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The Land Warrior Soldier System: A Case Study for the Acquisition of Soldier Systems

15 December 2008

by

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Abstract

This project provides an analysis of the Army's acquisition of the Land Warrior (LW) Soldier System. Its objectives are to document the history of the LW and provide an overview of the program to establish the components of both its development and deployment and its associated business and management characteristics. The product is a document that provides an analysis of the actions taken and the obstacles encountered and how the materiel developers, warfighters, user representatives and lawmakers dealt with them.

The LW need was approved in 1993. The requirement was to provide improvements for dismounted soldiers in the five specific capability categories of lethality, command and control, mobility, survivability, and sustainment. For a period lasting approximately 15 years, the LW has evolved. Despite this evolution, the Army terminated the program in FY 2007. Regardless, it has laid the foundation for follow-on soldier system initiatives. The LW was unsuccessful initially due to the misalignment of three interrelated and supporting components: 1) technical immaturity, 2) poor user acceptance, and 3) lack of senior leadership support. Successes that are more recent can be attributed to: 1) soldier-driven design, 2) improved technical maturity, and 3) proven employment of the system in combat by warfighters.

Keywords: Land Warrior, Land Warrior Soldier System, Soldier as a System, Ground Soldier Ensemble, 4-9 Infantry Battalion, Unit System Integrators, TCM Soldier, PEO Soldier, Program Manager Soldier Warrior, Product Manager Land Warrior, General Dynamics C4 Systems, Net-centric Warfare

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We dedicate this project to the fallen soldiers of 4-9 Infantry Battalion "Manchus." Without their sacrifice and the sacrifice of other fallen heroes in past wars and in the Global War on Terror, our way of life would be in peril.

Pfc. Bryant Christopher Compean, 19, of El Campo, TX, died October 24, 2006, from injuries sustained during a training accident at Yuma Proving Ground, AZ. Staff Sgt. David C. Kuehl, 27, of Wahpeton, ND, died May 22, 2007, in Taji, Iraq, of wounds suffered when an improvised explosive device detonated near his unit. Staff Sgt. Kristopher A. Higdon, 25, of Odessa, TX, and Pfc. Robert A. Worthington, 19, of Jackson, GA, died May 24, 2007, in Taji, Iraq, of wounds suffered when an improvised explosive device detonated near their unit. Spc. Mathew P. LaForest, 21, of Austin, TX, died May 25, 2007, in Taji, Iraq, of injuries suffered when his unit came in contact with enemy forces using small arms fire during combat operations. Pfc. Willard M. Kerchief III, 21, of Evansville, IN, died August 16, 2007, in Balad, Iraq, of wounds suffered from enemy small arms fire during combat operations in Taramiyah, Iraq. Cpl. Graham M. McMahon, 22, of Corvallis, OR, died September 19, 2007, in Balad, Iraq, from a non-combat related illness. All soldiers were assigned to the 4th Battalion, 9th Infantry Regiment, 4th Brigade, 2nd Infantry Division (Stryker Brigade Combat Team), Fort Lewis, Washington.

We would also like to take this opportunity to thank a few key individuals that made this project possible. While this list is long, it is not all encompassing. There are thousands of people out there who have made and are currently making a difference for soldiers.

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Lieutenant Colonel (Promotable) W.W. Prior and his "Manchu" battalion deserve the most thanks of all. Their dedication to the defense of our nation and the future of our Army remains an example for others to follow.

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List of Abbreviations and Acronyms

AAE	Army Acquisition Executive
ACS	Advanced Clothing Subsystem
ACTD	Advanced Concept Technology Demonstration
AETF	Army Evaluation Task Force
Air SS	Air Soldier System
ALSA	Aviation Life Support Equipment
AoA	Analysis of Alternatives
ARI	Army Research Institute
AROC	Army Requirements Oversight Council
ASA(ALT)	Assistant Secretary of the Army for Acquisition, Logistics and Technology
ASARC	Army Systems Acquisition Review Council
ASB	Army Science Board
ATD	Advanced Technology Demonstration/Development
ATEC	Army Test and Evaluation Command
AW	Air Warrior
BC	Battle Command
BES	Budget Estimate Submission
BFT	Blue Force Tracker
BOI	Basis of Issue
C4ISR	Communications, Computing, Control, Command, Intelligence, Sensor & Reconnaissance
CBA	Capability-based Assessment
CBP	Capability-based Planning
CCJO	Capstone Concept for Joint Operations
CDA	Commander's Digital Assistant
CDD	Capability Development Document

CDR	Critical Design Review
CG	Commanding General
CLS	Contractor Logistics Support
COA	Course of Action
COCOMs	Combatant Commanders
COIC	Critical Operational Issues and Criteria
CONOP	Concept of Operations
CONUS	Continental United States
COP	Common Operating Picture
COTS	Commercial Off-the-shelf
CPD	Capability Production Document
CPFF	Cost Plus Fixed Fee
CSA	Chief of Staff of the Army
CSS	Core Soldier System
CVCH	Capstone Concept for Joint Operations

DA	Department of the Army
DBCS	Dismounted Battle Command System
DCD	Director of Combat Developments
DCMA	Defense Contract Management Agency
DEMVAL	Demonstration and Validation
DoD	Department of Defense
DoD IG	Department of Defense Inspector General
DOT	Directorate of Operations and Training
DOTMLPF	Doctrine, Organization, Training, Material, Logistics, Personnel, and Facilities
DPG	Defense Planning Guidance
DT	Developmental Test
DVS	Daylight Video Sight

EA	Evolutionary Acquisition

EFA	Early Functional Assessment
EMD	Engineering and Manufacturing Development
EPLRS	Enhanced Position Location Reporting System
ET	Embedded Training
FAR	*Federal Acquisition Regulation*
FAT	First Article Testing
FAWG	Force Application Working Group
FBCB2	Force XXI Battle Command Brigade & Below
FCB	Functional Capabilities Board
FCS	Future Combat Systems
FFID	Future Force Integration Division
FFW	Future Force Warrior
FNA	Functional Needs Analysis
FOB	Forward Operating Base
FSA	Functional Solutions Analysis
FSR	Field Service Representative
FUE	First Unit Equipped
FWTI	Future Warrior Technology Integration
FY	Fiscal Year
FYDP	Future Year's Defense Plan
GAO	General Accountability Office
GDDS	General Dynamics Decision Systems
GDC4S	General Dynamics C4 Systems
GFE	Government-furnished Equipment
GPS	Global Positioning System
GSE	Ground Soldier Ensemble
GSS	Ground Soldier System
HASC	House Armed Services Committee

HIS	Headgear Integrated Subsystem
HMD	Helmet-mounted Display
HQDA	Headquarters, Department of the Army
HUMINT	Human Intelligence
IBA	Interceptor Body Armor
IB-CSAS	Integrated Battlefield Combat Situational Awareness System
IBCT	Interim Brigade Combat Team
ICD	Initial Capabilities Document
IDIQ	Indefinite Delivery, Indefinite Quantity
IG	Inspector General
INFOSYS	Information Systems
IOT&E	Initial Operational Test & Evaluation
IPT	Integrated Product Team
IR&D	Internal Research and Development
ISC	Individual Soldier Computer
ISR	Intelligence, Surveillance and Reconnaissance
JCB	Joint Capabilities Board
JCD	Joint Capabilities Document
JCF-AWE	Joint Contingency Force Army Warfighting Experiment
JCIDS	Joint Capabilities Integration Development System
JCTD	Joint Capability Technology Demonstration
JOpsC	Joint Operating Capability
JROC	Joint Requirements Oversight Council
JVMF	Joint Variable Message Format
JWSTP	Joint Warfighting Science and Technology Plan
KPP	Key Performance Parameters
KSA	Key System Attributes

LNO	Liaison Officer
LRIP	Low-rate Initial Production
LRU	Line Replaceable Unit
LTI	Lower Tactical Internet
LUT	Limited User Test
LW	Land Warrior
LW-IC	Land Warrior Initial Capability
LW NextGen	Land Warrior Next Generation
LW-SI	Land Warrior Stryker Interoperable
MANPAD	Man Portable Air Defense
MCC/PS	Microclimate Conditioning/Power Subsystem
MCoE	Maneuver Center of Excellence
MDA	Milestone Decision Authority
MDMP	Military Decision-making Process
MEDEVAC	Medical Evacuation
METT-T	Mission, Enemy, Troops Available, Time Available, Terrain
MFL	Multi-function Laser
MGS	Mobile Gun System
MILVAN	Military Van
MOA	Memorandum of Agreement
MOSA	Modular Open System Architecture
MTC	Master Training Course
MSS	Mounted Solider System
MW	Mounted Warrior
NAVICOM	Navigation, Information and Communication System
NCO	Non-commissioned Officer
NCW	Net-centric Warfare
NCWS	Net-centric Warfare Strategy
NET	New Equipment Training

NMS	National Military Strategy
NMSD	National Military Strategy Document
NSS	National Security Strategy
O&O	Operation and Organization
OE	Operational Event
ONS	Operational Needs Statement
OPA	Other Procurement Army
ORD	Operational Requirements Document
OSA	Open Systems Architecture
OSD	Office of the Secretary of Defense
OT	Operational Test
OTA	Other Transactions Agreements
P3I	Pre-planned Product Improvements
PA&E	Program Analysis & Evaluation Office
PBD	Program Budget Decision
PDM	Program Decision Memorandum
PDR	Preliminary Design Review
PEO	Program Executive Office
PM	Program/Product Manager
PMCS	Preventive Maintenance Checks and Services
PME	Peacetime Military Engagement
POM	Program Objective Memorandum
POR	Program of Record
PPBES	Planning, Programming, Budgeting and Execution System
PPBS	Planning, Programming, Budgeting System
RDT&E	Research, Development, Test & Evaluation
RFP	Request for Proposal
RGS	Requirements Generation System

ROE	Rules of Engagement
ROI	Rules of Interaction
RSTA	Reconnaissance, Surveillance and Target Acquisition
S&T	Science & Technology
SA	Situational Awareness
SaaS	Soldier as a System
SASO	Stability and Support Operations
SBCT	Stryker Brigade Combat Team
SDD	System Development and Demonstration
SECDEF	Secretary of Defense
SINCGARS	Single Channel Ground and Airborne Radio System
SIPE	Solider Integrated Protective Ensemble
SOF	Special Operations Forces
SOP	Standard Operating Procedures
SoS	System of Systems
TCM Soldier	TRADOC Capability Manager Soldier
TEISS-D	The Enhanced Integrated Soldier System-Dismounted
TEMP	Test and Evaluation Master Plan
TRAC	TRADOC Analysis Center
TRAC-WSMR	TRADOC Analysis Center, White Sands, New Mexico
TRADOC	US Army Training and Doctrine Command
TSM Soldier	TRADOC Systems Manager Soldier
TTP	Tactics, Techniques and Procedures
TWS	Thermal Weapon Site
USAIC	United States Army Infantry Center
USD (AT&L)	Undersecretary of Defense for Acquisition Technology & Logistics
USI	Unit System Integrator

VCSA	Vice-Chief of Staff of the Army
VIK	Vehicle Integration Kit
WLAN	Wireless Local Area Network
WMD	Weapons of Mass Destruction
WSS	Weapon Subsystem
WTCV	Weapons and Tracked Combat Vehicles
WUI	Weapon User Interface

I. Introduction

> Our warfighting edge is the combined effect of quality people, trained to razor sharpness, outfitted with modern equipment, led by tough, competent leaders, structured into an appropriate mix of forces by type, and employed according to up-to-date doctrine[...]. I am certain the single most important factor is the soldier. (Haley et al., 1991, p. 4)

> The Nation has entrusted the Army with preserving its peace and freedom, defending its democracy, and providing opportunities for its Soldiers to serve the country and personally develop their skills and citizenship. Consequently, we are and will continuously strive to remain among the most respected institutions in the United States. To fulfill our solemn obligation to the Nation, we must remain the preeminent land power on earth—the ultimate instrument of national resolve; strategically dominant on the ground where our Soldiers' engagements are decisive. (Department of the Army, 2005, p. 17)

The United States military has achieved radical technological advances in the last twenty years. Military combat vehicles, aircraft and missile defense systems have evolved from their Vietnam-era predecessors (which, at the time were considered technologically superior and first-rate) to revolutionary, network-enabled instruments of combat power. This first-rate equipment, when combined with top-quality soldiers, sailors, marines and airmen, realistic training and intense leader development, has been a key element of our continuing operational successes (Shalikashvili, 1996). *Joint Vision 2010* and *Joint Vision 2020* describe this combination of people, equipment, training and readiness, and leader development as their foundations (1996). Current doctrine carries this vision and tailors it to the realities of the present-day Global War on Terror. *United States Army Field Manual 1* characterizes current Army transformation as the most profound since World War II. Former Secretary of the Army, the Honorable Francis J. Harvey, describes this transformation as a continuous, adaptive cycle of innovation and experimentation informed by experience. The Army has changed its focus from the division level to the brigade level to achieve a more agile, modular force that is organized to fight as part of a joint force (Department of the Army, 2005).

Past efforts to achieve military dominance have spurred publicly announced, as well as highly classified, military-related technological innovation. However, until the invasions of Afghanistan and Iraq, public focus for technological advancement was on systems and combat platforms at the division-level and above—not necessarily on the individual soldier and the small combat unit. After these invasions and swift preliminary successes, the Department of Defense was lauded for a job well done; however, the public realization that US warfighters needed better situational awareness, lethality and survivability at the small combat unit level did not become apparent until highly publicized fighting ensued with the insurgencies in urban and rural areas across both Afghanistan and Iraq. Insurgents, embracing guerilla warfare tactics, attempted to negate our technological superiority by "hugging" our dispersed, small combat unit forces in tight urban and high mountain terrain and, thus, reduced our ability to apply combined arms firepower and leverage joint, cross-boundary operations. In Iraq, they chose dense, urban terrain and close proximity to civilian personnel and infrastructure to ambush, attack and confuse.

Despite vehicle-mounted, blue-force tracking technologies, the infantryman in contact on the ground lost situational awareness. To regain situational awareness, leaders and soldiers alike had to either get back to a combat vehicle or employ outdated, difficult methods such as tracking maneuvering friendly and enemy forces using a radio, map board, compass and grease pencil. As the capability gap in situational awareness at the soldier and small-combat-unit level became more apparent, many commands submitted operational needs statements requesting materiel solutions to resolve their deficits in capability. To date, program managers (PM), vendors and scientists continue to rush to the aid of the military and work diligently to close these gaps.

The Land Warrior (LW) Soldier System has recently closed many of these capability gaps. After 15 years of development, the LW Soldier System has been developed, tested and deployed with soldiers in combat. Its story has been an interesting one. Despite being replete with naysayers, restarts and controversy, its final chapter is yet to be written. LW's revolutionary contributions to the modern battlefield are influencing the way dismounted soldiers fight today and perhaps for years to come.

A. Background

The LW Soldier System need was identified on September 8, 1993. Since its inception, it has been one of the most controversial programs in the United States Army. For a period lasting approximately 15 years, the LW Soldier System has evolved. It has laid the foundation for follow-on soldier system initiatives like Ground Soldier System (GSS) and other complementary Soldier-as-a-System (SaaS) initiatives like Core Soldier System, Mounted Soldier System and Air Soldier System.[1]

The LW Soldier System is a first-generation integrated fighting system for dismounted soldiers. LW is intended to enhance the lethality, command-and-control, survivability, mobility and sustainability of individual soldiers, leaders and infantry units and to be fully interoperable with the digital command-and-control of other platforms.[2] The LW System's capabilities contribute to the *Joint Vision 2010/2020* operational concept of situational awareness and dominant maneuvering by dismounted forces. Its capabilities enable the Army's current focus on brigade-level (and below) adaptability in a joint environment. All four Services, including Special Operations Forces (SOF), have considered LW as a materiel solution to address some of their capability gaps. The Under Secretary of Defense for Acquisition, Technology and Logistics (USD (AT&L)), the Defense Acquisition Executive, designated the LW System as an Acquisition Category IC program on 17 December 2002 because the LW Program met the requirements for an (ACAT) IC program

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[1] Ground Soldier System is now called the Ground Soldier Ensemble (GSE). For more information on SaaS, see Appendix A.

[2] For a complete description of the LW Soldier System, see Appendix B.

based on estimated research, development, test and evaluation (RDT&E) costs (Ugone et al., 2002).

The LW System went through an extensive Doctrine, Organization, Training, Material, Logistics, Personnel, and Facilities (DOTMLPF) assessment and Limited User Test (LUT) in late 2006 and 2007. It then deployed with the first unit equipped, 4th Battalion, 9th Infantry Regiment, 4th Brigade Stryker Brigade Combat Team, 2nd Infantry Division, to Operation Iraqi Freedom from 2007 to 2008. During this deployment, attached teams of contractors, program management personnel and user representatives were on-hand to assist, gain feedback and capture lessons learned. A majority of this data is unrefined and has not been correlated to previous studies or research.

In November 2006, funding for LW and its successors such as Ground Soldier Ensemble (GSE) lost traction with lawmakers, and the program was terminated.[3] However, based on 4-9 Infantry's successful employment of the system in theater and on subsequent Operational Needs Statements (ONS) from both 4th and 5th Brigade Combat Teams, 2nd Infantry Division, both the LW and follow-on GSE Programs have regained congressional funding. The Army is currently in the process of procuring a brigade's worth of the current LW System, in addition to the planned GSE Program. Program Executive Office, Soldier (PEO Soldier), plans to establish the GSE PM in early Fiscal Year (FY) 2009 after the Joint Requirements Oversight Council (JROC) approves the GSE Capability Development Document (CDD) and a Milestone A decision is achieved.

The United States Army has had a difficult time developing, fielding and retaining support for the LW Soldier System. Disagreements originated from conflicting perspectives during the concept refinement phase and through to low-rate

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[3] The Ground Soldier System was re-designated the Ground Soldier Ensemble (GSE) in FY 2008. For consistency, we refer to GSS as GSE from this point forward.

initial production (LRIP). There was a validated requirement for LW, but its intended capabilities and basis of issue (BOI) changed over time based on both conflicts within the materiel development and user communities, as well as on budget concerns. Conflicting views stemmed from the leadership's early focus on designing for leaders' requirements and later emphasis on soldier usability. In other words, Army leadership agreed to the design of a system to provide command-and-control and situational awareness to small combat unit leaders, but during verification and validation, Army leadership switched its focus to the effectiveness of the system at the basic soldier and junior leader level. Compounding this were the technological challenges encountered when trying to connect the dismounted soldier to the network with a materiel solution that was acceptable in form, fit and function. A second contributing factor slowing LW's acceptance was the fact that soldier systems are open to significant amounts of subjectivity and user opinion compared to other system platforms. This is due to the fact that it is not a "one size fits all" system; soldiers come in many different sizes, must be able to perform a diverse mission set ranging from dismounted to airborne to mounted operations, and reside at multiple levels within the current Army formations. Last, complete understanding of the *pros* and *cons* of a system cannot be fully realized until the system is deployed or tested in large enough numbers to demonstrate the second- and third-order effects of changing the way soldiers, leaders and units fight (Kempin, 2008).

These issues are not unique to the LW Program. In a budget-constrained, cost-sensitive defense acquisitions environment that is replete with operational urgency, reliance on commercial off-the-shelf items has become the norm instead of reliance on traditional, developmental methods—especially for soldier programs. The Army is probably getting what is right for soldiers now; however, as our doctrine, organizations and equipment evolve, dismounted soldiers and leaders have to maintain pace, or they will not be integrated with future network-centric formations (Berger, 2008). By providing insights into the lessons learned for the acquisition of the first soldier system, this research will assist future efforts to effectively move the soldier and leader into the digital battlefield.

B. Objectives and Approach of This Study

Despite being the first soldier system to be developed, fielded to infantrymen, deployed to combat operations and then "terminated," the LW System still remains. The LW System will transition to the follow-on GSE—the ground-based soldier's link to the Future Combat Systems (FCS). This fact marks the study of the LW Program as a beneficial and, likewise, necessary exercise for disseminating information on issues of future soldier systems acquisition. For this same reason, this study focuses on capturing the lessons learned from the LW experience and on describing how they can be applied to similar programs. The following were the main questions that arose in our analysis. As such, they represent our key objectives:

- What is the LW Soldier System?
- What are the history and components of the context within which the LW Soldier System was conceived, designed and fielded?
- How did the United States Army organize for and execute the acquisition of the LW Soldier System?
- How did the Product Manager, LW, organize and execute the acquisition of the LW Soldier System?
- How did the prime contractor, General Dynamics, execute the acquisition of the LW Soldier System?
- What are the results of the 4th Battalion, 9th Infantry's experience during training, fielding and deployment of the LW Soldier System?
- What are the budget and policy decisions that affected the acquisition of the LW Solider System?
- What are the lessons learned from the United States Army's acquisition of the LW Soldier System?
- Which lessons can be generalized and applied to other programs for their successful management?

To answer these questions, we employed several methods for collecting and analyzing information. We interviewed key Government and contractor personnel, reviewed historical documentation, consulted with colleagues and faculty, and reviewed after-action reports and interviews with soldiers of 4th Battalion, 9th Infantry Regiment, 4th Brigade Stryker Combat Team, 2nd Infantry Division, Fort Lewis, Washington. These efforts resulted in detailed analyses that are organized into several categorical perspectives. These analyses are then synthesized, and significant issues are drawn out as considerations for future soldier program acquisition efforts.

Interviews of key players within the LW Program, both Government and prime-contractor, were critical to ensuring a complete representation of the issues. We spoke with stakeholders with differing perspectives on the program:

- Former and current Program Executive Office, Soldier,
- Former Program Manager Soldier Warrior,
- Former and current Product Manager LW,
- Training and Doctrine Command Capability Manager Soldier, United States Army Infantry Center,
- Director of Infantry Futures, United States Army Infantry Center,
- Director of Combat Developments, United States Army Infantry Center,
- United States Army Research Institute,
- United States Army Test and Evaluation Command,
- Former and current General Dynamics LW Program Managers,
- Current manager for General Dynamics C4ISR Business Development,
- 4th Battalion, 9th Infantry Regiment, 2nd Infantry Division Leadership and
- Training and Doctrine Analysis Centers Monterey, California, and White Sands, New Mexico.

C. Scope

Notwithstanding our goal to provide a comprehensive case analysis of LW, we could not possibly address all facets of this highly complex program within the scope of an MBA Project Report. There are many important research questions (for example, those dealing with LW contracting strategies) that remain to be investigated. Nor could we interview all relevant LW participants due to time and resource constraints. This report provides an in-depth, yet admittedly initial, analysis. LW thus remains a ripe area for further and more detailed research.

D. Organization of the Report

Chapter I introduces and frames the study. Chapter II provides an overview of the evolution of soldier systems from concept inception to current efforts. This chapter concludes with an overview of LW-related studies and their major findings. Chapter III describes the LW materiel developers' perspectives—including the acquisition strategy, details about its development, production, evaluation and deployment from both the Government and prime contractor's perspectives. Chapter IV provides the users' perspectives by combining information from both the user representative (Training and Doctrine Command System Manager - Soldier) and the first unit equipped (4-9 Infantry). This chapter captures the challenges of fielding new capabilities to a deploying unit and the soldiers' feedback from using LW during both user assessments and combat operations in Operation Iraqi Freedom. Chapter V delves into the budget decisions affecting the LW Program. Affordability and funding considerations—along with LW-specific budget decisions—are explained in an effort to build context to explain key programmatic decisions described later in the study. Chapter VI develops the way ahead for soldier systems by synthesizing previous chapters' analyses and highlighting key lessons learned from this study. We tie lessons learned into the strategic perspective for Department of Defense (DoD) acquisition and provide some issues that should be considered as the LW Program transitions to the GSE Program in FY 2009. Chapter VI concludes with several recommendations for further research.

II. The Historical Context for the Land Warrior System

> When the smoke cleared away, it was the man with the sword, or the crossbow, or the rifle who settled the final issue on the battlefield. (Urlings, 2004, p. 4)

> To adjust the condition of the Army to better meet the requirements of the next century, we articulate this vision: "Soldiers on point for the nation transforming this, the most respected army in the world, to a strategically responsive force that is dominant across the full spectrum of operations." With that overarching goal to frame us, the Army will undergo a major transformation. (Shinseki, 2000, p. 2)

Two schools of thought prevail in the challenge to develop cutting-edge, soldier-related technology. The first, as Marshall points out, is rudimentary: keep it simple—combat is hard enough; leave the technological enablers at the strategic level because in the end, it is the soldier on the ground that fights and wins on the battlefield. The second, as General Shinseki asserts above, is transformation: harness technological advances and push technology down to the tip of the spear to keep the warfighter in-step with the ever-changing battlefield of tomorrow. Both schools of thought are applicable and, when combined, help strike the precarious balance that must be achieved to provide the warfighter with the right equipment for the job. Like the formal acquisition process, the business of developing wearable, fightable, state-of-art soldier systems is a complex one. Full appreciation of the types of general issues raised, as well as methods implemented during the LW concept and product development, demonstration, production and deployment requires a full understanding of its context. The context for the LW System is best illustrated by providing historical information about its development. Furthermore, a brief description of notable supporting research about LW provides a point of departure for our study and its findings.[4]

A. An Abbreviated History of the LW Soldier System

> An Army is capable of functioning without horses or cannons, but an Army ceases to exist without Soldiers. (Jones, 2006, p. 1)

> Know the enemy and know yourself, in a hundred battles you will never know peril. When you are ignorant of the enemy but know yourself, your chances of winning or losing are equal. If ignorant of both your enemy and yourself, you are certain in every battle to be in peril. (Sun Tzu, 1910, p. 50)

> The general unreliability of all information presents a special problem: all action takes place, so to speak, in a kind of twilight…like fog. War is the realm of uncertainty; three quarters of the factors on which action in war is based are wrapped in a fog of greater or lesser uncertainty…The commander must work in a medium which his eyes cannot see, which his best deductive powers cannot always fathom; and [with] which, because of constant changes, he can rarely be familiar. (Von Clausewitz, 1908, p. 5)

B. Soldier System Origins

History includes many examples of the need for addressing the soldier as a system. Just after World War II, in his book *The Soldier's Load*, S.L.A. Marshall recognized the need to manage the soldier as a complete system in order to make the soldier more efficient and effective. BG Marshall pointed out that more thought and care was needed in the overall design of not only what soldiers are expected to carry into battle, but also of how they carry the total ensemble more efficiently and effectively (as cited in Jones, 2006). In general, this mindset has driven past and current science and technology (S&T) efforts to combine soldier equipment in a system-like manner to reduce size, weight and power requirments for what the soldier has to carry.

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[4] Also important to understand is the strategy that LW has evolved to operate within the Net-centric Warfare Strategy (NCWS). The NCWS and the digital battlefield are detailed in Appendix C. In addition, LW resides within the overarching SaaS strategy, which is outlined in Appendix A.

In addition to addressing the soldier as a system, the importance of communication between individuals, units and joint forces has become a critical capability gap for the current force. "Information, information processing, and communications networks are at the core of every military activity. Throughout history, military leaders have regarded information superiority as a key enabler of victory" (Shelton, 2000, p. 8). Since its inception, the Army has worked diligently to provide the right type of communication systems, information-processing tools and situational-awareness enablers to its forces to enable information dominance.

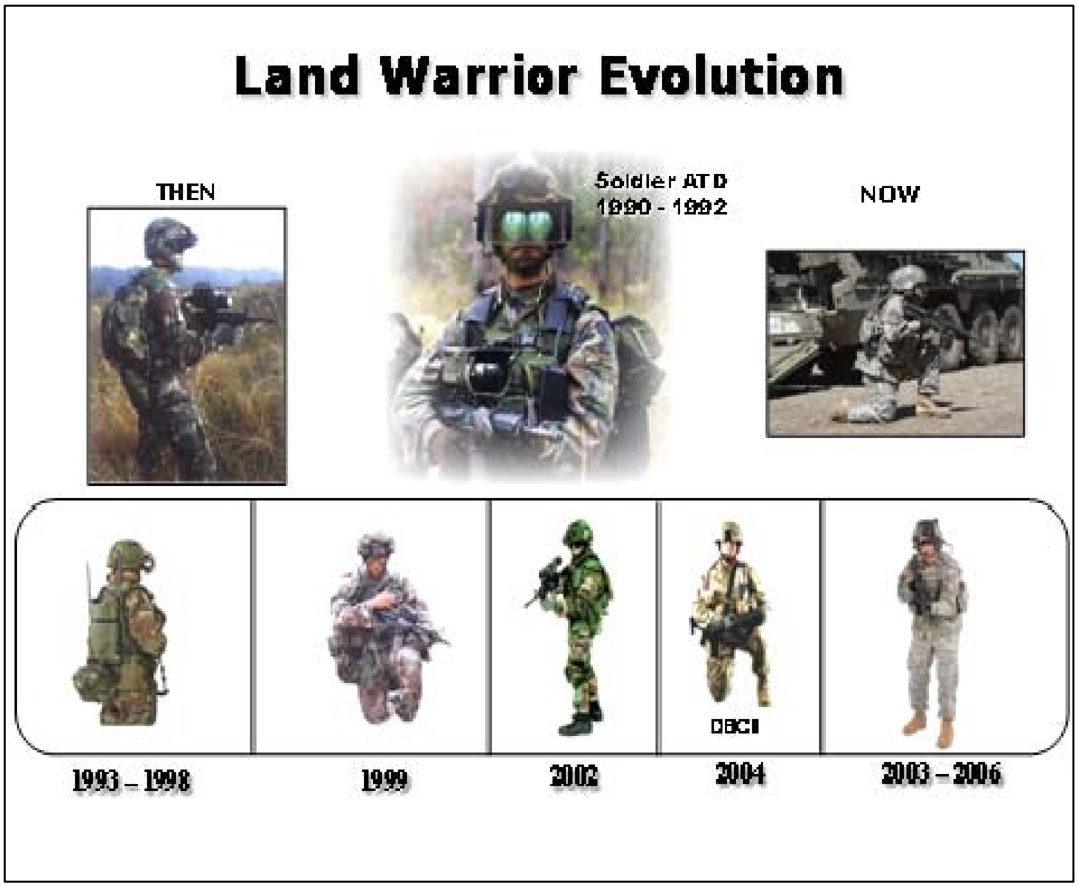

Figure 1. The Land Warrior Evolution
(Copeland, 2006)

C. The Soldier's Computer

Almost twenty years ago, in the late 1980s, a research analyst, James Schoening, "envisioned a small, wearable computer, integrated with a wireless link and helmet-mounted display (HMD), which could help individual soldiers on the front line" (Zieniewicz, Johnson, Wong & Flatt, 2002, p. 30). Along with a colleague, he transformed his idea into a system architecture with "targeted technologies, such as wireless data transmission, image capture, integrated Global Positioning System (GPS) receivers and menu-driven software" (2002, p. 30). By 1990, they put their ideas together and presented an early surrogate system—the Soldier's Computer (see Figure 2 below)—at the Army Materiel Command's trade show in Aberdeen, Maryland. It weighed approximately ten pounds, included software for creating reports and displaying tactical maps and used a trackball for data input. Soldiers could also transmit simple text reports to other units. The system was a success with senior Army leaders and congressional staff members. Thus, as the Soldier's Computer, the soldier system concept was quietly born.

Figure 2. The Soldier's Computer at First Trade Show in 1990
(Zieniewicz et al., 2002)

D. SIPE ATD

The Soldier's Computer shifted from a proprietary "brick" design to an open system, wearable design in 1991 (Zieniewicz et al., 2002). This concept served as the key component for the Soldier Integrated Protective Ensemble, Advanced Technology Demonstration (SIPE ATD). This initiative, led by Mrs. Carol Fitzgerald, was a three-year, 6.3A[5] program initiated by the Department of the Army in March 1990. The SIPE ATD was to provide a "proof of principle" of the soldier as a system (Middleton, Sutton, McIntyre & O'Keefe, 2000). More specifically, its goal was to join the soldier's entire individual electronic components (e.g., radio, weapons, etc.) into a single integrated system.

Successful testing of the SIPE ATD by soldiers at Fort Benning, Georgia, in 1992 solidified the concept from the users' perspective. This was the Army's first attempt at "digitizing" the individual soldier, and the soldiers who used the system were in awe (Zieniewicz et al., 2002). In particular, the soldiers were most impressed with the Thermal Weapon Sight (TWS), which fed directly to the helmet display, enabling them to fire around corners without exposing their upper torso and head to the enemy (Fernandez, 1992).

In addition to the TWS capability, the SIPE ATD demonstrated other components.

> The Headgear Integrated Subsystem (HIS), Weapon Subsystem (WSS) and the Individual Soldier Computer (ISC) significantly enhanced lethality by allowing the soldier to detect, identify, acquire and engage enemy targets at increased ranges during both day and

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[5] The DoD organizes its budget into 11 major force programs. One of these major force programs is Program 6—Research, Development, Test, and Evaluation. These program elements fund all research and development activities for weapon systems and forces that have not yet been approved for operational use. The category has six subcategories: 6.1, basic research; 6.2, applied research; 6.3a, advanced technology development; 6.3b, demonstration and validation (DEMVAL) activities; 6.4, engineering and manufacturing development, which completes engineering for and development of products that the Services will use (production-quality blueprints are typically an output); 6.5, RDT&E management support; and 6.6, operational systems development (CBO, 2008).

night and with improved accuracy. The HIS, WSS, and ISC proved to be vital to increasing the squad leader's capability to communicate with both superiors and subordinates, as well as to exercise more positive command-and-control over personnel, weapons, equipment, information and procedures. The Advanced Clothing Subsystem (ACS) and Microclimate Conditioning/Power Subsystem (MCC/PS) provided multi-threat and environmental protection while allowing the soldier to operate longer in a fully encapsulated mode.

The soldier's survivability was enhanced by the combination of the HIS, WSS and ISC, as well as by the ability to operate with greater dispersion, indirect viewing and increased lethality. (Middleton et al., 2000, p. 2).

Figure 3 below shows a soldier wearing the SIPE in 1992.

Figure 3. Soldier Wearing the SIPE During Testing in 1992[6]
(Fernandez, 1992)

Although each of the SIPE components provided the dismounted soldier tactical and operational benefits, it was determined that the greatest payoff was the synergistic effect of the various components working together, improving survivability

[6] The visor reduced ambient light and was a flip-up, flip-down display. It also provided ballistic and laser protection. The right-mounted sensor on the helmet's top was an image intensifier for night-vision capabilities. The large brown case is the computer radio-GPS unit.

and performance on the battlefield (Middleton et al., 2000). The integrated, yet modular, nature of SIPE enhanced mobility by allowing equipment to be configured based upon the mission, enemy, troops available, time available and the terrain (METT-T) (Middleton et al., 2000). As a direct result of the SIPE ATD, the capabilities in Figure 4 transitioned into LW full-scale development beginning in 1993.

Soldier to Soldier Communications	Weapons Interface
Integrated Video-enhanced Image Intensification (I2)	Ballistic, Laser Eye and Respiratory Protection
Advanced Uniform Components	Integrated Body Armor/Ammunition Carriage
Handwear	Footwear
Load-bearing Equipment	M16A2
Thermal Sight	Laser-aiming Light
Individual Soldier Computer	Global Positioning/Digital Mapping
Message Management/Reporting	Video Capture
Digital Compass	

Figure 4. Capabilities Transitioned from the SIPE ATD to the LW Program
(Middleton et al., 2000)

Although the SIPE ATD system enhanced the soldier's fighting capability, it needed to be more compact, lighter and to operate longer before it would be battlefield ready. The backpack-sized computer-radio-GPS unit weighed 18 pounds; the Helmet-mounted Display (HMD) integrated into the helmet weighed 8 pounds, and the high-voltage supply unit (driving the cathode ray tube-based display) weighed 15 pounds. Delays in capturing and sending still video images needed improvement, as existing communication channel capacities were maximized, and transmission delays of 45 to 75 seconds were causing the system to shut down. Clearly, soldier systems needed more work to take early materiel solutions and evolve them into combat-ready battlefield enablers.

E. The LW Soldier System

After two-and-a-half years of work within the SIPE ATD, the Chief of Staff of the Army was enthusiastic about furthering efforts to field an integrated fighting system with a wearable computer-radio-GPS unit for soldiers (Zieniewicz et al., 2002). On 8 September 1993, Headquarters, Department of the Army approved the mission needs statement for the LW Soldier System. After this approval, the LW project officially began. Its aim was to significantly improve and enhance the soldier's capability to shoot, move, communicate and survive on the future battlefield. Incorporated into the LW project were the capabilities offered from the SIPE ATD (see Figure 4 above), as well as additional capabilities such as mission data and manual storage devices. LW technologies were based on communications, computing, control, command, intelligence, sensor and reconnaissance (C4ISR). Efforts were made in the area of human factors engineering to make the system more user-friendly and comfortable, and strides were taken to reduce the weight and power requirements of the early SIPE ATD prototypes.

Design engineers faced other significant challenges, such as the range of LW's intended operational environment. Providing for extreme weather conditions and waterproofing requirements took considerable efforts. In sum, LW had to be easy to use, weigh almost nothing, work all day and all night, be rugged enough to withstand the rigors of intense combat, be comfortable to wear and be conveniently located on the body.

In 1994, the Army started writing the Operational Requirements Document[7] (ORD) for the LW Soldier System. The United States Army Infantry School provided the initial doctrine for the ORD. For a year, users and technical experts conceived

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[7] The ORD was replaced by the Capability Development Document (CDD) with the advent of the Joint Capabilities Integration Development System (JCIDS) process. See Appendix D for a description of the JCIDS process.

and reviewed LW's requirements' feasibility and applicability. Once the ORD was complete, the TRADOC Systems Manager, Soldier[8] at Fort Benning briefed the user requirements to the PM for Soldier Systems[9] and, thus, began the next phase of LW's acquisition lifecycle: materiel development.

The materiel developer, in coordination with the user, developed performance-based system specifications—describing what the system should do and specifying interface standards between components and other systems. The primary materiel developers (PM, Soldier Systems and PM, Soldier Electronics) wrote the system performance specifications as well as the contract for developing the system.

Hughes Aircraft (now Raytheon) was selected as the prime contractor for system development; however, in April 1998, technical difficulties (failed immersion and electromagnetic interference requirements) resulted in a program restructure. The Army decided to use an innovative approach, moving from "proprietary development" to one that maximized use of COTS technologies. A consortium of contractors was established, vice a prime contractor for system development (Augustine, 2008a). This consortium of contractors worked with the Government to allocate requirements to the subsystem level. Through the late 1990s, these contractors performed detailed design, build, integration and test tasks to produce the LW System (Zieniewicz et al., 2002).

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[8] Now known as TRADOC Capabilities Manager, Soldier (TCM Soldier). For consistency, we refer to TSM Soldier as TCM Soldier from this point forward.

[9] Now known as the Program Executive Officer, Soldier (PEO Soldier).

Figure 5. LW v0.6 in September 2000
(Zieniewicz et al., 2002)

F. LW Version 0.6

In 1999, work began on the first rugged design of LW: LW Version 0.6 (v0.6) (see Figure 5 above). The LW v0.6 used commercial off-the-shelf (COTS) and Government-furnished equipment/components (GFE), packaged to accommodate the users' operational requirements (Zieniewicz et al., 2002). The goal was to present it at the Joint Contingency Force Army Warfighting Experiment (JCF AWE) the following year, in September 2000. The plan was briefed at the highest levels, and during the Soldier Systems Review on 7 December 1999, senior Army leadership made the decision for LW to participate in the JCF AWE (Berger, 2008).

After over a decade of research, development and testing, in September of 2000, the LW v0.6 (see Figure 5 above) made it to the field with real soldiers at the JCF AWE at Fort Polk, Louisiana. LW v0.6 was tested during three different mission sets. The mission sets were completed with one platoon of 45 infantrymen from the 82nd Airborne from Fort Bragg, North Carolina, outfitted with the LW v0.6. A conventionally equipped opposition force made up of soldiers from Fort Polk, Louisiana, simulated enemy personnel. The first mission was to conduct a parachute assault and follow-on airfield seizure/security under conditions of limited visibility (at night). The second mission was an assault on a village, simulating urban terrain. The third mission was an ambush conducted at night (Zieniewicz et al., 2002).

During the conduct of the missions, using their helmet-mounted displays, soldiers could see their own locations and the location of the members of their unit. Wireless voice and message communication proved beneficial as well. Automatically transmitted situational reports allowed the platoon to assemble in the dark in record time. Night-vision image intensifiers proved advantageous while soldiers were lying in ambush. Overall, the system performed well, showed an improvement in fighting capabilities, and the results impressed the soldiers (2002).

The first major test of a working LW prototype was successful. By all accounts, the LW platoon scored high marks in lethality, situational awareness, navigation, and fratricide avoidance due to the LW leaders' capability to track their own troops. The final report from the JCF AWE experience noted:

> The mission test results broke all records when compared with previously equipped soldier results, hence proving the efficiency of wearable electronics in military applications by achieving revolutionary improvements in performance and the realization of capabilities never before imagined on the battlefield. (Zieniewicz et al., 2002, p. 37)

During 2001, substantial work was done on the LW ORD by Fort Benning and TRADOC. ORD requirements were restructured and put into a new format that attempted to link it to the Future Combat System (FCS)-enabled Objective Force Concept (Berger, 2008). This concept was only in draft and was, at the time, not yet approved. TRADOC Capability Manager Soldier (TCM Soldier) worked diligently to scope LW in the light of the Objective Force Concept. Hand-in-hand with the materiel developer, TCM Soldier rewrote the Operational & Organizational (O&O) Concept. The revised ORD was approved by TRADOC on 31 October 2001 and forwarded to Headquarters, Department of the Army (Berger, 2008).

Also during 2001, the materiel developer worked on the system's size, weight, power and communications issues. As far as size and weight were concerned, the LW v0.6 weighed 91 pounds with no relief in sight for the next increment, the LW Initial Capability (LW-IC) (Block I). Power issues were a major challenge, as conventional units were using up to one ton of batteries per day per infantry battalion. Both the materiel developer and the user realized that this would become a key dynamic of the basis of issue (BOI) equation: in other words, who would get LW and in what quantities. Compounding the logistics supportability issues was another dynamic of the BOI equation: cost per unit. Cost per unit was upwards of $32,000 per system at the time (D. Gallop, personal communication, November 3, 2008). While cost per unit remained an issue, logistics supportability ideas like vehicle-mounted battery charging were considered for future implementation. Communication issues were centered on whether or not to make the LW a secure communications system and how to connect it to the lower tactical internet (Berger, 2008). Developers wrestled over connectivity challenges associated with linking a dismounted materiel solution to the Lower Tactical Internet (LTI). The significant constraint to connectivity to the LTI was the L-Band gateway of complementary systems like FBCB2 and Blue Force Tracker (BFT) (D. Gallop, personal communication, November 3, 2008). Dismounted units did not "carry" these complementary systems on their backs—they were only resident on vehicles. These Army-wide issues were bigger than LW, but definitely had to be considerations during development.

Additional guidance on the acquisition timeline for LW was given in late 2001. Developmental testing (DT) for LW-IC (Block I) was to begin in October 2002, with training for operational testing (OT) beginning in April 2003. Operational testing was to take place in June 2003, right before the planned Milestone C Low-rate Initial Production (LRIP) decision in August 2003 (Berger, 2008).

Figure 6. LW Initial Capability Block 1.0
(Zieniewicz et al., 2002)

G. LW Initial Capability (LW-IC) Block I

LW-IC (Block I) (see Figure 6) spent 2002 in system development and demonstration. It was being developed using an Other Transactions Agreement (OTA)[10] with a consortium of "best of breed" contractors known as the LW Consortium (D. Gallop, personal communication, November 3, 2008). In 2002, its designers completed the critical design review (CDR). Also in 2002, efforts by the combat developer and user representative to establish the threshold LW capability as a bridge to the Objective Force continued. In November 2002, the Chief of Staff of the Army approved the LW ORD; subsequently, on 17 December 2002, it was designated an ACAT IC program (Berger, 2008).

The Product Manager for LW (PM LW) was working several issues at the same time during 2002. While LW-IC (Block I) was his focus, he was also working on competing a contract for LW Stryker Interoperable (LW-SI) Block II development. To establish a functional baseline—to determine what he had with the LW-IC (Block I) in an attempt to inform the LW-SI Block II developmental effort—he completed an ATEC-run early functional assessment (EFA) at Aberdeen Proving Ground with soldiers from the 82nd Airborne in December 2002. Based on their assessment, LW-IC was determined unreliable. The issue was that the LW-IC used a commercial-based architecture that was not robust enough for soldiers' needs and did not provide connectivity to the LTI. Regardless, the EFA accomplished the PM's intent; it established a functional baseline for LW-SI Block II developmental efforts (D. Gallop, personal communication, November 3, 2008).

Further developmental testing was planned to continue through March of 2003 in preparation for Initial Operational Test and Evaluation (IOT&E), which would begin in the 3rd Quarter of FY 2003. The first units scheduled to be equipped with

[10] An OTA is a transaction agreement characterized by enhanced flexibility and reduced administrative burden when compared with typical Government procurement contracts (Department of the Army, 2008).

the system were the 75th Ranger Regiment, followed by the newly formed Stryker Brigade Combat Teams (SBCT) and selected Special Operations Forces (SOF) (Berger, 2008). The PM LW wanted to give the intended end-user a vote as to LW-IC's form, fit and function (D. Gallop, personal communication, November 3, 2008). Thus, in January 2003, the 75th Ranger Regiment conducted a second early functional assessment (EFA) of the LW-IC (Block I) system. Results were available upon completion in February, and they were very distressing to both the materiel developer and the user representative. Similar to the 82nd's EFA the previous winter, issues surrounding reliability were the Rangers' main concern. These concerns, coupled with cost per unit and LTI connectivity challenges forced Congress and the PEO Soldier to dissolve the OTA with the LW Consortium for the development of LW-IC (Block I) (J. Moran, personal communication, October 27, 2008).

This decision halted production of the 140 systems being produced for the IOT&E. Furthermore, PEO Soldier indefinitely delayed IOT&E (previously scheduled to begin in the late spring) in favor of a different materiel solution, the Dismounted Battle Command System (DBCS)[11] (D. Gallop, personal communication, November 3, 2008). His reasoning for this choice came down to two issues: affordability and senior leadership directives. With respect to affordability, the DBCS was a materiel solution that met most of the LW requirements with a BOI that was palatable from a cost perspective—leader-focused instead of soldier-focused. From the senior leadership's perspective, Headquarters, Department of the Army (HQDA) and the Congress provided directive guidance to develop the DBCS materiel solution. On the other hand, the TCM Soldier, Colonel Ernie Forrest, was adamant that the optimal materiel solution was LW due to its lethality component, the WSS, as well as its intended BOI to every soldier. He wanted to capitalize on the synergistic effect of

[11] The DBCS was a material solution that provided LW-like situational awareness and communication capabilities. For a detailed description of DBCS, see Appendix E.

an interconnected force with a lethality package that allowed the user's hands to remain on the weapon. From the materiel developer's perspective, there was impartiality as to the form factor. The former PEO Soldier stated that he viewed getting the dismounted soldier capability in one of two form factors: "having either a handheld tablet [DBCS] or an eye-piece [LW]…I was impartial to either of them" (J. Moran, personal communication, October 27, 2008). Regardless, the OTA for LW-IC (Block I) development was officially dissolved in March 2003, and DT was stopped (D. Gallop, personal communication, November 3, 2008).

