and sometimes, when you look at your vehicle strategy, you have to take a look at the environment that you're going to operate in. There's a protection that comes from mobility. If you can move fast and if you can move on unpredictable routes, you can not necessarily armor up as much."

- Lieutenant General George Flynn, Commanding General, Marine Corps Combat Development Command, June 3, 2010

Innovative weight reduction programs currently being explored within the S&T community include:

- Modular Lightweight External Fuel Tank System (PEO LS SBIR)
- Expeditionary Light Armor Seeding Development (ONR)
- Advanced Concepts for Fuel Efficiency (ONR)
- Alternative Fuels & Petroleum, Oil & Lubricants (TARDEC)
- Efficient Powertrain Technologies Integration (ONR and TARDEC)
- Fuel Efficient MTVR (ONR FNC 12)
- Hybrid Vehicle Testing Program (TARDEC)
- Next Generation Engine Research (TARDEC)
- ISGs that reduce up to 300 pounds per vehicle
- Fuel efficiency programs will reduce the fuel required to be transported

5.00 PEO LS Programs

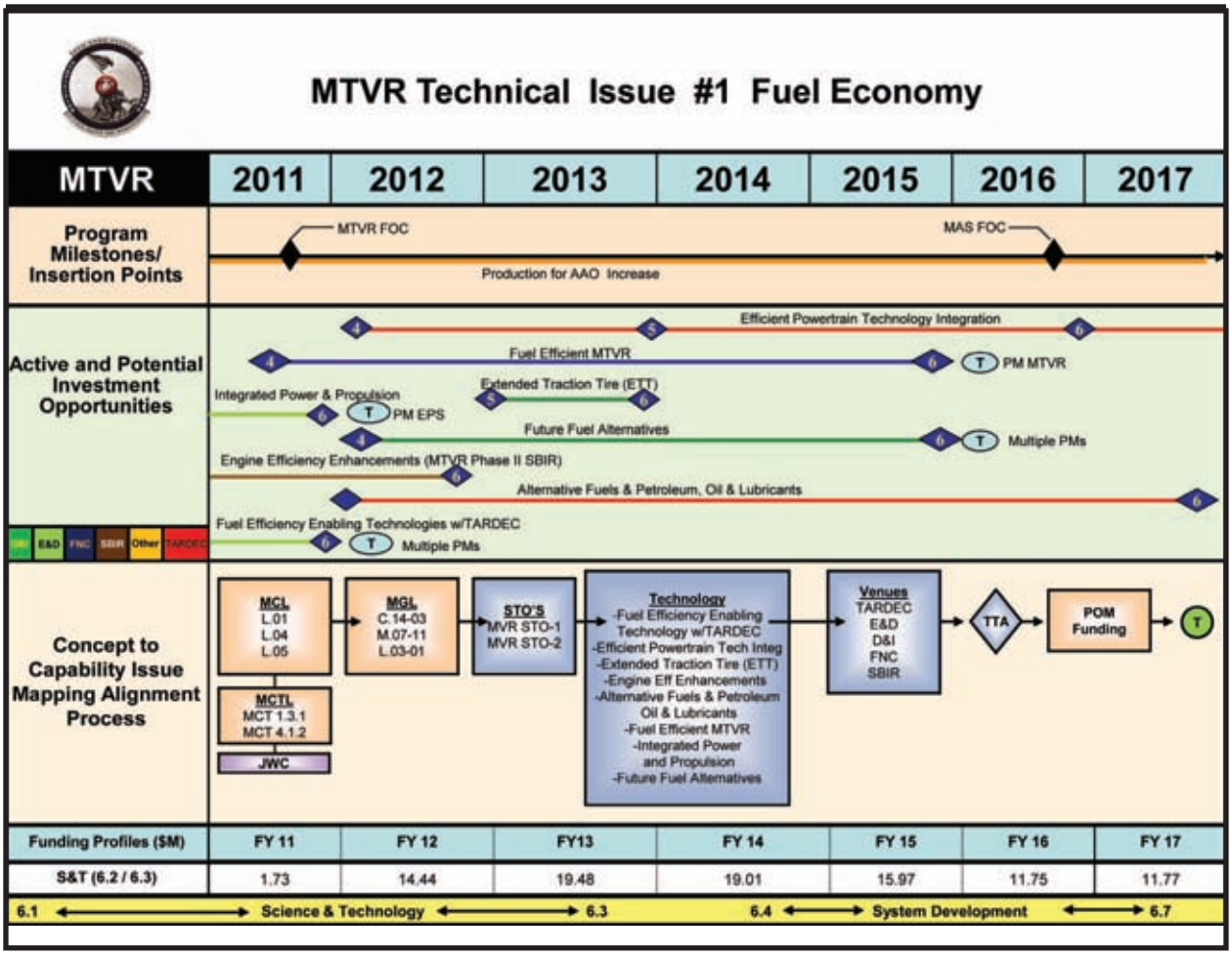


Figure 8 – Example of an Advanced Technology Investment Plan/Process for MTVR

Advanced Technology Investment Plan

The following sections discuss the Technology Investment Plan for each PEO LS program. The various PEO LS programs are introduced, Top Technical Issues are highlighted, S&T Venues (active and potential) are listed and a roadmap presented that aligns the S&T venues with the program schedule and funding.

Each PEO LS program has a dedicated section addressing the specific program's Top Three Technical Issues and is broken down into three parts:

Part One contains the individual program's description and quad chart that addresses the program's fundamental information and characteristics.

Part Two addresses the more detailed analysis of each program's Top Three Technical issues and further describes the active and potential S&T initiatives (venues) that address or could potentially address that particular issue.

Part Three graphically addresses the top three technical issues by breaking down each issue individually and aligning it from the concept to the capability it will provide (see Figure 8). This process traces the issue from the MAGTF Capabilities List (MCL), identifies the Gap in capability via the MAGTF Gap List (MGL), the Science and Technology Objectives (STOs) and various S&T technology venues that address the technical issue and illustrates the transition of the technology to the Program of Record.

Figure 8 provides an example of an Advanced Technology Investment Plan/Process for the MTVR program. The top area (tan) identifies opportunities for technology insertion followed by the S&T initiatives identified to help resolve the technology issues identified. The symbol (T) is used at the end of a project to identify the program that is being targeted for insertion of the new technology.

The color-coded key on the middle far left of the roadmap identifies types of S&T venues.

Discovery and Invention (D&I) programs consist of basic and applied research.

Exploitation and Development (E&D) focuses on incorporating the specific research into systems in preparation for inclusion into acquisition programs.

Future Naval Capabilities (FNCs) provide the best technology solutions to formally defined capability gaps, and usually leverage past D&I and E&D success.

Small Business Innovation Research (SBIR) / Small Business Technology Transfer (STTR) programs for small business innovation.

Other is a variety of other investment types including projects involving the Office of the Secretary of Defense (OSD), initiatives that are sponsored by the program office like Phase "A" sudies, congressional "plus ups," and all those not otherwise covered.

Tank Automotive Research, Development and Engineering Center (TARDEC), located in Warren, Michigan, is the US Armed Forces' research and development facility for advanced technology in ground systems. It is part of the Research, Development and Engineering Command (RDECOM), a major subordinate command of the United States Army Materiel Command. Current technology focus areas include Ground Vehicle Power and Mobility (GVPM), Ground System Survivability and Force Protection Technology, among others.

The diamond shapes depict the Transition Readiness Levels (TRLs). TRLs are used to measure the maturity level of the S&T activities and initiatives.

TRL 1 – Basic principle observation and report

TRL 2 – Technology concepts or applications (or both) formulated

TRL 3 – Analytical and experimental critical function or characteristic proof of concept (or both)

TRL 4 – Component or breadboard validation in a laboratory environment

TRL 5 – Component or breadboard validation in the relevant environment

TRL 6 – System/subsystem model or prototype demonstration in a relevant environment

TRL 7 – System prototype demonstration in an operational environment

Goal: Use all S&T venues to leverage resources for PEO LS programs to close Warfighter Gaps and solve Program Technology Needs.

The mapping alignment process traces the technology issue/S&T initiative from the required capability to the transitioned technology. Using MTVR as an example, MCL L.01 (Provide Supply Support) identifies the capability associated with the technical issue. M. 07-11 (Mobility In All Terrain And Climates) identifies the gap. Maneuver STO-1 identifies the S&T Objective (STO). The issues are then traced through potential technologies and venues to the funded transition of that advanced technology capability.

In summary, the Advanced Technology Investment Plan for each program captures the active and potential S&T initiatives that are aligned to high priority technical issues and capability gaps in order to "Focus the Future Faster" by delivering gap closing capabilities to the warfighter.

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Amphibious Combat Vehicle (ACV)

Capability Gaps

Introduced in 1972, sustained with both a 1983 service life extension program and a 1999 rebuild program, the AAV will be 40 years old in FY12. The AAV platform provides a limited capability for surface operations as envisioned by the Naval Operations Concept (NOC) and Marine Corps Operating Concept (MOC) in the 2015 timeframe due to its limited survivability, force protection, lethality, environmental controls for long distance water mobility, land mobility, and communications. The AAV7A1 shortcomings were identified in Marine Corps Mission Area Analyses (MAAs) for MA-21 Direct Fire and Maneuver, MA-22 Ground Tactical Mobility/ Counter-Mobility, MA-23 Close Combat, and MA-11 C2, with these deficiencies becoming issues in the timeframe beyond 2005.

Operational Impact

Upon cancellation of the Expeditionary Fighting Vehicle Program, five distinct capability gaps were evident with the current AAV, in the areas of force protection and survivability, network/ C2, lethality, land mobility, and water mobility. The ACV is intended to fill those current capability gaps in the amphibious portfolio. The ACV will provide tactical surface armored land and water mobility for the landing force. The ACV will be launched from amphibious ships from a point over the horizon (OTH) and will deliver the surface assault elements of the landing force at speeds over moderate seas, transition seamlessly from sea to land, and maneuver to inland objectives. It will provide surface power projection and, if necessary, forcible entry against a defended littoral. Crossing the beach in a seamless (non-stop) maneuver, the ACV will continue to inland objectives and provide Marine infantry forces armor protected mobility and firepower in support of all facets of ground combat operations. Tactics for units employing the ACV will usually call for the embarked Marine infantry to dismount as close to the objective as possible, relying on the vehicle's weapons system to provide direct fire in support of ground maneuver. The ACV's firepower will destroy, neutralize, or suppress antitank weapons, light armored vehicles, emplacements/bunkers, and dismounted infantry. The ACV's communications and information systems will provide the requisite situational awareness (SA) and navigation capabilities for the ACV crew and embarked Marine infantry to operate in the expeditionary environment. As an amphibious vehicle, the ACV provides the ground combat element with the means to reenter the sea, deploy along the littoral, and strike where the enemy is vulnerable. Additionally, the vehicle will be ideally suited for shore-to-shore, riverine, and shore-to-ship operations such as emergency evacuation.

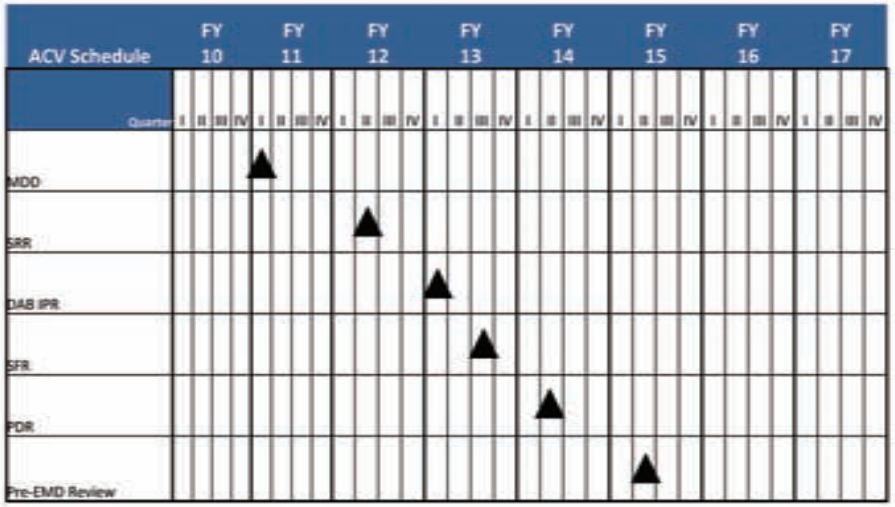
The ACV capabilities are key enablers for the Joint Force to conduct amphibious operations, specifically when forcible entry is required, and for the MAGTF to conduct operations across the range of military operations. The ACV will provide the MAGTF greater capacity with mobile armored protection to increase maneuverability throughout the sea to land domains and in an

extended land operational environment. The ACV will enable the MAGTF, as part of the Joint Force, the ability to concentrate combat power, support, and sustainment at decisive points. As a result, the ACV enabled force must deliver precise lethal and nonlethal effects and be interoperable with Joint, Interagency, Intergovernmental, and Multinational partners. The ACV will support network enabled mission command and have ready access to joint C4ISR.

Program Status

The associated Material Development Decision Defense Acquisition Board (MDD DAB) was conducted successfully in the first quarter of FY12. The ADM will provide analysis of alternatives study guidance in support of the AoA. Following the AoA, up to two prime contractors will be tasked to develop preliminary designs in support of the planned Milestone B in early FY15. An initial prototype build will lead to a fly off between the competing prime contractors and down select for final design efforts and eventual Milestone C at the end of FY19. Initial Operational Capability is planned for FY22 with Full Operational Capability in FY29.

Amphibious Combat Vehicle (ACV)



Program Description

Mission: General Support Lift / Amphibious Mobility / Firepower
Dimensions: Similar to EFV footprint for transportability

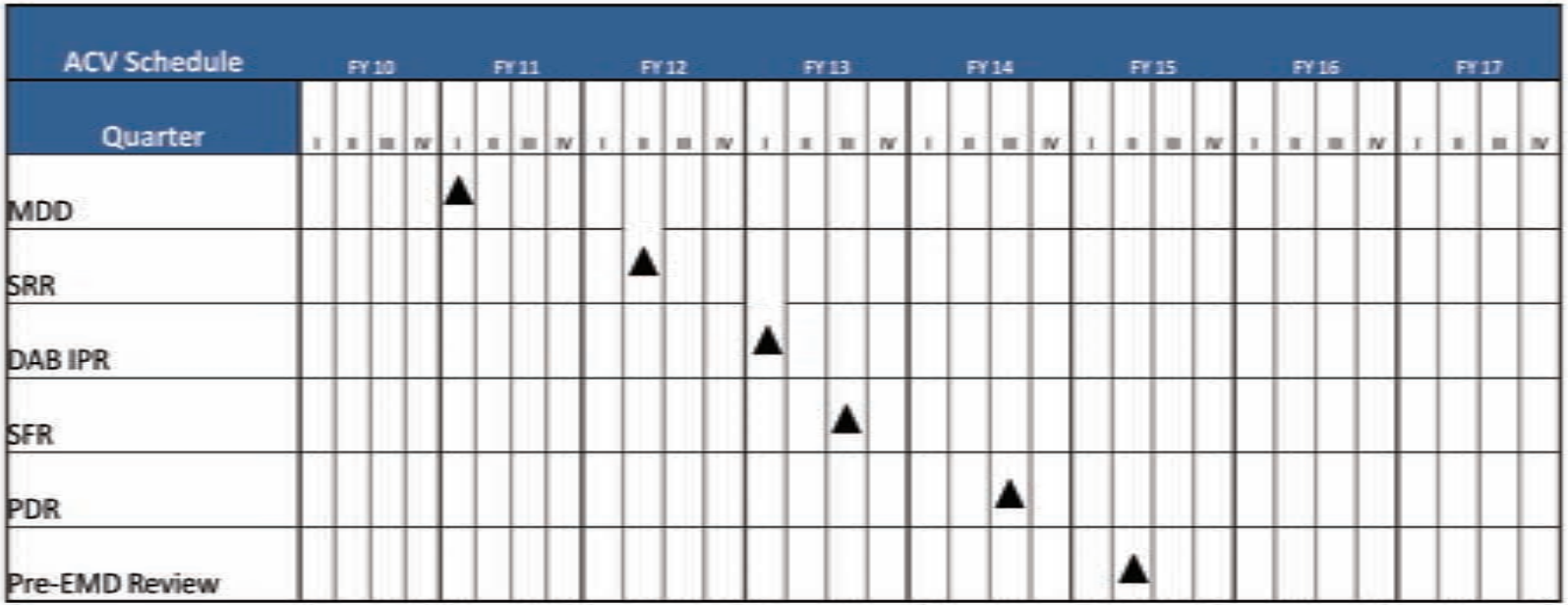
Weapon: Lethality Options under analysis
Fire control: Modern, Stabilized Day / Night Optics
Capacity: 17 Infantry Marines + 3 Marine Crewmen
Range: 200 mile
Speed: Mobility effective with MAGTF Maneuver Task Force

Program Status

Acquisition Status: Pre-AoA
Acquisition Objective: ~600
MS B/MS C: Q1 FY15/Q4 FY19
IOC/FOC: 2022/2028 (Projected)
Comments:

- AAO will provide lift for 8 Infantry Battalions

Amphibious Combat Vehicle (ACV)



ACV'S Top Three Program Issues:

1. Increase Survivability - As it relates to protecting the occupants of the vehicle and the vehicle itself from emerging threats, a continuing effort to maintain or even increase survivability. This includes such things as increasing armor protection while maintaining current weight (or with minimal weight gain), or decreasing detrimental impacts to the occupants and vehicle due to battle damage, such as through fuel system containment and fire suppression improvements.

2. Increased Weight Margin - The ACV will need to balance vehicle survivability (among other weight driving requirements) with the overall mobility performance and sea-keeping capability, as they generally trend in opposite directions. Overall, the requirement for increased weight margin creates strain on the ability of the vehicle to incorporate solutions to address other requirements/technical issues.

3. Crew Visibility - While the ACV vehicles are in silent watch and maneuvering on land and water, especially in tight formation in limited visibility (night, smoke, fog, etc.), the crew must maintain direct sensory knowledge of their surroundings in order to safely and effectively employ the system. This includes, but is not limited to, fully blacked out land/water operations, station keeping, obstacle detection (including near-surface obstacles), operation in urban environments, etc.

1. Increased Survivability

1a. Active S&T Initiatives for ACV

Small Business Innovative Research (SBIR)
- Laser Eye Protection (ACV SBIR I)
- Semi-active Damped Seating (ACV SBIR III)
- Modular Lightweight Armor System (ACV SBIR II)

Small Business Technology Transfer and Research (STTR)
- Low Cost, Low Weight, Self-Sealing Fuel Tank Technology Development (ACV STTR II)

Discovery and Innovation (D&I)
- Energy Absorbing Structures for Blast Mitigation Light Tactical Vehicles

1b. Potential S&T Initiatives for ACV

Discovery and Innovation (D&I)
- CSTV Shock Mitigating Seats
- Lightweight Armor Materials

Exploration & Development (E&D)
- CSTV Shock Mitigating Seats

TARDEC
- GSS- Blast Technology Development

Other
- DARPA AVM Program

2. Weight Margin

2a. Active S&T Initiatives for ACV

Small Business Innovation Research (SBIR)
- Aluminum Casting Alloy (ACV SBIR II)
- Modular Lightweight Armor System (ACV SBIR II)
- Modular Lightweight External Fuel Tank System (ACV SBIR I)

Small Business Technology Transfer and Research (STTR)
- Low Cost, Low Weight, Self-Sealing Fuel Tank Technology Development (ACV STTR II)

2b. Potential S&T Initiatives for ACV

Discovery & Invention (D&I)
- Lightweight Armor Materials
- Expeditionary Light Armor Seeding Development

Exploration & Development (E&D)
- Energy Storage Module to Reduce Fuel Consumption

TARDEC
- Energy Storage Research & Development

3. Crew Visibility

3a. No Active S&T Initiatives for ACV

3b. Potential S&T Initiatives for ACV

Small Business Innovation Research (SBIR)

- Innovative Cost-Effective Lightweight Transparent Armor for Vehicles (TARDEC SBIR I)
- Low Cost Manufacturing of the Ballistic Resistant Transparent Spinel Windows (TARDEC SBIR I)

Exploration & Development (E&D)

- "Flawless" Glass Armor

TARDEC

- Ground Combat Vehicle Vision Protection Program
- Transparent Armor

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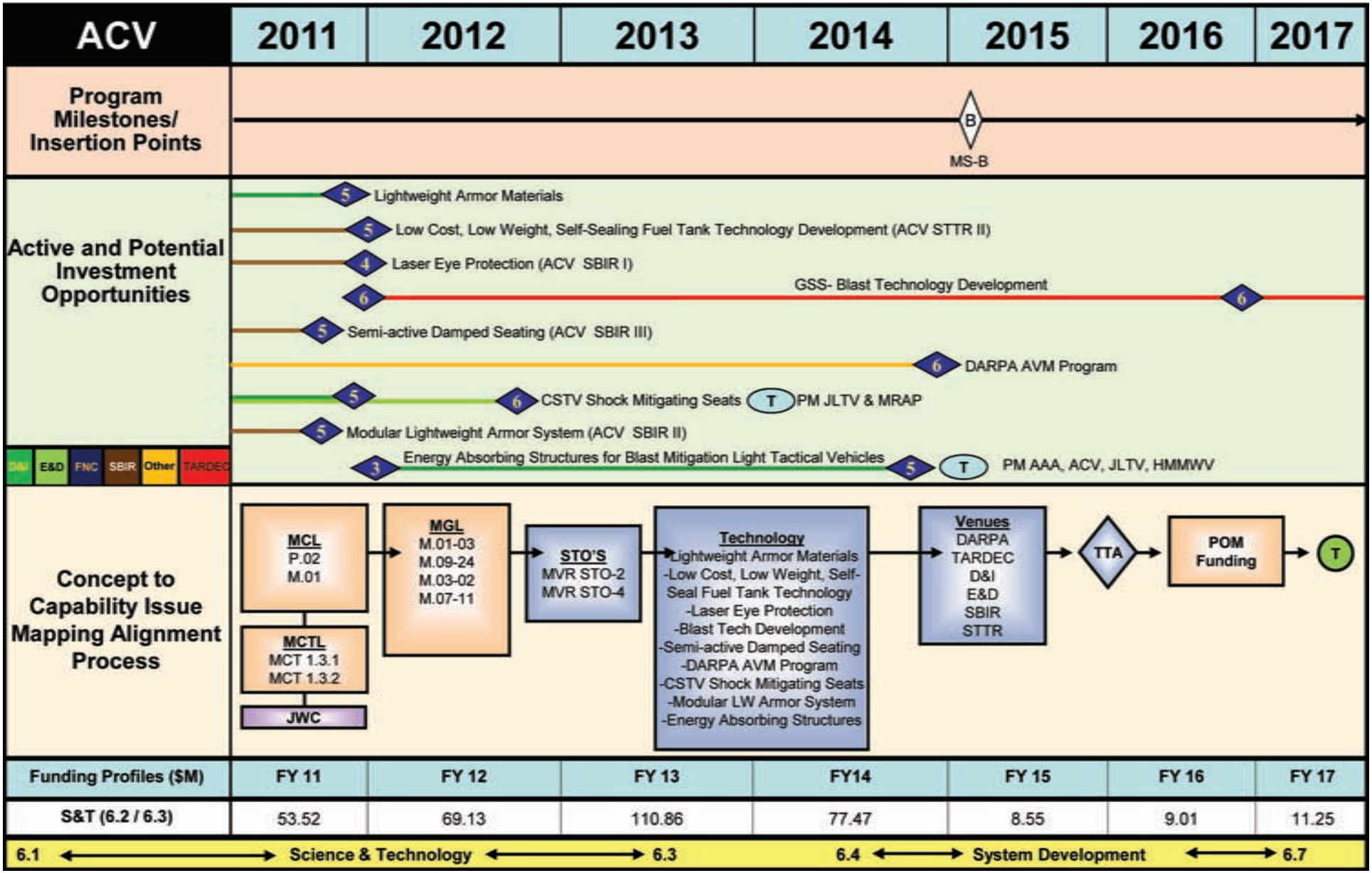
ACV Technical Issue #1 Increased Survivability



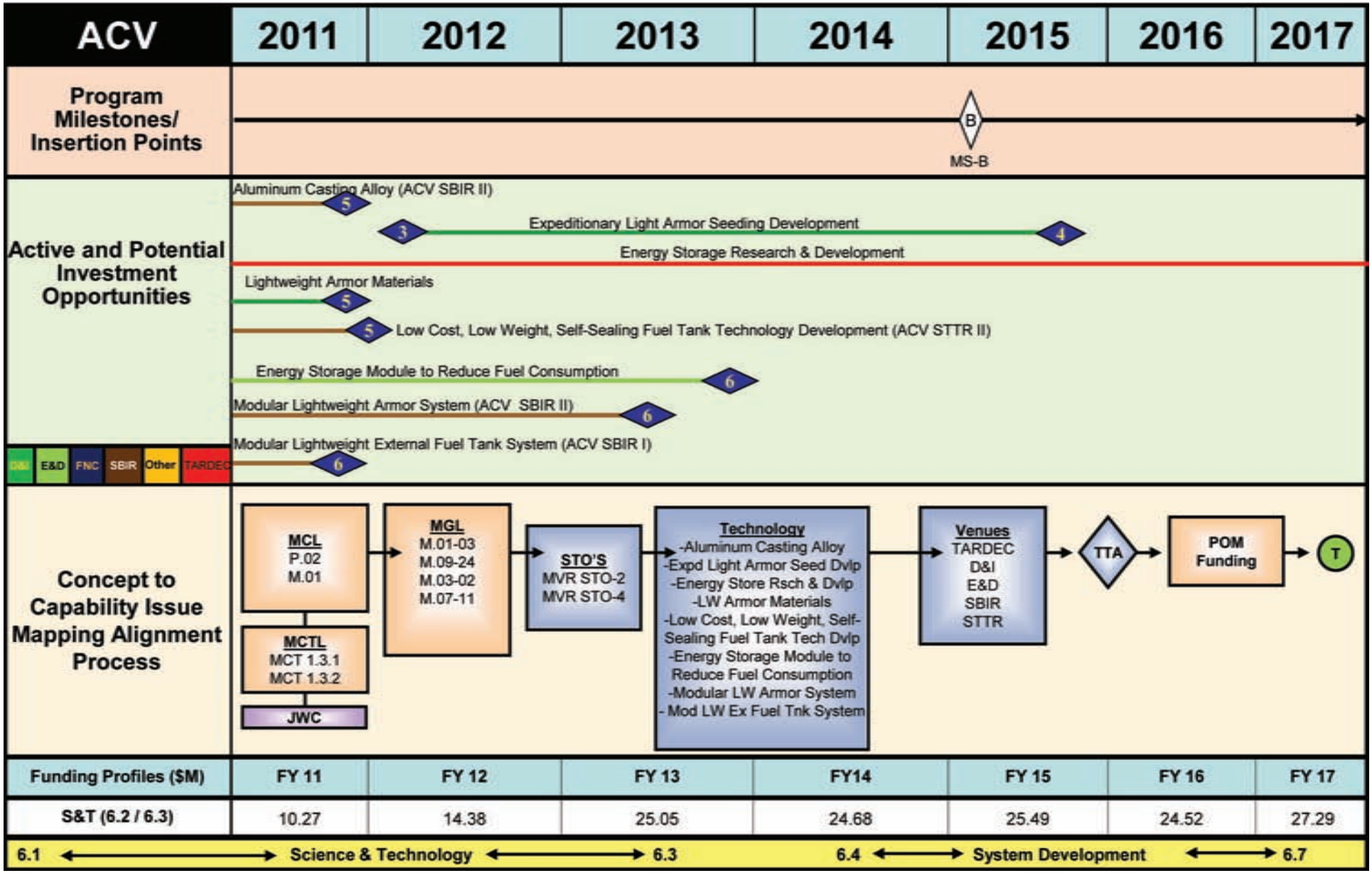
Funding Profiles ($M)	FY 11	FY 12	FY 13	FY14	FY 15	FY 16	FY 17
S&T (6.2 / 6.3)	53.52	69.13	110.86	77.47	8.55	9.01	11.25

6.1 ⟷ Science & Technology ⟷ 6.3 6.4 ⟷ System Development ⟷ 6.7

ACV Technical Issue #1 Increased Survivability

MCL	P.02 Protect Personnel/physical assets and LOCs M.01 Maneuver to secure	
MCTL	MCT 1.3.1 Conduct Maneuver MCT 1.3.2 Conduct Amphibious Operations	
MGL	M.01-03 AAV iso STOM M.09-24 Force Protection M.03-02 Protected mobility M.07-11 Mobility in all terrain & climates	
STO'S	MVR STO-2 Ground vehicle mobility MVR STO-4 Advanced materials and survivability technology to enhance the performance and survivability of combat vehicles & surface craft	
Technology	Active: -Low Cost, Low Weight, Self-Sealing Fuel Tank Technology Development (ACV STTR II) -Laser Eye Protection (ACV SBIR I) -Semi-active Damped Seating (ACV SBIR III)	Potential: -CSTV Shock Mitigating Seats -Lightweight Armor Materials -Blast Tech Development -DARPA AVM Program -Modular LW Armor System -Energy Absorbing Structures
Venues	DARPA, TARDEC, D&I, E&D, SBIR, STTR	
TTA	N/A	T Transition target for: PM ACV, JLTV, MRAP, AAA, HMMWV
POM Funding	MCCDC integration division	
T	Transition to a program of record	Comments/Issues:

ACV Technical Issue # 2 Increased Weight Margin



Funding Profiles ($M)	FY 11	FY 12	FY 13	FY14	FY 15	FY 16	FY 17
S&T (6.2 / 6.3)	10.27	14.38	25.05	24.68	25.49	24.52	27.29

6.1 ⟷ Science & Technology ⟷ 6.3 6.4 ⟷ System Development ⟷ 6.7

ACV Technical Issue # 2 Increased Weight Margin

MCL	P.02 Protect Personnel/physical assets and LOCs M.01 Maneuver to secure	
MCTL	MCT 1.3.1 Conduct Maneuver MCT 1.3.2 Conduct Amphibious Operations	
MGL	M.01-03 AAV iso STOM M.09-24 Force Protection M.03-02 Protected mobility M.09-03 Mobility in all terrain & climates	
STO'S	MVR STO-2 Ground vehicle mobility MVR STO-2 Advanced materials and survivability technology to enhance the performance and survivability of combat vehicles &surface craft	
Technology	Active: -Aluminum Casting Alloy (ACV SBIR II) -Low Cost, Low Weight, Self-Sealing Fuel Tank Technology Development (ACV STTR II) -Modular Lightweight Armor System (ACV SBIR II) -Modular Lightweight External Fuel Tank System (ACV SBIR I)	Potential: -Expeditionary Light Armor Seeding Development -Energy Storage Research & Development -Lightweight Armor Materials -Energy Storage Module to Reduce Fuel Consumption
Venues	TARDEC, D&I, E&D, SBIR, STTR	
TTA	N/A	T Transition target for: PM ACV
POM Funding	MCCDC integration division	
T	Transition to a program of record	Comments/Issues:

ACV Technical Issue #3 Crew Visibility

ACV	2011	2012	2013	2014	2015	2016	2017

Program Milestones/ Insertion Points

B — MS-B

Active and Potential Investment Opportunities

- 5 — 6: Ground Combat Vehicle Vision Protection Program
- Innovative Cost-Effective Lightweight Transparent Armor for Vehicles (TARDEC SBIR I): 4
- 5 — 7: Transparent Armor
- Low Cost Manufacturing of the Ballistic Resistant Transparent Spinel Windows (TARDEC SBIR I): 4
- 4 — 5: "Flawless "Glass Armor

D&I | E&D | FNC | SBIR | Other | TARDEC

Concept to Capability Issue Mapping Alignment Process

MCL: M.01, P.04 → MGL: M.01-03, M.07-11 → STO'S: MVR STO-7, MVR STO-9 → Technology: -Ground Combat Vehicle Vision Protection Program, -LWTransparent Armor, -Transparent Armor, -Man the Ballistic Resistant Transparent Spinel Windows, -"Flawless "Glass Armor → Venues: TARDEC, SBIR, E&D → TTA → POM Funding → T

MCTL: MCT 1.3.1, MCT 1.3.2, MCT 1.3.5 — JWC

Funding Profiles ($M)	FY 11	FY 12	FY 13	FY14	FY 15	FY 16	FY 17
S&T (6.2 / 6.3)	0.00	11.08	4.56	1.20	1.00	1.50	2.00

6.1 ⟷ Science & Technology ⟷ 6.3 6.4 ⟷ System Development ⟷ 6.7

ACV Technical Issue #3 Crew Visibility

MCL	M.01 Maneuver to secure P.04 Detect threats to protect/secure forces	
MCTL	MCT 1.3.1 Conduct Maneuver MCT 1.3.2 Conduct Amphibious Operations MCT 1.3.5 Navigate	
MGL	M.01-03 AAV in support of STOM M.07-11 Mobility in all terrain & climates	
STO'S	MVR STO-7 Explosive hazard detection from the surf zone to inland objectives MVR STO-9 Augmented cognition for combat vehicle crews & operators of maneuver systems	
Technology	Active: N/A	Potential: -Ground Combat Vehicle Vision Protection Program -Innovative Cost-Effective Lightweight Transparent Armor for Vehicles (TARDEC SBIR I) -Transparent Armor -Low Cost Manufacturing of the Ballistic Resistant Transparent Spinel Windows (TARDEC SBIR I) -"Flawless "Glass Armor
Venues	TARDEC, SBIR, E&D	
TTA		
POM Funding	MCCDC integration division	
T	Transition to a program of record	Comments/Issues:

The Joint Light Tactical Vehicles (JLTV)

The Joint Light Tactical Vehicle (JLTV) is a major Army-Marine Corps defense acquisition program for a new-generation wheeled vehicle that would replace a portion of the Services' High Mobility Multipurpose Wheeled Vehicle (HMMWV) fleet. The program's aim is to develop a new multi-mission light vehicle family with superior crew protection and performance compared to the HMMWVs. The JLTV family will balance critical weight and transportability constraints within performance, protection, and payload requirements – all while ensuring an affordable solution for the Army and USMC.

The JLTV program is aligned with a joint program office under the management of the U.S. Army's Project Manager for Tactical Vehicles, which falls under the leadership of the Program Executive Office for Combat Support and Combat Service Support (PEO CS&CSS). In October 2008, the Army awarded three industry teams – BAE Systems, General Tactical Vehicles (General Dynamics-AM General), and Lockheed Martin – Technology Development (TD) contracts to design and fabricate competitive prototypes for testing and evaluation.

In June 2011, the Services successfully accomplished the 27-month TD Phase, completing rigorous test and evaluation efforts at Aberdeen Test Center, Md. and Yuma Test Center, Az. The prototypes underwent ballistic protection, system performance, and reliability and maintainability tests to gauge technical potential against JLTV requirements, with an emphasis on identifying potential trade-offs to reduce system weight. The Services completed all planned performance and RAM testing; however, because of the increased requirement in under-body survivability, more challenging ballistic testing was conducted to help inform the Engineering and Manufacturing Development (EMD) Phase requirements. Additionally, JLTV's first helicopter sling load transportability test with the Army's CH-47D and the USMC's CH-53E was completed with four-passenger General Purpose vehicles.

The development of the JLTV reinforces the Services' approach to interoperable platforms that provide expeditionary and protected maneuver to forces currently supported by HMMWVs. The JLTVs also improve payload efficiency through chassis engineering, enabling the vehicles to be deployed with the appropriate amount of force protection through scalable armor solutions. Further, expected JLTV fleet reliability and fuel efficiency will be significantly greater than the current HMMWV fleet, which will reap millions of dollars in savings over the JLTV life-cycle.

The TD Phase has satisfied its intended purposes: demonstrate the integration of mature technologies as a complete system and provide an assessment of the technical and performance risks relevant to entering the EMD Phase.

The EMD Phase will be a full and open competition, with the selection of multiple offerors. Milestone B is currently scheduled for 3Q FY-12.

Crew Protection Imperative

The advent in Iraq and Afghanistan of improvised explosive devices (IEDs) has taken its toll on the U.S. military's unarmored flat-bottom HMMWVs, which were never designed to withstand IED or mine blasts. Up-armoring of HMMWVs through the addition of armor plates provided increased protection, but the increased weight reduced the vehicle's payload capacity, maneuverability, off-road mobility, and air transportability.

With the JLTV, the Army and Marine Corps hope to regain the performance once offered by the HMMWV while adding inherent crew protection against IED-like threats. Some of the JLTV industry TD designs feature a V-shaped hull similar to the MRAP vehicles, as well as a semi-active independent suspension system with a variable ride height which allows the underside of the hull to be raised, to facilitate IED blast deflection. High ground clearance also is essential for off-road mobility, and the ability to adjust to a low ground clearance height is essential to vehicle transport in height-restricted shipboard spaces.

The JLTV will feature inherent and B-kit scalable armor. The vehicle's inherent armor protection levels, sufficient for non-combat humanitarian operations, will be supplemented by the addition of bolt-on B-kit armor for enhanced protection during combat missions. All three industry teams used modular B-kit armor panels to keep weight down while providing ballistic, mine, and IED protection.

Vehicle Configurations

The JLTV Family of Vehicles (FoV) consists of two variants, a two-seat and a four-seat variant, and a companion trailer (JLTV-T). The two-seat variant has one base vehicle platform, the Utility (JLTV-UTL). The four-seat variant has two base vehicle platforms, the General Purpose (JLTV-GP) and the Close Combat Weapons Carrier (JLTV-CCWC). The JLTV-GP will serve as the base vehicle platform for three mission package variations, the Special Purpose (JLTV-SP), the Heavy Guns Carrier (JLTV-HGC), and the C2 On the Move (JLTV-C2OTM), to perform a wide range of military operations. The JLTV FoV must be light enough to allow two vehicles with 2,000 lbs of payload to be transported as an external sling load underneath a Marine Corps CH-53K helicopter. High commonality among the JLTV FoV is a key objective. The Army and Marine Corps want to minimize the life-cycle ownership costs of the JLTV FoV by maximizing commonality of components, spare and repair parts, tools, maintenance procedures and training.

Another key factor in lowering the life-cycle costs will be the JLTV FoV's higher reliability and maintainability, as well as the use of more fuel-efficient engines. The Army and Marine Corps have also minimized any service unique vehicle requirements.

The JLTV will feature an open systems electronics architecture that will facilitate integration of current and future sensor, communications, and navigation systems as they become available. As a result, the JLTV's crew will have significantly improved battlefield situational awareness, compared with vehicles today.

The Army currently plans to procure approximately 46,000 JLTVs, making-up nearly one-third of the light tactical wheeled vehicle fleet, while the Marine Corps plans to procure 5,500 vehicles; those numbers are subject to change as each service refines its Tactical Wheeled Vehicle strategy.

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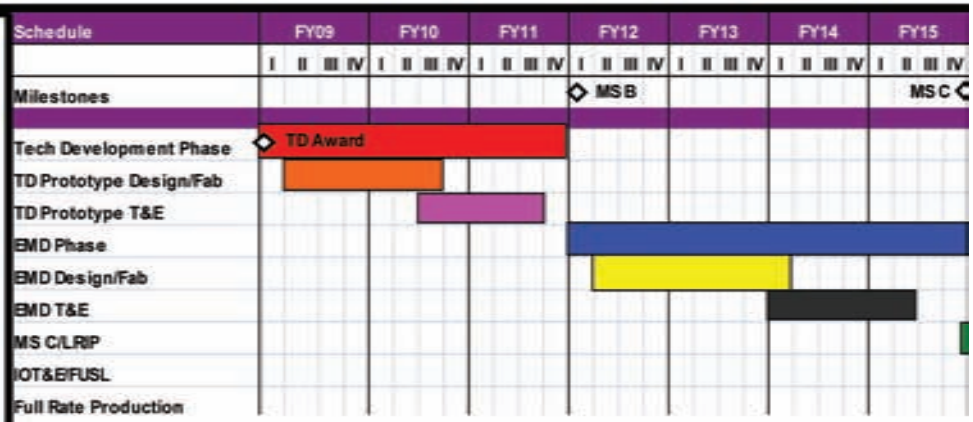
Joint Light Tactical Vehicle (JLTV)

BAE Systems Land and Armaments

General Tactical Vehicles

Lockheed Martin Systems Integration



Program Description

The JLTV is a Joint Army/Marine Corps program, which consists of a family of vehicles with companion trailers capable of performing multiple mission roles that will be designed to provide protected, sustained, networked mobility for personnel and payloads across the full Range Of Military Operations (traditional to irregular).

