TARDEC 30-YEAR STRATEGY

v2.0
March 2016

PREFACE

This document summarizes the overarching priorities and goals of the U.S. Army Tank Automotive Research Development and Engineering Center (TARDEC). The previous version of this strategy introduced the current landscape and shifting priorities of the U.S. Army and divided the mission of TARDEC into three distinct sections, or Value Streams. During the execution of the TARDEC 30-Year Strategy v1.0, it became apparent that the alignment of tasks under each Value Stream was challenging for both our employees and stakeholders to relate to. Version 2.0 was restructured to provide greater clarity and focus while keeping the familiar format of the previous version.

With a new title of "Shape the Future Force," Value Stream 1 remains largely unchanged with the addition of one new Line of Effort titled, "Maneuver Support, Sustainment and Logistics Optimization." Also, Capability Demonstrations were updated and brought under Value Stream 1 to emphasize that while the products of a Capability Demonstration could support a current program, these efforts were intended to demonstrate the potential effect that emerging capabilities could have on the future Army, from doctrine to policy.

Value Stream 2, retitled "Support Systems Across the Acquisition Life Cycle," pulls elements from the previous Value Streams 2 and 3 to create a cohesive outline of engineering support that TARDEC provides to the Army's current ground systems. TARDEC has historically been closely aligned with the Tank Armaments Command (TACOM) Life Cycle Management Command (LCMC) and this update to Value Stream 2 seeks to clearly identify the TARDEC functions which provide the TACOM LCMC with the technologies and services that current systems require.

A significant gap in the previous strategy was realized when we considered the question, "What is the foundation that supports work being done in Value Streams 1 and 2?" The new Value Stream 3, "Strengthen Foundational Competencies," is TARDEC's core purpose. Value Stream 3 is the strategy for developing our people, processes, and the tools required to accomplish our goals in Value Stream 1 and Value Stream 2. We recognize that the development of these core technical and non-technical competencies must be addressed to uphold TARDEC's ability to provide superior support to the Warfighter. Future versions of the strategy will continue to refine the goals of Value Stream 3.

In summary, the TARDEC 30-Year Strategy v2.0 should contain many familiar components. We have rearranged these components into a more relatable structure, while maintaining the integrity of the previous version. We hope that this strategy will continue to guide decisions about the future of the U.S. Army and the role that TARDEC will play.

CONTENTS

I. PURPOSE

The purpose of this document is to provide the overarching framework within which the Tank Automotive Research, Development and Engineering Center (TARDEC) will develop, integrate and sustain advanced manned and unmanned ground system capabilities for the current and future force. This document is the single source that presents TARDEC's strategic context and future direction.

II. INTRODUCTION

TARDEC is the ground system expert within the Army's Research, Development and Engineering Command (RDECOM). It provides engineering and scientific expertise for Department of Defense (DoD) manned and autonomy-enabled ground systems and ground support systems; serves as the nation's laboratory for advanced military automotive technology; and provides leadership for the Army's advanced Science and Technology (S&T) research, demonstration, development and full life-cycle engineering efforts.

TARDEC is also a part of the TACOM Life Cycle Management Command (LCMC). In this capacity, it is responsible for critical technical functions within the "acquisition – logistics – technology" system life-cycle model, including: technology maturation and integration, technology subject-matter expertise, technical authority, systems-level engineering analysis and systems engineering. These functions must ensure that all capability developments consider and inform strategic implications to the joint force across the Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities and Policy (DOTMLPF-P) spectrum.

TARDEC associates provide engineering support for more than 2,800 Army systems and many of the Army's and DoD's high priority joint development programs. The organization is responsible for maximizing the research, development, prototype production, transition and sustainment of technologies and their integration across ground systems to provide Warfighters enhanced capabilities.

III. CONTEXT

This strategy is shaped through enduring partnerships with the Training and Doctrine Command (TRADOC), Army Materiel Command, the Army's research, development and engineering community, S&T organizations across DoD, other federal agencies, industry (particularly automotive), academia, and international partners. Continuous S&T planning efforts also inform this strategy, including the Long-range Investment Requirements Analysis (LIRA) conducted by the Office of the Assistant Secretary of the Army for Acquisition, Logistics and Technology (ASA

(AL&T)) and the Army G8, the Long Range Research and Development Planning Program (LRRDPP) conducted by the Office of the Secretary of Defense (OSD), and OSD Communities of Interest (COI), particularly the Ground & Sea Platforms COI.

This strategy also addresses changes in America's strategic, technological and fiscal environments, following more than a decade of intense conflict and the Army's adjustment to a broader, joint-mission focus in which the Army integrates joint force efforts to provide direct interface to all aspects of National Power.

Strategic Environment. Recent national-level defense guidance and current world events portend an uncertain future movement out of a known conflict into an environment in which "the enemy is unknown, the location is unknown and the coalitions involved are unknown," (*TRADOC Army Operating Concept*, PAM 525-3-1), meaning that the U.S. Army must be able to respond to a greater scope of missions at a moment's notice.

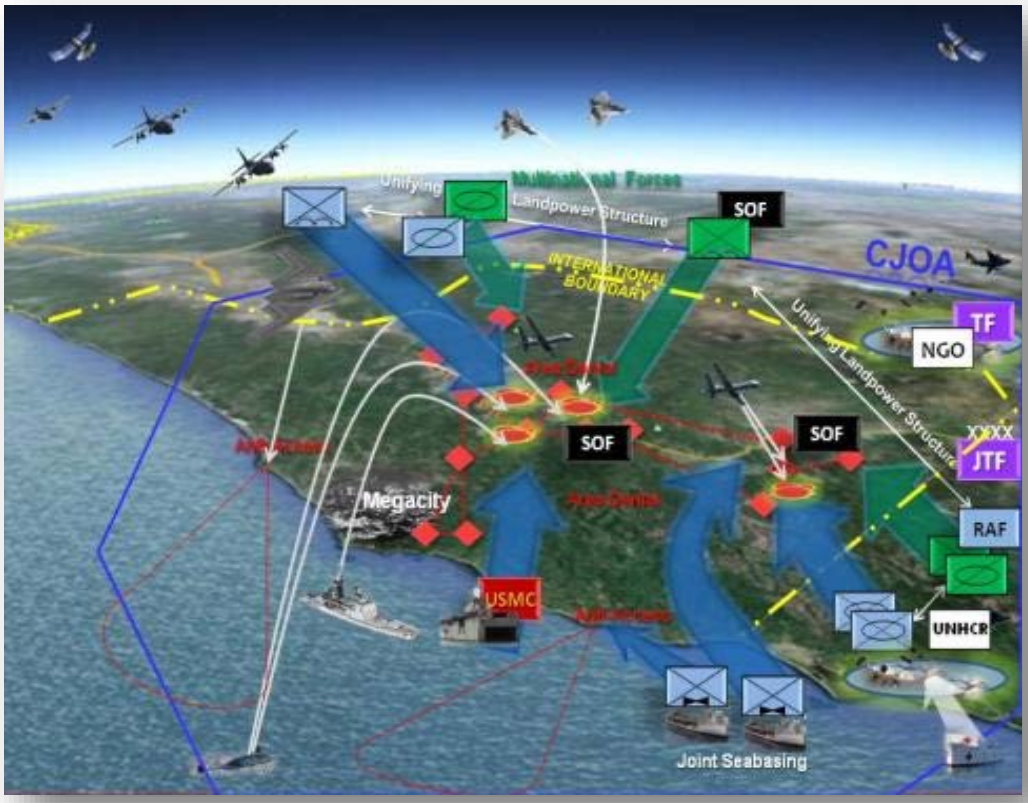

Figure 1: Win in a Complex World. In the future the United States has to anticipate all domains being contested while working with an undefined and constantly changing coalition. (*Army Operating Concept* and *Force 2025 & Beyond*, 2014)

As the strategic environment changes, so must TARDEC. One of the themes in this strategy is the concept of *operational adaptability* — the ability for Army leaders, Soldiers, and civilians to shape

conditions and respond effectively to a broad range of missions and situations with appropriate, flexible and responsive capabilities. Operational adaptability requires flexible organizations and institutions to support a wide variety of missions and adjust focus rapidly to prevent conflict, shape the security environment, and win the nation's wars. TARDEC's strategy supports the development and rapid enhancement of equipment that will enable appropriate, flexible and responsive capabilities to provide decisive land power. It also requires TARDEC to be flexible and adaptable so it may rapidly facilitate acquisition processes by having readily available systems, sub-systems, and component designs for changing strategic and tactical circumstances.

Technological Environment. TARDEC must be able to address the proliferation of increasingly sophisticated technologies such as advanced communications, a range of cyber-related challenges, unmanned air and ground systems and non-lethal weapons operated by allies and enemies. Additionally, TARDEC must increase the rate of in-house innovation and leverage the rate of innovation in the commercial sector to bridge a growing capability gap between commercial and military technologies. The organization must change how it approaches traditional ground systems research and development (R&D) by focusing on components, sub-systems, full systems and system architectures which fully exploit commercial advances through existing and new collaborative partnerships.

Fiscal Environment. A significant challenge for TARDEC will be how to navigate the current austere financial and economic environment. After more than a decade of constant growth and investment in defense, the Defense Department now must plan for fiscal reductions over the next decade.