H. LW Block II

After the Rangers conducted their early functional assessment, but prior to the results being released on 30 January 2003, General Dynamics C4 Systems (GDC4S) was awarded the LW contract as the prime contractor for the design and production of LW Block II. Since GDC4S was awarded the contract for producing the LW Block II, PEO Soldier directed GDC4S to re-scope and develop both LW-IC (Block I) and LW Block II Systems for Stryker units instead of the Rangers. "This directive was based on HQDA guidance to restructure the program around the LW-SI capabilities to leverage the existing Stryker EPLRS network to connect with the LTI" (D. Gallop, personal communication, November 3, 2008). Later that spring, the Commanding General, United States Army Infantry Center[12] (USAIC), signed a memorandum approving an update to the Critical Operational Issues and Criteria (COIC). This update to the COIC reflected the aforementioned LW Program restructure activities and the combining of the LW Block I and II efforts. The COIC was approved for LW Block II by Headquarters, Department of the Army, on 30 September 2003 (Berger, 2008).

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[12] Now known as the Maneuver Center of Excellence (MCoE).

GDC4S wasted no time after contract award, and the preliminary design review (PDR) was conducted for LW Block II on 30 July 2003. In late November, two issues came up. First, LW did not have an interoperability certification from the J6. Second, it was determined that an Analysis of Alternatives (AoA) had been started, but not completed for LW (Berger, 2008). The AoA had yet to be restarted when the LW Consortium OTA was dissolved earlier in the year. J6 certification[13] was completed; however, the AoA conducted—jointly by TRADOC Analysis Center-White Sands (TRAC WSMR) and the TCM Soldier—would not be completed for almost a year. For LW, calendar year 2003 ended with the approval of the LW Test and Evaluation Master Plan (TEMP) on 8 December 2003 (Berger, 2008).

The events of 2004 shaped the future of LW as we know it today. In August 2004, soon after completion of the LW Block II CDR on 27 May 2004, the Army reduced the funding for the LW Program in the FY 2006-2011 Program Objective Memorandum (POM) in favor of the DBCS (Augustine, 2008a). Procurement was refocused to fielding emerging situational awareness and command-and-control capabilities to the current force and merged the LW and FFW Advanced Concept Technology Demonstration (ACTD) to focus on the future force[14] (US House of Representatives, 2004a).

Immediately following this decision, the Commanding General, USAIC, and PEO Soldier briefed the Army Systems Acquisition Review Council (ASARC) to confirm the strategy to resource soldier modernization. The Chief of Infantry submitted a proposal, addressing the Army's need for an integrated modular soldier system to improve the warfighters' ability to fight in the Global War on Terror (GWOT). His proposal included funding to conduct a DOTMLPF assessment with a battalion within a Stryker Brigade Combat Team (SBCT). The intent of this

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13 J-6 System Validation of Joint Capabilities Integration and Development System (JCIDS) Acquisition Category (ACAT) programs/systems (CJCS, 2006).
14 For a detailed description of the FFW ACTD, see Appendix F.

assessment was to explore LW basis of issue (BOI) alternatives within the construct of a SBCT. A secondary benefit of the assessment was further refinement of the capabilities required in the future with Future Combat Systems (FCS) (Berger, 2008).

To reinforce the value of his proposal, the Chief of Infantry ordered a demonstration of LW Block II. Even though LW's funding was reduced in the POM, research and development had continued with GDC4S when it was returned to the tech-base for maturation in mid-2004 (Augustine, 2008a). GDC4S had prototype systems ready to demonstrate, and this venue would prove to breathe life back into the program.

From September to November, a side-by-side experiment was run at Fort Benning, Georgia, comparing the capabilities of a LW-equipped squad with those of a conventionally equipped squad. This "side-by-side" was successful in that it demonstrated tangible LW-enabled capabilities to decision-makers. Immediately following the "side-by-side," the Vice Chief of Staff of the Army, General Cody, recommended (in FY 2006) the equipping of one Stryker Battalion with LW-SI (Block II) capabilities (440 systems). Based on this recommended course of action, the Assistant Secretary of the Army for Acquisition, Logistics and Technology (ASA(ALT)) directed the equipping of a Stryker Battalion with LW to conduct a DOTMLPF assessment and tactics, techniques and procedures (TTP) development.[15] The Stryker Battalion chosen was the 2nd Cavalry Regiment, 2nd Infantry Division, Fort Lewis, Washington.[16] This directive did not reverse the previous POM decision to reduce the LW Program; however, it gave the program one last opportunity to prove its value for the Army (Berger, 2008).

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[15] See Appendix G for the memo directing the equipping of a Stryker Battalion with LW to conduct a DOTMLPF assessment and tactics, techniques and procedures development.

[16] Redesignated 4th Battalion, 9th Infantry Regiment, 4th Stryker Brigade Combat Team, 2nd Infantry Division.

I. LW Stryker Interoperable (LW-SI)—"Manchu"

In 2005, conditions were set for LW-SI (Block II) fielding to the 4th Battalion, 9th Infantry Regiment (Manchus) at Fort Lewis, Washington. The Manchus were reorganized and started standing up as new soldiers reported for duty and the chain of command was established. An agreement to do a limited user test (LUT) in conjunction with the DOTMLPF assessment was approved by unit leadership. GDC4S and the PM LW initiated further production of prototype LW-SI (Block II) Systems in preparation for the first unit to be equipped with soldier systems. By the end of the year, the train-the-trainer course began for the Manchus (Berger, 2008).

Systems production, testing and evaluation continued through May 2006. The unit received its LW-SI (Block II) systems and started new equipment training in June. DOTMLPF assessment activities paralleled unit-training activities throughout the rest of the year. Soldiers and materiel developers worked hand-in-hand on system upgrades and ergonomic improvements throughout the summer (Augustine, 2008a). The result was a user-improved LW-SI (Block II) named the "Manchu," the battalion's namesake (see Figure 7 below). These systems were not re-issued systems. They were user-improved systems, not new prototypes. They were the same prototype systems that underwent soldier-improved software and hardware upgrades and configurations (Augustine, 2008a).

Figure 7. LW “Manchu” Configuration
(Zieniewicz et al., 2002)

By the end of October 2006, the unit had embraced LW and demonstrated its capabilities at two VIP days. Initially, at the first VIP day in July 2006 (which was synchronized with the budget cycle by program management personnel), the unit expressed frustration with the system’s capabilities, configuration and weight. However, by the second VIP day, in October 2006, unit acceptance was achieved; the commander of 4-9 Infantry Regiment, LTC W.W. Prior, announced that he wanted to take both LW and its mounted counterpart, Mounted Warrior (MW), to Iraq in 2007.[17] The unit acceptance that influenced his decision was a direct result of the extensive soldier-driven, material developer-executed improvements to the system (Berger, 2008). The ATEC-run limited user test (LUT) conducted in September produced favorable results as well and reinforced his decision.

Almost immediately following LTC Prior’s decision, the LW Program was terminated by the Army. This termination was a direct result of the perception that Army decision-makers had of the program based on the dissatisfaction that 4-9

[17] For a detailed description of the Mounted Warrior system, see Appendix H.

Infantry expressed during the first VIP day (Cummings, 2008, July 17). In addition, a Milestone C Low-rate Initial Production (LRIP) decision was attempted in early 2007 but in the end, was denied by the Army. Regardless of these decisions, the Army supported LTC Prior's request, and LW was deployed to Iraq with his battalion in May of 2007.

The materiel developer and the users' representative accompanied 4-9 Infantry to conduct an in-country DOTMLPF assessment, as well as maintenance and logistics support (Cummings, 2008, July 17). After approximately six months of successful combat operations with the 4-9 Infantry, LW became very popular; other units were eager to see how well the system performed. During the deployment, a sister unit of the brigade to which 4-9 Infantry was assigned (5th Brigade, 2nd Infantry Division) was so impressed with the system's performance that its commander submitted an Operational Needs Statement (ONS) for the LW (2008, July 17). Funding for the ONS was approved through a supplemental budget request in May 2008 to conduct this equipping. At the time of this writing, efforts were underway to train the rest of this brigade on the LW System (US Senate, 2008).

To date, lessons learned and after-action reports from 4-9 Infantry Regiment's in-country experience are being compiled to capture the effectiveness of the LW Soldier System. These reports will provide a way ahead for the GSE[18]—the soldier system of tomorrow.

J. LW Supporting Studies and Related Research

From studies on human factors engineering to science and technology research, LW has had its share of attention in the past. Numerous supporting

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18In an effort to explain the importance of LW relative to the future GSE, the researchers wish to stress the origins and current status of the SaaS initiative and the GSE Program itself. See Appendix A for a complete overview of SaaS and Appendix I GSE Program Description.

studies, reports and research have been completed by academia, industry and the Department of Defense. This study builds upon the foundations of those studies in an attempt to gain insights for present and future program managers. To provide a point of departure for this study, a brief summary of eight key LW supporting studies and reports follows.

K. 1991 Army Science Board (ASB) Summer Study

In 1991, the ASB conducted a summer study with the following objectives:

> [E]valuate all aspects of the "soldier as a system"; consider how we do business today and whether that should change for the future; identify potential soldier performance "leap-aheads" and enabling technologies; consider psychological and physiological interfaces and assess science and technology: "Is it good enough?". (Haley et al., 1991, p. 1)

The 1991 summer study came to the following five conclusions:

1. The requirement to properly equip the soldier for combat is as complex as the requirements of other programs—such as the Abrams tank, Bradley Fighting Vehicle, Patriot Missile System, and Black Hawk helicopter programs;
2. Existing soldier equipment mismatches (due to lack of integration) are reducing combat efficiency and endangering soldiers;
3. The planned "block change" concept of equipping the force (no new equipment is fielded until enough is procured for the entire Army) is an outdated concept;
4. Promising new technological capabilities should be exploited to ensure battlefield overmatch for the American soldier; and,
5. The Army should develop and employ experimentation (wargaming and simulations) with emphasis on future soldier system threats (Lockhart, 2006).

The study further concluded that there was a need for the Army to manage the soldier as a system. It recommended that soldier requirements be derived from the functions soldiers have to perform in the face of the threat on future battlefields.

It also recommended that TRADOC provide prioritized capability needs in the form of requirements to guide the DOTMLPF development process for future soldier systems (Lockhart, 2006).

Last, the 1991 summer study surmised that the TCM Soldier's ability to effectively perform all functions within the existing manpower resources was questionable at best due to its greater breadth of responsibilities as compared to other TCMs. Due to multiple program requirements and the complexity associated with achieving required capabilities, the study further recommended that a general officer manage the acquisition of soldier systems (2006).

While the findings of the 1991 study were supported in most Army circles, they lacked an authoritative sponsoring force to guide the recommendations into Army-wide practice. Interestingly, shortly after its publication, the SIPE ATD verified the study's findings. The SIPE ATD demonstrated the soldier as a system, as well as the capability management necessary when developing systems for the soldier.

L. 1994 ASB Ad Hoc Study "Technology for the Future LW"

Momentum was building thanks to the successes of the SIPE ATD and the drafting of the LW ORD; thus, in 1994, the ASB conducted an ad hoc study entitled *Technology for the Future LW.* The study had three purposes: 1) identify high-payoff technologies, 2) recommend programs to overcome technical and system barriers, and 3) recommend appropriate demonstration projects (Montgomery, Godden, LaBerge & Wagner, 1994).

The ASB study found that the then-recent SIPE demonstrations offered convincing verification that new and affordable technology-driven techniques could provide cost-effective improvements to LW capabilities. Furthermore, these capabilities would have a profound positive effect on the Army's ability to perform its most stressing future contingency missions. The report concluded that there were three major barriers to the implementation of LW technologies: 1) the then-current acquisition system, 2) weight, and 3) cost. The study suggested that LW equipment must be delivered in quantity to soldiers in the field and that warfighters must be fully trained in the use of the equipment for them to be effective.

The final report of the 1994 study stated that Army planning was not adequately detailed for the evolution of LW technologies and that specific focus areas (which set priorities) were not defined. Due to unclear descriptions of novel capabilities, the report pointed out that near-term fielding of new LW technologies was uncertain. Lastly, the 1994 study report compared the Army's product planning process with the high-technology sector of US commercial business. The study described the planning process of US high-technology firms as focused on areas of greatest improvement, careful to avoid substantial proliferation of examined options, and as cross-functional in nature—whereas the Army did not have a top-down, new product planning process that came close to that in such firms. Panel members urged the Army to consider paralleling its processes for formulation of successful research programs with those of its successful industrial counterparts.

Eight key recommended management strategies emerged from the 1994 study:

1. Immediate effort should be undertaken within the Army to quantify the comparative cost effectiveness of production and fielding of LW technologies compared to the utility derived from other non-LW production options.
2. A continuing funding wedge must be budgeted to support production.
3. The funding wedge should be based on procurement with the following approximate goals:
    a. Minimum fielding quantity/item 10,000
    b. Average build-out period/item 5 years
    c. Average number of projects in pipeline at any time 5
    d. Average production cost/item $10,000

e. Total funding for new capability $100 Million/year

4. The Army must formulate a prioritized list of appropriate production candidates to be programmed and budgeted to support continuing production (along the lines of the outline above).

5. Based on the availability of LW items for production and funds available within the proposed budget wedge, a commitment to a schedule of new programs for future production must be laid out. Otherwise, funding should be used to procure initial equipment for all units rather than to continue procuring newly developed equipment.

6. A series of SIPE-like technology demonstrations should be conducted to qualify candidate technologies.

7. Based on long-term user needs and the timing of future SIPE-like user/technology testing, focused advanced technology programs should be selected from within the Army LW research and technology menu. While not all potential technologies should be focused toward these testing gates and user preferences, the Army must ensure the bulk of its technology exploration selections come from this process.

8. The Army should adopt a top-down, industry analogous, new product planning process whose end-product is definable. A definable product allows for meaningful prioritization, funding and sequencing of technology development efforts (Montgomery et al., 1994, pp. 7-8).

The significance of the ASB ad hoc study is that it set the course for the emerging LW acquisition strategy. At the time, the acqusition strategy was focused on the evolution of the system through technology demonstrations and focused upgrades and capability. Futhermore, in retrospect, its suggestion that LW equipment should be delivered in quantity to soldiers in the field and that they must be fully trained to be effective proved to be essential to its success. Unfortunately, its recommendations with respect to cost per unit were not used as a guideline. This proved detrimental to LW's support during the early 2000s.

M. United States General Accounting Office (GAO) 1996 Report

Following the 1994 ASB ad hoc study, the GAO completed a report in 1996 cautioning Congress that the LW acquisition strategy was too ambitious. The report's objectives were to: 1) determine the status of various technology and human-factor problems associated with system development, 2) evaluate the acquisition strategy for the LW System, and 3) assess plans to integrate the system within the digital battlefield (GAO, 1996).

The report pointed out that the program was facing a number of technical and human-factor problems that were not being adequately addressed. Furthermore, the report highlighted the fact that the Army had not yet developed prototypes for LW and that these lingering development problems could affect the system's ability to be ready for its then-scheduled IOT&E in August 1998. It suggested that program compromises could be on the horizon because of the then-recent Army decision to compress the overall acquisition schedule (GAO, 1996).

The significance of this report was its predictions of potential shortfalls in LW Program cost, management, performance and schedule aspects based on technical complexity. At the time, the Army planned to overlap development and operational testing of LW. The report cautioned that this change in acquisition strategy (permitting more rapid production and deployment) could bump procurement costs to over $1.4 billion. This projected cost and the complexity of the program were presented as evidence that the program needed more management attention. The report suggested that the program was incorrectly classified at ACAT III; because of its projected cost and complexity, it should be managed at the ACAT II level. Last, and perhaps most important, the report noted that because LW prototypes were not available while the Army tested other components of the evolving digital battlefield, successful demonstration of its ability to operate within the construct of other digital battlefield elements was not accomplished. The study's authors warned that there was no assurance that LW would perform as intended and that if it was produced on schedule, ahead of other digital battlefield components, interoperability of hardware and software components would be unproven and potentially compromised.

N. USAIC 1997 Dismounted Soldier Study

In 1997, the United States Army Infantry Center (USAIC) conducted a holistic study of the future requirements for dismounted soldiers. This study concluded that through the beginning decades of the 21st century, US forces will engage in smaller scale wars against asymmetric threats and that this dynamic will increase the need for dismounted ground forces (Lockhart, 2006). Also in 1997, the LW Early Operational Experiment Report confirmed that a systems approach to soldier requirements would provide greater payoffs in lethality, survivability, mobility, and situational awareness—for both the individual and the unit (2006).

These findings and previous work on SaaS and LW prompted the Army to create the Soldier System Command (SSCOM) to meet requirements for the SaaS. The SSCOM Project Manager, Soldier at Fort Belvoir, Virginia, was charged with coordinating the engineering/manufacturing development of the LW System with a program to insert new technology (Objective Force Warrior) under the direction of the Natick Research, Development and Engineering Center in Natick, Massachusetts (2006).

O. GAO 1999 Report

In December 1999, the GAO produced another report entitled *Army's Restructured LW Program Needs More Oversight.* This report followed up on the 1996 report and set out to: 1) identify the status of the system, 2) evaluate whether the current level of monitoring and oversight was sufficient based on projected LW development costs, 3) determine how the Army was ensuring LW's ability to operate with other digitized battlefield systems, and 4) assess whether technical and human-factor problems still needed resolution (GAO, 1999).

The report pointed out that LW was not going to meet its fielding date of September 2000 because technologies were not being developed fast enough. Time of completion was estimated to be delayed until 2004, with an estimated cost increase from $1.4 billion to $2.1 billion. Based on the schedule risk, cost increases and the technological complexity of the program, the report concluded that oversight of the program was insufficient. As in the 1996 report, this report mentioned integration issues with other digital battlefield components like the Force XXI Battle Command Brigade and Below (FBCB2). This interoperability issue was essential to the envisioned digital construct of the Objective Force. At the time of the report, incorporation of this important capability was unplanned for the LW System due to computer architecture incompatibility issues. Last, the report pointed out that some technical and human-factor problems remained unsolved and could cause the system to be ineffective altogether. Battery problems, ergonomic issues, electromagnetic interference issues and weight problems were noted as significant (GAO, 1999).

To remedy the noted deficiencies and to ensure that the LW development was completed before systems were fielded, the report recommended that the Secretary of Defense direct the Secretary of the Army to return the LW Program to the Program Definition and Risk Reduction phase until workable prototypes were produced. Furthermore, the GAO auditors recommended that LW be reclassified as an ACAT I system to ensure appropriate oversight and monitoring. Third, the GAO recommended that LW be required to demonstrate interoperability with FBCB2 as a risk-reduction measure and to ensure battlefield situational awareness. Last, the report recommended the Army should be required to thoroughly field-test LW prototypes and ensure that they passed water immersion, electromagnetic interface and airborne certifications prior to the fielding of any systems (1999).

The relevance of this report to the LW Program was its emphasis on increased oversight and increased interoperability with FBCB2. This report strengthened the May 2002 decision to manage the program at the Army Acquisition

Executive (AAE) level. This decision to designate LW as an ACAT IC program was based upon both this report's recommendation and estimated RDT&E costs (Ugone et al., 2002). The report's emphasis on interoperability was crucial to materiel developers, as this capability was unplanned due to system architecture. This recommendation proved to be a critical consideration during the LW System development—especially when the LW Consortium was its primary developer. It foreshadowed one of LW's darkest times from 2003-2004.

P. 2001 ASB Summer Study

Another Army Science Board summer study was completed in 2001, entitled *The Objective Force Soldier/Soldier Team.* The purpose of this study was to determine ways to enhance the Objective Force soldier and to recommend roadmaps to guide soldier integration as part of the FCS (Lockhart, 2006). The study produced three important findings: 1) that our country had a critical need for a Soldier/Marine team that can be deployed in time of crisis and can accomplish assigned missions with minimal casualties; 2) that if the Army took a systems approach oriented toward qualitative advance in six synergistic dimensions (lethality, survivability, C4ISR, mobility, sustainability, people), it could achieve a vision of a Soldier/Marine ten times as effective; 3) that there were certain priority programs (identified in the study) which would achieve desired gains; the study produced a series of roadmaps for implementation (Douglas, Downing, Steele, Hyder & Otstott, 2001).

Perhaps even more important to the soldier as a system concept was the study's recommendation for a top-level systems engineering approach to designing soldier systems. The study concluded that the term "soldier system" was a misnomer. It stated that soldier systems were being designed and developed as a series of programmatic and technical stove-pipes—with no overall systems architect charged with ensuring system performance, weight, power and sustainability objectives (Lockhart, 2006). It recommended assigning a chief engineer with overall system design responsibility that was empowered to conduct trade-offs to ensure system design technical feasibility, affordability and producibility (Douglas et al., 2001). The SaaS management concept can be attributed to the conclusions of this study.

Q. 2002 Department of Defense, Office of the Inspector General (DoD IG) Report

In 2002, the DoD IG provided a report to the Army's Auditor General and Defense Contract Management Agency (DCMA). The report's subject was the acquisition of the Army LW System (Ugone et al., 2002). The intent of the report was to highlight management, support and oversight issues regarding the LW Program. The study found that though the PM for the LW System effectively implemented an evolutionary acquisition strategy to develop and produce the system in three sequential blocks to reduce both technical risk and to expedite the fielding of its capabilities, additional management attention was required.

The DoD IG concluded that, due to incomplete system and operational requirements, undecided BOI definition, insufficient performance parameters (most notably, reliability), and force structure requirements, the Army would be less able to make informed affordability decisions to support future budget submissions for the program. Second, the IG noted that the PM would be less able to provide the acquisition community with measurable information on the value of using an Other Transactions Agreement (OTA) for acquisition programs. Using an OTA would allow for an increased level of commercial industry involvement and would maximize the rapid prototyping process. In addition, the PM had not inserted a provision for performance metrics in the OTA with the LW Consortium. Next, the study pointed out that the delegation agreement between the agreements officer for the program office and the DCMA, Syracuse, provided limited and vaguely defined requirements for administration support. The report stated that as a result, the PM would find it hard to obtain timely and meaningful information on LW Consortium performance against cost, schedule and performance requirements. The report concluded that the PM had not implemented specified processes, documentation, and reporting requirements in the risk management plan. Furthermore, promotion of continuous risk management and timely reporting to acquisition decision-makers on program risk and risk mitigation was not accomplished. Publication of this report prompted revision of the ORD by TRADOC and Government and contractor tightening of risk-management methods (Ugone et al., 2002). Furthermore, its conclusions strengthened the 2002 decision to compete the program and the 2003 decision to dissolve the LW Consortium.

The findings and recommendations of the aforementioned studies set the stage for further research. Included here were several of the major studies about soldier systems and LW from several different perspectives. Other notable research has been conducted surrounding soldier systems in the past. Dr. Jean Dyer, Army Research Institute, Fort Benning, Georgia, has spearheaded much of this effort. We recommend her research, as well as those others listed in Appendix J, for additional information.

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III. The LW Materiel Developers' Perspectives

> I guess a lot of people would probably stand up and show you a great flow chart with arrows about a process they developed that revolutionized acquisition and how great it was, and they would publish an article on it. My lesson learned is that all of these things, sometimes, well, just don't work. I hate to say that, but complete persistence is the only thing you can actually count on….I don't want to oversimplify it, but complete persistence, seeing where a problem is, taking great people—and those resources are unbelievable if you have good people that really want to try, that are loyal to what they are trying to do—loyal to the program, not the king, or the person, but to the program and they know it is the right thing—[is essential]. Having solid, good people who have the same mindset every day that they have to win—and they do—that is the difference with what we have done. When problems came up, this program [Land Warrior] has refused to have a show-stopper—refused. (Cummings, 2008, July 17)

> In my opinion, we could have been a lot more successful [initially] if there had been a better relationship between the PM and the contractor. Too many times it was too adversarial instead of more of a "let's work together and figure out what's going on" [relationship]. That has turned around. We have a very good relationship with the PM shop now; it seems to me that there is a lot more cooperation. That, to me, is one of the things that sure makes life easier—if you can establish a good relationship and maintain it between a contractor and the PM. (Spears, 2008)

A. Introduction

The comments above represent the perspectives of both the government PM for LW, LTC Brian Cummings, and the prime contractor, GDC4S, LW PM, Mr. Roger Spears. The first comment is grounded in persistence and the second, in cooperation. Both PMs have been at the helm during the LW's recent past and have provided unique perspectives on the acquisition efforts surrounding it. The intent of this chapter is to describe the events that took place from the perspectives of these two men in an attempt to gain an appreciation for the challenges that were overcome and to garner the lessons learned.

This chapter describes the roles of a PM from the perspectives of both the government and civilian materiel developers. We highlight some of the challenges inherent in the 21st century government acquisition environment. The relationships that PMs should have with their industry counterparts, as well as some new concepts to consider for today's acquisition environment, are discussed. Several tenets of program management are then described as guidelines for current and future PMs to consider. Next, we briefly define what an acquisition strategy is and some of the approaches that can be used to develop a new system or item. To frame the context within which the materiel developers operated, we then discuss the LW Program acquisition strategy by calendar year from 2001 until 2008. Included in this discussion are the LW PM's fielding plan, several key developmental activities during fielding, as well as major challenges encountered prior to 4-9 Infantry's deployment. We also detail the PM's plan to train and maintain the LW System during 4-9 Infantry's New Equipment Training (NET) through the 4-9's deployment in order to emphasize some of its unique challenges. We provide emphasis on the employment of the Unit System Integrator (USI) concept to show how the PM was able to incorporate changes identified by the user in both training and in combat. We conclude by providing some general lessons that may be applicable to other materiel developers in the defense acquisition community.

B. 21ST Century Program Management Challenges

PMs face many challenges due to the complexities inherent to the DoD acquisition environment. In some cases, these challenges have been around for years, in others, since just recently. They are based on several factors. First, while requirements are stated, many times they are not stable. They evolve with changes in Army doctrine, user needs and rapid advancements in technology. The PM's ability to keep pace with changes is a complex task in itself. Furthermore, when funding instability and bureaucracy are combined within the acquisition environment, they stifle rapid change, increase schedule and drive up program costs. Next, combat and support operations since Vietnam have added complexity to an evolving set of joint requirements that have broadened the scope of what the acquisition environment requires. Operation Urgent Fury, for example, revealed many problems in joint operations. These new joint requirements tore down the “stove-piped” walls of the traditional acquisition environment and created a host of new interfaces and strategic partners. Third, growing system complexity creates both technical and managerial challenges. A recent study completed by the US Air Force suggests that system complexity is perhaps the largest factor contributing to the reality of today’s acquisition environment. Its authors describe complexity as “the interactions between all of the entities comprising a system” (Rothenflue & Kwolek, 2006, p. 79). This “system complexity is a root cause and enables funding instability and bureaucracy to play larger roles in the overall schedule and cost of defense programs” (p. 79).

Consequently, the demands placed on PMs have rapidly increased since the start of the GWOT and have caused an evolution in acquisition management methods. Likewise, because industry counterparts must execute the government’s guidance, prime contractors’ methods have changed accordingly. The 21st century PM must be able to operate across the joint community—crossing functional, organizational and programmatic boundaries in order to deliver materiel within the recently implemented JCIDS construct. To be effective, a PM must have a broad technical background and have the ability to manage programs at the tactical level (1-year horizon), the operational level (2 year horizon) and the strategic level (3 years and beyond) with industry partner(s). In most cases, PMs have to get capabilities to the force quickly given today’s wartime posture and user expectations. They do not do this alone. They must foster support from appropriate government commands, staffs and agencies (Yakovac & Renee, 2007).

Some of today’s PMs, both government and civilian, must have the ability to manage “mega-systems.” These are “large-scale, potentially complex systems that cross traditional boundaries to provide capability beyond that achievable by their component parts" (2007, p. 4). While not all future systems will be "mega-systems," PMs must be able to manage the complexity of future software-intensive systems while managing the DoD-imposed interoperability requirements. PMs today must be able to manage in an environment in which requirements are often stated as "vision statements" or broad architectures. They must deal with a fluid, ever-changing technological atmosphere in which some system functionality of the program may be achieved only through interaction of various components. PMs have to manage uncertainty both in risk and in unanticipated and unforeseen opportunities that are due in large part to technology and software challenges. PMs must be able to leverage capabilities from other programs in an effort to find alternative solutions that meet their users' needs (Yakovac & Renee, 2007).

Figure 8 below depicts the evolution of program management—moving from traditional perspectives to a characterization of the current acquisition environment. This progress is framed within the contexts of the system, its implementation, its stakeholders and its strategic scope and mission environment. The model has three different layers: the inner and middle layers that represent how the acquisition environment has traditionally been characterized, and the outer layer representing how the acquisition environment can be characterized today. The inner and middle layers begin by characterizing acquisition program management as a single scope of effort within a relatively stable environment, with singular-user-generated requirements and predictable stakeholder relationships. This paradigm depicts acquisition management's desired outcomes as an improvement to existing capabilities of systems that have well-defined and known characteristics. The model's author suggests the two inner layers often times lead to the development of single-user, "stove-piped" designed systems. A "stove-piped" system is defined as a single piece of equipment that is based on an independent requirements document and has a single-user interface (2007, p. 6). The components within the system may have been complex but were independent of other systems on the battlefield. The systems tactics, techniques and procedures (TTPs) were developed once the system was fielded. Once the system was fielded, the unit determined how it would interface with already existing capabilities (2007, p. 6).

The outermost circle depicts today's increasingly complex program management environment and is applicable to the LW Program. PMs have to consider system capabilities (such as responsiveness, deployability, agility, versatility, lethality, and survivability). Today, more than ever before, these characteristics apply to everything we give our soldiers. PMs must cross multiple acquisition boundaries based on complex operational needs and evolving, forward-thinking, mission requirements that are used by the entire joint community. The current environment has multiple programs that, in some cases, are interdependent—with outputs that are more complicated than ever before. Expectations include fundamentally new capabilities at the extended enterprise level in the form of complex, interoperable, mega-systems that cross previously independent functional domains (Yakovac & Renee, 2007). PMs must synchronize programs that, in the past, were based in large part on individual requirements documents and single-user, "stove-piped" systems. These independent systems exist in the Joint, Interagency and Multinational environment. PMs must be able to design systems that interface with these systems so the warfighters on the ground can be interoperable across the battlespace and more lethal—due to an integrated design process with multiple capabilities at their disposal. Today's PM must be able to make trade-offs within a complex battlespace, within a system-of-systems (SoS) concept, to find the best capability that meets the warfighters' needs (2007, p. 6).

We will describe later in this chapter and in Chapter IV how the PM LW dealt with these ideas. With respect to trade-offs, the PM continuously fought affordability for capability trades within the context of distinct changes in Army vision—Net-centric Warfare and the Objective Force Concept. Added to the complexities of the increased interoperability requirements inherent to these concepts was the linking of the LW System to the FCS SoS. Furthermore, he dealt with these challenges with his user counterpart who, as detailed in Chapter IV, was representing an often split community that rarely spoke with one voice.

Figure 8. Emerging Acquisition Framework
(Yakovac & Renee, 2007)

C. PM Tenets for Managing Complexity

In order for the PM to succeed in today's fluid and complex acquisition environment, he should implement a few key tenets (Yakovac, 2004). These tenets can assist the PM in optimizing the program's operational capability, maximizing competition with industry, and ensuring interoperability with other battlefield systems and other developing programs. These tenets, coupled with the use of methods like a Modular Open System Approach (MOSA),[19] can reduce overall lifecycle cost and help a PM manage complexity. Today's PMs should consider these tenets as they strive to maximize program competition, maintain key acquisition milestones, and assist in increasing system performance attributes:

- Create opportunity for best of industry to participate. This will attract the best technological approaches and most reliable industry organizations to participate in developing future programs.
- Leverage the government technology base to the maximum extent. This allows the PM increased flexibility and the ability to incorporate technology. By leveraging this base, a PM will reduce proprietary issues, reduce overall program costs, and allow for rapid integration by the government with products supplied by multiple contractors.
- Use a collaborative environment from design through lifecycle management. The PM must continue to reach across the joint community—crossing functional, organizational and programmatic boundaries to integrate the most current and mature technologies.
- At minimum, implement component commonality at subsystem and component level to the maximum extent possible. This will reduce lifecycle cost of the program and allow for ease of capability upgrades during its lifecycle.
- Design and plan for technology integration and insertion to enable an overall integrated warfighting capability (this is closely related to MOSA).
- Maintain and shape the industrial base for future system capabilities/ technologies. The PM must conduct periodic risk analysis of the program's industrial base—ensuring that both the manufacturers and suppliers are continuing to meet the needs of the program.

[19]MOSA is the Department of Defense implementation of "open systems." The program manager should incorporate MOSA principles into the acquisition strategy to ensure access to the latest technologies and products, and to facilitate affordable and supportable system development and modernization of fielded assets (DAU, 2008, November).

- Provide a consistent and continuous definition of requirements. To do this, the PM must receive continuous user feedback and implement changes to the system that are cost effective and that meet the users' needs.
- Program Affordability—Balance performance and sustainment (Yakovac, 2004).

These tenets, when employed by a PM, will help him survive in today's complex acquisition environment. The relationship between the government PM and his industry counterpart is as important as it has ever been. Both must work together by exchanging ideas on new, integrated, cost-effective solutions to meet the demands of the user. In sum, both must be willing to take chances in breaking through technological issues by thinking outside the traditional acquisition environment's bounds.

In the case of LW, many chances were taken. For example, the PM LW's incorporation of soldier-driven design was a breakthrough. To accomplish this, he had to work closely with GDC4S. They did not have a lot of time to make this happen because the unit was preparing to deploy. Taking this chance was risky. As we later describe, the PM was able to go outside of the traditional acquisition paradigm and make it happen.

D. Acquisition Strategy

All government PMs must operate within the framework of an acquisition strategy. An acquisition strategy is defined by the *Federal Acquisition Regulation (FAR)* as "a strategy that is specifically tailored to a particular major system acquisition program" (General Services Administration, 2005). The acquisition strategy is the PM's overall plan for satisfying the mission need in the most effective, economical, and timely manner. The development of the acquisition strategy requires collaboration between the Milestone Decision Authority (MDA), the PM, and the functional communities engaged in and supporting DoD acquisition. A well-developed acquisition strategy can minimize the time and cost required to satisfy approved capability needs, and can maximize affordability throughout the program's lifecycle. The strategy should define the management approach and fully define the planning considerations and decisions of the program such as contract type and incentive arrangements (DoD, 2004).

The acquisition strategy defines the approach a program will use. To get away from a single-user system approach and to allow for faster procurement, the DoD's preferred strategy for rapid acquisition of mature technology is through evolutionary acquisition (EA). EA delivers capability in increments of useful military capability, recognizing the need for improvements. EA defines, develops, produces and fields an initial hardware or software capability. These initial capabilities can then be fielded to the user in a compressed period of time and are usually followed by subsequent improvements. This methodology, coupled with MOSA, can result in systems that are adaptable and that can respond to evolving needs of the user. The objective of EA is to balance required capabilities with available technology to put warfighting systems into the hands of the users quickly and affordably. The success of the EA strategy depends on a consistent and continuous definition of requirements and the maturation of technologies, the combination of which may lead to a structured approach to the development and production of systems. This structured approach provides increased capability while the program moves towards a materiel concept (DoD, 2008). This was the technique employed by the LW Program beginning in 2001. There are two different approaches to achieve EA—incremental and spiral.

An incremental approach is based on the premise that each individual system has its own set of thresholds and objectives that are defined by the user. The incremental approach requires well-defined requirements but lends itself to a stove-piped acquisition approach. The reason it creates "stove-piping" is because it is focused on individual systems instead of multiple, complementary systems. In an incremental approach, the capability has been identified, and the desired capability is known. The requirement is met over time through a series of increments, each dependent on available mature technology (Hawthorne & Lush, 2002).

The spiral approach differs slightly as it offers an “open-ended” approach. If a capability is identified, but its end-state requirements are unknown, requirements are refined through demonstration and risk management. Spiral development requires continuous user feedback. User feedback is essential to spiral development, as it ensures that each increment provides the user with the best possible capability. Updated requirements in future increments depend on user feedback and technology maturation (DoD, 2008). An example of a program that plans to apply this technique is the FCS Program. In this case, the FCS Program began with a capability that was more of a concept. This vision was identified well before end-state requirements could be completely defined. As the FCS Program matured, requirements have been refined through spirals defined by technology maturation and user feedback.

E. Land Warrior Program Management

During the early years of the LW Program (1996-2001), there were many decisions that affected the program. However, due to its long history and the researchers’ limited access to early program management personnel, this study focuses on the decisions affecting the program from 2001 to 2008. As detailed in Chapter II, the LW Program has been in existence as a Program of Record (POR) since 1996. During 1996-2001, the LW Program focused RDT&E efforts to enhance ground soldier capabilities in the areas of performance, lethality, survivability, and sustainment. The program began in 1996 with a sole-source developer, Hughes Aircraft (now Raytheon). By 1998, the PM Soldier had restructured the program, moving it from proprietary development with Hughes Aircraft to a COTS-based approach with the LW Consortium. The program leveraged this consortium of companies through an OTA to prototype the LW v0.6 and to mature its components. Its PMs also leveraged the work of the Government’s FFW ATD (then known as the

Objective Force Warrior ATD) to reduce program risk. These efforts got the LW Program off to a good start technologically.

Program challenges were encountered for the next several years, however, when in 1998 the Army embraced Net-centric Warfare (NCW). This concept evolved to the Objective Force Concept introduced in 2000, linking LW to the FCS vision and introducing myriad interoperability requirements. The years 1999 and 2000 were instrumental to early program efforts when the LW v0.6 advanced prototypes were built and effectively employed by soldiers during the JCF AWE. This effort marked the program's initial success and encouraged program management personnel and users. We continue the rest of the story below by providing a breakdown of the LW Program events by year (starting in 2001) and highlighting important points during each year that affected the program.

1. 2001

After success at the JCF AWE, in 2001, the program shifted from an incremental acquisition approach—utilizing LW-unique hardware and software technologies—to an EA strategy. The new strategy continued leveraging components and technologies available from other Government agencies, as well as COTS providers, to mature the functionalities of LW v0.6 and to build LW-IC (Block I). It incorporated MOSA to provide flexibility and reduce program risk. The idea was to open up the LW System's architecture so that when technology matured, it could be incorporated into the baseline LW v0.6 System. Also, as interoperability increased, it would give the materiel developer the ability to plug into other future Army and joint systems. This approach was also meant to reduce proprietary issues, reduce costs and allow the integration of products supplied by multiple contractors to be performed by the Government (Office of the Secretary of the Army, DoD, 2000a).

The LW Program was part of the Army's vision for soldiers to collectively fight at the small-unit level—stressing the collective synergy of a digitized team. During a LW update briefing on 21 February 2001, GEN Abrams, the TRADOC CG, recommended that the LW Program be "nested" in the newly created Objective Force Concept. This recommendation was intended to link the LW System to the newly created FCS. To incorporate this recommendation, TRADOC and the PM LW began restructuring the LW ORD. They constructed two different LW Operation & Organization concepts (O&O). One was a threshold capability O&O, the second, an objective capability O&O (Berger, 2008).

These changes caused the PM to reassess the LW Program's overall strategy, as well as to determine the technical feasibility of emerging interoperability requirements to the FCS System-of-systems (SoS)—which at the time was only a concept on paper. Of note, the PM received additional guidance from Congress to push the Science & Technology (S&T) community for more efficient power and weight reductions and to continue exploring non-secure communications options. The PM did this with the Government's FFW ATD. The FFW ATD was designed to develop and demonstrate technology improvements of the LW baseline system for Pre-planned Product Improvements (P3I) and to address critical technical issues of LW's size, weight, power, fightability, and cost. Also, an important study (described in Chapter II) was completed in 2001: the ASB Summer Study. This study reported that the LW Program had several technical and programmatic stove-piped systems and lacked an overall systems architect to oversee system performance, weight, power and sustainability issues (Lockhart, 2006). This study recommended assigning a chief engineer to conduct trade-offs to ensure technical feasibility, affordability and producibility (Douglas et al., 2001). It is unclear whether or not the PM acted on this recommendation. What is clear, however, is that the PM was not without challenges. Due to technological challenges and program restructuring activities in 2001, the scheduled LW developmental test (DT) was moved from December 2001 to October 2002—a ten-month slip in schedule. In addition, the scheduled operational test (OT) training scheduled for November 2002 was moved to April/May 2003—a seven-month schedule slip (Berger, 2008).

2. 2002

In 2002, the PM continued to pursue a MOSA approach. In anticipation of increased interoperability requirements, some of which were yet to be defined, he did this to both minimize developmental challenges and build flexibility into the product. In addition, the LW PM used an OTA as the procurement method with a consortium of contractors known as the LW Consortium. The PM Soldier at the time, Colonel Bruce Jette, intended to increase the level of commercial involvement in an effort to address anticipated technology challenges (D. Gallop, personal communication, November 3, 2008). One significant point brought out by the 2002 DoD IG Report to the Army Auditor General and DCMA (discussed in Chapter II) highlights the reasoning behind this change. "Because of incomplete LW System and operational requirements, undecided BOI definition and insufficient performance parameters (reliability), the Army would be less able to make informed affordability decisions to support future budget submissions if a sole source method was used" (Ugone et al., 2002).

To address concerns surrounding the program's complexity and the need for additional oversight of the LW Program, the program management office was re-designated PEO Soldier from PM Soldier in June 2002. This elevated the top-level management of the program from an O-6/Colonel level to an O-7/Brigadier General level. Additional changes in oversight at the Army level occurred in 2002, as well. The LW Program had started as an ACAT III program in 1996, but on 29 May 2002, the LW Program was re-designated an ACAT ID program by the Army Acquisition Executive (AAE). Then, in December of 2002, it was re-designated an ACAT IC program by the USD (AT&L). Both of these decisions were directly attributable to the program's substantial amount of RDT&E funding and its growing complexity (Berger, 2008).

The change to ACAT I classified the program as a major development. Major developments are not authorized under an OTA; therefore, when the program was first elevated to an ACAT I program in May 2002, the PEO Soldier at the time, BG Moran, directed a full and open competition for a new LW contract. This process took approximately nine months (J. Moran, personal communication, October 27, 2008).

Despite the LW Program's elevated ACAT level, the OTA was still in place over the course of 2002. The PM LW continued with the LW Consortium for the remainder of the year and into early 2003. During late 2002, LW testing took place at Aberdeen Proving Ground, Maryland. This developmental test (DT) was an early functional assessment run by ATEC and negotiated by soldiers from the 82nd Airborne. Its purpose was twofold; first, LW had to meet specific criteria prior to entering operational testing planned for 2003; second, the PM LW wanted to get a functional baseline to determine the performance of the LW-IC (Block I) prior to entering a contract for Block II development (D. Gallop, personal communication, November 3, 2008). Results of the assessment were grim. ATEC reported that the capabilities were not ready and would probably never be (J. Moran, personal communication, October 27, 2008).

The results of the assessments at Aberdeen caused concerns over continuing program technology issues. These concerns caused the PM to re-schedule LW's OT from November 2002, to June/July 2003—a schedule slip of seven months. In addition, he re-scheduled LW's Milestone C for October 2003—lengthening the schedule by two months. By the end October of 2002, the PM LW had a good idea of the LW-IC (Block I) issues in terms of reliability. However, he had not given the intended first end-user a vote, so he maintained the scheduled early functional assessments planned for early 2003 with the 75th Ranger Regiment. He realized that multiple data points in terms of functional capabilities and limitations would reinforce the need for development of LW-SI (Block II) (D. Gallop, personal communication, November 3, 2008).

3. 2003

In January 2003, the scheduled early functional assessment of the LW-IC (Block I) was performed by the Army Rangers. The results of the assessment proved to be initially devastating to the program. The Rangers assessed the system as unsatisfactory in the areas of form, fit and function. While this assessment and the October 2002 assessments provided a functional baseline, they both indicated that the LW-IC commercial architecture provided by the LW Consortium was not robust enough for the soldier's environment and could not provide requisite connectivity to the lower tactical internet (LTI). In addition, the Rangers' assessment determined that the weapon subsystem (WSS) provided minimal utility—foreshadowing later findings with 4-9 Infantry in 2006.

In the opinion of many at the program management office and GDC4S, this test was set up to be a failure from the beginning. The Rangers were only given basic instructions on how to use the system and then told to go out and execute their standard operations. Consequently, the Rangers did not understand or attempt to use the capabilities that the LW System was designed to offer. Because the Rangers did not train-up on the system and fully incorporate it into their standard operating procedures, they determined that it did not provide them with enhanced capabilities. The Rangers contend that the mindset of some decision-makers going into the test was that the system had to "stand on its own." They felt that if the integrators had to assist with the training, employment and integration, then there was something wrong (Augustine, 2008a).

The viewpoints of the PEO Soldier and the PM LW during that timeframe were opposite of those interviewed at the PM office and GDC4S. In their opinion, they trained the participants in both assessments properly and did the assessments as risk-reducing and data-gathering efforts in an attempt to inform the LW-IC functional baseline and prepare for LW Block II development. PEO/PM intentions were never to set up the program for failure. Instead, they were setting it up for successful transition upon contract award (J. Moran, personal communication, October 27, 2008).

Based on the negative feedback from the Rangers, the PEO Soldier concluded that he had concerns about LW-IC (Block I) operational reliability and, consequently, he dissolved the OTAs with the LW Consortium. This action stopped the production of the 140 LW-IC (Block I) Systems being produced by the LW Consortium for the IOT&E that was scheduled to be executed in June-July 2003 (Augustine, 2008a).

In line with the PM's EA approach and concurrent with the Rangers' failed assessment, on 30 January 2003, GDC4S was awarded a cost-plus-fixed-fee (CPFF) contract to build the LW-SI (Block II) (Berger, 2008). After the experience with LW-IC (Block I), the PEO Soldier recommended that GDC4S focus its efforts on incorporating the LW-IC (Block I) capabilities into the LW-SI (Block II) Systems (Berger, 2008). Consequently, the OSD and HQDA restructured the program in February 2003 to leverage the LW-IC lessons learned and to focus LW development on Stryker interoperability requirements (D. Gallop, personal communication, November 3, 2008). LW-SI (Block II) Systems were scheduled to be fielded to Stryker-equipped units in FY 2009 (Berger, 2008).