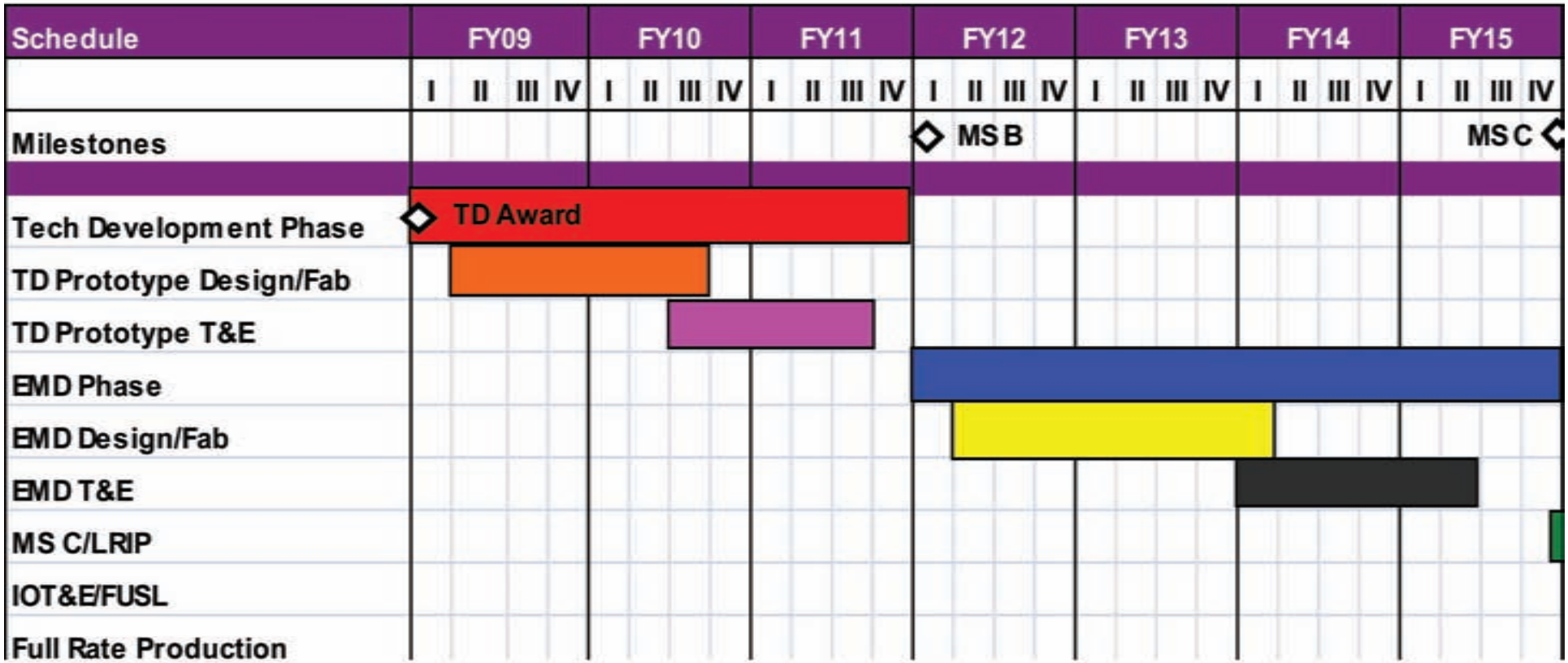
The initial production of JLTVs will provide the Operational Forces with tactical wheeled vehicles that provide a high level of scalable protection, improved sustainment, and net-ready maneuver platforms, that are strategically and operationally transportable, and tactically mobile across all terrain.

IOC: 2017 FOC: TBD AO: Increment I – 5,550

Program Status

- DAE Acquisition Review on 10 Sep 07 directed JLTV to enter at MS A
- JLTV MS A DAB convened 5 Dec 07
  - MS A Acquisition Decision Memorandum approved 21 Dec 07
  - Proceeding as Joint Pre-Major Defense Acquisition Program
  - MDA – USD (AT&L)
- TD contracts awarded Oct 08 to Lockheed, GTV and BAE
- All contractors delivered TD vehicles and testing commenced June 09

Joint Light Tactical Vehicle (JLTV)



The Joint Light Tactical Vehicles (JLTV)

JLTV'S Top Three Program Technology Issues:

1. Weight/Armor - The JLTV must be transportable by rotary and fixed wing aircraft, as well as aboard amphibious shipping and Maritime Prepositioning Ships (MPS). Any additional weight could hinder the vehicle's ability to be transported. Force protection needs will require higher levels of armor protection while still meeting the JLTV's transportability requirement.

2. Reliability, Availability, Maintainability (RAM) Modeling and Simulation (M&S) Modeling the reliability of the vehicle is critical to determine if there are maintainability issues. Fully integrated systems engineering M&S tool can dramatically reduce the TOC while maximizing the effectiveness of limited S&T resources to transition optimized, focused capabilities. Design tradeoffs are traceable, transparent and consistent.

3. Seat Shock/Vibration - Protect crew against current and emerging vehicle IED mine threats and rollovers. Emphasis on lower leg, spine and multiple directional protection. The crew and passengers of the vehicle must be able to perform their duties at the conclusion of the ride.

1. Weight/Armor:

1a. Active S&T Initiatives for JLTV

Discovery and Innovation (D&I)
- Energy Absorbing Structures for Blast Mitigation Light Tactical Vehicles
- Expeditionary Light Armor Seeding Development

Other
- JLTV Phase 'A' Light Weight Armor Study
- JLTV SE Toolkit

1b. Potential S&T Initiatives for JLTV

Discovery and Innovation (D&I)
- Lightweight Armor Materials

Small Business Innovation Research (SBIR)
- Modular Lightweight Armor System (ACV SBIR II)
- Aluminum Casting Alloy (ACV SBIR II)

Small Business Technology Transfer and Research (STTR)

- Low Cost, Low Weight, Self-Sealing Fuel Tank Technology Development (ACV STTR II)

TARDEC

- GSS- Blast Technology Development

Other

- Fuel Tank Protection System Swampworks

2. Reliability, Availability, Maintainability (RAM) Modeling and Simulation (M&S):

2a. Active S&T Initiatives for JLTV

Other

- JLTV SE Toolkit

2b. Potential S&T Initiatives for JLTV

Exploration & Development (E&D)

- Composite Armor Modeling and Optimization (CAM)
- Novel Ceramic Armor Configuration Modeling

TARDEC

- Survivability Optimization Modeling (TOSOM)
- Survivability Analysis and Optimization
- Armor Durability Simulation

Other

- HMMWV Trade Space M&S

3. Seat Shock/Vibration:

3a. Active S&T Initiatives for JLTV

Discovery and Innovation (D&I)

- Energy Absorbing Structures for Blast Mitigation
- CSTV Shock Mitigating Seats

Exploration & Development (E&D)

- CSTV Shock Mitigating Seats

3b. Potential S&T Initiatives for JLTV

Small Business Innovation Research (SBIR)

- Semi-Active Damped Seating (ACV SBIR III)

TARDEC

- GSS Blast Technology Development

Other

- MTVR Blast Seat Evals

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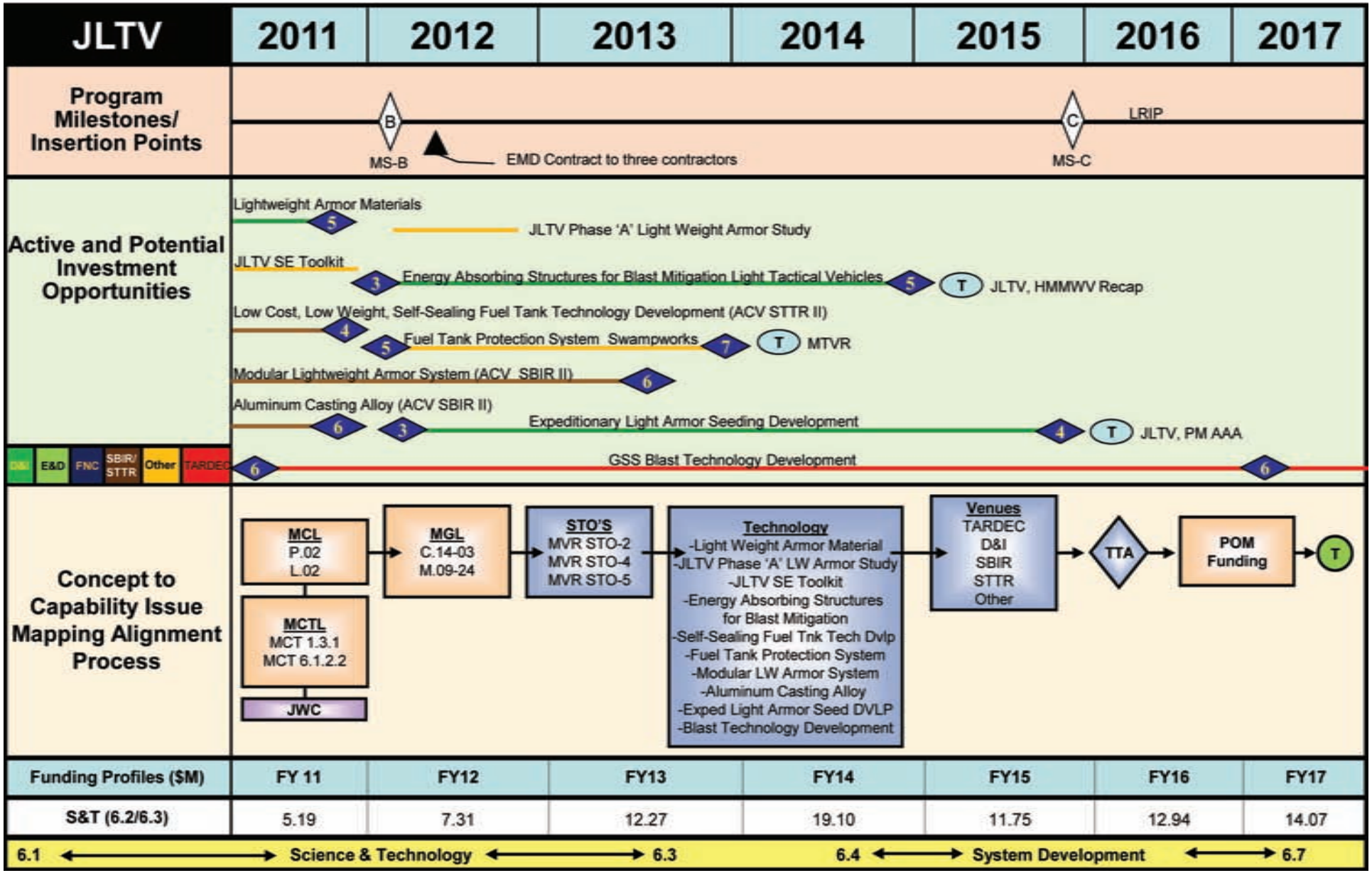
JLTV Technical Issue #1 Weight/Armor



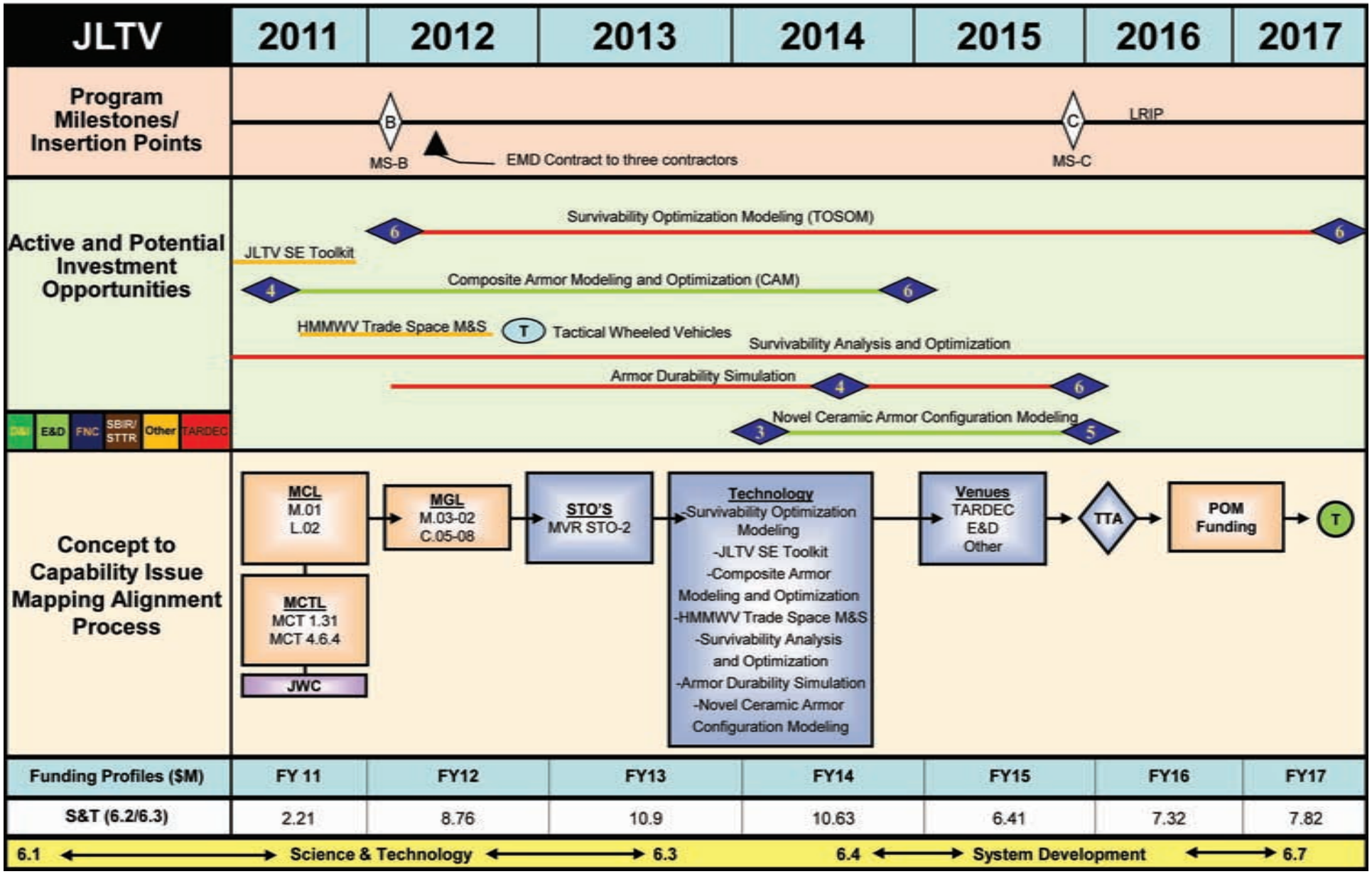
Funding Profiles ($M)	FY 11	FY12	FY13	FY14	FY15	FY16	FY17
S&T (6.2/6.3)	5.19	7.31	12.27	19.10	11.75	12.94	14.07

6.1 ⟷ Science & Technology ⟷ 6.3 6.4 ⟷ System Development ⟷ 6.7

JLTV Technical Issue #1 Weight/Armor

MCL	P.02 Protect personnel, physical assets and LOCs L.02 Maintain equipment	
MCTL	MCT 1.3.1 Conduct Maneuver MCT 6.1.2.2 Harden Installations, Vehicles and Equipment	
MGL	C.14-03 Limited Transport Capability M.09-24 Force Protection	
STO'S	MVR STO-2 Ground vehicle mobility MVR STO-4 Advanced materials and survivability technology to enhance the performance and survivability of combat vehicles & surface crafts MVR STO-5 Vehicle & surface craft design for Marine usability, habitability and survivability	
Technology	Active: -JLTV Phase 'A' Light Weight Armor Study -JLTV SE Toolkit -Energy Absorbing Structures for Blast Mitigation Light Tactical Vehicles -Expeditionary Light Armor Seeding Development	Potential: -Light Weight Armor Materials (Univ. Delaware, Penn St.) -Low Cost, Low Weight, Self-Sealing Fuel Tank Technology Development (ACV STTR II) -Fuel Tank Protection System Swampworks -Modular Lightweight Armor System (ACV SBIR II) -Aluminum Casting Alloy (ACV SBIR II) -GSS Blast Technology Development
Venues	D&I, FNC, Plus-ups, E&D,SBIR	
TTA		T Transition target for: PM JLTV, MTVR, HMMWV, AAA
POM Funding	MCCDC integration division	
T	Transition to a program of record	Comments/Issues:

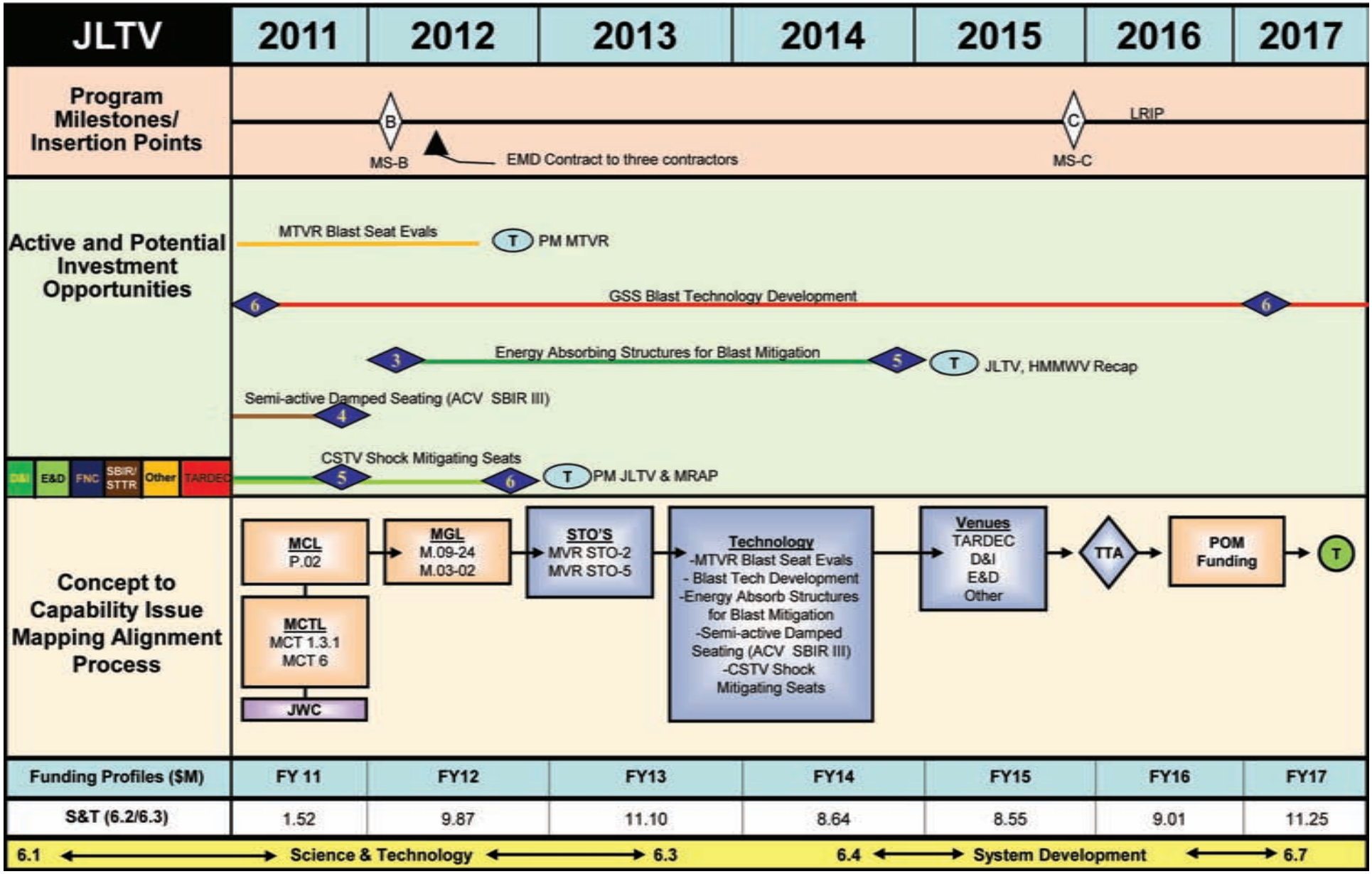
JLTV Technical Issue #2 Reliability/Affordability/ Maintainability (RAM) Modeling and Simulation (M&S)



JLTV Technical Issue #2 Reliability/Affordability/ Maintainability (RAM)

MCL	M.01 Maneuver to secure L.02 Maintain equipment		
MCTL	MCT 1.31 Conduct Maneuver MCT 4.6.4 Provide Simulators and Simulator Support Facilities		
MGL	M.03-02 Protected mobility C.05-08 Visualization Tools		
STO'S	MVR STO-2 Ground vehicle mobility		
Technology	Active: -JLTV SE Toolkit		Potential: -Survivability Optimization Modeling (TOSOM) -Composite Armor Modeling and Optimization (CAM) -HMMWV Trade Space M&S -Survivability Analysis and Optimization -Armor Durability Simulation -Novel Ceramic Armor Configuration Modeling
Venues	TARDEC, E&D, Other		
TTA		T	Transition target for: PM JLTV & other Tactical Wheeled Vehicles
POM Funding	MCCDC integration division		
T	Transition to a program of record	Comments/Issues:	

JLTV Technical Issue #3 Seat Shock/Vibration



Funding Profiles ($M)	FY 11	FY12	FY13	FY14	FY15	FY16	FY17
S&T (6.2/6.3)	1.52	9.87	11.10	8.64	8.55	9.01	11.25

6.1 ⟷ Science & Technology ⟷ 6.3 6.4 ⟷ System Development ⟷ 6.7

JLTV Technical Issue #3 Seat Shock/Vibration

MCL	P.02 Protect personnel, physical assets and LOCs	
MCTL	MCT 1.3.1 Conduct Maneuver MCT 6 Protect the Force	
MGL	M.09-24 Force Protection M.03-02 Protected mobility	
STO'S	MVR STO-4 Advanced materials and survivability technology to enhance the performance and survivability of combat vehicles & surface craft MVR STO-5 Vehicle & surface craft design for Marine usability, habitability, & survivability	
Technology	Active: -CSTV Shock Mitigating Seats -Energy Absorbing Structures for Blast Mitigation	Potential: -MTVR Blast Seat Evals -GSS Blast Technology Development -Semi-active Damped Seating (ACV SBIR III)
Venues	Active: D&I, E&D	Potential: TARDEC, Other, SBIR
TTA	Not required, only required on FNC	T Transition target for: PM JLTV, MRAP, MTVR, HMMWV
POM Funding	MCCDC integration division	
T	Transition to a program of record	Comments/Issues:

Marine Personnel Carrier (MPC)

The Marine Corps has reaffirmed a requirement for a new Marine Personnel Carrier (MPC), an advanced generation eight-wheeled armored personnel carrier that would provide general support lift to Marine infantry in the ground combat element based maneuver task force. The MPC requirement is shaped to provide a balance of performance, protection and payload in order to set the conditions for fielding a combat vehicle that will be effective across the range of military operations.

The MPC family of vehicles will consist of a base vehicle and two supporting mission role variants. The MPC-Personnel will be the base vehicle, two of which carry and support a reinforced rifle squad of 17 Marines (one ACV would do the same). Each vehicle would carry 9 combat-equipped Marines and a three-man crew. This meets the need to transport more Marine infantrymen than the existing Light Armored Vehicle (LAV) or HMMWV platforms while providing greater protection. The eight-wheeled LAV is not employed as an armored personnel carrier and usually carries a four-person Marine scout/reconnaissance team in addition to its crew. The MPC-Command will be equipped to serve as a mobile command-echelon/ fire-support coordination center for the infantry battalion headquarters. The MPC-Recovery will be the maintenance and recovery variant of the MPC.

An MPC company lifts an infantry battalion in conjunction with the infantry's organic wheeled assets. Like the planned ACV, MPCs will be assigned to the Assault Amphibian Battalions of the Marine Division currently outfitted with AAVs. The reconstituted Assault Amphibian battalion would tentatively consist of one MPC company (nominally 88 vehicles) and three ACV companies (about 45 vehicles each).

The MPC supports expeditionary maneuver by enhancing the Marine Air Ground Task Force's (MAGTF) tactical and operational protected mobility. Conceptually, the MPC will complement the ACV and will be delivered to the fight as part of the reinforcing echelon of the MAGTF during forcible entry operations and in of support sustained operations ashore. The MPC will enable the GCE to maintain lift capacity requirements and provides an additional balanced platform that will be capable across the range of military operations.

The Marine Corps leadership deferred a Milestone A go-ahead for the MPC program in May 2008.

MPCs would also be supported by JLTVs carrying heavy weapons, communications equipment, and cargo.

The MPC will be designed to cross rivers and inland bodies of water in a Marine Air-Ground Task Force's littoral operational area. The MPC likely would have a remotely operated weapon station turret fitted with a .50 caliber machine gun, a 7.62 mm machine gun, or an automated Mk. 19 grenade launcher with a thermal sight. The MPC crew could provide direct fire in support of dismounted Marine infantrymen.

The program has built an MPC Technology Demonstrator test bed vehicle at the Nevada Automotive Test Center, Carson City, Nev., which is being used to evaluate all required performance attributes, including mobility (powerpack, drive train, and suspension system), survivability, electrical power generation and distribution, vehicle health monitoring, and the communication system.

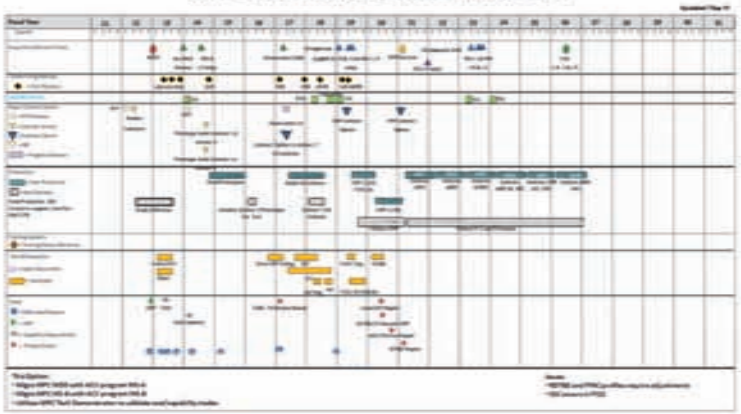
A Capabilities Development Document (CDD) for the program is in development. The MPC test bed vehicle effort will inform the CDD with respect to achievable operational performance requirements and inform the program office of potential integration risks.

The MPC may be a pilot program for cooperation between the Marine Corps and the Army's Tank Automotive Research and Development Engineering Center in Warren, Mich., as part of the program's risk-reduction efforts before it becomes a formal acquisition program.
In May 2011, The MPC program was transferred out from under the formerly chartered authority of Program Manager, Light Armored Vehicles (PM LAV), TACOM Life Cycle Management Command, Warren, Michigan, to, Program Manager, Advanced Amphibious Assault (PM AAA), Woodbridge, Virginia. The MPC will continue to remain under the PEO oversight of PEO Land Systems, in Quantico, Virginia.

Marine Personnel Carrier (MPC)

Resource Sponsor: CD&I

MPC INTEGRATED PROGRAM PLAN



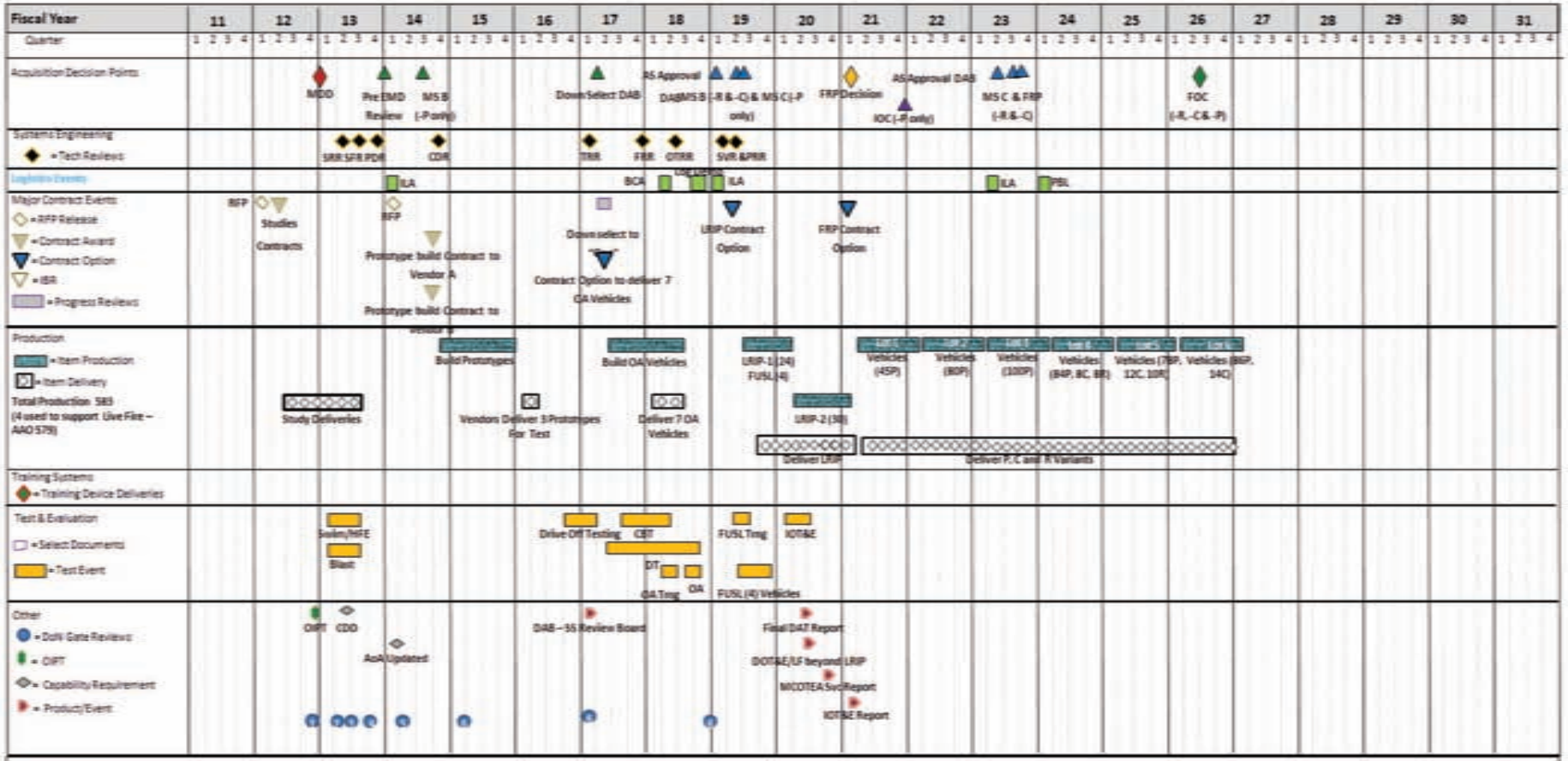
Program Description

- The MPC will provide four battalions of armored personnel carrier-based, general support lift to the GCE of the MAGTF
- The MPC will be effective across the range of military operations during sustained operations ashore and reinforce the ACV-equipped assault echelon during forcible entry operations
- An MPC Company is designed to lift an infantry battalion in conjunction with the infantry's organic wheeled assets
- MPC will field a base vehicle (MPC-Personnel) and two supporting mission role variants: MPC-Command and Control (MPC-C) and MPC-Recovery (MPC-R)

Program Status

- The MPC program is pre-Milestone A.

Marine Personnel Carrier (MPC)



This Option:

- Aligns MPC MDD with ACV program MS-A
- Aligns MPC MS-B with ACV program MS-B
- Utilizes MPC Tech Demonstrator to validate cost/capability trades

Issues:

- RDT&E and PMC profiles require adjustments
- IOC occurs in FY22

MPC's Top Three Program Technology Issues:

1. Survivability - The space, weight, and power required to protect the vehicle occupants will challenge the vehicle performance requirements. We need lightweight survivability solutions with specific focus on blast and direct fire protection

2. Weight - Meeting the weight target for MPC will be difficult given the survivability requirements, volume for buoyancy, and troop/equipment capacity. Light weight solutions for vehicle materials and components are needed.

3. On-Board and Exportable Power - Internal power demands as currently defined for the MPC exceeds the ability of the MPC to export power when the vehicle is stationary. There is a need to incorporate power generation, management and distribution technologies to enable adequate power distribution to include on and off vehicle applications including silent watch capability.

1. Survivability:

1a. No Active S&T Initiatives for MPC

1b. Potential S&T Initiatives for MPC

Discovery and Innovation (D&I)
- Lightweight Armor Materials
- Energy Absorbing Structures for Blast Mitigation
- CSTV Shock Mitigating Seats

Exploration & Development (E&D)
- CSTV Shock Mitigating Seats

Small Business Technology Transfer and Research (STTR)
- Mitigation of Fuel Tank Explosions and Fires (MTVR STTR Phase I)

TARDEC
- Advanced Combat Vehicle Armor Development (ACVAD)

Other
- AMAS JCTD
- Fuel Tank Protection System Swampworks
- MTVR Blast Seat Evals

2. Weight:

2a. No Active S&T Initiatives for MPC

2b. Potential S&T Initiatives for MPC

Exploration & Development (E&D)
- Lightweight Armor Materials
- Expeditionary Light Armor Seeding Development

Discovery and Innovation (D&I)
- Energy Storage Module to Reduce Fuel Consumption

Small Business Innovation Research (SBIR)
- Aluminum Casting Alloy (ACV SBIR II)
- Modular Lightweight Armor System (ACV SBIR II)
- Modular Lightweight External Fuel Tank System (ACV SBIR I)

Small Business Technology Transfer and Research (STTR)
- Low Cost, Low Weight, Self-Sealing Fuel Tank Technology Development (ACV STTR II)

TARDEC
- Advanced Combat Vehicle Armor Development (ACVAD)

Other
- JLTV Phase 'A' Light Weight Armor Study

3. On-Board and Exportable Power:

3a. Active S&T Initiatives for MPC
- Phase 'A' Power Distribution & Management Study

3b. Potential S&T Initiatives for MPC

Exploration & Development (E&D)
- Vehicle Integrated Power and Propulsion

Future Naval Capability (FNC)
- Fuel Efficient MTVR

TARDEC
- Ground Vehicle APU System Development *JP-8 Fuel Cell System
- Ground Vehicle APU System Development * High Power Density Common APU
- Energy Storage Research & Development

Other
- On-Board Vehicle Power Systems Development

MPC Technical Issue #1 Survivability

MPC	2011	2012	2013	2014	2015	2016	2017
Program Milestones/ Insertion Points	The MPC Program is currently Pre-Milestone A						

Active and Potential Investment Opportunities

- Lightweight Armor Materials (5)
- Autonomous Mobility Appliqué System(AMAS) JCTD (4, 6)
- Mitigation of Fuel Tank Explosions and Fires (MTVR STTR Phase I) (4)
- Fuel Tank Protection System Swampworks (5, 7, T) MTVR
- Advanced Combat Vehicle Armor Development (ACVAD) (4, 5, 6)
- Energy Absorbing Structures for Blast Mitigation (3, 5, T) JLTV, HMMWV Recap
- MTVR Blast Seat Evals (T) PM MTVR
- CSTV Shock Mitigating Seats (5, 6, T) PM JLTV & MRAP

D&I | E&D | FNC | SBIR/ STTR | Other | TARDEC

Concept to Capability Issue Mapping Alignment Process

MCL: P.02, M.01 → MGL: M.09-24, M.03-02, M.09-03 → STO'S: MVR STO-2, MVR STO-4 → Technology: -Lightweight Armor Materials, -Autonomous Mobility Appliqué System(AMAS) JCTD, -Mitigation of Fuel Tank Explosions and Fires, -Fuel Tank Protection System, -Advanced Combat Vehicle Armor Development, -Energy Absorbing Structures for Blast Mitigation, -MTVR Blast Seat Evals, -CSTV Shock Mitigating Seats → Venues: D&I, SBIR, TARDEC, E&D, Other → TTA → POM Funding → T

MCTL: MCT 1.3.1

JWC

Funding Profiles ($M)	FY 11	FY 12	FY 13	FY14	FY 15	FY 16	FY 17
S&T (6.2 / 6.3)	3.24	19.83	17.36	10.57	14.00	14.15	1.00

6.1 ⟷ Science & Technology ⟷ 6.3 6.4 ⟷ System Development ⟷ 6.7

MPC Technical Issue #1 Survivability

MCL	P.02 Protect personnel, physical assets and LOCs M.01 Maneuver to secure	
MCTL	MCT 1.3.1 Conduct Maneuver	
MGL	M.09-24 Force Protection M.03-02 Protected mobility M.09-03 Protect armor platforms against RPG and ATGMs	
STO'S	MVR STO-2 Ground vehicle mobility MVR STO-4 Advanced materials and survivability technology to enhance the performance and survivability of combat vehicles	
Technology	Active: None	Potential: -Lightweight Armor Materials -Autonomous Mobility Appliqué System(AMAS) JCTD -Mitigation of Fuel Tank Explosions and Fires -Fuel Tank Protection System -Advanced Combat Vehicle Armor Development -Energy Absorbing Structures for Blast Mitigation -MTVR Blast Seat Evals -CSTV Shock Mitigating Seats
Venues	D&I, SBIR, TARDEC, E&D, Other	
TTA	N/A	
POM Funding	MCCDC Integration Division	
T	Transition to a program of record	Comments/Issues:

MPC Technical Issue #2 Weight

MPC	2011	2012	2013	2014	2015	2016	2017
Program Milestones/ Insertion Points	The MPC Program is currently Pre-Milestone A						

Active and Potential Investment Opportunities

- Aluminum Casting Alloy (ACV SBIR II) — 6
- 3 — Expeditionary Light Armor Seeding Development — 4 — T — JLTV, PM AAA
- JLTV Phase 'A' Light Weight Armor Study
- Lightweight Armor Materials — 5
- Advanced Combat Vehicle Armor Development (ACVAD) — 4 — 5 — 6
- 6 — Low Cost, Low Weight, Self-Sealing Fuel Tank Technology Development (ACV STTR II)
- Energy Storage Module to Reduce Fuel Consumption — 5
- Modular Lightweight Armor System (ACV SBIR II) — 6
- Modular Lightweight External Fuel Tank System (ACV SBIR I) — 6

D&I | E&D | FNC | SBIR/STTR | Other | TARDEC

Concept to Capability Issue Mapping Alignment Process

MCL: P.02, M.01 → MGL: M.09-25, M.07-02, M.09-07 → STO'S: MVR STO-2, MVR STO-4, MVR STO-5 → Technology: -Aluminum Casting Alloy, -Expeditionary Light Armor Seeding Development, -JLTV Phase 'A' Light Weight Armor Study, -Advanced Combat Vehicle Armor Development, -Low Cost, Low Weight, Self-Sealing Fuel Tank Technology Development, -Modular Ltwt Armor System → Venues: D&I, E&D, SBIR, TARDEC → TTA → POM Funding → T

MCTL: MCT 1.3.1, MCT 1.4.1 → JWC

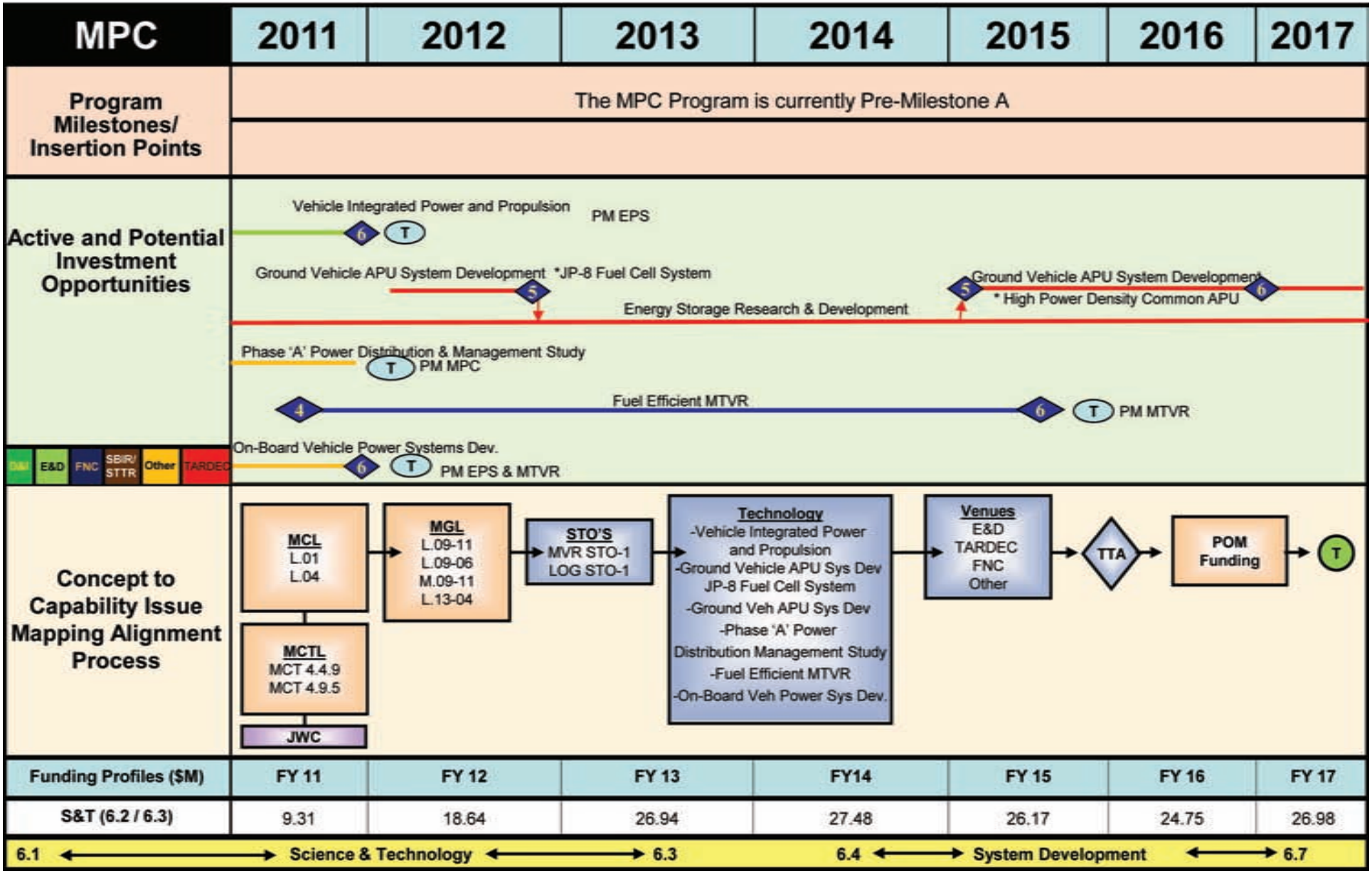
Funding Profiles ($M)	FY 11	FY 12	FY 13	FY14	FY 15	FY 16	FY 17
S&T (6.2 / 6.3)	3.98	9.92	7.22	9.80	14.50	14.15	1.00

6.1 ⟷ Science & Technology ⟷ 6.3 6.4 ⟷ System Development ⟷ 6.7

MPC Technical Issue #2 Weight

MCL	P.02 Protect personnel, physical assets and LOCs M.01 Maneuver to secure	
MCTL	MCT 1.3.1 Conduct Maneuver MCT 1.4.1 Conduct Mobility Operations	
MGL	M.09-25 Movement Standards M.07-02 Light Armored Recon M.09-07 Assault Gap Crossing	
STO'S	MVR STO-2 Ground vehicle mobility MVR STO-4 Advanced materials and survivability technology to enhance the performance and survivability of combat vehicles and surface craft MVR STO-5 Vehicle and surface craft design for Marine usability, habitability, and survivability	
Technology	Active: -N/A	Potential: -Aluminum Casting Alloy -Expeditionary Light Armor Seeding Development -JLTV Phase 'A' Light Weight Armor Study -Advanced Combat Vehicle Armor Development -Lightweight Armor Materials -Energy Storage Module to Reduce Fuel Consumption -Low Cost, Low Weight, Self-Sealing Fuel Tank Technology Development -Modular Lightweight External Fuel Tank System -Modular Ltwt Armor System
Venues	D&I, E&D, SBIR, TARDEC, Other	
TTA	N/A	
POM Funding	MCCDC integration division	
T	Transition to a program of record	Comments/Issues:

MPC Technical Issue #3 Onboard and Exportable Power



MPC Technical Issue #3 Onboard and Exportable Power

MCL	L.01 Provide supply support L.04 Provide logistics services	
MCTL	MCT 4.4.9 Conduct Tactical Electrical Supply MCT 4.9.5 Supply Electrical Power	
MGL	L.09-11 Alternate Power Sources L.09-06 On Move Power Generation M.09-11 Exportable Power For On-Board Systems L.13-04 Power generation/ distribution	
STO'S	MVR STO-1 Fuel efficient and power generating vehicle systems LOG STO-1 Asset versatility	
Technology	Active: None	Potential: -Vehicle Integrated Power and Propulsion -Ground Vehicle APU Systems Development JP-8 Fuel Cell System -Ground Vehicle APU Systems Development -Phase 'A' Power Distribution Management Study -Fuel Efficient MTVR -On-Board Vehicle Power Systems Development
Venues	E&D,TARDEC , FNC, Other	
TTA	Fuel Efficient MTVR	T Transition target: MTVR
POM Funding	MCCDC Integration Division	
T	Transition to a program of record	Comments/Issues:

Logistics Vehicle System Replacement (LVSR)

The Logistics Vehicle System Replacement (LVSR) is a new Marine Corps heavy in the Marine Logistics Group (MLG), Marine Divisions (MAR DIVs) and Marine Aircraft Wings (MAWs). The LVSR also offers reduced life-cycle costs. Both vehicles can carry 22.5 tons on the highway, but the more powerful LVSR can transport 16.5 tons off road, compared with 12.5 tons for the LVS.