While the United States remains the preeminent global power, it will continue to confront numerous adversaries that may require it to rapidly deploy forces anywhere at any time. Furthermore, global economic conditions are forcing the country and military organizations to make difficult fiscal choices. These contextual factors create the need for TARDEC to develop adaptable and flexible capabilities that deliver long-term value to the Army while leveraging commercial innovation and partner resources in order to maximize cost effectiveness and accommodate increases in complexity, uncertainty and scope of future operations.

IV. STRATEGIC FRAMEWORK

A. MISSION

TARDEC's mission is to develop, integrate and sustain the right technology solutions for all manned and unmanned DoD ground systems and combat support systems to improve Current Force effectiveness and provide superior capabilities for the Future Force.

B. VISION

TARDEC's vision is to be the first choice of technology and engineering expertise for ground vehicle systems and support equipment – today and tomorrow.

Overall, TARDEC's vision supports the Army's strategic direction by resolving challenges, fiscal constraints, and Army priorities in a manner that strives to provide enduring value to ground systems. TARDEC aims to help the Army achieve enduring value through a number of means, many of which are interrelated. These include: (1) developing and demonstrating advanced and cost-effective capabilities for the Warfighter; (2) maximizing adaptability and flexibility of current and future platforms to maintain technological superiority; (3) reducing manpower, logistics and similar burdens on the battlefield; (4) improving operating efficiencies, such as reductions in space, weight, power, and cooling requirements and reducing fuel and energy consumption for ground systems; and (5) developing the systems engineering services that fully support the full product life cycle from concept to sustainment. Each of these means also requires the associated aim of investing in the infrastructure (people, processes and tools) to increase the rate at which these capabilities may become available to the Warfighter.

TARDEC builds trust by gaining a thorough understanding of stakeholders' needs, and then by providing the products and services to meet those needs. Historically, TARDEC's stakeholders have leveraged TARDEC's Technical Authority in several key ground vehicle competencies such as Combat Vehicle Propulsion, Fire Suppression and Sustainment Engineering. This technical authority extends from the development of new technologies to the integration of sub-systems and full systems, and includes all engineering support services such as technical data management and technical review expertise. To better serve TARDEC's stakeholders in the future, TARDEC will sustain existing technical authority areas and continue to mature towards technical authority in critical emerging areas that include Autonomy-Enabled Systems, Vehicle Security Engineering, and Active Protection Systems. In addition, stakeholder needs change consistently; in some cases those needs are the mission of other RDECOM organizations. In these instances, it is critical for TARDEC to be the ground vehicle entry point into the expertise of RDECOM to bring the full weight of the command to solve current vehicle challenges and provide a system-level solution to the program/product manager (PM).

The vision is supported by four-themes of TARDEC's strategy that are pervasive throughout all efforts. These themes are defined below:

a) **FLEXIBLE:** Flexible systems have many ways to accomplish a particular mission.
b) **ADAPTABLE:** Adaptable systems are able to rapidly change the way they are deployed to accomplish their missions, optimizing for the current environment.
c) **MODULAR**: Modularity in this context is a design that enables the tailorability of system components and mission packages.
d) **SMART:** Smart systems use autonomous capability to reduce the physical and cognitive burden on the Soldier.

TARDEC's vision is also aligned to the organization's cultural identity – five key tenets by which TARDEC associates collectively characterize the values, norms and way of life in the organization. The elements of TARDEC's cultural identity are:

- **Excellence in Program Execution**: TARDEC embodies an engineering culture founded on systems engineering and program management best practices. Stakeholders recognize the organization for its technology and engineering excellence.
- **Preferred Source for Ground System Life Cycle Engineering**: TARDEC is the recognized conduit to the greater RDECOM ground maneuver capability. It is the trusted and valued partner for collaboration with the other research, development, and engineering centers (RDECs) and the Army Research Laboratory (ARL).
- **Center of Innovation**: TARDEC rapidly generates new ideas and shapes them into advanced capabilities and solutions.
- **Committed to Employee Development**: TARDEC continuously develops its people to be the very best in their fields.
- **Workplace of Choice**: TARDEC's workforce exhibits ownership in what the organization is doing.

C. APPROACH

In order to organize the major areas of effort within TARDEC and to align the supporting efforts necessary to accomplish this work, TARDEC has defined the following terms that will be used: Value Streams (VSs), Lines of Effort (LOEs), Key Outcomes (KOs), and Capability Demonstrations (CDs). Each of TARDEC's three VSs contain LOEs which are meant to further subdivide and define the responsibilities of the VS. LOEs contain KOs which serve as goals and objectives of each LOE. These KOs may be technical in nature, or they may outline strategic plans for interacting with stakeholders. The CDs integrate elements from several areas of the strategy as appropriate.

TARDEC has three **Value Streams** (VSs) that serve as the divisions of the end-to-end activities which, ultimately, deliver required products or services to Soldiers. The first value stream (VS1) entitled "*Shape the Future Force*," focuses on developing new concepts and capabilities to inform requirements of the future force. The second value stream (VS2) serves to "*Support Systems Across the Acquisition Life Cycle*" and focuses on providing the engineering and technology support required for ground systems as they are realized, upgraded or sustained. Lastly, the third value stream (VS3) is entitled "*Strengthen Foundational Competencies*" and focuses on strategically improving TARDEC's core technical and non-technical competencies; the people, processes and tools which support all of TARDEC's stakeholders through deliverables in VS1 or VS2. All three VS's are integrated in ways that provide unprecedented value and capability to the Army.

Lines of Effort (LOEs) are subordinate to each VS and enable their respective VS by focusing associated programs and strategic goals within each VS. LOE owners develop and manage objectives that target delivery-oriented outcomes and capability demonstrations. In turn, they ensure aligned programs achieve their objectives and contribute to the strategy's execution. This process focuses on what must be done, unifies efforts and supports task organization to achieve desired outcomes.

Within each LOE are deliverables, **Key Outcomes** (KOs), which may take the form of experiments, models, designs, information, hardware, and/or strategic deliverables. KOs are shaped by LOE goals, capability gaps, stakeholder feedback, strategic documents, and leadership direction. Some outcomes may support more than one VS, LOE or CD.

Capability Demonstrations (CDs) focus on holistic integration of various components (technology solutions, knowledge, skills, etc.) from across the three VS's to demonstrate a warfighting capability that informs the development of future Army requirements; as such, the CDs are housed within VS1. CDs drive future ground system concepts, technology investments and engineering development. In turn, these help to shape strategic decisions about the future force and existing platform upgrades. Some CDs may be delivered as physical or virtual demonstrations to integrate outcomes if that is the most appropriate method. Throughout strategy execution, there will be continuous feedback to inform ground system concepts and developments that support desired outcomes.

V. VALUE STREAMS

VALUE STREAM 1 (VS1):
SHAPE THE FUTURE FORCE

The focus of VS1 is to shape the future force by informing the requirements processes that define the future direction of Army ground systems. This is accomplished by working closely with TRADOC and developing new capabilities that are enabled by leap-ahead, innovative, modular, flexible, smart, and adaptable technologies and architectures to demonstrate the art of the possible and to influence considerations across the entire DOTMLPF-P. VS1 will rely on foundational competencies from VS3 in order to rapidly provide cutting edge technology, data and expertise to shape future ground system requirements. New capabilities that are demonstrated during execution of VS1 efforts will be assessed for transition to VS2 for integration on current platforms.

As the current conflicts draw down and the Army prepares for future missions, a renewed emphasis will be placed on the S&T community to develop technologies and capabilities that allow the Warfighter to respond quickly in environments that are unknown, but unknowable and constantly changing. In addition, future fiscal austerity measures will force any proposed new platforms to maximize their return on investment by providing leap-ahead (rather than evolutionary) increases in capability and demonstrate their ability to remain operationally relevant over extended periods of time.

TARDEC will continue to realize many of these new capabilities as virtual and/or physical prototype demonstrations within current and future CDs. The list of CDs have been developed based on critical Army future requirements, current trends in S&T research and leadership guidance. TARDEC executives, operational leaders, and strategic planners have prioritized the CDs and numerous supporting initiatives that align to this strategy. The organization has outlined a process to engage these efforts while gathering feedback from senior DA leaders, stakeholders and other partners. Some CDs are currently active, others are in planning stages or will be

executed at a future date as technology advancement and resources allow. Active CDs are noted by the year in which program plans and/or demonstrator concepts were developed.