The major challenge for the materiel developer was to provide the required functionality in an affordable materiel solution. Due to LW ensemble cost concerns, HQDA provided additional guidance to focus on command-and-control and situational awareness capabilities. The resulting materiel solutions were the Dismounted Battle Command System (DBCS) and Commander's Digital Assistant (CDA). The challenge of both efforts was effective connectivity to the LTI—similar to LW's shortcomings. The significant constraint to connectivity to the LTI was the L-Band gateway of Force XXI Battle Command Brigade & Below (FBCB2) and Blue Force Tracker (BFT) (D. Gallop, personal communication, November 3, 2008).

The DBCS was not intended to be a substitute program to replace LW. Instead, it was offered as an option due to LW developmental challenges. The PEO Soldier had to look for alternative technical solutions to fill the gaps for a dismounted soldier situational awareness/command-and-control capability. He viewed the dismounted soldier capabilities in either the form of a handheld tablet (DBCS) or an ensemble with an eyepiece (LW). He was impartial to either form factor. After congressional direction, primary focus shifted to the DBCS for the next eighteen months (J. Moran, personal communication, October 27, 2008).

4. 2004

In 2004, the PM worked with GDC4S to procure LW Block II variants and the DBCS. For LW, in accordance with the PEO Soldier's guidance, the LW-IC variant was targeted for issue to the Army Rangers and the LW-SI variant, for one Stryker Brigade Combat Team (SBCT). When GDC4S was awarded the contract to build the LW Block II variants, the PM established an ambitious schedule to complete prototyping by the end of 2004. He did not want to waste any time given a planned first unit equipped (FUE) goal of FY 2009 (Augustine, 2008a). However, out of LW's unit cost concerns and the aforementioned congressional direction, the PM's attention shifted towards DBCS for the duration of 2004.

The LW Program's budget was significantly reduced in the POM 06-11 in favor of the aforementioned less-expensive, less-capable system, the DBCS (Office of the Secretary of the Army, DoD, 2003). The budget for procurement was decreased by Congress because of the failed DTs in late 2002 and early 2003, as well as the LW funding reduction in the POM. "The decision to re-focus the capabilities of the DBCS set the LW Program back by at least a year, if not 18 months" (Spears, 2008). Also, a recommendation was made to merge both the LW and FFW ATD. This was because of a perception by both Congress and senior Army leaders that the two programs were very similar, and the two systems' differences were unclear to them (US House of Representatives, 2004).

During 2004, the PEO Soldier and Commanding General (CG), USAIC, briefed the ASARC on soldier modernization. They submitted a request to the Army Systems Acquisition Review Council (ASARC) to conduct a DOTMLPF assessment with one LW-equipped SBCT Battalion to explore LW Basis of Issue (BOI) alternatives and refine the capabilities that were required of LW with the FCS. Additionally, the Commanding General (CG), USAIC, requested a side-by-side demonstration with LW Block II prototypes that GDC4S had just completed to demonstrate LW's enhanced capabilities as compared to standard equipped soldiers (Berger, 2008).

The side-by-side demonstration was approved, and its success prompted the VCSA to recommend the equipping of one Stryker Battalion at Fort Lewis, Washington, to conduct the DOTMLPF assessment as well as further define Tactics, Techniques and Procedures (TTPs) for the system. Based upon this recommendation, the ASA(ALT) directed TRADOC and the LW PM to do the DOTMLPF assessment and a Limited User Test (LUT) in FY 2006. This directive was a turning point in the program. Within the span of approximately eighteen months, LW went from being a rejected system to a more capable Block II prototype that now had a chance at two essential SDD activities. This was a testament to the efforts by both the PM and GDC4S. As pointed out in the opening statements of this chapter, persistence paid off, and cooperation was essential.

5. 2005

During 2005, the PM LW and GDC4S were not without challenges. Early in FY 2005 (November 2004), the AAE approved the PEO Soldier and CG USAIC's joint request to do the DOTMLPF assessment. However, in the memorandum that he directly issued to the LW PM, he directed a complete shift in the PM's focus from LW Block II development to the development of the DBCS. Now the LW PM was directed to provide DBCS capabilities for up to 30 Brigade Combat Teams (to include SBCTs) as well as support the VCSA's decision to equip one SBCT with LW capability. The memo directed that the LW PM modify the CPFF contract for LW Block II with GDC4S in an effort to conserve resources and re-focus efforts to get a baseline command-and-control capability to the force faster (Bolton, 2004).

This directive was in response to growing pressure from the warfighter to get a dismounted command-and-control capability for the fights in Iraq and Afghanistan. Accordingly, the LW PM shifted his acquisition strategy to solely focus on developing the DBCS. Conveniently, LW's prime contractor, GDC4S, was also developing the DBCS. Despite the change in the PM's priorities, GDC4S continued to work on the LW System—incorporating some of its own Internal Research and Development (IR&D) funds. This allowed the General Dynamics team to continue working on improvements to the LW Block II System while also supporting the PM's new focus on getting DBCS developed and out to the Army (Spears, 2008).

In July, PM LW and TCM Soldier held a meeting to review DOTMLPF study issues and finalize recommended study issues for the LW DOTMLPF assessment scheduled for FY 2006. Shortly after this meeting, in August 2005, the PM LW supported Army Test and Evaluation Command (ATEC) at a DBCS Operational Test (OT) at Fort Drum, New York, with the 10th Mountain Division. This test was also supported by both GDC4S and TCM Soldier.

There was a consensus with many of those involved in the testing that, like the failed LW DT in 2003, the DBCS test was also set up to fail from the beginning. "The system was given to a unit that was not digitally savvy. They did not even have the basic FBCB2 System in their vehicles and did not have the communications infrastructure to support a system like the DBCS" (Augustine, 2008a). On the other hand, GDC4S personnel who supported the OT at Fort Drum felt that the DBCS capabilities and requirements were dictated from the PEO Soldier rather than having a performance-based requirement. From some perspectives at GDC4S, this was due in large part to personalities in the PEO Soldier Program Office that were unwilling to listen to recommendations from the contractor on how to make the system better. “The PEO Soldier was very rigid with no trade-offs or compromises in what the system needed to look like and in what the system must be able to do” (Kempin, 2008).

The former PEO Soldier and PM LW contend that these perceptions were inaccurate. The PM LW at the time viewed the DBCS path as “just another chance at provding situational awareness capabilities to the dismounted force in an affordable manner. At the time, many vendors were going directly to deployed units with handheld command-and-control capabilities. Some felt threatened that the DBCS would take over the LW effort” (D. Gallop, personal communication, November 3, 2008). He viewed the entire event as a parallel effort with LW instead of a competing effort. “There were never any intentions to replace it [LW]” (D. Gallop, personal communication, November 3, 2008). As mentioned, the PEO Soldier at the time described his perspective as impartial. He was directed by Congress to look at alternative solutions, and he intended to do just that (J. Moran, personal communication, October 27, 2008).

The DBCS OT demonstrated that the system was not ready for fielding due to issues encountered with its inconvenient size, excessive weight, poor soldier integration, interoperability limitations and increased soldier workload. The DBCS evaluation went so poorly that it caused the PM LW to again restructure his efforts. Based on input from users as to what they actually wanted from a dismounted soldier system, he quickly turned his attention back to LW (Augustine, 2008a). Given the technical difficulties encountered with a digitally immature unit and the upcoming DOTMLPF assesssment, his priorites shifed back to prototyping LW-SI (Block II).

To prepare for the DOTMLPF assessment and LUT, a train-the-trainer course was conducted with 4-9 Infantry at Fort Lewis, Washington, in December 2005. Facilitated by the Omega Training Group, the course was designed to familiarize leaders in 4-9 Infantry with the LW System. The Omega Training Group subcontract was through GDC4S. The first day of training specifically focused on presenting a detailed system overview, providing familiarization, as well as laying out the plan to train the rest of the battalion. The next day of training focused on educating battalion and company leaders on the system itself. Their instruction consisted of a LW-SI (Block II) System capability overview and was designed to show the leaders what the system did and how it could be employed to enhance their unit's capabilities. The PM believed that this initial train-the-trainer course would greatly enhance the unit's acceptance of the LW System. In addition, this training was used as a trial run for NET in an effort to smooth it out. NET training was planned to begin for the rest of the battalion beginning in June 2006 (Augustine, 2008a).

6. 2006

In response to the failed DBCS OT at Fort Drum and the upcoming equipping of the 4-9 Infantry, the PM LW's number one priority was LW. His main effort shifted to the production of prototype LW-SI (Block II) Systems, to include applicable long-lead items for 4-9 Infantry's equipping and evaluation. The PM LW focused GDC4S on the production of essential LW interface equipment like vehicle integration kits (VIK). In conjunction with TCM Soldier and unit leadership, he conducted DOTMLPF assessment, NET and LUT preparations. In addition, he made significant progress in coordinating efforts with the FFW ATD in accordance with Congressional recommendations made in 2004 (Augustine, 2008a).

Based on our research, we believe that 2006 represented the biggest challenge to the PM LW. The PM LW dealt with an increasing "chasm" that had existed between the user and the acquisition community for about ten years. This chasm was brought to the forefront in 2006. It was created by an Infantry community that was split into sub-communities (heavy, light, airborne and SOF)—all with differing ideas on what "right looked like" for soldier systems. These differing opinions created many LW naysayers within the user community. In addition, due to the GWOT and the pressing need for command-and-control/battle command/situational awareness capabilities, users could not understand why a program that had been around since 1996 had offered little in the way of fielded, effective equipment. They were frustrated because they could get a civilian cellular telephone with enhanced communication and GPS capabilities in a small-form factor, but could not get the same out of a soldier system. In addition, they did not want to add a lot of weight to their already overloaded dismounted infantryman.

a. Moore's Model

This chasm, identified in the book *Crossing the Chasm* by Gregory A. Moore (2002), is described within a marketing context. Moore defines it as the gulf between two distinct marketplaces. While this "chasm" is a marketing concept, the researchers feel this is very applicable to the LW System's acceptance by the Army, its sub-communities and lawmakers. Moore describes these two distinct marketplaces as an "early market" and a "mainstream use market." The early marketplace is dominated by early adapters—in this case, the TCM Soldier, PM LW and the VCSA—as well as insiders who are quick to appreciate the nature and benefits of new developments. The insiders included the 4-9 Infantry's Battalion Commander, Command Sergeant Major and several company First Sergeants. The early market is made up of people who are enthusiastic about a product because they believe it shows great potential. This group tends to be relatively small. The second is a mainstream marketplace that represents the "rest of us" who want the benefits of the technology but do not want to "experience it" in all of its gory details. In this case, the mainstream marketplaces were senior Army leaders and Congressmen. Moore states that "making the transition from the *early market* to the *mainstream market* is the greatest peril for any marketing plan" (Moore, 2002, p. 20).

Continuing with the model, there is then a period in which everyone tends to watch and see if anything can be made of the product and its capabilities; this is where the chasm comes into play. If the product is found to deliver a set of tangible outcomes or capabilities at a reasonable price, then a mainstream market is formed (user acceptance) (Moore, 2002). In his book, Moore introduces The Revised Technology Adoption Lifecycle Model shown in Figure 9 below.

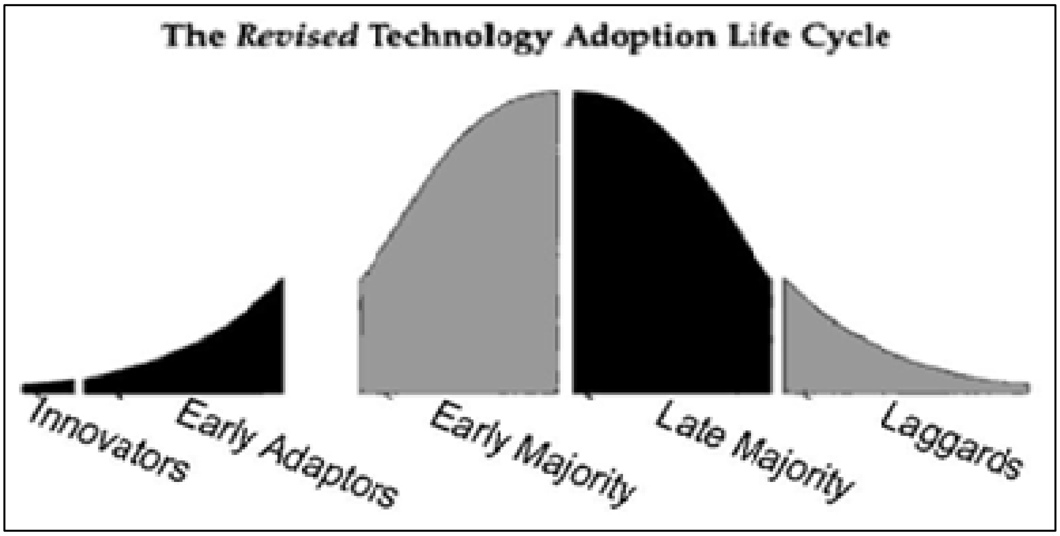

Figure 9. The Revised Technology Adoption Lifecycle
(Moore, 2002, p. 17)

Moore's model depicts several cracks in the traditional technology adoption bell curve. The first is between the innovators and the early adapters. This occurs when there is a useable product, but its benefits cannot be properly translated to potential users. In LW's case, this can be illustrated by the failed LW assessment with the Rangers in early 2003 when a gap was opened between potential early adapters and its innovators. The product was useable, but its benefits were dismissed due to a lack of training and poor incorporation into standard operations. The second crack identified, equally important as the first, is the gap between the early majority and the late majority. This gap occurs because innovative technology demands that the user community be technologically proficient. As the late majority are much less apt to become technologically proficient, this gap becomes reality. In order to bridge this gap, the technology must be made easier for the late majority to accept; if it is not, then successful transition to the product or system may never happen. The last group identified on the curve is the laggards. This group does not want anything to do with technology based on both personal and/or economic reasons and will most likely never adopt the new technology (Moore, 2002).

For LW in 2006, the most relevant part of the curve is the “chasm” that separates the early adapters from the early majority. This is the most dangerous part of the bell curve, but one that goes largely unnoticed until it is too late. This part of the curve is characterized by early adapters who are trying to introduce some kind of revolutionary change like the LW System. They appreciate and understand the benefits of the new technology; however, they have a strong sense of practicality and are sometimes content to wait and see if the new technology is beneficial. If the technology is successful, they will want to purchase the system; however, they will want to keep with the old ways of operating. In addition, they want the new technology to enhance their current procedures and want it to work properly from the beginning (Moore, 2002).

To cross the chasm, Moore advocates that a company focus on a single market or a “beachhead.” This focus is required to win domination over a small, specific market and to use it as a springboard to win extended markets. This is applicable to the PM’s struggle with marketing the LW System to the Army. He had to establish a beachhead with 4-9 Infantry and then leverage its acceptance to proliferate LW technology adoption to the rest of the Army. As his beachhead, 4-9 Infantry would become an advocate for the system to win over senior leaders by showing that the LW System was acceptable for the warfighter. This was no small task. He first had to win over 4-9 Infantry before he could even begin to work on the rest of the Army. He had to do this within the context of a constrained budget environment, the precedence of a rocky program history and an infantry user community that was reluctant to add additional weight to soldiers and was split on its idea of what was best for a “one-size-fits-all” soldier system.

b. Points of Light

Out of concern for the soldiers in the unit that were preparing for deployment, the PM did not want to disrupt the way the unit trained. Initially, he wanted to integrate the LW System into 4-9 Infantry's standard deployment train-up as well as show how LW would enhance unit capabilities. This in itself was difficult. In addition, the PM knew his biggest challenge would be user acceptance (Augustine, 2008a). In an attempt to accomplish both unit training synchronization and LW training and assessment, he devised a NET schedule with 4-9 Infantry and planned the LUT (with ATEC) following a three-month period of pre-deployment training. To gain early acceptance in the unit, the PM implemented his "points of light" plan. His points of light plan required an identification of the formal and informal leaders in the unit. This was his method to gain LW System acceptance using the natural leaders that were mentors to soldiers. The PM hoped that by getting LW accepted by these unit points of light, the unit as a whole would be quicker to accept the LW System (Cummings, 2008, July 17).

c. New Equipment Training (NET)

The battalion NET was different from the train-the-trainer block of instruction in December 2005. It was conducted by company, in a sequential manner, which coincided with each company's LW equipping (see NET plan, Appendix J). The NET was a two-week event of mainly classroom instruction that focused on familiarizing soldiers with the complexities of the LW-SI (Block II) System. The first week of NET focused on the technical aspects of the LW System; the second week emphasized field training. The NET was facilitated by full-time instructors from Omega Training Group with TCM Soldier, PM LW and GDC4S personnel in support. Field Service Representatives (FSRs) and Contractor Logistic Support (CLS) personnel were provided by the PM LW and GDC4S respectively. Following NET, the battalion was to use the LW Systems in the conduct of its pre-deployment training to gain familiarity and either accept or reject the system. NET for all companies was completed by early June, when the unit's focus shifted to battalion pre-deployment training.

One of the issues later identified in the PM's NET plan was that he failed to properly plan for follow-on training for soldiers who arrived at the unit after the initial, battalion-wide NET was conducted. Consequently, when new soldiers arrived at the unit, the PM did not have certified instructors at his disposal to train the unit. Regardless, he had to get them trained. To accommodate these late arrivals, he conducted a series of mini-NETs. He ended up spending nearly $30,000 per mini-NET over the course of the rest of the year on indefinite-delivery, indefinite-quantity (IDIQ) contracts with GDC4S—sending trainers back to Fort Lewis to train incoming soldiers.[20] Another issue that ended up affecting the PM's NET plan was a lack of consistency in the quality of NET instructors. Some instructors were temporary and only hired for a short duration. These trainers did not have enough experience with the LW System to properly teach its employment. This caused a gap in the learning curve for some of the companies in the battalion and did not help foster ownership of the systems (Cummings, 2008, July 17).

Shortly after all units in the 4-9 Infantry had received NET, the PM scheduled a LW VIP day in July to coincide with the budget cycle. The timing of the VIP day was planned with the hopes of positively influencing the Army's near-term budget decision. This VIP day was an effort to build on perceived LW Program momentum and create senior leader "buy-in." This buy-in was noted as critical to the success of LW after the PM's experience with the failed DBCS test in 2005. Using the chasm analogy, this was a method the PM and GDC4S planned to use to try to cross the acceptance gap between early adapters and the early majority.

Unfortunately for the program, during the VIP day, several soldiers from 4-9 Infantry expressed frustration with the system's overall size, weight and

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[20] IDIQ contracts provide for an indefinite quantity of supplies or services during a fixed period.

configuration. In hindsight, one of the biggest downfalls of the first VIP day was that the soldiers picked to participate in the demonstration had yet to fully incorporate the system into their operations and were unfamiliar with the system's ability to enhance their unit's operations (Berger, 2008). There was also a lack of focus on the part of the unit on the importance of the event. To some in the unit, the LW was a distraction, to others a tremendous capability. Most, however, agreed that the system needed to stand on its own (Augustine, 2008a).

d. Unit System Integrators (USIs)

During 4-9 Infantry's LW training, the PM LW had trouble with properly integrating all he needed to get done with all that the unit had to accomplish prior to its deployment. In other words, while the unit was preparing for combat, the PM wanted to get the unit trained on LW and to support the DOTMLPF assessment and LUT. This conflict in priorities caused a lack of synchronization with the 4-9 Infantry's training schedule, which the PM did not own. The result was the PM's daily struggle to integrate his requirements and desires with the unit's training priorities. Admittedly, the PM did not have the right personnel with the right skill sets or the right amount of personnel on his staff to integrate with 4-9 Infantry's subordinate units' training schedules. In fact, for most of the summer, he had only one or two personnel dedicated to promoting the LW's capabilities. Instead, most of the PM's team's time at Fort Lewis was spent with acquisition issues such as working with GDC4S, conducting VIP visits and monitoring training, rather than on assisting with incorporating the LW and its capabilities into unit Standard Operating Procedures (SOPs) and TTPs. This shortfall in personnel and the PM's inability to have direct, credible links to the unit directly influenced his ability to decipher the changes the unit wanted (Cummings, 2008, July 17). This lack of integration caused a decline in unit acceptance; consequently, unit confidence suffered, and the chasm widened.

This growing chasm led the PM to establish the Unit System Integrator (USI) concept.[21] The primary purpose of the USI concept was to utilize a certified LW instructor, knowledgeable on all technical issues of the system and that could assist the unit with incorporating the LW System into its training plans and operational procedures. The USI team consisted of retired, senior, non-commissioned officers (NCOs) placed at the company and battalion levels throughout the 4-9 Infantry. This concept was the single biggest means by which the PM gathered relevant feedback from the unit (Cummings, 2008, July 17).

The responsibilities of the USIs were different at each level within the battalion, but all had the same purpose: build unit confidence in the LW System and assist the unit in incorporating it into its operations. The battalion-level USIs were responsible for the training and integration of LW to the battalion support and specialty platoons (scouts, mortars and the Battalion Commander's Personal Security Detachment). They participated in battalion training meetings to ensure that all battalion-level LW needs were identified and reported to the PM. These needs were subsequently prioritized by the PM, GDC4S and unit leadership. The USIs developed integration plans for soldier-improvements to 4-9 Infantry's LW equipment and provided training recommendations to incorporate the system into its unit SOPs. Company-level USIs were responsible for being "coaches, teachers and mentors." The company-level USIs coordinated with company leadership for training, maintenance and employment of the LW System through company training meetings; they also participated in field training events. During training meetings, the USIs were responsible for assisting company leadership in developing training that would incorporate the use of TTPs that leveraged the capabilities of the LW System. During field training events, the USIs helped the unit prepare for combat using their personal experiences as former senior NCOs and their extensive knowledge of LW (Augustine, 2008a).

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[21] For a detailed description of the USI Concept and Top-Ten Process, see Appendix K.

Compatibility between the USI and the unit proved to be vital to LW's successful implementation. To get compatibility, the PM evaluated each USI's personality and the personality of the unit leadership. He then placed the USIs within the unit that had the best personality match. The USIs were empowered to provide feedback directly to the PM on issues ranging from the units' technical thoughts to recommended changes to the units' training schedule (Cummings, 2008, July 17).

The implementation of the USI concept improved communication overnight for the PM LW. Once the USIs were integrated, he was able to gain a better idea of the real changes that needed to take place with the system—both from the technological perspective as well as the human-system-integration perspective. The USIs acted as communication conduits to exchange information and ideas between the PM and the unit; they also served as the eyes and ears of the PM (see Figure 10 below). Their credibility inspired buy-in from the unit, increased unit confidence and started to bridge the chasm between LW and 4-9 Infantry as they started incorporating LW into their standard operations (Augustine, 2008a).

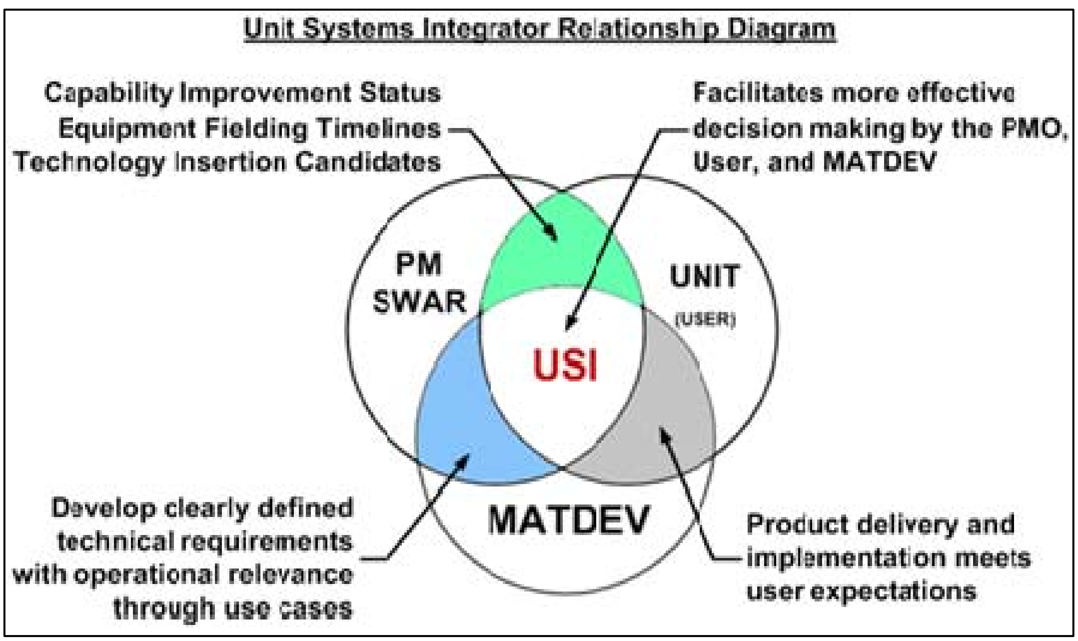

Figure 10. Integration of the Unit System Integrator (USI)
(Cummings, 2008, September 22)

The USI program did not come without challenges. Initially, some USIs did not fully embrace or understand the LW System and became sympathetic to the naysayers within the unit. In some cases, the USIs actually negatively impacted some parts of the unit. This damaged LW System acceptance in some of the companies early on. This initial setback frustrated the PM, but he saw the USI concept's potential, and, in a bold decision, he decided that rather than having the entire battalion be successful with the LW System, that he was going to focus on one company—Bravo Company (who happened to be the company chosen from the LUT). He believed that if Bravo Company embraced the LW System, then the rest of the battalion would follow (Augustine, 2008a).

e. The Top-Ten Process

The PM's focus on Bravo Company, coupled with the USI concept, jump-started unit acceptance and initiated the process of human-centered, soldier-driven design. To manage this, the PM LW implemented the "Top-Ten Process." The Top-Ten Process became a structured means of information exchange between soldiers, USIs, the LW PM and GDC4S engineers. It resulted in significant cost savings and schedule compressions for the LW Program. The Top-Ten Process allowed for immediate incorporation of user feedback and helped the PM reduce time-to-delivery by providing an accurate picture of user recommendations for system changes (Augustine, 2008a).

The Top-Ten Process became iterative and proved to effectively capture, analyze, and prioritize user inputs regarding potential system improvements and further technology integration time after time. The result of the process was a "Top-Ten List" that was prioritized based upon soldier input and cost and schedule feasibility. GDC4S, in coordination with the USIs, PM and PM SWAR engineers, developed a capability modification plan that incorporated recommended modifications from the Top-Ten List. The process was updated regularly, ensuring there were continuous soldier-driven improvements to the LW Systems (Augustine, 2008a).

The most important goals for the PM and prime contractor were to show the users that they were responsive to their needs. By making responsive improvements to the system's form, fit and function, the PM and GDC4S created unit confidence that fostered a sense of ownership of the LW System within the 4-9 Infantry. For GDC4S, being a part of the integration effort at Fort Lewis helped them to hear first-hand what the soldiers wanted, rather than just read about it in an e-mail. This collaboration made the Top-Ten Process extremely effective. The lead GDC4S engineer commented that "once the process was developed and refined with the PM's input, it was important to show the users that we were responsive to their needs. We looked for the 'low-hanging fruit'—changes that could be made to the system within a day or week" (Wood, 2008).

After the USI concept was implemented, and soldier-driven improvements started bringing tangible results, a second VIP day was conducted in late September. This VIP day was conducted by the 4-9 Infantry's Battalion Commander and C Company, 4-9 Infantry. By this time, soldier-driven improvements were being made, and unit confidence was growing. Bravo Company was just completing the ATEC-run LUT, and early results were encouraging. Also by this time, C Company had incorporated the LW System into its operations and had embraced its capability. During this VIP day demonstration, it quickly became apparent that the unit had successfully navigated the chasm. The soldiers spoke highly of the system during the demonstration, and the Battalion Commander, LTC W.W. Prior, announced that he wanted his unit to take the LW Systems to combat (Cummings, 2008, July 17).

7. 2007

There were several important events that took place in 2007. First, the PM LW, TRAC WSMR, ATEC and TCM Solider worked to finalize the results of the initial

DOTMLPF assessment as well as the LUT.[22] These results were key to the finalization of the LW MS C LRIP decision scheduled for 2nd Quarter, FY 2007. Second, 4-9 Infantry made final preparations for deployment to Iraq. The PM LW assisted the unit by preparing for LW-specific logistics support. This included final system preventive maintenance checks and services (PMCS), as well as the compiling of spare parts. The PM also worked diligently to establish the support team that would deploy with 4-9 Infantry.

In early FY 2007, however, the LW Program was officially terminated by the Army. This was due in large part to a view by congressional and senior Army leadership that the program suffered from poor system performance, unscheduled cost and schedule overruns and the fact that after over a decade of work, nothing had been fielded in any great quantity. However, a report to Congress by the Department of Defense Director of Operational Test and Evaluation assessed LW System being fielded to the 4-9 Infantry, as “on track” to be operationally effective and suitable (US Senate, 2007).

At this point, because the LW System was terminated, the PM only had what remained of the money intended for the LW DOTMLPF assessment and LUT. This gave him a very limited budget to perform any fixes to the system and a small logistics support package to sustain LW—especially in combat. Regardless, he persisted and built his deployment support plan with what he had. Included in his deployment package was a twenty-one man support element that included USIs, FSRs, and GDC4S CLS personnel.[23] Even though he had to improvise, the flip side was that he no longer had a lot of oversight by outside elements. This allowed him to focus on supporting the 4-9 Infantry the best he could while still managing a terminated program (Cummings, 2008, July 17).

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[22] The DOTMLPF assessment continued during the 4-9 Infantry deployment in order to capture future LW TTPs.

[23] See Appendix L for the PM LW Support Plan.

To support the system and the unit, the PM sent every spare part and system he had to Iraq in Military Vans (MILVANs) to a centralized forward operating base (FOB) in Taji, Iraq, where the entire battalion was deployed. After several months, some of 4-9 Infantry's companies were re-task organized to other units throughout Iraq. To continue the logistics support to the detached companies, the PM LW trained "master warriors" within the companies and sent spare parts forward with them. He also sent USIs and FSRs forward with the unit to address system needs and soldier issues. Master warriors were soldiers identified within the unit to be LW savvy. They received more in-depth blocks of instruction on maintenance and repair of the LW System and components in an effort to be self-sustaining (Cummings, 2008, July 17).

The unit and PM LW pressed ahead with the 15-month deployment to Iraq. The aforementioned PM LW support package that deployed with the unit followed the soldiers from Kuwait into Iraq. One of each support person (FSR, CLS, USI) was deployed with each company in the battalion. Unlike their USI counterparts, the FSRs and the CLSs did not integrate into the unit, but instead focused on fixing LW technical issues at the battalion level (Cummings, 2008, July 17). In order to properly capture and implement recommended soldier-driven system improvements during the deployment, the PM continued both the USI concept and the Top-Ten Process.

To facilitate the communications and improvements with GDC4S while deployed, the PM rotated his USIs back to the Continental United States (CONUS) every three months from Iraq. The process was simple. First, he provided the Top-Ten List to GDC4S by e-mail. He followed up his e-mail with re-deploying USIs working face-to-face with GDC4S to translate operational requirements into materiel solutions. Once USIs arrived at the GD facility in Scottsdale, Arizona, they worked with GDC4S lab engineers to incorporate feedback from Iraq into improvements that could be quickly turned back around and given to the unit. The USIs' translation of recommendations to GDC4S engineers was noted as vital to getting changes made properly and expeditiously. USIs ensured understanding between what the 4-9 Infantry soldiers wanted and what the GDC4S engineers could provide (Augustine, 2008a).

Most changes came in the way of software upgrades and small hardware fixes. Not all of the changes could be implemented because of time and cost, but all of the recommended changes were archived for potential follow-on changes to the LW System (Wood, 2008). Some of the recommendations taken back to GDC4S by the USIs were incorporated using the GDC4S's EDGE facility. This facility enabled quick material upgrades and integration with other emerging technologies[24] (Cummings, 2008, July 17).

The USIs did not have contractual authority to make the changes to the LW System with GDC4S on behalf of the PM LW. Because of this, the PM still had to approve the changes. He did this once technical feasibility was determined by GDC4S, and he had evaluated cost impacts. The PM LW only funded changes that would directly support 4-9 Infantry in Iraq. If the changes or upgrades could not get back to the unit in time to be verified in Iraq, they were not prioritized. In addition to minor form, fit and function upgrades, GDC4S used IR&D funds to continue more costly improvements and longer-lead item changes to the LW System in the anticipation of future Army interest in the program (Cummings, 2008, July 17). These efforts proved valuable to GDC4S and the PM LW when 5th Brigade, 2nd

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[24] The EDGE facility, originally opened in November 2006, is capable of developing and testing new capabilities and technologies. It is a facility formed out of a joint venture of academia, US Government and industry and is, to date, credited with supporting more than ten technology initiatives since it opened. The facility is free to users and is sponsored by the US Government and academic institutions (White, 2007). The EDGE is characterized as a one-stop-shop for soldier modernization programs and is described as a catalogue for tactical systems, accessories, software and components (2007). The EDGE provides an operating process that will bring cutting-edge technology to the tactical edge of the battlespace faster, by aligning the innovations of EDGE members with requests and feedback from warfighters and warfighting programs; PMs can deliver capabilities quickly that are relevant, interoperable and responsive (2007). The EDGE facility's common architecture allows customers to access a "plug-and-play" capability—making quick adaptation of new or emerging technologies and incorporation of the needs of the soldier possible (2007).

Infantry, Stryker Brigade Combat Team (5-2 SBCT) submitted an ONS for the LW System in late 2007.

F. Future Planned Upgrades

The 5-2 SBCT's ONS was approved by Congress in May of 2008. In anticipation of this ONS-driven fielding, several upgrades to the "LW Next Generation" (LW NextGen) System are being worked by both GDC4S and the PM at the time of this writing. Many of these upgrades are based on 4-9 Infantry's recommendations that previously could not be implemented due to time and cost constraints.

The evolution of the LW NextGen System is planned to meet or exceed the minimum capabilities of the Army's future soldier system, the GSE. The LW NextGen will concentrate on improvements in reducing its size and weight and on reducing its power requirements. The LW NextGen System will be more configurable, enable mission tailoring, and will include 15 of the 32 recommended improvements made by 4-9 Infantry soldiers during their deployment. The LW NextGen System will be 30% lighter (reducing its weight from 15.4 pounds to 10.4 pounds), 31% smaller (reducing the overall size of the system from 413 to 285 cubic inches), and will cost 23% less than current systems—allowing the Army to equip more soldiers. The upgraded system will have open interfaces that will allow multiple options for technology insertions and additional accessories for the soldier. In addition, to better assist the PM, one of the ways GDC4S is reducing costs (as well as cycle-time) is by moving personnel who are aiding in the development and testing of the software code to the GDC4S facility at Scottsdale, Arizona. GDC4S, PM SWAR and TCM Soldier continue to collaborate through weekly meetings, ensuring that the ability to rapidly meet the needs of the 5-2 SBCT is accomplished (General Dynamics, 2007).

To better support the 5-2 SBCT, the PM plans to implement changes from his previous approach with 4-9 Infantry. To increase cooperation in meeting the needs of the unit, an USI will now be placed at the brigade level to work in concert with both the battalion and company USIs (see Figure 11 below). The brigade USI will be responsible for interacting daily with the brigade command team and S3 operations officer to ensure top-down integration is achieved. In addition, the brigade-level USI will actively assist the PM LW and GDC4S engineers in the development, integration, and acceptance testing of new LW equipment. The brigade USI will be the main liaison between with PM and the unit. He will prioritize lessons learned and assist in the coordination of providing improvements to current LW capabilities. The brigade-level USI will be responsible for the coordination of all lower-level USIs and LW support personnel, ensuring the unit's needs and concerns are addressed in a timely manner (Augustine, 2008a). The intent is not to usurp the PM's role, but rather to augment his ability to close the gap between the materiel developer and the unit.

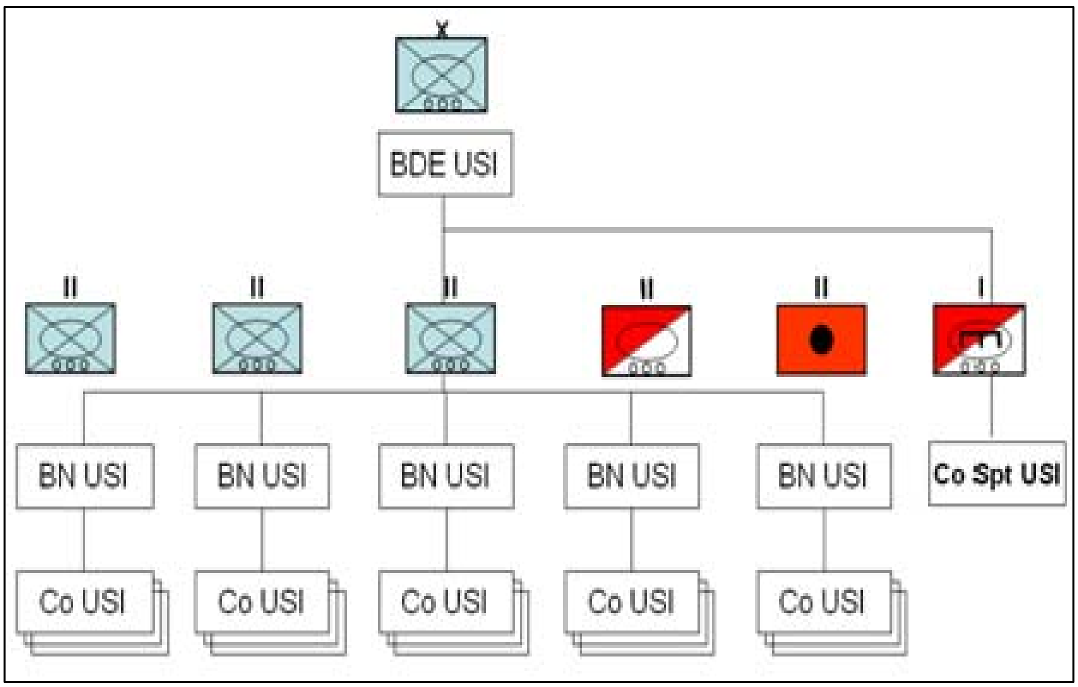

Figure 11. Unit System Integrator Structure for 5-2 SBCT
(Augustine, 2008b)

G. Lessons Learned

There were several lessons learned by the PM LW and GDC4S prior to, during and after 4-9 Infantry's deployment. There were several things noted as vital to unit-system integration: soldier acceptance, unity of effort among system integrators, and the PM's ability to work with GDC4S responsively. These LW-specific tenets proved to be effective and, if implemented, could assist other materiel developers within the Army.

First, the PM had to find a way to bridge the chasm between the LW System's early adapters and the unit. The initial idea of conducting a standard LW NET that only focused on the technical aspects of the system failed to get necessary user buy-in because it was not focused on incorporating LW into the unit's standard operations. In order to gain a foothold in user acceptance, the PM first leveraged his unit "Points of Light" concept. This was focused on establishing acceptance from within the ranks in hopes of influencing other soldiers within the unit. This was an initial attempt at bridging the chasm between early adapters and the early majority. In addition to the points of light concept, the PM's implementation of the USI concept and the careful matching of the right USI with the right unit quickly bridged the communication gap between the PM and the unit and built a level of acceptance and confidence that proliferated throughout the unit. Through these innovative concepts, the PM was able to create unit buy-in and ultimately prove that the LW System could enhance 4-9 Infantry's standard operations.

To manage the process of human-centered, soldier-driven design improvements, the PM LW implemented the Top-Ten Process. This prioritized list—coupled with the PM's analysis of feasibility with respect to cost, schedule and performance—enabled effective communication between the PM, the unit and GDC4S engineers. This list communicated the unit's vision of what changes needed to be made to the system and aligned them with the PM's overall plan. System software improvements and human-centered design changes were completed quickly by the PM LW and GDC4S and returned to the unit. This flexibility with respect to soldier-driven improvements enhanced soldier acceptance and confidence and showed them that their concerns were being addressed in a responsive manner.

Last, and perhaps most interesting, the PM was able to implement these visionary concepts and methods in large part because the LW Program was terminated. He had very little oversight once the program was terminated; however, he had “top cover” support from the PEO Soldier. This essential top cover gave the PM LW the flexibility to make changes to the system based upon soldier input gathered from their lessons learned and recommendations. Changes that normally would have taken months, maybe even years, to implement using traditional acquisition methods, took only weeks.

In sum, the PEO Soldier, PM LW and GDC4S believed in the LW System’s capabilities and went to extraordinary lengths to ensure that 4-9 Infantry soldiers were supported and set-up for success. The result is a testament to their collaborative approach and unwavering persistence. These ingredients of collaboration and persistence, as well as other aforementioned methods, should be considered by other PMs in the future.

H. Conclusions

Some of the lessons learned from the materiel developers’ perspective with LW can be generalized and applied to the management of other programs within the DoD acquisition community. First, user acceptance and support must be present for a program to succeed. While a new warfighting system may close a capability gap or fulfill a requirement, without user support for a materiel solution, the program may be doomed. Next, the PM should be given the top cover and flexibility to adapt his acquisition strategy to user-driven requirements. To do this, the PM must have a firm understanding of the potential implications to his program’s cost, schedule, performance and myriad other factors (e.g., training support packages, test and evaluation master plan, etc.).

When introducing a new system or system innovation, it is important for a PM to cross the chasm between the early adapters and the early majority in any marketplace as soon as possible. Bridging this chasm early in the acceptance process will encourage early buy-in—thus fostering stronger overall confidence in the product. Next, the ability of PMs to gather, prioritize and rapidly respond to customer feedback is essential. It breeds a perception of responsiveness that increases end-user satisfaction and overall confidence in the acquisition process. Successful managers must also pay attention to the concept of product advocacy. With this in mind, beachheads should be established early and should be carefully leveraged to influence a greater population. Furthermore, while unique, the environment that LW found itself in once the program was terminated was, in the end, conducive to its success. PM persistence to support the warfighter despite programmatic challenges is a vital ingredient to getting the warfighters what they need. In the end, PMs must do the best with what they have; this persistence, coupled with top cover, contributes to program success.

From a strategic perspective, two fundamental takeaways should also be considered. First, the assumption that commercial-like technologies can be easily adapted to meet military requirements will likely lead to program cost and schedule increases. LW experienced this early on with the LW Consortium and, while a good idea at the time, this assumption created cost and schedule increases early in the program's history. This led to a prolonged timeline, increased frustration by both the PM and the user and an increase in cost that only compounded the problem. Second, the introduction of technology demonstrations early in the program to showcase system potential and to sell it to the stakeholders—i.e., Congress, Office of the Secretary of Defense (OSD), etc.—can backfire if done too early. This was evident at Fort Lewis, Washington, during the first VIP day; the LW was terminated while the user was just becoming familiar with the system and embracing its benefits. Other PMs must be careful to temper their approach at marketing their products with respect to the underlying and constant “drum beat” of the PPBES process (J. Yakovac, personal communication, September 18, 2008).

IV. The LW Users' Perspectives

> This system [Land Warrior] is as significant and important as rifled barrels once were over smooth bore barrels. It will change the way we fight. (Department of the Army Press, 2007, p. 1)

> Based on assessment results, it looks like we will deploy with the new Land Warrior Systems. (Program Executive Office Soldier, 2006)

> The Manchu Battalion, 4-9 Infantry, has dominated the enemy in dismounted operations in Iraq with the help of Land Warrior. The combat information available to leaders through the system helps us to decide and act faster than the insurgents can match. Land Warrior could, with some improvements, provide the same advantages to the entire US Infantry force. Our national priorities should demand no less and our national treasure—our Soldiers—deserves no less. (Prior, 2008, p. 13)

A. Introduction

The above quotes capture the words of two of the most important leaders in the recent history of the LW Program. The first, COL Ernie Forrest, was the TCM Soldier[25] during a majority of the time prior to when the second, the warfighter, 4-9 Infantry's Battalion Commander, LTC Bill Prior, endorsed the system and asked to take it to combat. COL Forrest was a visionary and staunch advocate for the LW System and dug his heels in to keep the LW effort alive during a majority of its tumultuous times from 2003 to 2006. As the warfighter's advocate, he felt it was his duty; as a visionary, he was compelled to support the system by his faith in LW's ability to change how the dismounted soldier fights. Once the LW System was delivered to LTC Prior's Battalion, the warfighters got their vote. His soldiers put it to the test and initially despised it, but eventually became its staunchest advocates.

[25] The TRADOC Systems Manager (TSM) Soldier was re-designated the TRADOC Capability Manager (TCM) Soldier by TRADOC in 2006. This was done in an effort to focus the title on capabilities instead of systems. For consistency, we use TCM Soldier throughout this case study.

The true users of any combat system are the soldiers, marines, airmen and sailors who employ it during training and combat operations. They provide the requirements or needs for new combat systems and equipment through their determination of gaps in their existing capabilities. By defining the gap(s) in their capabilities and stating their requirement(s), they start the DOTMLPF process that is designed to determine whether or not a materiel solution is required, or if changes in existing DOTMLPF are adequate to fulfill the requirement. If a materiel solution is necessary, the acquisition process is initiated, and the road to materiel development begins.

Once the materiel development of new combat systems starts, the true users, or warfighters, are normally busy operating within their operational roles. Because they are busy preparing for or conducting operations, they are unable to focus their attention on the systems' acquisition processes. Instead, they expect a new combat system or piece of equipment to be fielded to them that meets their requirement(s) and closes their capability gap(s). They deserve a system or piece of equipment that has been adequately developed, put through its paces, thoroughly tested and is ready for employment. To ensure this, an informed, effective user representative is required when the materiel development process begins to advocate the warfighters' needs and serve as the Army's conscience. The TCM Soldier fulfills this role for soldier-related materiel acquisition. He must be the honest broker between the warfighter and the materiel developer. The current TCM Soldier, Colonel Jim Riley, sums it up well:

> It is important that he remember that he is the users' representative when they [the warfighters] can't speak for themselves. He should try to facilitate as much as possible a direct link by the real users and the PM. As the conscience of the Army, he has to tell the rest of the army the information [about the program]. If everybody else isn't keeping track of what is going on or isn't aware of what is going on, it [the information about the program] gets lost. (Riley, 2008)

As mentioned in Chapter II, the users for LW were the first unit equipped, the 4-9 Infantry "Manchus." Prior to receiving LW, however, the TRADOC Capability Manager, Soldier (TCM Soldier), served as the user representative and oversaw the system's development from concept through to its fielding to the Manchus. This chapter briefly describes Army TRADOC Capability Managers (TCMs). It provides details about the TCM for LW, the TCM Soldier. It describes the TCM Soldier's role during the LW System's development, fielding and deployment. Furthermore, it touches upon 4-9 Infantry's experience with LW and provides initial results from the post-deployment survey administered by ATEC in May 2008. The chapter concludes with a discussion of lessons learned from the users' perspectives and generalizes those lessons for the DoD Acquisition community.