The LVSR can travel up to 65 miles per hour on paved surfaces and has a cruising range of 300 miles. It can ford 5 feet of water. Built by Oshkosh Corporation, the new tactical-distribution heavy hauler carries fuel, water, ammunition, standardized containers, palletized cargo, and heavy equipment. The earlier-vintage LVS, also built by Oshkosh, is a two-piece truck-trailer, with a four-wheel-drive front power unit and five categories of trailer rear-body units. In contrast, the all-wheel-drive LVSR has a straight body design in three different variants – cargo, wrecker, and tractor. The wrecker performs heavy wrecker/recovery missions. The tractor variant will tow heavy engineer equipment and combat vehicles with the 40-ton Medium-Heavy Equipment Trailer.

The LVSR, with a standard two-person cab (and a third position for an optional machine gunner position), uses Oshkosh's TAK-4 independent suspension system for improved mobility and off-road maneuverability. The suspension system allows each wheel to move up and down separately in response to uneven surfaces, reducing the stress on the axle and keeping the vehicle more level on rough terrain. The LVSR appears to move like a giant caterpillar.
Oshkosh's mechanical rear-steer technology, in which the rear wheels actually steer separately, the LVSR makes a complete 360-degree turn in only about 84 feet. This tight turning radius facilitates vehicle storage aboard ship. The LVSR has a 600-horsepower Caterpillar diesel engine and an Allison 7-speed automatic transmission. The vehicle is 35.5 feet long, 8 feet wide and 12 feet high. It has a "cab-over" design, in which the cab hangs out over the front wheels fairly low to the ground.

The vehicle features factory-installed, integral underbody armor for cab floor mine-blast protection. To counter improvised explosive devices (IEDs), the Marine Corps has fitted the LVSR's cab with a removable, add-on armor package developed by the OEM, Oshkosh Corporation, and Israel's Plasan Sasa. Unlike previous tactical trucks with armor added after the fact due to the threats in Iraq and Afghanistan, the LVSR vehicle was designed and built to accommodate the weight of its armor package without degrading vehicle performance.

Fielding of the LVSR cargo variant began in early summer 2009; the vehicle achieved an initial operational capability in September of that year. The program received approval for full-rate production for the cargo variant in December 2009 and for the Wrecker and Tractor variants in April 2011.

As of August 2011, 1,1134 (1,106 Cargo, 17 Wrecker Low-Rate Initial Production (LRIP) vehicles and 11 LRIP Tractors) LVSRs had been delivered to the Marine Corps and 199 were in Afghanistan. After delivery, the vehicles are fitted with additional warfighting equipment (i.e. IED "jammers", tactical radios, and other electronics) before being shipped overseas.

The wrecker variant is able to recover heavy Mine-Resistant Ambush-Protected (MRAP) vehicles, which have given the 7-ton Medium Tactical Vehicle Replacement (MTVR) wrecker some difficulty. The initial deliveries of LVSR Wreckers to Afghanistan were expedited based on requests from theater commanders, with the first two vehicles arriving in-theater April 2011.

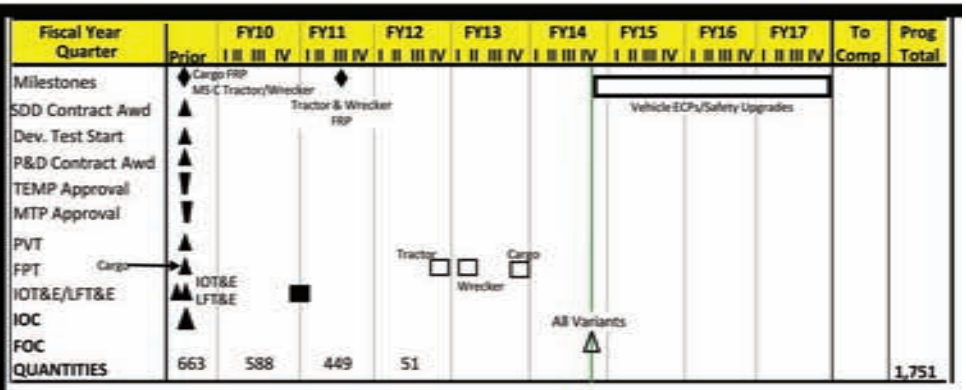
The Marine Corps' LVSR Approved Acquisition Objective (AAO) is 2,000. To date, 1,713 vehicles are on contract made up of 1,318 cargo variants, 123 wreckers, and 272 tractors, Miller said.

The Marine Corps began deploying the first four LVSR Cargo vehicles to Afghanistan in September 2009 in support of urgent fielding of the Mobile Trauma Bay. The latter is a fully enclosed and armored surgical unit with three operating stations in modular pieces that are mounted on the back of an LVSR. The Mobile Trauma Bay allows a five-person shock trauma platoon to treat severely wounded Marines earlier at forward casualty- collection points instead of making them wait for a medevac helicopter or ground vehicle.

The LVSR's in-cab vehicle electronic diagnostics system lets the driver monitor the engine, transmission, brakes, central tire inflation system, and other critical components. The vehicle's simplified maintenance features a single-source lubrication system, which houses the engine oil, transfer case, hydraulics, and transmission in the same reservoir.

The LVSR and the MTVR, both built by Oshkosh, share common parts and similar maintenance.

Logistics Vehicle System Replacement (LVSR)



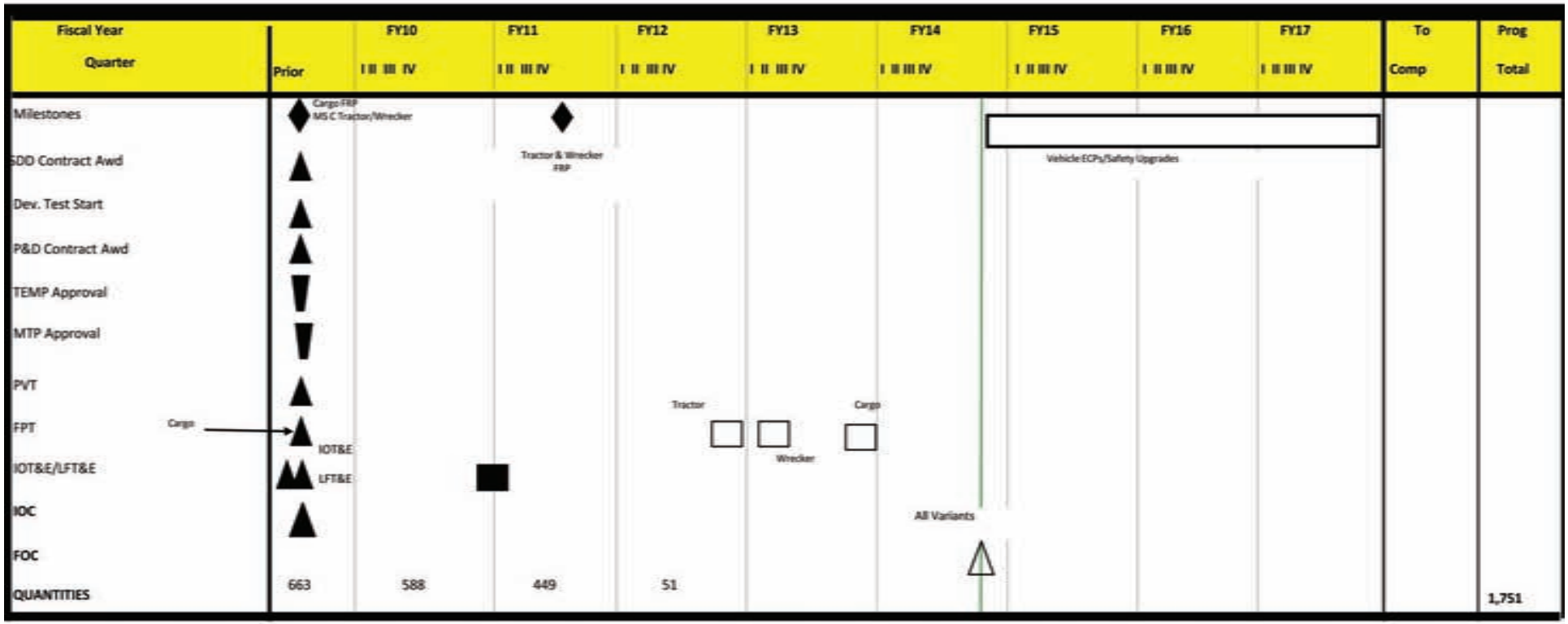
Program Description

The Logistics Vehicle System Replacement (LVSR) will replace the current Marine Corps heavy-tactical wheeled vehicle, the Logistics Vehicle System (LVS). As the Marine Corps' heavy-tactical distribution system, the LVSR Cargo variant will transport bulk liquids (fuel and water); ammunition; standardized containers; bulk, break-bulk, palletized cargo, and bridging equipment. The LVSR Wrecker variant will perform heavy wrecker/recovery missions, while the LVSR Tractor variant will tow heavy engineer equipment and combat vehicles with the M870A2 40 ton Medium Heavy Equipment Trailer (MHET).

Program Status

- AAO 2000 Includes (1489 Cargo, 349 Tractors, & 162 Wreckers)
- Prime Contractor: Oshkosh Corporation
- Significant events
  - All variants in process of fielding
  - MARCENT – 182 Cargo variants delivered 2Q FY11
  - LRIP Wrecker fielding to OEF started 2QFY11 (Total qty 51; MEF fwd request to reduce qty to 36 pending approval)
  - Tractor & Wrecker FRP completed 4/21/11
  - Tractor fielding to OEF started Jul 11 (Total qty to be 60)
  - Current Production Contract extended 16 months to Sep 12

Logistics Vehicle System Replacement (LVSR)



Logistics Vehicle System Replacement (LVSR)

LVSR's Top Three Program Technology Issues:

1. Fuel Economy - At 2.0 miles per gallon, coupled with the Fully Burden Cost of Fuel (FBCF), a moderate increase in fuel efficiency of the LVSR has the potential of saving millions of dollars. Current fuel efficiency efforts that have LVSR potential are: engine mounted fuel efficiency technologies and regenerative breaking.

2. Current & Future C4I Integration Demands - The addition of multiple communications and electronics equipment to the LVSR will soon exceed the vehicle's power generating capability. In addition, interoperability, heat rejection, and space claim issues present human systems integration challenges to the crew. Although there are no active S&T initiatives specifically addressing these demands, there are numerous ONR and TARDEC programs addressing vehicle power demands.

3. Increased Survivability - Although the addition of armor has directly increased survivability of the LVSR, continuing effort is required to maintain or increase survivability of the vehicle and occupants from emerging threats. This includes increasing armor protection while maintaining or reducing current weight, improvements in blast resistant seats, crew egress systems, and advanced fire suppression systems.

1. Fuel Economy:

1a. No Active S&T Initiatives for LVSR

1b. Potential S&T Initiatives for LVSR

Discovery & Invention (D&I)
- Future Fuel Alternatives
- Extended Traction Tire (ETT)

Exploration & Development (E&D)
- Integrated Power and Propulsion
- Fuel Efficient Enabling Technologies w/ TARDEC

Future Naval Capability (FNC)
- Fuel Efficient MTVR

Small Business Innovation Research (SBIR)
- Engine Efficiency Enhancements (MTVR Phase II SBIR)

TARDEC
- Alternative Fuels & Petroleum, Oil & Lubricants
- Efficient Powertrain Technology Integration

2. <u>Current & Future Power Demands:</u>

2a. No Active S&T Initiatives for LVSR

2b. Potential S&T Initiatives for LVSR

Exploration & Development (E&D)
- Modular Vehicle Platform (MVP)
- Integrated Power & Propulsion

TARDEC
- Electrical Power Systems
- Vehicle Electronics Integration Technologies
- Distributed Soldier Load Through SMART Vehicle Control
- Vehicle Electronics Architecture and Standards

Other
- NUCLEUS Effort

3. <u>Increased Survivability:</u>

3a. No Active S&T Initiatives for LVSR

3b. Potential S&T Initiatives for LVSR

Discovery & Invention (D&I)
- Lightweight Armor Materials
- CSTV Shock Mitigating Seats
- Energy Absorbing Structures for Blast Mitigation

Exploration & Development (E&D)
- CSTV Shock Mitigating Seats
- Silencing USMC Vehicles

Small Business Innovation Research (SBIR)
- Mitigation of Blast Injuries through M&S (MTVR SBIR Phase II)

Small Business Technology Transfer and Research (STTR)
- Mitigation of Fuel Tank Explosions and Fires (MTVR STTR Phase I)

TARDEC

- RPG Active Protection (RAP)
- Enhanced RPG Active Protection (ERAP)

Other

- AMAS JCTD
- Fuel Tank Protection System Swampworks
- MTVR Blast Seat Evals

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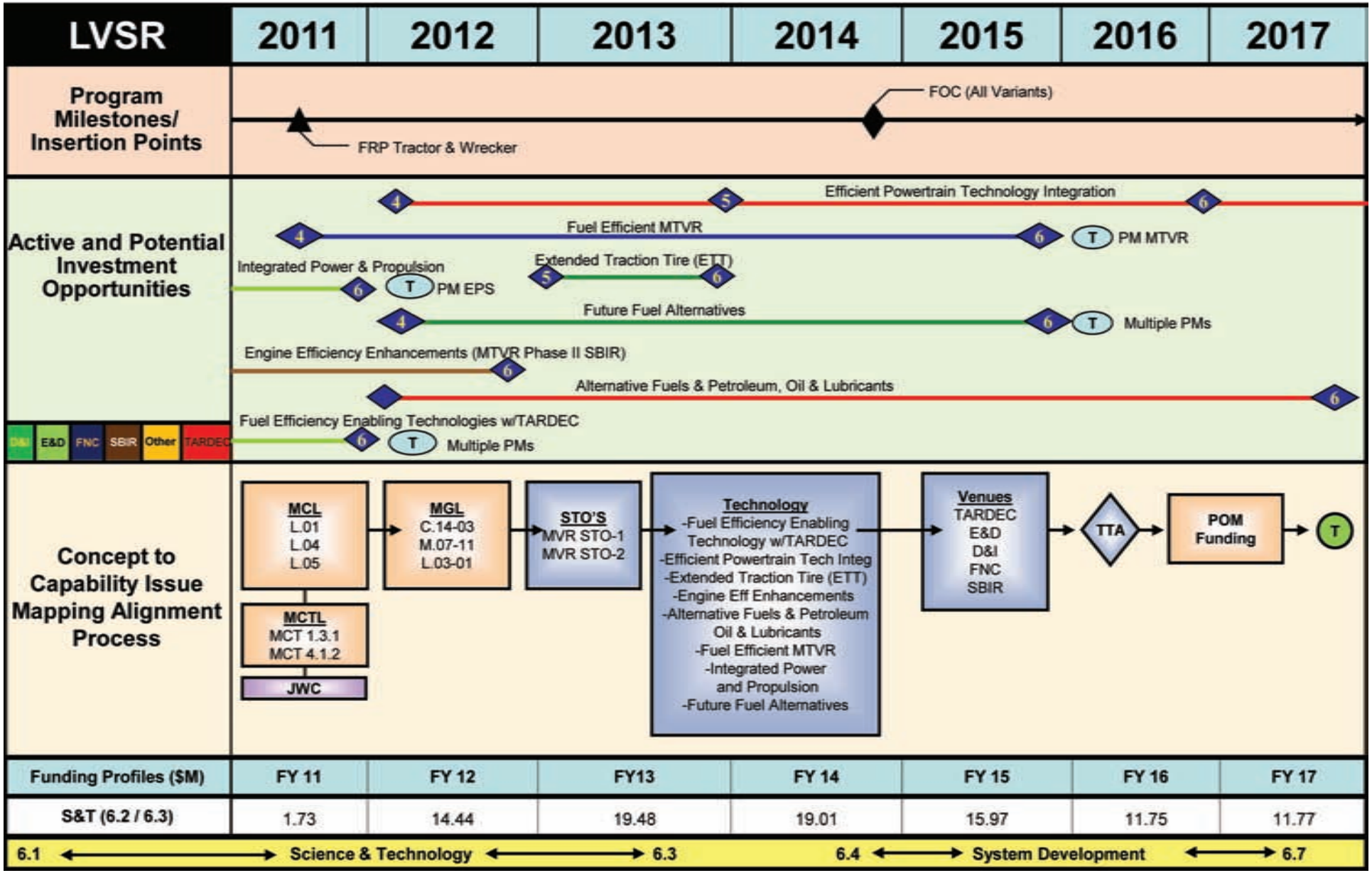
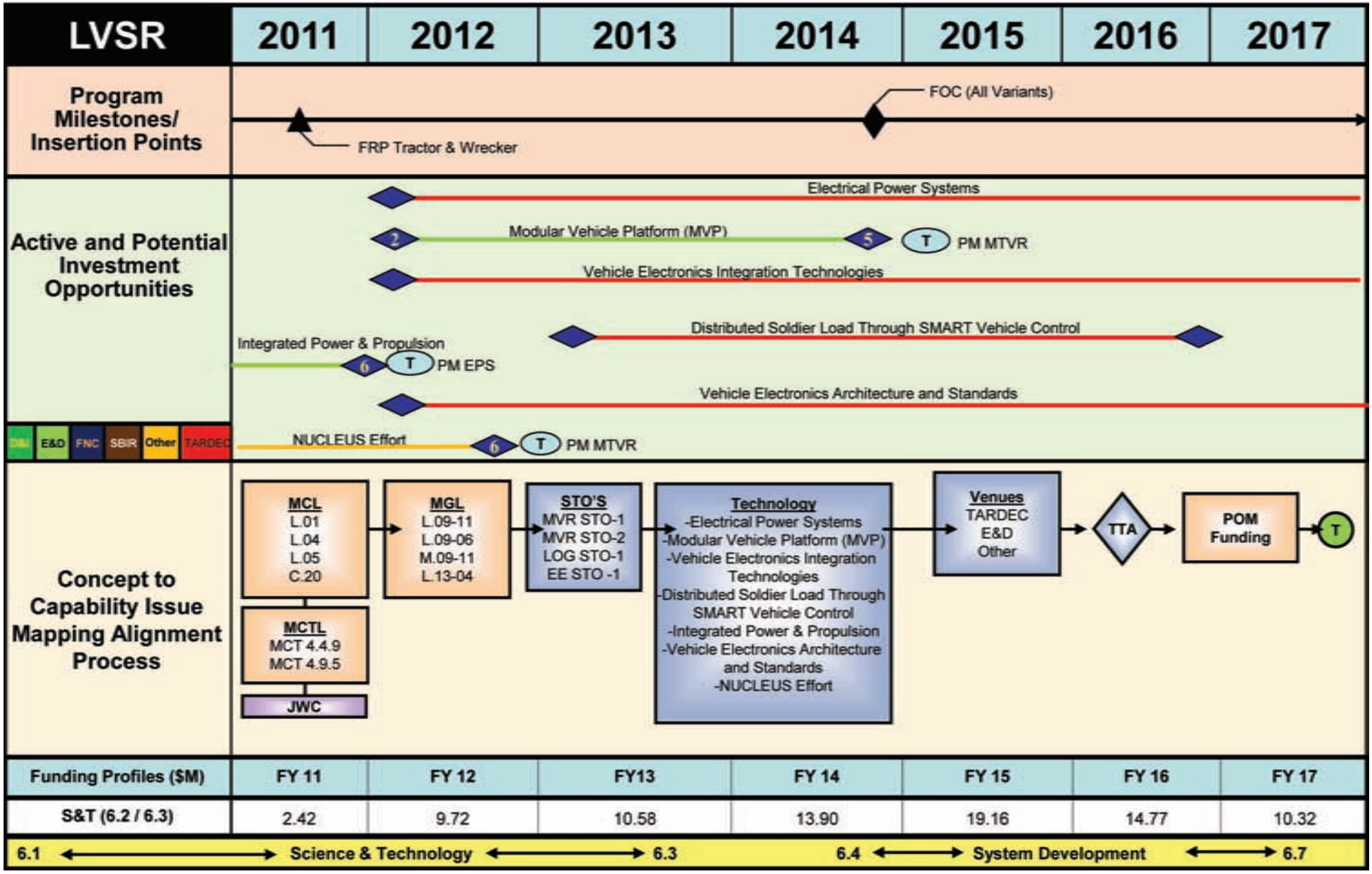
LVSR Technical Issue #1 Fuel Economy



LVSR Technical Issue #1 Fuel Economy

MCL	L.01 Provide supply support L.04 Provide logistics services L.05 Provide deployment and distribution support.	
MCTL	MCT 1.3.1 Conduct Maneuver MCT 4.1.2 Conduct Ground Supply Operations	
MGL	C.14-03 Limited Transport Capability M.07-11 Mobility in all terrain & climates L.03-01 Sustainment Distribution	
STO'S	MVR STO-1 Fuel efficient power generating systems MVR STO-2 Ground vehicle mobility	
Technology	Active: N/A	Potential: -Efficient Powertrain Technology Integration -Extended Traction Tire (ETT) -Integrated Power & Propulsion -Future Fuel Alternatives -Alternative Fuels & Petroleum, Oil & Lubricants -Fuel efficiency Enabling Technology with TARDEC -Fuel Efficient MTVR -Engine Efficiency Enhancements (MTVR Phase II SBIR)
Venues	TARDEC, E&D, D&I, FNC, SBIR,	
TTA	w/ MTVR	T Transition target for: PM MTVR, EPS, Multiple PMs
POM Funding	MCCDC integration division	
T	Transition to a program of record	Comments/Issues:

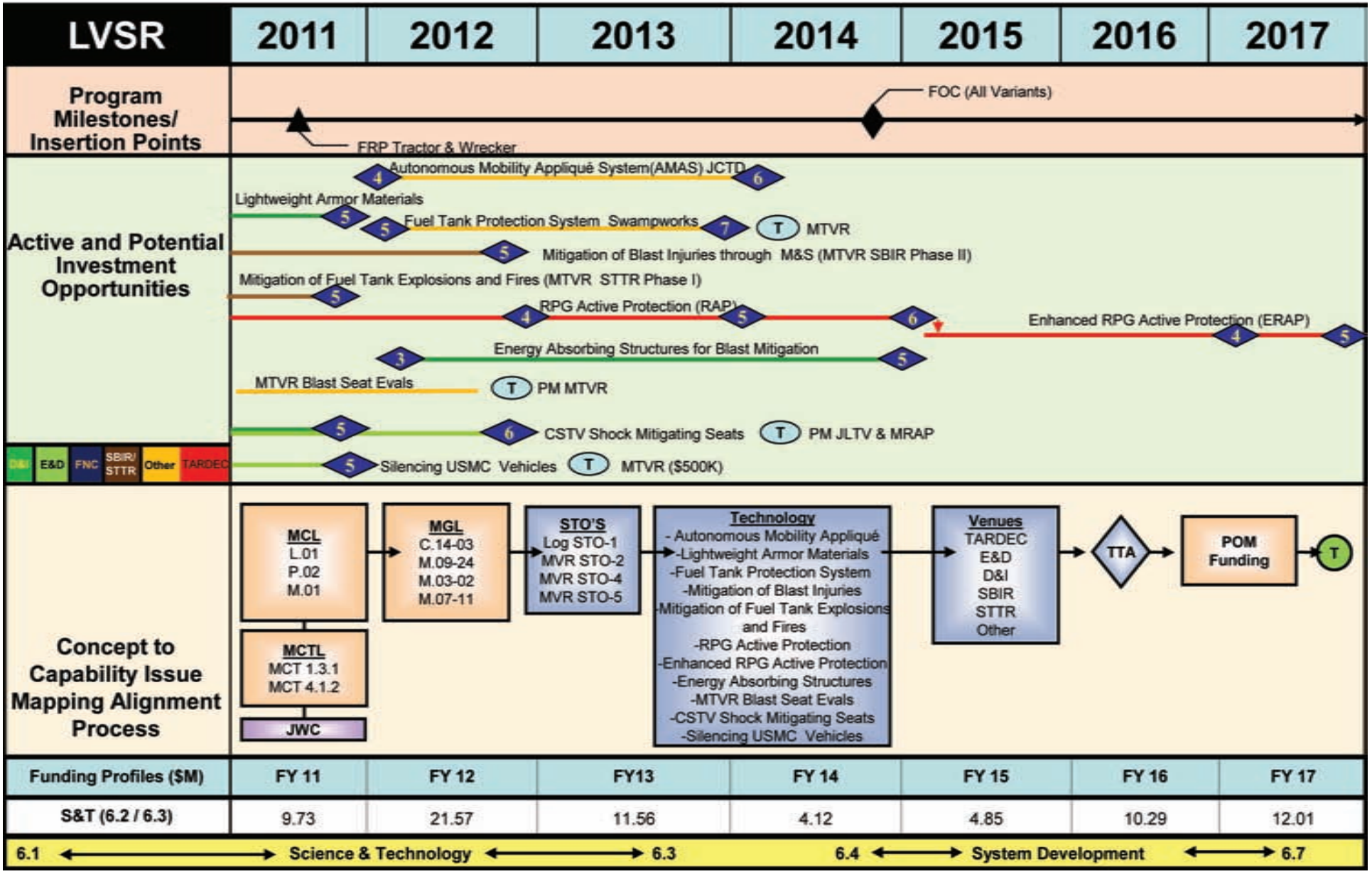
LVSR Technical Issue #2 Current & Future C4I Integration Demands



LVSR Technical Issue #2 Current & Future C4I Integration Demands

MCL	L.01 Provide supply support L.04 Provide logistics services L.05 Provide deployment and distribution support C.20 Optimize Networks	
MCTL	MCT 4.4.9 Conduct Tactical Electrical Supply MCT 4.9.5 Supply Electrical Power	
MGL	L.09-11 Alternate Power Sources L.09-06 On Move Power Generation M.09-11 Exportable Power For On-Board Systems L.13-04 Power Generation/ Distribution	
STO'S	MVR STO-1 Fuel efficient & power generating vehicle systems MVR STO-2 Ground vehicle mobility LOG STO-1 Asset versatility EE STO-1 Expeditionary energy harvesting	
Technology	Active: N/A	Potential: -Electrical Power Systems -Vehicle Electronics Integration Technologies -Distributed Soldier Load Through SMART Vehicle Control -Integrated Power & Propulsion -Vehicle Electronics Architecture and Standards -NUCLEUS Effort -Modular Vehicle Platform (MVP)
Venues	TARDEC, E&D, Other	
TTA	No TTAs is needed	T Transition target for: PM MTVR, EPS
POM Funding	MCCDC integration division	
T	Transition to a program of record	Comments/Issues:

LVSR Technical Issue #3 Increased Survivability



LVSR Technical Issue #3 Increased Survivability

MCL	L.01 Provide supply support P.02 Protect Personnel physical assets & LOCs M.01 Maneuver to secure		
MCTL	MCT 1.3.1 Conduct Maneuver MCT 4.1.2 Conduct Ground Supply Operations		
MGL	C.14-03 Limited Transport Capability M.09-24 Force Protection M.03-02 Protected Mobility M.07-11 Mobility in all terrain & climates		
STO'S	Log STO-1 Asset versatility MVR STO-2 Ground vehicle mobility MVR STO-4 Advanced materials and survivability technology to enhance the performance and survivability of combat vehicles &surface craft MVR STO-5 Vehicle and surface craft design for Marine usability, habitability, and survivability		
Technology	Active: N/A	Potential: Fuel Tank Protection System Swampworks -Mitigation of Blast Injuries through M&S (MTVR SBIR Phase II) -Mitigation of Fuel Tank Explosions and Fires (MTVR STTR Phase I) -MTVR Blast Seat Evals -Silencing USMC Vehicles	Potential continued: -Autonomous Mobility Appliqué System(AMAS) JCTD -Lightweight Armor Materials -RPG Active Protection (RAP) -Enhanced RPG Active Protection (ERAP) -Energy Absorbing Structures for Blast Mitigation -CSTV Shock Mitigating Seats
Venues	TARDEC, D&I, E&D, SBIR, STTR, Other		
TTA		T Transition target for: PM MTVR, MRAP, JLTV	
POM Funding	MCCDC integration division		
T	Transition to a program of record	Comments/Issues:	

Medium Tactical Vehicle Replacement (MTVR)

In service since 2001, the six-wheel, 7-ton, all-terrain Medium Tactical Vehicle Replacement (MTVR) truck is a popular Marine Corps workhorse. The multi-purpose vehicle has replaced the service's aging 5-ton trucks.

The MTVR hauls fuel, water, food, and supplies, as well as Marines, and also tows the M777 Lightweight 155 mm howitzer. Built by Oshkosh Corporation, the remarkable MTVR can traverse terrain previously regarded as impassable by military trucks.

There are four MTVR models, each carrying a crew of three Marines in its cab: a cargo variant, a dump truck, a wrecker, and a tractor. In addition, the High Mobility Artillery Rocket system (HIMARS) also includes an MTVR ammunition Resupply Vehicle (RSV) and trailer. There is a high level of commonality across the family of vehicles.

The predominant standard cargo variant is 26 feet long, 8 feet wide and 12 feet high. It can haul up to 15 tons of payload on paved primary or secondary roads to a maximum speed of 65 miles per hour, or can carry 7.1 tons cross country. The MTVR can traverse a 60 percent gradient and a 30 percent side slope with its maximum cross-country load, and can ford 5 feet of water. It has an on-road cruising range of 300 miles.

The vehicle features Oshkosh's high-performance TAK-4 independent suspension, which provides superior mobility and off-road maneuverability. It allows each wheel to move up and down separately in response to uneven surfaces, reducing the stress on the axle and keeping the vehicle more level on rough terrain. The MTVR also features a 425-horsepower Caterpillar engine, an Allison 7-speed automatic transmission, anti-lock brakes with automatic traction control, a central tire inflation system, an aluminum cab, and special corrosion protection. The MTVR wrecker variant is equipped with mechanical rear-steer technology, which aids in tight turns for vehicle recovery missions.

More than 8,900 MTVRs are in service with the Marine Corps. The Marine Corps' Ground Combat Tactical Vehicle (GCTV) Strategy reduced the MTVR AAO to 8,750 vehicles. The Navy SeaBees also possess over 1,800 MTVRs that are used in riverine and combat engineering missions. More than 800 USMC MTVRs have been in service in Afghanistan. The MTVR wrecker variant has been in high demand in Iraq and Afghanistan to recover heavy Mine-Resistant Ambush-Protected (MRAP) vehicles.

To improve the vehicle's level of protection against mines and improvised explosive devices (IEDs), the MTVR Armor System (MAS) was designed as a permanent modification to the vehicle. It provides complete 360-degree protection as well as overhead and underbody protection for the cab occupants.

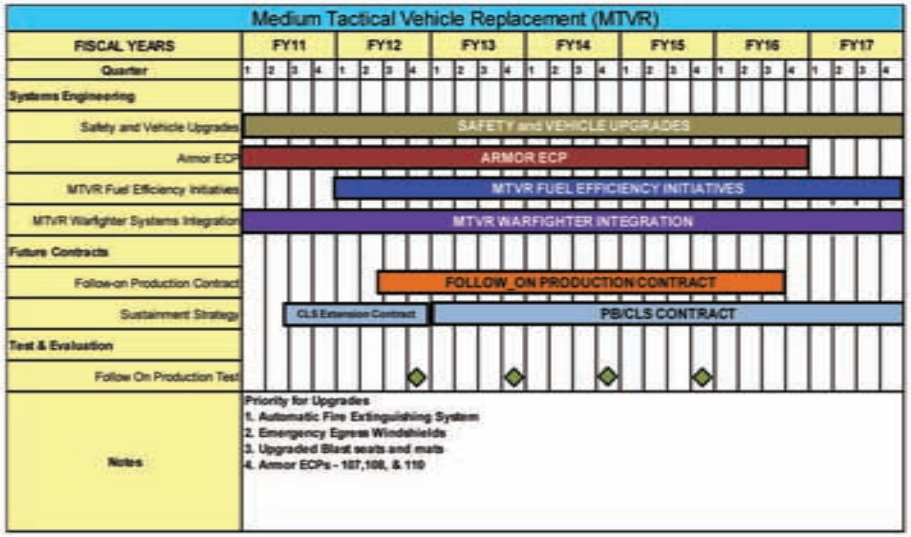
The armor kit was developed by the MTVR OEM, Oshkosh Corporation, and Israel's Plasan Sasa. Installation of MAS on MTVR cargo variants deployed overseas began in late 2004-early 2005. The kit's effectiveness had been proven in combat by late 2005. The dump truck and tractor MAS variants began fielding in December 2006.

MAS includes integrated, permanently mounted cab armor, as well as an upgraded front suspension, and air conditioning system. On selected armored vehicles, the Marine Corps Transparent Armor Gun Shield (MCTAGS), which provides a protective "turret" for the vehicle gunner, and a removable armored personnel carrier for the vehicle's cargo bay, nicknamed "the Armadillo", are added. The latter is a capsule with armored sides, ballistic glass windows, bench seats, and a tarp-covered open top.

The Marine Corps has continued to improve the MAS in response to Urgent Universal Need Statements from the field, including adding increased underbody blast protection and fuel tank fire-protection kits. The newest configuration of MAS is a "reducible height" version that includes a removable cab roof to facilitate storing the MTVR trucks on Maritime Prepositioning Ships. The Marine Corps completed installations of MAS in all of its MTVR variants in Afghanistan and Iraq, including the dump truck and tractor models, in December 2008. MAS installations for vehicles in the continental United States, as well as those on Maritime Prepositioning Ships and at III MEF locations in Japan and Hawaii, have been ongoing since 2008, and will continue through 2012. The Marine Corps' Deputy Commandant for Combat Development & Integration (CD&I) is still determining how many of the MTVRs in the stateside Marine Expeditionary Forces need to be armored.

The Corps plans to install MAS on about half of its MTVR fleet, but could scale back that number because the MAS adds a lot of weight and reduces fuel economy. Even though the armor was added to the MTVR after it was designed, the vehicle has the capability to carry the added weight without severely affecting its performance. The suspension has been modified, not just because of the added weight of the armor, but also because of all the government-furnished equipment that is added to the vehicle, such as an IED jammer and the Blue Force Tracking digital map system. The Marine Corps' MTVR and its new Logistics Vehicle System Replacement (LVSR), also built by Oshkosh, form a formidable logistical tandem. They also share many common parts and similar maintenance, which streamlines service and support while reducing downtime.