The CDs that TARDEC has identified are:

- **CD1:** Demonstrate critical combat vehicle subsystems required to support future combat vehicle programs of record (PORs). (2013-present)

- **CD2:** Demonstrate a battlefield fuel reduction and water generation capability to reduce the logistics burden. (2013-present)

- **CD3:** Demonstrate an operationally relevant, air-droppable, light ground combat vehicle capability. (2015-present)

- **CD4:** Demonstrate multi-role, reconfigurable platforms with interchangeable mission modules for maximum flexibility, scalability and adaptability. (2013-present)

- **CD5:** Demonstrate unmanned vehicles capable of maneuvering with mounted and dismounted units. (2014-present)

- **CD6:** Demonstrate integrated 360° situational awareness capability in ground vehicle closed-hatch operations, potentially with reduced crew numbers and reduced Soldier cognitive burden. (2016-present)

- **CD7:** Demonstrate beyond-line-of-sight (BLOS) mission command of autonomy- enabled technologies that extend the reach of the Warfighter above, on and below ground. (2015-present)

- **CD8:** Demonstrate ground vehicle architectures and technologies designed to allow the vehicle to function "as a member of the squad." (Future)

- **CD9:** Demonstrate robust cyber-secured ground vehicle architecture and integrated technologies designed to operate in noisy, complex and hostile electromagnetic and cyber environments. (Future)

- **CD10:** Demonstrate the capability to detect and respond to a variety of threats using onboard and external sources on a single platform and on multiple cooperative platforms. (Future)

- **CD11:** Demonstrate enhanced multi-modal mobility capabilities which provide novel and unconventional solutions to operate in a broad spectrum of challenging environments. (Future)

- **CD12:** Demonstrate the capability to conduct unit resupply and sustainment operations using optionally-manned and unmanned vehicles. (2013-present)

- **CD13:** Demonstrate advanced signature management capability on ground systems. (Future)

- **CD14:** Demonstrate the use of intuitive ground vehicle user interfaces and vehicle-embedded training to reduce the Soldier's cognitive burden, reduce specialized vehicle training and enhance Soldier performance on ground systems. (Future)

The VS1 LOEs represent the technology areas with the highest potential to ensure the enduring value of future ground systems and enable many of the ongoing and future CDs. Specifically, these areas were selected based on: (1) potential "order of magnitude" technological advances; (2) potential future force and system contributions to capability developments across the RDECOM Ground Maneuver Portfolio; and (3) alignment to the TARDEC vision of developing and integrating revolutionary capabilities.

The five VS1 LOEs are:

- **LOE 1.1:** Autonomy-Enabled Systems
- **LOE 1.2:** Ground System Architecture
- **LOE 1.3:** Protected Mobility
- **LOE 1.4:** Power Density and Energy Efficiency
- **LOE 1.5:** Maneuver Support, Sustainment and Logistics Optimization

LOE 1.1: AUTONOMY-ENABLED SYSTEMS

Description. The Army S&T Community has adopted the goal to employ autonomy-enabled systems technologies which support the Soldier in every aspect of their life. This goal is detailed in the Robotic and Autonomous Systems (RAS) Strategy and is linked very closely to the objectives of this LOE. Recent military operations have demonstrated the potential tactical value of UGS and other autonomy-enabled systems – specifically for Explosive Ordnance Disposal (EOD) missions and route clearance operations in the Iraq and Afghan theaters. The systems used for these functions have been predominantly, if not exclusively, tele-operated or remote controlled requiring full-time oversight from Soldiers, Marines or Airmen, placing significant cognitive workload upon the operators and denying many of those operators their usual situational awareness. TARDEC aims to minimize the cognitive burden and physical workload through the addition of autonomy-enabled systems into the Army's ground system fleet.

TARDEC will create viable autonomy-enabled systems and expedite the process of capability integration through the use of early adopters, Soldier experimentation and robots on military bases. To foster accelerated development, these S&T "push" pathways will provide the operational Army the needed capabilities using autonomy-enabled system technologies. It stresses the use of "living laboratories," illustrated in the Autonomous Robotics for Installation and Base Operations (ARIBO) concept; early adopter usage, specifically by the Special Forces communities; and the traditional method of Soldier testing, demonstration and shake-down for

concept of operations (CONOPS) and technology transfer program (TTP) development. Ultimately, these pathways will assist in shaping requirements for future PORs and overall usage and acceptance into the force structure. TARDEC will also ensure that autonomy-enabled systems take into account cybersecurity during S&T pathways to ensure that cybersecurity is addressed during all stages of technology and system development.

Autonomy-enabled systems are force multipliers and afford combatant commanders greater operational flexibility by allowing machines to assume challenging and dangerous tasks, in turn, allowing Soldiers to focus on other aspects of the mission. This LOE aims to ease overburdened Soldiers in small units and reduce logistics burden of storing, transporting, distributing, and retrograding materials.

Key Outcomes. As described in this section, LOE 1.1 employs an S&T "push" strategy by leveraging three distinct pathways for effective transitions. To accomplish this, an evolutionary approach is taken to define the key outcomes for the next 30 years through demonstration or experimentation with respect to requirements:

- VS1 – LOE1 – KO1 (1.1.1): Demonstrate control methodologies of unmanned ground assets from distant, remote locations to increase stand-off to reduce risk to Soldiers.
- VS1 – LOE1 – KO2 (1.1.2): Deploy/operate a long-range, multi-mission capable unmanned system to extend the Soldiers' reach.
- VS1 – LOE1 – KO3 (1.1.3): Demonstrate unmanned convoy operations to support global logistical resupply operations to reduce Soldiers' burdens.
- VS1 – LOE1 – KO4 (1.1.4): Develop autonomous systems with a high degree of inherent mobility to augment Soldiers' mission capability.
- VS1 – LOE1 – KO5 (1.1.5): Demonstrate a seamless collaborative manned/unmanned system that integrates robotic, lethality, survivability, power and Mission Command (MC) technologies into a lightweight, mobile and deployable combat system for global operations.

LOE 1.2: GROUND SYSTEM ARCHITECTURE

Description. The purpose of the Ground System Architecture LOE is to define the standards for how systems should be designed, how they communicate to other vehicle systems and to systems external to a single platform, and to deliver representative system level designs that reduce future demands on development and integration. Architectures for ground systems can be divided into the following domains:

- Networks
- Computing resources
- User interface
- Electrical power

- System intelligence
- Physical structures

Use of these domains enable engineers to model various concerns, in turn enabling designers to make better technical choices in system design that address the operational, functional and performance requirements for the overall system. Common concerns may include: “How open is my system?”; “Does it comply with mandated standards?” and “Does it address the design constraints of size, weight, power and cooling?” LOE 1.2 will primarily focus on investigating the application and integration of advanced technologies that could enable new capabilities for future system designs, and how the domains listed above must evolve over time. In this context, architectures are used to model a particular component, subsystem or system design.

Through partnering with TRADOC, the capturing of future concepts and the supporting technology roadmaps will result in better defining and shaping architecture requirements for future PORs.

The development of system architectures critical for maximizing the adaptability and flexibility of vehicle platforms as it enables greater modularity and commonality across the future fleet and provides the power infrastructure for future capabilities. The intent is to make adding, upgrading and swapping components, subsystems and systems software elements faster, easier, and cheaper. System architecture development enables the efficient integration of all new technologies and reduces the future life cycle cost of upgrading the systems. The associated standards that are generated through the development of architectures will be written into the requirements of future platform, which moves the Army away from proprietary technology solutions on each ground system and drives an additional layer of competition at the sub-system and component levels.

Key Outcomes.

- VS1 – LOE2 – KO1 (1.2.1): Develop a common cyber-secured open system architecture for all ground systems and subsystems to enable systems, such as active protection, autonomous appliqué systems, and mobility/data/electrical/communications hardware and software, to be easily adapted to specific/discrete platforms to reduce integration time and facilitate increases in system capability and minimize risks to ground systems from cyber attacks.
- VS1 – LOE2 – KO2 (1.2.2): Deliver via design and engineering, system level designs and system integration laboratories which reduce future development and integration time and costs, allowing more capabilities to be added faster.
- VS1 – LOE2 – KO3 (1.2.3): Demonstrate enhanced power distribution and vehicle control systems that improve performance, reduce fuel consumption and enable additional capabilities.
- VS1 – LOE2 – KO4 (1.2.4): Develop and demonstrate physical architecture definitions and design guidelines to enable rapid and cost effective forward adaptability for changing vehicle requirements.

LOE 1.3: PROTECTED MOBILITY

Description. LOE 1.3 focuses on ground vehicle capabilities that enable military ground vehicles to be globally deployable, operationally mobile in all environments, and protected from symmetrical and asymmetrical threats. This LOE ensures Army ground systems will have the capabilities necessary to dominate the future battlefield by providing a mission appropriate balance of survivability and mobility technologies. To do so requires driving developments in both new, lighter weight protection technologies for both the system and its occupants to ensure survival against evolving threats, and innovative ground vehicle mobility and gap-crossing capabilities in order to operate in any terrain, in any situation, at any vehicle weight, anywhere in the world. Other keys to achieving dominant protected mobility are:

- Non-traditional methods to reducing vehicle weight
- Technological advances resulting in reduced signatures
- Increased top speed, braking and cross-country mobility
- Improved vehicle stability
- Burst-speed capability to outmaneuver enemy forces
- Cybersecurity and electromagnetic defense systems
- Multifunctional armor
- Reactive, moveable and proactive armor
- Countermeasures against Unmanned Aerial Vehicles
- Modular active protective systems (MAPS)
- Smart underbody blast protection
- Survivability against fire, lasers and other high-energy threats
- Autonomous bridge launching

Developments in protected mobility technologies have the potential to provide leap-ahead capabilities that will redefine the way Soldiers fight and ensure Soldiers can maneuver to trouble spots whenever and wherever they are needed. Additionally, protected mobility technologies have the potential to be modular and adaptive, providing the flexibility to be integrated onto existing and future manned and unmanned platforms. Employing the new paradigm of adaptive, cooperative and distributed protection for ground systems brings new capabilities to the table that can be tailored for the specific threat environment.

Key Outcomes.

- VS1 – LOE3 – KO1 (1.3.1): Demonstrate an optimal and active balance of mobility and protection.
- VS1 – LOE3 – KO2 (1.3.2): Develop, integrate and demonstrate advanced force protection capability suites (example: technologies to mitigate/defeat the enemy's ability to detect, acquire, hit, penetrate and kill) which enable the system and its

occupants to survive threats and recover from contact, while maintaining an optimal balance of mobility and protection to allow sustained operations anywhere in the world.