B. Army TRADOC Capability Managers (TCMs)

As mentioned previously, throughout the systems acquisition process, Army warfighters require an advocate for their needs. To respond to this requirement, TRADOC established TCMs to provide user representation during the development of major systems. TCMs are normally considered for establishment between Milestones A and B, at the end of concept exploration, or when a concept is approved. TCMs are normally O-6/Colonel duty positions.[26] Programs must meet the following criteria for establishment of a TCM:

- Program must be an ACAT I, ACAT II, or other high-priority materiel system as determined by the CG, TRADOC.
- Program must be a program manager/program executive officer-managed program.
- Workload must be such that the program cannot be managed within the resources and structure available to the proponent.

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[26] For a description of the duties and responsibilities of a TCM, see *TRADOC Regulation 71-12*, dated 1 March 2002.

- Workload or uniqueness of the program must be such that an existing TCM cannot assume the program. Intent of this regulation is not to preclude combining of individual system responsibilities in one TCM.
- Program must be higher priority or have greater need for a TCM than existing TCM-managed programs (Training and Doctrine Command, 2002).

C. TCM Soldier

The LW System resides within the purview of the TCM Soldier at the Maneuver Center of Excellence[27] (MCoE) at Fort Benning, Georgia. The TCM Soldier performs as the conscience of the Army and the MCoE for the soldier—all soldiers: core, mounted, ground and air soldiers—within Army formations. TCM Soldier is the Army's centralized manager, user representative and integrator of DOTMLPF for soldier capabilities within Army formations to ensure success on the battlefield. TCM Soldier provides intensive management of everything worn, consumed or carried for individual soldier use in a tactical environment to maximize lethality, command and control, survivability, sustainment and mobility. For systems and subsystems that comprise or impact the SaaS, TCM Soldier directs and approves those components which concern only the individual soldier; approves those which concern additional soldier equipment; coordinates with those which concern tables of organizational equipment and common tables of allowances; consults on those which concern Army facilities and equipment; and, is informed about components which constitute Army systems (Berger, 2008).

The TCM Soldier is the user advocate and counterpart to the materiel developer, PEO Soldier.[28] TCM Soldier coordinates with other TCMs within TRADOC and works through the Director of Capabilities Development and Integration, MCoE, to accomplish assigned tasks. In coordination with appropriate

[27] United States Army Infantry Center (USAIC) was re-designated the Maneuver Center of Excellence (MCoE) in FY 2007.

[28] PM Soldier was re-designated PEO Soldier on 7 June 2002 (Berger, 2008).

proponents, other TCMs, PEO Soldier, and PMs, the TCM Soldier ensures associated deliverables are developed along timelines to meet Army milestones. The TCM Soldier manages all facets of user activities but must ultimately ensure all aspects of training are synchronized with the fielding of assigned capabilities (Berger, 2008).

D. TCM Soldier & LW Development

The TCM Soldier's role in the development of LW can be described as one of unwavering support for the Army soldier given the status of technology, fiscal constraints, Department of the Army (DA) guidance and concurrent operational events. This support, coupled with both cooperative materiel developers and Army and Congressional decision-makers, has contributed to LW's many successes and, in some cases, its setbacks. By the current TCM Soldier's own admission, there are things that the TCM Soldier could have done better, but at the end of the day, his office and their predecessors have done their best to assist the soldier (Riley, 2008).

Evidence of TCM Soldier's involvement in the LW Program goes back to the early 1990s before LW was even a formal program. When the LW ORD was approved in April 1994, the TCM Soldier was designated as its user representative (Berger, 2008). Once LW was officially a POR in 1996, TCM Soldier's involvement has continued in parallel with the program's timeline and continues to this day.[29]

[29] It is important to note here that the TCM Soldier does not just manage the LW Program. His/her responsibilities include all other programs that affect what the soldier carries and consumes. This includes major end-items, SaaS, the Rapid Fielding Initiative (RFI) and other programs. Given their small organization, it has been very challenging for them to manage all of these efforts as well as LW, and we will touch on that later in the study. For the current TCM Soldier's Organizational Chart, see Appendix M.

E. Early TCM Soldier LW Involvement

From 1994 to 1998, TCM Soldier's focus was the LW, MW and Air Warrior (AW) Programs. TCM Soldier managed LW from Fort Benning, MW from Fort Knox, Kentucky, and AW from Fort Rucker, Alabama. At Fort Benning, TCM Soldier's concerns for LW revolved around how to employ the LW System, as well as its impact on Army DOTMLPF. TCM Soldier worked closely with PM Soldier and Hughes Aircraft (now Raytheon) during the prototyping of the first LW System (Berger, 2008). During that time, TCM Soldier was also working with TRAC-WSMR for LW-related analysis that included both modeling and simulation of the LW System's capabilities (Augustine, 2008a).

In 1998, the LW ORD, originally approved in 1994, was revised by the USAIC in an effort to bring it into compliance with ACAT I Material Acquisition Program reference requirements. As the user representative, TCM Soldier led this revision effort, guiding the effort through its nearly four-year approval process. Changes in Army vision from 1999 to 2002 had to be considered; these catalyzed numerous changes that had to be incorporated into the original LW ORD in order to link it to the Objective Force Concept. In addition, as described in previous chapters, the PM Soldier restructured the LW Program in 1998 in an effort to move away from proprietary development and towards an innovative approach that maximized the use of COTS components and technologies and incorporated GFE (Berger, 2008). This change increased the TCM Soldier's involvement; he also had to keep up with multiple vendors—versus a single prime contractor.

In 1999, when the LW Consortium took the lead with LW development, the TCM Soldier provided a user representative to the team, SFC Chris Augustine. His job was to guide the LW Consortium and the PM on what the warfighter needed in a soldier system. He did this through constant presence at all of the LW Consortium's facilities. With a seasoned infantryman's perspective and a background in analysis, he was empowered by the TCM to work with the PM and the LW Consortium to assist with the development of LW v0.6. Augustine focused on human-centered form, fit and function by translating user requirements to engineers (Augustine, 2008a). His efforts paid off when, in September 2000, the resulting prototype LW v0.6 Systems were favorably evaluated at the JCF-AWE by warfighters from the 82nd Airborne. This favorable evaluation was the direct result of the TCM Soldier's work with the materiel developers. Also vital to the effort were several weeks of LW training and preparation conducted by the TCM Soldier at Fort Benning with the soldiers from the 82nd Airborne. Soldiers were equipped, trained and well-practiced on the LW Systems prior to the event (Berger, 2008).

After the JCF-AWE, the TCM Soldier continued to work on revising the LW ORD. During 2001, substantial work was done on the LW ORD to restructure its requirements and put them into a new format that attempted to link it to the FCS-enabled Objective Force Concept (Berger, 2008). This push was based upon guidance from the SECDEF, The Honorable Donald Rumsfeld, and the Chief of Staff of the Army (CSA), General Eric Shinseki, that directed transformation of the Army into a modular force focused on the future (J. Yakovac, personal communication, September 18, 2008). TCM Soldier worked to scope LW in light of the Objective Force Concept and, hand-in-hand with PM Soldier and the Director of Combat Developments (DCD), USAIC, rewrote the O&O. The revised ORD was approved by TRADOC on 31 October 2001 and forwarded to Headquarters, Department of the Army (Berger, 2008).

In 2002, LW evolved from the v0.6 to the LW-IC (Block I). During this evolution, the TCM Soldier continued to work closely with the PM Soldier (re-designated PEO Soldier on 7 June 2002). The year 2002 was filled with developmental testing (DT)—to include safety testing, immersion testing, and reliability testing—at Aberdeen Proving Ground, Maryland, all of which the TCM Soldier monitored for the user. Soldiers from the 82nd Airborne conducted the ATEC-run assessments. The PM LW at the time, LTC Dave Gallop, contends that the soldiers were properly trained for the assessments (D. Gallop, personal communication, November 3, 2008). The testing at Aberdeen Proving Ground brought forth some serious issues with LW-IC (Block I) reliability. Testers from ATEC that conducted the functional assessments concluded that LW-IC capabilities were not ready and probably would never be ready (J. Moran, personal communication, October 27, 2008).

Regardless of materiel development challenges in 2002, the TCM Soldier and the USAIC worked dilligently to revise the LW ORD to match Objective Force Concept requirements. The revised LW ORD was finally approved by the Chief of Staff of the Army in November 2002, and the LW Program was redesignated an ACAT IC Program on 17 December 2002.[30] From the TCM Soldier's perspective, the key to success for the ORD approval was a close working relationship with all agencies involved. The relationship cannot be an "us versus them." "All parties have to be synchronized and work together to get the job done" (Berger, 2008).

In 2003, the TCM Soldier started the year by participating in another early functional assessment of LW-IC (Block I)—this time with the first intended end-user, the 75th Ranger Regiment. The PM LW at the time, LTC Dave Gallop, reported that the Rangers were trained on the LW Systems prior to their assessment (D. Gallop, personal communication, November 3, 2008). However, a member of the TCM Soldier staff at the time, SFC Chris Augustine, stated that there was not a very good train-up. He contended that "they [TCM Soldier] only went to the test and got the results" (Augustine, 2008a). He argued that their lack of familiarization and training proved to be detrimental to the Rangers' perspective on the system; consequently, the Ranger's found the LW System unsuitable (2008a).

[30]It took the Department of the Army almost a full year to approve the revised LW ORD due to an evolution in Army vision. First, in 2001, the GWOT started. Second, the Army moved to an Objective Force Concept, with FCS as its central effort. The revised LW ORD had to incorporate FCS into its requirements, which were still in concept refinement during 2002.

Regardless of whether or not the Rangers were trained, the results were similar to the assessments conducted by the 82nd Airborne soldiers at Aberdeen Proving Ground the previous year. Concerns surrounding reliability and fightability were shared by both the Rangers and, as the user advocate, the TCM Soldier. The materiel developer echoed these concerns as well. As a result, LW was assessed as being behind schedule and not meeting entrance criteria for OT. Subsequently, the decision to dissolve the OTA with the LW Consortium for the development of LW-IC (Block I) Systems was made by the PEO Soldier (J. Moran, personal communication, October 27, 2008). TCM Soldier supported this decision along with the Commander, USAIC (Berger, 2008).

The decisions to dissolve the OTA and end the LW Consortium's developmental efforts were critical events in the LW's developmental history, as they re-focused both the TCM Soldier and the PM LW on the DBCS.[31] They also created misperceptions in several key players. These misperceptions festered over time and created a divide between the user representative and the materiel developer.

From the TCM Soldier's perspective, the reason behind not going and training the Rangers on the system was that the PEO Soldier at the time felt like LW:

> needed to stand on its own. If the TCM Soldier and the PM LW had to go and show them how to use the LW System, then there was something obviously wrong. It was a calculated move to show LW was a failure and bring DBCS forward because DBCS was what the PEO Soldier, BG Moran, believed in; he thought that DBCS was the right [materiel] solution. He did not believe in LW as the right solution—he never thought it would work. He didn't think soldiers would ever accept it and didn't think there was any value added. (Augustine, 2008a)

The flaw in the approach used with the Rangers' assessment was described with the following analogy.

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31 The Dismounted Battle Command System (DBCS) is described in Appendix E.

> It would be like back in the thirties, if you just showed up to a division and said, "Here's a hundred tanks; here's how you turn them on and put gas in them; now we are leaving"—no doctrinal changes, no warfare or strategic implications, nothing, just: here's your tanks. Of course, when you have a unit who are doing their standard missions, and they don't make any changes or adapt their TTPs to reflect new capabilities, their response is, "There is no value added"—which is exactly what they [PEO Soldier] wanted to hear. (Augustine, 2008a)

At the time, the PEO Soldier and his PM LW had completely different perspectives. From the PEO's perspective, he had to develop a dismounted situational awareness capability whether it was a handheld, tablet device (DBCS) or a soldier ensemble with an eye-piece (LW). He was impartial to either materiel solution. Furthermore, his PM LW had two functional assessments that both pointed to serious reliability issues (J. Moran, personal communication, October 27, 2008). The PM LW conducted these two assessments as risk-reduction mechanisms and as determinations of what he had from a functional perspective prior to contract award for LW Block II. Complicating matters were LW-IC (Block I) cost concerns and difficulties that he encountered with the TCM Soldier when trying to trade functionality for cost. Specifically, the TCM Soldier was adamant about keeping the lethality capability that the LW System provided through the weapon subsystem (WSS). Also, the TCM Soldier wanted the BOI to include every dismounted soldier instead of just key leaders. The TCM Soldier's vision was that a BOI to every soldier would create a synergistic effect that boosted the potential of its capbilities. These issues, when combined, drove cost per unit to nearly $32,000 per system. Last, but not least, "the LW-IC (Block I) commericial-based architecture was not robust enough for the soldier's environment and could not provide connectivity to the LTI" (D. Gallop, personal communication, November 3, 2008). This was a key capability that the materiel solution had to have to be interoperable with FBCB2 and Blue Force Tracker (BFT).

These issues were not new during late 2002 and early 2003. Rather, they were noted by HQDA and Congress earlier in 2002; consequently, the PEO Soldier was directed to compete the LW Block II effort. He also noted that he had to do this because LW was an ACAT I program, and an OTA was not authorized. "You cannot do a major development under an OTA" (J. Moran, personal communication, October 27, 2008). Last, the former PEO Soldier emphasized that the DBCS was not a substitute program to replace the LW. Instead, it was offered as an option to the LW because it was having so many difficulties. He had to look for alternative technical solutions to fill dismounted soldier capability gaps, and the DBCS was already under development (J. Moran, personal communication, October 27, 2008).

Regardless of the intentions, it is clear that LW survived to become what it is today because of the decision to dissolve the LW Consortium and compete the LW Block II efforts. Openly competing the contract for LW Block II and subsequent program decisions outlined in Chapter III contributed to its later successes. From the user representative's perspective, however, the events of late 2002 and early 2003 set the stage for subsequent disagreements over the determination of the right materiel solution. In the end, the disagreements served the program well as they polished the materiel solution so it could be placed into the hands of soldiers.

F. Recent TCM Soldier LW Involvement

At about the same time the Rangers finished the early functional assessment of LW-IC (Block I), on 30 January 2003, GDC4S was awarded a competitive contract for the design and production of LW Block II Systems. This, coupled with the PEO Soldier's decision to dissolve the LW Consortium, made for a busy 2003 for the TCM Soldier office. The TCM Soldier worked with PEO Soldier's PM Soldier Warrior (SWAR) and PM LW to lay out the plan for LW Block II.[32] In July, TCM Soldier participated in the preliminary design review (PDR) with GDC4S and PM LW. Later in the fall, the TCM Soldier worked with PM LW, PM SWAR, PM FBCB2, and TCM

[32] The PM Soldier Warrior (PM SWAR) is the Program Manager (O-6/Colonel) that the LW Product Manager (O-5/Lieutenant Colonel) is a part of organizationally. The PM SWAR provides managerial support to the LW PM and often directly supports the LW PM with interfaces requiring more senior support.

FBCB2 on a memorandum of agreement (MOA). This MOA was intended to establish formal collaboration in support of LW's connectivity to the FBCB2 with the DBCS and the Commander's Digital Assistant (CDA). This was in response to the need to tie the LW System into the Lower Tactical Internet (LTI) (Berger, 2008).

The TCM Soldier advised and consulted with GDC4S on developing the LW System that would evolve over the following three years into the LW-SI (Block II). From the very beginning of 2003, when GDC4S was awarded the contract for LW Block II, TCM Soldier knew that it was important to be involved. Based on the successful experience with Augustine and the LW Consortium and LW v0.6, the TCM Soldier managed his office to maximize its ability to stay abreast of the materiel developers. By being involved with translating requirements into materiel with GDC4S engineers, form, fit and function issues could be resolved in a collaborative manner. This was intended to reduce schedule and performance risk. This close relationship that TCM Soldier fostered with GDC4S early in the materiel acquisition process was noted by both the GDC4S PM and the TCM Soldier as a crucial aspect of the LW System's successful evolution—despite funding constraints and early warfighter acceptance issues (M. Showah, personal communication, August 8, 2008).

Also in 2003, TCM Soldier (in conjuction with PM SWAR) made efforts to conform to the recently implemented JCIDS process. In November, the Joint Requirements Oversight Council (JROC) briefing was submitted to HQDA, together with the updated LW ORD. Following that submission, late in November, a Force Applications Working Group (FAWG) briefing was conducted. At the FAWG, two major potential issues were raised. First, there was no J6-interoperability certification for LW and second, the LW, AoA had yet to be completed. These two issues were discussed in early December at a Functional Capabilities Board (FCB) briefing. The result of this briefing was a recommendation by the FCB that the LW ORD not proceed to the Joint Capabilities Board (JCB) (scheduled for 10 December 2003) or to the JROC (scheduled for 18 December 2003). While TCM Soldier's role in the J6 certification proved to be minimal (it was approved 30 days after the FAWG), its role in the LW AoA with TRADOC Analysis Center White Sands, New Mexico (TRAC WSMR), consumed much of the following two years (Berger, 2008).

In 2004, TCM Soldier worked with GDC4S and PM LW on the LW Critical Design Review (CDR). This was completed in late May 2004. During the summer, TCM Soldier, along with GDC4S and PM SWAR, were also involved with the development of the DBCS and CDA. These efforts were directed by the PEO Soldier based on Army guidance to refocus procurement on emerging SA/C2 capabilities to the current force (DBCS & CDA) due to the loss of faith in LW-IC (Block I) reliabilty in 2003 (Berger, 2008).

While funding and focus was withdrawn from LW, it still remained the USAIC's number one priority (Berger, 2008). In light of this continued emphasis, the TCM Soldier directed Major Paul Mazure, Assistant TCM Soldier, to lead a side-by-side demonstration of the LW-SI (Block II) at Fort Benning, Georgia. The goal was to provide a side-by-side comparison of a LW-equipped infantry squad and a conventionally equipped infantry squad. The purpose was to determine the difference in the squad's lethality, mobility and battle command and then to tie the findings into the LW AoA. Major Mazure and the TCM Soldier/PM LW team worked to equip, train and prepare the squads participating in the demonstration (P. Mazure, personal communication, September 13, 2008).

The side-by-side that the TCM Soldier orchestrated was a huge success for the LW Program. Much like the JCF AWE, the TCM Soldier fully prepared the soldiers that participated. The squad that was conventionally equipped was trained on the tasks that they needed to complete during the demonstration. The squad using LW was trained on both LW equipment familiarization and LW employment TTPs. The side-by-side results helped to inform key decision-makers—specifically the Vice Chief of Staff of the Army, General Cody, whose support helped to revive LW from its major funding setbacks. His support spurred much of what was to become TCM Soldier's focus for the next three years: the equipping of one Stryker Battalion with LW capabilities (Augustine, 2008a).

In February 2005, the Army Acquisition Executive (AAE) issued an ADM directing the PM LW to refocus his acquisition strategy to provide DBCS to leaders of up to 30 BCTs as well as to support the VCSA decision to equip one Stryker Battalion with LW-SI Systems. TRADOC followed the ADM with a directive to conduct a DOTMLPF assessment of a LW-equipped Stryker Battalion.[33]. Following this direction, the TCM Soldier hosted a meeting to start the process of planning for the DOTMLPF assessment of the Stryker Battalion. Participants included TRAC-WSMR, PM LW, PM SWAR, Army Test and Evaluation Command (ATEC), the Infantry Forces Research Unit of the Army Research Institute (ARI), the Soldier Division of the DCD, USAIC, and the Systems Division of the Directorate of Operations and Training (DOT), USAIC. This TCM Soldier-led effort resulted in a finalization of the recommended DOTMLPF study issues submitted to the CG, USAIC and TRADOC. The study issues surrounded LW BOI considerations.[34] The two considerations were a LW BOI down to every soldier or an issue only to leaders, team leader level and above (Wainer, 2006).

Preceeding this effort was a Phase I LW AoA gap analysis led by TCM Soldier and supported by the USAIC and TRAC WSMR. The results of the Phase I AoA identified the 19 small unit capability gaps shown below in Figure 13. These capability gaps were derived from a Functional Needs Analysis (FNA) and Functional Solutions Analysis (FSA). The gaps in capability that required a materiel solution (18 of 19) put into focus the study issues that the LW DOTMLPF assessment needed to address (Wainer, 2006). Figure 13 below outlines the results of the FSA and shows both the 19 small unit capability gaps and the assessment on

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33 See Appendix G for the original TRADOC Memorandum directing the DOTMLPF assessment.

34 See Appendix N for the LW DOTMLPF Assessment, LUT Results and Land Warrior BOI Alternatives.

whether or not a material solution was required. The table also identifies the extent to which the LW Block II filled or mitigated the gaps. Gaps in red were noted as highly critical to mission success, yellow as moderately critical to mission success, and green as less critical to mission success.

FSA Results: Is a Materiel Solution Required? *(1 of 2)*

Task with Gap	Is Materiel Solution Required?	LW Block II Fills or Mitigates Gap?
Enter a building during an urban operation (skill level 10).	Y	pending*
Locate mine and booby trap indicators by visual means (skill level 10).	Y	N
React to man-to-man contact (combatives) (skill level 10).	N	N
Coordinate with adjacent units (MTP leader task).	Y	Y
Perform voice communications (skill level 10).	Y	Y
Conduct vehicle / personnel checkpoints (skill level 30).	Y	pending*
Fight dismounted in conjunction with armored vehicles (MTP Leader task).	Y	Y
Direct dismount from an armored vehicle (skill level 30).	Y	Y
Move under direct fire (skill level 10).	Y	Y
Leaders gain and maintain situational awareness / situational understanding (MPT leader task).	Y	Y
Receive and issue orders and instructions with overlays (MTP leader task).	Y	Y

* Assessment cannot be made until TTPs are developed that account for LW functionalities.

Figure 12. FSA Results from LW Phase I AoA
(Wainer, 2006, p. 5)

FSA Results : Is a Materiel Solution Required? *(2 of 2)*

Task with Gap	Is Materiel Solution Required?	LW Block II Fills or Mitigates Gap?
Coordinate movements and fires of subordinate elements (MTP leader task).	Y	Y
Kill or suppress enemy personnel and vehicles using indirect fire assets (skill level 20).	Y	Y
Conduct engagement with precision munitions (joint task).	Y	N
Receive, process, and report tactical information (MTP leader task).	Y	Y
Navigate dismounted as a small unit (skill level 10, two skill level 20, and one MTP leader tasks).	Y	Y
Request and adjust fires from a joint source [Naval gunfire; USMC cannon and mortar fire; USMC rotary wing fire; USMC, USN, and USAF fixed wing fires] (joint task).	Y	pending*
Kill or suppress enemy personnel using individual direct fire weapon (skill level 10).	Y	Y
Direct employment of smoke (skill level 40).	Y	N

** Assessment cannot be made until TTPs are developed that account for LW functionalities.*

Figure 13. FSA Results from LW Phase I AoA
(Wainer, 2006, p. 6)

During August 2005, the TCM Soldier was also involved with conducting a DBCS operational event (OE) with ATEC, PM LW and the 10th Mountain Division at Fort Drum, New York. Unlike the JCF AWE and side-by-side events, the TCM Soldier was not extensively involved. Due to a shortage in TCM Soldier personnel, only one officer went to Fort Drum prior to the event to familiarize, train and help with TTPs. This proved to be insufficient, as the lightfighters at Fort Drum lacked even the most basic of digital battlefield capabilities. Not suprisingly, the warfighters at 10th Mountain found the DBCS unsuitable for light infantry operations (Augustine, 2008a). This failed OE marked the end of the DBCS and, accordingly, TCM Soldier re-focused on getting prepared for the DOTMLPF assessment with the Stryker

Battalion[35] chosen by the Army, the 1st Squadron, 2nd Cavalry Regiment (later redesignated 4th Battalion, 9th Infantry).

G. TCM Soldier, LW and 4-9 Infantry

The fall of 2005 was extremely busy for both 4-9 Infantry and TCM Soldier. Preparations for the equipping, new equipment training and DOTMLPF assessment with the 4-9 Infantry were underway. 4-9 Infantry was organizing and only had a handful of Non-Commissioned Officers (NCOs) and Officers in its ranks. Soldiers to fill the companies and platoons would not be on board for several months (Pitch, 2008). In September 2005, an additional task was picked up by the TCM Soldier and PM LW when the 4th Brigade, 2nd Infantry Division Commander, COL Lear agreed to do a LUT in conjunction with the DOTMLPF assessment. This added yet another event to plan in conjunction with the unit and ATEC (Berger, 2008).

The first event for the equipping of 4-9 Infantry was a Master Training Course (MTC), which was put together by the TCM Soldier, Omega Training Group and the PM LW. This course was designed to provide in-depth training to senior leaders within 4-9 Infantry so that when the rest of the battalion was equipped, the process would be rehearsed and, therefore, smoother. In addition, it would help the TCM Soldier, Omega Training Group and the PM LW assess the adequacy and feasibility of the training program that the entire unit would end up receiving in the spring (Augustine, 2008a).

The MTC was successfully executed in December of 2005 and marked the first major event for the TCM Soldier, LW PM and 4-9 Infantry at Fort Lewis, Washington. Other events were also planned for 4-9 Infantry. A phased, equipping and subsequent NET for each unit within 4-9 Infantry was to be executed in the late

[35] For a detailed description of a Stryker Battalion see FM 3-21.31, The Stryker Brigade Combat Team.

Spring and early Summer of 2006. After NET was completed for each company, a DOTMLPF assessment was to take place concurrently with unit train-up for deployment. In September, an ATEC-led LUT was to take place with one rifle company from 4-9 Infantry. See Figure 14 for a pictoral description of the LW DOTMLPF assessment team and Figure 15 for both the DOTMLPF assessment and LUT plan.

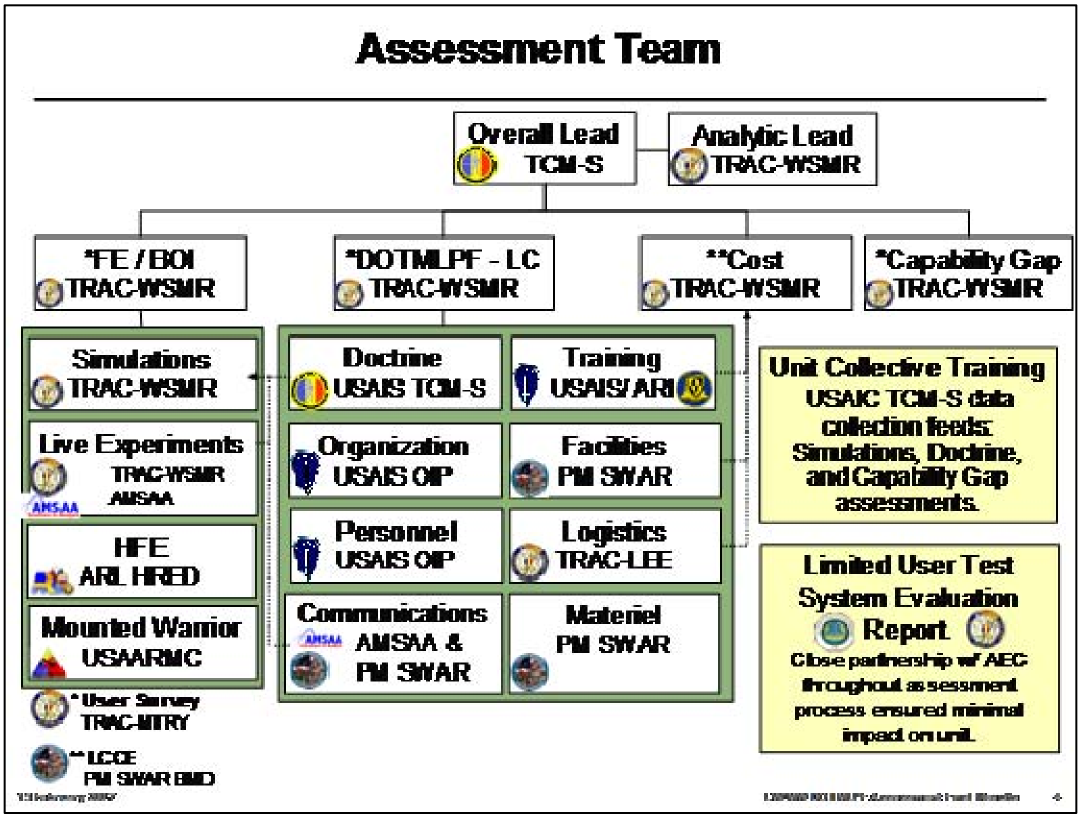

Figure 14. DOTMLPF Assessment Task Organization
(Wainer, 2007, p. 3)

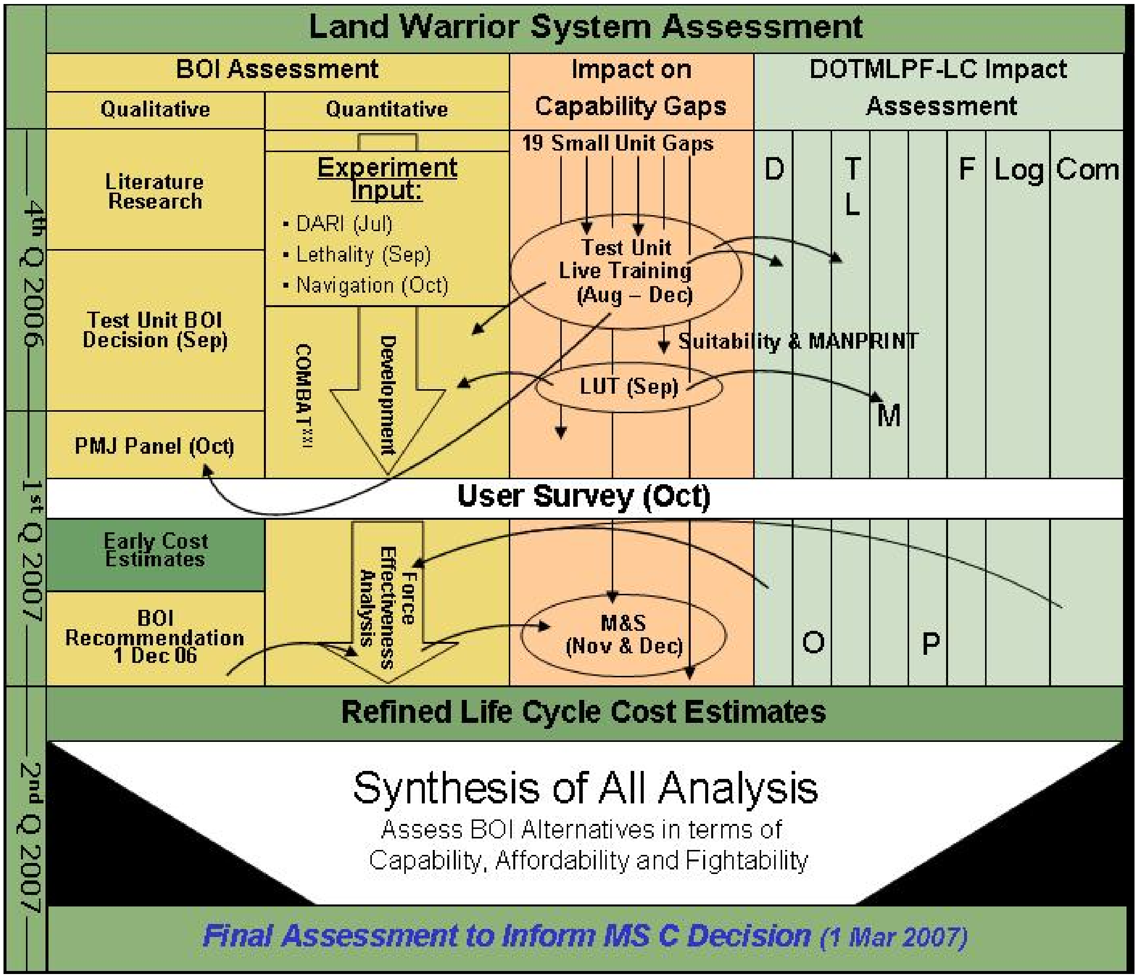

Figure 15. DOTMLPF Assessment & LUT Plan
(Wainer, 2007, p. 9)

In early 2006, TCM Soldier, in conjunction with the PM LW and Omega Training Group, executed 4-9 Infantry's NET. The 4-9 Infantry was equipped with LW by May and completed with NET by the end of June. During this timeframe, the TCM Soldier was also fully engaged with staffing the Ground Soldier Systems Capabilities Development Document (GSS CDD), other SaaS-related issues and myriad other tasks. While the LW equipping and NET with 4-9 Infantry was the TCM Soldier's main effort, there were only six officers and two NCOs available to task for all of the office's responsibilities. Consequently, only two officers and two NCOs were dedicated to the mission full-time. One officer was dedicated to the DOTMLPF assessment, and the other to the LUT. The three others, including the TCM himself, were only partially involved (Qualls, 2008). This small footprint made integration with the entire battalion virtually impossible from the beginning. Consequently, from the time NET took place until August (approximately three months), TCM Soldier integration with the unit was limited. Likewise, the PM only had one person who was dedicated to unit-integration efforts. Consequently, unit emphasis on incorporating LW into its training suffered. This lack of incorporation led to a dip in battalion-wide confidence in the system (Cummings, 2008, July 17).

Following NET, TCM Soldier, in coordination with 4-9 Infantry, GDC4S and PM LW, facilitated the first VIP day in July 2006. The TCM Soldier, GDC4S and PM LW planned and conducted the VIP day with 4-9 Infantry's Scout Platoon. Based on negative soldier feedback at the VIP day (during a candid question-and-answer session with decision-makers), the LW System was viewed as a failure by many attendees. Noted by the soldiers were issues with the LW System's weight, space requirements on their outer tactical vest, daylight video sight (DVS—part of the WSS), cabling requirements and unreliable communications. The Scout Platoon's frustration with the LW System was not the only thing of note during this timeframe: a unit-wide dip in LW System confidence was occurring as well. This can be attributed to: 1) an insufficient NET that solely focused on the technical aspects of the system, 2) the lack of incorporation of the LW-enhancing tasks into unit training, and, 3) the failure to incorporate ergonomic, soldier-driven upgrades by this point in the program. By the time the unit went to its first collective training event in August 2006, unit confidence was at an all-time low. This was when the aforementioned USI concept was devised by the PM LW, and soldier-driven design started to become reality. Subsequently, unit confidence started to rise (Augustine, 2008a).

With unit confidence growing, TCM Soldier—in coordination with TRAC WSMR—led the DOTMLPF assessment throughout the end of the summer and early fall of 2006. In September, the TCM Soldier supported the ATEC-led LUT that was conducted with B Company, 4-9 Infantry, as well as planned and executed a second VIP day with the Battalion leadership and C Company, 4-9 Infantry (Qualls, 2008). The second VIP day was a huge success, and the battalion commander, LTC Bill Prior, announced to the Army that he wanted to take LW with his battalion to Operation Iraqi Freedom (OIF) (Berger, 2008).

As the Manchus trained in their LW Systems, they realized that if they were going to take it to combat, they wanted some improvements. This desire, coupled with the PM LW's methodology that later evolved into the previously described "Top-Ten Process," started with a few of the unit's key leaders. These leaders, who were identified by the PM LW and his staff early in the equipping process as unit "points of light," saw the value of the LW System but did not necessarily like how it was configured. Once given the opportunity to re-configure it, and when their ideas became reality, these key leaders realized that they were supported by the PM LW; he was willing to tailor the LW System to meet their needs. This encouraged members of 4-9 Infantry to come up with ideas for improving the system. When they got their ideas together, they put them into a Top-Ten List that they submitted to the PM LW. The PM LW and 4-9 Infantry leadership then prioritized the improvements and worked them with GDC4S. These human-centered, ergonomic improvements proved to be vital to unit confidence in the system, and in the end, to their ownership of it (Griffith, 2008).

This unit "ownership" marked a shift in the TCM Soldier's role in the LW Program. As the warfighters embraced the LW System, they became their own advocates for system improvement. This allowed the TCM Soldier to streamline his already overloaded staff and truly focus them on the DOTMLPF and LUT efforts. He also engaged his information operations campaign to get the word out that LW's success was growing with 4-9 Infantry (Berger, 2008).

In late 2006 and early 2007, TCM Soldier worked diligently with TRAC WSMR and PM LW to synergize the results of the DOTMLPF assessment, LUT and soldier feedback.[36] The purpose was twofold. First, results of these assessments needed to be finalized for the LW MS C LRIP decision scheduled for late Spring 2007. Second, while the initial results of the DOTMLPF assessment at Fort Lewis were useful, it was determined that further assessments were needed in a combat environment. In order to know what to focus on during the deployment, gaps in information had to be determined so that TCM Soldier personnel could focus on collecting the right data while in Iraq (Berger, 2008). Parallel to these efforts, TCM Soldier also began the tedious process of documenting the many TTPs that 4-9 Infantry had developed as they employed LW and incorporated it into their day-to-day operations (Qualls, 2008).

H. TCM Soldier, LW and 4-9 Infantry In Iraq

Personnel from TCM Soldier deployed with 4-9 Infantry to combat in late April 2007.[37] The deployment lasted fifteen months, and the TCM Soldier worked hand-in-hand with the unit to continue the LW DOTMLPF assessment, capture lessons learned and develop LW TTPs. During the deployment, the TCM Soldier rotated a team consisting of one officer and one NCO to reside with the PM and the unit. These teams provided weekly reports focused on combat-related DOTMLPF assessment issues. They also worked with the 4-9 Infantry on developing LW-specific TTPs. This data was sent back to Fort Benning, TRADOC and PEO Soldier to transmit LW-related lessons learned to the Army as well as to inform decision-makers working on the development of the future GSS. The Manchus continued to provide recommendations for LW System improvements and TTPs to the PM LW throughout their 15-month deployment[38] (Pitch, 2008).

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[36] For a detailed description of the results of the DOTMLPF assessment and LUT results, see Appendix N.

[37] For a detailed description of the TCM Soldier deployment assessment plan, see Appendix O.

[38] For a detailed description of the evolution of the LW-SI (Block II) to the LW Manchu and 4-9 Infantry's improvements, see Appendix P.

While deployed, LW-equipped soldiers and leaders in 4-9 Infantry embraced the LW Systems capabilities and took it to levels that went beyond the vision of its developers.

> Honestly, it's one piece of equipment that we won't leave the FOB without. Because it provides you [information about] where you are, where your fellow units are and as long as you are keeping contact with the enemy and populating via situational report or "tactical chemlights," you are going to [have] a good idea of where the enemy is at as well. Moreover, those three things give you the facts when having to maneuver forces against an objective. The Land Warrior is a giant plus, in my opinion, and it is going to have to be one of those things that every unit in the Army is at least exposed to so they can see the benefits of it. (Griffith, 2008)

ATEC conducted a post-combat survey with the unit once they redeployed. It reflects its members' opinion of using LW in combat. Captured below in Figure 16 are its preliminary, sanitized results.

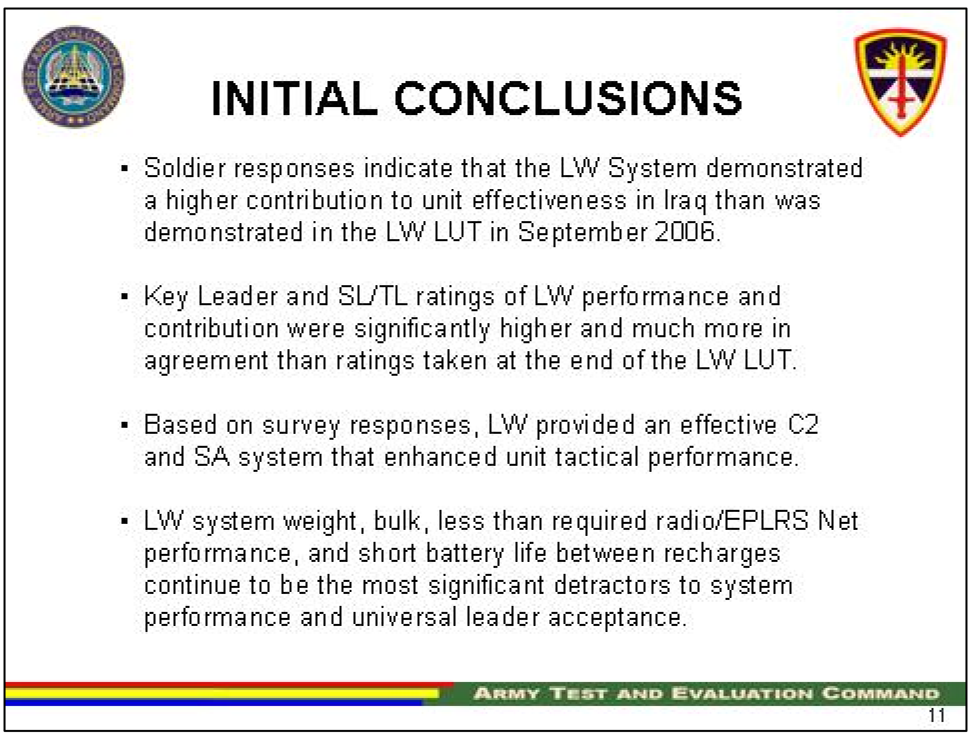

Figure 16. Initial 4-9 Infantry Post-combat Survey Results
(Qualls, 2008)

While 4-9 Infantry was in Iraq, its success was monitored by other units both in-theater and stateside. Based on the LW System success in the hands of 4-9 Infantry, on 11 September 2007, 5th Brigade, 2nd Infantry Division (5-2 SBCT) submitted an ONS for LW. Funding for the ONS was approved in May 2008, and the TCM Soldier is continuing its work with PM LW and Fort Lewis in preparation for equipping the 5-2 SBCT. The 4-9 Infantry re-deployed from OIF in late Spring 2008 and has started preparing for its next deployment at a date to be determined (Berger, 2008).

Currently, the TCM Soldier is in the process of refining LW lessons learned and assisting the PEO Soldier with the requisite documentation and implementation of lessons learned that will inform the newly termed GSE Program. In parallel, TCM Soldier is also working with the Future Force Integration Division (FFID) at Fort Bliss, Texas, for further evaluation of a few LW Systems. This work will pave the way for the incorporation of the dismounted soldier into the FCS SoS[39] (Berger, 2008).

I. Lessons Learned

There were several lessons that resulted from TCM Soldier's experience in the early 2000s through to the equipping and assessment of 4-9 Infantry at Fort Lewis, Washington, and deployment to OIF. Synchronization of efforts, up-front unit integration, TCM flexibility, PM flexibility for incorporation of unit improvements and sensitivity to unit confidence/acceptance all have been noted as important aspects from the users' representative and the warfighters' perspectives.

First, while the TCM Soldier, the PM LW and the warfighter all had different responsibilities, the entire team had to work towards the same goal (Riley, 2008). Unsynchronized individual responsibilities caused lots of frustration and did not help

[39] The final results of the LW DOTMLPF are authorized for distribution to DoD and US DoD contractors only (as of 24 October 2008). For a compilation of the LW lessons learned from both Fort Lewis, Washington, and Iraq, contact TRADOC Capabilities Manager, Soldier.

to efficiently achieve the overall goals of developing LW, equipping 4-9 Infantry with LW, assessing LW and preparing 4-9 Infantry for combat. For example, and rightly so, 4-9 Infantry's unit training plans were focused on preparing its soldiers for their combat deployment. This focus was not initially synchronized very well with LW training and assessment goals. This was due to an intense focus on preparation for combat training by the Battalion Commander, Command Sergeant Major and S-3, and a general lack of support for employing the LW System in scenarios that exercised its utility. Instead of conducting collective training that exercised its situational awareness or battle-command capabilities, their training plans were focused on close quarters battle skills like "shoot houses" and battle drills. This focus was probably right for the battalion at the time because they were trying to get their newly formed unit ready for combat, but proved to be not very helpful to what the PM LW or TCM Soldier needed to accomplish (Augustine, 2008a).

The lesson here is that all participants in a fielding and/or assessment effort must be focused on the same thing. While there will always be differing subordinate goals and responsibilities, it is important that all efforts are synchronized to accomplish the overarching mission. This overarching mission has to be determined early in the process, communicated and supported throughout all organizations involved.

Next, the TCM Soldier was short-staffed and had myriad other responsibilities during the 2006 timeframe (Berger, 2008). As a result, during the equipping, DOTMLPF assessment and train-up for combat, the office staff was not as integrated with the unit as it could have been during the NET and subsequent DOTMLPF assessment. This resulted in challenges with focused data collection, unit-scheduling conflicts and lack of soldier acceptance of the LW System (Augustine, 2008a). These challenges were eventually overcome by the LW PM's USI plan that was described in detail in Chapter III.

There is a management issue here that drives home an important lesson for any resource-constrained organization. The lesson is that it is important to do a "troops-to-task" analysis early in the planning process to determine where gaps in resources exist. These gaps must be addressed early rather than later, otherwise a situation will arise like the one experienced by the LW team in the summer of 2006. The need to go back and close resourcing gaps can impact cost and schedule, but more importantly, may stifle crucial momentum that is required when fielding an item that requires user acceptance. This management issue is not just the TCM's burden to bear. It involves the PM, the unit commander and leaders of supporting agencies. This relationship brings forth another related issue: unity of command. Many times, the TCM outranks the PM or vice versa. In a perfect world, a clear chain of command should be established to deal with these issues. In most cases, as in this one, a memorandum of agreement (MOA) should be considered as well.

From a strategic perspective, the TCM has to be very careful about how firmly to dig in his/her heels and how aggressively to "sell" the system. "The USAIC and all TCMs can fall into this trap of having a reputation of holding their ground, and it is all or nothing" (Riley, 2008). The TCM Soldier embraced this mentality when he tried to make the case for LW to naysayers during the early days of the program. At first, when the rest of the Army was told about LW, the WSS of the LW was emphasized repeatedly as a key component to the system's lethality. Among many claims, the one that stuck was that that it would enable soldiers to shoot around corners. In the end, this capability proved to be not very important and actually disliked by the warfighter. "The TCM Soldier's focus on this capability almost caused the loss of the entire program and in fact, some say created a naysayer out of General Schoomaker, the CSA at the time of the LW's termination" (Riley, 2008).

This situation illustrates two broader lessons that all user representatives should consider. First, trade-offs are going to happen with any system throughout the early part of the acquisition process. The key is to identify what is important to the warfighters, prioritize their requirements and conduct consequent trade-offs.