Medium Tactical Vehicle Replacement (MTVR)



Program Description

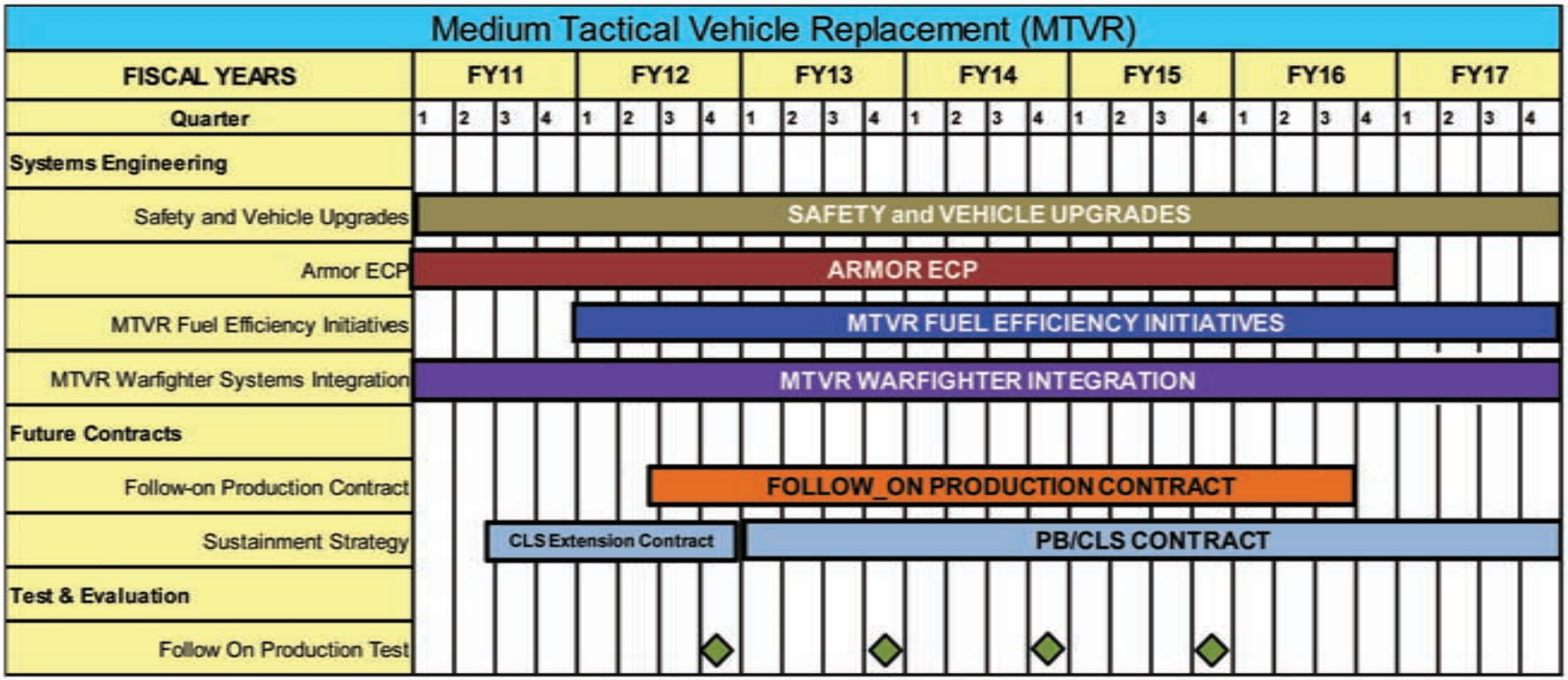
- The MTVR replaced the aging M809/M939 series 5-ton trucks with state-of-the-art commercial automotive technology beginning in 2001. The MTVR Cargo truck has a 7.1-ton off road and 15-ton on road payload and a 22-year service life. MTVR variants include the Cargo, Dump, Wrecker, Tractor (5th Wheel) and High Mobility Artillery Rocket System (HIMARS) Re-Supply Vehicle. There is a high level of commonality across the family of vehicles.
- The MTVR Armor System (MAS) provides complete 360-degree protection as well as overhead and underbody protection for the crew compartment. The MAS is a permanent modification to the vehicle and includes an upgraded front suspension and cab rebuild. The kit includes a removable personnel carrier (with ballistic glass), air conditioning system, and machine gun mount. All vehicles in theater include MAS armor.

Program Status

Significant events:

- Follow-on production contract award planned 2nd Qtr FY12
- PB/CLS sustainment contract (award 4th Qtr FY12)
- OEF urgent requirement Upgrade Capability planned 2nd Qtr FY12.
- MTVR Upgrades
  1. Automatic Fire Extinguishing System (AFES)
  2. Emergency Egress Windshields
  3. Upgraded Blast seats and mats
  4. Armor ECPs

Medium Tactical Vehicle Replacement (MTVR)



Medium Tactical Vehicle Replacement (MTVR)

MTVR's TOP THREE PROGRAM ISSUES:

1. <u>Fuel Economy</u> - At 3.8 miles per gallon, coupled with the Fully Burden Cost of Fuel (FBCF), moderate increases in fuel efficiency of the MTVR has the potential of saving millions of dollars. Current fuel efficiency efforts include the Fuel Efficient MTVR, and multiple ONR and TARDEC projects that are exploring engine mounted fuel efficiency technologies, regenerative braking, accessory electrification, hybrid and electric drive.

2. <u>Current & Future C4I Integration Demands</u> - The addition of multiple communications and electronics equipment to the MTVR, interoperability, heat rejection, and space claim issues present human systems integration challenges to the crew. Although there are no active S&T initiatives specifically addressing these demands, there are PMO, ONR and TARDEC programs addressing these issues.

3. <u>Increased Survivability</u> - Although the addition of armor has directly increased survivability of the MTVR, continuing effort is required to maintain or increase survivability of the vehicle and occupants from emerging threats. This includes increasing armor protection while maintaining or reducing current weight, improvements in blast resistant seats, crew egress systems, and advanced fire suppression systems.

1. <u>Fuel Economy:</u>

1a. Active S&T Initiatives for MTVR

Future Naval Capability (FNC)
- Fuel Efficient MTVR

Small Business Innovation Research (SBIR)
- Engine Efficiency Enhancements (MTVR Phase II SBIR)

1b. Potential S&T Initiatives for MTVR

Discovery & Invention (D&I)
- Future Fuel Alternatives
- Extended Traction Tire (ETT)

Exploration & Development (E&D)
- Integrated Power and Propulsion
- Fuel Efficient Enabling Technologies w/ TARDEC

TARDEC
- Alternative Fuels & Petroleum, Oil & Lubricants
- Efficient Powertrain Technology Integration

2. Current & Future Power Demands:

2a. Active S&T Initiatives for MTVR

Exploration & Development (E&D)
- Modular Vehicle Platform (MVP)

Other
- NUCLEUS Effort

2b. Potential S&T Initiatives for MTVR

Exploration & Development (E&D)
- Integrated Power & Propulsion

TARDEC
- Electrical Power Systems
- Vehicle Electronics Integration Technologies
- Distributed Soldier Load Through SMART Vehicle Control
- Vehicle Electronics Architecture and Standards

3. Increased Survivability:

3a. Active S&T Initiatives for MTVR

Exploration & Development (E&D)
- CSTV Shock Mitigating Seats
- Silencing USMC Vehicles

Small Business Innovation Research (SBIR)
- Mitigation of Blast Injuries through M&S (MTVR SBIR Phase II)

Small Business Technology Transfer and Research (STTR)
- Mitigation of Fuel Tank Explosions and Fires (MTVR STTR Phase I)

Other
- Fuel Tank Protection System Swampworks
- MTVR Blast Seat Evals

3b. Potential S&T Initiatives for MTVR

Discovery & Invention (D&I)

- Lightweight Armor Materials
- CSTV Shock Mitigating Seats
- Energy Absorbing Structures for Blast Mitigation

Exploration & Development (E&D)

- CSTV Shock Mitigating Seats

TARDEC

- RPG Active Protection (RAP)
- Enhanced RPG Active Protection (ERAP)
-

Other

- AMAS JCTD

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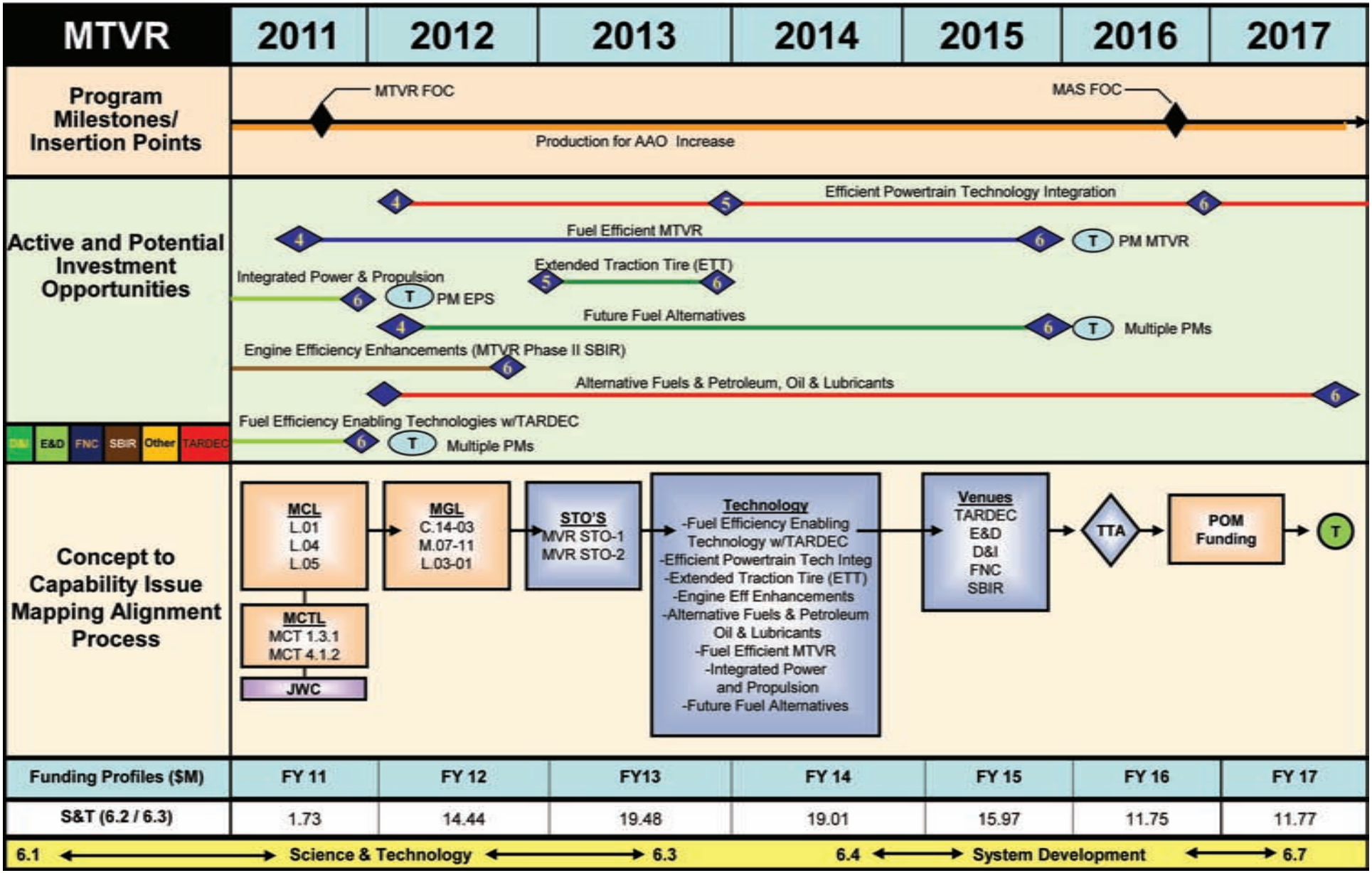
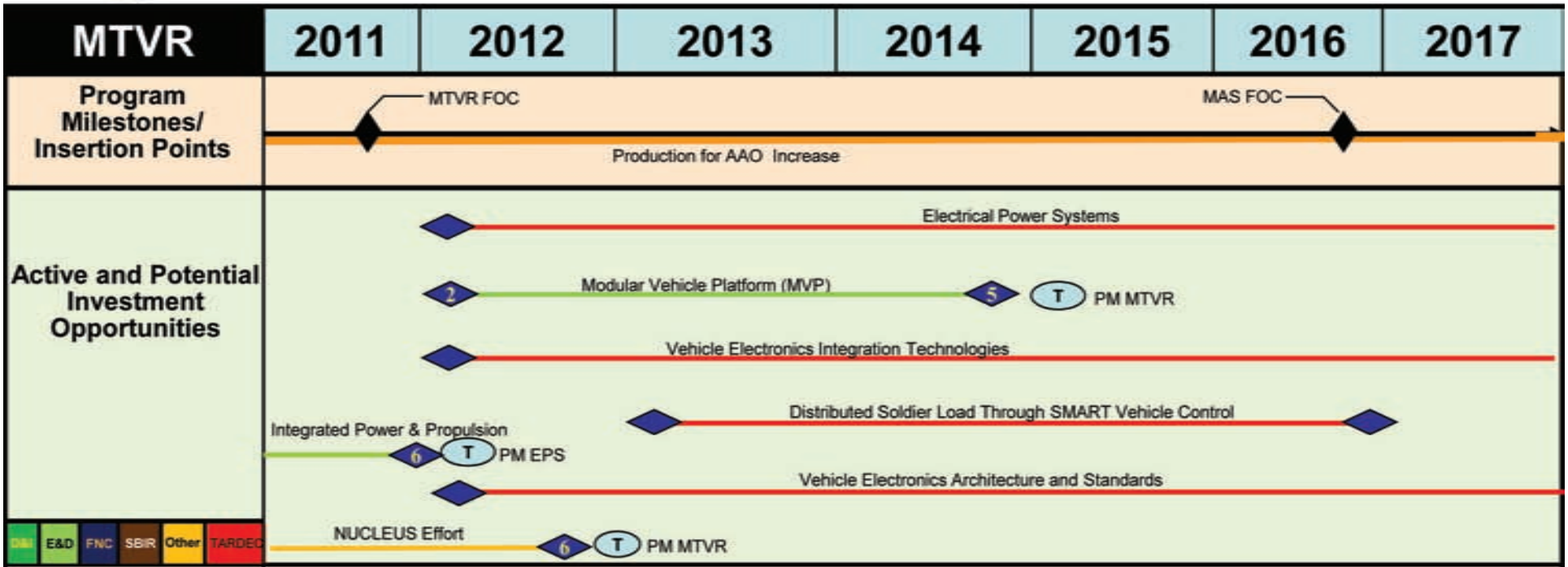
MTVR Technical Issue #1 Fuel Economy



MTVR Technical Issue #1 Fuel Economy

MCL	L.01 Provide supply support L.04 Provide logistics services L.05 Provide deployment and distribution support.	
MCTL	MCT 1.3.1 Conduct Maneuver MCT 4.1.2 Conduct Ground Supply Operations	
MGL	C.14-03 Limited Transport Capability M.07-11 Mobility in all terrain & climates L.03-01 Sustainment Distribution	
STO'S	MVR STO-1 Fuel efficient power generating systems MVR STO-2 Ground vehicle mobility	
Technology	Active: -Fuel Efficient MTVR -Engine Efficiency Enhancements (MTVR Phase II SBIR)	Potential: -Efficient Powertrain Technology Integration -Extended Traction Tire (ETT) -Integrated Power & Propulsion -Future Fuel Alternatives -Alternative Fuels & Petroleum, Oil & Lubricants -Fuel efficiency Enabling Technology with TARDEC
Venues	TARDEC, E&D, D&I, FNC, SBIR,	
TTA	w/ MTVR	T Transition target for: PM MTVR, EPS, Multiple PMs
POM Funding	MCCDC integration division	
T	Transition to a program of record	Comments/Issues:

MTVR Technical Issue #2 Current & Future C4I Integration Demands



Concept to Capability Issue Mapping Alignment Process

MCL
L.01
L.04
L.05
C.20

MCTL
MCT 4.4.9
MCT 4.9.5

JWC

MGL
L.09-11
L.09-06
M.09-11
L.13-04

STO'S
MVR STO-1
MVR STO-2
LOG STO-1
EE STO -1

Technology
-Electrical Power Systems
-Modular Vehicle Platform (MVP)
-Vehicle Electronics Integration Technologies
-Distributed Soldier Load Through SMART Vehicle Control
-Integrated Power & Propulsion
-Vehicle Electronics Architecture and Standards
-NUCLEUS Effort

Venues
TARDEC
E&D
Other

TTA

POM Funding

T

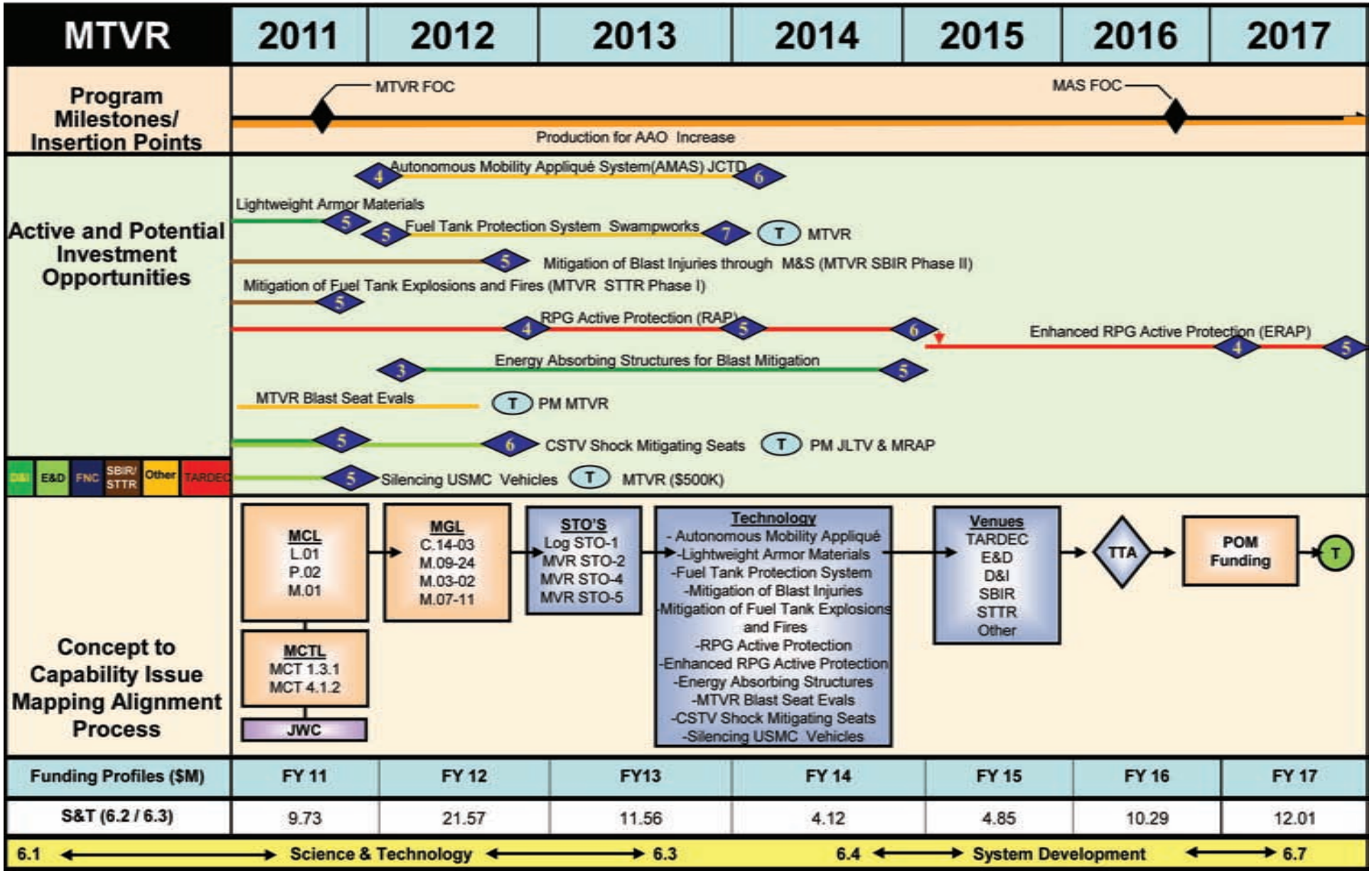
Funding Profiles ($M)	FY 11	FY 12	FY13	FY 14	FY 15	FY 16	FY 17
S&T (6.2 / 6.3)	2.42	9.72	10.58	13.90	19.16	14.77	10.32

6.1 ⟷ Science & Technology ⟷ 6.3 6.4 ⟷ System Development ⟷ 6.7

MTVR Technical Issue #2 Current & Future C4I Integration Demands

MCL	L.01 Provide supply support L.04 Provide logistics services L.05 Provide deployment and distribution support C.20 Optimize Networks	
MCTL	MCT 4.4.9 Conduct Tactical Electrical Supply MCT 4.9.5 Supply Electrical Power	
MGL	L.09-11 Alternate Power Sources L.09-06 On Move Power Generation M.09-11 Exportable Power For On-Board Systems L.13-04 Power Generation/ Distribution	
STO'S	MVR STO-1 Fuel efficient & power generating vehicle systems MVR STO-2 Ground vehicle mobility LOG STO-1 Asset versatility EE STO-1 Expeditionary energy harvesting	
Technology	Active: -NUCLEUS Effort -Modular Vehicle Platform (MVP)	Potential: -Electrical Power Systems -Vehicle Electronics Integration Technologies -Distributed Soldier Load Through SMART Vehicle Control -Integrated Power & Propulsion -Vehicle Electronics Architecture and Standards
Venues	TARDEC, E&D, Other	
TTA	No TTAs is needed	T Transition target for: PM MTVR, EPS
POM Funding	MCCDC integration division	
T	Transition to a program of record	Comments/Issues:

MTVR Technical Issue #3 Increased Survivability



MTVR Technical Issue #3 Increased Survivability

MCL	L.01 Provide supply support P.02 Protect Personnel physical assets & LOCs M.01 Maneuver to secure	
MCTL	MCT 1.3.1 Conduct Maneuver MCT 4.1.2 Conduct Ground Supply Operations	
MGL	C.14-03 Limited Transport Capability M.09-24 Force Protection M.03-02 Protected Mobility M.07-11 Mobility in all terrain & climates	
STO'S	Log STO-1 Asset versatility MVR STO-2 Ground vehicle mobility MVR STO-4 Advanced materials and survivability technology to enhance the performance and survivability of combat vehicles &surface craft MVR STO-5 Vehicle and surface craft design for Marine usability, habitability, and survivability	
Technology	Active: -Fuel Tank Protection System Swampworks -Mitigation of Blast Injuries through M&S (MTVR SBIR Phase II) -Mitigation of Fuel Tank Explosions and Fires (MTVR STTR Phase I) -MTVR Blast Seat Evals -Silencing USMC Vehicles	Potential: -Autonomous Mobility Appliqué System(AMAS) JCTD -Lightweight Armor Materials -RPG Active Protection (RAP) -Enhanced RPG Active Protection (ERAP) -Energy Absorbing Structures for Blast Mitigation -CSTV Shock Mitigating Seats
Venues	TARDEC, D&I, E&D, SBIR, STTR, Other	
TTA		T Transition target for: PM MTVR, MRAP, JLTV
POM Funding	MCCDC integration division	
T	Transition to a program of record	Comments/Issues:

Common Aviation Command and Control System (CAC2S)

The Common Aviation Command and Control System (CAC2S) provides a complete modernization replacement for the Command and Control (C2) equipment of the Marine Air Command and Control System (MACCS) which is nearing the end of its service life. CAC2S replaces single mission, stove-piped military specification, legacy systems while providing commonality in training and logistics support. CAC2S fulfills joint net-ready capability standards required of all DOD C2 systems and remedies the operational, technical, and performance deficiencies of the existing MACCS. The main capability of CAC2S will be in the Tactical Air Command Center (TACC), Direct Air Support Center (DASC), and Tactical Air Operations Center (TAOC).

The CAC2S will provide a complete and coordinated modernization of the equipment of the MACCS. CAC2S will eliminate current dissimilar systems and provide the Aviation Combat Element with the necessary hardware, software, and facilities to effectively command, control, and coordinate air operations while integrated with naval and joint C2. CAC2S will be comprised of standardized modular and scalable tactical facilities, hardware, and software that will significantly reduce the physical size and logistical footprint of the MACCS. In 2005, the Marine Requirements Oversight Council chose CAC2S along with Command and Control Personal Computer as foundation components of MAGTF C2. This decision paves the way for improved integration across the MAGTF.

CAC2S will have three HMMWV-based components: the Processing and Display Subsystem (PDS), the Communications Subsystem (CS), and the Sensor Data Subsystem (SDS). The three combine to create one complete air C2 system. The Marine Corps restructured the CAC2S program in May 2009 to reduce technical risk. It adopted a revised acquisition strategy, implementation of which is in two phases.

Phase I will leverage the Combat Operations Center program and the MRQ-12 HMMWV based communications system supporting the MACCS today to create the PDS and CS of CAC2S. The development of the more technically challenging SDS will be developed and fielded in Phase II. The SDS will fuse sensor inputs from expeditionary radars, as well as real-time and near real-time data from ground force C2 centers, weapon systems, unmanned aerial vehicles (UAVs), and planned F-35B Joint Strike Fighters, into a common operational picture of the battlespace.

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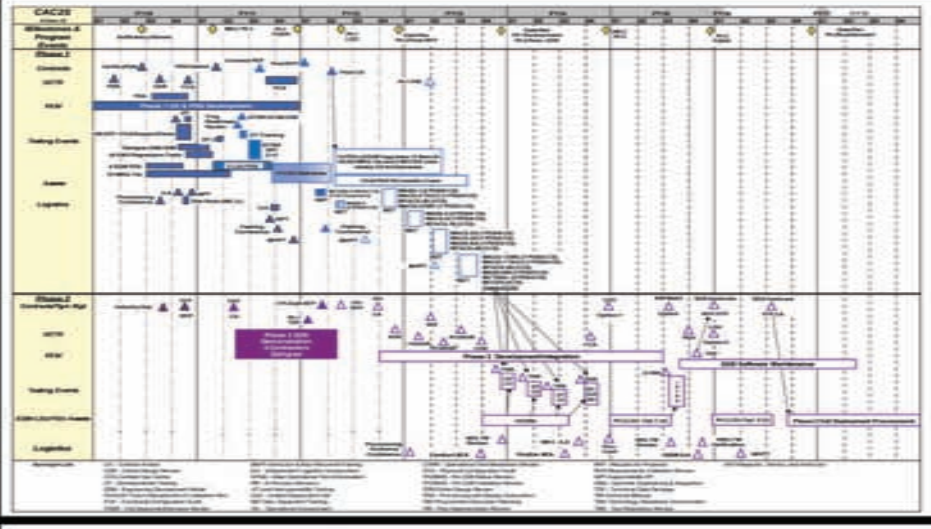
Common Aviation Command and Control System (CAC2S) Program Overview



Program Description

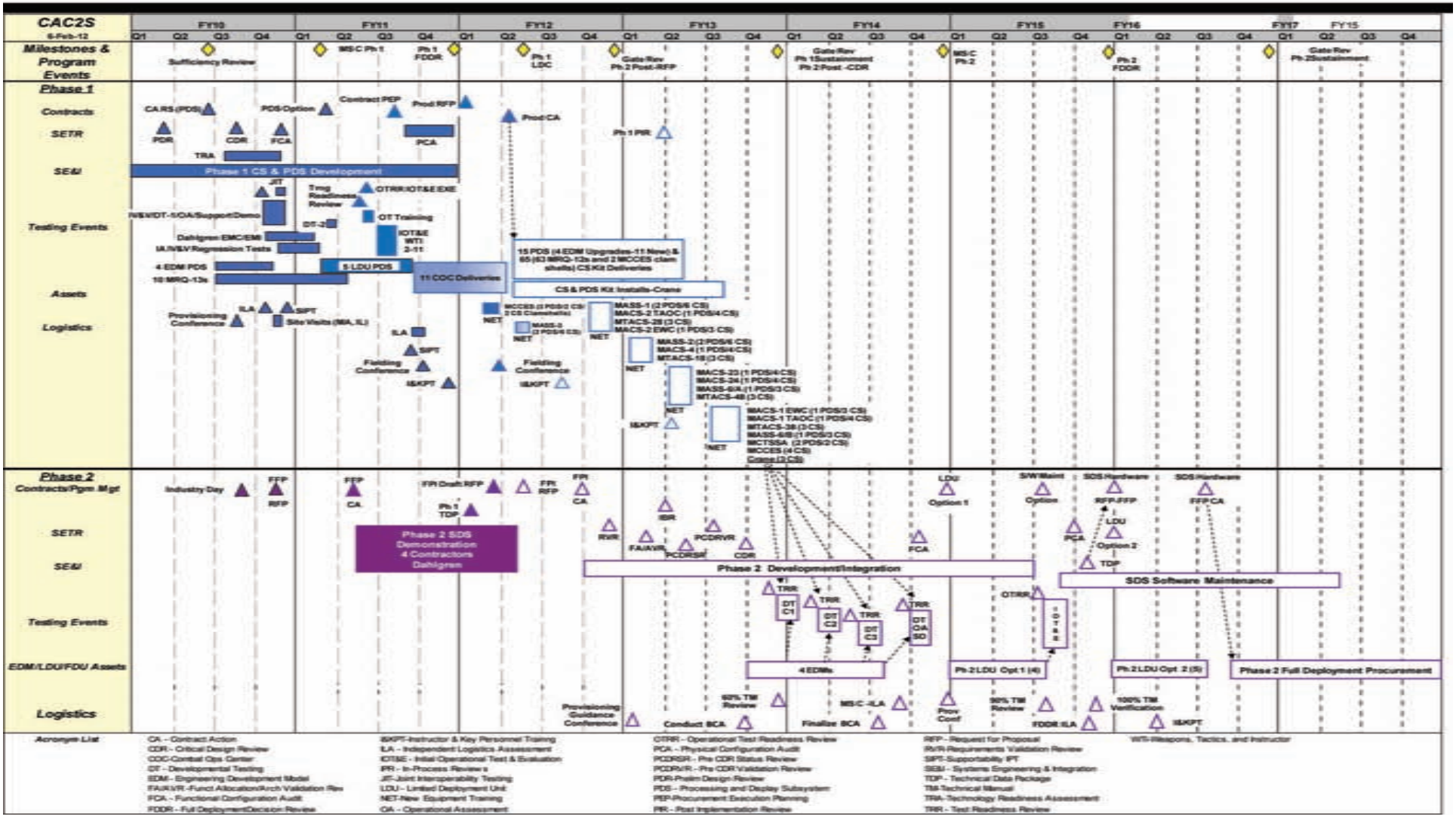
The Common Aviation Command and Control System (CAC2S) is a coordinated modernization effort to replace the existing aviation command and control equipment of the Marine Air Command and Control System (MACCS) and to provide the Aviation Combat Element (ACE) with the necessary hardware, software, equipment, and facilities to effectively command, control, and coordinate aviation operations. The CAC2S system will accomplish the MACCS missions with a suite of operationally scalable modules to support the Marine Air Ground Task Force (MAGTF), Joint, and Coalition Forces. The CAC2S integrates the functions of aviation command and control into an interoperable system that will support the core competencies of all Marine Corps warfighting concepts. Increment I of the CAC2S will be accomplished through a two phased approach. Phase 1 will accommodate fielding of operationally relevant capabilities by upgrading fielded MACCS equipment with mature, ready technologies and will establish an initial product baseline Processing and Display Subsystem and Communications Subsystem. Phase 2 is structured to accommodate the integration of technologies necessary for the CAC2S Sensor Data Subsystem to meet remaining ACE Battle Management and Command and Control requirements. Phase 2 completion will result in the delivery of the full CAC2S Increment I capabilities.

Phase 1		Phase 2	
Event	Date	Event	Date
FDD	4QFY11	MS C	4QFY14
LDC	2QFY12	FDD	3QFY16

Program Status

- CAC2S Phase 1, Full Deployment Decision ADM was signed 25 Oct 2011.
- CAC2S Phase 1 fielding to MASS -3 is in progress.
- CAC2S Phase 2 engineering/integration and demonstration efforts (by the four Phase 2 contractors) in the MCTSSA STIL and Dahlgren SIL were completed Dec 2011.

Common Aviation Command and Control System (CAC2S) Program Overview



CAC2S' Top Three Program Technology Issues:

1. Global Track Manager Database - Management of multi-sourced tracks that are available from anywhere in the Marine Air Command and Control System (MACCS). The agencies of the MACCS are often dispersed geographically and receive track data from multiple sources. In order to effectively share ground and air track information throughout the MACCS, better tools for management of a synchronized global track database must be developed.

2. Hardware Infrastructure Design - Smaller physical footprint and more efficient power usage. More mobile communication systems. A critical requirement for the future MACCS is a smaller, mobile tactical footprint with more efficient power generation and management. Even though operator spaces and communication assets have become smaller, the HMMWV based power generation still requires a significant footprint often requiring vehicles just to tow generators. Technology improvements in power generation and management as well as smaller communication form factors will improve tactical mobility and sustainment.

3. Multiple Interface Formats - Data interfaces or translators to fuse and display track data from multiple sources. The MACCS is uniquely required to integrate and display for controllers and commanders data from numerous sources such as ground and air tracks, air defense information, and intelligence information from numerous sources. This growing volume of data must be fused into a single coherent display to aid in rapid decision making.

1. Global Track Manager Database:

1.a No Active S&T Initiatives for CAC2S

1.b Potential S&T Initiatives for CAC2S

Small Business Innovation Research (SBIR)

- Sensor Data Fusion for Intelligent Systems Monitoring and Decision Making (Air Force Phase I SBIR)
- Sensor Data Fusion (Missile Defense Agency Phase I SBIR)

2. Hardware Infrastructure Design:

2.a No Active S&T Initiatives for CAC2S

2.b Potential S&T Initiatives for CAC2S

TARDEC

- Ground Vehicle Power & Mobility (GVPM) Vehicle Integrated JP8 Fuel Cell APU System

Exploration & Development (E&D)
- Integrated Power & Propulsion

Other
- On-Board Vehicle Power Systems Development

3. <u>Multiple Interface Formats:</u>

3.a No Active S&T Initiatives for CAC2S

3.b Potential S&T Initiatives for CAC2S

Discovery and Intervention (D&I)
- Adaptive networks

Future Naval Capability (FNC)
- Self Organizing Networks

Other
- NUCLEUS Effort

CAC2S Technical Issue #1 Global Track Manager Database

CAC2S	2011	2012	2013	2014	2015	2016	2017

Program Milestones/ Insertion Points

- MS C Phase 1
- LDC Phase 1
- Gate Review Post RFP
- Gate Review - Phase 1 Sustainment, Phase 2 Post CDR
- MS C Phase 2
- Gate Review Phase I Sustainment
- FDDR Phase 2
- Gate Review Phase 2 Sustainment

Active and Potential Investment Opportunities

- 5 — Sensor Data Fusion for Intelligent Systems Monitoring and Decision Making (Air Force Phase I SBIR)
- 5 — Sensor Data Fusion (Missile Defense Agency Phase I SBIR)

D&I | E&D | FNC | SBIR | Other | TARDEC

Concept to Capability Issue Mapping Alignment Process

MCL: C.03, C.12, M.02 → MGL: L.09-11, L.09-06, M.09-11, L.13-04 → STO'S: LOG STO-6, MVR STO-1 → Technology: -Sensor Data Fusion, -Sensor Data Fusion for Intel Systems Monitoring & Decision Making → Venues: SBIR → TTA → POM Funding → T

MCTL: MCT 4.4.9, MCT 4.9.5 → JWC

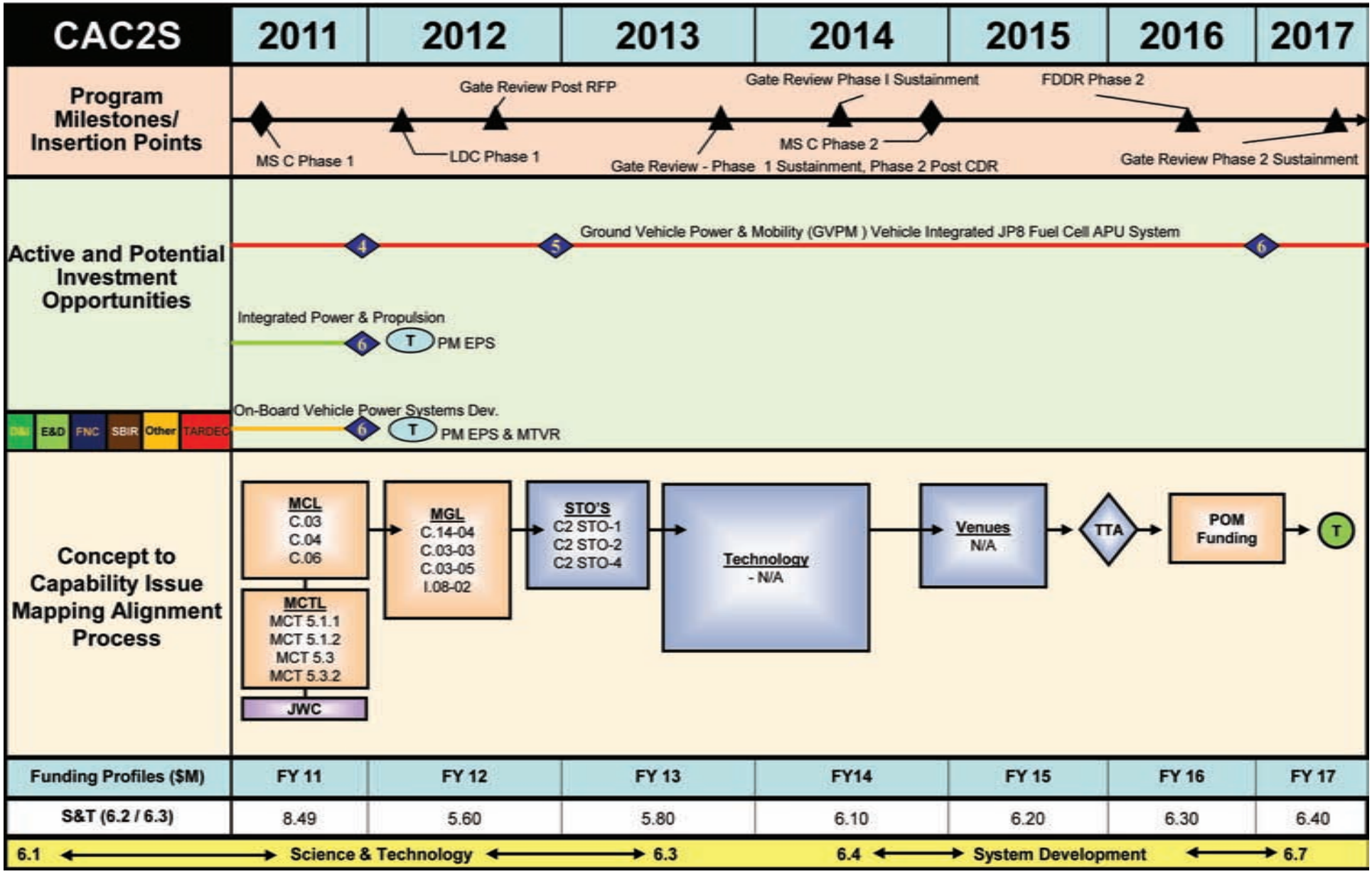
Funding Profiles ($M)	FY 11	FY 12	FY 13	FY14	FY 15	FY 16	FY 17
S&T (6.2 / 6.3)	0.2	0.2					

6.1 ⟷ Science & Technology ⟷ 6.3 6.4 ⟷ System Development ⟷ 6.7

CAC2S Technical Issue #1 Global Track Manager Database

MCL	C.03 Achieve Situational Understanding C.12 Share Situational Understanding M.02 Maneuver to engage kinetically	
MCTL	MCT 4.4.9 Conduct Tactical Electrical Supply MCT 4.9.5 Supply Electrical Power	
MGL	L.09-11 Alternate Power Sources L.09-06 On-Move Power Generation M.09-11 Exportable Power For On-Board Systems L.13-04 Power generation/ distribution	
STO'S	LOG STO-6 Materials for reduced maintenance MVR STO-1 Fuel efficient and power generating vehicle systems	
Technology	Active: -N/A	Potential: -Sensor Data Fusion -Sensor Data Fusion for Intel Systems Monitoring & Decision Making
Venues	SBIR	
Army		
TTA	No TTA is required for the projects listed	T Transition target for: N/A
POM Funding	MCCDC Integration Division	
T	Transition to a program of record	Comments/Issues:

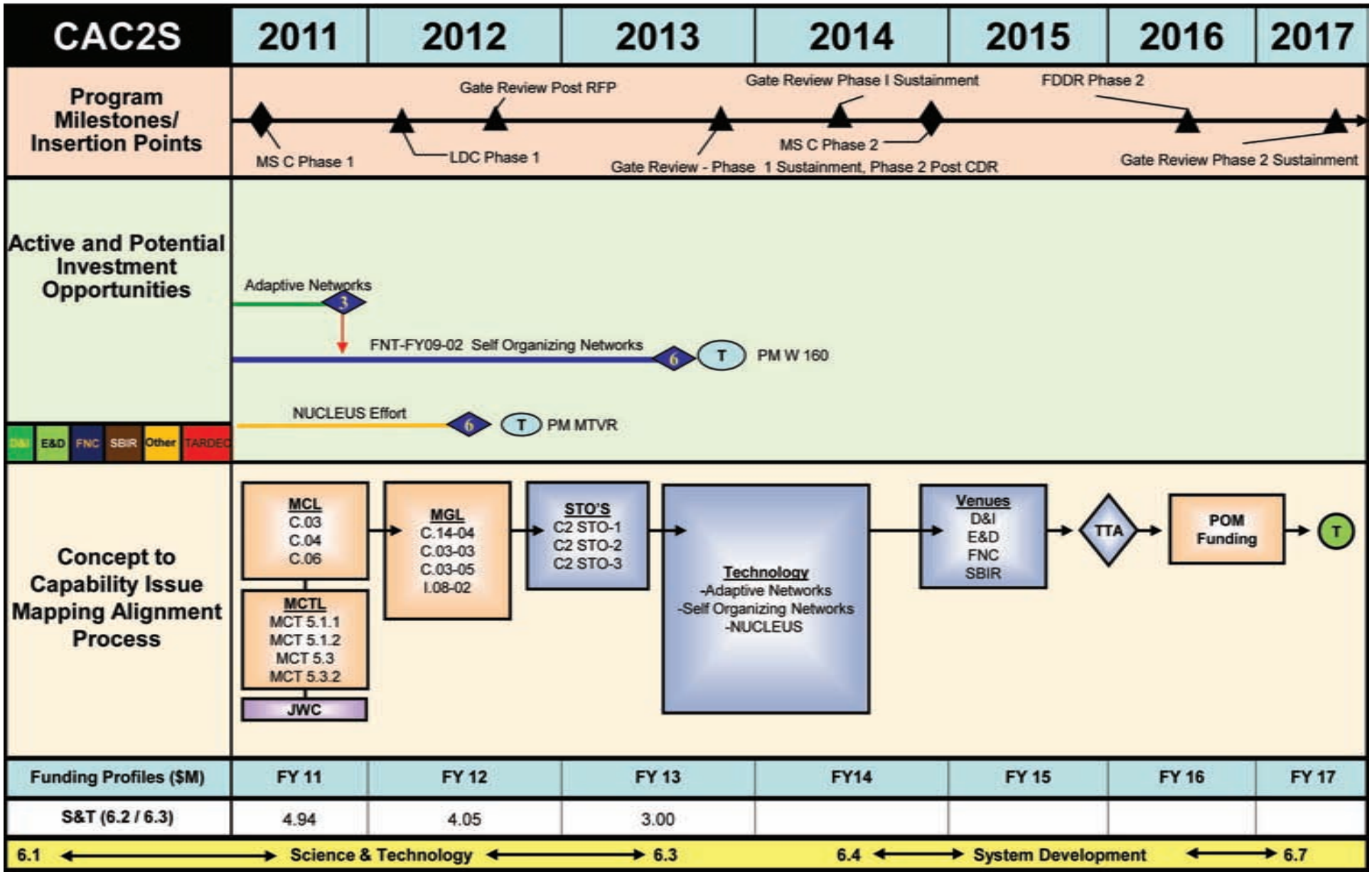
CAC2S Technical Issue #2 Hardware Infrastructure Design



CAC2S Technical Issue #2 Hardware Infrastructure Design

MCL	C.03 Achieve situational understanding C.04 Communicate commanders intent and guidance C.06 Synchronize execution across all domains	
MCTL	MCT 5.1.1 Provide and Maintain Communications MCT 5.1.2 Manage Means of Communicating Information MCT 5.3 Direct, Lead, Coordinate Forces/Operations MCT 5.3.2 Establish Means to Command and Control	
MGL	C.14-04 Communications Infrastructure C.05-05 Knowledge Sharing Process	C.03-03 Shared Situational Awareness (SA) I.08-02 Database Sharing and Synchronization
STO'S	C2 STO-1 Converged service networks with assured, robust communications linking all echelons of the MAGTF C2 STO-2 Multilevel information security and information assurance C2 STO-4 Improved situational awareness for warfighters at all echelons	
Technology	Active: -N/A	Potential: -N/A
Venues		
Army	CERDEC R.CER.2010.03 Cognitive Protocols for Cognitive Networks STTC R.STT 2010.02 Embedded Training for Command and Control for Mounted and Dismounted ETCC-M/D	
TTA		T Transition target for: N/A
POM Funding	MCCDC integration division	
T	Transition to a program of record	Comments/Issues:

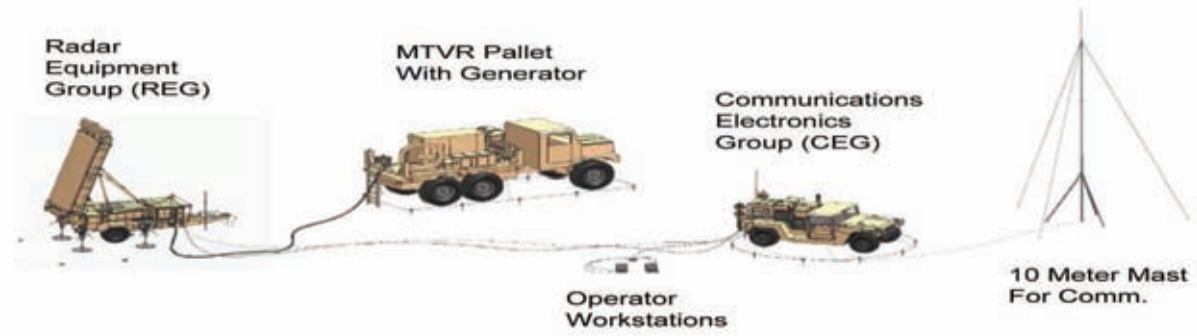
CAC2S Technical Issue #3 Multiple Interface Formats



CAC2S Technical Issue #3 Multiple Interface Formats

MCL	C.03 Achieve situational understanding C.04 Communicate commanders intent and guidance C.06 Synchronize execution across all domains		
MCTL	MCT 5.1.1 Provide and Maintain Communications MCT 5.1.2 Manage Means of Communicating Information MCT 5.3 Direct, Lead, Coordinate Forces/Operations MCT 5.3.2 Establish Means to Command and Control		
MGL	C.14-04 Communications Infrastructure C.05-05 Knowledge Sharing Process	C.03-03 Shared Situational Awareness (SA) I.08-02 Database Sharing and Synchronization	
STO'S	C2 STO-1 Converged service networks with assured, robust communications linking all echelons of the MAGTF C2 STO-2 Multilevel information security and information assurance C2 STO-3 Improved situational awareness for warfighters at all echelons		
Technology	Active: -N/A	Potential: -Adaptive Networks -Self Organizing Networks -NUCLEUS effort	
Venues	FNC, D&I		
Army			
TTA		T	Transition target for: PM MAGTF C2, CNS
POM Funding	MCCDC integration division		
T	Transition to a program of record	Comments/Issues:	

Ground Air Task Oriented Radar (G/ATOR)

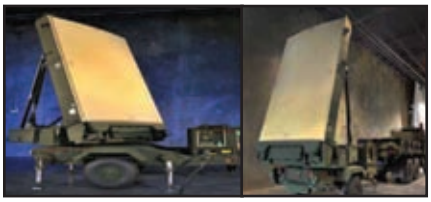


The Ground/Air Task-Oriented Radar (G/ATOR), in development by the Marine Corps, is a three-dimensional short-to-medium-range tactical radar designed to detect, identify, and track low-level cruise missiles, manned aircraft, and unmanned aerial vehicles as well as rockets and mortar and artillery fire. Due to advances in digital radar technology, the G/ATOR will be a highly mobile, multi-role radar system that will perform the functions of five different legacy ground-based radars it is slated to replace; providing increased range, accuracy, tactical mobility, and reliability.

The radar will perform air surveillance, cue air defense weapons, perform counter-fire target acquisition (of enemy artillery and mortar firing locations), and provide data to air traffic controllers. Consolidating these functions into a single multi-role radar will dramatically reduce Marine Corps logistics, operating, and training costs.

The G/ATOR program is currently in the engineering and manufacturing development phase; Northrop Grumman Electronic Systems in Baltimore, MD, is the prime contractor. The entire G/ATOR system is transported by only two up armored vehicles – a six-wheel, 7-ton Medium Tactical Vehicle Replacement (MTVR) all-terrain truck built by Oshkosh, and a single HMMWV. In G/ATOR's operational configuration, its large radar antenna array is mounted on an integrated trailer towed by the MTVR vehicle, and is folded down flat during movement. The antenna array remains on the trailer during all operations, and is electro-mechanically elevated and leveled for use. The MTVR truck carries a pallet with a generator and support equipment. The HMMWV carries the radar system's palletized Communications-Electronic Group (CEG). Both pallets can be self-extracted from the vehicles.

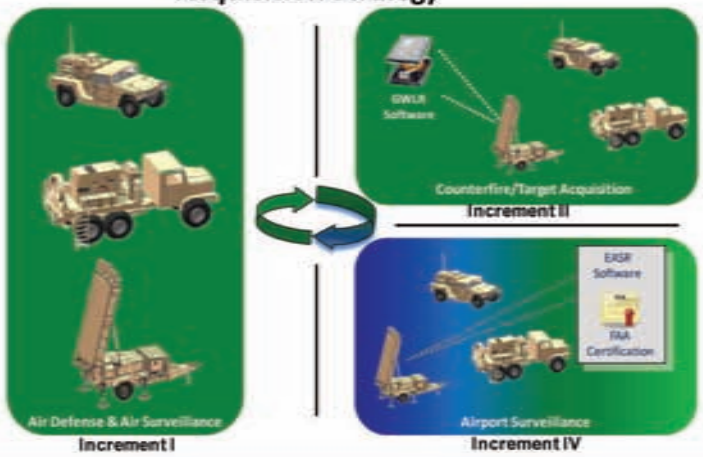
G/ATOR will be fielded over time in increments. Increment I, scheduled for an initial operational capability (IOC) and a full rate production decision in 2016, is the air surveillance and short-range air defense radar, which will replace the AN/TPS-63, AN/MPQ-62, and AN/UPS-3 radars. Increment I will provide all the basic hardware for future increments, which will add new capabilities through mission-specific software packages. Increment II, slated for an IOC in 2017, will add the enemy rockets, artillery and mortar target locating capability, replacing the existing

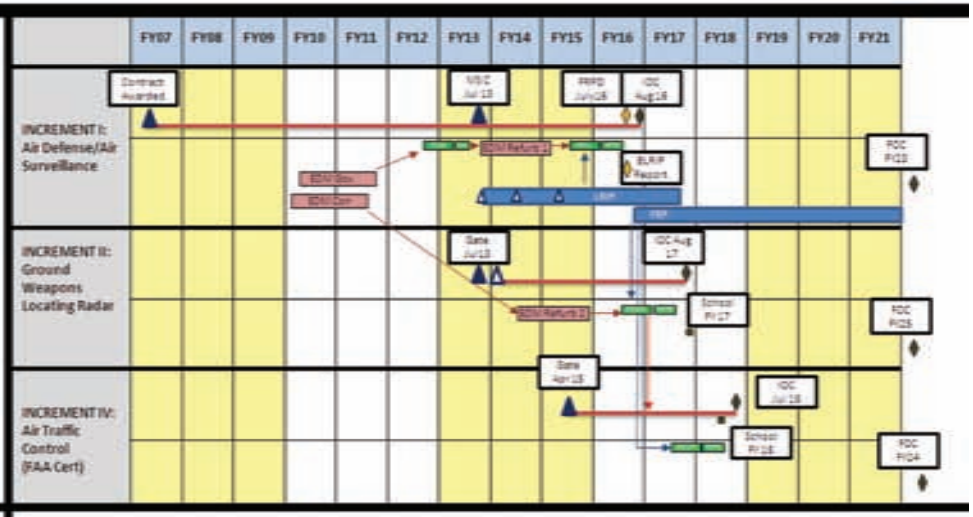


AN/TPQ-46 radar. Increment IV, scheduled for an IOC in 2018, will add military air traffic control functionality, replacing the Marine Corps' AN/TPS-73 radar and the Airport Surveillance Radar portion of the AN/TPN-31A Air Traffic Navigation, Integration, and Coordination System. Increment III, which encompassed tactical enhancements to the other increments, has been deferred until the other three increments are developed. The incremental program will allow the Marine Corps to "neck down" over time to only two primary radars – the expeditionary short-to-medium- range G/ATOR and the large, transportable AN/TPS-59(V)3 long-range air surveillance radar. G/ATOR Increment I also will serve as a gap filler radar, covering areas out of view of the TPS-59(V) 3 due to line-of-sight limitations. With the exception of the MTVR vehicle, the major G/ATOR system components – the trailer with antenna array, the HMMWV with the CEG pallet, and the generator pallet – will be transportable in external sling loads by Marine Corps heavy-lift helicopters and MV-22 Osprey tilt-rotor aircraft. The key to achieving G/ATOR's multi-role capabilities within a highly mobile expeditionary system is Active Electronically Scanned Array (AESA) radar technology. Unlike mechanically scanned radars with curved-dish antennas, an active phased-array radar can steer its agile beams electronically. G/ATOR's antenna array is made up of many highly reliable small solid-state transmit-receive modules, each a small radar in itself that can alternate between transmitting and receiving. AESA radars can operate in multiple modes simultaneously and can track significantly more targets than older systems.

G/ATOR provides 360-degree coverage against airborne threats, mechanically scanning in azimuth and electronically scanning in elevation. For some missions, the antenna will be stationary and will scan a sector of the airspace it is facing electronically in two dimensions – azimuth and elevation. The need to keep weight down to allow the radar system to be air lifted with rotary-wing aircraft drove to an air-cooled array instead of a more common but much heavier closed-loop liquid cooling system. The array has to be kept at a constant temperature across all of its transmit-receive modules for peak performance, and the air cooling has proven to be very effective. G/ATOR has a larger array and sees literally twice as far as the legacy systems it will replace; it's much lighter, primarily due to the AESA active elements on the array and the air cooling system. In March 2009, Northrop Grumman successfully completed the G/ATOR program's Critical Design Review, the final hurdle before the company began building the first Increment I engineering development model (EDM) prototype system. Northrop Grumman now has two EDMs undergoing contractor integration and testing, with Government Developmental Test scheduled to begin in July of 2012. Milestone C approval for low-rate initial production of the G/ATOR Increment I radar system is scheduled in 2013. The Marine Corps' Approved Acquisition Objective is a total of 67 G/ATOR systems – 17 Increment I radars, 38 Increment IIs, and 12 Increment IVs.

Ground/Air Task Oriented Radar
AN/TPS-80 G/ATOR





Mission & Requirements

- 3D, short/medium range multi-role radar designed to detect unmanned aerial systems, cruise missiles, air breathing targets, rockets, artillery and mortars.
  - Satisfies Warfighters' expeditionary needs across MAGTF spectrum
- Replaces five legacy radar systems with a single MAGTF solution:

AN/UPS-3 Tactical Defense Alert	Inc I	Air Defense/Surveillance
AN/MPQ-62 Continuous Wave Acq	Inc I	Air Defense/Surveillance
AN/TPS-63 Air Surveillance	Inc I	Air Defense/Surveillance
AN/TPQ-46 Counter-Battery/ Target Acq	Inc II	Ground Weapons Locating
AN/TPS-73 Air Traffic Control	Inc IV	Air Traffic Control

Capability/Improvements

- Increased range, accuracy, tactical mobility and reliability
- One system through tech insertion leveraged from prior variants:

Inc I:	Air Defense/Surveillance Radar (ADSR)	Qty 17
Inc II:	Ground Weapons Locating Radar (GWLR)	Qty 28
Inc IV:	Expeditionary Airport Surveillance Radar (EASR)	Qty 12
	AAO Qty	57

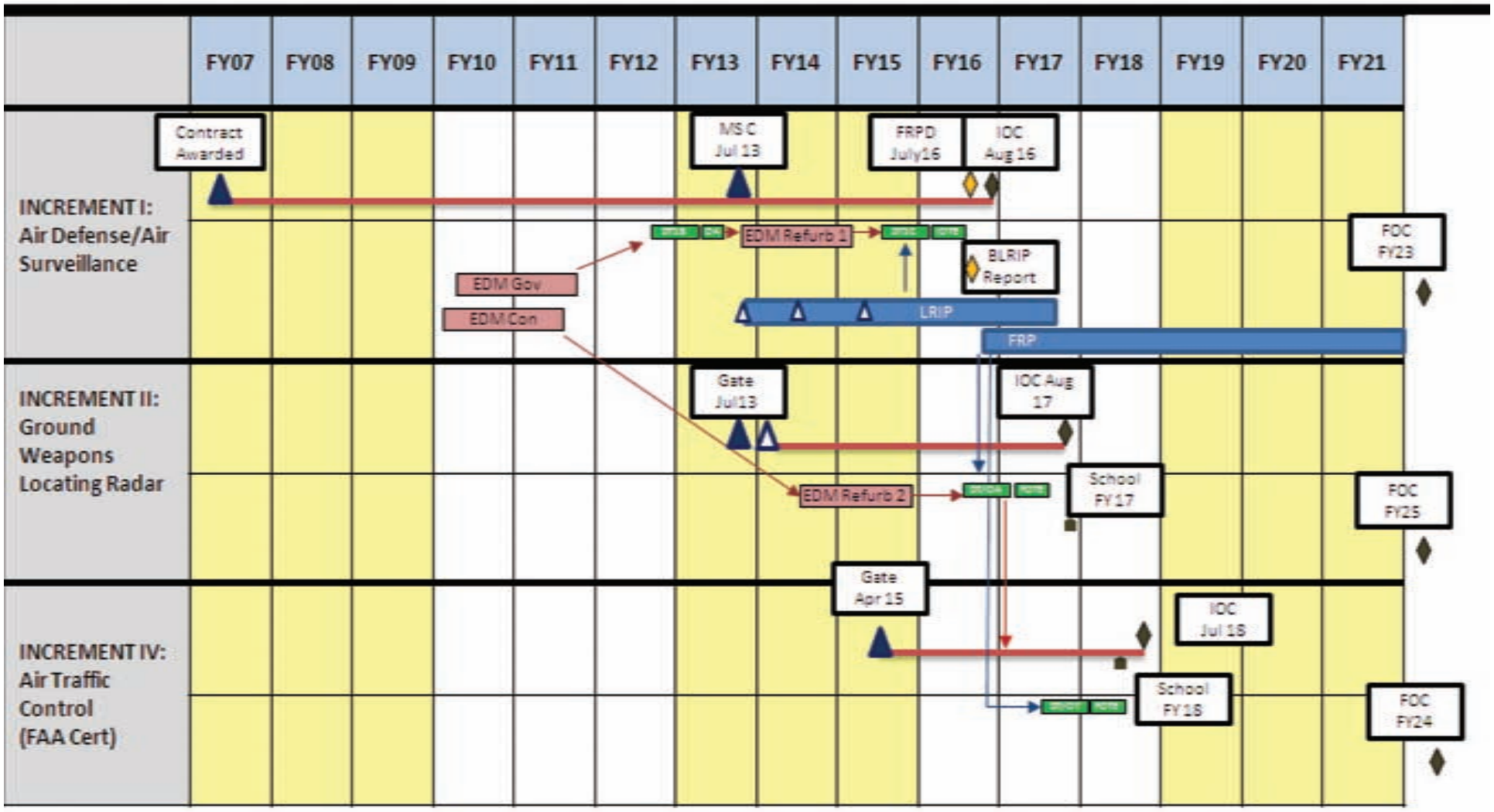
Recent History

- MROC of March 2010 endorsed proposed program plan
- Increment III Mode 5/S capability absorbed into Increment IV—all other Increment III capabilities deferred
- Resourced in PB 12
- Increment IV funding remains a BISOG issue
- Designated ACAT IC by AT&L ADM 28 Oct 2011
- MCCDC AAO change to 57

Upcoming Events

- FY12
  - Developmental Testing: DT 1B1/1B2
  - Production Readiness Review
- FY13
  - DT1B3 and Operational Assessment
  - Milestone C Decision
  - LRIP contract award

Ground/Air Task Oriented Radar
AN/TPS-80 G/ATOR



G/ATOR's Top Three Program Technology Issues:

1. Lowering Manufacturing Costs - Overall system production costs are high. Multiple areas of production are being evaluated for cost savings, including: (1) Air ducts that provide precise mounting and cooling of the T/R Modules and array elements. The air duct is very time consuming to produce and assemble and thus very expensive. (2) T/R Module packaging requires expensive materials and hermetic sealing which reduces yield. (3) Circulator Isolator Resistor Filters boards required for T/R Module requires multi-step medium yield manufacturing process.

2. Transit/Receive (T/R) Module Efficiency - The G/ATOR system currently operates at the limit of its prime power source. As the largest aggregate consumer of power, the T/R modules low power efficiency has been targeted for improvement. (1) Higher efficiency power amplification, (2) higher efficiency DC/DC power supply, and (3) greater integration of components are specific areas being considered for improvement.

3. GaN Reliability - Enhancements in GaN based integrated circuits can potentially reduce costs and increase performance for the T/R modules of the radar. GaN integrated circuits has proven able to handle higher heat and higher frequencies but there remain some reliability challenges in producing the integrated circuits.

1. Lowering Manufacturing Costs:

1a. Active S&T Initiatives for G/ATOR

Small Business Innovation Research (SBIR)

- Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits (G/ATOR SBIR Phase I)

1b. Potential S&T Initiatives for G/ATOR

Small Business Innovation Research (SBIR)

- High-Efficiency Solid-State S&X-Band Radar Power Amplifiers (NAVSEA SBIR Phase I)

Other

- Gator Phase A Study Reduce the cost of the TRMs

2. Transit/Receive (T/R) module Efficiency (Power):

2a. Active S&T Initiatives for G/ATOR

Small Business Innovation Research (SBIR)

- Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits (G/ATOR SBIR I)

2b. Potential S&T Initiatives for G/ATOR

TARDEC

- Ground Vehicle Power & Mobility (GVPM) Vehicle Integrated JP8 Fuel Cell APU System

Exploration & Development (E&D)

- Integrated Power and Propulsion

Other

- On-Board Vehicle Power Systems Development

3. GaN Reliability:

3a. Active S&T Initiatives for G/ATOR

- Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits (G/ATOR SBIR I)

3b. Potential S&T Initiatives for G/ATOR

Small Business Innovation Research (SBIR)

- High-Efficiency Solid-State S&X-Band Radar Power Amplifiers (NAVSEA SBIR I)

Other

- Develop & Demonstrate a GaN T/R Switch - QRF

G/ATOR Technical Issue #1 Lowering Manufacturing Costs

G/ATOR	2011	2012	2013	2014	2015	2016	2017
Program Milestones/ Insertion Points			C MS-C			FRPD IOC	
Active and Potential Investment Opportunities	Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits (G/ATOR SBIR Phase I) 4 High-Efficiency Solid-State S&X-Band Radar Power Amplifiers (NAVSEA SBIR Phase I) 5 G/ATOR Phase A Study Reduce the cost of the TRMs						
Concept to Capability Issue Mapping Alignment Process	MCL: C.15, C.16, P.02 MCTL: MCT 1.3.1, MCT 5.3.5.1, MCT 5.3.5.5, MCT 6.1.2.3 JWC	MGL: F.05-13, F.05-10, M.05-04	STO'S: LOG STO-6	Technology: -Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits -High-Efficiency Solid-State S&X-Band Radar Power Amplifiers - Reduce the cost of the TRMs	Venues: SBIR, QRF TTA	POM Funding	T

Funding Profiles ($M)	FY 11	FY 12	FY 13	FY14	FY 15	FY 16	FY 17
S&T (6.2 / 6.3)	0.1	0.1	0.1				

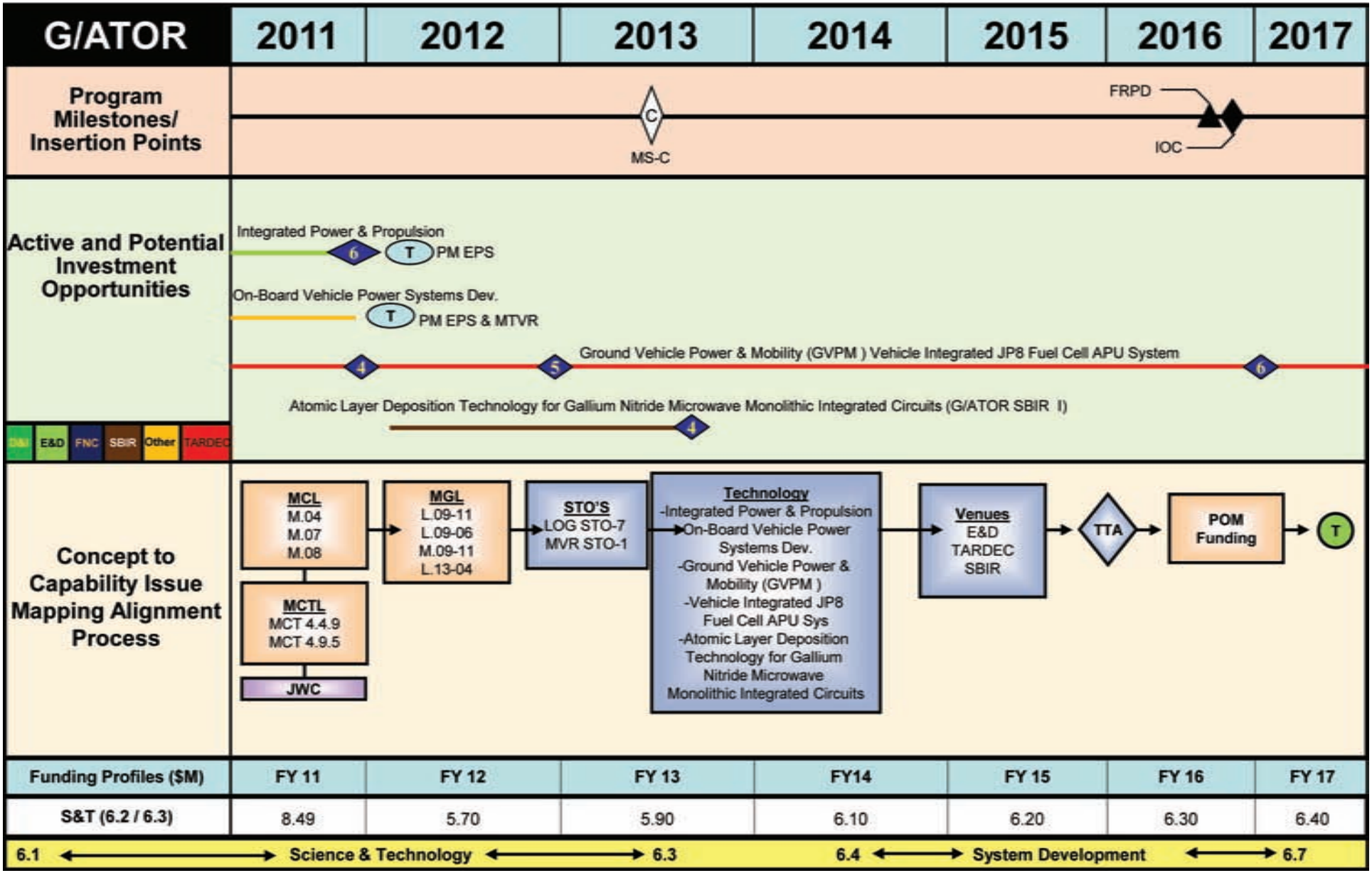
6.1 ⟷ Science & Technology ⟷ 6.3 6.4 ⟷ System Development ⟷ 6.7

O&M | E&D | FNC | SBIR | Other | TARDEC

G/ATOR Technical Issue #1 Lowering Manufacturing Costs

MCL	C.15 Maintain relevant information C.16 Process information P.02 Protect personnel, physical assets and LOCs		
MCTL	MCT 1.3.1 Conduct Maneuver MCT 5.3.5.1 Conduct Air Direction MCT 5.3.5.4 Conduct Airspace Control MCT 5.3.5.5 Coordinate/Employ Airspace Control Measures MCT 6.1.2.3 Conduct Passive Air Defense		
MGL	F.05-13 Indirect Fire Detection Correlation and Networking Capability F.05-10 Indirect Fire Detection Capability M.05-09 Indirect Fire Warning Capability		
STO'S	LOG STO-6 Materials for reduced maintenance		
Technology	Active: Atomic Layer Deposition Tech for GaN Mwave Monolithic Integrated Circuits Phase A Study Reduce the cost of theTRMs	Pending: N/A	Potential: High-Efficiency Solid-State S&X-Band Radar Power Amplifiers (NAVSEA SBIR)
Venues	QRF, SBIR		
TTA	N/A		
POM Funding	MCCDC integration Division		
T	Transition to a program of record	Comments/Issues:	

G/ATOR Technical Issue #2 T/R Module Efficiency (Power)



Funding Profiles ($M)	FY 11	FY 12	FY 13	FY14	FY 15	FY 16	FY 17
S&T (6.2 / 6.3)	8.49	5.70	5.90	6.10	6.20	6.30	6.40

6.1 ⟷ Science & Technology ⟷ 6.3 6.4 ⟷ System Development ⟷ 6.7

G/ATOR Technical Issue #2 T/R Module Efficiency (Power)

MCL	C.20 Optimize networks L.02 Maintain equipment M.02 Maneuver to engage kinetically	
MCTL	MCT 4.4.9 Conduct Tactical Electrical Supply MCT 4.9.5 Supply Electrical Power	
MGL	L.09-11 Alternate Power Sources L.09-06 On Move Power Generation M.09-11 Exportable Power For On-Board Systems L.13-04 Power generation/ distribution	
STO'S	LOG STO-7 Materials for reduced maintenance MVR STO-1 Advanced power plants, drive trains and suspensions	
Technology	Active: Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits (G/ATOR SBIR I)	Potential: On-Board Vehicle Power Systems Dev. -Ground Vehicle Power & Mobility (GVPM) -Vehicle Integrated JP8 Fuel Cell APU Sys -Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits
Venues	E&D, Plus-Ups, QRF	
Army		
TTA	No TTAs are required	T Transition target for: PM MTVR, EPS
POM Funding	MCCDC integration division	
T	Transition to a program of record	Comments/Issues:

G/ATOR Technical Issue #3 GaN (Gallium Nitride) Reliability

G/ATOR	2011	2012	2013	2014	2015	2016	2017
Program Milestones/ Insertion Points			C MS-C			FRPD IOC	
Active and Potential Investment Opportunities	Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits (G/ATOR SBIR I) 4						
	High-Efficiency Solid-State S&X-Band Radar Power Amplifiers (NAVSEA SBIR I) 5						
DM E&D FNC SBIR Other TARDEC	Develop & Demonstrate a GaN T/R Switch - QRF						
Concept to Capability Issue Mapping Alignment Process	MCL C.06 C.14 C.20 → MGL C.14-03 L.03-01 → STO'S MVR STO-1 MVR STO-2 FIRES STO-2 → Technology: -Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits -High-Efficiency Solid-State S&X-Band Radar Power Amplifiers -Develop & Demonstrate -a GaN T/R Switch → Venues QRF SBIR → TTA → POM Funding → T						
	MCTL MCT 1.3.1 MCT 5.3.5.1 MCT 5.3.5.5 MCT 6.1.2.3						
	JWC						

Funding Profiles ($M)	FY 11	FY 12	FY 13	FY14	FY 15	FY 16	FY 17
S&T (6.2 / 6.3)	0.1	0.1	0.1				

6.1 ⟷ Science & Technology ⟷ 6.3 6.4 ⟷ System Development ⟷ 6.7

G/ATOR Technical Issue #3 GaN (Gallium Nitride) Reliability

MCL	C.06 Synchronize execution across all domains C.14 Create/produce information C.20 Optimize networks	
MCTL	MCT 1.3.1 Conduct Maneuver MCT 5.3.5.1 Conduct Air Direction MCT 5.3.5.5 Coordinate/Employ Airspace Control Measures MCT 6.1.2.3 Conduct Passive Air Defense	
MGL	C.14-03 Limited Transport Capability L.03-01 Sustainment Distribution	
STO'S	MVR STO-1 Advanced power plants, drive trains, and suspensions MVR STO-2 Advanced materials and survivability technology to enhance the performance and survivability of combat vehicles FIRES STO-2 Integrated lightweight day-night optics	
Technology	Active: Atomic Layer Deposition Technology for Gallium Nitride Microwave Monolithic Integrated Circuits (G/ATOR SBIR I)	Potential: High-Efficiency Solid-State S&X-Band Radar Power Amplifiers (NAVSEA SBIR I) Develop & Demonstrate a GaN T/R Switch - QRF
Venues	Quick Reaction Fund , SBIR	
Army	N/A	
TTA	No TTA is required.	
POM Funding	MCCDC integration division	
T	Transition to a program of record	Comments/Issues:

Lightweight 155mm Howitzer (LW 155)

The Lightweight 155 mm Howitzer (LW155) is a highly successful joint U.S. Army/Marine Corps acquisition program that entered full-rate production in 2005. The prime contractor for the LW155, which is designated the M777, is the U.K.'s BAE Systems. It has delivered more than 725 of the towed howitzers to the Army and Marine Corps. The M777 will become the Corps' sole howitzer.

The proven combat performance in Iraq and Afghanistan of the M777, or "Triple 7," has earned it the reputation of being the most effective towed howitzer of its kind. The goal of the LW155 program was to develop a more capable replacement for the aging and heavy M198 155 mm towed howitzer in both the Marine Corps and Army, one that weighed less than 10,000 pounds. That goal was achieved.

The weight of the M777 is 9,700 pounds, compared with more than 16,000 pounds for the M198. This was made possible by the use of titanium and aluminum alloys in all of its major structures except its steel gun tube, as well as hydraulic systems to operate several components.

This weight reduction translates into greater strategic deployability – two M777s can fit into a C-130 transport, compared with one M198 – and greater tactical mobility. Unlike the M198, the M777 is light enough that it can be airlifted by all Marine Corps medium- and heavy-lift helicopters (CH-53Es, CH- 46Es, and CH-53Ds) as well as new MV-22 Osprey tilt-rotor aircraft, providing commanders with significant operational flexibility.

The M777 features greater survivability than the M198 by virtue of its shorter emplacement and displacement times – both under three minutes compared with 10-12 minutes for the M198 – providing it the ability to "shoot and scoot."

The LW155 fires standard unguided projectiles to a range of 15 miles and rocket-assisted projectiles to 19 miles. Its rate of fire is four rounds per minute maximum and two rounds per minute sustained. The latest M777A2 version of the howitzer added a software upgrade and a Digital Fire Control System (DFCS) from BAE Systems that allows the gun to program and fire

a longer-range and more accurate round – the M982 Excalibur Guided Projectile. The Excalibur munition, developed by Raytheon and BAE Systems, can reach ranges in excess of 25 miles while always landing within 10 meters of its target.

With the upgrade Marine Corps' and the Army's towed artillery have the ability to deliver precision fires, allowing them, according to BAE Systems, "to target a specific room within a building, reducing the chance of innocent casualties and allowing supporting fire to be brought down much closer to friendly troops." U.S. forces have used the Excalibur projectile effectively in Iraq. The M777A2's onboard DFCS is used to accurately locate and aim the gun. With the majority of its components mounted on and underneath the gun's main cradle section, the DFCS includes a GPS receiver; an inertial navigation unit; a vehicle motion sensor; a mission computer; a battery power supply; secure voice and data radios for communicating with and passing data to and from the fire direction center; and separate displays for the gunner, assistant gunner, and chief of section.

The hand-held Chief of Section Display is connected to the DFCS by a cable and shows the details of a fire mission transmitted from the fire direction center – the firing azimuth, elevation, and propellant charge – on its screen. The DFCS has made the LW155 guns more autonomous. At many of the forward operating bases in Afghanistan, only two guns are being deployed instead of an entire battery of six. Commanders are actually getting greater coverage by dispersing the guns more geographically.

The M777 achieved an initial operational capability in December 2005. All USMC guns are now M777A2s and Excalibur-capable. The Marine Corps has fully fielded the LW155 to its 10th, 11th, 12th, and 14th Marine Regiments and to its schoolhouses. Additional guns are outfitting the Maritime Prepositioning Ships and war reserve stocks.

The Marine Corps' Approved Acquisition Objective is 511 M777A2s (its original plan was to buy 356). The service had ordered 489 as of this past July, with 372 delivered. The Corps is slated to receive its final deliveries in November 2012.

The prime mover towing the Marine Corps' M777A2s is the 7-ton Medium Tactical Vehicle Replacement (MTVR) truck. The M777A2 is exceeding its reliability requirement of 800 mean rounds fired between system aborts – achieving 880, the biggest reliability issue to date has been the wear and tear incurred by the cables that run to the gun, such as from the Chief of Section Display, and are out in the open.

An under way LW155 software upgrade effort aims to allow all of the ballistic computations to be done on the howitzer itself rather than relying on a fire direction center to transmit firing data to the gun. A forward observer would call in a grid location that would come directly to the gun instead of to the fire direction center, reducing the time to fire. Another M777A2 upgrade in the works designed to reduce logistics costs involves removing the DFCS mission computer from the gun and embedding its functionality into the Chief of Section Display.

Canada has received 37 M777s through U.S. Foreign Military Sales (FMS). Australia is buying the M777A2 through FMS. As of May 2011, nine out of 35 weapons have been delivered to Australia. The U.S. government also has been discussing with India an FMS sale of M777s. The M777 program is managed by the Army/Marine Corps Towed Artillery Systems Joint Program Office at Picatinny Arsenal, N.J. BAE System's facility at Hattiesburg, Miss., is responsible for final integration and test of the weapon system. The manufacture and assembly of the complex titanium structures and associated recoil components are carried out at Barrow-in-Furness in the U.K.

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Lightweight 155 Howitzer

Mission:

Provide direct, reinforcing, and general support fires to maneuver forces. Direct support artillery for the Stryker Brigade Combat Teams. Replaces the M198 howitzer as the general support artillery for light forces in the Army. Replaces all howitzers in all missions in the USMC.

Capability / Improvements:

Improved lethality & strategic deployment

Increased tactical mobility & reliability

Improved Survivability (decreased emplace/displace time -- shoot and scoot tactics with digital fire control)

Digitizes Army and USMC towed artillery

First artillery platform with Excalibur capability fully embedded

Requirements:

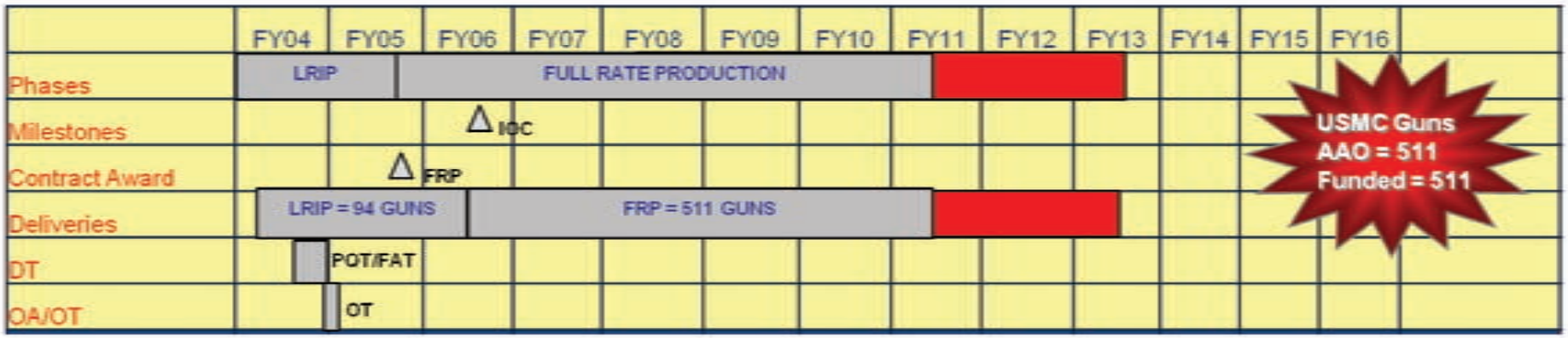
Weight	10,000 pounds or less
Emplace, Displace	<3 min, 2-3 min
Maximum Range	30 km (assisted)
Rate-of-Fire	4/min max, 2/min sustained
Prime Mover	Current 5T truck, FMTV, MTVR
Air Mobility	MV22, CH53D/E, CH47D
Fire Control	Digital & Optical
Precision Fire	Excalibur Capable & PGK Capable

Program Status:

- Nov 04 JORD – All KPP's Met
- Joint USMC/Army Program in Full Rate Production
- >700 Weapons Fielded to USMC and Army
- All Weapons M777A2 (Excalibur Capable)
- Used Very Effectively in OEF & OIF
- FMS Case with Canada & Australia; India FMS Case Expected FY12

	IOC	FOC	AAO	AAO Funded	AAO Unfunded
USMC	Dec 05	Jun 11	511	511	0
Army	Oct 06	Jun 14	542	418	0

Lightweight 155 Howitzer



Lightweight 155mm Howitzer (LW 155)

LW 155'S Top Three Program Technology Issues:

1. Modular Artillery Charge (MACS) Compatibility with the M777A2 Howitzer - The Joint Program Management Office (JPMO) will pursue a dual path to address compatibility issues with the M232A1 propelling charge. The primary path is to have Benet Labs redesign the breech and primer feed mechanism components to survive MACS loading. The secondary path is to pursue a laser ignition system which will be designed to handle the MACS load. The JPMO will down select and will retrofit the solution starting in 2013. There is currently no funding allocated for this effort.