- VS1 – LOE3 – KO3 (1.3.3): Develop and demonstrate advanced mobility capability while maintaining an optimal balance of mobility and protection to allow sustained operations anywhere in the world.

LOE 1.4: POWER DENSITY AND ENERGY EFFICIENCY

Description. The purpose of LOE 1.4 is to inform future requirements of innovative, power-dense, efficient components, subsystems and systems to enable leap-ahead capabilities on future ground systems. Increasing the power density and energy efficiency of ground systems, which include ground vehicles (manned and autonomy-enabled) and tactical ground support systems, enable a lighter, more capable force that consumes less energy, is deployable worldwide and is operationally mobile in all environments.

The development of more power-dense components, subsystems and systems increases vehicle design flexibility and the ability to integrate disruptive, high power capabilities including advanced propulsion, directed energy weapons and energy-based protection systems. LOE 1.4 also enables greater operational flexibility by reducing the logistical burdens imposed by ground system operations. Overall, increased power density results in reduced vehicle size and weight, increasing survivability, mobility, and deployability. Increased energy efficiency will result in increased vehicle range, endurance and operational tempo, while reducing the number of logistics convoys on the battlefield.

With respect to ground vehicles, the most effective ways to reduce energy consumption are by decreasing rolling resistance, decreasing vehicle weight and increasing powertrain efficiency. Each is inter-related and it is necessary for TARDEC to fully understand and optimize the tradeoffs to inform requirements for future ground vehicles. Additionally, due to diverse operating environments, future ground systems must be smart and adaptable, possessing reduced fuel and water requirements and real-time asset visibility in a forward base environment, which would subsequently reduce logistics and transportation burdens.

Key Outcomes.

- VS1 – LOE4 – KO1 (1.4.1): Develop high-performance vehicle power systems which provide greater than 100 kilowatts of electrical power for onboard and export/auxiliary use, while also minimizing size and weight.
- VS1 – LOE4 – KO3 (1.4.2): Reduce the thermal burden under armor that enhances operational movement and tactical mobility.
- VS1 – LOE4 – KO4 (1.4.3): Deliver alternative fuels to increase energy security, and new fluids to reduce ground systems energy demand.

LOE 1.5: MANEUVER SUPPORT, SUSTAINMENT, AND LOGISTICS OPTIMIZATION

Description. LOE 1.5 recognizes that TARDEC must provide technologies that will advance and optimize maneuver support, sustainment and logistics capability on the battlefield. Such technologies are required for the Army to meet the vision of an expeditionary Army that can be rapidly deployed in a scalable, tailored, and operationally and tactically significant force as described in *Force 2025* and *The Army Operating Concept (AOC): Win in a Complex World*. Technologies and demonstrations within this LOE provide potential game changing capabilities to increase the speed and effectiveness of future expeditionary forces by reducing constant logistics burdens.

The *AOC* states, "The Army's ability to sustain operations on land is essential to the Joint Force's ability to implement foreign policy and achieve favorable outcomes consistent with U.S. interests." Army units must be able to integrate efforts with Joint and coalition forces to sustain high-tempo operations at the end of long and contested supply lines. Innovative technology is required to create new and enhanced capabilities to reduce vulnerability to ground interdiction, reduce logistics demand, improve reliability, and generate water locally, among others. Moreover, every echelon must have scalable organic capabilities to preserve freedom of maneuver even if logistical support slows.

Army capabilities must grow through the development of technology to be able to set the theater, that is, establish and maintain the conditions necessary to retain Joint Force freedom of maneuver in future operational environments. The Army combines forward deployed forces and rotational forces to develop, maintain and operate the theater structure. Joint forces depend on the Army to provide essential capabilities in maneuver support, sustainment, and logistics.

Further, the Army must project National Power, which includes the ability to deploy and sustain land power rapidly and effectively in and from multiple locations and domains. The Army is the Joint-Force element tasked to conduct sustained campaign-quality land operations that compel adversaries through the physical occupation of vital terrain and infrastructure and consolidate gains to achieve sustainable outcomes. Achieving these objectives requires new technology and capabilities to mitigate the effects of obstacles and hazards and shape the battlefield.

The draft *U.S. Army Functional Concept for Sustainment 2020-2040*, the draft *U.S. Army Functional Concept for Maneuver Support,* and the *Force 2025* concept amplify relevant points from the *AOC* and note that maneuver and sustainment forces must be able to extend operational reach, prolong endurance and allow freedom of action for the Joint Force. These points are critical enablers to the future expeditionary Army. KOs of this LOE will focus on: 1) optimized logistics, 2) reduced reliance on intermediate staging bases and sustainment forces, 3) self-sufficient combat units, 4) mitigate the effects of obstacles and hazards, and 5) shape terrain.

Key Outcomes.

- VS1 – LOE5 – KO1 (1.5.1): Develop Bridging knowledge and technologies to fill known capability gaps and inform future requirements documents to provide gap- crossing equipment that ensures freedom of mobility for Soldiers and ground systems.
- VS1 – LOE5 – KO2 (1.5.2): Research, develop and/or standardize fluids, lubricants, fuels and tribological solutions to simplify life-cycle logistics and improve reliability, availability and maintainability of military ground systems.
- VS1 – LOE5 – KO3 (1.5.3): Develop technology to reduce the logistical burden of the Warfighter by improving the Lines of Communication (horizontal construction) and expediting the loading and unloading of material.
- VS1 – LOE5 – KO4 (1.5.4): Develop technology solutions that reduce life cycle logistics, improve reliability and inform requirements associated with water treatment, generation, storage, and distribution quality analysis on the battlefield.
- VS1 – LOE5 – KO5 (1.5.5): Develop technology to reduce the logistical burden and life-cycle cost of storing, transporting, maintaining quality control, and achieving real-time asset visibility for bulk petroleum.

VALUE STREAM 2 (VS2):
SUPPORT SYSTEMS ACROSS THE ACQUISITION LIFE CYCLE

The efforts undertaken in VS2 extend the operational relevance and cost effectiveness of currently-fielded ground systems. To achieve these results, current systems must: 1) continually upgrade their capabilities to maintain technological superiority and 2) possess the capacity to accommodate new capabilities as they are developed. In addition, the Army must have the means to understand and mitigate the costs of sustaining each platform. VS2 is linked to both VS1 & VS3. For example, technologies developed under VS1 for future PORs may be leveraged for current PORs. Similarly, while VS3 is focused on strategically investing in new or improved engineering-enabling capabilities (Foundational Competencies), VS2 will leverage these capabilities to enhance TARDEC's ability to provide world-class support to all external and internal stakeholders.

The objective of VS2 is to ensure TARDEC is the preferred source of affordable engineering service and support for the ground systems community. This will be accomplished by providing the overall ***"Best Service and Value"*** available to all customers. This means that TARDEC will be the leader and preferred choice in Systems Engineering Activities (SEA) and be recognized for technical authority on all of the Army "Ground Vehicle Systems." TARDEC's expert knowledge will be leveraged throughout a product's life cycle from concept through development and procurement, to production and sustainment, and eventually disposal. This will be accomplished primarily through three LOEs, which together will maintain the technical authority, support long-term system sustainment with rapid improvements and modernization, and provide future capabilities that are affordable and sustainable. VS2 can be further defined through three distinct LOEs:

- **LOE 2.1 - Technical Program Support**. This LOE describes the purposeful activities required for TARDEC to establish and maintain the technical authority in areas such as technical data acquisition and management, knowledge management, design, integration, testing and technical requirements for all ground vehicles systems.

- **LOE 2.2 - Sustainment Engineering**: This LOE describes TARDEC's support to current vehicle platforms that are either in or moving into sustainment. These services will be delivered by manufacturing advanced sustainment capabilities and procedures for technical data package (TDP) development, providing integrated materiel and configuration management, and acting as the custodian for the Army's Records Management System (RMS).

- **LOE 2.3 - Tech Alignment & Transition**: This LOE describes how TARDEC develops and integrates affordable customer-focused technology solutions that are aligned to current ground vehicle systems through relevant S&T investments that ensure successful technology transition.

LOE 2.1: TECHNICAL PROGRAM SUPPORT

Description: TARDEC's goal is for external customers to utilize TARDEC as the technical authority in key competency areas, regardless of any regulations declaring TARDEC as such. That is, in those key areas, external customers feel compelled to use TARDEC as the place for unbiased, reliable answers and for excellent service. This is accomplished through TARDEC's world-class workforce with the unique ability to draw upon a wide array of expertise within the Systems Engineering competencies to develop innovative solutions to complex problems.

This LOE focuses on providing our customers with engineering expertise in the areas of system-level development and integration, technical data acquisition, technical reviews, requirements standardization and technical specification development.

Key Outcomes.

- VS2 – LOE1 – KO1 (2.1.1): TARDEC as the system-level technical authority. Demonstrate superior requirements development, concepts, analysis, design, integration, testing and prototyping from the component level to the complete system by performing full-up system level design and build in-house services.

- VS2 – LOE1 – KO2 (2.1.2): TARDEC as the technical data acquisition and management authority. Provide guidance to customers in deciding when and how to acquire and manage technical data and technical data rights from original equipment manufacturers (OEMs). When technical data is required, assist customers with the acquisition and management of a TDP used to support their vehicle system throughout its life cycle, and enable successful transition to sustainment.