This requires talking to the warfighters—not just the combat developer and acquisition communities. It requires understanding the current and future fight and prioritizing capabilities in a manner that will address gaps in capability accordingly. It also indicates a fundamental and endemic shortcoming with the requirements process. Analysis is done at the "front-end" to determine capability gaps. However, that cannot be the end of the story. Some agency is needed to continue to track requirements and to make adaptations as necessary. As described, this is one of the primary purposes of TCMs. Second, it is important to identify what attributes are the "selling points" of the item and then take great care to communicate those attributes in a manner the end-user can relate to. If this is not done, support for any system is difficult to garner—a key to getting "buy-in" for any system that significantly affects standard operations. Obtaining buy-in is always going to be difficult for the TCM Soldier, as the community with which he primarily interacts is often split. The Infantry community has different needs because it has several sub-communities—light, heavy, airborne and SOF. Rarely do these communities all speak with one voice. This fact makes getting buy-in from the Infantry community as a whole infinitely harder (J. Yakovac, personal communication, September 18, 2008).

In line with the notion of fostering buy-in was the flawed emphasis communicated to the Army on the LW capabilities of situational awareness and planning; what should have been emphasized was battle command.

> Panning is about visualization. Situational awareness is about visualization. Battle command is about seeing and directing and describing. That is the action. That is how you convey. That is how you make things happen. Not by visualizing. You can visualize all you want. But the power comes from your ability to describe when the guy can't see and isn't standing next to you. LW is about battle command. (Riley, 2008)

If this capability had been emphasized and better understood by the Army prior to having to equip a unit, test it out and deploy it to combat, it might have saved the LW Program years of development and smoothed out its rocky history (Riley, 2008).

This situation further reinforces the aforementioned lesson about communicating the right "selling points" of a system. Without a good strategic communications plan, support suffers until proof of concept is provided. Users have to rely on the hope that the system will do all that its developers and advocates say it will do. In the case of multi-million dollar items, hope is probably not the best course of action. For now, TRADOC relies on credibility as a key characteristic for any TCM. In line with that, TRADOC appoints TCMs from the operational community at the rank of O-6/Colonel. He is usually a "warfighter" with broad tactical, operational and some strategic experience. This credibility empowers his position and allows him to be an effective user representative. However, given the LW experience, another characteristic for all TCMs should potentially be considered by TRADOC. Perhaps TCMs should have some marketing experience or training as a prerequisite for selection as a user representative. This will allow him to leverage marketing techniques, coupled with credibility to create "buy-in" from the warfighting community. Regardless, it is important that he complement the materiel developer's focus on cost, schedule and performance, by focusing on the requirements (J. Dillard, personal communication, November 5, 2008).

Planning for system familiarization and suggestions for improvements from the unit proved to be important when decision-makers were projecting how the unit would accept the system and how it would assess its readiness for deployment to combat. "We have to accept that we [TCMs] are going to get it wrong or we are going to get it incomplete" (Riley, 2008). "Not until a collective group of warfighters gets their hands on a system, works with it, improves it and incorporates it into their daily operations, will they embrace the system and make it their own" (Augustine, 2008a). The "unit confidence" curve depicted in Figure 17 below depicts 4-9 Infantry's acceptance of the system during 2006.

The curve below is an applicable depiction of how unit confidence flows during fielding situations involving revolutionary, unproven capabilities. Unit confidence starts rather high as the end-users are initially exposed to the system or item during NET. This is because they are being told what the system does and what it could potentially do by its advocates. Unless intervention takes place to incorporate the new item into the unit's operations, confidence decreases as the responsibility for integration becomes solely borne by the end-user. There has to be a forcing function that makes the unit integrate the new capabilities into its normal operations, or confidence may never be achieved. If a knowledgeable, credible advocate does not facilitate this "incorporation," confidence will continue to dive. In some cases, an advocate within the unit that sees the broader potential of the system might garner support. In others, an emphasis on unit incorporation of the system might be driven by the chain of command. A method for reversing this digression that was employed by the PM LW was the use of Unit System Integrators (USIs). The USI concept encouraged the incorporation of LW into unit standard operations. In addition, the PM LW provided the unit with the flexibility to tailor the system to meet its members' needs. This method showed the operational military unit that the PM was responsive to its needs. These two important decisions started in August 2006 and are depicted below as the rise in unit confidence. If the flexibility exists to leverage these techniques, unit confidence should increase faster than it would if just relying on system familiarity through everyday use and/or a chain of command emphasis.

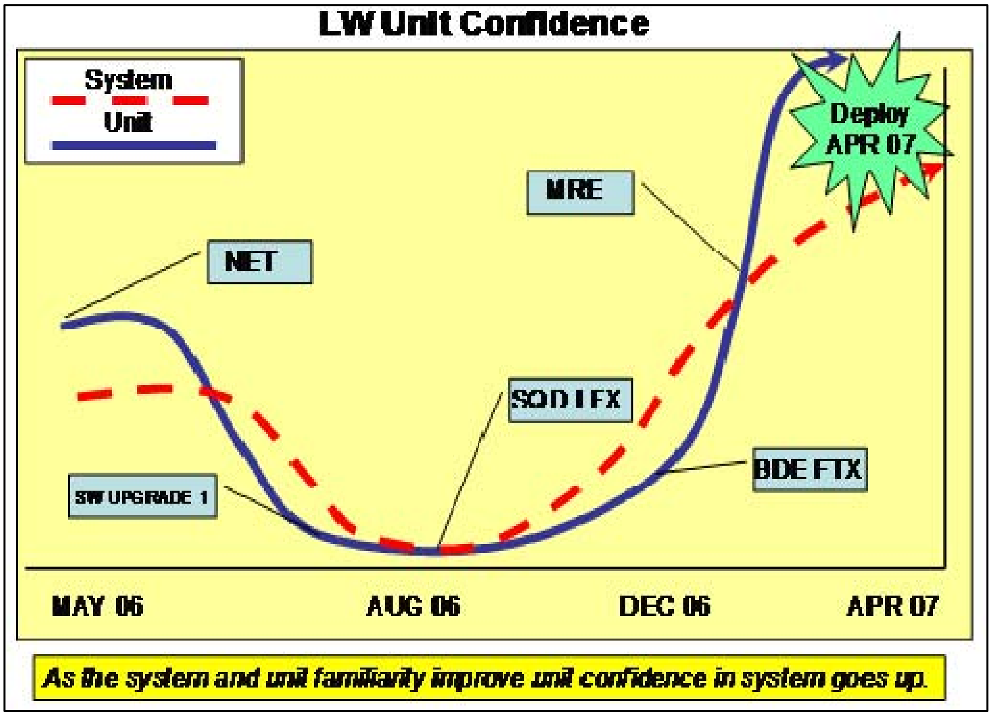

Figure 17. LW Unit Confidence Curve
(Qualls, 2008)

Unit confidence and "ownership" proved to be probably the most important contributor to LW's success with 4-9 Infantry at Fort Lewis and then later in Iraq. As described in Chapter III, from early on, several "points of light" in the unit were identified by the PM. These individuals became the advocates for the system. These leaders within the unit were instrumental to the improvement of the LW System. Leveraging the aforementioned Top-Ten Process, the LW evolved from a LW-SI (Block II) designed by PM, TCM Soldier, and GDC4S to a soldier-designed LW Manchu. As described in Chapter II, the LW Manchu is an improvement on the LW-SI (Block II) that was originally issued to 4-9 Infantry in the spring of 2006. It was then re-designed by soldiers for soldiers during their training as well as deployment (Augustine, 2008a). Key to their confidence and ownership of the LW Manchu was their ability to re-configure the system, ask for improved capabilities and see measured improvements based on their inputs. "If every other program in the Army did it like that…it would be awesome" (Pitch, 2008).

The broader lesson applicable to other programs is the idea of giving a product to the users and then giving them the latitude to tailor the design to their needs. This technique is bold, and while not always applicable, can be effective. To do this, a PM should conduct a detailed risk analysis to determine cost and schedule impacts as well as technical feasibility. The PM must consider whether or not it is supportable and what impacts it may have to BOI, training packages, logistics support, testing, and many other issues. In addition, he should implement a structured approach that facilitates the improvement process. Without a structured approach that involves the unit, the program management team and the contractor(s), synchronization issues could arise and become disastrous. The PM also has to take into account where in the equipping process he is. This may affect whether or not he loses momentum with the unit in terms of acceptance. If the process is not synchronized well and executed quickly, soldiers may become too negative and potentially lose confidence in the product. It is also important to consider availability of the user organization. With the Army's current operational tempo (OPTEMPO), it is difficult to find time between deployment cycles to allow for new product evaluations that require system improvements and upgrades. Fortunately for the FCS Program, the Army has recently created an evaluation unit, the 5th Brigade Combat Team, 1st Armored Division, Army Evaluation Task Force (AETF) at Fort Bliss, Texas, for this very purpose.[40]

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40 The AETF enables the Army to thoroughly evaluate materiel and to develop tactics, techniques and procedures, as well as the means to train and develop leaders. This will maximize the FCS Program's value to not just the Army, but to combatant commanders who will employ these combat formations. It will help the Army "get it right the first time" with FCS by identifying any potential flaws or improvements early so the Army can rapidly deliver the best equipment for our Soldiers. The AETF will allow the Army to integrate and field the enablers for achieving technology and training superiority, which are the necessary ingredients to future operational success (US Army Training and Doctrine Command, 2008).

J. Conclusions

Some of the lessons learned from the users' experience with LW can be generalized and applied to other programs. First, it is important to communicate a new capability or system in terms that the warfighter can relate to. The ability of the warfighters to visualize the implications of new capabilities on their operations is essential for fostering their support early in a program's lifecycle. Second, forward-thinking management in a resource-constrained situation is a pre-requisite for success. A thorough task analysis must be completed with all organizations involved prior to the beginning of any major event to determine gaps in resources. For TCMs, this comes down to balancing staffing with requirements. Adequate staffing is essential for any major program—be it a tank, helicopter or any major weapon system. The key here is to identify requirements, prioritize them and determine deficiencies up-front and early. If more personnel are required, leadership must identify where they are going to come from, who is going to pay for them and how they are going to fit into the near- and long-term program plan. In most cases across the Army, TCMs are understaffed due to constrained uniformed acquisition personnel resources. To remedy this, TRADOC and the Army acquisition community should consider filling TCMs with uniformed personnel based upon Army program prioritization and requirements. Third, unit "points of light," or system/item advocates, should be identified by a PM that is fielding a new system to a unit. These advocates are the PM's "beachhead" in the unit that will strengthen the product credibility and boost confidence of the users, who may otherwise be naysayers. Fourth, if it is possible to conduct soldier-driven, human-centered, ergonomic improvements to a product(s), a PM should do so. Not only do such inclusions improve unit confidence when its members see a PM respond to their needs, but they tailor the product to what the warfighters want and, thus, increase their sense of ownership. This technique is not without risk, however. Careful consideration should be given to its feasibility. Supportability, technical feasibility, cost and schedule implications have to be analyzed to determine if the benefits outweigh the risks.

From a strategic perspective, two essential takeaways are apparent. First, the soldier is the most difficult "system" to interface to. One size never fits all, and everyone has an opinion as to what is best. What is acceptable to one group of users is unlikely to be acceptable to all, and because no two users think alike, they cannot normally agree to what is good enough. Second, although TRADOC is the requirements generator for the Army, it may or may not be able to accurately reflect the needs of the Army. Up-front warfighter involvement is necessary to get Army requirements right. Involvement of Combatant Commanders (COCOMs) at the beginning of the acquisition process may address this Army-level issue (J. Yakovac, personal communication, September 18, 2008).

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V. Budget Decisions Affecting the LW Program

A. Introduction

This chapter outlines the budget allocated for the Army's LW Soldier System. It details, by FY, the Army's acquisition strategy, any House and/or Senate report language that impacted the LW Program's budget appropriation(s) and the appropriation conference reports. We first introduce the basic procedures in the federal budget process. Next, we provide an analysis of each FY's budget pertaining to the LW Soldier System since it became a POR in 1996. Last, we provide a summary of the key budget decisions that affected the LW Program to date. A detailed view of each FY's budget breakdown, by budget activity, starting in 1996 through 2009, is in Appendix Q.

B. Basic Concepts of the Federal Budget Process

The defense budget is not a single document or process. It is defined in terms of budget authority, obligations and outlays. Congress provides the Department of Defense (DoD) funds in the form of budget authority. Budget authority is allocated to individual agencies within the DoD. These individual agencies obligate the funds that lead to outlays. Outlays are made on specific contracts by each agency (Tyszkiewicz & Dagget, 1998). An outlay represents the actual expenditure of funds through the form of a check, cash or electronic funds transfer (Keith, 2008).

The DoD prepares its budget using the Planning, Programming, Budgeting and Execution System (PPBES). The PPBES assists in developing budget policy and meeting the demands of the Services' budget activities. The purpose of the PPBES process is to provide a structured approach to the allocation of resources in support of the National Military Strategy (NMS) and provide the best mix of forces and equipment within a constrained budget environment. The PPBES has four very distinct phases: the planning phase, programming phase, budgeting phase and budget execution phase (Jones & McCaffery, 2008).

The planning phase begins at the executive branch level with the National Security Strategy (NSS). The NSS identifies threats to the country in an effort to develop an overall plan to counter them. Part of this phase also includes the issuance of the Defense Planning Guidance (DPG) and the Future Years' Defense Plan (FYDP). The DPG provides the Services guidance for the development of the Services' Program Objective Memorandums (POM) during the programming phase of PPBES. The FYDP is a six-year projection of Service-wide force structure requirements (Jones & McCaffery, 2008).

During the programming phase, the Services produce a POM that addresses how they will allocate their budget funds over a six-year period and how their plans support the DPG. Once completed, the Services' POMs are reviewed by the Joint Chiefs of Staff to ensure they are compliant with the National Military Strategy Document (NMSD) and the DPG.

The budgeting phase begins with the identification of approved programs in each Service POM. Each Service "costs out" each of its programs that support the POM and submits those numbers as part of the budget estimate submission (BES) (Jones & McCaffery, 2008). The military budgets are then reviewed—first by the DoD comptroller and then ultimately by the Secretary of Defense (SECDEF). The SECDEF review ensures compliance with the DPG and the NSS. Changes to the Services' POMs are submitted through program decision memoranda (PDM). Program budget decisions (PBD) may change the budget before becoming a part of the President's final budget. Both the POMs and the budgets are reviewed in tandem; the POM by the Program Analysis and Evaluation Office (PA&E), the budget by the comptroller. Once the President's budget is completed, Congress reviews it and considers it in its development of the defense authorization and appropriation acts (Jones & McCaffery, 2008).

During the execution phase of the PPBES, the DoD gains approval to spend the appropriations approved by Congress. Appropriations are laws enacted by Congress that provide the DoD the authority to incur obligations and provide the Treasury the authority to make payments. Citing that budget authority, the DoD obligates the Government to make payments for goods and services (P. Candreva, personal communication, October 7, 2008). Appropriated funds are normally obligated during the first fiscal year for which they are provided, or else they expire (Tyszkiewicz & Dagget, 1998). Through outlays, appropriated funds are distributed to the Services and allocated to specific contracts or programs. This is done through an "allotment process," which requires the DoD to show Congress how it will spend what has been appropriated. The DoD breaks its planned spending down by month, quarter or, as in the case of the LW Program, by FY (Jones & McCaffery, 2008).

In full-funding scenarios, when Congress appropriates funds for defense programs, it provides all of the costs of the programs' activities up front for one fiscal year (Tyszkiewicz & Dagget, 1998). This allows for full visibility of the true cost of the program, but does not guarantee that the program will be completed with the amount of money budgeted or within the time allotted due to unplanned cost over-runs, design changes, technological uncertainties and/or changes in inflation. Some of these contingencies were experienced in the LW Program and are described later in the chapter.

C. LW Acquisition Strategies and Congressional Budget Decisions

1. FY 1996

a. Acquisition Strategy for FY 1996

The LW Program was created as a result of the FY 1996 Congressional direction to consolidate previous soldier system efforts into a Program of Record

(POR). As a POR, the LW Program was intended to address critical Army needs to enhance the performance, lethality, survivability, and sustainment of the individual ground soldier. This consolidation brought S&T funding and non-S&T funding together under one project (Office of the Secretary of the Army, DoD, 1997a).

In FY 1996, the LW acquisition strategy was based solely upon RDT&E, with an emphasis on the aforementioned ground soldier enhancements by focusing on LW-unique capabilities and components. To support this strategy, in FY 1996, the Army requested and was appropriated $30.5 million in RDT&E, Advanced Technology Development (ATD) and Logistics Advanced Technology (Office of the Secretary of the Army, DoD, 1997b).

2. FY 1997

a. Acquisition Strategy for FY 1997

The acquisition strategy for 1997 continued with a focus on LW RDT&E. RDT&E was to focus on continued enhancements in the areas of performance, lethality, survivability and sustainment of the individual soldier. To continue this effort, the Army requested, and was appropriated, $15.9 million for LW in the areas of RDT&E, ATD and Logistics Advanced Technology, with additional funding requested for the out years. Also identified in the FY 1997's budget was a change summary explanation, in which funds were reprogrammed to cover both increases in program restructures as well as an urban operations testing site for LW (Office of the Secretary of the Army, DoD, 1997b).

3. FY 1998

a. Acquisition Strategy for FY 1998

The acquisition strategy during FY 1998 was focused on technology insertions to the LW functional baseline. The plan was to perform risk reductions aimed at providing technologies that offered improvements in weight as well as capabilities. Efforts to develop the helmet-mounted display, digital voice communications, a voice-activated radio and a radio relay package were all part of these technologies. The strategy included an Integrated Product Team (IPT) approach to determine which technologies from the LW S&T program would be integrated into the LW POR (Office of the Secretary of the Army, DoD, 1997a).

To support this strategy, the Army requested $33 million under Engineering and Manufacturing Development (EMD), Combat Feeding, Clothing and Equipment in direct support of the LW POR. Embedded in this funding request were smaller programs that directly supported LW's work under the budget activity, Weapons and Tracked Combat Vehicles (WTCV) under the title M-4 Carbine Modifications and M-16 rifle Modifications. The M-4 Carbine Modifications and M-16 rifle Modifications program were appropriated for $2.1 million and $7.6 million respectively (US House of Representatives, 1998). In addition, in the *House Report 105-206*, (accompanying the *Defense Authorization Bill*), the House Armed Services Committee (HASC) added a $9.3 million earmark for continued testing and development of the LW System (Office of the Secretary of the Army, DoD, 1997b). The LW Program was appropriated all requested funding for the program in the appropriation conference report.

4. FY 1999

a. Acquisition Strategy for FY 1999

This fiscal year's strategy focused on near-term technology insertions—including enhanced weapon mounted sensor interfaces, increased reliability, reductions in weight, increased usability and navigation system improvement. The strategy focused on completing a competitive production contract to be awarded upon completion of a successful Milestone C production decision during the first quarter of FY 2000. The LW Systems being planned for procurement would enable dismounted forces to share situational data with each other and with other battlefield weapons platforms (Office of the Secretary of the Army, DoD, 1998a).

To support near-term technology insertions, the Army requested $39.9 million for RDT&E, EMD, Combat Feeding, Clothing and Equipment and $9.3 million for RDT&E, ATD, with additional funding requests for small business innovation research and small business technology transfer programs to enhance competition on LW technologies and capabilities (Office of the Secretary of the Army, DoD, 1998b).

The House appropriations report recommended an increase in RDT&E funding of $5.6 million and a reduction of $5.6 million in LW future technology development from the requested $9.3 million. The committee recommended an increase of $20 million to continue the development and testing of the LW System, stating:

> although the Army views the LW as a successful program, the committee is concerned with a number of technical issues which the Army must resolve before the system is fielded. The weight and power management are two major areas of concern that continue to put risk in the program. As a result of these concerns, the yet to be completed IOT&E that was scheduled for fiscal year 1998 has been delayed to fiscal year 1999. (US House of Representatives, 1998a)

It was noted in the report that the Army reported a 9% cost growth due to cost overruns, additional program requirements and technology maturation issues.

Concerned that the program schedule had slipped because of technology concerns, the committee recommended additional RDT&E funding to resolve LW's technical issues and recommended that it was premature to move towards procurement. The Senate echoed the House's concerns about technological issues and recommended an overall reduction of $4.7 million for LW RDT&E based on "significant technical difficulties in hardware/software integration and schedule slip" (US Senate, 1999a). The appropriations conference report increased the LW Program by $10 million instead of the recommended increase of $20 million to continue RDT&E (US House of Representatives, 1998c).

5. FY 2000

a. Acquisition Strategy for FY 2000

The acquisition strategy for FY 2000 represented a significant change from previous years, shifting from a solely RDT&E focus to procurement. A procurement objective was established to deliver a total of 34,000 systems. This number included an initial LRIP quantity of 18,000 systems to establish a production base for the system. Embedded in the LRIP was an option to annually provide an additional 4,155 systems from the prime contractor to allow time for the Government to release the LW request for proposal (RFP), evaluate potential proposals and hardware and award the production contract (Office of the Secretary of the Army, DoD, 1999a.). This option would allow the selected contractor to set up its production line, produce the first batch of LW Systems and undergo first article testing (FAT).

To support this strategy, the Army requested $86.6 million under RDT&E, EMD, Combat Feeding, Clothing and Equipment and $6.3 million in RDT&E, ATD, Warfighter Advanced Technology. The House appropriations report recommended a $26 million decrease in funding for LW EMD. No explanation was given in the report for the recommended decrease, but, based the upon previous years' congressional concerns, an assumption can be made that there was a continuation of technology challenges in the LW Program. Challenges with LW's size, weight and power capabilities and difficulties in both hardware and software integration could be attributed to a failure to utilize an acquisition open-architecture approach (US House of Representatives, 1999a). The Senate recommended decreasing LW EMD by $26.5 million. This recommendation was based on previous proposed Senate reductions and concerns about the Program's technical difficulties in hardware- and software-integration issues (US Senate, 1999a). The appropriation conference report decreased the LW EMD by $50 million instead of the recommended $26.5 million (US House of Representatives, 1999b).

6. FY 2001

a. Acquisition Strategy for FY 2001

Due to technical challenges of some of LW's unique subsystems, for FY 2001, the acquisition strategy changed from an incremental acquisition approach (utilizing LW unique hardware, software and stove-pipe technologies) to an evolutionary approach. This approach aimed at taking advantage of components available from other Government agencies as well as Commercial Off-the-shelf (COTS) components and technologies; it also used a more OSA approach. This approach intended to increase the program manager's flexibility as well as his ability to incorporate technology. In addition, this was meant to reduce proprietary issues, reduce costs and allow integration to be performed by the Government with products supplied by multiple contractors. The goal of this strategy was to enable the PM to negotiate a sole-source contract for LRIP, with the option to move towards full-rate production (Office of the Secretary of the Army, DoD, 2000a).

To support the LW evolutionary approach, the Army requested $60.1 million in RDT&E, EMD, Combat Feeding, Clothing and Equipment, and $6.3 million in RDT&E, ATD, Warfighter Advanced Technology for the Future Warrior Technology Integration (FWTI) (Office of the Secretary of the Army, DoD, 2000b). FWTI was an ACTD designed to develop and demonstrate technology improvements of the LW baseline system for Pre-planned Product Improvements (P3I). FWTI was merged with the LW Program to assist in addressing critical technical issues of LW's size, weight, power, fightability, and cost. In addition, once merged, FWTI was to focus on the maturation of the integrated navigation, system voice control, combat identification and on the development of tethered hardware and software interfaces among LW-specific systems (Office of the Secretary of the Army, DoD, 2000b). The Army's request for funding of LW RDT&E was appropriated with no increases or decreases.

7. FY 2002

a. Acquisition Strategy for FY 2002

Out of concern for potential LW Program reversion to LW-unique hardware and software, Congress directed the LW Program to use an open system architecture approach. This approach called for minimizing LW-unique hardware and software and was intended to minimize LW-unique technology challenges and shortfalls. The LW Program used OTAs as the procurement method in an effort to increase the level of commercial involvement and, hopefully, address the program's technology challenges. An OTA is a transaction agreement characterized by enhanced flexibility and reduced administrative burden when compared with typical Government procurement contracts (Department of the Army, 2008, October 3). Follow-on procurement for the LW was required to utilize the *Federal Acquisition Regulation (FAR*)-based full and open competition standards. This was a shift in strategy from previous years, which had been based upon a sole-source contracting approach. The Army increased the LW total procurement objective to 47,245 units—an increase of 13,245 systems from the earlier procurement objective in FY 2000 (Office of the Secretary of the Army, DoD, 2001).

The Army requested $61.7 million in RDT&E, EMD and $35.5 million in RDT&E, ATD, Warfighter Advanced Technology for the newly merged FWTI ACTD. The strategy during FY 2002 was to continue the FY 2001 vision of leveraging the FWTI to assist LW Program in addressing size, weight, power and cost concerns, as well as to further the maturation of LW integrated navigation, system voice control, combat identification and the development of tethered hardware and software interfaces (Office of the Secretary of the Army, DoD, 2002). The appropriations report approved the Army's requested budget for LW RDT&E with no increases or decreases annotated in the appropriations report.

8. FY 2003

a. Acquisition Strategy for FY 2003

The acquisition strategy for FY 2003 was the same as the previous two years: leverage COTS and Government components and capabilities to minimize LW-unique hardware and software components, and utilize an OSA approach and OTA procurement method. A change of 1,556 LW Systems in FY 2003 increased the Army's planned LW procurement to 48,801 units (Office of the Secretary of the Army, DoD, 2002).

To continue supporting this, the Army requested $60.3 million for RDT&E, EMD to incorporate software and hardware upgrades, begin development of LW Block II, conduct IOT&E, and provide contractor support during DT and IOT&E. The appropriations conference report approved the Army's funding request of $60.3 million.

9. FY 2004

a. Acquisition Strategy for FY 2004

The program continued with an evolutionary acquisition strategy in FY 2004. The Program moved to a production contract to procure the LW-IC. This procurement was targeted at outfitting Army Rangers with LW-IC (LW Block I Systems), as well as one SBCT with LW-Stryker Interoperable (LW-SI) systems. This procurement strategy was intended to produce an integrated soldier system in late FY 2004 (Office of the Secretary of the Army, DoD, 2003).

To support this new procurement objective, the Army requested $94.8 million for LW, Other Procurement, Army (OPA), for 2,425 systems and shifted RDT&E to System Development and Demonstration (SDD) (Department of the Army, 2003). The Army requested $49.2 million in RDT&E, SDD, to enable the fielding of LW-IC to the Army Rangers. This procurement of the LW-IC was intended to form the foundation for the procurement of future warrior systems.

The House appropriations report noted that the failed LW DT in February 2003 resulted in the re-structuring of the program's funding. The report noted concerns about the program's design instability and continued troubled history with size, weight and power. Because of these ongoing issues, the House recommended shifting $58.5 million from OPA to RDT&E to continue to develop LW capabilities. The committee directed the Secretary of the Army to provide a report to the congressional defense committees no later than 31 January 2004. This report was required to identify LW's Key Performance Parameters (KPPs), an assessment of how the program's objectives and KPPs changed, and how costs could adjust under the revised LW Program. Also required was a comparison of the revised development and fielding schedule as compared to the previous acquisition program baseline (US House of Representatives, 2004b). The Senate recommended a complete reduction of OPA funds of $94.8 million, with $32.7 million of the $94.8

million moved to LW RDT&E. This recommendation was based upon the failed DT with the Army Rangers in February 2003 (US Senate, 2003a).

The Senate's *National Defense Authorization Report* also took note of the failed DT in 2003 due to subsystem reliability issues; however, it also recognized that the system met user functionality requirements in situational awareness, survivability and enhanced communications. The report acknowledged measures by the Army to capture feedback from the failed DT and steps the Army was taking to improve subsystem reliability through risk mitigation. In the same report, a note was made of the Army's request for funding to be moved from OPA to LW RDT&E to fund a risk-mitigation study to improve subsystem reliability. The report also noted there was no funding for the Integrated Battlefield Combat Situational Awareness System (IB-CSAS), a system with capabilities for improved positioning, location, tracking and small, lightweight soldier sensors for laser-based combat identification systems. The IB-CSAS could ensure that technology could be included as a P3I for transition to fielded LW Systems. The issues noted in this SASC report impacted the Senate's recommendation of transferring $73.5 million from LW Procurement to LW Development, of which $15 million was to be used for furthering IB-CSAS's development. This recommendation would increase the total LW RDT&E budget to $122.7 million and eliminate $21.3 million for OPA (US Senate, 2003b).

The appropriation conference report reduced the LW procurement budget from $94.8 million to $1.6 million. It shifted $32.7 million of the $94.8 million from OPA to LW RDT&E for continued work on the IB-CSAS and risk-mitigation measures for LW subsystems. Lastly, it eliminated $62.1 million overall from the LW Program (US House of Representatives, 2004a).

10. FY 2005

a. Acquisition Strategy for FY 2005

FY 2005 represented a change from the planned procurement of the LW System. Instead of focusing procurement on Army Rangers, the procurement strategy was re-focused to incorporate emerging technologies found in the DBCS into SBCTs. The LW total procurement objective increased by 10,099 systems, to a total procurement objective of 58,900 LW units (Office of the Secretary of the Army, DoD, 2004a).

In FY 2005, the LW Program suffered one of its biggest setbacks. In a memorandum for the LW Program dated 03 November 2004, Mr. Claude M. Bolton Jr., the AAE, directed the program to "refocus the LW Acquisition strategy by restructuring the LW-Stryker Interoperable (LW-SI) to provide the Dismounted Battle Command System (DBCS) capability to leaders for up to 30 Brigade Combat Teams to include Stryker Brigade Combat Teams." This memorandum directed the PM to "make the required contractual modifications with the system integrator, General Dynamics, to conserve resources, re-orient effort and support this memorandum" (Bolton, 2004). In essence, this memorandum caused the Army to reduce funding for the LW Program and reallocate it to the DBCS as the materiel solution for enhancing the capabilities of the dismounted ground soldier.

The DBCS had two different systems, the Commander's Digital Assistant (CDA) and the Enhanced Position Location Reporting System (EPLRS) MicroLight Radio waveform, both tied into the LTI and carrying standard Joint Variable Message Format digital messages to users across the network. The DBCS was viewed as being more technically capable and more ready to use than the LW System. The decision to reduce funding of the LW Program, based upon the failed DT of 2003, and the move towards the DBCS materiel solution brought the LW

Program to a halt and stifled any efforts to move forward with FY 2004-planned RDT&E risk-mitigation measures.

For FY 2005, the Army requested $91.3 million for RDT&E, SDD. The request was justified based on the Program's acknowledgement that LW-IC (Block I), the system configuration for the Army Rangers, was not ready to enter LRIP. Because of the inability to enter LRIP, LW-SI (Block II) development started as part of the ASARC approved LW baselining activity (Office of the Secretary of the Army, DoD, 2005b).

The House Defense sub-committee expressed concerns about the LW's failures in DT and the overall instability in the design of the system. The committee noted there were two similar programs underway during the same time, LW and FFW. The committee recommended merging these programs and combining their resources. Because of this recommendation, the committee reduced the RDT&E funding request by $20 million and directed the Army to merge the funding and management of the LW and FFW Programs (US House of Representatives, 2004a).

The Senate, however, was most concerned that the LW Program had been in existence as a POR for ten years and had not yet fielded an acceptable system. On the other hand, the committee members were pleased that the LW Program was transferred to the management of PEO Soldier. They felt that PEO Soldier's management would enable the Army to dedicate enough resources and attention to technologies that would make the Program much more achievable, as well as re-focus it on soldiers. They were also concerned that the FFW and the LW Programs were on separate paths that were not acting in concert for the benefit of the soldier. Therefore, they directed the Army to "submit to the congressional defense committees a plan to consolidate both programs into a single program, taking advantage of both programs' capabilities" (US Senate, 2004a). The committee recommended a reduction of $15 million to the FFW program in anticipation of the programs merger. In its final guidance, the committee further recommended the LW

Program refocus its procurement strategy with emerging technologies found in DBCS into SBCTs (US Senate, 2004b).

In the report to accompany the *National Defense Authorization Report*, the Senate noted the Army's request for $91.3 million for LW development and an increase of $2.5 million to continue IB-CSAS development (US Senate, 2004b). The appropriations conference report reduced the LW/ FFW RDT&E by a total of $20 million in anticipation of the two programs consolidating and concurred with recommendations that the program re-focus its procurement strategy with emerging technologies found in the DBCS into SBCTs (US House of Representatives, 2004b).

11. FY 2006

a. Acquisition Strategy for FY 2006

The FY 2006 acquisition strategy complied with congressional intent to leverage successes from proven LW components. It refocused the LW Program to spiral-out DBCS capabilities for soldiers in the near-term. The LW integrated ensemble systems, to include applicable long-lead items, were to be produced for an SBCT for evaluation purposes. The LW Program and FFW ATD made progress in consolidating in accordance with the FY 2005 congressional recommendations. As a continuing effort to develop the future of LW, the Army began planning development of the GSS. The GSS was intended to be the future dismounted soldier system. The idea was to leverage technological advancements from the S&T community, including FFW, into the integrated modular soldier system of the future (Office of the Secretary of the Army, DoD, 2005).

In an effort to comply with congressional intent, the Army moved funding from SDD, Combat Feeding, Clothing and Equipment to SDD, Soldier Systems-Warrior Demonstration and Evaluation. This move intended to focus on spiraling successful, developed LW technologies (mainly the DBCS capabilities) into LW-SI (LW Block II), for a near-term solution. The intent was to accelerate components that addressed the dismounted soldier of the FCS System-of-systems (FCS-SoS). To achieve this, the Army requested $50.2 million for LW RDT&E and $35.7 for LW Procurement.

In both the Senate and House Appropriations Reports, the committees supported the $35.7 million for OPA, which included procurement of DBCS capabilities (US Senate, 2005). The appropriations conference report approved $35.7 million for OPA and appropriated the Army $50.2 million for RDT&E under Soldier Systems-Warrior Demonstration and Evaluation for LW (US House of Representatives, 2005).

12. FY 2007

a. Acquisition Strategy for FY 2007

In FY 2005, the Army was directed to perform a DOTMLPF assessment and LUT to determine which Army capability gaps the LW and MW Systems could fill. As previously discussed, these assessments were carried out beginning in FY 2006 and ending in FY 2007. To accomplish these assessments, the Army equipped the Stryker-equipped 4-9 Infantry Battalion with both LW and MW Systems in FY 2006. The intent of these evaluations was to support a LW Milestone C LRIP decision by the AAE.

In FY 2007, funding shifted, and the LW Program budget lines changed. The new budget line was changed to include both the LW and MW Programs. The justification for this consolidation was that the two Programs complemented each other. "The Mounted Warrior Soldier System provides the dismounted and mounted soldiers increased capabilities to conduct offensive and defensive operations through uninterrupted viewing of their platform and dismounted soldiers" (Office of the Secretary of the Army, DoD, 2006). The Army requested $27.5 million for the LW/MW Program RDT&E, SDD, Soldier Systems-Warrior Demonstration and

Evaluation, and $9.3 million under OPA, Soldier Enhancement, for the procurement of 127 LW units for continued Army SBCT LW/MW evaluation.

The Senate recommended a plus-up of $4 million (from an original $4 million, to a total of $8 million) for Soldier Enhancement, OPA, for the fielding of the LW Systems to an SBCT for evaluation. The $4 million plus-up for LW OPA was a result of the Army decision to cancel the DBCS in favor of the LW materiel solution. In addition, since the FFW and LW Programs were merged in FY 2006, the Senate recommended a reduction in FFW funding by $5 million (US Senate, 2006). The appropriation conference report appropriated the additional $4 million from DBCS to LW Soldier Enhancement for a total of $8 million for OPA (US House of Representatives, 2006).

13. FY 2008

a. Acquisition Strategy for FY 2008

In FY 2008, the Army officially terminated the LW Program, and LW capabilities transitioned to the Army's new GSE Program (formerly termed GSS). The GSE Program's strategy is to integrate multiple LW sub-components and leverage emerging technologies for the dismounted soldier. The LW Program strategy continued, however, focusing on procuring additional LW Systems to field to the remaining two battalions of the SBCT at Fort Lewis, Washington (Office of the Secretary of the Army, DoD, 2007).

What is important to note during this budget year is that in the report accompanying the Senate *National Defense Authorization Bill*, the Senate added $80 million to restore funding for the LW Program despite its termination. This was to ensure that enough LW Systems were available to field and sustain two remaining SBCTs at Fort Lewis. The restoration was based on the many successes of the LW-equipped 4-9 Infantry, in combat, in Iraq. Despite the Senate's opinion that the LW

Program suffered from poor management, poor system performance and from unscheduled cost and schedule overruns, they recognized that the then-current system configuration provided increased capabilities for the dismounted soldier (enhanced situational awareness, command-and-control, voice and data radio, Global Positioning System capabilities, a computer subsystem, and a control card for identity management).

The report included a statement that:

> the Department of Defense Director of Operational Test and Evaluation assessed LW with the 4th Battalion, 9th Infantry, a Stryker unit preparing to deploy, and in a letter to this committee, determined that the system was "on track" to be operationally effective, and suitable, even though it has not completed Initial Operational Testing. (US Senate, 2007)

The report noted that the Army intended to take the LW System to a Milestone C production decision to begin LRIP but did not intend to fund the LRIP. The Senate also voiced concern that that Army terminated the program and wrote:

> The committee believes that such a decision may be short-sighted and urges the Army to review the decision to terminate the LW Program. The committee recommends an addition of $30.4 million for SDD, Soldier Systems-Warrior Demonstration and Evaluation and $49.5 million in OPA to continue development of the LW Program and to procure LRIP items of equipment to field the remaining two battalions of the Stryker Brigade Combat Team currently equipped with LW. (US Senate, 2007)

It is important to note here that the Army included in its FY 2008 supplemental appropriation request sufficient funding to outfit an additional SBCT (in addition to the other two battalions previously described) at Fort Lewis with LW capabilities. This is important because this was a direct result of an ONS submitted by the 5th Brigade, 2nd Infantry Division commander based upon 4-9 Infantry's success in combat.

14. FY 2009

In FY 2009, the Senate defense authorization report observed that:

> The Army's budget request did not include any funds in OPA for LW. The committee remains concerned that the Army has terminated this program despite significant investment, its promising test results, and its performance in combat. In FY 2008, the Director of Operational Test and Evaluation indicated that the system's test items could deploy to Iraq with the 4th Battalion, 9th Infantry, the Army approved the plan, and the battalion is currently using the system effectively today. In testimony to the committee this year, the Army indicated that it would move forward with the LW Program based on the test results and feedback from the soldiers of the 4th Battalion, 9th Infantry." (US Senate, 2008)

The Senate said that it was encouraged by the Army's additional supplemental funding request in FY 2008 and recommended accelerating the procurement of the LW System for the 5-2 SBCT preparing to deploy (US Senate, 2008). Based on this support, the FY 2008 supplemental funding request was approved. This commitment of support to a terminated program reflects the value that both the Army and lawmakers place on the LW Program.

In 2008, the 5-2 SBCT was training on LW Systems used by 4-9 Infantry in preparation for its deployment. New, improved LW Systems are in the production process, and a plan is in place to field them to the 5-2 SBCT prior to its deployment.

D. Summary of Key LW Budget Decisions

This chapter identified several key decision points that affected the LW Program throughout the course of its acquisition. In retrospect, these congressional budget decisions affected the LW Program's ability to move forward in the acquisition process. Some decisions were beneficial, while others were detrimental.

First, in both FY 1999 and FY 2000, the Army was premature in its decision to attempt to move to procurement despite the inadequate technological readiness level of the prototype LW Systems. The Army intended for this decision to accelerate the LW Program; instead, it caused Congressional funding concerns and appeared overly ambitious. Next in FY 2001, the LW Program changed its acquisition strategy to an evolutionary approach. This was important because it reduced technological risk and cost and allowed the program to focus on RDT&E versus procurement. This change in strategy allowed the program to mature and the system to evolve from an unacceptable form factor to a soldier-focused, human-centered design system. Despite this focus, a user-accepted form factor was delayed in its development until FY 2006. In FY 2003, LW-IC (Block I) was rejected by both the 82nd Airborne and the Army Rangers during DT. These rejections, coupled with the Army decision in FY 2004 to focus on a more affordable DBCS, were a combination that proved initially devastating to the LW Program. Because the program experienced a significant reduction in funding in the FY 2004 budget, the LW Program lost nearly two calendar years of progress and extended its tumultuous history in the eyes of naysayers.

Returned to the tech base for technology maturation in FY 2004 and then given a second chance in FY 2006, the LW System was finally deployed. 4-9 Infantry warfighters saved the LW Program during their successful DOTMLPF assessment and LUT. These events would never been possible if the program had not been competed and re-designed by GDC4S. This timeframe was not without challenges. During the summer of FY 2006, the first VIP day (planned and executed to coincide with the Army's budget cycle) proved devastating when 4-9 Infantry soldiers expressed a premature and extreme dissatisfaction to key decision-makers. This dissatisfaction led these same decision-makers to terminate the program in the FY 2007 budget. In hindsight, this decision proved to be a hasty one; once the unit actually trained, it embraced the system from late FY 2006 through FY 2008. As a result, in FY 2008, the Senate provided $80 million to restore funding to the terminated LW Program.

In FY 2009, funds were provided to field enhanced LW Systems to additional SBCTs. This additional fielding of LW Systems reinforces the intent of the Army and

Congress to continue the pursuit of soldier systems in the future (despite not having a Milestone C LRIP decision). In fact, all of this effort has paved the way for the recent establishment of the next generation soldier system program, the GSE.

VI. Case Study Summary, Conclusions and Recommendations

> In this business [Army Acquisition], any case study that is done right requires an understanding of the need and the context within which it was derived and evolved (J. Yakovac, personal communication, September 18, 2008)

A. Summary

This case study suggests that the LW Program has experienced a rocky road. This is not surprising given the many changes in the defense environment since the early 1990s when the LW Program started. From the end of the Cold War, to the DoD emphasis on transformation and net-centricity, and now to the GWOT, it is clear that the context within which the requirement for soldier systems was derived and evolved has played a big role in LW's successes and failures. Likewise, LW's materiel developers have contributed to the program's setbacks and its achievements. Their efforts can be characterized as pushing the limits of technology to meet the users' needs, while at the same time dealing with funding instability, conflicting priorities and perspectives as well as a user community that was difficult to satisfy. The users and their representatives were difficult to appease, as they had their share of challenges of trying to decide on a "one-size-fits-all" system for a community that was not homogenous. These challenges were often exacerbated by varying levels of buy-in that resulted from the discontinuous innovation that the revolutionary LW System proved to be. Finally, and from a fiscal perspective, depending upon the year, Army and congressional budget decisions proved to be both detrimental and beneficial to the LW Program.

We organize this case study's conclusions by synthesizing previous chapters' analyses and highlighting key lessons learned. The purpose of these syntheses is to bring together several "stove-piped" views of some of the components of LW's acquisition (historical context, materiel developers, user representatives, warfighters and funding), draw conclusions and develop recommendations for potential ways ahead for the acquisition of similar items. Furthermore, we tie some of the lessons that were learned into the strategic perspective for DoD acquisition and some issues that should be considered as the LW Program transitions to the GSE Program in FY 2009. Lastly, as this is the first case study on LW, we provide several recommendations for further research.

From our perspective, there were four key turning points during the LW Program's history. The first was in 2000 when the Army attempted to accelerate its acquisition strategy by trying to move LW from the tech base to procurement prematurely. This sent a signal to lawmakers and naysayers that the acquisition strategy was potentially too ambitious. The second happened in late 2002 and early 2003 when the LW-IC (Block I) System failed its early functional assessments with the 82nd Airborne at Aberdeen Proving Ground, Maryland, and the Rangers at Hunter Army Airfield, Georgia. These negative results further empowered naysayers and discouraged the continuation of the LW effort for nearly two years—despite a contract award to GDC4S for LW Block II. The third happened in FY 2006 when senior Army leadership made the decision to give LW another chance with 4-9 Infantry at Fort Lewis, Washington. This decision proved to breathe life back into the program. The most recent turning point was the 4-9 Infantry's tremendous, but tumultuous incorporation of LW into its unit's standard operating procedures during both 2006 at Fort Lewis, Washington, and 2007-2008 in combat in Iraq. The Fort Lewis experience proved initially devastating to the LW Program, but in the end, paved the way for what became perhaps the most important turning point for the future of soldier systems.

By 2000, the Army had embraced the Network Centric Warfare (NCW) Strategy for platforms and was in the throes of detailing the Objective Force Concept. Budgets were tight, and the GWOT had not yet been initiated by the 9/11 attacks against the US homeland. Four years of development had taken place with Hughes Aircraft, the LW Consortium and the Objective Force Warrior ATD, and a materiel solution for the networked dismounted soldier was just completing its first warfighter evaluation at the JCF AWE. For the PM LW and the TCM Soldier, LW prototyping and testing were progressing well. Despite this progress, in 2000, the Army's ambitious move from an RDT&E focus to procurement sent the LW Program down a difficult path that would not conclude for almost five years.

The PM's original intent was to respond to a seemingly satisfied user community that was happy with the LW v0.6 after its successful experience at the JCF AWE and place some capability into the hands of military users. Instead, however, a number of technical- and human-factor-related issues (as well as requirements that incorporated the newly conceived FCS concept) derailed his plan. Users liked the LW concept, but in the end, the LW v0.6 did not meet their needs in size, weight, power, form, fit or function requirements. These reasons—coupled with a difficult user community that had trouble speaking with one voice—empowered naysayers and discouraged innovators. In addition, failure by the materiel developer to effectively utilize a modular open systems approach and over-reliance on LW-unique hardware and software caused an increase in overall cost and schedule. These shortcomings resulted in inflexibility when attempts were made to adapt to increasing interoperability requirements dictated by the Army-driven Objective Force Concept and in an FCS that was, at the time, little more than "PowerPoint deep." Consequently, because of these missteps and lack of user "buy-in," Congress chose to increase LW RDT&E funding and temper procurement expectations for the near-term. This sent a signal that there was still faith in the LW concept, but a hesitancy to endorse its completion.