2. Power Upgrades - The power supply of the digital fire control is inadequate to support the type of operations required in Afghanistan. The full combat potential of a digitized M777A2 is not being realized because of the current limitations associated with the power subsystem. The JPMO is pursuing an initiative to replace the power distribution system and the batteries with advanced components that would eliminate this problem.

3. Thermal Warning Device Reliability - The current mercury thermal warning device used to measure the outside diameter temperature of the gun tube has accuracy and durability issues. After a critical field failure at Ft. Bragg, the LW155 Program Office began looking into replacing the mechanical device with an electronic thermal warning device. Benet Laboratories has initiated development of an electronic sensor package and handheld display as part of an overseas contingency operation (OCO) effort. The JPMO will leverage this effort and develop a standalone display.

1. Modular Artillery Charge (MACS) Compatibility with the M777A2 Howitzer:

1a. No Active S&T Initiatives for LW 155

1b. Potential S&T Initiatives for LW 155

Other

- Laser Ignition

2. Power Upgrades:

2a. No Active S&T Initiatives for LW 155

2b. Potential S&T Initiatives for LW 155

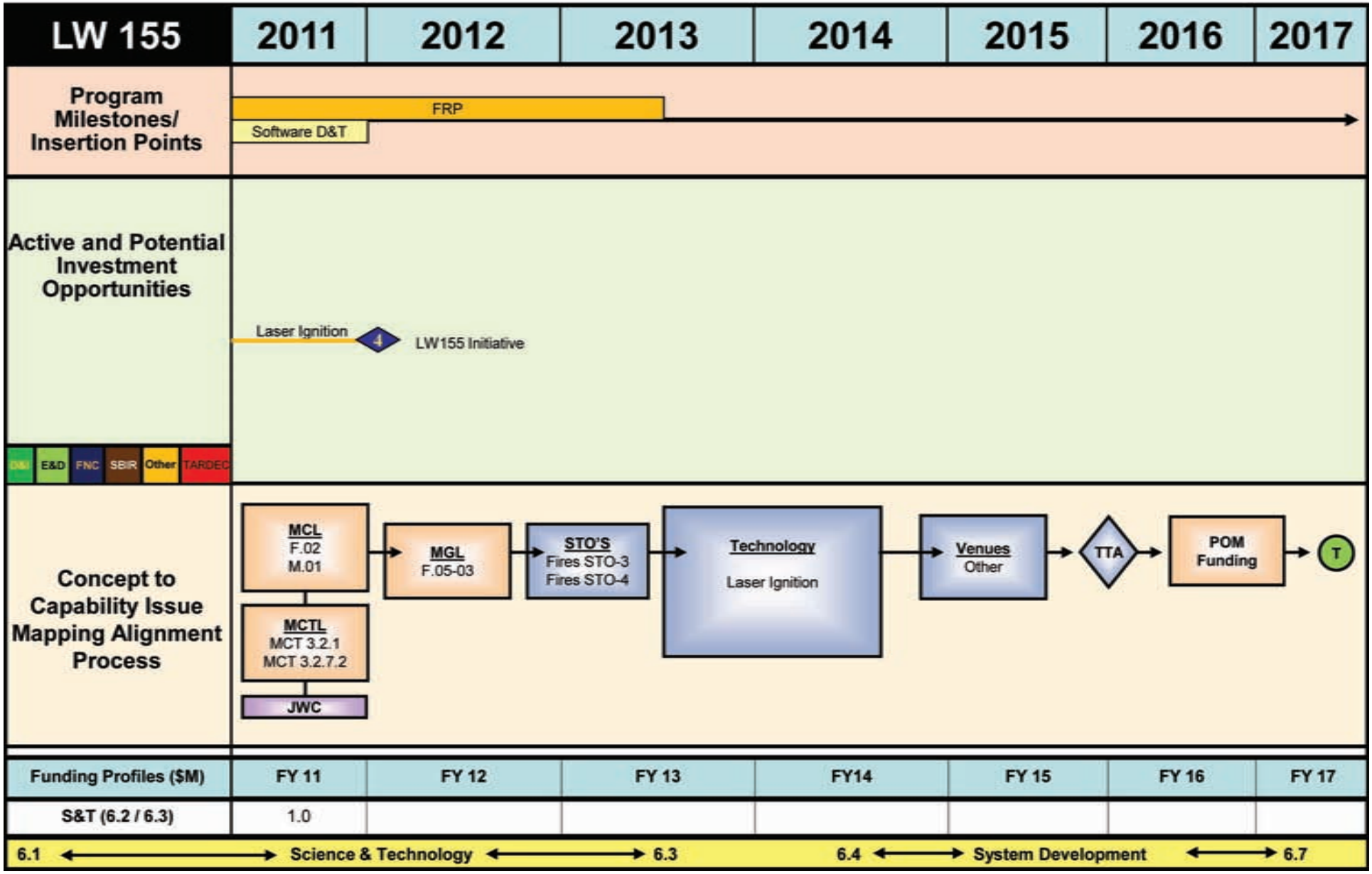
- The JPMO is pursuing an initiative to replace the power distribution system and the batteries with advanced components that would eliminate this problem.

3. <u>Thermal Warning Device Reliability:</u>

3a. No Active S&T Initiatives for LW 155

3b. No Potential S&T Initiatives for LW 155

LW 155 Technical Issue #1
Modular Artillery Charge (MACS) Compatibility



LW 155 Technical Issue #1
Modular Artillery Charge (MACS) Compatibility

MCL	F.02 Engage the adversary kinetically M.01 Maneuver to secure	
MCTL	MCT 3.2.1 Conduct Fire Support Tasks MCT 3.2.7.2 Control Indirect Fires	
MGL	F.05-03 Ground Fires Sustainment/Enhancement	
STO'S	Fires STO-3 Advanced ammunition Fires STO-4 Increased capabilities and reduced weight of all ground combat weapons systems	
Technology	Active: Laser Ignition	Potential: N/A
Venues	Basic Research	
TTA	N/A	
POM Funding	MCCDC integration division	
T	Transition to a program of record	Comments/Issues:

LW 155 Technical Issue #2 Power Upgrades

LW 155	2011	2012	2013	2014	2015	2016	2017
Program Milestones/ Insertion Points	FRP; Software D&T						
Active and Potential Investment Opportunities	The JPMO is pursuing an initiative to replace the power distribution system and the batteries with advanced components that would eliminate this problem.						
Concept to Capability Issue Mapping Alignment Process	MCL F.02 M.01 → MGL L.09-11 M.09-11 L.13-04 → STO'S Fires STO-4 → Technology - N/A → Venues N/A → TTA → POM Funding → T; MCTL MCT 4.4.9 MCT 3.2.7.2; JWC						
Funding Profiles ($M)	FY 11	FY 12	FY 13	FY14	FY 15	FY 16	FY 17
S&T (6.2 / 6.3)							

6.1 ← → Science & Technology ← → 6.3 6.4 ← → System Development ← → 6.7

LW 155 Technical Issue #2 Power Upgrades

MCL	F.02 Engage the adversary kinetically M.01 Maneuver to secure	
MCTL	MCT 4.4.9 Conduct Tactical Electrical Supply MCT 3.2.7.2 Conduct Indirect Fires	
MGL	L.09-11 Alternate Power Sources M.09-11 Exportable Power For On-Board Systems L13-04 Power generation/ distribution	
STO'S	Fires STO-4 Increased capabilities and reduced weight of all ground combat weapons systems	
Technology	Active: -N/A	Potential:
Venues		
TTA		
POM Funding	MCCDC integration division	
T	Transition to a program of record	Comments/Issues:

LW 155 Technical Issue #3
Thermal Warning Device Reliability

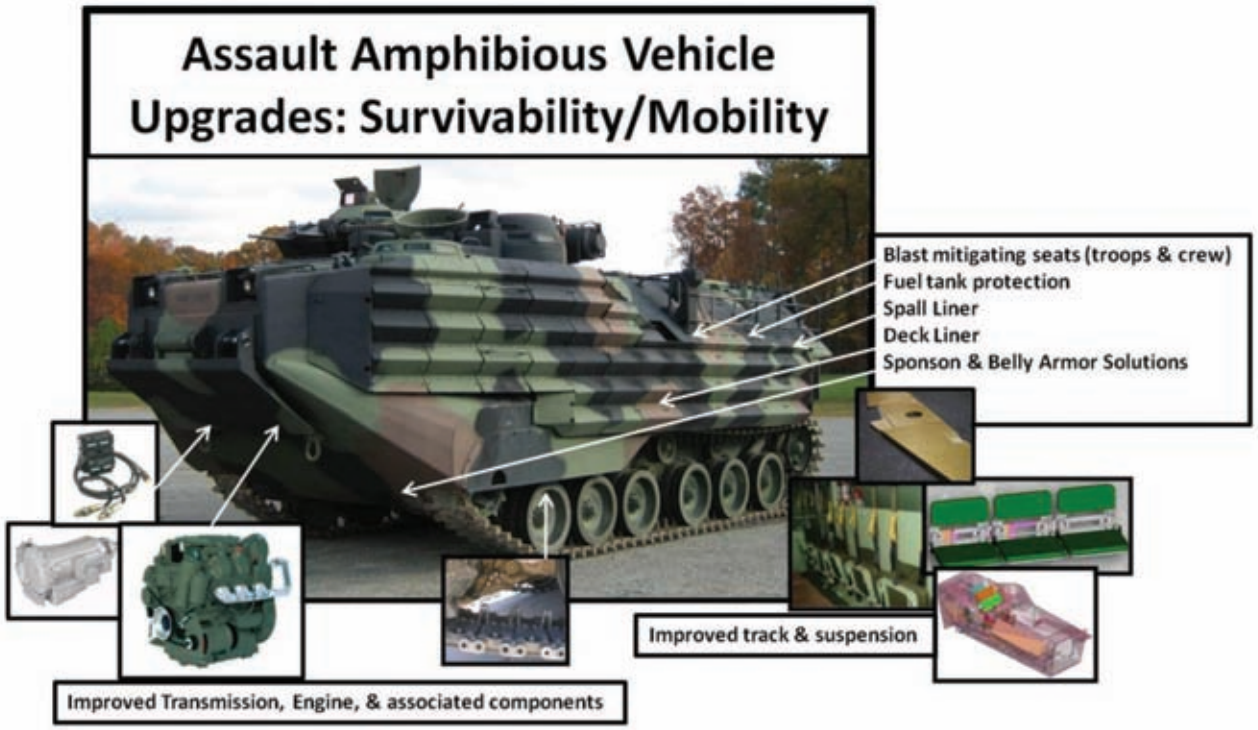
LW 155	2011	2012	2013	2014	2015	2016	2017
Program Milestones/ Insertion Points	FRP; Software D&T						
Active and Potential Investment Opportunities	N/A						
Concept to Capability Issue Mapping Alignment Process	MCL F.02 M.01; MCTL MCT 3.2.1 MCT 3.2.7.2; JWC	MGL F.05-03	STO'S Fires STO-4	Technology N/A	Venues N/A	TTA	POM Funding; T
Funding Profiles ($M)	FY 11	FY 12	FY 13	FY14	FY 15	FY 16	FY 17
S&T (6.2 / 6.3)							

DM | E&D | FNC | SBIR | Other | TARDEC

6.1 ⟷ Science & Technology ⟷ 6.3 6.4 ⟷ System Development ⟷ 6.7

LW 155 Technical Issue #3
Thermal Warning Device Reliability

MCL	F.02 Engage the adversary kinetically M.01 Maneuver to secure	
MCTL	MCT 3.2.1 Conduct Fire Support Tasks MCT 3.2.7.2 Conduct Indirect Fires	
MGL	F.05-03 Ground Fires Sustainment/Enhancement	
STO'S	Fires STO-4 Increased capabilities and reduced weight of all ground combat weapons systems	
Technology	Active: -N/A	Potential: -N/A
Venues	E&D	
Army	N/A	
TTA	N/A	
POM Funding	MCCDC integration division	
T	Transition to a program of record	Comments/Issues:



Assault Amphibious Vehicle (AAV7A1 RAM/RS) Family of Vehicles (FoV) Upgrade Description

The Assault Amphibious Vehicle, initially fielded in 1972, remains the primary general-support Armored Personnel Carrier (APC) for Marine infantry. The AAV FoV consists of the AAVP7A1 RAM/RS APC and two supporting mission-role variants: AAVC7A1 RAM/RS command and AAVR7A1 RAM/RS recovery. The AAV7A1 RAM/RS FoV provides ship to shore to objective mobility as well as direct fire-support with organic weapons. Programmed to be replaced by a new amphibious combat vehicle, the AAV7A1 RAM/RS FoV will continue to serve the Marine Corps until at least 2025. The AAV7A1 RAM/RS FoV previously underwent a series of capability enhancements to improve mobility, improve reliability, and extend the platforms' service life.

The AAV Upgrade Program will further improve survivability and land and water mobility of the AAV, serving as a capability bridge to fielding and replacement by a new amphibious combat vehicle. This initiative will improve force protection and platform survivability by integrating technically mature upgrades into the existing hull. These upgrades will include: underbelly and sponson armor, blast-mitigating seats for embarked Marines and crew, spall lining, fuel tank protection, deck liners, and automotive and suspension upgrades to maintain current land and water mobility characteristics with the anticipated increased weight growth. These upgrades are

slated for approximately 392 AAVP7A1 RAM/RS with potential select upgrades applied to the Communications and Recovery variants.

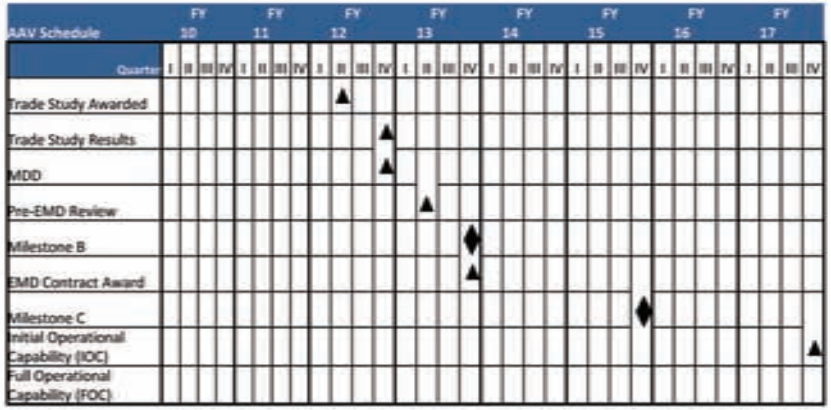
Operational Impact

The upgraded Assault Amphibious Vehicle will provide significant survivability improvements through increased protection against current and future threats. Through improvements in both physical armor systems and supporting subsystems within the hull of the AAV, the upgraded vehicles will increase protection to embarked Marines and crew.

Program Status

The AAV Upgrades program will enter the acquisition life cycle at Milestone B during FY13 and begin the engineering, manufacturing and development phase. Currently, Developmental Testing is planned for late FY14 followed by Operational Testing in late FY16. Low Rate Initial Production is planned for late FY15, and Full Rate Pro-duction is planned to begin in 3rd quarter FY17. Initial fielding is planned for late FY17.

Assault Amphibious Vehicle (AAV)



Program Description

- AAV Upgrade AAO provides 4 Infantry Battalions lift capacity to the MAGTF
- The AAV Upgrade is to be a **bridge capability** to ACV. *Focus* - restore operational relevance to the AAV by updating outdated protection attributes

Mission: General Support Lift / Amphibious Mobility
Dimensions: H: 130 in
W: 130 in
L: 321 in
Wt: 46,330 lbs (curb wt)
Weapons: HMG
Payload: 21 Infantry Marines + 3 Marine crewmen
Range: 200 miles
Speed: Effective with M1A1 off-road / 6 knots in water

Program Status

Acquisition Status: Pre MS-B
Acquisition Objective: 392
IOC/FOC: FY17/FY23

Assault Amphibious Vehicle (AAV)

AAV Schedule	FY 10				FY 11				FY 12				FY 13				FY 14				FY 15				FY 16				FY 17			
Quarter	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Trade Study Awarded										▲																						
Trade Study Results												▲																				
MDD												▲																				
Pre-EMD Review														▲																		
Milestone B																♦																
EMD Contract Award																▲																
Milestone C																								♦								
Initial Operational Capability (IOC)																																▲
Full Operational Capability (FOC)																																

AAV'S Top Three Program Technology Issues:

1. Survivability - Advances in ceramic and layered armor that can improve survivability and reduce weight. AAV Upgrade will likely be looking for a combined internal and external belly armor solution. AAV Upgrade will likely also look at seat survivability and spall liner in addition to armor solutions.

2. Weight/buoyancy management - Enhancing survivability will likely add weight to the AAV platform. A critical need for advances in technology is the development of alternative light weight, economical materials along with design improvements to increase and protect buoyancy.

3. Sustainment/In-service engineering - The AAV is a 40-year old platform that will remain in service for years to come. The AAV Upgrade program will not be fielded until FY17 and will not be an across-the-board upgrade, or SLEP, or reliability upgrade, but instead will be focused on survivability while "doing no harm" to current attributes such as mobility. The day-to-day logistics and technical challenges of managing such a dated platform become more pronounced every day due to component obsolescence (radios, intercoms, mechanical parts), age of the vehicle, and daily operations.

1. Survivability:

1.a No Active S&T Initiatives for AAV

1.b Potential S&T Initiatives for AAV

Discovery and Invention (D&I)
- Energy Absorbing Structures for Blast Mitigation
- CSTV Shock Mitigating Seats
- Lightweight Armor Materials

TARDEC
- GSS- Blast Technology Development

Other
- MTVR Blast Seat Evals

Small Business Innovation Research (SBIR)
- Aluminum Casting Alloy (ACV SBIR II)
- Modular Lightweight Armor System (ACV SBIR II)
- Semi-active Damped Seating (ACV SBIR III)

2. Weight/Buoyancy Management:

2.a No Active S&T Initiatives for AAV

2.b Potential S&T Initiatives for AAV

Exploitation and Development (E&D)

- Vehicle Stability

Small Business Innovation Research (SBIR)

- Aluminum Casting Alloy (ACV SBIR Phase I)
- Lightweight High Temp Armor (ACV SBIR Phase II)
- Modular Lightweight External Fuel Tank System (ACV SBIR Phase II)
- Modular Lightweight Armor System (ACV SBIR II)

3. Sustainment/In-Service Engineering:

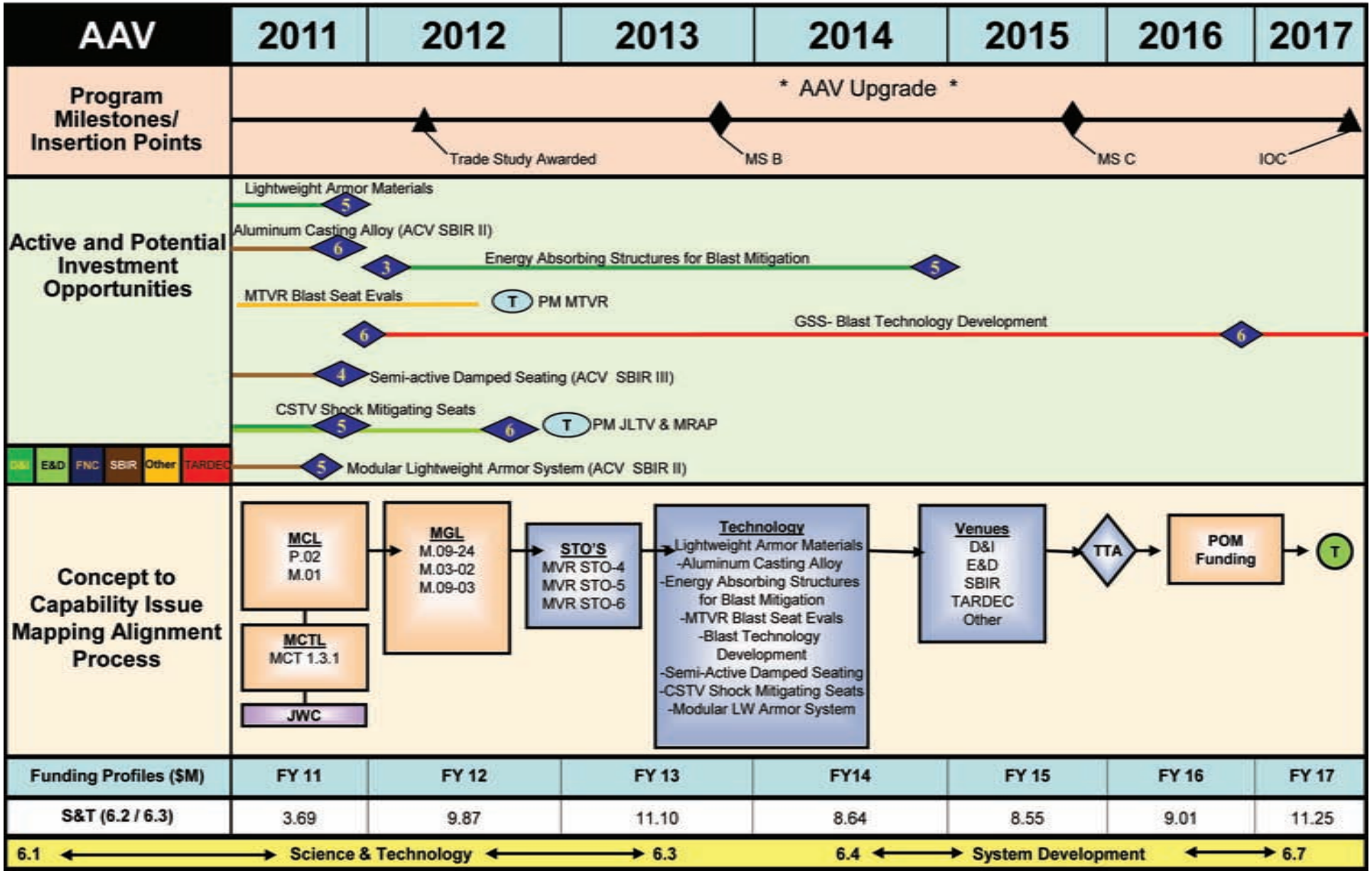
3.a No Active S&T Initiatives for AAV

3.b Potential S&T Initiatives for AAV

TARDEC

- Elastomer Maturation for Increased Track Durability
- Component Integration

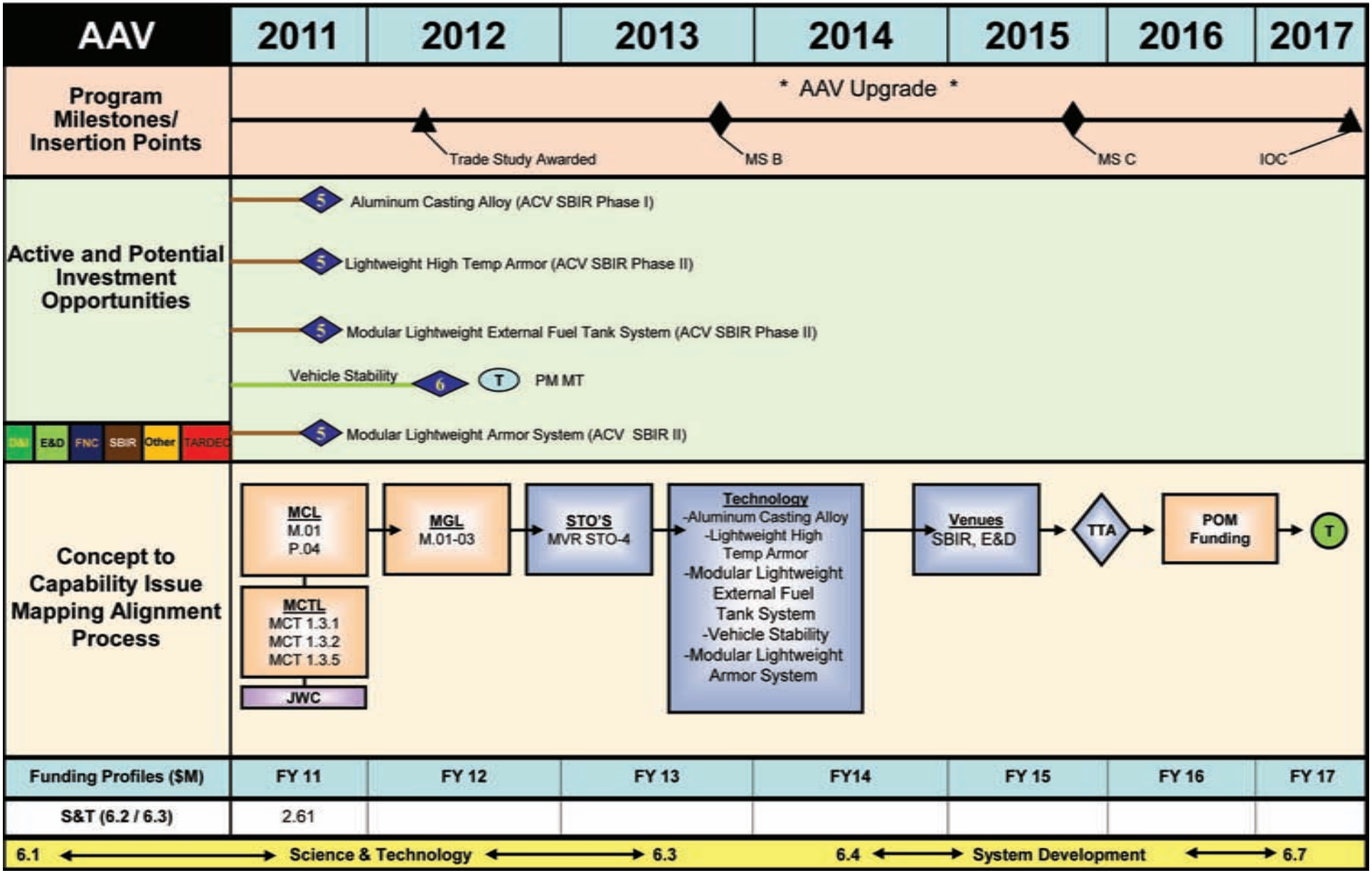
AAV Technical Issue #1 Survivability



AAV Technical Issue #1 Survivability

MCL	P.02 Protect Personnel/physical assets and LOCs M.01 Maneuver to secure		
MCTL	MCT 1.3.1 Conduct Maneuver		
MGL	M.09-24 Force Protection M.03-02 Protected mobility M.09-03 Protect armor platforms against RPG and ATGMs		
STO'S	MVR STO-4 Advanced materials and survivability technology to enhance the performance and survivability of combat vehicles and surface craft MVR STO-5 Vehicle and surface craft design for Marine usability, habitability, and survivability MVR STO-6 Mine and IED neutralization		
Technology	Active: None	Pending: N/A	-Potential: --Lightweight Armor Materials -Aluminum Casting Alloy -Energy Absorbing Structures for Blast Mitigation -MTVR Blast Seat Evals -Blast Technology Development -Semi-Active Damped Seating -CSTV Shock Mitigating Seats -Modular LW Armor System
Venues	D&I, E&D, SBIR, TARDEC, Other		
TTA	N/A	T Transition target for: PM LAV, JLTV, MRAP & Multiple PMs	
POM Funding	MCCDC integration division		
T	Transition to a program of record	Comments/Issues:	

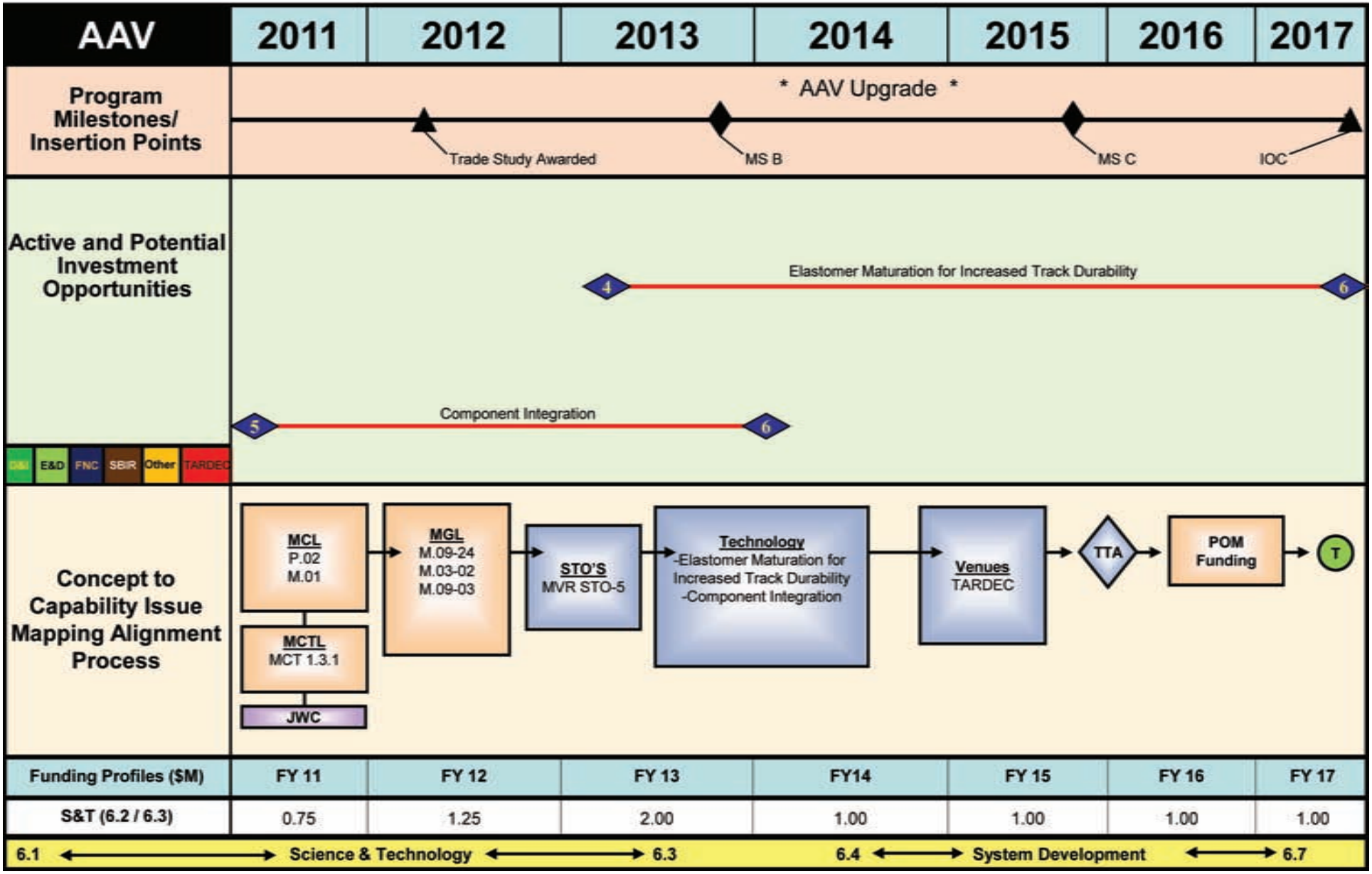
AAV Technical Issue #2 Weight/Buoyancy Management



AAV Technical Issue #2 Weight/Buoyancy Management

MCL	M.01 Maneuver to secure P.04 Detect threats to protect/secure forces	
MCTL	MCT 1.3.1 Conduct Maneuver MCT 1.3.2 Conduct Amphibious Operations MCT 1.3.5 Navigate	
MGL	M.01-03 AAV in support of STOM	
STO'S	MVR STO-4 Advanced materials and survivability technology to enhance the performance and survivability of combat vehicles and surface craft	
Technology	Active: None	Potential: Aluminum Casting Alloy Lightweight High Temp Armor Modular Lightweight External Fuel Tank System Vehicle Stability Modular Lightweight Armor System
Venues	SBIR, E&D	
TTA		
POM Funding	MCCDC integration Division	
T	Transition to a program of record	Comments/Issues:

AAV Technical Issue # 3 Sustainment/In-service Engineering



AAV Technical Issue # 3 Sustainment/In-service Engineering

MCL	P.02 Protect Personnel/physical assets and LOCs M.01 Maneuver to secure		
MCTL	MCT 1.3.1 Conduct Maneuver		
MGL	M.09-24 Force Protection M.03-02 Protected mobility M.09-03 Protect armor platforms against RPG and ATGMs		
STO'S	MVR STO-5 Vehicle and surface craft design for Marine usability, habitability, and survivability		
Technology	Active: None	Pending: None	Potential: -Elastomer Maturation for Increased Track Durability -Component Integration
Venues	TARDEC		
TTA	N/A	T	
POM Funding	MCCDC Integration Division		
T	Transition to a program of record	Comments/Issues:	

High Mobility
Multipurpose Wheeled Vehicle (HMMWV)

The High Mobility Multipurpose Wheeled Vehicle Expanded Capacity Vehicle (HMMWV ECV) is the 4th generation design of the HMMWV and is replacing the aging fleet of Base variant, A1, and some A2 variants. The HMMWV was originally fielded to Marine Corps units in the mid-1980s. The ECV is the latest generation and upgrades include: 6.5L Turbo engine; microprocessor-controlled engine electrical start system; more powerful Environment Protection Agency compliant engine; increased payload (500lbs); improved corrosion prevention; and access panels to facilitate maintenance. Current Armor Guidance from Marine Corps Combat Development Command (MCCDC) is 100% of the HMMWV fleet to have Integrated Armor Package (IAP) at a minimum, with 60% fully up-armored.

To successfully accomplish its mission, Marine Air-Ground Task Forces (MAGTFs) require a light tactical vehicle for command and control, troop transport, light cargo transport, shelter carrier, towed weapons prime mover, and weapons platform throughout all areas of the battlefield or mission area. Also, there are 71 United States Marine Corps (USMC) component programs that use the HMMWV as their prime mover. For units that require specific vehicle configurations, the detailed requirements will be provided in kit form, capable of being installed at General Support (GS) maintenance level or below, or by incorporation of Component of Major End Items (CMEI)/Component of End Items (COEI) by the system integrator. To meet the new AAO requirement and achieve a HMMWV fleet of 100% IAP and 60% fully up-armored, a major transition of HMMWV types and configurations is on-going.

The USMC has procured, fielded, and supported large numbers of HMMWVs for many years; therefore, the infrastructure and processes are established to support fielding Expanded Capability Vehicle (ECVs), and to phase-out Base, A1, and some A2 variants. Marine Corps HMMWV Inspect and Repair only as Necessary (IROAN) and SLEP Recapitalization projects have been ongoing at Marine Corps and Army depots. The Marine Corps began depot repairs to IROAN legacy HMMWVs in the early 1990s which continued through 1999. IROAN of HMMWV by Marine Corps depots was discontinued at that time. In 2007, IROAN began again

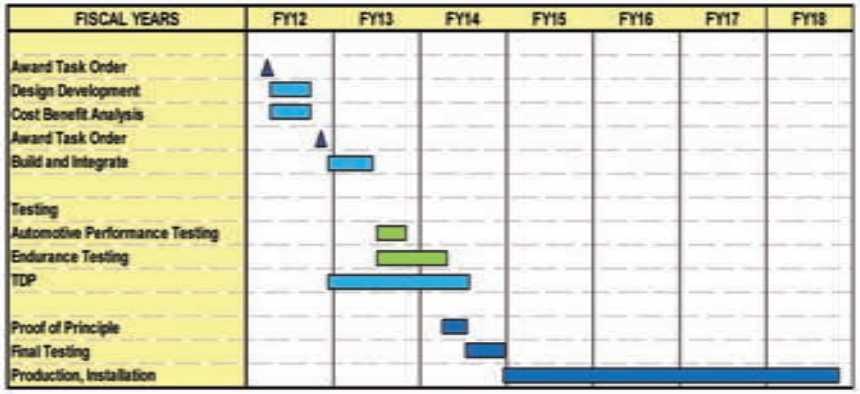
on the HMMWVs as a basic total rebuild due to issues with corrosion and failing parts. In 2009, the depots were directed to only IROAN HMMWVA2s with Marine Armor Kit (MAK) armor and Enhanced Capability Vehicles (ECVs). Since 2007 over 7,000 HMMWVs and ECVs have been IROANed by Marine Corps depots since 2007. The Marine Corps currently does all IROANs, RESETs, and rebuilds in-house at USMC depots, but has in the past contracted with the Army to IROAN vehicles at the Red River Army Depot in Texarkana, Texas.

As a result of the armoring levels required to meet the demands of Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF), HMMWV fleet performance has been significantly degraded due to overloaded conditions created by the armoring of the vehicle. As a result the HMMWV platform has exhibited increased maintenance demands, increased braking distances, increased acceleration times, reduced side slope and grade performance and degraded on/off road performance. Currently the Marine Corps HMMWV program office has initiated an effort to improve the HMMWV through a series of upgrades to gain back vehicle performance degraded by the need to armor the platform. This effort, known as the HMMWV Product Improvement Program (PIP), will focus on cost effective improvements in the areas of performance, safety, survivability and reliability. These targeted improvements will focus on the fully armored variants that will not be replaced by the upcoming Joint Light Tactical Vehicle (JLTV). Key areas of the modification include improving safety to include upgrades to braking, suspension components, wheels and tires for better vehicle stability, driver control and reduction of roll-overs. The modification will also look at improving performance by upgrading engines and transmissions for increased fuel efficiency and performance as well as upgrading the cooling system to prevent overheating and reduced failures. Optimizing suspension solutions will improve reliability by reducing forces transmitted to the vehicle chassis which will lead to a reduction in operation and maintenance costs. Finally the incorporation of a Central Tire Inflation System (CTIS) will allow for reduced tire pressures during off-road use to improve mobility and ride quality. These upgrades will provide the means to facilitate the necessary service life extension of the HMMWV platform to 2030 and beyond.

In December 2011, The HMMWV program was transferred out from under the formerly chartered authority of Program Manager, Motor Transportation (PM MT), Marine Corps Systems Command, Quantico, Virginia, to Program Executive Officer Land Systems, Program Manager, Light Tactical Vehicles, Quantico, Virginia.

High Mobility Multipurpose Wheeled Vehicle (HMMWV)

Modification Schedule



Program Description

Serve as the primary light tactical ground transport platform for command and control, troop transport, light cargo transport, shelter carrier, towed weapons prime mover, and weapons platform throughout all areas of the battlefield or mission area. Currently, approximately 70 other TAMCNs are associated to the HMMWV for employment.