- VS2 – LOE1 – KO3 (2.1.3): TARDEC as the technical review authority. Provide well educated, trained and skilled technical staffing support to customers during program execution and technical reviews to perform independent analyses, provide technically sound feedback and enable data-driven, informed decisions.

- VS2 – LOE1 – KO4 (2.1.4): TARDEC as the technical requirements authority. Lead a continuous collaborative effort between the TARDEC SMEs, customers, and the user community that develops and maintains the common set of standard requirements to be utilized and amended across future programs and platforms. These efforts enable TARDEC's critical role as an advocate for technology transition and directly influence future efforts.

- VS2 – LOE1 – KO5 (2.1.5): TARDEC as the ground systems standardization authority. Develop, maintain and support technical specifications (military standards, commercial item descriptions, etc.) that accurately define the functional requirements, desired capability and operational environment with sufficient criteria for verifying functionality and performance.

LOE 2.2: SUSTAINMENT ENGINEERING

Description. The Chief of Staff of the Army set his top priority as Readiness. "Readiness for ground combat is – and will remain – the U.S. Army's #1 priority…Readiness is #1, and there is no other #1."

There are many ways TARDEC can support this priority. One of the most significant is through technical support in the operations and sustainment phase of the life cycle, or Sustainment Engineering. TARDEC seeks to be established as the top choice Engineering Support Activity (ESA) for sustainment of all ground systems that enter the latter life-cycle stages.

This LOE ensures the enduring value of future systems by outlining the necessary elements needed to enable full sustainment of ground systems. Continuous engineering will be required on DoD ground systems to keep them relevant and ready. This includes field technical issues resolution, depot and maintenance support, secondary item support and software sustainment.

The tools and processes developed in support of this LOE must be flexible and adaptable, reducing the logistics footprint, creating solutions that can be quickly utilized to solve field issues, and helping maintainers and users increase availability of equipment. The following KOs will facilitate TARDEC in performing this mission.

Key Outcomes.

- VS2 – LOE2 – KO1 (2.2.1): TARDEC to establish and implement a Technical Sustainment Readiness Review (SRR). This KO seeks to establish a framework for technical reviews, in accordance with the Product Support Strategy (PSS), which will ensure complete system technical data in preparation for sustainment activities. TARDEC will serve as the ESA lead to manage technical data and define roles and responsibilities for the post-production support as detailed in the Sustainment Plan Supportability Strategy. The SRR will provide a baseline to TARDEC on the state of the system in terms of cost drivers, risk areas, depot/arsenal overhaul/rebuild programs and schedules, and resources available to support the system in sustainment. This will ensure TARDEC will have the proper sustainment support systems in place prior to transition, which will ultimately assist life cycle managers and increase readiness rates.

- VS2 – LOE2 – KO2 (2.2.2): TARDEC to serve as the System Level Obsolescence Risk Manager. Obsolescence is a major issue that the sustainment community is witnessing which continues to negatively affect readiness rates. Although this issue prevails across all components on ground systems, electronics obsolescence has the ability to be the critical issue in the future. Access to design information at the subcomponent level, or its associated software, is necessary to resolve these issues before they become a readiness driver or otherwise affect field units. TARDEC will utilize best of breed obsolescence management tools and processes to proactively identify material support risk and provide actionable mitigation in support of system overhaul programs and overall system readiness rates.

- VS2 – LOE2 – KO3 (2.2.3): TARDEC to enable rapid acquisition of secondary parts to ensure users get items expeditiously. This rapid acquisition will be through instantaneous access to complete, accurate, and up-to-date product (engineering, configuration, quality and logistics) data across DoD. This data will pre-position (i.e., a pull vs. push environment) TDPs for secondary item procurement and provide on-demand information such as equivalent products, vendors, replacements for obsolete items and hazardous materials. This will help reduce administrative lead time (ALT) for secondary item procurements to near zero days ensuring that depots and field units are not experiencing readiness problems due to excessive review time for spare parts.

- VS2 – LOE2 – KO4 (2.2.4): TARDEC as the first choice in ESA for all ground systems in sustainment. This includes providing quick and viable technical solutions to customer inquiries and field support requests to maintain a high readiness rate on all platforms and ensure safe systems for the Warfighters. This also involves maintaining a high level of knowledge and tools on the supported platforms/systems to enable troubleshooting of problems. This can take the form of facility vehicles, System Integration Labs (SILs), access to

technical data and manuals and a high level of competence across TARDEC/RDECOM to support any issues that may come up in the field. TARDEC will also synchronize sustainment execution management processes with customers to establish TARDEC as the first choice ESA for ground systems in sustainment to enable rapid innovation and agile technical support. This includes improving the metrics tracked in the sustainment arena.

- VS2 – LOE2 – KO5 (2.2.5): TARDEC to provide engineering support for RESET, RECAP, Rebuild, and Overhaul programs. This is accomplished with production readiness through the validation of Bill of Materials (BOMs) prior to system build. Technical Data availability, completeness and compatibility assessments across communities is also an area of emphasis to include storage National Maintenance Work Requirement/Depot Maintenance Work Requirement (NMWR/DMWR) data and flat file/manufacturing BOM data in a common tool. This will promote TARDEC as the Technical Authority in terms of Manufacturing & Production Engineering, and ensure all technical data is available to the organic site prior to the start of production. TARDEC will also identify, maintain and grow manufacturing technologies and technical capabilities and competencies in support of organic industrial base critical skills, while partnering with depot/arsenals, universities, and industry.

- VS2 – LOE2 – KO6 (2.2.6): TARDEC to implement a reverse engineering capability to reduce impacts on logistics, acquisition, sustainment and readiness. It is clear that a robust and agile reverse engineering process will be necessary to support systems in sustainment. Issues can come up quickly in this phase of the life cycle and a process to address issues of all sizes will be instrumental in helping the life cycle managers keep readiness rates up. Reverse engineering drives competition from sole-source to multi-source suppliers. This in turn creates competition driving prices lower and creates another source for acquisition during "High Demand" situations.

- VS2 – LOE2 – KO7 (2.2.7): Establish and Implement the TARDEC Software Engineering Center as the Software Support Agency (SSA) or Life Cycle Software Engineering Center (LCSEC) for all Army Ground Systems. Army Regulation 750-1 requires the, "transition of software support planning, programming, budgeting and executing system responsibility from the material developer (MATDEV) to the LCSEC prior to the end of the weapon system hardware production (to include block upgrades), the MATDEV, in coordination with the LCSEC, will obtain DCS, G-4 and ASA(ALT) approval and document the approved transition date. Life cycle software support embraces all software-related activities for a weapon systems embedded operational software." Post Production Software Support (PPSS) is a subset of life cycle software support that begins with completion of the weapon system hardware production. This KO seeks to establish TARDEC SEC as the Life Cycle Software Engineering Center (LCSEC) for all Army Ground Systems.

LOE 2.3: TECH ALIGNMENT & TRANSITION

Description. This LOE describes how TARDEC aligns, develops and transitions new technologies to current platforms. TARDEC's ability to develop and maintain close working relationships with the PMs is critical for success of this LOE. These relationships are developed through frequent communication and dialogue at all levels of the organization, including SMEs, matrix personnel, CIEs, and leadership. Additionally, TARDEC ensures communication with the pertinent OEMs and collaborates where appropriate to ensure the PM gets the best solution with the best cost, schedule, and performance.

Working closely with the PMs, TARDEC synchronizes S&T investments with POR timelines through the LIRA process. The objective of LOE 2.1 is to improve the fidelity of the data gathered during this exercise by roadmaps linking products from RDECOM's tech base to modernization and upgrade plans for all ground vehicles. TARDEC applies best practices from systems engineering and project management through a stage-gated TARGET process to generate, resource and track project execution to deliver real solutions that address PM needs. TARDEC actively manages item cost, project cost, project schedule, and system performance requirements to ensure a viable transition.

The needs for TARDEC S&T projects come from Warfighter outcomes, capability needs analysis (CNA) Gaps through Joint Capabilities Integration Development System (JCIDS), formalized requirements documents and PM-specified needs lists. Additionally, TARDEC will decompose platform capability gaps, life-cycle cost drivers, and size, weight, power and cost (SWAP-C) margins to identify additional opportunities for improvement. Because the PM's needs change over time, TARDEC will actively manage requirements and adjust as necessary to ensure the end product is the right solution.

Finally, to ensure successful transition, the needs analysis process will be expanded to document customer commitment to a project by redefining PM 'endorsement' and the technology transition agreement (TTA) process.

Key Outcomes.

- VS2 – LOE3 – KO1 (2.3.1): POR Integration. Drive an increased number of technology products to the field by implementing the processes, tools and training, as described in VS3, necessary for executing customer priorities and life- cycle requirements. Enable TARDEC to identify and align technology programs and services to specific acquisition program events. Develop and mature technology in coordination with the customer to ensure transition.

- VS2 – LOE3 – KO2 (2.3.2): Rapid upgrades and prototyping for PORs. Ensure TARDEC services, readiness and availability to respond to acquisition program requests for design, systems integration, rapid upgrades, prototyping and low- volume production. Deliver the necessary products for transition to high-volume production partners. Provide adaptable and flexible options for customers: quick to fund, in-house skill growth, competitive cost and schedule, and competitive TDP output.

- VS2 – LOE3 – KO3 (2.3.3): Restore the performance of PORs engineering change proposals (ECPs). Work in partnership with the PM office and the user community to ensure technology solutions are feasible and affordable. Recommend options that satisfy the requirements of the PORs. Guide technology development towards meeting performance and affordability targets by applying in-house skills and competencies.