By 2003, urgency for acquiring improved dismounted soldier capabilities was growing, as the GWOT was underway in Afghanistan. Dismounted soldiers in the mountains were predominantly waging the fight. It quickly became apparent that they had little in the way of command-and-control, situational awareness and battle command capabilities when compared to platform-centric forces. Companies raced to the fight to provide COTS handheld situational awareness tools. Connectivity to FBCB2 and BFT remained the challenge. Furthermore, preparations were being made for the invasion of Iraq. RDT&E efforts focused on maturing technology continued under the PM LW and the LW Consortium over the three years since the JCF AWE. Their efforts to improve form, fit and function were driven by program management personnel and the TCM Soldier. While well represented by several user representatives, focus on command-and-control, situational awareness and communications interoperability remained divided by conflicting views. These views stemmed from an early focus on designing LW to meet leaders' requirements rather than on junior soldier and leader usability. This focus remained uncorrected—despite the Army's experience on the ground in Afghanistan and Iraq, where the fight was being prosecuted by companies, platoons and squads. These issues became apparent when, in late 2002 and early 2003, the 82nd Airborne at Aberdeen and the Rangers at Hunter Army Airfield conducted functional assessments of the LW-IC (Block I) System. Their rejections of the system, coupled with its less-than-robust commercial architecture that did not connect to the lower tactical internet, was disturbing. While the assessments gave the PM LW a functional baseline as he moved to LW Block II development, they also created concerns and framed mindsets that were, in the end, difficult to overcome. These concerns about the program by both the PEO Soldier and the TCM Soldier led to the dissolution of the LW Consortium and the end of Block I development. A shift in focus from LW to the DBCS resulted. This shift in focus created a loss in momentum for the program that was not revived for almost two years. At about the same time, GDC4S was awarded the LW Block II contract. Its efforts, coupled with the TCM Soldier's vision, kept development alive.

In 2003, the Army's need for networked dismounted soldier capability did not die with LW's termination. Instead, the materiel developer and user representative were directed to shift focus to the less-expensive, less capable DBCS. HQDA and Congress directed the shift due to unit cost concerns and the urgent need to get command-and-control and situational awareness capabilities to the dismounted force. After nearly two years in Iraq and four in Afghanistan, the need for affordable dismounted soldier situational awareness, command-and-control and battle command capabilities was more than solidified. It was very apparent that platform-oriented forces operating in dense, unfamiliar terrain needed a tool once they got out of their vehicles that provided the same type of capabilities as vehicle-mounted enablers (like FBCB2). While the need was clear and efforts were underway to get a good solution, after nearly one and one-half years, the DBCS efforts failed to satisfy the warfighter.

Clearly, a number of efforts were undertaken to close this capability gap; despite the DBCS failure, the Army persisted in seeking a solution. However, during this same timeframe, congressional confidence waned. Consequently, the LW Program took a significant budget cut in 2004. Despite budget cuts and parallel efforts, the LW Block II was on contract with GDC4S and prototyped by late 2004. By 2005, it was demonstrated during a side-by-side event at Fort Benning, Georgia, that shed light on its potential. Subsequently, LW was revived by the AAE when, in FY 2005, he directed a DOTMLPF assessment with a Stryker-equipped unit. After the failure with DBCS, the PM shifted his efforts to back to LW and the AAE-directed assessments scheduled for 2006.

The DOTMLPF assessment started in FY 2006 proved tenuous, but vital to the LW effort. While it was ambitious for the PM LW to plan the assessment and follow-on LUT with a newly formed unit preparing for combat, his efforts and those of his team paid tremendous dividends to the future of soldier systems. The perceived momentum during the early stages of the experience at Fort Lewis—during the equipping and subsequent NET and the decision to synchronize a VIP day with the budget cycle—proved to be hasty. While the budget had not yet been decided, key decision-makers that would influence it in the coming months honed in on the premature negative unit feedback and made their decision to terminate the program for good. This event lost precious momentum with unit acceptance, and during the process, their confidence spiraled downward.

The 4-9 Infantry had its share of difficulties, as well. Its leaders were preparing their newly formed battalion for deployment and combat, and the LW System was not their first priority. Lack of confidence and conflicting priorities paired with lack of incorporation and poor integration proved to be a recipe for disaster. Over a decade of work was seemingly for naught until the PM LW, LTC Cummings, devised and implemented the USI concept. This concept was just in time, as the ATEC-run LUT began. The PM LW made another bold decision during this timeframe. He provided the unit with the capability to influence LW System design. The 4-9 Infantry embraced this opportunity through a series of soldier-identified, ergonomic and technological improvements. It tailored the system to meet its needs; subsequently, its members' sense of ownership increased. The PM did not stop there. Despite the first VIP day's perceived failure, he directed another VIP day that was set-up by the TCM Soldier, GDC4S and his program management office, but was run by the unit and its leadership. LTC (P) W.W. Prior and his Manchus gave the system their vote of confidence and asked to take LW to combat with them in late September. In hindsight, this proved to be a little late considering the program's subsequent termination in November 2006.

Once the Manchus embraced the LW System and incorporated it into training events that exercised its capabilities, they grew dependent upon it. The ATEC's LUT results showed an increase in capability, and the LW DOTMLPF initial results were promising. However, the Army's decision to terminate the program did not reflect this enthusiasm. Rather, it reflected the prematurity of the first VIP day. Regardless, the PM LW, GDC4S and TCM Soldier persisted. They worked together with what money they had left and did their best to support the Manchus during their deployment to OIF. Once deployed, the Manchus found utility in the LW System that even the staunchest of its advocates never perceived. Their incorporation of the system's capabilities into their combat operations provided much more than proof of principle. Their acceptance proliferated throughout the Stryker community and caught the attention of Army leadership and policy-makers. Consequently, faith in the soldier system concept was restored, and the chasm was crossed from early adaptors to the early majority.

The future of soldier systems seems to be solidified. Despite two terminations of the LW Program, its resulting innovations and capabilities have survived. At the time of this report, the 5-2 SBCT is being equipped with new and improved LW Systems—LW NextGen, which incorporates many of the improvements recommended by 4-9 Infantry soldiers. Furthermore, the GSE Program is beginning (launched by a program new-start), and the budget reflects Army and congressional faith in its future. Clearly, these newfound successes have not come without difficulties. Many more obstacles will surely be encountered as the GSE is incorporated into the controversial and technology-challenged FCS Program. The FCS chasm has yet to be crossed, and while this introduces some risk to future soldier systems, persistence and proven soldier-driven design should pave the way for warfighter acceptance. In addition, technology is maturing at a tremendous rate. Size, weight and power issues will continue to be addressed, leveraging the hard, expensive lessons that the LW Program has learned. For the acquisition community, the end-state remains paramount. That is: provide the warfighter with the best capabilities that technology and affordability allow so that overmatch is achieved, and our enemies are decisively defeated. In the words of LTC(P) Prior, "our national priorities should demand no less, and our national treasure—our Soldiers—deserve no less" (Prior, 2008, p. 14).

B. Conclusions

Based on our research, we offer several conclusions. The LW was unsuccessful initially due to the misalignment of three interrelated and supporting components: 1) technical immaturity, 2) poor user acceptance, and 3) lack of senior leadership support. Successes that are more recent can be attributed to: 1) soldier-driven design, 2) improved technical maturity, and 3) proven employment of the system in combat with warfighters.

First, the perceived success of the LW v0.6 System during the JCF AWE caused its advocates to attempt to move from RDT&E to a procurement strategy too quickly. LW-unique systems and subsystems had technology issues that had not matured, and issues with size, weight and power that had been inadequately addressed in user requirements documents. The attempt to move to procurement was stymied by a deliberate budget decision by Congress that reflected its reluctance to expeditiously procure dismounted soldier capabilities. We attribute this decision to the pre-GWOT historical context and lack of a unified user community that did not speak with one voice.

Second, the LW Program did not set the proper conditions during preparations for the early functional assessments with the 82nd Airborne and the Rangers in late 2002/early 2003. A lack of unified focus on the required capabilities that the system must provide and at what level of command and control the system would be employed set the stage for rejection. Compounding these issues was a commercial-based architecture that was not robust enough for the soldier's environment and that could not provide connectivity to the LTI. Additionally, some have the opinion that the PM and TCM Soldier did not properly prepare the Rangers by training them and integrating the LW into their operations prior to their assessment of the system. In the opinions of the PM and TCM Soldier, the poor design, coupled with the lack of integration, resulted in a loss in user acceptance and a loss of support by senior leadership. Regardless of conflicting viewpoints and the LW's problems at the time, there was still an urgent need to get enhanced battle command and soldier situational awareness capabilities to the Army's operational units engaged in combat. This rush to field capabilities in an affordable form factor with a reduced BOI pushed the DBCS to the forefront and caused decision-makers to return LW to the tech base to be further matured.

After DBCS failed its early OT with the 10th Mountain Division in 2004, the LW was back to the forefront, and the program took a new direction. While early efforts with 4-9 Infantry empowered naysayers and highlighted continued technical issues and lack of user acceptance, the introduction of soldier-driven design and unit-system integration reinvigorated the program. Soldier-driven design and innovative system integration techniques also spurred technical maturity. While not without risk, the flexibility to tailor the LW to warfighters' needs and the PM's responsiveness to their inputs empowered the 4-9 Infantry and ultimately led to its soldiers' becoming advocates of LW. Their advocacy and willingness to incorporate LW into their operations in combat pushed the technology to new heights and solidified the soldier system concept. This has established a beachhead from which soldier system incorporation into the future force can flourish.

C. Recommendations

Follow-on soldier system programs should utilize an integrated modular open systems approach (MOSA) that will encourage the use of COTS and GOTS components from the outset. Future systems must have a reliable architecture that is robust enough to survive the combat environment. This approach allows for risk reduction as technology matures and upgrades are required; it also reduces overall lifecycle costs. Included in this recommendation is the premise that the warfighter community is involved in the form, fit and function design of any system. Integration of the user community early in the program's life enhances the PM's ability to gain acceptance of the system and its potential capabilities. This also ensures that improvements are made that are focused at the right level and on the right needs.

Attention to affordability and BOI should be at the forefront of program management and user representative efforts, as well. If not, cost per unit “sticker shock” will surely inhibit acceptance of materiel solutions—no matter how effective they are. The combination of these approaches should create essential senior leader buy-in—a necessity for any expensive acquisition program.

After initial testing, the PM, in coordination with the warfighters, should continue to refine requirements. Based upon continuously refined requirements, he should make every effort to improve the system in a responsive manner. Likewise, PMs should be careful about appearing overly ambitious when planning to move from SDD to a procurement decision. A thorough analysis of technical maturity, user acceptance and senior leader buy-in should be conducted prior to attempting a Milestone C production decision. At the same time, these efforts must not lag. Follow-on efforts must capitalize on LW’s momentum. If follow-on programs drag out for more than a decade (as has LW), they will surely lose steam. Two to three years is about the most time that follow-on efforts have to get an increment of improved military capability out to the force that is affordable and reliable.

When introducing a new system or innovation, it is important for a PM to cross the chasm between the early adapters and the early majority in any marketplace as soon as possible. Bridging this chasm early in the acceptance process will allow for greater potential for early buy-in—thus fostering stronger overall confidence in the product. As mentioned, soldier systems have probably crossed the chasm, but their interoperability with other programs that may not be accepted introduces some risk. Successful managers must also pay attention to the concept of product advocacy. With this in mind, a “points of light” system established early and then carefully leveraged will influence a greater population.

Prior to the introduction of any new capability, proper integration with users should be program management’s priority. Proper integration enables users to become comfortable with new technologies and allows them to integrate the new capability into their standard operations. Given that, users should not get new capabilities without some ideas of how that new capability will change operations. A mechanism should be in place to ease this transition and build unit confidence early in the NET process. If done properly, this transition will also provide the opportunity for the unit to make informed judgments on the value of the capabilities and knowledgeable recommendations for their application, as well as on improvements.

If a PM has the opportunity and resources to provide flexibility for soldier-driven design, then he should make every effort to do it. To be effective, a PM should establish clear lines of communication with the warfighter. This will allow a managed approach to gathering feedback so that educated, informed decisions about changes are made responsively to soldier needs. Furthermore, to do this, a PM must evaluate the amount of top cover that he has from his superiors. This top cover is essential when a PM is adapting an acquisition strategy to user-driven requirements. To do this, the PM must have a thorough risk-mitigation plan and a firm understanding of the potential implications to his program's cost, schedule, performance and myriad other factors (e.g., training support packages, test and evaluation master plan, etc.). In the end, a PM's ability to facilitate user-driven change breeds a perception of responsiveness that increases end-user satisfaction and overall confidence in the acquisition process.

When challenges in a program occur, a PM should be the optimistic leader that remains persistent. If the warfighter requires a capability, the materiel developer has to make every effort within reason to acquire a solution for that need. PM persistence to support the warfighter despite programmatic challenges is essential to getting the warfighters what they need. In the end, the combination of doing the best with what is available and top cover should contribute to program success.

From a strategic perspective, there are several key takeaways to consider:

- Assuming commercial-like technologies can be easily adapted to meet military requirements, they could lead to program cost and schedule increases.

- Introducing technology demonstrations too early in the program to showcase its potential and sell it to the stakeholders (i.e., Congress, Office of the Secretary of Defense (OSD), etc.) can backfire if done too early. PMs should be careful to temper their approach at marketing their products with respect to the underlying and constant "drum beat" of the PPBES process. There are a few times during the budgeting cycle when PMs should pay particular attention. For example, during the Spring timeframe, budgets are being built, during the Summer discussed and during the Fall solidified. If influencing a budget decision is desired, a PM should consider the budget process and tailor the timing of his marketing plan accordingly.

- PMs tasked with building systems that interface with soldiers should keep in mind that the soldier is the most difficult "system" with which to interface. One size never fits all, and everyone has an opinion as to what is best. What is acceptable to one group of users is not acceptable to all, and because no two users think alike, they cannot normally agree to what is good enough.

- Although TRADOC is the requirements generator for the Army, it may or may not be able to accurately reflect the needs of the Army. Up-front warfighter involvement is necessary if a PM is to get Army requirements right.

D. Path Forward

The value of LW capabilities to the Army has been proven by 4-9 Infantry. Consequently, soldier systems have crossed the chasm from early adapters of a disruptive technology to the early majority. Soldier systems are on a crucial path; they are soon to be continuous innovations or "accepted" products that do not require behavioral change and only require normal upgrades. In fact, many other countries have developed soldier systems similar in capability to LW.[41] NATO

[41] For a detailed description of international soldier system efforts, see Appendix R.

partners and others have their own variants, and it will not be long before they begin employing them to close their dismounted soldier capability gaps.

For the US, the long-term vision for the GSE Program calls for integration into the FCS Program. This presents some opportunities for both programs, but also introduces risk. One of the significant opportunities involves providing a great number of networked, soldier capabilities to the FCS-equipped force. The synergy that will surely result from putting an entire system-of-systems together that includes both soldiers and platforms will be something with which to contend. The risk is that the FCS Program has yet to cross the chasm. Fortunately, by adding this proven soldier system capability, the bridge across the chasm has started with a strong foundation.

In order to maintain momentum, there are some key considerations as the transition to the GSE Program takes place sometime in FY 2009. This is not an all-inclusive list; rather, it is one that everyone should consider. In line with our recommendations above, aforementioned supported research and our studies at the Naval Postgraduate School, considerations include:

Near-term

- Continue quality support to 5-2 SBCT LW NextGen fielding.
- Focus on incremental improvements to the current functional baseline (LW-SI) using lessons learned.
- Field what is technologically ready now, and integrate other follow-on efforts (when they are ready) later.
- Make system improvements by soldier-driven, human-centered design, and focus on getting the dismounted soldier into the FCS network. Work with the FCS team and warfighters at the Army Evaluation Task Force to get the form, fit and function right.

Long-term

- Consider improvements in reliability and robustness with focused improvements in size, weight, power and cost. GSE must be an affordable system at a cost of $10,000 or less per system and with a BOI that is at the leader level.
- Synchronize program efforts with IBCT modernization. IBCTs are the least capable force and lack a robust communications structure.
- Introduce competition early in the GSE Program to get innovative solutions and drive down costs.
- Build training packages that are affordable and effective. A train-the-trainer approach will breed self-sufficiency.
- Apply risk management continuously throughout all phases of the program.
- Consider a Performance-based Logistics approach to provide overarching logistical support with cost savings.
- Develop and vigorously execute a comprehensive Information Operations plan.

E. Recommendations for Further Research

As this is the first case study on the LW System, numerous questions remain unanswered and provide a point of departure for recommended further research and study.

First, and relatively time sensitive, is an in-depth analysis of the challenges associated with providing dismounted, networked soldier system capability to the Infantry Brigade Combat Team (IBCT). This will most likely prove to be one of the biggest hurdles for future soldier systems, as the IBCT lacks a robust communications backbone and platforms from which to host network enablers. This will be timely in that the IBCT is currently the least capable of all Army formations, yet it is at the tip of the spear in the mountains of Afghanistan and elsewhere.

Second, due to the Army's current posture in the GWOT, the DoD acquisition community has found itself in a unique situation. Not only has rapid fielding become almost second nature, but support to forward-deployed forces has become a requirement for most PEOs. An in-depth analysis that explores the acquisition community's support to forward-deployed units would be beneficial to PMs that find themselves in a situation similar to the one described in this study. Rather than having to create a support package from scratch, react to emerging requirements and employ creative techniques, PMs with access to research in this area could utilize a compilation of lessons learned and recommendations to consider.

Last, the notion of leveraging soldier-driven, human-centered design was detailed in this case study. Recently, the Army created an evaluation unit, the 5th Brigade Combat Team, 1st Armored Division, Army Evaluation Task Force (AETF) at Fort Bliss, Texas, for this very purpose. It would be beneficial to the Army to study its methods, successes and challenges as it provides support to TRADOC and the FCS Program. This work could inform the DoD acquisition community with respect to risk-reduction, human-centered design and TTP development. Lessons learned and recommendations could prove vital to decision-makers as they face increasing requirements for interoperability and other 21st century complexities.

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Appendix A. The Soldier as a System Initiative

> "If we are really good, and we are, the soldier of 2025 will be as effective as the tank of 1995" (Carey, 1999).

Just as Desert Storm ended, the *1991 Army Science Board Summer Study* identified a need for the Army to manage the Soldier-as-a-System (SaaS). Shortly thereafter, the SIPE ATD verified this need. In 1993, following the SIPE ATD, the Land Warrior program was formed. It focused on providing a soldier-system approach to infantry-based forces. Its mission needs were approved by the Department of the Army on 8 September 1993 and identified needed improvements for individual dismounted soldiers in the capability categories of: command-and-control, lethality, survivability, mobility, and sustainment (US Information Center, 2001). The follow-on *March 1997 Land Warrior Early Operational Experiment Report* confirmed the fact that a systems approach to soldier requirements would provide greater payoffs in lethality, survivability, mobility and situational awareness—for both the individual and the unit (Jones, 2006). Developmental efforts continued through the late 1990s, and in 2000, Land Warrior Version 0.6 was successfully tested by soldiers at Fort Polk, Louisiana, at the Joint Contingency Forces Advanced Warfighting Experiment (JCF AWE). As further enhancements were made to Land Warrior, Army transformation efforts were in full swing. Platforms were receiving significant attention; however, soldier modernization efforts were lacking structure. At the time, over 300 separate requirements documents were driving the acquisition process for Soldier equipment. In order to get his arms around soldier requirements, in July 2003, General Kevin P. Byrnes (the Commanding General of TRADOC) directed a series of briefings (Liberstat, 2004). These briefings resulted in the consolidation of soldier requirements into six soldier capability documents (CDDs): Core Soldier, Ground Soldier, Air Soldier, Mounted Soldier, Maneuver Support Soldier and Maneuver Sustainment Soldier.

The new SaaS process was a paradigm shift from the old way of developing requirements. The Core Soldier CDD captures the requirements for all soldiers all of the time and establishes the foundation for Ground, Air, Mounted, Maneuver Support and Maneuver Sustainment soldiers (Liberstat, 2004). Soldier programs are then consolidated and aligned into each of the four CDDs, ensuring soldier requirements are aligned and integrated.[42] In addition to aligning required capabilities, a proponent lead for each requirement is established, and soldier equipment is consolidated. Lastly, cross-walks among the four CDDs reduce duplication of effort and identify capability gaps not yet captured (see Figure 18 below).

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[42] Core soldier CDD was consolidated. It now encompasses both Maneuver support and Maneuver sustainment CDD; that is why this number went from six to four.

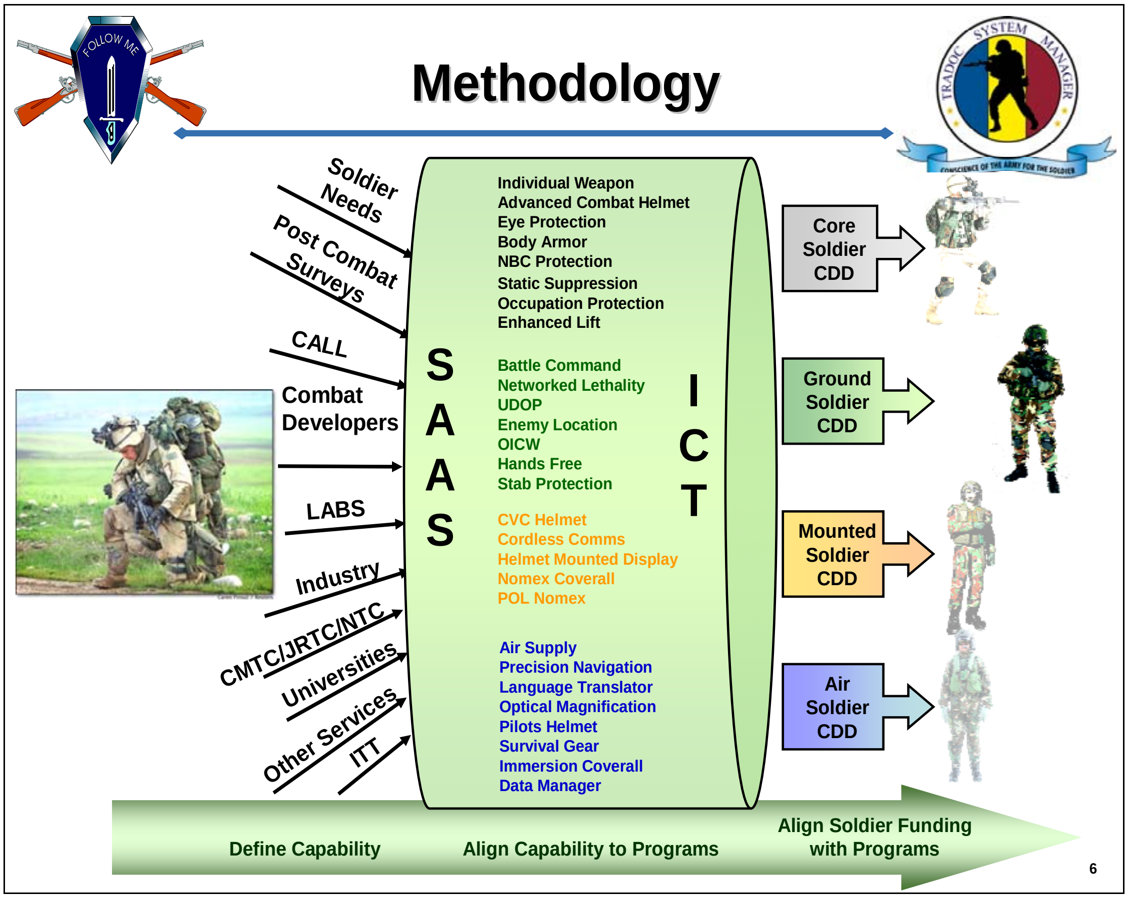

Figure 18. SaaS Requirements Development Strategy and Methodology (Copeland, 2006)

A secondary benefit of the SaaS approach is the consolidation of all soldier equipment-funding lines (Liberstat, 2004). Historically, soldier programs competed as much with each other for funding as they did with other weapon systems (2004). This resulted in under-funded soldier programs and equipment whose funding became an easy target for other weapon systems or programs. By consolidating program management and funding the entire system, much like the Future Combat Systems and Stryker programs, the SaaS concept protects soldier programs during the Planning, Programming, Budgeting and Execution (PPBE) process.

The SaaS concept will enhance individual soldier's capabilities to protect and defend themselves. In doing so, the collective efforts of this modernization program will provide a more efficient and effective future force.

The Army's senior leadership recognizes the soldier is the single most important asset in the Army. It is soldiers, with their intelligence, flexibility, and adaptability, who ultimately accomplish the Army's missions and functions. The soldier must operate both the simple and complex equipment and weapon systems the Army uses. As Army equipment and weapon systems become even more sophisticated and complex, the soldier's intelligence, training, flexibility, and adaptability become increasingly important.

The intent of the SaaS concept is to provide all individual soldiers with superior capabilities to accomplish assigned tasks and conduct missions against any opponent, based on a holistic approach to modernization. This includes a full DOTMLPF analyses approach to resolve issues and address soldiers' needs (see Figure 19 below).

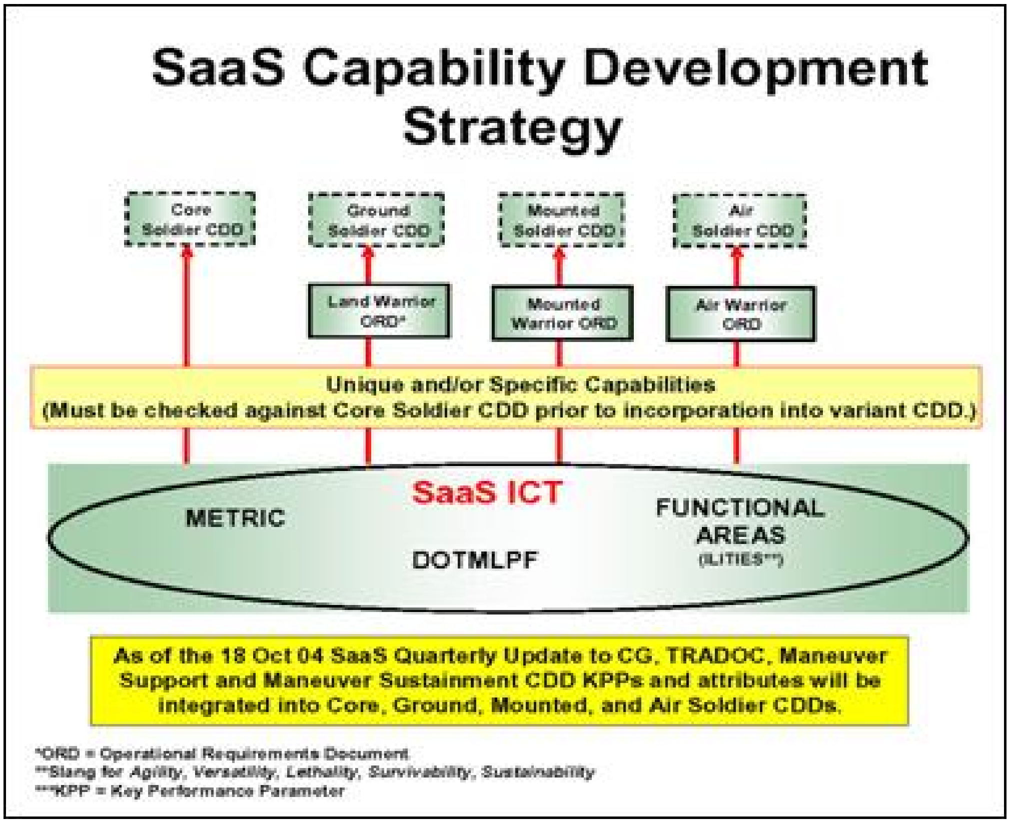

Figure 19. SaaS Capability Development Strategy
(Jones, 2006)

System Description: In September 2005, the Joint Requirements Oversight Council (JROC) validated the SaaS Initial Capabilities Document (ICD). This ICD documents a systematic approach to optimize soldier effectiveness and demonstrates the need to adjust soldier DOTMLPF solutions with fully integrated, modular capabilities to improve the responsiveness, deployability, agility, versatility, lethality, survivability, sustainability, and interoperability of the future force. The intent of the SaaS program is to capture all those items of equipment that the soldier wears, carries, or consumes to accomplish any mission from garrison to full-scale war. The SaaS program addresses equipping the soldier as *an integrated fighting* *system*, just as any combat vehicle or aircraft. This provides soldiers with solutions that meet their needs within the boundaries and norms of common human performance. It also provides a fully *integrated system-of-systems approach* to increase the capabilities of all soldiers to perform individual and collective tasks.

The program cornerstone is a Soldier Capabilities Framework consisting of four Army Requirements Oversight Council (AROC)-validated Capability Development Documents (CDDs) (Core, Ground, Air and Mounted) intended to capture all Soldier capabilities (see Figure 20 below). These documents use a DOTMLPF capability development assessment of lethality, survivability, mobility, sustainability, and battle command and situational awareness in terms of performance, power, weight, volume, cost, training, and criticality of need (the metrics). They address the need to improve soldier-machine interface to enhance the performance of present and future combat platforms; they also establish integrated baseline capabilities from which to derive Soldier modernization efforts.

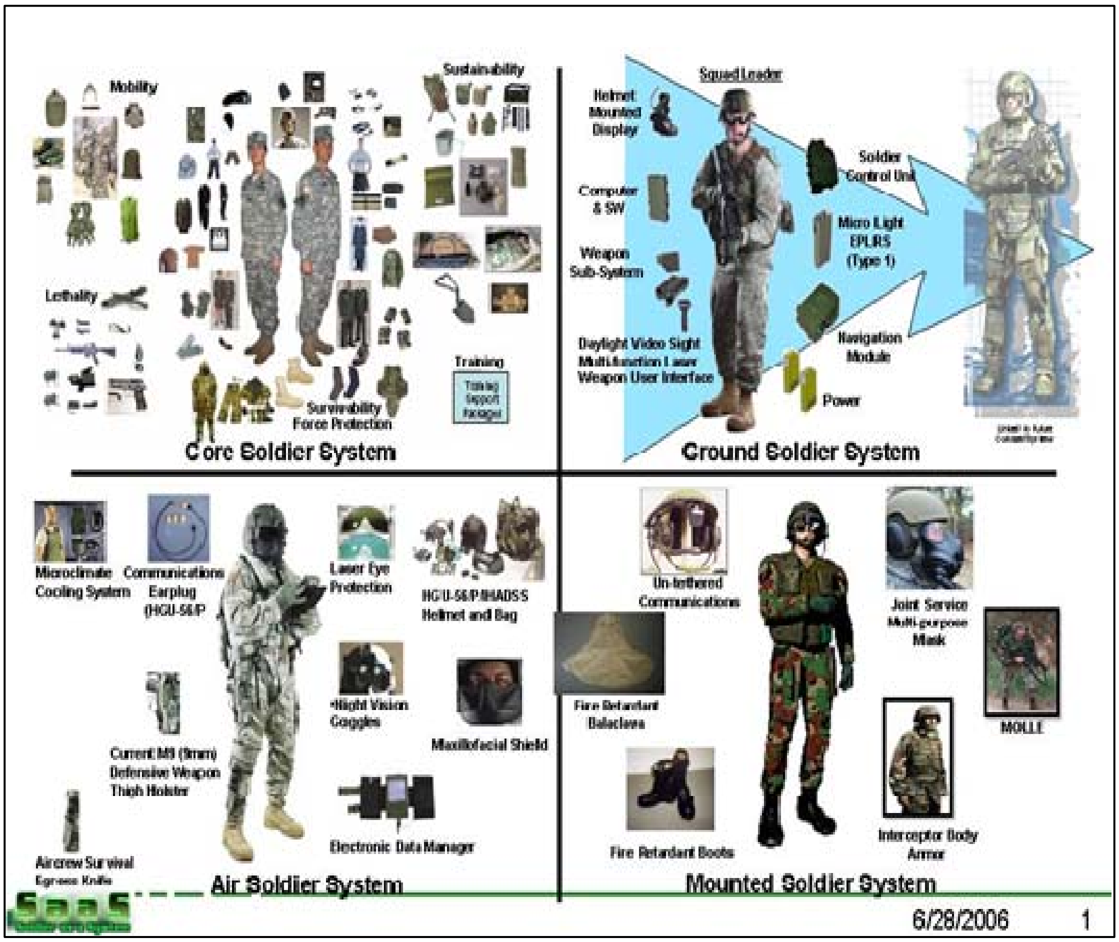

Figure 20. Soldier as a System Descriptions
(Castillo, 2008)

The following four Soldier requirements documents are AROC-validated and working through Joint Staffing for JROC approval; estimated completion was summer 2006: *Capability Development Document for Core Soldier System,* AROC validated 7 November 2005; *Capability Production Document for Air Soldier System,* AROC validated 15 December 2005; *Capability Development Document for Ground Soldier System,* AROC Validated 24 January 2006 (now in final staffing with JROC); *Capability Development Document for Mounted Soldier System,* AROC validated 8 March 2006.

Core Soldier System (CSS): The CSS provides the materiel required by all soldiers to execute Warrior Tasks and Battle Drills and to perform basic soldier functions. These items encompass those capabilities necessary for all soldiers to be able to shoot, move and communicate. CSS serves as the basis for the Ground, Air and Mounted Systems.

Ground Soldier System (GSS): GSS integrates multiple soldier systems and components and leverages emerging technologies to provide overmatching operational capabilities to all ground combatant soldiers, their attachments and small units. These capabilities include increased Battle Command (BC), Situational Awareness and Situational Understanding (SA/SU), Embedded Training (ET), lethality, mobility, force protection, and sustainability. The scope is all dismounted warfighters in FYs 2010-2020. The GSS begins with improvements over the LW Increment II capabilities and then builds upon the GSS capabilities to meet the needs of all Soldiers who conduct close combat on the ground in the Future Force.

Air Soldier System (Air SS): Air SS is an integrated, modular, mission-tailorable Aviation Life Support Equipment (ALSE) and protective ensemble for aircrew soldiers. The Air SS is intended for aircrews of select manned aircraft in maneuver, maneuver support and maneuver sustainment roles involved in missions ranging from Major Combat Operations, Stability Operations, Homeland Security, and Strategic Deterrence. These aircrew soldiers include: pilots, crew chiefs, flight engineers, flight medics, door gunners, and flight surgeons. Air SS provides the future requirements for soldiers who will man the FCS BCT aviation elements.

Mounted Soldier (MSS): MSS consists of lightweight, modular, mission tailorable, integrated equipment and Command, Control, Communications and Computers (C^4) devices, worn, carried, or used by mounted soldiers when conducting tactical operations from their assigned platforms/vehicles. Components include: an improved Combat Vehicle Crewmember Helmet (CVCH) with Heads-up Display and an Un-tethered Communications System. Other components include the Mounted Soldier’s over-garment, gloves, footwear, and ballistic protection; CB protective mask, CB protective over-garment, CB protective gloves and footwear; individual equipment-carrying capability, ballistic/laser, sun, wind, and dust eye protection, and individual weapon. The MSS contains the requirements for the FCS 2-man MGV common crew and other crews.

All SaaS documents are cross-walked with the FCS ORD in order to ensure that mutually supporting capabilities between the SaaS and FCS capabilities are identified and captured.

In future warfare, more than ever before, technology will increase man-machine requirements for the soldier. The individual soldier will remain the Army's center of gravity. The successful identification and validation of SaaS requirements are critical in the establishment of better DOTMLPF that will enable soldiers to do their jobs more efficiently and effectively. This integration concept will enhance soldier capabilities and provide for the efficient and effective use of soldier funding in support of the Army's vision of the future force (Castillo, 2008).

Appendix B. Land Warrior Description, Mission Needs Statement and Evolution

Provided by Pat Berger, Deputy TCM Soldier

<u>General Description of Operational Capability.</u>

1.1 <u>Mission Need</u>**.** A need exists to integrate multiple soldier components and rapidly leverage emerging technology to enable increased small unit lethality, command and control, mobility, survivability, and sustainment. The evolution of the soldier as a system concept originated from the Mission Needs Statement for The Enhanced Integrated Soldier System – Dismounted (TEISS-D), approved 8 September 1993. The soldier as a system concept that provides an integrated system's approach to increasing soldier and small unit capability is the Land Warrior (LW) Program.

1.2 <u>Overall Mission Area</u>. The core mission of task organized infantry soldiers equipped with the LW System regardless of employment (light force, Interim Brigade Combat Team (IBCT), Airborne, etc) is to close with the enemy by means of fires and maneuver to destroy or capture him, or repel his assault by fire, close combat, and counterattack. The enhanced capability of the LW System will better enable mission performance of the following Army Universal Task List Tactical Actions, Missions and Operations. LW-equipped soldiers will support Army Tactical Mission (ATM) 1.0-Conduct Offensive Actions, Army Tactical Mission 2.0-Conduct Defensive Missions, Army Tactical Mission 3.0-Conduct Stability Actions, and more specifically, Army Tactical Mission 5.0-Conduct Tactical Mission Tasks. Although no requirements are specifically derived from Army Tactical Mission 4.0-Conduct Support Operations, the enhanced command and control (C2) capability would enable small unit efficiency and local situational awareness.

1.3 <u>Capstone Requirements Document (CRD)</u>. Not applicable.

1.4 <u>Proposed System Description</u>.

1.4.1 The LW System will be issued for the purpose of enhancing Infantry team combat power, rather than only individual Infantryman. The system develops and integrates of an assortment of systems, components and technologies into a cohesive and combat effective system. In the context of overall soldier load management, the LW System integrates weapon subsystem components into the soldier system, providing visual and acoustic access to computer and sensor information, integrating soldier and weapons based night vision capability, providing accurate position location, establishing voice and data transmit/receive capability for critical information exchange requirements, determining soldier location data for navigation, enhancing individual soldier nuclear, biological, chemical (NBC) and ballistic protection, and integrating upgraded soldier load carrying equipment. The result of successful development and integration of these capabilities will be small units able to better pre-arrange the conditions of the fight prior to contact and strike with decisive maneuver once contact is decided upon. With increased C2 capability of LW, small units will be more efficient and better able to apply METT-C to better reduce soldier's load. LW-equipped soldiers in squads and teams will primarily utilize the system design to close with and destroy the enemy, whether fighting dismounted enabled by mounted, mounted enabled by dismounted, or dismounted. LW equipped leaders will rely more heavily on the command and control capability and functions that establish a common operating picture. As the echelon of leaders increases, weapons function reliance will decrease while command and control requirements increase.

1.4.2 Requirements are blocked into three sections. Block I ("Threshold" system) establishes basic fighting and command and control capability for the light infantry company and below. Block II expands system capability to interoperate with the mounted interim force. Block III (full capability system) provides an evolutionary link to the Objective Force Warrior.

1.5 <u>Supporting Analysis</u>

1.6 <u>Description of Missions</u>: The LW equipped unit will be employed as part of a task organized, combined arms team. The LW System will provide the means to enhance organizational combat power across the spectrum of tactical actions, missions, and operations. Infantry unit design enables the force to achieve dominance across the full scale of contingencies from Stability and Support Operation (SASO), Small Scale Contingency (SSC) to a Major Theater of War (MTW). Tasks associated with these mission areas require a system that enables success in close combat. Two critical conditions invariably influence success in close combat. The first is the dismounted force's ability to pre-arrange the conditions of the fight to friendly advantage. The second is the ability to strike the enemy with decisive maneuver while limiting the enemy's ability to effectively engage friendly forces.

1.6.1 <u>Pre-arranging the Condition of the Fight</u>.

1.6.1.1. Friendly forces must be able to develop the situation out of contact prior to making physical or visual contact with the enemy. To do so, every tactical formation down to the individual level must have access to real time information on the terrain, obstacle, and the composition and disposition and intentions of relevant enemy and friendly units. The threshold LW system will enable squad, platoon and company synergist effect through an enhanced ability to acquire and distribute knowledge. Enemy disposition will be derived via soldier reporting and leader synchronization. LW equipped leaders will be provided the means to establish and maintain a common operating picture that will assist in rapid adjustments to the tactical plan, more robust combat power synchronization, and an overall higher unit operational tempo.

1.6.1.2. While out of contact, LW equipped forces continue to have access to timely information. This is enabled through efficiently receiving and disseminating critical information at the appropriate level of command. LW equipped units will maintain freedom of action and rapid tempo by receiving situational awareness and displaying this information in such a manner that allows leaders to rapidly make adjustments to the maneuver plan. Sensor equipment (day, thermal sights, lasers, etc.) integrated onto the soldier's primary weapon provide the small unit the inherent ability to generate and immediately distribute situational understanding information in order to provide the force enhanced situational understanding. A modular soldier load capability, integrated soldier load management, and ergonomically correct placement of LW components on the soldier's body combine to reduce fatigue and directly preserve combat power for the dismounted close fight. The threshold system, supported by a LW equipped Battalion Staff, more accurately assesses enemy disposition and is better enabled to support the commander's intent in the close fight by maneuvering to a position of advantage out of contact.

1.6.2. Strike the Enemy with Decisive Maneuver.

1.6.2.1. The Infantry battalion applies its combat power to produce overmatching effects at the decisive time and place to defeat the enemy and accomplish its mission. Subordinate units are employed as the primary elements of the battalion's combat power against specific decisive points, key forces, and capabilities within the battalion. Within the scope of battalion operations, companies, platoons, and squads must maximize their ability to choose decisive engagement from positions of advantage, employing and synchronizing fire and maneuver that culminates in tactical assault to finish the engagement followed by a rapid transition to exploitation and pursuit. LW units will be expected to execute the traditional forms of maneuver of penetration, frontal attack, envelopment, turning movement, and infiltration. A LW equipped small unit will be better enabled to rely on forms of maneuver requiring greater precision while avoiding engagements such as the frontal attack that are characterized by minimal maneuver precision and marginal situational understanding of enemy disposition and intent.

1.6.2.2. As a component of a higher command achieving superior knowledge, the LW unit chooses the time and location of decisive engagement. These attacks are originated by continuing maneuver from established positions of advantage. Once forces are decisively engaged, the primary purpose of any infantry based force is to close with and destroy the enemy. The threshold system will enable teams and their leaders to leverage information to rapidly seize and retain the initiative as a distinguishing characteristic. Leaders will make better decisions more quickly than their enemies. The intent of Objective

Force (block III) equipped soldiers is to maximize the small unit's ability to see first, have far better situational awareness, understand first so that they may act first from a position of advantage, and finish decisively as part of combined arms team. Exploiting situational understanding, leaders will better synchronize maneuver and provide accurate supporting fires. The LW capability will minimize the difference in day and night operational tempo by providing soldier and unit maneuver control unprecedented in typical limited visibility tactical assaults. The LW equipped soldier will be more survivable in the close fight through the ability to fire his weapon from a reduced exposure position. The soldier's sight picture is transmitted to remote display, thereby reducing head and shoulder exposure during the direct fire engagement. The LW soldier will also integrate survivability improvements such as improved body armor and chemical protective over-garments.

1.7 <u>Operational and Organizational (O&O) Description</u>. The LW System will enable Infantry small units, under the control of maneuver companies and battalions, to dominate conventional and asymmetrical threats, in close combat through improved lethality, survivability, mobility, and sustainment. The LW System will also provide small units, individual combatants, and leaders improved tactical (situational) awareness, understanding, and command and control. LW enables small units and leaders within digitized or non-digitized forces to conduct distributed operations as they close with and destroy enemy forces. Small units become an integrated system of systems (weapons, sensors and communications). LW equipped units begin an evolutionary process that will mature towards full capability equipped small units capable of providing sensor to shooter linkages, electronic exchange of terrain data (i.e., building diagrams, city maps, key utilities, restricted, compartmented terrain, etc.) as well as integration with Intelligence, Surveillance and Reconnaissance (ISR) assets. Units equipped with LW will have the capabilities to share communications vertically and horizontally, monitor the movements of small unit combatants, accurately control organic and supporting fires, and fight dispersed. As a result of greatly improved tactical awareness, the LW equipped small unit will be able to know where each unit/combatant is, and will have greater knowledge of the enemy situation. LW equipped leaders will leverage system capability to enhance troop leading procedures, solve tactical dilemmas, and direct effective combat action. As small unit network security issues are resolved, these units and combatants will receive information from other sensor subsystems and external sources in support of the close fight. Infantry Airborne, Air Assault, IBCT, Light, Mechanized, and Ranger maneuver battalion small units (platoons, squads, and fire teams), and those soldiers in direct support of LW equipped units (i.e., Combat Engineers, Forward Observers, Fire Support Teams, and Combat Medics) will be equipped with LW. The U.S. Marine Corps (USMC), Cavalry Scouts, and Special Operations Forces (SOF) may also employ LW. The LW equipped Infantry force will be employed across the full spectrum of military operations. LW is first and foremost a close combat fighting system; it will provide organizational enhancements to all types of Infantry units in lethality, survivability, tactical awareness, mobility, sustainability, and training. As the distribution of LW expands into platoon, company, and key battalion staff, LW weapons integration is of less importance than the ability to effectively command and control subordinate formations. The threshold system will enable leaders to conduct troop leading procedures as well as visualize, describe, and direct subordinate elements. Infantry maneuver battalion and company organizations perform command and staff functions and are structured in accordance with each type of Infantry organization. Companies are composed of platoons and support elements. Both battalions and companies may be supplemented by attachments or task organized into task forces.

1.7.1 Force Benefit. The LW System provides units of action critically needed capabilities in legacy and initial/interim forces to accomplish assigned combat tasks. LW, beginning at the small unit level, provides:

1.7.1.1 A common operational picture of the close fight; enhanced leader control in the close fight between maneuver and support elements, and between dismounted and mounted elements; accurate and timely sharing of voice, data, and graphical information, and mutual tracking of individual locations, enabling tactical understanding at all levels, which in turn, enables full synchronization of maneuver and fires, intra-small unit cooperative engagements, fire distribution and fire control.

1.7.1.2 Increased survivability of units through enhanced situational understanding, individual (body armor) and collective force protection (unit dispersion in the close fight, protected or reduced fire engagement, individual locations and tracking), and reduced incidences of fratricide.

1.7.1.3 The ability to generate and maintain reliable combat power through engineering design of a robust electronics system. System built in diagnostics and fault isolation reduces the need to evacuate total systems but focuses on fault identification at the small unit level enhanced by rapid reporting of repair needs; providing the means to detect and repair problems at the lowest level, increasing the availability to the end-user.

1.7.1.4 Increased small unit lethality through controlled, efficient maneuver combined with a greater ability to mass combat power (direct and indirect) at the proper point and time.

1.7.1.5 Increased movement efficiency through accurate visualization of the battlespace at all levels, integrated navigation, load reduction, and thermal and image intensification sensors, which enables units to move farther, faster, and fight longer.

1.7.1.6 Increased leadership and command enhancements at the small tactical level, by providing leaders the means to fully understand the situation and to better control the maneuver of his unit and deliver all forms of effects.

1.7.2 Employment. The Dismounted soldiers fighting within a task organized infantry company will employ the threshold LW System. Battalion command elements and primary staff will employ LW to the extent that these soldiers will be dismounted and separated from their main command post or other assets that can host and transport other digital command and control capability ("light digital tactical operations center (TOC)"). The threshold capability is targeted to provide operational effectiveness improvement to the dismounted squad, platoon, and company. LW equipped Infantry maneuver companies and small units will conduct offensive, defensive, and stability and support missions across the full spectrum of military operations. As system capability matures, LW will be employed within the interim force. By providing interoperability with the interim force this fielding, enables dismounted enabled by mounted or mounted enabled by dismounted.