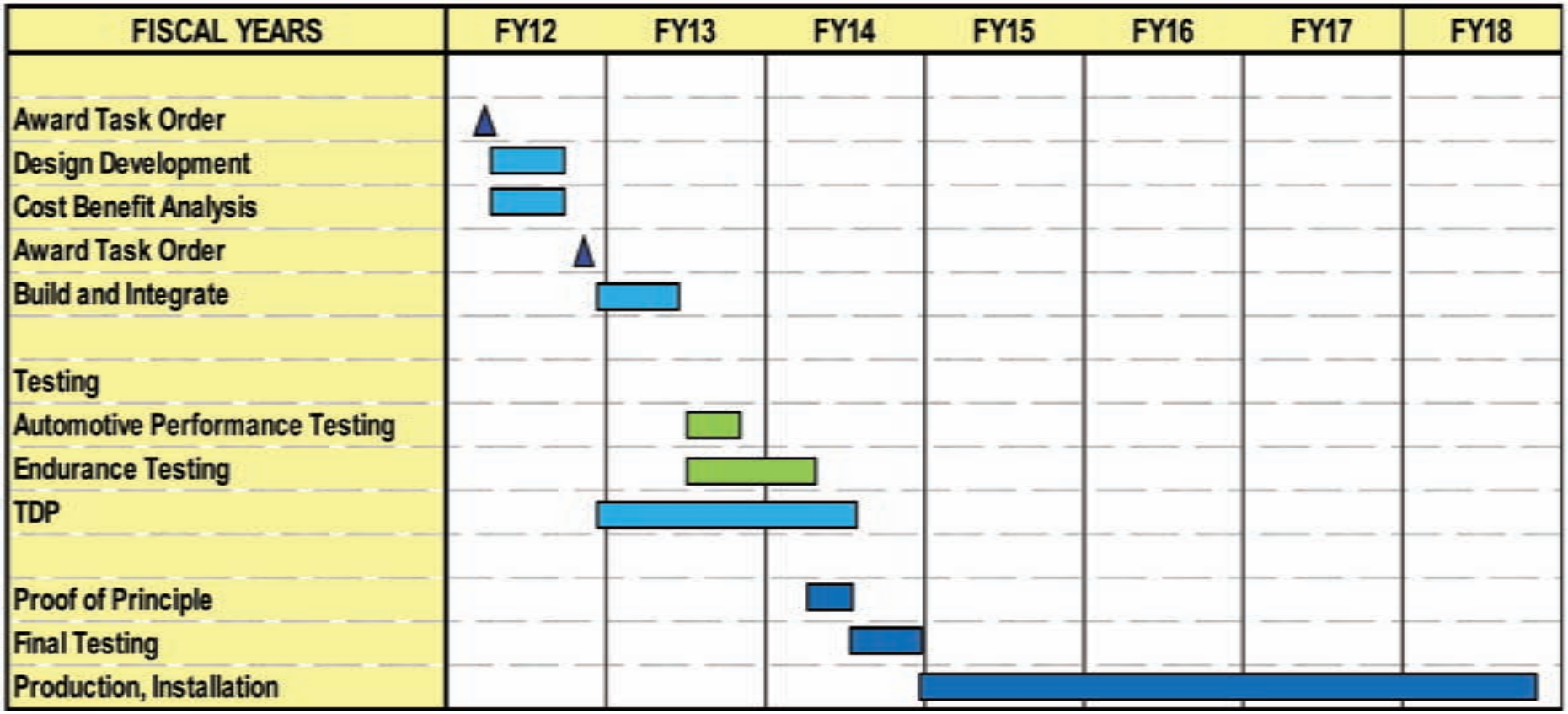
The High Mobility Multipurpose Wheeled Vehicle Expanded Capacity Vehicle (HMMWV ECV) is the 4th generation design of the HMMWV. The HMMWV fleet includes a mix of A2 and ECV variants. Current armoring guidance is for a mixed fleet of 60% fully up-armored and 40% IAP.

ECV upgrades include: 6.5L Turbo engine; microprocessor-controlled engine electrical start system; more powerful EPA compliant engine; increased payload (500lbs); improved corrosion prevention; and access panels to facilitate maintenance.

Program Status

- ACAT: IC
- Full Rate Production Decision – mid 1980s
- Fielding beginning: 1984 4th qtr
- IOC: 1986 1st qtr
- FOC: TBD
- AAO: 24,241
- Contract Type: Requirements based multi-year
- Prime Contractor: AM General
- Award Date: 1984
- Fleet consists of A2 and ECV variants

High Mobility Multipurpose Wheeled Vehicle (HMMWV)



HMMWV'S Top Three Program Technology Issues:

1. Performance - As a result of the armoring levels required to meet the demands of Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) the HMMWV fleets performance has been significantly degraded. This degradation stems from the consequences of overloading the vehicles with the currently installed B-Kit and Fragmentation (FRAG) armor kits. Additional payload and armoring or any off-road operational scenarios further diminish automotive performance causing reduced vehicle stability, reduced ride height, and poor ride quality, hindering overall automotive performance.

2. Survivability - While significant improvements have been made to improve the survivability of both the A2 and ECV HMMWV fleet via the employment of the Marine Armor Kits (MAK) kits for A2 variants and B-kits in combination with FRAG kits for the ECVs, there are still capability gaps in the current platforms. The Marine Corps HMMWV Program office is currently exploring technologies and methods to improve the underbody survivability of the HMMWV platform, specifically the ECV platform, in combination with on going efforts to extend the service life to meet the Light Tactical Vehicle need of the Marine Corps.

3. Reliability/Durability - Evaluation of the operational Reliability and Maintainability (RAM) data gathered from current combat operations and vehicle testing have shown that HMMWV up-armoring has resulted in a significant degradation of performance, vehicle reliability and availability. Incidents of collapsed springs, broken upper and lower control arms, failed suspension bushings, cracked frames, crushed air conditioning condensers, cracked radiators, and failed gear drive hubs have increased significantly. HMMWV components are unable to withstand the additional stresses produced by the suspension bottoming out, coil spring binding, and the jarring effects of overloaded suspension components and reduced suspension travel. The results of the decrease reliability and durability performance has been degreased readiness and significantly increased operational costs.

1. Performance:

1a. Active S&T Initiatives for HMMWV

Other

- Spaceframe Technology HMMWV
- HMMWV Suspension Upgrade (HSU)
- HMMWV 3 – Axis Stability

1.b Potential S&T Initiatives for HMMWV

Small Business Innovation Research (SBIR)
- Semi-active Damped Seating (ACV SBIR III)

Discovery and Invention (D&I)
- CSTV Shock Mitigating Seats
- Integrated Mobility Dynamics Control

Other
- JLTV Phase 'A' Light Weight Armor Study

2. <u>Survivability:</u>

2.a Active S&T Initiatives for HMMWV

Discovery and Invention (D&I)
- Energy Absorbing Structures for Blast Mitigation

2.b Potential S&T Initiatives for HMMWV

Discovery and Invention (D&I)
- CSTV Shock Mitigating Seats
-

Small Business Technology Transfer (STTR)
- Low Cost, Low Weight, Self-Sealing Fuel Tank Technology Development (ACV STTR II)

Exploration and Development (E&D)
- Survivability Analysis of Alternatives Tool
- Future Naval Capability (FNC)
- Advanced LAV Suspension

Other
- Fuel Tank Protection System Swampworks

3. <u>Reliability/Durability:</u>

3.a Active S&T Initiatives for HMMWV

Discovery and Invention (D&I)
- Energy Absorbing Structures for Blast Mitigation Light Tactical Vehicles

Other

- HMMWV Trade Space M&S
- Spaceframe Technology HMMWV
- HMMWV Suspension Upgrade (HSU)
- HMMWV 3 – Axis Stability

3.b Potential S&T Initiatives for HMMWV

Other

- Military Vehicle High Performance Capabilities (MVHPC)
- Fuel Tank Protection System Swampworks
- JLTV SE Toolkit

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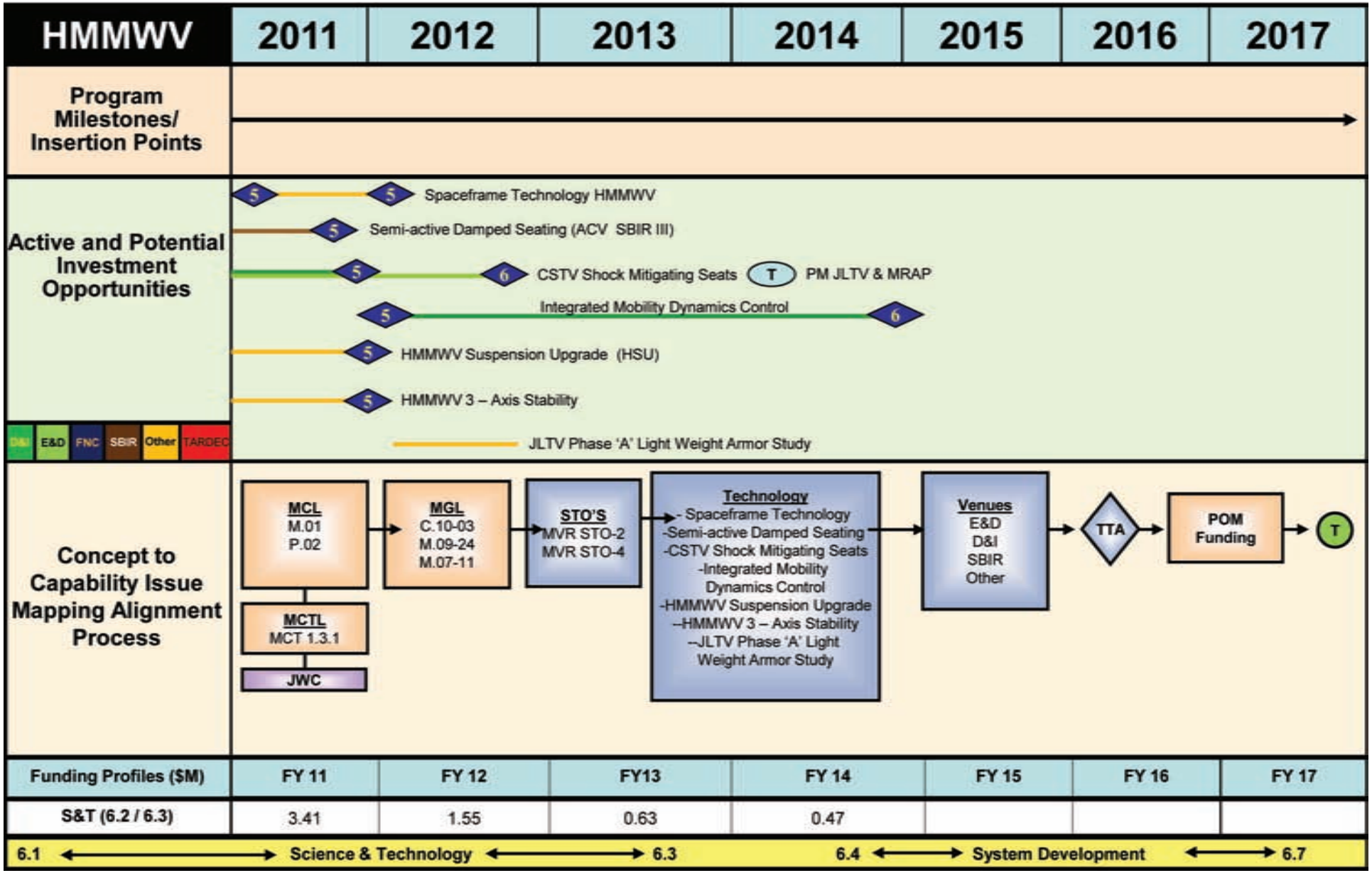
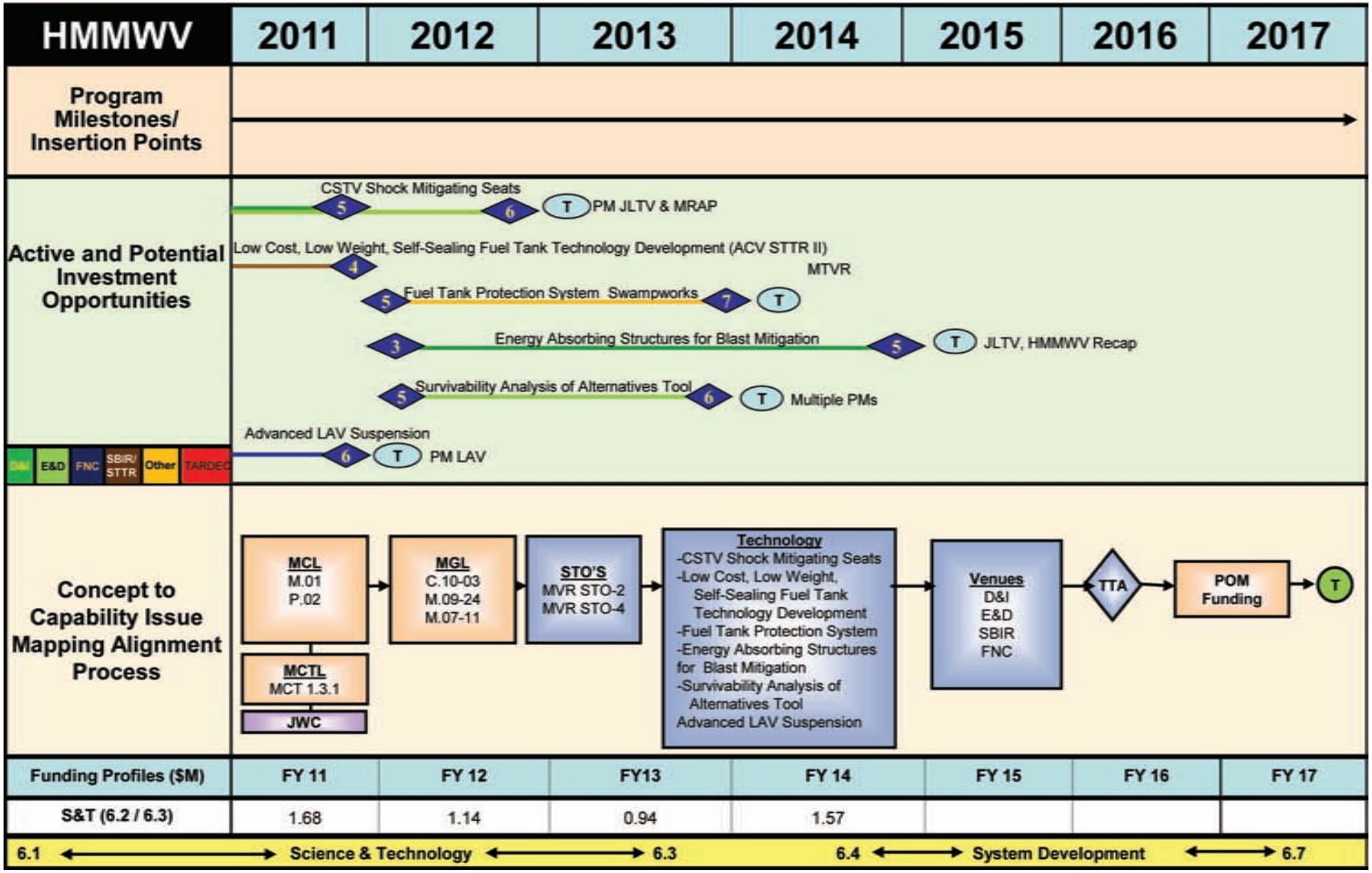
HMMWV Technical Issue #1 Performance



HMMWV Technical Issue #1 Performance

MCL	M.01 Maneuver to Secure P.02 Protect personnel, physical assets and LOCs	
MCTL	MCT 1.3.1 Conduct Maneuver	
MGL	C.10-03 Limited transport capability M.09-24 Force protection M.07-11 Mobility in all terrain and climates	
STO'S	MVR STO-2 Ground vehicle mobility MVR STO-4 Advanced materials and survivability technology to enhance the performance and survivability of combat vehicles and surface craft	
Technology	Active: -Spaceframe Technology -HMMWV Suspension Upgrade -HMMWV 3 – Axis Stability	Potential: -Semi-active Damped Seating -CSTV Shock Mitigating Seats -Integrated Mobility Dynamics Control -JLTV Phase 'A' Light Weight Armor Study
Venues	E&D, D&I, SBIR, Other	
TTA	N/A	
POM Funding	MCCDC integration Division	
T	Transition to a program of record	Comments/Issues:

HMMWV Technical Issue #2 Survivability



Funding Profiles ($M)	FY 11	FY 12	FY13	FY 14	FY 15	FY 16	FY 17
S&T (6.2 / 6.3)	1.68	1.14	0.94	1.57			

6.1 ⟷ Science & Technology ⟷ 6.3 6.4 ⟷ System Development ⟷ 6.7

HMMWV Technical Issue #2 Survivability

MCL	M.01 Maneuver to Secure P.02 Protect personnel, physical assets and LOCs		
MCTL	MCT 1.3.1 Conduct Maneuver		
MGL	C.10-03 Limited transport capability M.09-24 Force protection M.07-11 Mobility in all terrain and climates		
STO'S	MVR STO-2 Ground vehicle mobility MVR STO-4 Advanced materials and survivability technology to enhance the performance and survivability of combat vehicles and surface craft		
Technology	Active: Energy Absorbing Structures for Blast Mitigation	Potential: -CSTV Shock Mitigating Seats -Low Cost, Low Weight, Self-Sealing Fuel Tank Technology Development -Fuel Tank Protection System -Survivability Analysis of Alternatives Tool -Advanced LAV Suspension	
Venues	D&I, E&D, SBIR, Other (Swampworks), FNC		
TTA	Advanced LAV Suspension	T	Transition target for PM LAV
POM Funding	MCCDC integration division		
T	Transition to a program of record	Comments/Issues:	

HMMWV Technical Issue #3 Reliability/Durability

HMMWV	2011	2012	2013	2014	2015	2016	2017
Program Milestones/ Insertion Points							
Active and Potential Investment Opportunities							
Concept to Capability Issue Mapping Alignment Process							

Active and Potential Investment Opportunities

- HMMWV Trade Space M&S — T — Tactical Wheeled Vehicles
- 3 — Energy Absorbing Structures for Blast Mitigation Light Tactical Vehicles — 5 — T — JLTV, HMMWV Recap
- 7 — 7 — Military Vehicle High Performance Capabilities (MVHPC) — T — Tactical Wheeled Vehicles
- 5 — 5 — Spaceframe Technology HMMWV
- 5 — HMMWV Suspension Upgrade (HSU)
- 5 — Fuel Tank Protection System Swampworks — 7 — T — MTVR
- 5 — HMMWV 3 – Axis Stability
- JLTV SE Toolkit

D&I | E&D | FNC | SBIR | Other | TARDEC

Concept to Capability Issue Mapping Alignment Process

MCL: M.01, P.02, L.02 → MGL: C.10-03, M.09-24, M.07-11 → STO'S: MVR STO-2, MVR STO-4 → Technology: -HMMWV Trade Space M&S, -Energy Absorbing Structures for Blast Mitigation Light Tactical Vehicles, -Military Vehicle High Performance Capabilities, -Spaceframe Technology, - HMMWV Suspension Upgrade, -Fuel Tank Protection System, -HMMWV 3 – Axis Stability, - JLTV SE Toolkit → Venues: D&I, Other → TTA → POM Funding → T

MCTL: MCT 1.3.1 → JWC

Funding Profiles ($M)	FY 11	FY 12	FY13	FY 14	FY 15	FY 16	FY 17
S&T (6.2 / 6.3)	4.49	0.85	0.64	1.17			

6.1 ⟷ Science & Technology ⟷ 6.3 6.4 ⟷ System Development ⟷ 6.7

HMMWV Technical Issue #3 Reliability/Durability

MCL	M.01 Maneuver to Secure P.02 Protect personnel, physical assets and LOCs L.02 Maintain equipment	
MCTL	MCT 1.3.1 Conduct Maneuver	
MGL	C.10-03 Limited transport capability M.09-24 Force protection M.07-11 Mobility in all terrain and climates	
STO'S	MVR STO-2 Ground vehicle mobility MVR STO-4 Advanced materials and survivability technology to enhance the performance and survivability of combat vehicles and surface craft	
Technology	Active: - Energy Absorbing Structures for Blast Mitigation Light Tactical Vehicles -HMMWV Trade Space M&S -Spaceframe Technology HMMWV -HMMWV Suspension Upgrade -HMMWV 3 – Axis Stability	Potential: -Military Vehicle High Performance Capabilities -Fuel Tank Protection System -JLTV SE Toolkit
Venues	D&I, Other	
TTA	N/A	
POM Funding	MCCDC Integration Division	
T	Transition to a program of record	Comments/Issues:

Appendix A: ATIP Overview / Background / Purpose

Overview

This PEO LS ATIP focuses on an overarching strategy of "engagement" within the established S&T process to better leverage all available resources to resolve Program Manager (PM) technology issues. It employs the PEO LS S&T "Concept to Capability" process to identify and prioritize the Top Technical Issues identified by each PM within PEO LS. This prioritized list of High Priority Technologies helps to inform S&T investment planning, align potential stakeholder support and leverage all available resources. By delivering technologies essential to resolve identified program technical issues, the ATIP will achieve the desired end state to "Focus the Future Faster" in support of our warfighters.

Background

Mission: The PEO LS mission is to meet the warfighters' needs by devoting fulltime attention to Marines Corps weapon systems acquisition, while partnering with Marine Corps Systems Command, in order to develop, deliver and provide life-cycle planning for all assigned programs. The PEO LS ATIP will assist PEO LS in accomplishing this mission by supporting resolution of Program Top Technical Issues. These programs include:

- Amphibious Combat Vehicle (ACV)
- Joint Light Tactical Vehicle (JLTV)
- Marine Personnel Carrier (MPC)
- Logistics Vehicle System Replacement (LVSR)
- Medium Tactical Vehicle Replacement (MTVR)
- Common Aviation Command and Control System (CAC2S)
- Ground/Air Task-Oriented Radar (G/ATOR)
- Lightweight 155MM Howitzer (LW 155)
- Assault Amphibious Vehicle (AAV)
- High Mobility Multipurpose Wheeled Vehicle (HMMWV)

Purpose

The purpose of the PEO LS ATIP is to establish a repeatable "Concepts to Capability" process designed to:

- Identify and Prioritize Top Technical Issues within PEO LS Programs
- Inform, Influence and Align S&T Investments
- Resolve Capability Gaps & Technology Issues
- Support Technology Insertion and Transition into PoRs

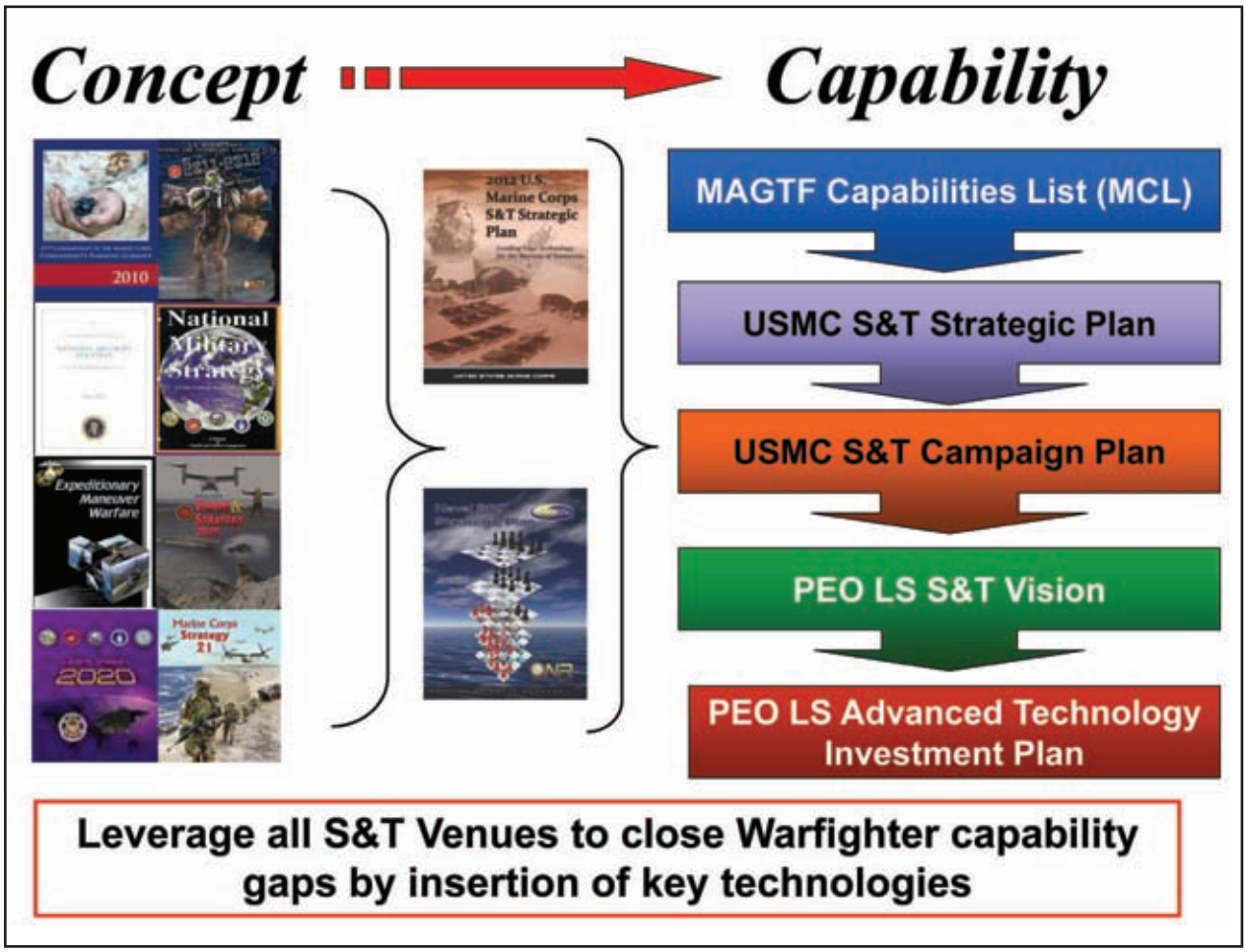


Figure 9 – ATIP "Concept to Capability" Alignment

The ATIP describes how PEO LS S&T developed and employs their "Concept to Capability" process to identify the top PEO LS PM technical issues, prioritize those technical issues to inform and align potential stakeholder support and leverage available S&T resources (Figure 9) in order to deliver/transition technologies essential to resolve those issues. The ATIP assists in the closure of identified technology gaps and the rapid transition of concept aligned technologies into PoR thereby "Focusing the Future Faster" in support of our warfighter.

PEO LS S&T Mission:

"Focus the Future Faster" in support of the warfighter by facilitating the rapid transition of advanced technologies into PoRs that close high priority capability gaps and resolve program technical issues.

PEO LS S&T Vision:

Provide state-of-the-art technology to the warfighter.

PEO LS S&T Strategic Goals:

a. Partner with MARCORSYSCOM to develop a prioritized list of technology focus areas to inform and align stakeholder support while maximizing available S&T resources.

b. Leverage available S&T venues in support of PEO LS programs in order to resolve technology needs, transition capability into PoRs and rapidly close warfighter gaps.

c. Develop and maintain a "Concept to Capabilities" process and associated procedures to identify and prioritize PEO LS Top Technical Issues with associated high priority technologies and Technology Focus Areas required to resolve Top Technical Issues identified within the process.

d. Develop a PEO LS S&T technology investment strategy that provides guidance to S&T Developers (ONR, DARPA, ARL, etc.) and helps focus future S&T investments on PEO LS program technical needs.

e. Actively engage the Marine Corps Warfighting Laboratory (MCWL) Technology and Experimentation Divisions to align efforts and leverage experimentation in support of PEO LS program technical issues.

f. Actively pursue and facilitate Memorandums of Understanding (MOUs) and Memorandums of Agreement (MOAs) with key S&T Enterprise members to leverage support for PEO LS Programs.

PEO LS S&T Objectives:

The PEO LS S&T objectives, roles and responsibilities and organization are focused to support concept aligned, capabilities based technology requirements in order to influence and inform the S&T investment process and support technology transition into PoRs.

There are six PEO LS Science and Technology objectives as identified below:

- **Identify** - Top Technical Issues across PEO LS Programs
- **Communicate** - Top Issues to Key Stakeholders and Inform Decision Makers
- **Align** - Top Issues with High Priority Capability Gaps and Technology Focus Areas
- **Engage** - All Applicable S&T Venues and Stakeholders to Leverage Resources
- **Resolve** - Identified Technical Issues
- **Transition** - Capability to PoR and Close Warfighter Gaps

PEO LS S&T Roles & Responsibilities:

The PEO LS S&T Director serves as the primary advisor for all PEO LS S&T policy and process issues. The PEO LS S&T Director maintains awareness of applicable S&T advances and requirements in order to resolve program technical issues. Additionally, the Director serves as a conduit for the flow of critical S&T information between all applicable S&T forums and PEO LS. The PEO LS S&T Director's primary role is to ensure the timely delivery of technology solutions to the warfighter. In order to meet the PEO LS S&T objectives, the PEO LS S&T Director will accomplish the following tasks:

Figure 10 – PEO LS S&T Organization

a. Actively engage across all relevant S&T forums, provide leadership, visibility, advocacy, and focus to develop and deliver technologies to meet current and emerging warfighter Requirements.

b. Integrate S&T development efforts across PEO LS programs in order to reduce redundancies and mitigate technical risk.

c. Advocate, promote and facilitate the use of PEO LS processes and structures to implement science, research, engineering, and investment efforts.

d. Provide leaders and key representatives across PEO LS with insight and understanding of critical cross program needs, associated technical requirements and issues.

e. Provide insight and understanding of PEO LS programs, requirements and capabilities to external stakeholders.

f. Facilitate the development of partnerships and collaboration opportunities with external commands, offices, agencies, academia, and industry.

g. Participate in the S&T Investment planning process through all established forums to include the Program Objective Memorandum (POM) process and the Deputy Commandant (DC), Combat Development & Integration (CD&I) warfighter Program Evaluation Board (PEB).

h. Maintain an active role in the Marine Corps Expeditionary Force Development System (EFDS) process, focusing actions to inform the development of relevant Capabilities Development Documents (CDDs) and supporting requirements.

i. Conduct liaison with relevant S&T forums (such as MCSC S&T Working Group) and programs to ensure collaboration and liaison within all "3 Circle" activities related to the combat developer, material developer and S&T developer organizations. (Figure 10)

j. Serve as the PEO LS Core Member to the United States Marine Corps (USMC) S&T Integrated Product Team (IPT).

k. Identify PEO LS S&T Representatives to serve as USMC S&T IPT Functional Working Group (FWG) members and to assist PEO LS Program Managers (PMs) in the transition of technologies into PoRs.

l. Pursue Career Field Certification requirements in Systems Planning, Research, Development and Engineering – Science and Technology Management for all PEO LS S&T representatives.

m. Ensure PEO LS S&T Representatives are well informed and fully able to leverage all available resources to address program technical issues and close warfighter gaps.

n. Provide senior leadership with visibility into PEO LS Science and Technology workforce needs.

o. Serve as PEO LS principal advocate for directing, educating and enhancing the PEO LS Science and Technology Representative workforce, resources, and all associated capabilities.

p. Direct and oversee PEO LS representation and participation in the bi-annual USMC S&T Strategic Plan revision.

q. Foster collaboration and cultivate a strong internal network of S&T professionals across PEO LS and Marine Corps Systems Command (MCSC).

r. Develop, influence and support well focused and fully aligned Technology Transition Agreements.

s. Accelerate the utilization of Science and Technology based innovations and technology solutions to resolve identified PoRs technical issues.

t. Contribute to the broad spectrum of innovation and targeted technology transition initiatives to include Future Naval Capabilities (FNCs), Small Business Innovative Research (SBIR), Small Business Technology Transfers (STTRs), Joint Capability Technology Transfers (JCTDs), Manufacturing Technology (MANTECH) program, Rapid Technology Transitions (RTTs), Technology Insertion Program for Savings (TIPS), and the Technology Transition Initiative (TTI) processes.

u. Participate in all relevant S&T venues (Figure 11) in order to provide supporting resources to resolve PEO LS PoRs technical issues. Engage with DoD agencies and organizations, Marine Corps Systems Command (MCSC), Navy Systems Commands, other Services, ONR, DARPA, academia and industry to coordinate supporting technology development priorities, planning, execution and transition. Maintain close ties to and be constantly informed on industry R&D, academic research and work related to program technical issues ongoing at Government laboratories.

Science & Technology Resourcing Venues	
Advanced Tech Demos (ATDs) w/Industry	Navy International Cooperative Program (NICOP)
Advanced Technology Program (ATP)	Navy Rapid Deployment Capability Program (RDC)
Coalition Warfare Project	OSD/DDR&E Direct Funding
Combatant Commander Command and Control Initiatives Program (C2IP)	Other Govt. Agencies (NASA, DARPA, CIA, etc)
Cooperative R&D Agreement (CRADA)	Partnerships for Innovation Program (PIP)
Discovery & Invention (D&I)	Quick Reaction Fund Program (QRFP)
Federally Funded R&D Centers (FFRDC)	Research Development Demonstration (RDD)
Future Naval Capabilities (FNC)	Rapid Technology Transition (RTT)
Innovative Naval Prototype (INP) Program	Reduction in Total Ownership Costs (RTOC)
Joint A/C Survivability Program Office (JASPO)	S&T Research (STTR)
Joint Capability Tech. Demonstration (JCTD)	Small Business Innovation Research (SBIR)
Manufacturing Technology (MANTECH)	Swamp Works
Marine Corps Technology Division	Tech Solutions
National Labs (Draper, Sarnoff, ORNL, etc.)	Technology Insertion Program for Savings (TIPS)
Naval Innovation Lab (NaIL)	Technology Transition Initiative (TTI)

Figure 11 – S&T Resourcing Venue Matrix

v. Identify Science and Technology options suitable for addressing Warfighting Requirements through consultation within PEO LS, specifically program managers and their appropriate representatives and key stakeholders.

w. Develop a PEO LS S&T technology investment strategy that provides guidance to S&T Developers (ONR, DARPA, ARL, etc.) and helps focus future S&T investments on PEO LS program technical needs.

x. Actively engage the Marine Corps Warfighting Laboratory (MCWL) Technology and Experimentation Divisions to align efforts and leverage experimentation in support of PEO LS program technical issues.

y. Actively pursue and facilitate Memorandums of Understanding (MOUs) and Memorandum of Agreements (MOAs) with key S&T Enterprise members to leverage support for PEO LS Programs.

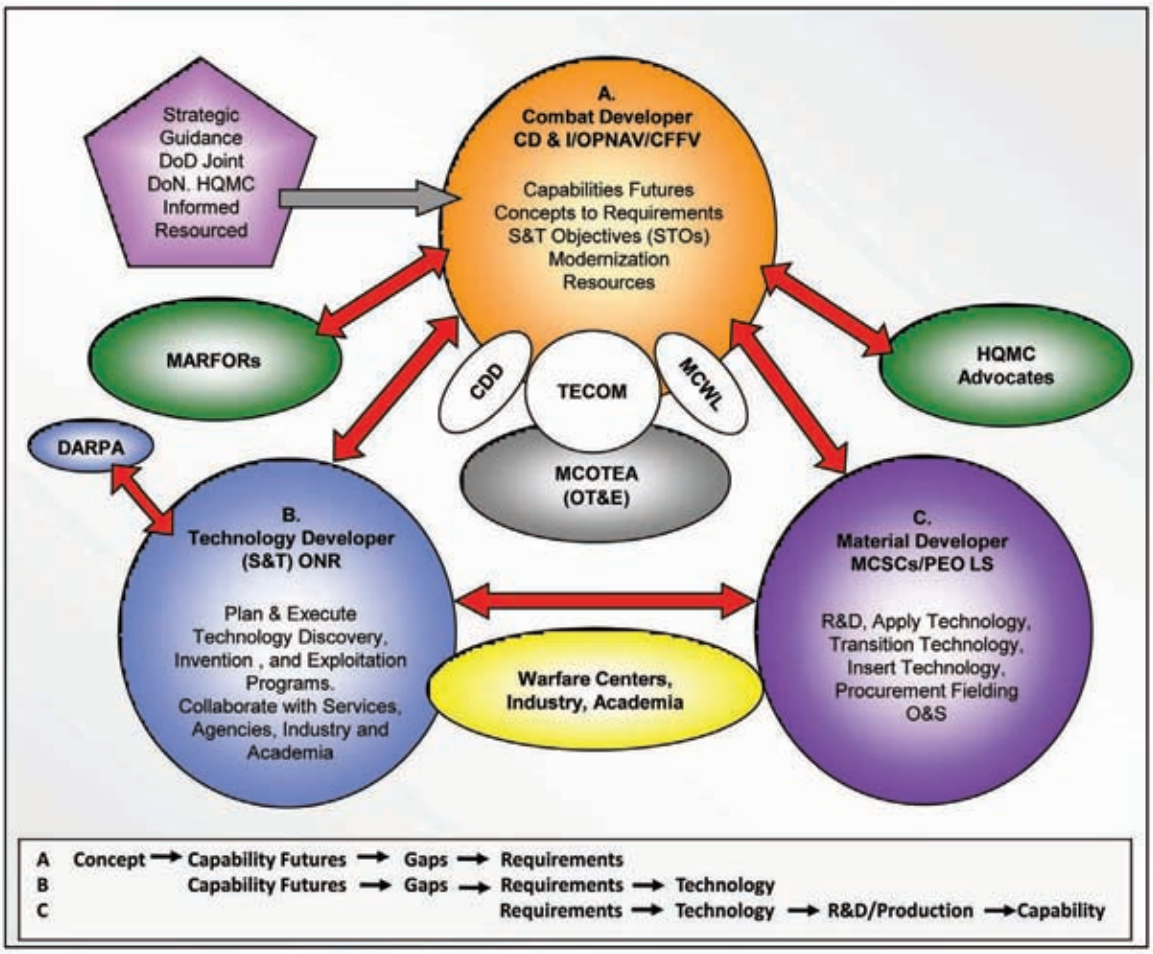


Figure 12 – Marine Corps S&T Enterprise "3 Circles"

Marine Corps S&T Integrated Program Team

The Marine Corps S&T Integrated Program Team (IPT), illustrated in Figure 13, is chartered through the Deputy Commandant for Combat Development and Integration (DC, CD&I) as the Advocate for Marine Corps S&T. The DC, CD&I exercises S&T oversight responsibilities through the Commanding General, Marine Corps Warfighting Laboratory (CG MCWL) who serves as DC, CD&I's designated Executive Agent (EA) for Marine Corps S&T (EA S&T).

As the EA for S&T, CG MCWL establishes and coordinates the Marine Corps S&T process, and in conjunction with the ONR Code 30 Department Head, provides DC, CD&I with the proposed Science and Technology Objectives (STOs) in support of Marine Corps concepts and requirements while focusing on emerging technology opportunities.

The S&T IPT supports the EA for S&T in exercising S&T oversight responsibilities and coordinating the S&T activities of the Marine Corps S&T process. The S&T IPT serves as a "common forum" that provides all organizations within the Marine Corps S&T community "3 Circles" with a voice in the overall S&T process (Appendix C, Ref D.13.).

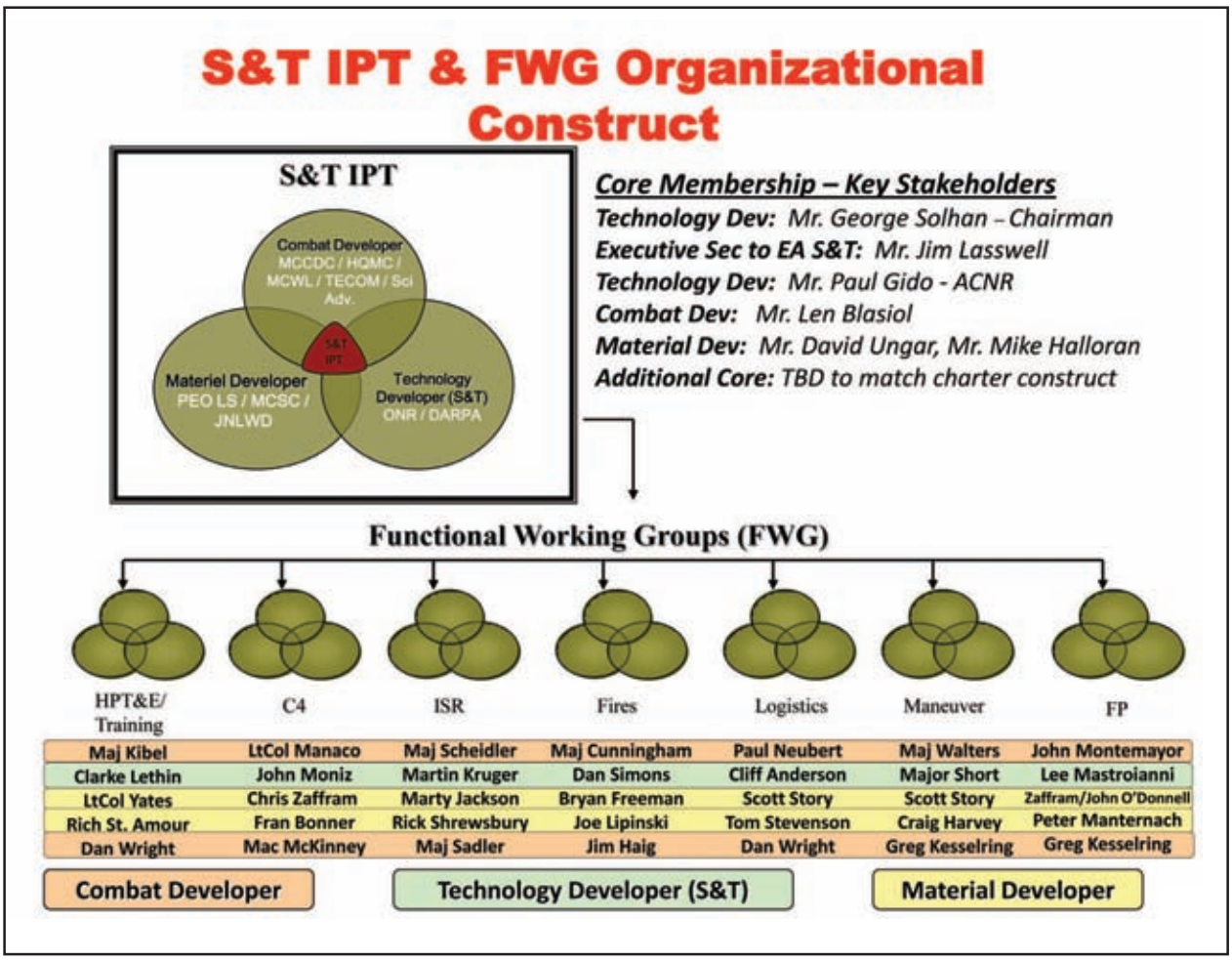


Figure 13 – USMC S&T IPT FWG Organizational Construct

Appendix B: PEO LS S&T "Concept to Capability" Process

The ATIP sets in place the actions and activities PEO LS S&T Directorate employs within the "Concept to Capability" process to identify and resolve the top PEO LS PM technical issues. The collaborative partnerships in Figure 13 ("Concept to Capability" S&T Partnership) reflect the activities within the process framework and are also intended to inform and align potential stakeholder support, leverage all available resources, resolve technical issues, and close capability gaps by rapidly transitioning technology to PoR.