VALUE STREAM 3 (VS3):
STRENGTHEN FOUNDATIONAL COMPETENCIES

The focus of VS3 is to strategically improve TARDEC's core technical and non-technical competencies through the people, processes, tools and facilities which support all of TARDEC's stakeholders through utilization in VS1 or VS2. VS3 uses an integrative approach of Technical and Mission Enhancing LOEs which allow TARDEC leadership to make decisions to strategically grow, sustain or divest in the VS3 resources that form the foundational competency. This undertaking aims to position TARDEC to provide superior products and services, such as military ground system engineering, experimentation, analysis, system integration, prototyping, manufacturing, assessment and sustainment engineering services to VS1, VS2, and other stakeholders in a reduced cycle time.

Strong systems engineering and product development processes enable TARDEC to rapidly develop and implement new ground vehicle capabilities. TARDEC's unique programs are managed through a systems engineering process and a gated product development framework called the TARDEC Gated Evaluation Track (TARGET). The TARGET process reduces product development timelines, standardizes program management techniques and enables effective solutions to transition to customers on schedule.

TARDEC's suite of virtual and physical engineering tools accelerate innovation by enabling rapid development and evaluation of both future vehicle concepts and current fleet upgrades. In the digital environment, TARDEC evaluates technology solutions in virtual simulations prior to physical prototype builds. For example, the TARDEC Virtual Experiments Capability (TVEC) tool leverages video game technology to replicate operational scenarios and receive Soldier feedback on future vehicle concepts. In the physical environment, TARDEC utilizes its unique lab

capabilities to manufacture, integrate and assess real-world prototypes to validate performance. The synergistic coupling of advanced design, manufacturing, integration and assessment tools is known as the Digital-Physical Thread (DPT) and forms the foundation for delivering advanced solutions to the Warfighter.

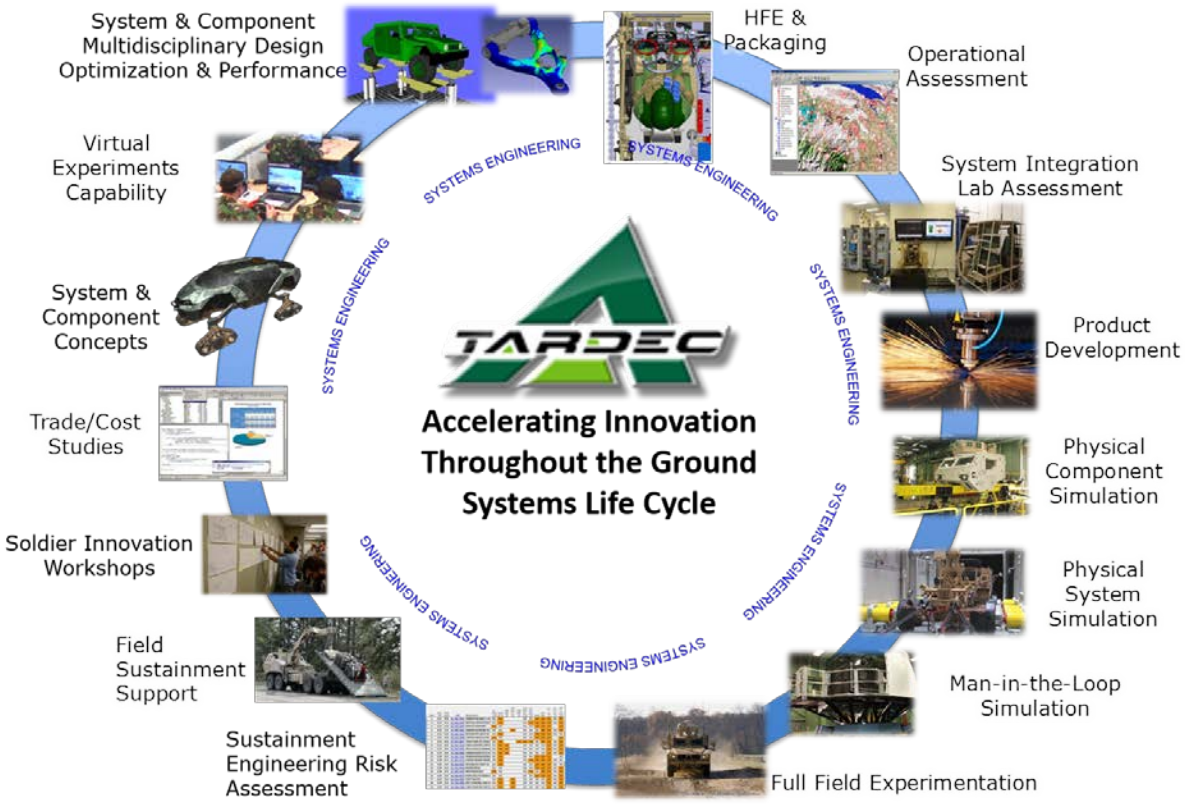

Figure 2: TARDEC Digital Physical Thread (DPT)

TECHNICAL LINES OF EFFORT

The Technical LOEs in VS3 are identified as the core competencies that build the basis of TARDEC's technical body of knowledge. Technical LOEs are enablers of VS1 and VS2 and will inform requirements, technology and performance trades, POR milestone decisions, test methods, concept development, risk mitigation, and training. Technical LOEs 1-15 encompass TARDEC's expertise to design, develop, integrate, analyze, assess, mature, and support ground systems and their critical technologies. KOs in these LOEs set the goals to enhance the necessary technical expertise for TARDEC's future. These KOs are detailed in in a separate 30-Year Strategy Appendix that is currently for TARDEC internal use only.

- LOE 3.1: Force Projection Technology
- LOE 3.2: Ground System Physical Simulation & Test
- LOE 3.3: Ground System Survivability
- LOE 3.4: Ground Systems Autonomy Capability Development & Integration
- LOE 3.5: Ground Systems Software Engineering & Tactical Cyber Security
- LOE 3.6: Ground Systems Technical Planning & Management
- LOE 3.7: Ground System Development, Fabrication, Integration and Engineering
- LOE 3.8: Ground Vehicle Advanced Concepts Development
- LOE 3.9: Ground Vehicle Power and Mobility
- LOE 3.10: Platform Engineering
- LOE 3.11: Product Life Cycle Engineering (PLE)
- LOE 3.12: Quality
- LOE 3.13: Sustainment Engineering
- LOE 3.14: Ground Vehicle Performance Analysis & Assessment
- LOE 3.15: Vehicle Electronics and Architecture

LOE 3.1 FORCE PROJECTION TECHNOLOGY

Description.
LOE 3.1 is focused on developing and integrating advanced sea and ground capabilities into a cohesive force, and use energy-efficient technologies and novel Mission Command, communications and multi-functional systems to support forced entry operations, maneuver support, sustainment, and logistics optimization.

LOE 3.2 GROUND SYSTEM PHYSICAL SIMULATION & TEST

Description.
LOE 3.2 is focused on becoming the technical authority for modeling and simulation (M&S) in the test and evaluation process to provide vehicle simulation, test, and evaluation services to accelerate innovation and ensure the delivery of superior capabilities through: real-world relevant system/sub-system/component testing and characterization with laboratory precision and repeatability; hardware/software/Warfighter-in-the-loop simulation and experimentation;

T&E management expertise for the development of ground systems; maximum use of TARDEC's DPT framework. This provides a critical strategy to innovatively test for performance and reliability of developing platforms and mitigate risks associated with the successful deployment of vehicles and weapons systems while ensuring timely focus on reliability and maintainability requirements.

LOE 3.3 GROUND SYSTEM SURVIVABILITY

Description.
LOE 3.3, Ground System Survivability (GSS) is defined as providing holistic vehicle and occupant-centric protection. To accomplish this mission, many technologies and capabilities are being developed and integrated. These include but are not limited to: foundational armor (opaque and transparent); advanced armor (sensor enhanced, electrified and adaptive); hit and kill avoidance-active protection (MAPS, MAPS Cybersecurity and Electromagnetic); vision and directed energy protection (laser and sensor); fire protection; lightweight vehicle structures; exterior and interior blast and countermine (seats, floors, air bags, active blast). GSS is uniquely capable to deliver these technologies through in-house lab capabilities: ballistics and blast labs; armor materials fabrication and characterization facilities; crash test and high-impact rate lab facilities; vehicle rollover test range; electrical and optio-electrical energy labs; active protection SIL; and fire protection lab facilities.

LOE 3.4 GROUND SYSTEMS AUTONOMY CAPABILITY DEVELOPMENT & INTEGRATION

Description.
LOE 3.4 is focused on providing innovative unmanned ground vehicles driven by Warfighter requirements through advanced technology research, development, experimentation and system integration. Specific emphasis is placed on manned-unmanned teaming for both mounted and dismounted units, air/ground teaming with both manned and unmanned assets, improved ground vehicle 360-degree vision, architectures and kits to enable optionally-manned and unmanned vehicles, and leveraging investments across DoD, industry, and OGAs to test and evaluate unmanned systems.

LOE 3.5 GROUND SYSTEMS SOFTWARE ENGINEERING & TACTICAL CYBER SECURITY

Description.
LOE 3.5 is focused on providing information systems security engineering, software assurance, software life-cycle engineering support, software technical support, software sustainment and ground vehicle life-cycle software engineering.