1.7.2.1 Offensive operations seek to seize, retain, and exploit the initiative to defeat the enemy decisively. Battles may be linear or nonlinear and conducted in contiguous or noncontiguous areas of operations. Infantry forces (companies, platoons and below) will utilize the LW objective system capability within the LW to evolve small unit tactics from deliberate operations designed to find the enemy; react to contact and seize objectives to an operational environment of developing the situation largely out of contact; maneuver to positions of advantage out of contact while retaining freedom of maneuver; and conclude by conducting decisive combat at the time and place of friendly force choosing.

1.7.2.1.1 LW equipped units are more capable of developing the situation out of contact through access to timely information to build situational awareness. A common operational picture provides the information required in a tactical unit to ensure soldiers in the force know where they are, know where their unit members are, and as information is acquired or disseminated from a higher command, where the enemy is located. The primary requirements that will drive enhanced capability are a networked small unit information infrastructure that generates and routes critical information to soldiers and leaders combined with a near real time visual friendly and enemy common operating picture that provides key leaders the means to determine required adjustments to the tactical plan. LW key leaders located at the battalion staff will review and update the enemy common operating picture. LW leaders will also update a friendly common picture scaled to their area of operations. The LW equipped soldier observes his sector and provides activity reports. Subsequent blocks of the LW program evolve system capability towards full ABCS interoperability across the IBCT force structure and further set a process to evolve toward the Objective Force Warrior. Some critical characteristics of this capability will be automatic blue tracking, dissemination of relevant enemy force analysis products in near or real time and reporting, updates from other forces and assets within the organization.

1.7.2.1.2 LW equipped forces are better enabled to maneuver to positions of advantage out of contact while retaining freedom of maneuver through the enhanced capability of soldiers and leaders having near real time access to a tailored friendly and enemy common operating picture. Enemy locations either become known prior to contact or once contact is made. Leaders can choose alternative schemes of maneuver that do not rely on significant forces to fix an enemy prior to unit movement to destroy the enemy. Given a broader tactical perspective that generates situational understanding, leaders will have the option of retaining freedom of maneuver and protecting the force to attack more dangerous targets first rather than simply react to contact en-route to an ultimate objective. Maneuver units will be able to more effectively identify assailable flanks and positions of advantage through knowledge of the enemy's dispositions and posture. Commanders will have greater insight into and control over the most effective time to conduct maneuver. Better knowledge further permits commanders to choose the best routes to the objective area with respect to stealth, speed, and momentum. Through the confidence built by knowing the locations of friendly force in day or night, small unit agility is enhanced. More complex movements can be accomplished to gain positions of advantage with the distinct force protection improvement of being able to rapidly synchronize shifts in the maneuver plan with adjustments to supporting fires.

1.7.2.1.3 Decisive operations are ultimately based on tactical success in close combat. LW-equipped units must be effective in closing with and destroying the enemy and seizing and controlling key terrain. The key aspect of close combat tactical actions will be the ability for LW equipped units of action to integrate firepower, maneuver, and assault to win the close combat fight wherever the enemy is found. During contact, LW-equipped small units will maneuver to positions of advantage, initiate decisive contact at the chosen time and place while integrating fire and maneuver. Through the integrated capability provided to LW soldiers in the close fight, small units will be able to employ speed, stealth, and deception to avoid detection, protect movement, retain freedom of action, engage enemy forces while en route, and build momentum. The LW-equipped unit adapts on the move, adjusting routes and objectives based on changes to the situation, fighting the enemy, not the plan. The LW tactical assault is characterized by highly precise and synchronized fire and maneuver. Support by fire elements have exact personnel location and can place effective suppressive fire on distinct locations. Indirect fire assets are more precisely synchronized due to a clear visualization of all soldiers in the assault and knowledge of the enemy disposition and intent. The net effect is that LW-equipped soldiers firing the most casualty producing weapons should use much less ammunition to achieve greater effect. LW-equipped soldiers also have the option to seek greater cover and place effective small arms fire on targets through use of an indirect weapons viewing and aiming capability. The LW-equipped unit seeks to engage the enemy one time, denying him the opportunity to retreat and reconstitute. This goal requires both close assault and finishing actions that continue contact with retreating forces to destroy them in detail.

1.7.2.2 The purpose of defensive operations is to defeat enemy attacks with the desired end state to buy time, economize forces, and develop conditions favorable for resuming offensive operations. Defending forces await the attackers blow and defeat the attack by successfully deflecting it. All phases of defensive operations are enhanced through tactical awareness, providing a common tactical picture throughout the entire defense. LW enables focusing and concentration of fires, fire control and distribution, proper commitment of reserves or execution of the counterattack, and execution of alternate and primary battle plans. Capability is enhanced in defensive preparation through collaborative planning within the unit and coordinated execution of available direct, indirect, and intelligence, surveillance, and reconnaissance elements enhances small unit lethality within depth of the battlespace. LW capabilities provide a combat multiplier in the conduct of a defense, enabling early detection of the enemy force and rapid reporting and dissemination of information. As the threat advances, it is attacked with precision from protected positions, through maneuver and indirect fire support, in support of the close fight. The result is the disruption of the attacker's tempo and synchronization with actions designed to prevent them from massing combat power. Tactical awareness and understanding, coupled with combat identification capabilities, enhances the LW equipped force ability to mass effects of overwhelming combat power within a wide variety of battlefield conditions. A characteristic of defensive operations is that commanders accept risk in some areas to mass effects elsewhere. The common operating picture containing both friendly and enemy situational awareness capability enables commanders to mitigate risk given the ability to better discern enemy disposition and intent. Ultimately LW enables concentration of forces with enhanced C2 for fire control and distribution, commitment of reserves, timely occupation of battle positions and counter attacks.

1.7.2.3 Stability and Support Operations (SASO). In accordance with U.S. national military strategy and as evidenced by current and recent military operations, the Army will continue to be involved in SASO. Stability operations promote and protect U.S. national interests by influencing the threat, political, and information dimensions of the operational environment. Support operations are usually non-linear and non-contiguous. Commanders designate the decisive, shaping, and sustaining operations necessary for mission success. In support operations the enemy is often diseased, hungry or the consequences of disaster. Although the LW System was designed primarily as a combat system to provide Infantry maneuver battalion, companies, small units, and individual combatants an overmatch capability against enemy forces, it also provides flexibility for employment across the full spectrum of military operations.

1.7.3 Organizational Description. There are six types of Infantry platoon organizations. Each is organized similarly, but have some differences. All have a platoon headquarters with a platoon leader, platoon sergeant, radiotelephone operator (RTO), an attached forward observer and a combat medic. All have three rifle squads, and all have machine gun and/or anti-armor sections separate from the rifle squads and under platoon leader control. Differences among the platoons concern the numbers and locations of machine guns within the platoon, and the fact that the airborne and air assault platoons have a platoon level anti-armor section in the weapons squad. The mechanized and IBCT platoon's three rifle squads are transported in their respective vehicle assets and will fight either dismounted or remain mounted. The light infantry organization is also characterized by two critical deficiencies; soldier mobility and logistics re-supply. These will be discussed and the LW in paragraphs 1.7.3.3 and 1.7.3.4 below.

1.7.3.1 All rifle squads are identical. All are authorized nine individual combatants: a squad leader and two identical fire teams consisting of a team leader, an automatic rifleman, a grenadier, and a rifleman. Squad equipment may vary in accordance with the mission and parent organization requirements.

1.7.3.2 The fire team is the Infantry's (and the Army's) basic element of fire and movement, with one fire team providing a base of fire while the other team moves to a more advantageous position to accomplish assigned tasks.

1.7.3.3 Soldier loads traditionally are in excess of established human factors guidelines. Components of a soldier's carried load include those items needed to sustain the soldier while out of enemy contact (sustainment load) and a combat load. The combat load is comprised on two subordinate loads. The combat load "crosses the line of departure" with the soldier. When contact in not likely, soldiers will march with this load. When contact is expected or planned via deliberate action, units will remove items required for immediate sustainment (approach march load) and conduct combat operations with items needed for the close fight (fighting load). Without considering soldier basic clothing, helmet and other basic survivability items, a platoon's total ammo and enhanced survivability capability generates a platoon weight of approximately 2,578 pounds (39 soldiers). This segment of weight alone can equal 66 pounds per soldier. Personal gear (such as pack, clothing, helmet, load carrying equipment, mission specific equipment) will continue to exacerbate the problem. The LW program design requirement begins to address this issue by establishing requirements control for the soldiers combat load. Addressed later in this document, the soldier's combat load is based on human factors designs and is critical to preserving soldier combat power. Addressing the other aspects of the platoon load required to conduct effective missions entails long term requirements design and a comprehensive review / modification of light force O&O's.

1.7.3.4 Light force sustainment is also a significant challenge to generating and sustaining combat power. Light forces have no vehicles at the company and below although the battalion support unit provides typically one cargo vehicle. A typical light force re-supply event occurs with two logistics packages; once in the morning and once in the evening. This process keeps units supported with basic classes of supply under normal operations with the exception of barrier materials. While the LW system is expected to eliminate the need for certain battery types, the LW power source is expected to increase unit logistics throughput requirements. To better accommodate unit limitations in re-supply continued analysis based on actual developmental and operational tests is required. Unit logistical impact assessment will potentially generate force structure changes to support the dismounted infantry force more effectively.

1.7.4 Other Systems to Interact with. The threshold LW equipped soldier will initially interact within special operations and conventional forces of the combined arms team but will only share digital information with other similarly equipped soldiers. As network security issues are resolved, future blocks of the LW Program will provide extensive interoperability to include sharing information with the Force XXI Battle Command Brigade and Below (FBCB2) system and other ABCS devices as required. Interoperability with current and future live, constructive and virtual simulations and simulators is to be defined and implemented at appropriate program phases, and documented in the program Simulation Support Plan (SSP). The LW equipped soldier, when a component of legacy or interim forces, will utilize the carrier vehicle for power sustainment and situational awareness linkages. LW communications (i.e., Wireless Local Area Network (WLAN)) and advanced combat net radios (CNR) work in conjunction with legacy communications (e.g., Single Channel Ground and Airborne Radio System (SINCGARS)) at the battalion and below level. As security issues on mixed networks are resolved, interoperability requirements will be implemented and blocked to enable interface with existing and proposed command, control, computers, communications, intelligence, surveillance, and reconnaissance (C4ISR) systems in primarily Army, joint and multinational activities (e.g., “FBCB2 like,” Tactical Internet, Army Battle Command Systems (ABCS), etc). Interfaces will be echelon and situation dependent. Tactical information to include intelligence, surveillance, and reconnaissance capabilities enable decentralized execution of operations, collaborative planning, synchronization, force protection, current mission execution, continued situation development, and mission planning for subsequent combat tasks among subordinate units and systems, peers, combat support, combat service support, and higher units.

1.7.5 Support Needed.

1.7.5.1 LW units will be supported logistically by both military and contract personnel using the most cost and operationally effective means available during peacetime with acceptable risk when in transition to wartime.

1.7.5.2 The LW System will be fielded to units and maintained under a field and sustainment support structure. Field level maintenance—includes tasks such as preventive maintenance checks and services (PMCS) by the operator in accordance with appropriate –10 series technical manuals, the conduct of built-in-test (BIT) checks, fault identification and the replacement of inoperative components and designated line replaceable units (LRUs). LW equipped units must have limited stocks of operational spares. Component repair will be performed by a sustainment maintenance activity. Sustainment maintenance activities will repair and return LRU and subassembly repairable unit/shop replaceable unit (SRU) components back to the supply system.

1.7.6. Command, Control, Communications, Computers, Reconnaissance, Surveillance, and Intelligence (C4ISR). The situational awareness and communications systems of the LW System/equipped unit must be capable of interfacing with existing and proposed C4ISR systems in primarily Army, joint and multinational activities (e.g., “FBCB2-like,” Tactical Internet, ABCS, etc). As security issues with mixed networks are resolved, LW equipped Infantry maneuver battalions will have the ability to network (send and receive information, obtain information from databases) and interact with, and among, subordinate units and systems, peers, combat support, combat service support, and higher units. Specific interfaces will be echelon and situation dependent. The ability to network and collaboratively generate combat power creates an operational structure that is redundant and allows the combat battalion to maintain momentum of operations even if connectivity is temporarily lost during contact.

1.7.7 Inter-Service or Allied Cooperation. The Infantry Center and the Project Manager – Soldier Systems are aware of, and are monitoring, the development of “LW-like” capabilities of other services, allies, and nations. The potential exists for sharing, leveraging, or interfacing with these programs to support LW Program goals. The U.S. Army Special Operations Command's SOF Personal Equipment Advanced Requirements (SPEAR) program is an effort to rapidly field successive lightweight and advanced SOF unique components of clothing and individual equipment while integrating them into a tailorable system. The USMC is conducting a series of experiments to identify potential Marine Corps requirements that could be met by the LW Program. The USMC is preparing a capstone requirements document for an integrated Infantry combat system, which will lay the framework for a formal leveraging of efforts between the U.S. Army and the USMC for the modernization of the infantryman. Interoperability with NATO allies is desired. There are a number of allied and other countries that are exploring an integrated soldier system. Their efforts generally fall into two categories: 1) fielding a system that integrates everything worn, carried, or consumed for individual use on the battlefield; and 2) adaptation of current technology for military uses.

1.8 Time-phased Requirements in Support of Evolutionary Acquisition. LW requirements definition will implement evolutionary acquisition to first field a core capability with an open structure that provides for future increments in capability upgrades. Land Warrior is dependent on communications, position location devices, sensors, range finding and direction determining capabilities and interface with organic weapons at the Infantry platoon and company level. The first LW requirements definition is designed to build and field the minimum acceptable system necessary to satisfy initial warfighting needs based on threat and mission requirements. Subsequent blocks upgrade previous versions as well as introduce new capability oriented again on threat, mission requirements and unit type. The LW requirements structure is specified in three blocks that conform to the Army Transformation plan.

1.8.1 Block I requirements are the minimum essential capabilities needed to prosecute the close fight and are primarily focused for light and special purpose units. These requirements will enable the Land Warrior equipped unit to enter contact at a time and place of choosing, continue to overwhelm the enemy with fire and maneuver, and finish the enemy with tactical assault. Key to these capabilities are the ability to provide LW leaders and units changes in orders (Fragmentary Orders), standard map products, essential graphics for the fight, friendly and enemy target locations, exchange of spot and situation reports, position and orientation as well as the capability to engage the enemy at maximum effective range of the small arms direct fire weapon system. Achieving this block depends upon the team radio communication as well as a longer range capability for leaders, position location devices, network management, approved data structures, laser range finder, heading reference capability, and proper interface with organic small arms weapons in the Infantry platoon and company.

1.8.2 Block II requirements are the minimum essential needed to provide capabilities to enable the Land Warrior soldier to execute the dismounted fight as a member of the Interim Force Vehicle enabled by platform capabilities. These requirements will enable Land Warrior equipped soldiers while moving mounted to effectively gain situational awareness while moving mounted from Brigade organic assets and give key leaders the ability to effectively communicate and update the tactical plan. Furthermore these capabilities will permit combat operations either mounted enabled by dismounted, dismounted enabled by mounted or dismounted. By utilizing the vehicle system as well as materiel decreases in soldier load, soldiers will achieve faster march rates and reduce energy expenditure. Improved power sources, combined with the ability to recharge from the Interim Force Vehicle will help reduce the soldier load, decrease the logistics footprint by not requiring as many batteries for re-supply, and reduced unit operations and support costs. Achieving this block depends upon ABCS interoperability, reduced soldier load, and a recharging capability for the interim force vehicle with a Land Warrior interface.

1.8.3 The requirements in Block III will evolve into the Objective Force Warrior (OFW) that is the desired full capability system. The Block III requirements will be defined after the Analysis of Alternatives and initial testing of the Block I system; the RFP for and LTI has recently been released. The Objective Force O&O Concept and Operational Architecture will also contribute to the development of the Block III requirements. Specific Block III requirements are premature but will be provided in accordance with TRADOC requirements development timelines.

Ultimately, Block III must provide the small units of combat soldiers to operate as a fully integrated team, and as part of a larger team whether fighting mounted enabled by dismounted, dismounted enable by mounted, or dismounted (Berger, 2008, 15 July).

Land Warrior Mission Needs Statement

Mission Need Statement Summary

As identified in the Mission Need Statement approved by the Department of the Army on 8 Sep 93, improvement is needed in the five specific capability categories of lethality, command and control, mobility, survivability, and sustainment. The soldier has a requirement to see better in order to locate and kill the enemy under all visibility conditions, increasing his lethality. The C3I enhancements must allow the soldier to: send and receive secure voice communications; create, send, receive, and store information; display and transmit still frame video and thermal visual images, to include digital maps and graphics; and transmit and receive position location information and calls for fire. The system must facilitate far target location, target hand-off and fire distribution. Improvements in lethality, C3I, mobility and sustainment will implicitly enhance soldier survivability. Land Warrior should provide the maximum protection that technology can afford (within the defined soldier load limits) from small arms direct fire, directed energy weapons, effects of nuclear, biological, and chemical (NBC), and fragments resulting from indirect fire. It must be compatible with mobility requirements for all types of dismounted soldiers. Vision enhancements are required which will substantially increase the soldiers mobility capability and target acquisition during adverse environmental conditions such as darkness, rain, fog, snow or intended/unintended battlefield smoke.

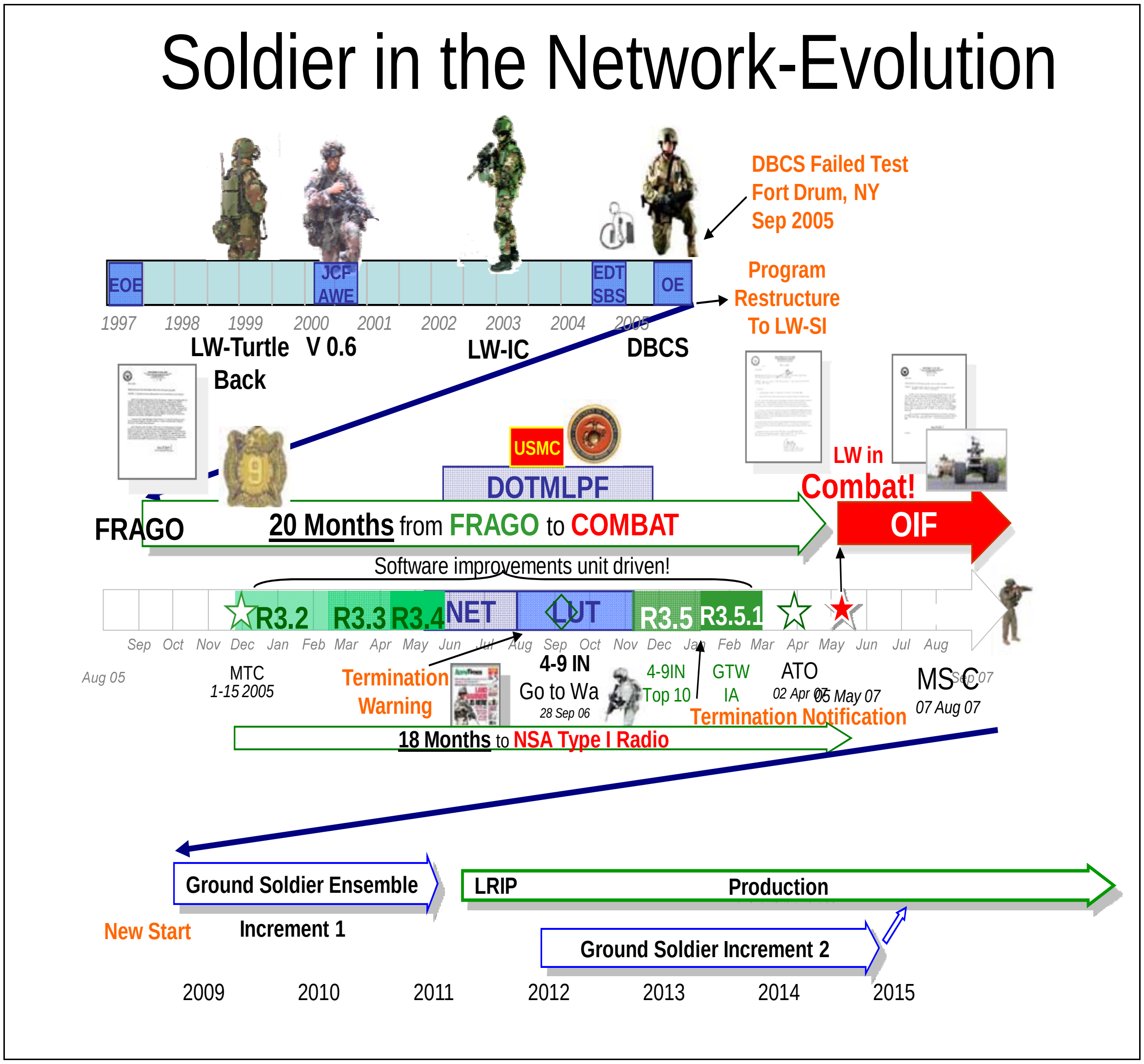

Figure 21. Soldier in the Network-Evolution
(Witherel, 2008)

Figure 22. Land Warrior Stryker-Interoperable (Block II) System
(Witherel, 2008)

Figure 23. Land Warrior Stryker-Interoperable (Block II) System
(Witherel, 2008)

Figure 24. Land Warrior Weight Comparison
(Witherel, 2008)

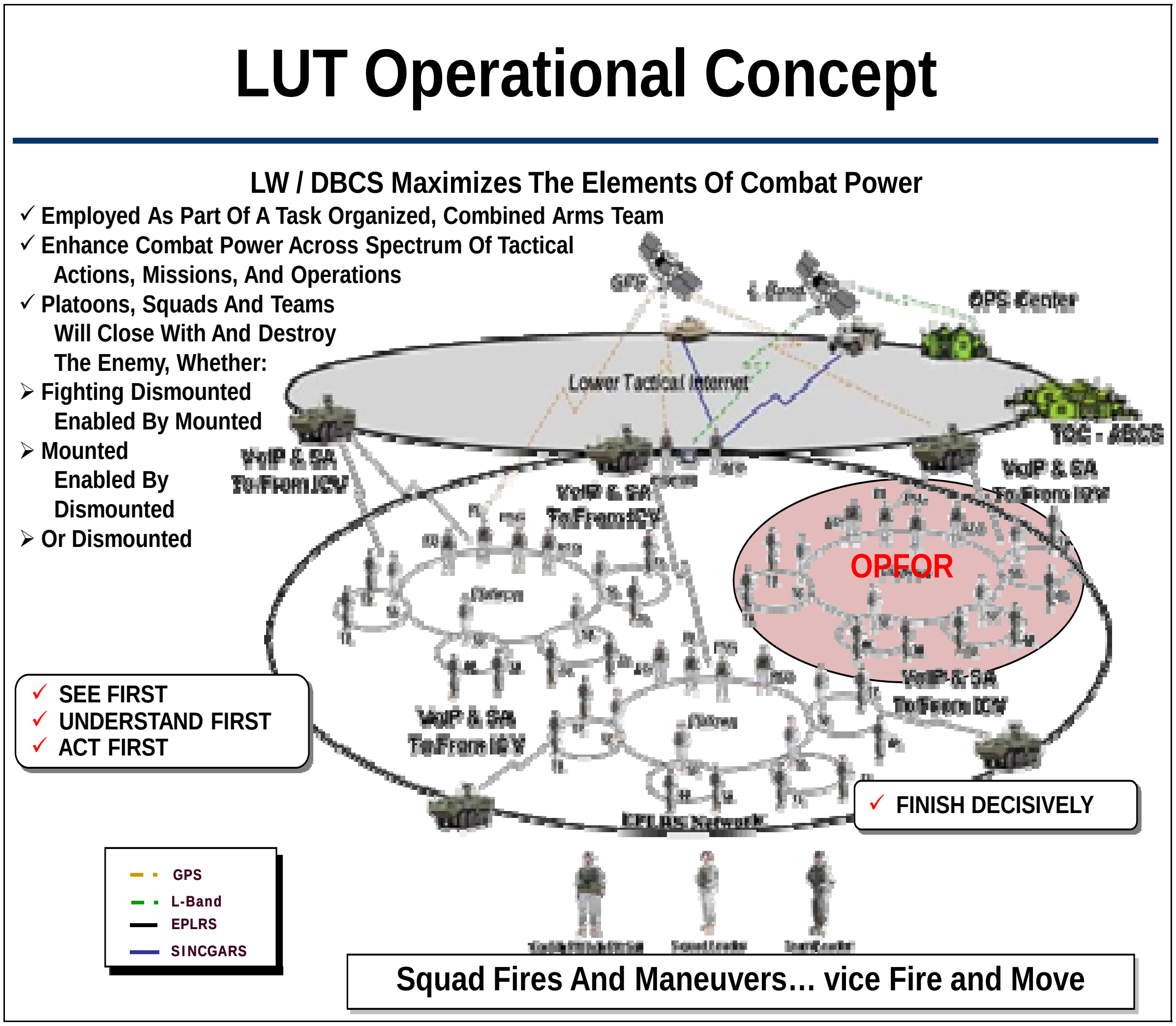

Figure 25. Land Warrior Block II Operational View
(Witherel, 2008)

Figure 26. Land Warrior Ensemble
(Witherel, 2008)

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Appendix C. Net-centric Warfare

The Network-centric Warfare Strategy

> As the world enters a new millennium, our military simultaneously enters a new era in warfare—an era in which warfare is affected by a changing strategic environment and rapid technological change. The United States and our multinational partners are experiencing a transition from the Industrial Age to the Information Age. Simultaneously, we are fully engaged in a global war on terrorism set in a new period of globalization. These changes, as well as experiences gained during recent and ongoing military operations, have resulted in the current drive to transform the force with network-centric warfare (NCW) as the centerpiece of this effort. (Cebrowski, 2005, p. 3)

Formally conceived in the mid-1990s, and proven during the Global War on Terror, NCW has served as a guiding principle for the development of soldier systems like Land Warrior. LW has evolved to complement and enable NCW at the small-combat-unit, tactical and operational levels of war. In hindsight, its beginnings were laced with forward-thinking, strategic goals that have become reality. As the DoD moves towards increased reliance on network-centric operations, it is important for us to consider the long journey that was made to equip the first unit of infantry soldiers with these capabilities. Perhaps through reflection, decision-makers can avoid the lengthy, bumpy road that LW and similar soldier systems have traveled.

NCW is an emerging theory of war and constitutes the military's response to the Information Age. NCW broadly describes the combination of strategies, tactics, techniques, procedures, and organizations that a fully or even a partially networked force can employ to create a decisive warfighting advantage (Cebrowski, 2005). NCW is an information superiority-enabled concept of operations that describes the way US forces organize and fight in the Information Age (2005). NCW generates increased combat power by networking sensors, decision-makers and shooters to achieve shared situational awareness, increased command-and-control, high operations tempo, greater networked lethality, increased survivability and a degree of self-synchronization (Cebrowski, 2003). NCW translates information superiority into combat power by effectively linking friendly forces within the battlespace, providing improved shared awareness of the situation, and enabling more rapid, effective decision-making. NCW has had a profound impact on the planning and conduct of war by allowing US forces to get inside an adversary's decision cycle—changing the rules of warfare and dictating the pace of military operations (2003). NCW provides an edge at all three levels of military operations—strategic, operational and tactical. At the strategic level, NCW selects a competitive space and determines the scope, pace and intensity of the competition. At the operational level, it determines the key competitive attributes and applies and masters them. At the tactical level, its synergistic effects are executed within the battlespace. One of the first descriptions of NCW was published in a 1998 *US Naval Institute Proceedings* Article. The authors compared the transformational impact of the *levee en masse* during the Napoleonic period with the potential impacts of NCW.

NCW and all of its associated revolutions in military affairs grow out of and draw their power from the fundamental changes in American society. These changes have been dominated by the co-evolution of economics, information technology, and business processes and organizations, and they are linked by three themes:

- The shift in focus from the platform to the network;
- The shift from viewing actors as independent to viewing them as part of a continuously adapting ecosystem; and
- The importance of making strategic choices to adapt or even survive in such changing ecosystems (Cebrowski, 2005, p. 5).

Cebrowski explains that these ideas have not just changed the nature of American business today—they have changed and will continue to change the way military operations are conducted (2005).

Force transformation is frequently emphasized by national leadership as the heart of the US defense strategy, and NCW has a central role in it. Transformation supports the four major defense policy goals: assuring allies and friends; dissuading future military competition; deterring threats and coercion against US interests; and, if deterrence fails, decisively defeating any adversary (Cebrowski, 2005). Overall, the DoD's transformation addresses three major areas: how we do business within the DoD, how we work with our interagency and multinational partners, and how we fight (2005). NCW is transforming how we fight and, thus, remains at the very center of force transformation. Force transformation includes new technologies, but also depends on the development of new operational concepts, organizational structures and relationships (2005). The ongoing shift from platform-centric to network-centric thinking and NCW is vital to force transformation and to the conduct of joint warfare in the Information age.

It is important to describe NCW with respect to force transformation, as Land Warrior and other soldier systems are designed to harness its tenets and principles in an effort to maintain a competitive advantage over potential adversaries—now and in the future. Land Warrior resides within the four basic tenets of NCW and enables its governing principles.

Forces that are networked outfight forces that are not, everything else being equal. Evidence of the power of NCW, collected from a wide range of US military activities (combat operations, training events, exercises, demonstrations) strengthens the four NCW tenets:

- A robustly networked force improves information sharing.
- Information sharing enhances the quality of information and shared situational awareness.
- Shared situational awareness enables collaboration and self-synchronization, and enhances sustainability and speed of command.
- These, in turn, dramatically increase mission effectiveness.

While it is not suggested that the governing principles for a network-centric force have supplanted or are going to replace the time-tested principles of war—mass, objective, offensive, security, economy of force, maneuver, unity of command, surprise, simplicity—they provide added direction for the execution of military operations in the Information Age.

- Fight first for information superiority
- Access to information: shared awareness
- Speed of command and decision-making
- Self-synchronization
- Dispersed forces: non-contiguous operations
- De-massification
- Deep sensor reach
- Alter initial conditions at higher rates of change
- Compressed operations and levels of war (Cebrowski, 2003, p. 8).

The source of the NCW warfighting advantage is the improved capabilities that networked forces experience over those that are not. Capabilities such as sharing, accessing and exchanging information improve operations in the information domain and provide warfighters with a significant advantage over forces that are not networked or are less networked. The implementation of NCW is providing an advantage for US forces (2003). Digitization and networking can be combined and employed to develop a common operational picture that reduces the ambiguity and confusion of combat to clearly identify the positions of friendly forces and the known positions of the enemy (2003). This common operational picture has proven to increase the warfighters' awareness and their understanding of tactical and operational situations. The ability to develop a higher level of situational awareness in less time than an adversary, combined with an ability to act on it, is a source of significant warfighting advantage for the ground combat soldier (2003). The Director, Force Transformation, Office of the Secretary of Defense, states:

> In the conduct of information age warfare by networked forces, the relative information advantage of U.S. forces, as compared to our opponents, will be key to deterring threats and coercion against U.S. interests, or if deterrence fails, to decisively defeating the enemy. (Cebrowski, 2003, p. 4)

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Appendix D. The Joint Capabilities Integration and Development System (JCIDS)

The Joint Capabilities Integration and Development System (JCIDS), normally a methodical and sequential process, provides the framework under which all joint, top-driven acquisition programs are structured.

JCIDS is the most current procedure used by the DoD to meet warfighter needs and forms the foundation for future defense acquisition programs. The JCIDS process replaced the Requirements Generation System (RGS). The JCIDS process streamlined the acquisition process and deleted numerous redundancies in a Service-specific, “stove-piped” process. The intent of JCIDS is to provide a guide for requirements generation and identification of needs that are joint in nature. The process is highly dependent on warfighter feedback during the early stages of development of a program. The JCIDS is a fail-safe method of ensuring that warfighters’ needs and concerns are being addressed (Jones & McCaffery, 2008).

Three key processes within the DoD must work hand-in-hand to ensure that warfighters’ needs are met. As illustrated in Figure 25 below, they are the requirements process (JCIDS), the acquisition process, and the Planning, Programming, Budgeting and Execution (PPBE) process. To provide systems that meet the required capabilities, these three processes must be synchronized to support decision-making (Chairman of the Joint Chiefs of Staff, 2006). Considering the long-term nature of budgeting within the federal government, the PPBE process normally also makes JCIDS a relatively slow process and unresponsive to immediate needs.

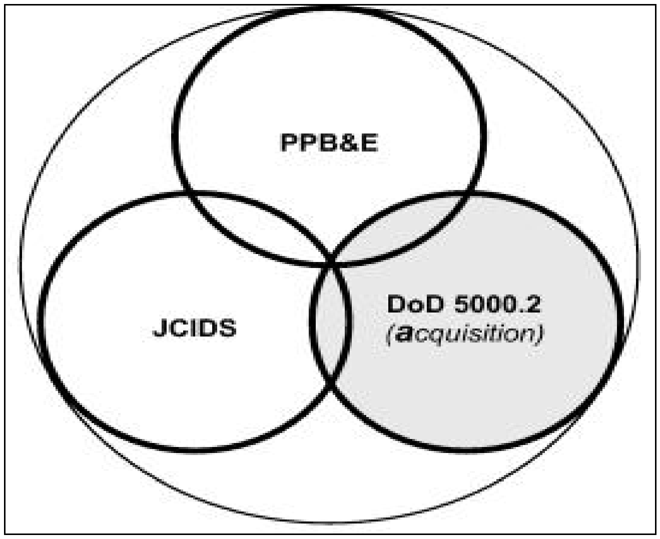

Figure 27. Major Decision Support Systems
(Nowalski, 2007)

The JCIDS process was developed not only to identify joint warfighting requirements, but also to prioritize them. While the central objective of JCIDS is to attend to the shortfalls of joint operations as defined by combatant commanders, the primary objective is to ensure that warfighters receive what is needed to accomplish the mission. The decision authority for the capabilities requirements is the Joint Requirements Oversight Council (JROC), which reviews, validates, and makes recommendations on acquisition programs based on their categories and key performance parameters. The JROC prioritizes acquisition programs and validates capabilities as well as performance criteria for these programs (CJCS, 2006).

The first step in initiating the JCIDS process is to conduct a capabilities-based assessment (CBA) that identifies the capabilities required, performance criteria, and shortfalls of existing systems to meet those requirements. This process results in a Joint Capabilities Document (JCD) or Initial Capabilities Document (ICD) that validates the need to address a capability gap and verifies that affordable and technically feasible solutions exist to address those requirements. Following validation, the JCD or ICD becomes the basis for further analysis by the assigned action service or agency. This analysis results in a capability development document (CDD) that identifies the best technical approach. CDD approval by the JROC validates the key performance parameters of the selected approach, assesses the risk with respect to cost, schedule, and technology maturity, and assesses the affordability of the system based on available resources. JROC approval of the CDD is one of the key factors involved in the decision to initiate a program (CJCS, 2006).

The JROC's role during the entire process and in approving the ICD, CDD, and the Capabilities Production Document (CPD) is to make certain that the system being developed meets the warfighters' needs, does not stray from the original requirement as defined in the JCD or ICD, and remains at an affordable cost. The JCIDS process has been continually refined since its inception, and the information required at each level is well scrutinized to ensure that effective and appropriate decisions are made. The following passage from the executive summary of the *Chairman of the Joint Chiefs of Staff Instruction 6212.01D,* the JCIDS overview document, summarizes the process's intent:

> The JCIDS process was designed to be a robust process to support the complex decisions required of the JROC and the acquisition community in identifying and procuring future capabilities. Recognizing that not all capabilities/weapon systems require the same level of consideration, the JCIDS process is tailorable. The JROC has identified several alternative paths to allow accelerated identification of capability gaps and potential solutions, and to allow them to enter into the JCIDS process at the appropriate stage to deliver those capabilities more rapidly. (CJCS, 2006)

The JCIDS is one component of the capability-based planning (CBP) process. The CBP process encompasses the principal DoD decision-support processes for transforming the military forces to support the national military strategy and the defense strategy. JCIDS plays a key role in identifying the capabilities required by the warfighters to support the National Defense Strategy and the National Military Strategy, but successful delivery of those capabilities relies on the JCIDS process working in concert with the other joint and DoD decision processes encapsulated in CBP. The procedures established in the JCIDS support the Chairman and JROC in advising the Secretary of Defense in identifying, assessing, and prioritizing joint military capability needs (Meyers, 2003).

The JCIDS process implements a capabilities-based approach that better leverages the expertise of all government agencies to identify improvements to existing capabilities and to develop new warfighting capabilities. This approach requires a collaborative process that utilizes joint concepts and integrated architectures to identify prioritized capability gaps and integrated joint DOTMLPF and policy approaches (materiel and non-materiel) to resolve those gaps. New capability requirements—both materiel and non-materiel—must relate directly to capabilities identified through the Joint Operating Capabilities (JOpsC). Therefore, the JOpsC are not intended to provide immediate solutions, but proposed solutions that can afford careful examination over a more extended period of time. Concept of operations (CONOPs) may indicate short-term capability needs. CONOPs allow the joint community to adjust or divest current capabilities by providing the operational context needed to justify or modify current programs. As they are developed, the JOpsC and, if necessary, Service concepts will provide the conceptual basis for

CBAs to answer these questions by identifying capabilities, gaps, and redundancies as well as potential non-materiel and materiel approaches to addressing the issues. A CBA may also be based on a combatant command, Service, or Defense agency CONOPs. Due to the wide variance in the scope of capabilities covered by the JCIDS process, the breadth and depth of the CBA must be tailored. The unknowns identified in the process of performing the CBA may drive requirements for experimentation. Joint experimentation explores concepts to identify joint and component DOTMLPF change recommendations and capabilities gaps. Experimentation provides insight and understanding of the concepts and capabilities that are possible given the maturity of specific technologies and capabilities that need additional research and development emphasis. Experimentation and assessment can help establish measures of effectiveness to indicate achievement of desired operational capabilities (Meyers, 2003).

The prioritized joint warfighting capabilities identified through the JCIDS process should serve to inform the science and technology community and focus the developmental efforts of the community as specified in the *Joint Warfighting Science and Technology Plan* (JWSTP).

Joint Capability Technology Demonstrations (JCTDs), Advanced Concept Technology Demonstrations (ACTDs), and qualified prototype projects are important mechanisms in this process because they are used to assess the military utility of new capabilities, accelerate maturation of advanced technologies, and provide insight into non-materiel implications. They are on a scale large enough to demonstrate operational utility and end-to-end system integrity. The JROC reviews and validates joint mission needs cited as the foundation of JCTDs/ACTDs. Follow-on JCIDS action is taken as appropriate (Meyers, 2003).

Throughout the JCIDS analysis process, the FCBs will provide oversight and assessment as appropriate to ensure the analysis takes into account joint capabilities, concerns, and approaches to solutions (CJCS, 2006). The FCBs are also responsible for assessing capabilities, priorities, and trade-offs across the range of functional areas using the JCAs as an organizing construct. The FCBs provide recommendations to the JROC. Each FCB will be supported by one or more O-6/Colonel-level-led FCB working groups (Meyers, 2003).

In a capabilities-based approach, decision-makers must establish a common understanding of how a capability is identified and expressed in the ICD. A capability is the ability to achieve a desired effect under specified standards and conditions through combinations of means and ways to perform a set of tasks. The top-down capabilities identification methodology provides a method to identify gaps in the ability of the combatant command to execute assigned missions and assess associated risk(s). This methodology also establishes the link between the characteristics of the future joint force identified in the Capstone Concept for Joint Operations (CCJO) and individual capabilities (Meyers, 2003).

The individual JCIDS documents support the implementation of non-materiel solutions and the development and production of materiel solutions. Key components of the CDD and CPD are: 1) the integrated architecture products that ensure the Department of Defense understands the links between capabilities and systems and can make appropriate acquisition decisions, and 2) the performance attributes—including key performance parameters (KPP) and key system attributes (KSAs) that define the most critical elements of performance for the systems under development (Meyers, 2003).

The documentation developed during the JCIDS process provides the formal communication of capability gaps between the operator and the acquisition, test and evaluation, and resource management communities. The document formats and review processes are mandatory and are to be used throughout the DoD for all acquisition programs, regardless of acquisition category (ACAT) (Meyers, 2003).