The PEO LS S&T "Concept to Capability" Process is a repeatable process with ongoing review and focused feedback. The process actions begin with an in-depth understanding and alignment to the overarching concepts identified in Marine Corps Vision and Strategy 2025 and capstone concepts for the future. It is critical to employ these guiding documents and concepts to inform and align the capability requirements, guide technical development and provide best value investing. An understanding of the Warfighters' Concepts and the core-capabilities required to enable those concepts is the next step in the process. Also critical is an understanding of the top level strategic and operational service issues (listed below) that rely on material solutions for resolution.

- Lightening the MAGTF Load
- Increasing Energy Efficiency
- Reducing the Sustainment Footprint in the Expeditionary Environment
- Increasing Ground Tactical Vehicle Survivability & Mobility

Figure 14 – "Concept to Capability" S&T Partnership

Once the operational concepts and capabilities are understood, an analysis is performed to identify the MAGTF capabilities and technology gaps. These capabilities and gaps are codified in the MAGTF Capability List (MCL) and MAGTF Gap List (MGL), as well as the Solutions Planning Directive (SPD) and the MAGTF Requirements List (MRL).

A review is conducted to align any and all applicable Science and Technology Objectives (STOs) to the technology issues/capability gaps. This alignment of STOs with high priority gaps ensures traceability of PEO LS S&T investments and enables stronger support within the POM process. Without funding there is no capability transition.

Once the alignment is complete, a thorough review of current S&T initiatives is conducted to highlight those initiatives that have potential to resolve the identified technology issue/capability gap. If it is determined a "delta" exists and no current S&T initiative is in place to address/resolve the gap, then potential S&T venues are evaluated and a "new" S&T initiative is submitted via the appropriate forum – matching gaps in technology to the appropriate venue able to best align resources to resolve the program technical issue and schedule.

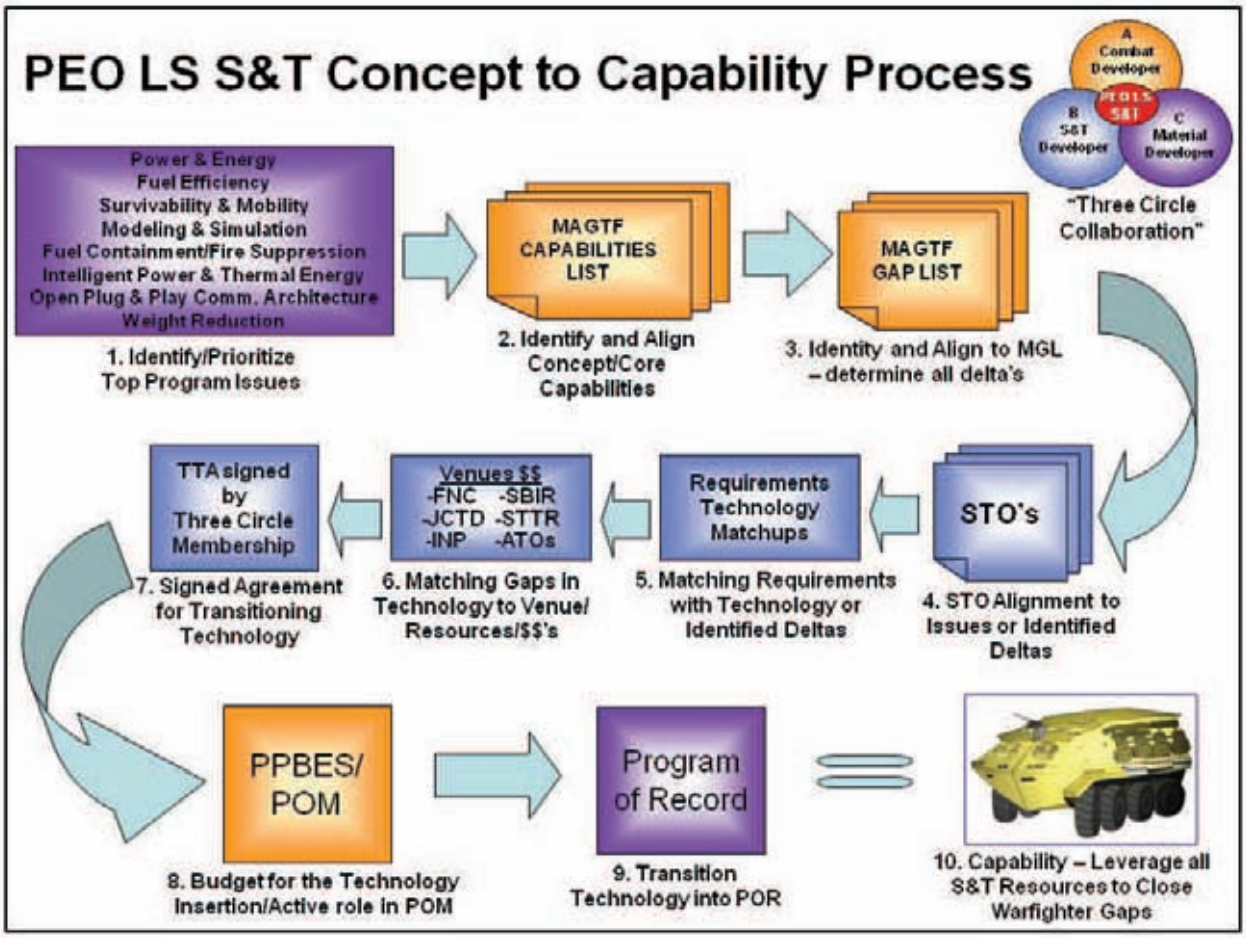


Figure 15 – PEO LS ATIP "Concept to Capability" Process

Upon approval of the new S&T initiative, the PM, as well as all "3 Circle" members capture the shared commitment within the framework of a formalized Technology Transition Agreement (TTA). After the TTA is signed by the appropriate level of "3 Circle" leadership, the S&T Representative continues to work closely with the PM to ensure funding support is available (in the POM) to integrate and transition the technology to the appropriate PoR and close the associated Warfighter gap.

By working through the "Concept to Capability" process (Figure 15) potential S&T opportunities and solutions are identified, enabling PEO LS S&T Representatives to better inform requirements, provide "best value" S&T investing and transition gap closing technologies to Programs of Record.

Program Objective Memorandum (POM)

Planning and funding today's diverse and sophisticated weapons systems presents many difficult challenges. Complex program requirements, shrinking budgets, and competing resources can exponentially increase the challenge. In an effort to effectively execute programs, every funding and solution opportunity needs to be exploited. The PEO LS S&T Director will maintain an active awareness of S&T opportunities both for technical solutions as well as funding possibilities.

The chart below depicts the dollar value of the S&T resources of the Army, Navy and DARPA (currently $11.7B per year).

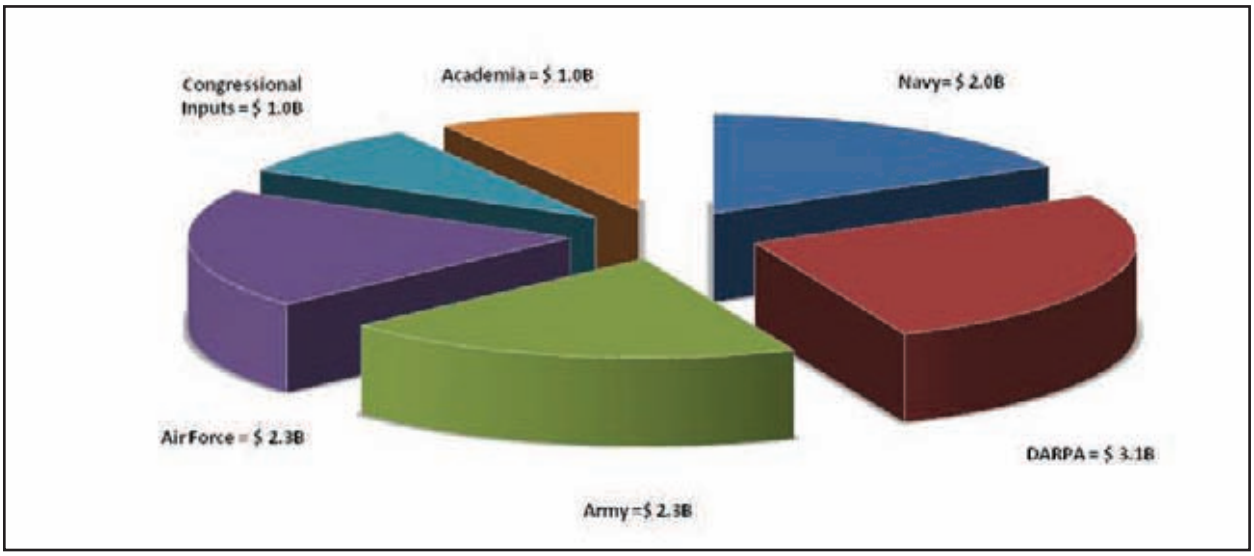


Figure 16 – Available S&T Funds in FY 12 = $11.7B

The best way to leverage this funding is though consistent, informed engagement across all "3 Circle" partners.

Transition of S&T initiatives into Programs of Record is the goal.

The Expeditionary Force Development System (EFDS)

Expeditionary Force Development System (EFDS) is the current Marine Corps process designed to allow for equipment fielding or doctrine/training changes. The goal of EFDS is to provide prioritized responsiveness in meeting the needs and challenges of modern day Warfighters. EFDS incorporates a phased approach encompassing "cradle-to-grave" methodology. EFDS may begin with a developmental concept and result in doctrine/training changes; or a material requirement that ends with the fielding of new equipment.

The EFDS process phases are: Capabilities Analysis; Solutions Analysis; Program Development, and Capabilities Implementation and Transition. Each phase has critical time periods when informed participation with key stakeholders and gatekeepers can shape the direction of program efforts and future POMs, providing a direct effect on capabilities. PEO LS will ensure active participation in all phases of the EFDS process.

Planning for Transition

In order to transition S&T capability initiatives, engagement within the total EFDS process is necessary. Through this informed engagement, PEO LS representatives will build program issue and situational awareness, support, and sponsorship with the key POM decision makers.
By ensuring issue and program awareness among "3 Circle" members, PEO LS S&T representatives will better ensure that technology transition is planned and accounted for at the appropriate point in the program schedule, limiting funding shortfalls and missed technology transition opportunities.

Total Ownership Cost (TOC)

Total Ownership Cost (TOC) is a concept designed to determine the true cost of design, development, ownership, and support of DoD weapons systems. At the DoD level, TOC is comprised of:

- The Costs of Research and Development
- The Cost to Acquire, Own and Operate
- The Costs to Recruit, Retain, Separate, and Support Military and Civilian Personnel
- The Cost of Disposing Defense Systems, Other Equipment, and Real Property
- All Other Associated Program Business Operations Costs

At the individual program level, TOC is synonymous with the Life Cycle Cost (LCC) of the system.

Over 85% of total program costs are incurred post Milestone C.

Traditional acquisition programs (Figure 17) incur the majority of their TOC costs post milestone C. This is a result of modifications, changes, technology insertions and in some cases Pre-Planned Product Improvement (P3I) efforts. Though necessary to extend the life and increase capabilities of programs, costs incurred to integrate technologies at the later stages of a program can be significant.

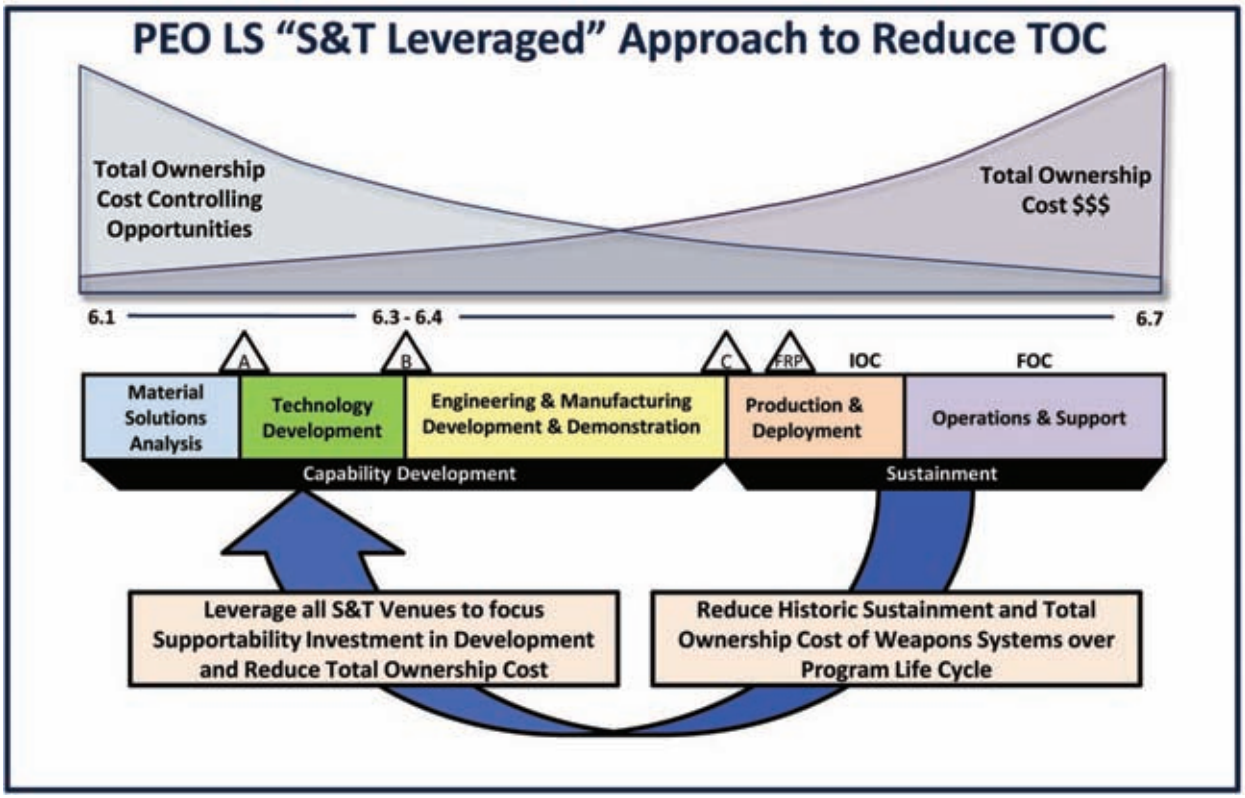


Figure 17 – PEO LS is Moving to a Focus on Total Ownership Costs.

S&T's impact on TOC

Through effective engagement of the S&T process, PEO LS S&T representatives can help indentify initiatives that result in solutions to problems and challenges not currently being explored by the programs. By identifying initiatives such as Modeling and Simulation (M&S) efforts and potential capability enhancements, design changes can be implemented early in the manufacturing process, thus limiting the costs of re-tooling and significantly reduce the cost of design changes commonly associated with modifications occurring post Milestone C.

In some cases, S&T technology insertion may help to reduce TOC of post MS C programs through upgrades and technology enhancements. An example would be a technology enhancement that improves the reliability of a vehicle. Besides increasing reliability, technology enhancements could also reduce maintenance (man hours), decrease the number of parts required to support a less reliable system (inventory) and extend the vehicle's useful life.

Keeping Program Managers informed of emerging technologies can further influence TOC by allowing PMs to design-in modular applications that will better facilitate technology insertion and integration upon maturity, negating the need for major system redesigns.

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Appendix C: References

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3. National Plan to Achieve Maritime Domain Awareness (2005)
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2. Concept for Unified Action through Civil-Military Integration (May 2009)

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4. Expeditionary Maneuver from the Sea (2008)
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8. MAGTF Solutions Planning Directive (POM 12)
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13. United States Marine Corps Concept and Programs (2008)
14. United States Marine Corps S&T IPT Charter (3 Jan 2007)
15. United States Marine Corps S&T Handbook (May 2007)

E. Web Links

1. ONR Web Links

   a. FNC: http://www.onr.navy.mil/Science-Technology/Directorates/Transition/Future-Naval-Capabilities-FNC.aspx
   b. SBIR at ONR: http://www.onr.navy.mil/Science-Technology/Directorates/Transition/SBIR-STTR.aspx
   c. SBIR at Navy: http://www.navysbir.com/
   d. MANTECH: http://www.onr.navy.mil/Science-Technology/Directorates/Transition/Manufacturing-ManTech.aspx
   e. RTT: http://www.onr.navy.mil/Science-Technology/Directorates/Transition/Technology-Transition-Initiatives-03TTX/Rapid-Technology-Transition-RTT.aspx
   f. SWAMPWORKS: http://www.onr.navy.mil/Science-Technology/Directorates/office-innovation/swampworks-innovation.aspx
   g. TECH SOLUTIONS: https://www.onrglobal.navy.mil/techsolutions/login.asp?backlink=/techsolutions/Default.asp

2. USMC Web Links

   a. Marine Corps Combat Development Command: https://www.mccdc.usmc.mil/
   b. Marine Corps Systems Command: http://www.marcorsyscom.usmc.mil/
   c. PEO Land Systems: http://www.marcorsyscom.usmc.mil/peolandsystems/
   d. Marine Corps Warfighting Lab: http://www.marines.mil/unit/mcwl/Pages/Welcome.aspx

Appendix D: Acronyms

AAO	Approved Acquisition Objective
AAV	Assault Amphibious Vehicle (Also known as AAV7A1)
ACAT	Acquisition Category
ACTD	Advanced Concept Technology Demonstration
ACV	Amphibious Combat Vehicle
ACMC	Assistant Commandant of the Marine Corps
ACVAD	Advanced Combat Vehicle Armor Development
AEMA	Advanced Electro-Magnetic Armor
AESA	Active Electronically Scanned Array
AFES	Automatioc Fire / Explosion Extinguishing System
AFV	Armored Fighting Vehicle
AMAS	Autonomous Mobility Appliqué System
AoA	Analysis of Alternatives
APC	Armored Personnel Carrier
APS	Active Protection System
APU	Auxiliary Power Unit
ARDEC	Army Research Development and Engineering Center
ARL	Army Research Lab
ASN (RDA)	Assistant Secretary of the Navy (Research, Development, and Acquisition)
ATF	Amphibious Task Force
ATGM	Air to Ground Missile
ATI	Advanced Technology Integrator
ATIP	Advanced Technology Investment Plan
AT&L	Acquisition, Technology & Logistics
ATO	Advanced Technology Objective
AVM	Advanced Vehicle Make
BA	Budget Authority
BAA	Broad Agency Announcement
BLUF	Bottom Line Up Front
C2	Command and Control
C4	Command, Control, Communication, and Computer Systems
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveil-lance, and Reconnaissance
CAC2S	Common Aviation Command and Control System
CAM	Composite Armor Modeling
CASSI	Concepts, Analysis, Systems, Simulations, and Integrations
CBM	Concept Based Maintenance

CD&I	Combat Development and Integration
CDD	Capability Development Document
CDR	Critical Design Review
CEG	Communications Electronics Group
CG	Commanding General
CIO	Chief Information Officer
CMC	Commandant of the Marine Corps
CMEI	Component Major End Item
CNR	Chief of Naval Research
COC	Combat Operations Center
COE	Centers of Excellence
COE	Common Operating Environment
COEI	Component of End Items
COP	Common Operational Picture
CEC	Cooperative Engagement Facility
CFFV	Clean Fuel Fleet Vehicle
COMMARFOR	Commander Marine Forces
CONOPS	Concept of Operations
CPP	Commercialization Pilot Program
CSTV	Combat Science and Technology Vehicle
C-RAM	Counter Rocket Artillery and Mortar
CS	Communications Subsystem
CS&CSS	Combat Support and Combat Service Support
CTO	Chief Technology Officer
D&I	Discovery & Invention
DAB	Defense Acquisition Board
DAC	Defense Acquisition Challenge
DARPA	Defense Advanced Research Projects Agency
DASC	Direct Air Support Center
DC	Deputy Commandant
DC, CD&I	Deputy Commandant, Combat Development and Integration
DDR&E	Department of Defense Research and Engineering
DFCS	Digital Fire Control System
DO	Distributed Operations
DoD	Department of Defense
DoN	Department of the Navy
DOTMLPF	Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities
DPM	Deputy Program Manager
DRR	Design Readiness Review

DSB	Defense Science Board
D-UUNS	Deliberate Urgent Universal Need Statement
E&D	Exploration and Development
EA, S&T	Executive Agent, Science & Technology
EC	Enabling Capability
ECO	Enhanced Company Operations
ECV	Expanded Capability Vehicle
ECP	Engineering Change Proposal
ED	Executive Director
EDM	Engineering Development Model
EFDS	Expeditionary Force Development System
EFP	Explosively Formed Penetrator
EFV	Expeditionary Fighting Vehicle
EM	Electro-Magnetic
EMD	Engineering and Manufacturing Development
EMO	Enhanced MAGTF Operations
EMW	Expeditionary Maneuver Warfare
EO	Electrical Optical
EOD	Explosive Ordinance Disposal
EPS	Expeditionary Power Systems
EW	Electronic Warfare
ExFOB	Expeditionary Forward Operating Base
FBCF	Fully Burdened Cost of Fuel
FCT	Foreign Comparative Test
FEA	Front End Analysis
FED	Fuel Efficient Ground Vehicle Demonstrator
FMS	Foreign Military Sales
FNC	Future Naval Capability
FOC	Full Operational Capability
FOV	Family of Vehicles
FRP	Full Rate Production
FRPD	Full Rate Production Decision
FWG	Functional Working Group
FY	Fiscal Year
FYDP	Future Year Defense Plan
G/ATOR	Ground/Air Task-Oriented Radar
GCE	Ground Combat Element
GCS	Ground Combat Systems
GCV	Ground Combat Vehicle
GPS	Global Positioning System

GS	General Support
GUI	Graphical user Interface
GunPACS	Gunslinger Package for Advanced Convoy Security
GVPM	Ground Vehicle Power and Mobility
GVW	Gross Vehicle Weight
GWOT	Global War on Terror
HEV	Hybrid Electric Vehicle
HEVEA	Hybrid Electric Vehicle Experimentation Assessment
HIMARS	High Mobility Artillery Rocket System
HMMWV	High Mobility Multipurpose Wheeled Vehicle
HQMC	Headquarters Marine Corps
IA	Information Assurance
IAP	Integrated Armor Package
IAR	Independent Applied Research, In-House Applied Research
ICD	Initial Capabilities Document
IDIQ	Indefinite Delivery, Indefinite Quantity Contract
IED	Improvised Explosive Device
IFAB	Instant Foundry Adaptive through Bits
ILIR	Independent Laboratory In-House Research
INP	Innovative Naval Prototype
IOC	Initial Operational Capability
IOT&E	Initial Operational Test & Evaluation
IPR	In Process Review
IPT	Integrated Product Team
IR	Infrared
IROAN	Inspect Repair Only As Necessary
ISG	Integrated Starter Generator
ISR	Intelligence, Surveillance, and Reconnaissance
ITV	Internally Transportable Vehicle
IVT	Infinitely Variable Transmission
JCTD	Joint Concept Technology Demonstration
JCGV	Joint Center for Ground Vehicles
JLTV	Joint Light Tactical Vehicle
JP	Joint Program
JPMO	Joint Program Management Office
JWC	Joint Warfighting Capability
KE	Kinetic Energy
KPP	Key Performance Parameter
LAM	Lightweight Armor Materials

LAV	Light Armored Vehicle
LCC	Life Cycle Cost
LCCE	Life Cycle Cost Estimate
LCM	Life Cycle Management
LDC	Limited Deployment Capability
LFTE	Live, Fire, Test and Evaluation
LRIP	Low Rate Initial Production
LSG	Lightweight Synchronous Generator
LVS	Logistics Vehicle System
LVSR	Logistics Vehicle System Replacement
LW155	Lightweight 155mm Howitzer
M&S	Modeling and Simulation
M2C2	Mobile Marine Command and Control
MAA	Mission Area Analyses
MACCS	Marine Air Command and Control System
MAGTF	Marine Air Ground Task Force
MAIS	Major Automated Information System
MANTECH	Manufacturing Technology
MARCENT	Marine Corps Forces Central Command
MARFORS	Marine Forces
MAS	MTVR Armor System
M-ATV	MRAP – All Terrain Vehicle
MC	Marine Corps
MCCDC	Marine Corps Combat Development Command
MCL	MAGTF Capabilities List
MCM	Mine Countermeasures
MCOTEA	Marine Corps Operational Test and Evaluation Activity
MCSC	Marine Corps Systems Command
MCTL	Military Critical Technologies List
MCTAGS	Marine Corps Transparent Armor Gun Shield
MCWL	Marine Corps Warfighting Lab
MDA	Milestone Decision Authority, Maritime Domain Awareness
MDAPS	Major Defense Acquisition Programs
MDD	Material Development Decision
MEB	Marine Expeditionary Brigade
MEF	Marine Expeditionary Force
MEU	Marine Expeditionary Unit
MGL	MAGTF Gap List
MIO	Maritime Interception Operation

MOA	Memorandum of Agreement
MOC	Marine Corps Operating Concept
MPC	Marine Personnel Carrier
MPS	Maritime Prepositioned Ships
MRAP	Mine Resistant Armor Protected
MROC	Marine Requirements Oversight Council
MS	Milestone
MTVR	Medium Tactical Vehicle Replacement
MVP	Modular Vehicle Platform
NaIL	Naval Innovation Laboratory
NAC	National Automotive Center
NATC	Nevada Automotive Test Center
NMS	National Military Strategy
NOC	Naval Operations Concept
NRAC	Naval Research Advisory Committee
NRE	Naval Research Enterprise
NRL	Naval Research Laboratory
NRMM	NATO Reference Mobility Model
NSWC	Naval Surface Warfare Center
NUCLEUS	Networked User Control of Locally Embedded and Unique Systems
NWDC	Navy Weapons Development Command
OBVP	On-Board Vehicle Power
OCO	Overseas Contingency Operations
OEF	Operation Enduring Freedom
OEM	Original Equipment Manufacturer
OIF	Operation Iraqi Freedom
OMFTS	Operational Maneuver from the Sea
ONR	Office of Naval Research
OPNAV	Office of the Chief of Naval Operations
O&S	Operation and Sustainment
OSD	Office of the Secretary of Defense
OT&E	Operational Test and Evaluation
P&D	Production and Deployment
P3I	Preplanned Product Improvement
PDR	Principal Design Review
PDS	Processing and Display Subsystem
PE	Program Element
PEO CS&CSS	Program Executive Office Combat Systems and Combat Support Systems
PEO LS	Program Executive Officer Land Systems

PG	Product Group
PGD	Product Group Director
PIP	Product Improvement Program
PO	Program Officer
POA&M	Plan of Action & Milestones
POM	Program Objectives Memorandum
PoR	Program of Record
PM	Program Manager
PMC	Procurement Marine Corps
PMT	Project Management Team
PP&O	Plans, Policies and Operations
PPBES	Planning, Programming, Budgeting and Execution System
PPE	Personal Protective Equipment
PVT	Production Validation Test
QRF	Quick Reaction Fund
R&D	Research & Development
RAM	Reliability, Availability, and Maintainability
RAP	RPG Active Protection
RCIP	Rapid Capacity Insertion Process
RDA	Research Development and Acquisitions
RDD	Rapid Development and Deployment
RDECOM	Research, Development, and Engineering Command
RDT&E	Research, Development, Test, & Evaluation
RO	Requirements Officer
SA	Situational Awareness
SBIR	Small Business Innovation Research
SCTVC	Small Combat Tactical Vehicle Capsule
SD	System Demonstration
SDD	System Development and Demonstration
SDS	Sensor Data Subsystem
SE&I	System Engineering & Integration
SE&TO	Systems Engineering & Technology Office
SECNAV	Secretary of the Navy
SI	System Integration
SIAT	System Engineering, Interoperability, Architecture and Technology
SIL	Systems Integration Lab
SIPR	Secure Internet Protocol Router Network
SLEP	Service Life Extension Program
SME	Subject Matter Expert

SON	Statement of Need
SoS	System of Systems
SOW	Statement of Work
SPAWAR	Space and Naval Warfare Systems Command
SPD	Systems Planning Document
SSEB	Source Selection Evaluation Board
STO	Science & Technology Objective
STOM	Ship-to-Objective Maneuver
STTR	Small Business Technology Transfer
SVR	System Verification Review
T&E	Test & Evaluation
TACC	Tactical Air Command Center
TACOM	US Army Tank Automotive and Armaments Command
TAOC	Tactical Air Operations Center
TARDEC	US Army Tank Automotive Research, Development and Engineering Center
TD	Technology Development
TECOM	Training and Education Command
TGV	Tactical Ground Vehicle
TIP	Technology Insertion Program
TIPS	Technology Insertion Program for Savings
TOA	Total Obligation Authority
TOC	Total Ownership Cost
TOG	Technology Oversight Group
TOSOM	Threat Oriented Survivability Optimization Model
TRA	Technology Readiness Area
TRL	Technology Readiness Level
TTA	Technology Transition Agreement
TTCP	Technology Transfer Control Plan
TTI	Technology Transition Initiative
TWV	Tactical Wheeled Vehicle
UAV	Unmanned Aerial Vehicle
ULV	Ultra Light Vehicle
UNS	Universal Need Statement
USA	United States Army
USAF	United States Air Force
USD AT&L	Office of the Under Secretary of Defense Acquisition, Technology and Logistics
USMC	United States Marine Corps
UUNS	Urgent Universal Need Statement

VCSA	Vice Chief of Staff of the Army
VCNO	Vice Chief of Naval Operations
VEA	Vehicle Electronics Architecture
VICTORY	Vehicular Integration for C4ISR/EW Interoperability
WIAMAN	Warfighter Injury Assessment Manikin

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Appendix E: Glossary of Terms

Army Technology Objectives (ATO)
To provide guidance to the S&T community, the Army has established a set of 200 Science and Technology Objectives (STO). A STO states a specific, measurable, major technological advancement to be achieved by a specific fiscal year. It must be consistent with the funding available in the current year budget, the Future–Years Defense Plan (FYDP) and the Program Objective Memorandum (POM).

Concepts
Visionary statement that describe operating approaches for addressing the challenges and opportunities for future warfighting. By design, concepts are broad and intended to spur debate: concepts state what we want to accomplish in future operations, not how to do so.

Command and Control (C2)
The exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission

CONOPS
Illustrative statements of operational/tactical roles, missions and activities of those elements for which we want to identify key problem areas. Concepts state what we want to accomplish, a CONOPS provides a method for how (…but not the only method).

Defense Acquisition Board (DAB)
The Department's senior-level forum for advising the Under Secretary of Defense (Acquisition, Technology and Logistics) (USD (AT&L)) on critical decisions concerning Acquisition Category (ACAT) ID programs. The DAB is composed of the Department's senior acquisition officials.

Full Operational Capability (FOC)
In general, attained when all units and/or organizations in the force structure scheduled to receive a system 1) have received it and 2) have the ability to employ and maintain it. The specifics for any particular system FOC are defined in that system's Capability Development Document and Capability Production Document.

Full Rate Production (FRP)
Contracting for economic production quantities following stabilization of the system design and validation of the production process.

Full Rate Production and Deployment (FRP&D)
The second effort of the Production and Deployment (P&D) phase defined and established by

DoDI 5000.2. This effort follows a successful Full Rate Production Decision Review (FRPDR). The system is produced at rate production and deployed to the field or fleet. This phase overlaps the Operations and Support (O&S) phase since fielded systems are operated and supported (sustained) while Full Rate Production (FRP) is ongoing.

Future Naval Capability (FNC)
A program within Office of Naval Research (ONR) to align with the pillars of the Chief of Naval Operations' and the Commandant of the Marine Corps' vision for the future—Naval Power 21—and to focus on providing Enabling Capabilities (ECs) to close warfighting gaps. The FNC program provides the technology solutions to stated Office of the Chief of Naval Operations (OPNAV) requirements by bundling discrete but interrelated S&T products that deliver a distinctly measurable improvement within a five-year time frame.

Initial Operational Capability (IOC)
The first attainment of the capability to employ effectively a weapon, item of equipment, or system of approved specific characteristics that is manned or operated by an adequately trained, equipped, and supported military unit or force.

Initial Operational Test and Evaluation (IOT&E)
Dedicated Operational Test and Evaluation (OT&E) conducted on production, or production representative articles, to determine whether systems are operationally effective and suitable, and which supports the decision to proceed Beyond Low Rate Initial Production (BLRIP).

Key Capabilities
Describe high-priority problems, and what is necessary to overcome these problems. Can include both needs and opportunities. A capability should describe a specific battlefield function or task, with associated metrics that can be achieved by a series of specific implementing ideas.

Life Cycle Cost (LCC)
The total cost to the government of acquisition and ownership of a system over its useful life. It includes the cost of development, acquisition, operations, and support (to include manpower), and where applicable, disposal. For defense systems, LCC is also called Total Ownership Cost (TOC).

Life Cycle Management (LCM)
A management process applied throughout the life of a system that bases all programmatic decisions on the anticipated mission-related and economic benefits derived over the life of the system.

Live Fire Test and Evaluation (LFT&E)
A test process to evaluate the vulnerability and/or lethality aspects of a conventional weapon or conventional weapon system. LFT&E is a statutory requirement (Title 10 U.S.C. § 2366) for covered systems, major munitions programs, missile programs, or product improvements to a covered system, major munitions programs, or missile programs before they can proceed Beyond Low Rate Initial Production (BLRIP). By law, a covered system is any vehicle, weapon platform,

or conventional weapon system that includes features designed to provide some degree of protection to users in combat and that is an Acquisition Category (ACAT) I or ACAT II program.

Low Rate Initial Production (LRIP)
The first effort of the Production and Deployment (P&D) phase. The purpose of this effort is to establish an initial production base for the system, permit an orderly ramp-up sufficient to lead to a smooth transition to Full Rate Production (FRP), and to provide production representative articles for Initial Operational Test and Evaluation (IOT&E) and full-up live fire testing. This effort concludes with a Full Rate Production Decision Review (FRPDR) to authorize the Full Rate Production and Deployment (FRP&D) effort.

Marine Air Ground Task Force (MAGTF)
The Marine Corps principal organization for all missions across the range of military operations, composed of forces task-organized under a single commander capable of responding rapidly to a contingency anywhere in the world. The types of forces in the Marine air-ground task force (MAGTF) are functionally grouped into four core elements: a command element, an aviation combat element, a ground combat element, and a combat service support element. The four core elements are categories of forces, not formal commands. The basic structure of the MAGTF never varies, though the number, size, and type of Marine Corps units comprising each of its four elements will always be mission dependent. The flexibility of the organizational structure allows for one or more subordinate MAGTFs to be assigned. Also called MAGTF.

MAGTF Capability List (MCL)
The Commandant's Planning Guidance (CPG) is applied to the Expeditionary Maneuver Warfare (EMW) Capability List (ECL) to arrive at a prioritized list of warfighting gaps and shortfalls identified in the Functional Needs Analysis (FNA). This prioritized list is the MCL and it is used as a basis for the Marine Corps S&T Strategic Plan.

MAGTF Gap List. (MGL)
A prioritized list of USMC capability gaps, organized by Warfighting Functions.

Marine Corps Task List (MCTL)
The standardized, doctrinally based, lexicon of Marine Corps tasks required for reporting all combat missions, contingency operations capabilities and readiness. It supports warfighting by providing a common language for development of readiness reporting and defines capability requirements for combat development.

META
Meta takes its name from the goal of developing tools to create a "meta-representation" of a system that captures the detailed design at varying levels of functional and logical abstraction. These tools would enable engineers to combine the system requirements with a library of component models to produce a set of feasible designs that could be assessed for their complexity.

Milestone (MS)
The point at which a recommendation is made and approval sought regarding starting or continuing an acquisition program, i.e., proceeding to the next phase. Milestones established by DoDI 5000.2 are: MS A that approves entry into the Technology Development (TD) phase; MS B that approves entry into the System Development and Demonstration (SDD) phase; and MS C that approves entry into the Production and Deployment (P&D) phase.

Operational Tenets
Explain or catalog critical enabling aspects of the CONOPS. For example, if a CONOPS seeks to increase the force's area of influence, Tenets associated with that increase may further explain particular characteristics (e.g., extending senses, increasing fires range, etc.) or categorize areas.

S&T Investment Plan
Assessment of relative priorities, technical feasibility, risk, and affordability lead to technology projects comprising a multi-year S&T program. Resulting products are transitioned to the Warfighter directly (via PEO LS) or indirectly (via industry) or are evaluated for operational utility via experimentation.

S&T Objectives (STOs)
STOs are to S&T as capabilities are to concepts. They describe the high-priority technology enhancements needed to "close" operational gaps. STOs do not necessarily specify the technological solution, but they do specify what the technology developer needs to accomplish. STOs identify the priority objectives needed to implement the vision for the 21st century Marine Corps.

Source Selection Evaluation Board (SSEB)
A group of military and/or government civilian personnel, representing functional and technical disciplines, that is charged with evaluating proposals and developing summary facts and findings during source selection.

System Development and Demonstration (SDD)
The third phase of the life cycle as defined and established by DoDI 5000.2. This phase consists of two efforts, System Integration (SI) and System Demonstration (SD), and begins after Milestone B. It also contains a Design Readiness Review (DRR) at the conclusion of the SI effort. A successful Milestone B can place the program in either SI or SD. A program planning to proceed into SD at the conclusion of SI will first undergo a DRR to confirm that the program is progressing satisfactorily during the phase.

System Verification Review (SVR)
A multi-disciplined technical review to ensure that the system is ready to proceed into Low-Rate Initial Production and Full-Rate Production within cost (program budget), schedule (program schedule), risk, and other system constraints. Generally this review provides an audit trail from the Critical Design Review. It is synonymous with Functional Configuration Audit.

Technology Gap Analysis
Identifying key capabilities is, in effect, Operational gap analysis. Technology gap analysis seeks specific implementing actions to enable the capabilities. S&T related gap analysis seeks to identify implementing actions that can be accomplished by technology

Total Ownership Cost (TOC)
A concept designed to determine the true cost of design, development, ownership, and support of DoD weapons systems. At the DoD level, TOC is comprised of the costs to research, develop, acquire, own, operate, and dispose of defense systems, other equipment, and real property; the costs to recruit, retain, separate, and otherwise support military and civilian personnel; and all other costs of the business operations of the DoD. At the individual program level, TOC is synonymous with the Life Cycle Cost (LCC) of the system. See Life Cycle Cost.

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Appendix F: PEO LS Focus Areas

Linkage to Naval S&T Strategic Plan Focus Areas

PEO LS S&T
Focus Areas Linkage to
Naval S&T Strategic Plan
Focus Areas

PEO LS S&T Focus Areas	ONR Naval S&T Focus Areas												
	Power and Energy	Operational Environments	Maritime Domain Awareness	Asymmetric and Irregular Warfare	Information Superiority and Communication	Power Projection	Assure Access and Hold at Risk	Distributed Operations	Naval Warfighter Performance	Survivability and Self-Defense	Platform Mobility	Fleet/Force Sustainment	Total Ownership Cost
Power & Energy	X	X	X	X	X		X	X	X		X	X	X
Fuel Efficiency	X			X		X		X	X		X	X	X
Survivability & Mobility	X			X		X	X	X	X	X	X	X	X
Modeling & Simulation	X	X		X		X	X	X	X	X	X	X	X
Fuel Containment & Fire Suppression				X			X	X	X	X	X		X
Open Plug & Play Comms Architecture		X		X	X	X	X	X	X	X	X	X	X
Intelligent Power & Thermal Energy	X	X		X				X	X	X	X	X	X
Weight Reduction	X	X		X				X	X	X	X	X	X

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"Focus The Future Faster"