LOE 3.6 GROUND SYSTEMS TECHNICAL PLANNING & MANAGEMENT

Description.
LOE 3.6 provides world-class products and services to support Government customers and stakeholders as the sought after center of excellence in life cycle systems engineering (SE). Integrated SE expertise for Government partners and stakeholders is provided through:

- SE knowledge integration, approach and tools
- SE process development
- Identification, application and execution of SE best practices
- Requirements analysis
- Risk assessment and management (Army lead)
- Reliability, Availability and Maintainability (RAM) life-cycle analysis, support and management
- SE human capital support
- Operational and doctrinal analysis to support technology programs
- Architecture development and model-based SE support
- Manufacturing technology assessment and engineering
- Logistics analytical assessments
- SE tool support and training

LOE 3.7 GROUND SYSTEM DEVELOPMENT, FABRICATION, INTEGRATION AND ENGINEERING

Description.
LOE 3.7 focuses on the mission to develop, fabricate and integrate advanced solutions into current and future ground systems. TARDEC's Center for Systems Integration is a one-stop center for design, engineering, machining, metalworking, coating, welding and assembly of both sub and full-system-level functional prototypes and production TDPs for all DoD tactical and combat systems, and for combat support equipment. Work is executed in a fully managed EVM environment with project engineering on staff. Work supports the full life cycle of a product from concept through testing, fielding and sustainment.

LOE 3.8 GROUND VEHICLE ADVANCED CONCEPTS DEVELOPMENT

Description.
LOE 3.8 focuses on rapidly developing flexible and adaptable systems able to meet the uncertainty of the future battlefield per needs described in the *AOC* and Combat Vehicle Modernization Strategy. Developing and assessing virtual concepts for modifications to existing vehicles as well as new start systems provides an effective way to refine and assess requirements and technology to ensure that the most effective ground systems are fielded in the most efficient manner.

LOE 3.9 GROUND VEHICLE POWER AND MOBILITY

Description.
LOE 3.9, Ground Vehicle Power and Mobility (GVPM), focuses on research, development, integration and testing of advanced propulsion and power generation systems to provide the Warfighter with expanded capabilities in current and future vehicle platforms. To achieve this mission, GVPM is developing future capabilities which target improved mobility, higher system efficiency and better space utilization of the vehicle. GVPM is uniquely equipped with resources and lab capabilities in its Ground Systems Power & Energy Laboratory (GSPEL) to deliver and validate these technologies through its in-house lab capabilities which include: engine combustion research and state-of-the-art engine and transmission dynamometers, complete wheeled and tracked vehicle testing under extreme environmental conditions, fuel cell development and testing, electric motor and generator test lab, and battery test lab for advanced chemistry batteries at the cell, module, and complete pack levels. In addition, GVPM has the capability to develop software architecture and control algorithms to allow adequate function interface between the different systems in the vehicle. The group regularly works with OEMs to develop in-house complete control of their new hardware.

LOE 3.10 PLATFORM ENGINEERING

Description.
LOE 3.10 focuses on the Platform Engineering mission to understand vehicle-specific system level engineering. Platform Engineering personnel are typically assigned as matrix support to Program Management Offices (PMOs) in general support of a specific ground system. These engineers are engaged in various points of the product life cycle post-Milestone B, whether it be in PMO R&D budget, procurement, manufacture, transportation, modification, rebuild, overhaul, storage or maintenance. The mission continues to be pro-active on these fronts in order to mitigate overall program risk, reduce costs, and provide the Warfighter with equipment that meets or exceeds system requirements.

LOE 3.11 PRODUCT LIFE CYCLE ENGINEERING (PLE)

Description.
LOE 3.11 supports TACOM LCMC acquisition and sustainment efforts across the full life cycle for all ground tactical and combat vehicles. This LOE provides the necessary technical information to manage the configuration of tactical and combat vehicles. PLE also provides customers with laboratory facilities for testing in materials characterization, failure analysis, heating, ventilation and, air conditioning systems and components, vehicle electrical systems and components, and 28-volt military vehicle charging systems. Finally, PLE provides subject-matter expertise in materials engineering, corrosion, environmental engineering, reverse engineering, industrial base engineering, vehicle cabin thermal management, electrical systems and components, and charging systems.

LOE 3.12 QUALITY

Description.
LOE 3.12 focuses on maximizing the readiness and sustainability of TACOM's ground vehicle systems by providing support to all quality functions within the Army's worldwide research, development, engineering, acquisition and logistics missions.

LOE 3.13 SUSTAINMENT ENGINEERING

Description.
LOE 3.13 provides sustainment engineering support, including system, subsystem and component-level product engineering and integration expertise to post-production fielded equipment to maintain and improve readiness and safety. Sustainment Engineering also integrates the latest technology kits into fielded vehicles to improve readiness and safety.

LOE 3.14 GROUND VEHICLE PERFORMANCE ANALYSIS AND ASSESSMENT

Description.
LOE 3.14 uses in-house engineering analysts to perform Soldier-centric vehicle assessments of new systems and modifications to existing systems. Assessments advise customers on impacts to system-level performance and also identify improvements to Army and DoD vehicle designs. Analytics has world-class experts in numerous areas including: vehicle dynamics, blast and crash M&S, injury biomechanics, physics of failure, engine and powertrain M&S, computational fluid dynamics, reduced-order modeling, and data mining and optimization analyses. This LOE enables TARDEC to provide DoD with a one-stop shop for rigorous evaluation of existing and conceptual vehicle systems.

LOE 3.15 VEHICLE ELECTRONICS AND ARCHITECTURE

Description.
LOE 3.15 supports current and future ground vehicles through research and definition of open, reliable and adaptable architectures. Functions of VEA include communication integration, power distribution, networking, and electronic technologies. VEA is also responsible for the design of architectures and component integration solutions and the execution of testing and verification through the operation of SILs. VEA evaluates component compliance, supports electromagnetic environmental effects (E3) test and evaluation, and provides additional customer support.

MISSION ENHANCING LINES OF EFFORT

Mission Enhancing LOEs (16-33) encompass TARDEC's competencies that are fundamental to TARDEC's business processes. These competencies are often found in supporting roles to the Technical competencies, but are no less critical to the success of TARDEC's mission. KOs of these LOEs outline goals across a wide range of fields that support TARDEC as a whole – from personnel to facilities management and beyond. These KOs have been captured in a separate 30-Year Strategy Appendix for internal TARDEC use at this time.

- LOE 3.16 - Acquisition/Contracting Management Support
- LOE 3.17 - Administrative
- LOE 3.18 - Business Development/External Collaborations
- LOE 3.19 – Chief Information Officer (CIO)/Information Technology
- LOE 3.20 - Facilities Management
- LOE 3.21 - Leadership
- LOE 3.22 - Logistics
- LOE 3.23 - Operations
- LOE 3.24 - Project Management
- LOE 3.25 - Resource Management
- LOE 3.26 - Safety, Environmental & Occupational Health
- LOE 3.27 - Strategic Planning and Communications
- LOE 3.28 - Portfolio Management
- LOE 3.29 - Supervisory
- LOE 3.30 - Value Engineering
- LOE 3.31 - Web-Enabling Systems
- LOE 3.32 - Workforce Development
- LOE 3.33 - Workforce Management

LOE 3.16 ACQUISITION/CONTRACTING MANAGEMENT SUPPORT

Description.
LOE 3.16 focuses on acquisition/contracting management support tasks and activities, including statements of work, procurement policy, contract reviews, contract auditions, bids, proposals,

acquisition strategies, acquisition logistics, source selection, acquisition business law and acquisition planning.

LOE 3.17 ADMINISTRATIVE

Description.
LOE 3.17 focuses on providing administrative support to specific departments or organizations. Support includes fielding telephone calls, receiving and directing visitors, calendar scheduling, word processing, creating spreadsheets and presentations, and filing. The Administrative competency comprises effective communications, Microsoft Office competency, timekeeping, travel preparation, correspondence, employee assistance, records management and scheduling.

LOE 3.18 BUSINESS DEVELOPMENT/EXTERNAL COLLABORATIONS

Description.
LOE 3.18 focuses on identifying, pursuing and accelerating business opportunities that improve resource utilization for both the government and external partners.

- Connect with others who develop, demonstrate and accelerate technology
- Communicate the Army's ground vehicle technical needs
- Create collaborative business agreements

LOE 3.19 CIO/INFORMATION TECHNOLOGY

Description.
LOE 3.19 provides mission-enabling information technology systems and solutions ensuring confidentiality, integrity and availability through innovation, governance and support.

LOE 3.20 FACILITIES MANAGEMENT

Description.
LOE 3.20 focuses on managing the sustainment, modernization and acquisition of facilities and laboratories while providing engineering management services and support to enable business units to concentrate on research, development, test and evaluation (RDT&E) capability development and mission requirements.

LOE 3.21 LEADERSHIP

Description.

LOE 3.21 focuses on developing a TARDEC organizational culture of empowered leadership at all levels, aligned with the Army's whole person concept and as described in the *AOC* and Human *Dimension Concept*. This culture will only be possible by recognizing that leadership exists at all levels in this organization and by perpetuating an environment of empowerment, learning, and development. TARDEC's leadership program provides key tools for focusing on our most important asset: our people.

LOE 3.22 LOGISTICS

Description.
LOE 3.22 focuses on managing the TARDEC property book and ensuring that the organization is adhering to the command supply discipline program, RDECOM guidelines and Army regulations. Logistics also executes the sustainment of TARDEC's non-tactical, tactical, combat and prototype fleet to support VS1 and VS2 LOEs. Additionally, logistics planners coordinate TARDEC's transportation and storage needs as required.

LOE 3.23 OPERATIONS

Description.
LOE 3.23 focuses on coordinating operational plans for TARDEC, and ensuring proper integration across planning horizons for current and future operations, plans, training, and exercises directly in support of TARDEC's RDT&E mission.

LOE 3.24 PROJECT MANAGEMENT

Description.
LOE 3.24 develops, provides, maintains and facilitates a comprehensive, yet efficient system of processes that assures all projects across the TARDEC enterprise operate within established cost, schedule, performance, and risk constraints, while ensuring that TARDEC is investing in the most optimal portfolio of projects.

LOE 3.25 RESOURCE MANAGEMENT

Description.
LOE 3.25 is comprised of: acquisition management; programming, planning and execution (PPE); and managerial and business operations. Key resource management functions include: acquisition program management; Program Objective Memorandum program management; manpower requirements management; business processes management; and budget execution management.

LOE 3.26 SAFETY, ENVIRONMENTAL AND OCCUPATIONAL HEALTH

Description.
LOE 3.26 focuses on assuring that TARDEC associates, contractors and visitors are provided environmentally safe and healthful working conditions to enable Business Unit and Staff personnel to focus on RDT&E capability development and mission requirements.

LOE 3.27 STRATEGIC PLANNING AND COMMUNICATIONS

Description.
LOE 3.27 focuses on developing and communicating the Army's ground vehicle S&T strategy and facilitates and synchronizes TARDEC's future plans in order to (1) shape the Future Force, (2) enhance the Current Force, and (3) optimize TARDEC's engineering capabilities. Additionally, this competency focuses on generating positive awareness and understanding of TARDEC and the research, development and systems engineering its associates execute on behalf of the U.S. Army by proactively shaping the media environment across all messaging and communication platforms to: provide timely, responsive and focused information to customer requests; motivate decision makers and centers of influence; engage current and potential collaborative partners in government, industry and academia; attract and retain the best and brightest employees with the requisite engineering and technical skills; engender community-wide pride through decisive media and public engagement.

LOE 3.28 PORTFOLIO MANAGEMENT

Description.
LOE 3.28 focuses on the centralized management of one or more portfolios, which includes identifying, prioritizing, authorizing, managing, and controlling projects, programs and other related work to achieve specific strategic business objectives.

LOE 3.29 SUPERVISORY

Description.
LOE 3.29 focuses on supervisor capability to learn and update skills continuously to keep pace with the modern age. Individuals need to continually learn new things to keep up with the times, within a profession, to be competent in any given job.

LOE 3.30 VALUE ENGINEERING

Description.

LOE 3.30 focuses on the optimization of project life cycle costs, time savings, quality improvement, expanding market share, problem solving, and effective use of resources.

LOE 3.31 WEB-ENABLING SYSTEMS

Description.
LOE 3.31 focuses on providing TARDEC with mission-enabling information technology systems and solutions ensuring confidentiality, integrity and availability through innovation, governance and support. Current efforts include investigation of web-based tools to analyze and implement increased collaboration efficiency within TARDEC and across the enterprise.

LOE 3.32 WORKFORCE DEVELOPMENT

Description.
LOE 3.32 is focused on developing TARDEC's workforce to establish depth in critical skills and mature the pool of existing and future leaders. Functions include forecasting, analyzing, and facilitating personnel levels, skills and competency requirements.

LOE 3.33 WORKFORCE MANAGEMENT

Description.
LOE 3.33 is focused on management and oversight of all matters concerning TARDEC's human resources, and ensuring that all personnel and human capital asset requirements are met to properly maintain workforce levels in support of TARDEC's missions.

VI. PATH FORWARD

As the United States military moves into future operational environments, TARDEC recognizes that in order to provide the Warfighter with a differential advantage in any situation, future ground systems must be designed to give the commander the ability to rapidly adapt and respond on the battlefield. TARDEC's capabilities, that is the people and their skills and tools, are uniquely positioned to continue informing the future requirements for existing, emerging and currently undefined ground systems that will, ultimately, provide the Warfighter an advantage.

A future set of subordinate documents will provide a detailed description of execution for each VS of the strategy. The TARDEC 30-Year Strategy will be updated periodically or as prescribed by the TARDEC Director or higher headquarters to ensure that TARDEC remains on the leading edge of ground system capability development.

APPENDIX A. STRATEGIC REFERENCES

1) *Army Operating Concept* and *Force 2025 & Beyond* Briefing to Maneuver Conference, Perkins, David G., Commanding General, U.S. Army Training and Doctrine Command (TRADOC) (Sept. 11, 2014), http://www.benning.army.mil/mcoe/maneuverconference/2014/presentation/ppt/GENPerkins.pptx

2) *Capstone Concept for Joint Operations: Joint Force 2020* (Sept. 10, 2012)

3) TRADOC Pamphlet (Pam) 525-3-0, *U.S. Army Capstone Concept* (Dec. 19, 2012)

4) U.S. Army Combat Vehicle Modernization Strategy, Draft Version 0.996, Maneuver, Aviation and Soldier Division, Army Capabilities Integration Center (ARCIC),TRADOC

5) TRADOC Pam 525-8-5, *U.S. Army Functional Concept for Engagement* (2014, February 24)

6) TRADOC Pamphlet 525-3-4, Draft Revision 0.5, *U.S. Army Functional Concept for Fires*

7) TRADOC Pamphlet 525-3-5, Draft Revision 0.73, *U.S Army Functional Concepts for Maneuver Support and Protection*

8) TRADOC Pamphlet 525-3-3, Draft Revision 0.3, *U.S Army Functional Concept for Mission Command*

9) TRADOC Pamphlet 525-3-6, Draft Version 0.7, *U.S Army Functional Concept for Movement and Maneuver*

10) TRADOC Pamphlet 525-4-1, Draft Version 0.7, *U.S Army Functional Concept for Sustainment*

11) U.S. Army RDECOM Strategic Plan (2015), *Enabling Battlefield Dominance Through Technology*

12) U.S. Army Robotics and Autonomous Systems Strategy 2015-2020, Draft Version 0.36

13) TRADOC Pamphlet 525-3-1, *U.S Army Operating Concept: Win in a Complex World* (Oct. 31, 2014)

Army Publishing Directorate Home Page. Army regulations, Department of the Army (DA) pamphlets, Field Manuals, Army Doctrine Publications, Army Doctrine Reference Publications. http://www.apd.army.mil/

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APPENDIX B. ACRONYM LIST

ALT: Administrative Lead Time
AOC: Army Operating Concept
ARIBO: Autonomous Robotics for Installation and Base Operations
ARL: Army Research Laboratory
ASA (AL&T): Office of the Assistant Secretary of the Army for Acquisition, Logistics and Technology
BOM: Bill of Materials
CAN: capability needs analysis
CD: Capability Demonstrations
CIO: Chief Information Officer
COI: Communities of Interest
CONOPS: concept of operations
DA: Department of the Army
DMWR: Depot Maintenance Work Requirement
DoD: Department of Defense
DOTMLPF-P: Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities and Policy
DPT: Digital-Physical Thread
ECP: Engineering Change Proposal
EOD: Explosive Ordnance Disposal
ESA: Engineering Support Activity
GSPEL: Ground System Power and Energy Laboratory
GSS: Ground System Survivability
GVPM: Ground Vehicle Power and Mobility
JCIDS: Joint Capabilities Integration Development System
KO: Key Outcome
LCMC: Life Cycle Management Command (LCMC)
LCSEC: Life Cycle Software Engineering Center
LIRA: Long-range Investment Requirements Analysis
LOE: Line of Effort
LRRDPP: Long Range Research and Development Planning Program
MAPS: Modular Active Protection System
MATDEV: Material Developer
MC: Mission Command
M&S: Modeling and Simulation
NMWR: National Maintenance Work Requirement
OEM: Original Equipment Manufacturer
OGA: Other Government Organization
OSD: Office of the Secretary of Defense
Pam: Pamphlet
PLE: Product Life cycle Engineering

PM: Program/Product Manager
PMO: Program/Product Management Office
POR: Program of Record
PPSS: Post Production Software Support
PSS: Product Support Strategy
RAM: Reliability, Availability and Maintainability
RAS: Robotic and Autonomous Systems
RMS: Records Management System
RDECOM: Research, Development and Engineering Command
RDEC: Research, Development and Engineering Center
RDT&E: Research, Development, Test and Evaluation
R&D: Research and Development
SE: Systems Engineering
SEA: Systems Engineering Activity
SIL: System Integration Laboratory
SME: Subject-Matter Expert
SRR: Sustainment Readiness Review
S&T: Science and Technology
TACOM: Tank-automotive and Armaments Command
TARDEC: Tank Automotive Research, Development and Engineering Center
TARGET: TARDEC Gated Evaluation Track
TDP: Technical Data Package
TRADOC: Training and Doctrine Command
TTA: Technology Transition Agreement
TVEC: TARDEC Virtual Experiments Capability
UAV: Unmanned Aerial Vehicle
UGS: Unmanned Ground System
VS: Value Stream

APPENDIX C. VALUE STREAM 3 KEY OUTCOMES

Separate attachment. Can be found on the TARDEC Portal. For Internal Use Only at this time.