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Appendix E. Dismounted Battle Command System (DBCS)

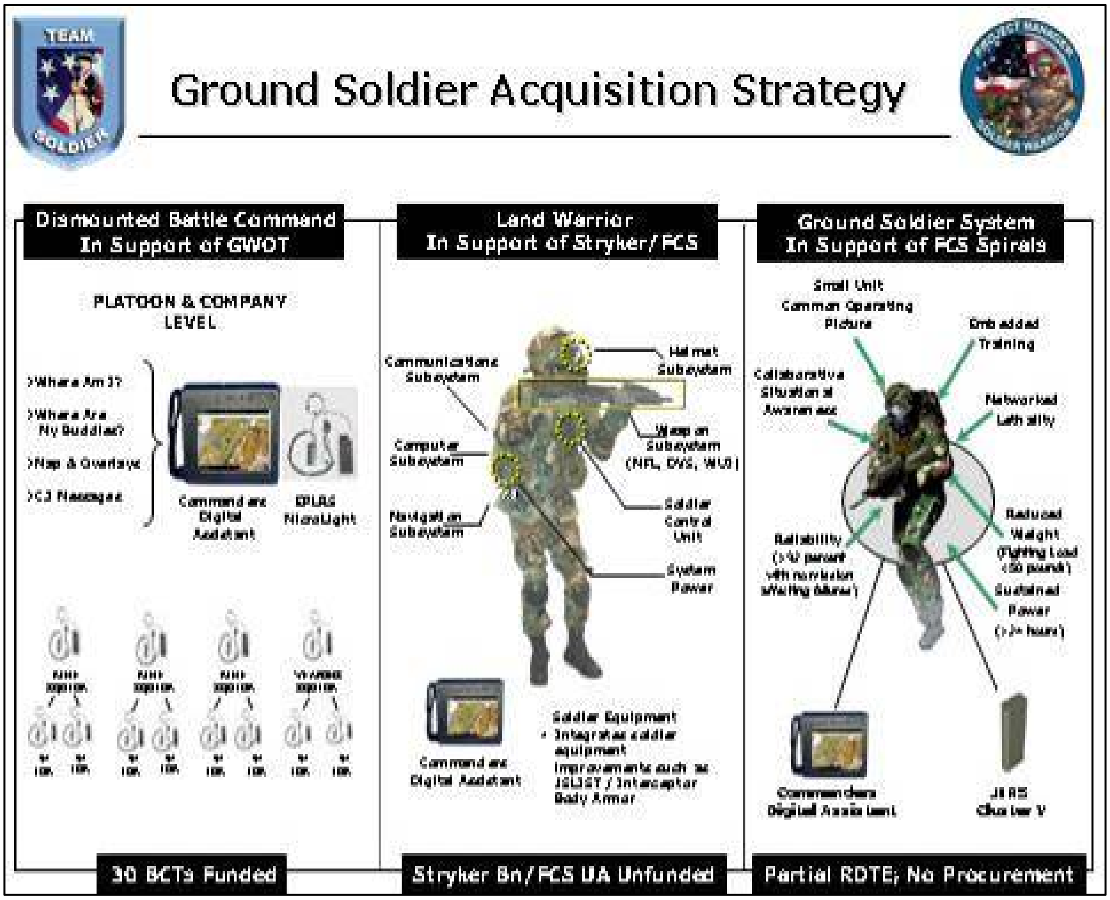

Figure 28. Ground Soldier System Acquisition Strategy
(Kempin, 2008)

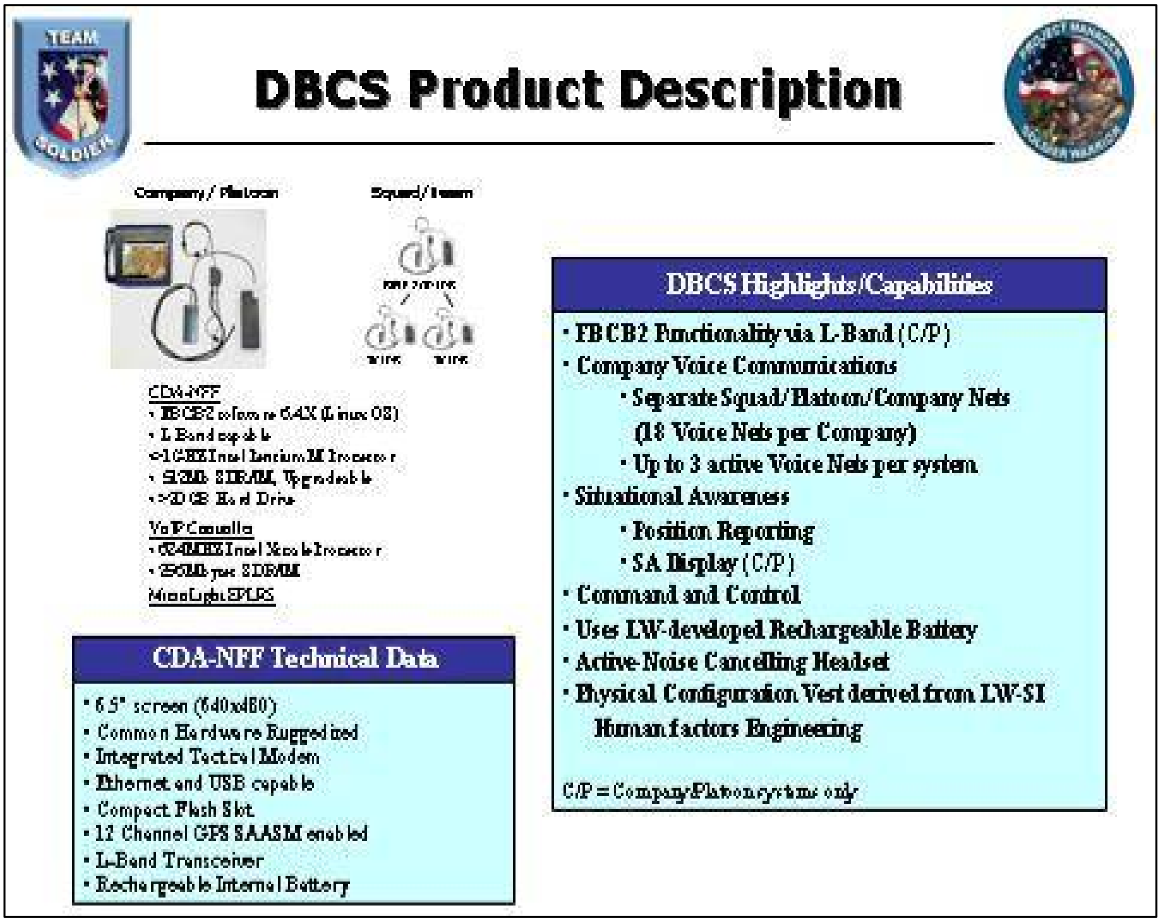

Figure 29. Dismounted Battle Command System Description
(Kempin, 2008)

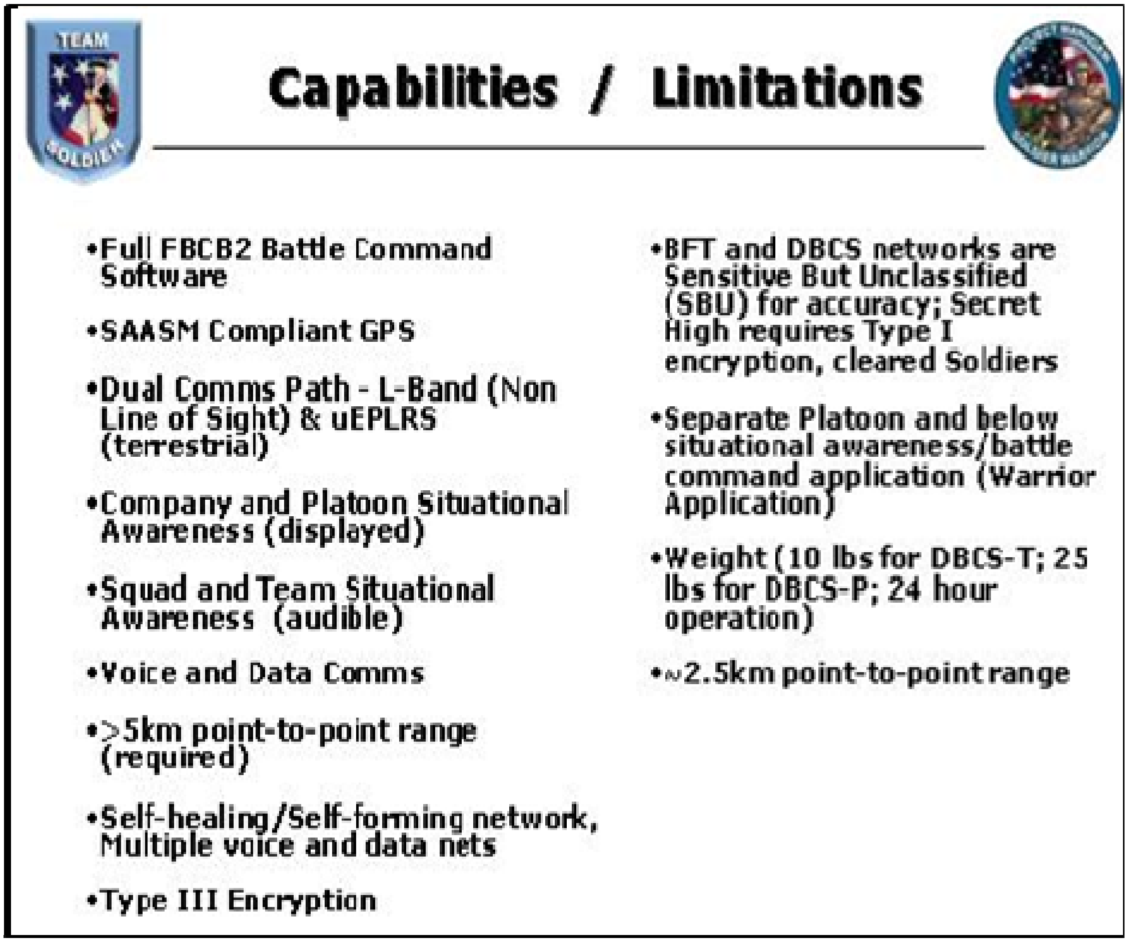

Figure 30. Dismounted Battle Command System Capabilities and Limitations
(Kempin, 2008)

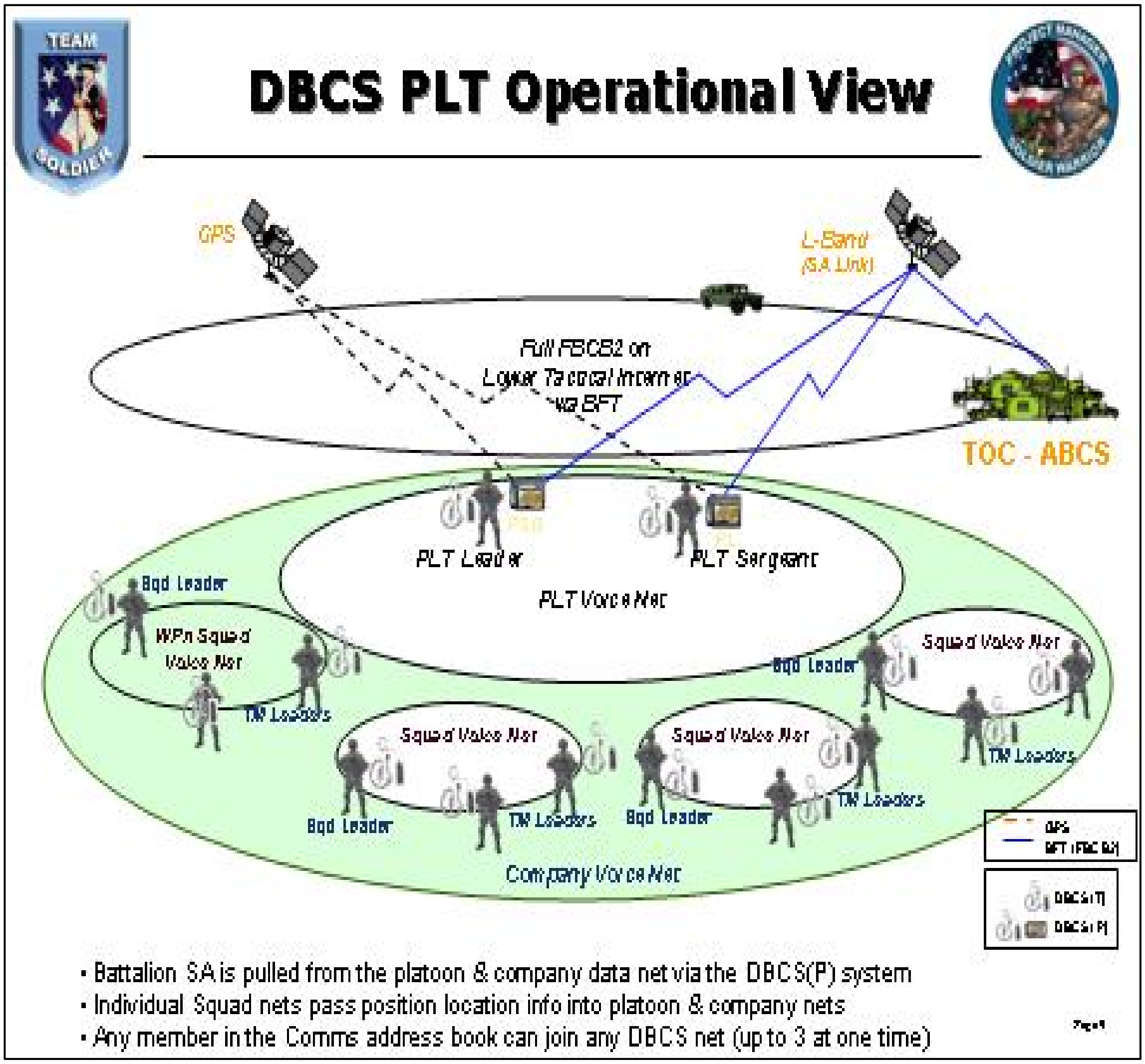

Figure 31. Dismounted Battle Command System Platoon Operational View
(Kempin, 2008)

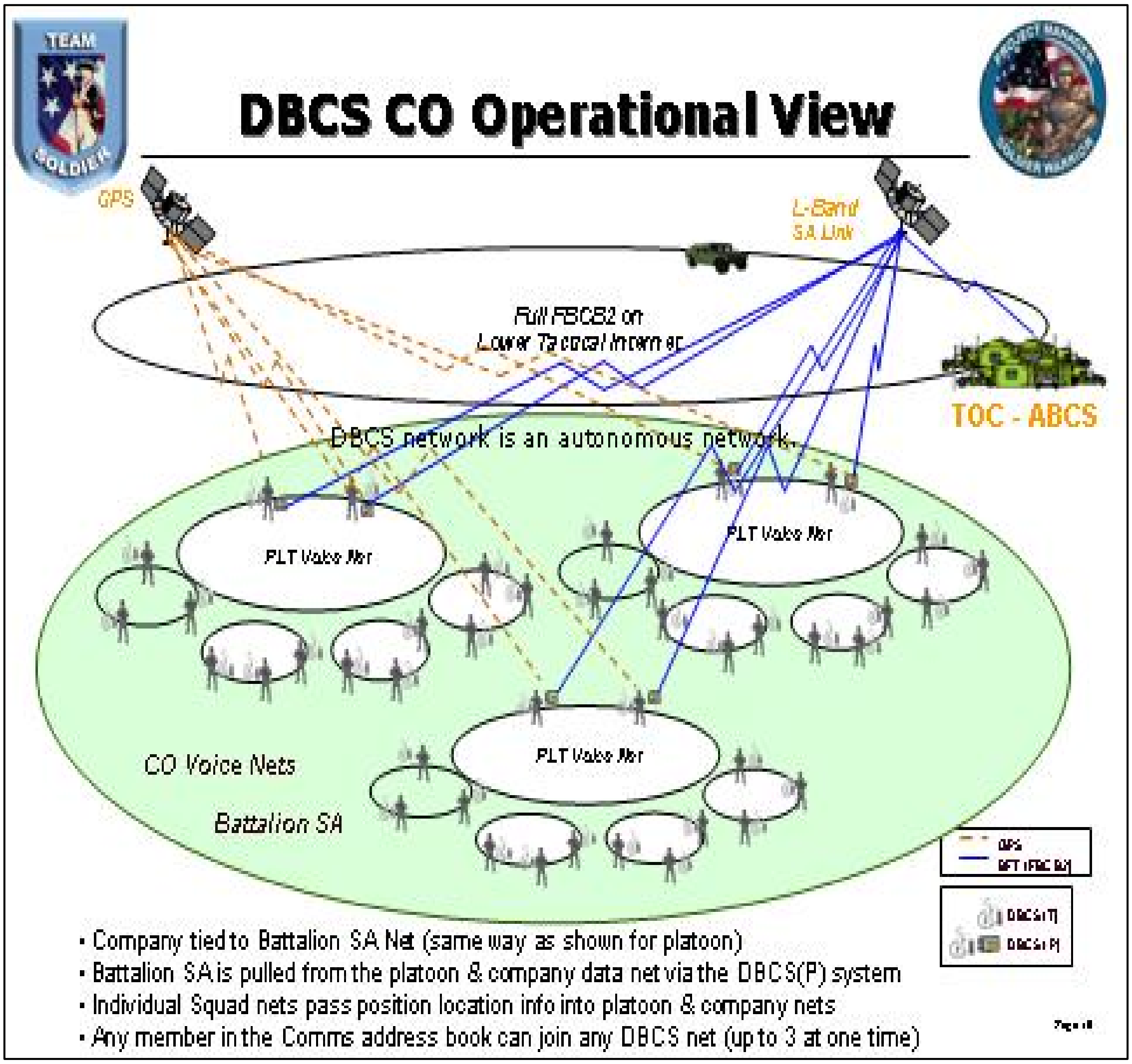

Figure 32. Dismounted Battle Command Company Operational View
(Kempin, 2008)

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Appendix F. Future Force Warrior Advanced Technology Demonstration Purpose, Description, Scope and Timeline

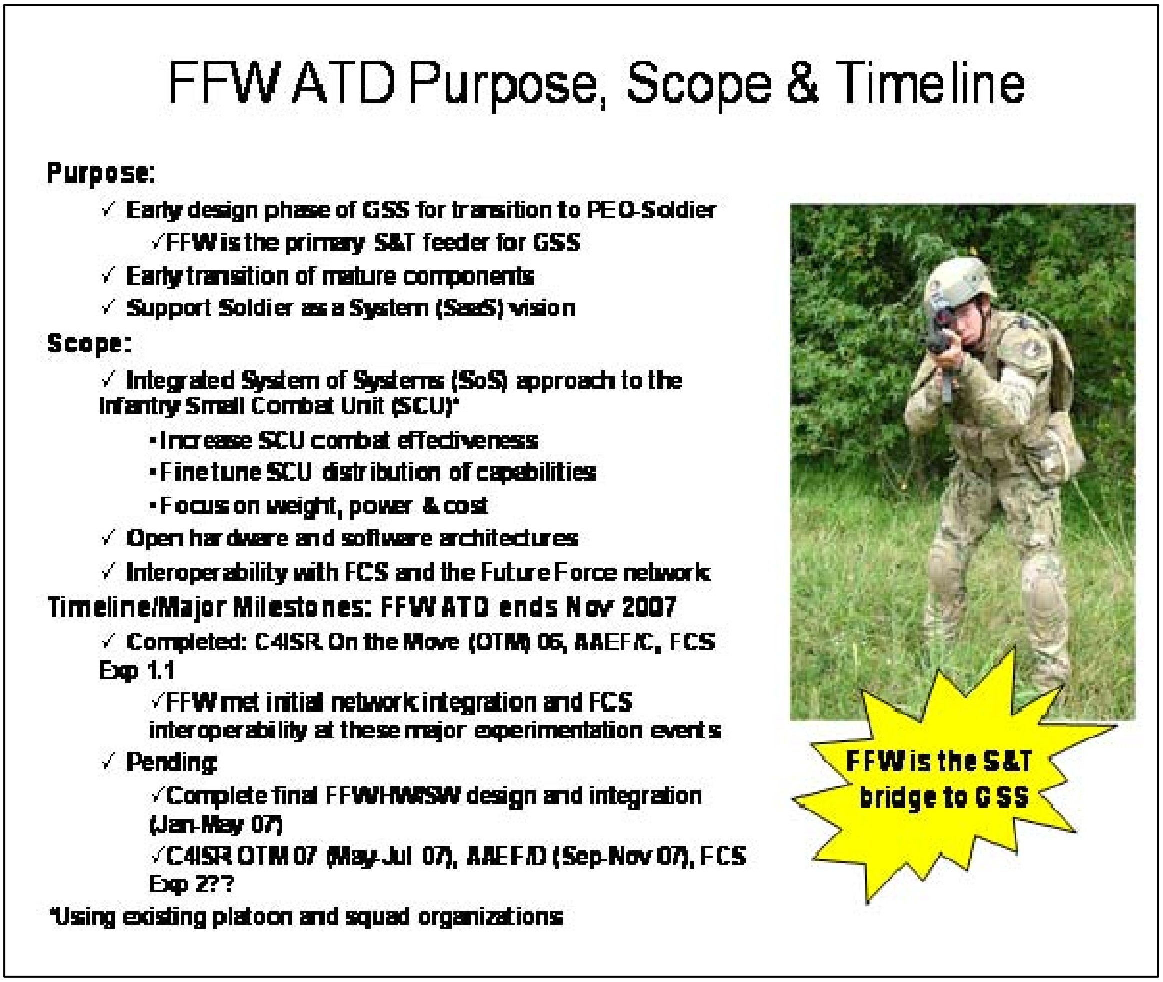

Figure 33. Future Force Warrior Purpose, Scope and Timeline
(Fitzgerald, 2007)

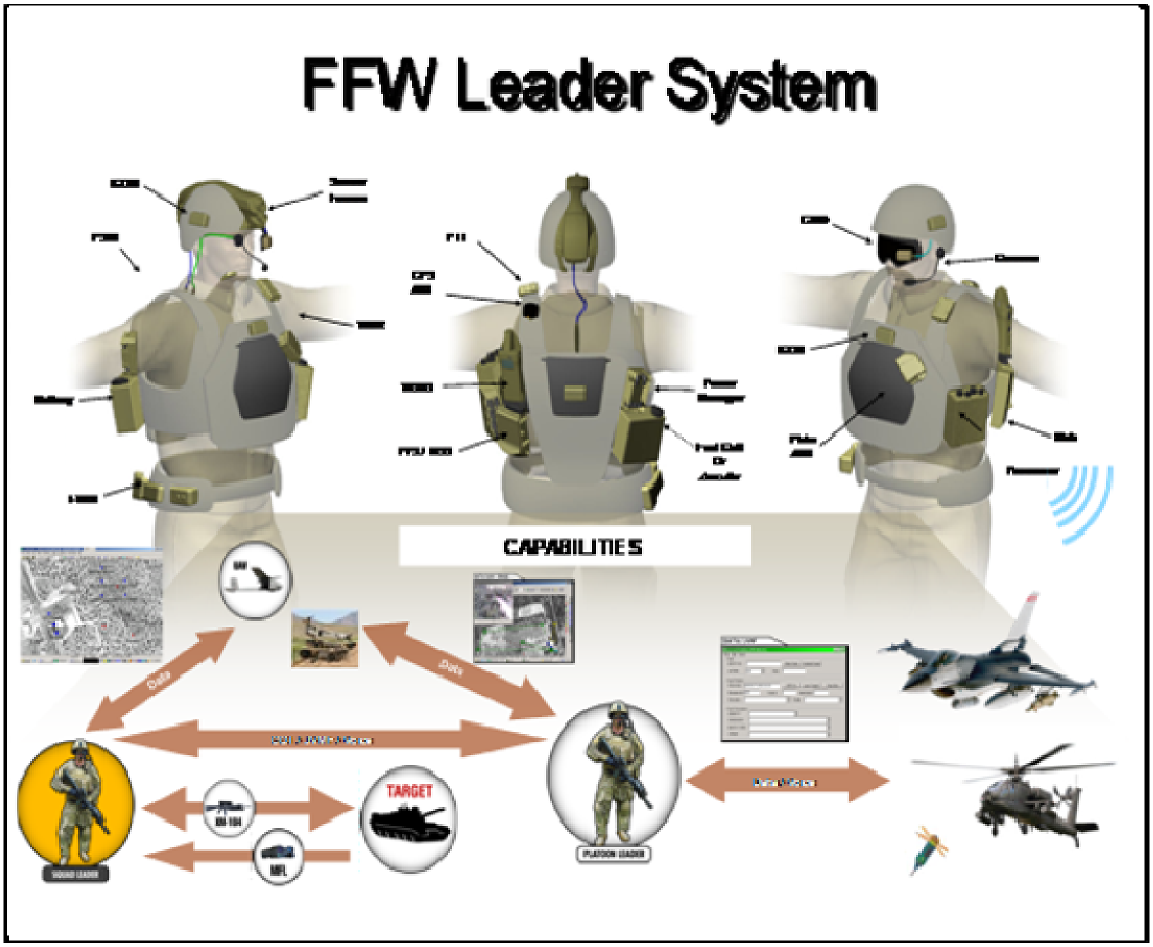

Figure 34. Future Force Warrior Leader System
(Fitzgerald, 2007)

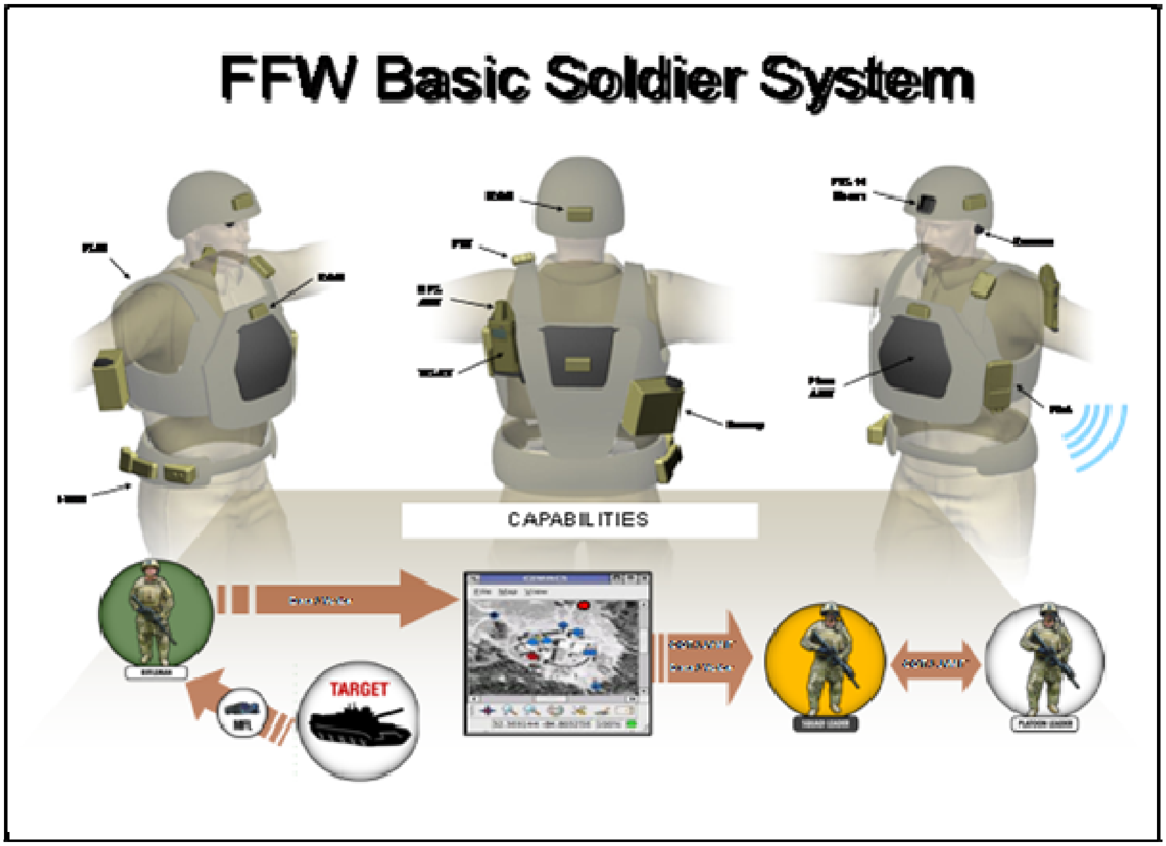

Figure 35. Future Force Warrior Basic Soldier System
(Fitzgerald, 2007)

Figure 36. Capabilities of the Future Force Warrior
(Fitzgerald, 2007)

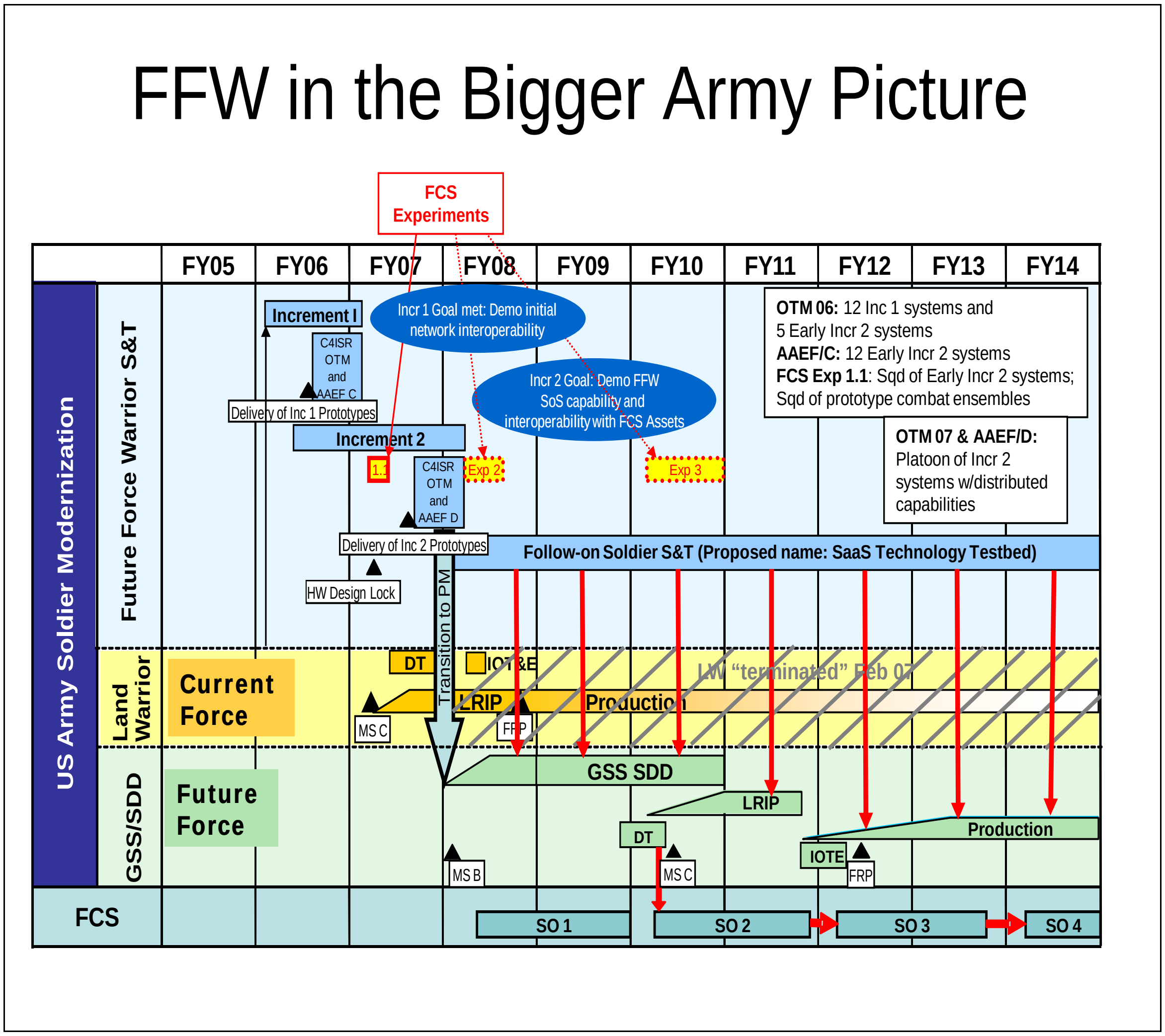

Figure 37. Future Force Warrior Acquisition Timeline
(Fitzgerald, 2007)

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Appendix G. TRADOC Memorandum Directing the DOTMLPF Assessment

DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY TRAINING AND DOCTRINE COMMAND
FUTURES CENTER
33 INGALLS ROAD
FORT MONROE, VIRGINIA 23651-1067

REPLY TO
ATTENTION OF

ATFC-RA

10 Feb 05

MEMORANDUM FOR

COMMANDER, U.S. ARMY INFANTRY CENTER AND FORT BENNING, FORT BENNING, GA 31905-2607
DIRECTOR, U.S. ARMY TRADOC ANALYSIS CENTER, 255 SEDGWICK AVENUE, FORT LEAVENWORTH, KS 66027-2345

SUBJECT: Land Warrior (LW) / Mounted Warrior (MW) Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, and Facilities (DOTMLPF) Assessment

1. References.

a. Memorandum, HQDA, ASA(ALT), 10 Feb 05, subject: Acquisition Decision Memorandum for the Land Warrior (LW) Program.

b. Memorandum, HQDA, 17 Mar 05, subject: Minutes of the Land Warrior (LW) Analysis Study Advisory Group (SAG) Meeting, 9 Feb, 05.

c. Memorandum, HQDA, ASA(ALT), 28 Oct 05, subject: Acquisition Decision Memorandum for the Land Warrior (LW) Program.

2. Purpose. This memorandum provides direction to the U.S. Army Infantry Center (USAIC) and TRADOC Analysis Center (TRAC) for the execution of the Vice Chief of Staff of the Army (VCSA) mandated LW/MW DOTMLPF assessment. Per reference a, the VCSA ordered that a Stryker battalion be equipped with LW and MW for the purposes of conducting a DOTMLPF assessment.

3. Objective. The assessment will provide a DOTMLPF assessment to inform the VCSA and a potential LW Milestone (MS) C decision in FY07 (per reference c).

4. Alternatives. This is a non-standard analysis preceding a potential MS C decision. As such, there are no traditional

alternatives. The evaluation unit will be equipped with LW with a Basis of Issue (BOI) down to individual Soldier for the DOTMLPF Assessment. The current Army Acquisition Objective (AAO) BOI is LW down to Team Leader (TL) level. The Army Test and Evaluation Command (ATEC) will conduct a Limited User Test (LUT) using the AAO BOI within the DOTMLPF Assessment timeframe.

5. Study Issues.

a. What are the operationally preferred LW and MW BOIs?

b. What are the doctrinal and tactics, techniques, and procedure (TTP) implications of fielding LW and MW?

c. What are the organizational implications of fielding LW and MW?

d. What are the training implications of fielding LW and MW?

e. What are the materiel implications of fielding LW and MW?

f. What are the personnel implications of fielding LW and MW?

g. What are facility implications of fielding LW and MW?

h. What are the logistic implications of fielding LW and MW?

i. What are the communications implications of fielding LW and MW?

j. What are the force effectiveness impacts of fielding LW and MW?

k. How do LW and MW impact on small unit capability gaps?

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g. What are facility implications of fielding LW and MW?

h. What are the logistic implications of fielding LW and MW?

i. What are the communications implications of fielding LW and MW?

j. What are the force effectiveness impacts of fielding LW and MW?

k. How do LW and MW impact on small unit capability gaps?

6. Responsibilities.

a. Director, FC Capabilities Development. Co-chair an Integrated Product Team (IPT) to oversee the assessment work.

b. Director, FC Requirements Integration.

(1) Participate as a member of the IPT.

(2) Work with the Study Agency to determine availability of funding, if required.

(3) Review the study plan and final report.

c. USAIC.

(1) Co-chair the IPT.

(2) As the DOTMLPF Assessment lead, support TRAC as required in the conduct of the analysis.

(3) Coordinate all activities with the unit, Fort Lewis installation, and Project Manager (PM).

(4) Be prepared to assist in LUT as necessary.

(5) Determine and consolidate resource requirements and submit unfunded requirements (UFRs) to TRADOC FC.

(6) Prepare final DOTMLPF Assessment report and out brief results through HQ, TRADOC Futures Center.

d. TRAC.

(1) Appoint a TRAC study lead to support USAIC in the analysis effort.

(2) Support USAIC in preparing and briefing the Study Plan to the IPT.

(3) Provide modeling support and other assistance as coordinated with ATEC to assist in the LUT.

(4) Assist USAIC in the preparation and presentation of the final report.

d. Army Materiel Systems Analysis Activity (AMSAA).

(1) Participate as a member of the IPT.

(2) Request AMSAA provide system performance data requested by the Study Director.

e. ATEC.

(1) Participate as a member of the IPT.

(2) Request ATEC provide technical data collection support as needed and operational test expertise to assist the study director in the planning and execution of the assessment.

f. TRADOC FC Directors, Studies and Analysis Division and Force Applications Division. Participate as members of the IPT.

g. Program Executive Office Soldier (PEO-S) and Program Manager for Soldier Warrior (PM SWAR). Participate as members of the IPT.

7. Coordinating Instructions.

a. The study director and TRAC study lead will conduct In-Process Reviews, as required, at key study points and to prepare for IPT presentations.

b. Assessment data collection and analysis must be conducted around the unit go-to-war preparation. The study team must minimize the impact on unit training.

c. The assessment will discern operational differences between the AAO LW BOI and LW down to the individual Soldier.

Comparison must be made by working in conjunction with ATEC, which will conduct a LUT using the AAO BOI within the assessment time frame.

d. Direct coordination between USAIC, TRAC, AMSAA, and ATEC is authorized.

e. All involved organizations will estimate resource requirements and submit UFRs through the study director to TRADOC FC.

f. Deliverables.

(1) Present the study plan to the IPT **NLT 15 Mar 06.**

(2) Present emerging results to the IPT **NLT 31 OCT 06.**

(3) Present final results **NLT 2QFY07.**

8. Points of contact.

a. TRAC. Barry Bazemore, ATRC-TD, DSN 552-5511, barry.bazemore@us.army.mil.

b. Infantry Center. MAJ Ted Qualls, ATZB-CDS, DSN 835-7213, quallst@benning.army.mil.

c. TRADOC Futures Center. Mark Murray, ATFC-RA, (757) 788-5834 (DSN 680), marky.murray@us.army.mil; and Steve Younger, ATFC-DF, (757) 788-3114 (DSN 680).

Allan M. Resnick

ALLAN M. RESNICK
Director, Requirements
Integration

ATFC-RA
SUBJECT: Land Warrior (LW) / Mounted Warrior (MW) Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, and Facilities (DOTMLPF) Assessment

CF:
Deputy Chief of Staff, G3 (DAMO-AC, DAMO-CI), 400 Army Pentagon, Washington, D.C. 20310-0400
Deputy Chief of Staff, G8 (DAPR-FDZ), 700 Army Pentagon, Washington, D.C. 20310-0700
Deputy Under Secretary of the Army (Operations Research), Office of the Under Secretary, SAUS-OR, 102 Army Pentagon, Washington, D.C. 20310-0102
Deputy Assistant Secretary of the Army for Cost and Economics, SFFM-CA, 1421 Jefferson Davis Highway, Suite 9000, Arlington, VA 22202-3259
Military Deputy/Director, Army Acquisition Corps, Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology), 103 Army Pentagon, Washington, D.C. 20310-0103

Commander
U.S. Army Infantry Center and Fort Benning, (ATZB-ZD, ATZB-CDS), Fort Benning, GA 31905-5000
U.S. Army Training and Doctrine Command, Deputy Chief of Staff for Intelligence, A/DCSINT-Threats, 700 Scott Avenue, Fort Leavenworth, KS 66027-1323
U.S. Army Materiel Command, AMCRDA, 5001 Eisenhower Ave, Alexandria, VA 22304-4841
U.S. Army Research, Development and Engineering Command, AMSRD-CG, 5183 Blackhawk Road, Aberdeen Proving Ground, MD 21010-5424
U.S. Army Operational Test Command, 91012 Station Avenue, Fort Hood, TX 76544-5068
Army Test and Evaluation Command, 4501 Ford Avenue, Alexandria, VA 22302-1458

Director
Futures Center, ATFC-DF, Fort Monroe, VA 23651-1067
TRAC-FLVN, ATRC-F, 255 Sedgwick Avenue, Fort Leavenworth, KS 66027-2345
TRAC-WSMR, ATRC-W, Building 1400, Martin Luther King Drive, White Sands Missile Range, NM 88002-5502
TRAC-LEE, ATRC-L, 401 1st Street, Suite 401, Fort Lee, VA 23801-1511
(CONT)

ATFC-RA
SUBJECT: Land Warrior (LW) / Mounted Warrior (MW) Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, and Facilities (DOTMLPF) Assessment

CF: (CONT)
Army Materiel Systems Analysis Activity, AMSRD-AMS-D, 392 Hopkins Road, Aberdeen Proving Ground, MD 21005-5071
Army Research Lab, 2800 Powder Mill Road, Adelphi, MD 20783-1197

Program Executive Office Soldier, SFAE-SDR, 5901 Putnam Road, Bldg 328, Fort Belvoir, VA 22060-5422
Project Manager Soldier Warrior, SFAE-SDR-SWAR, 10125 Kingman Road, Bldg 317, Fort Belvoir, VA 22060-5820

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Figure 38. DOTMLPF Directed Study Memorandum
(Berger, 2008)

Appendix H. Mounted Warrior

Figure 39. Mounted Warrior Soldier System
(Castillo, 2008)

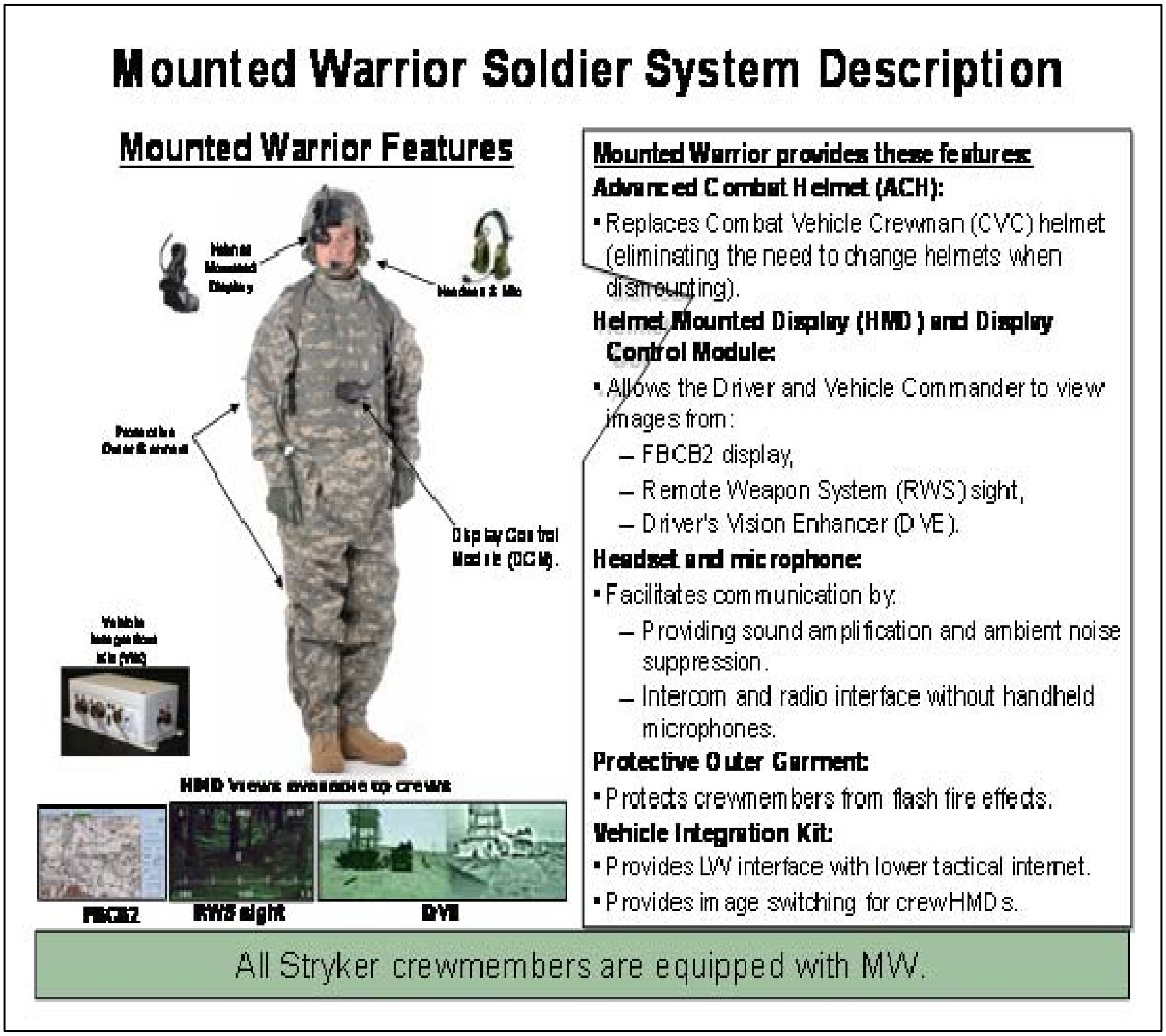

Figure 40. Mounted Warrior Soldier System Description
(Castillo, 2008)

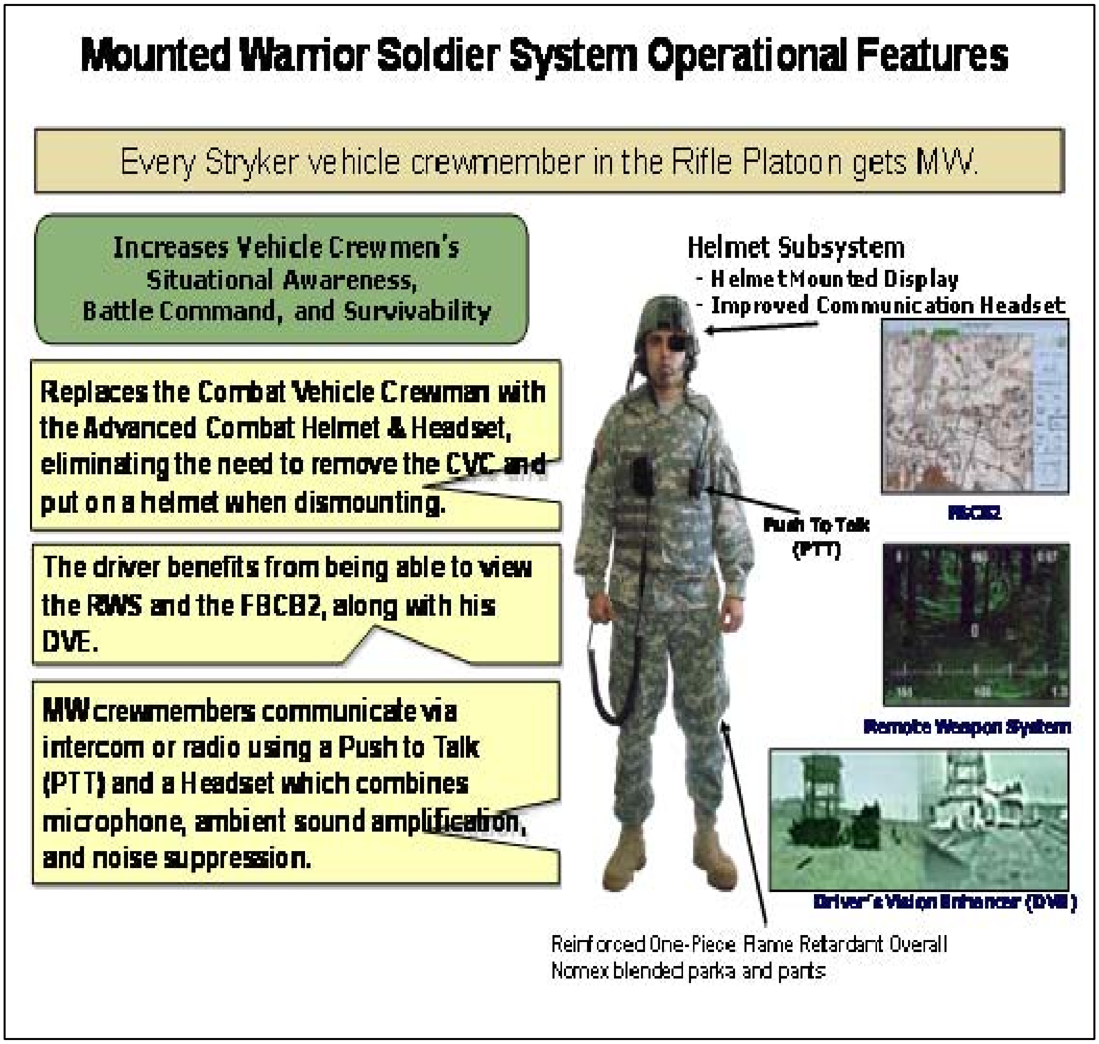

Figure 41. Mounted Warrior Soldier System Description
(Castillo, 2008)

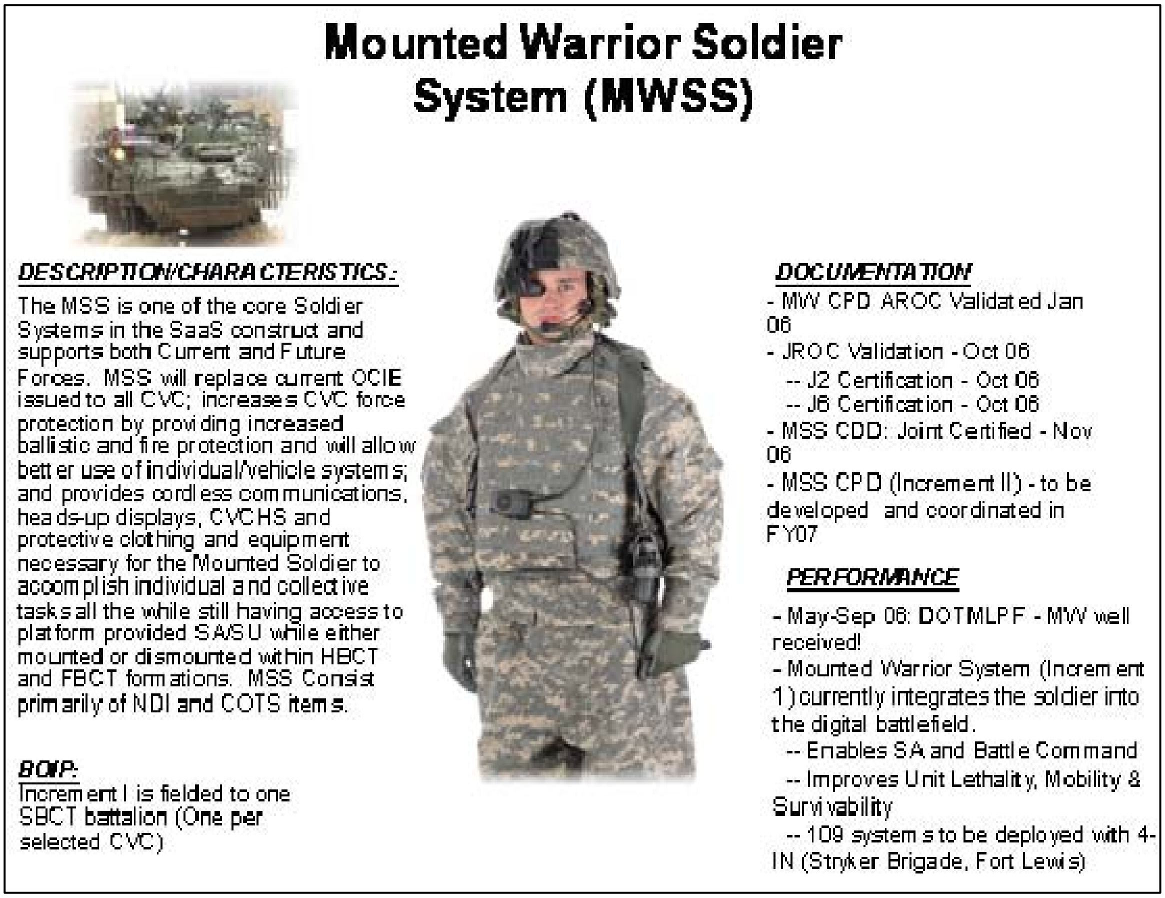

Figure 42. Mounted Warrior Soldier System
(Castillo, 2008)

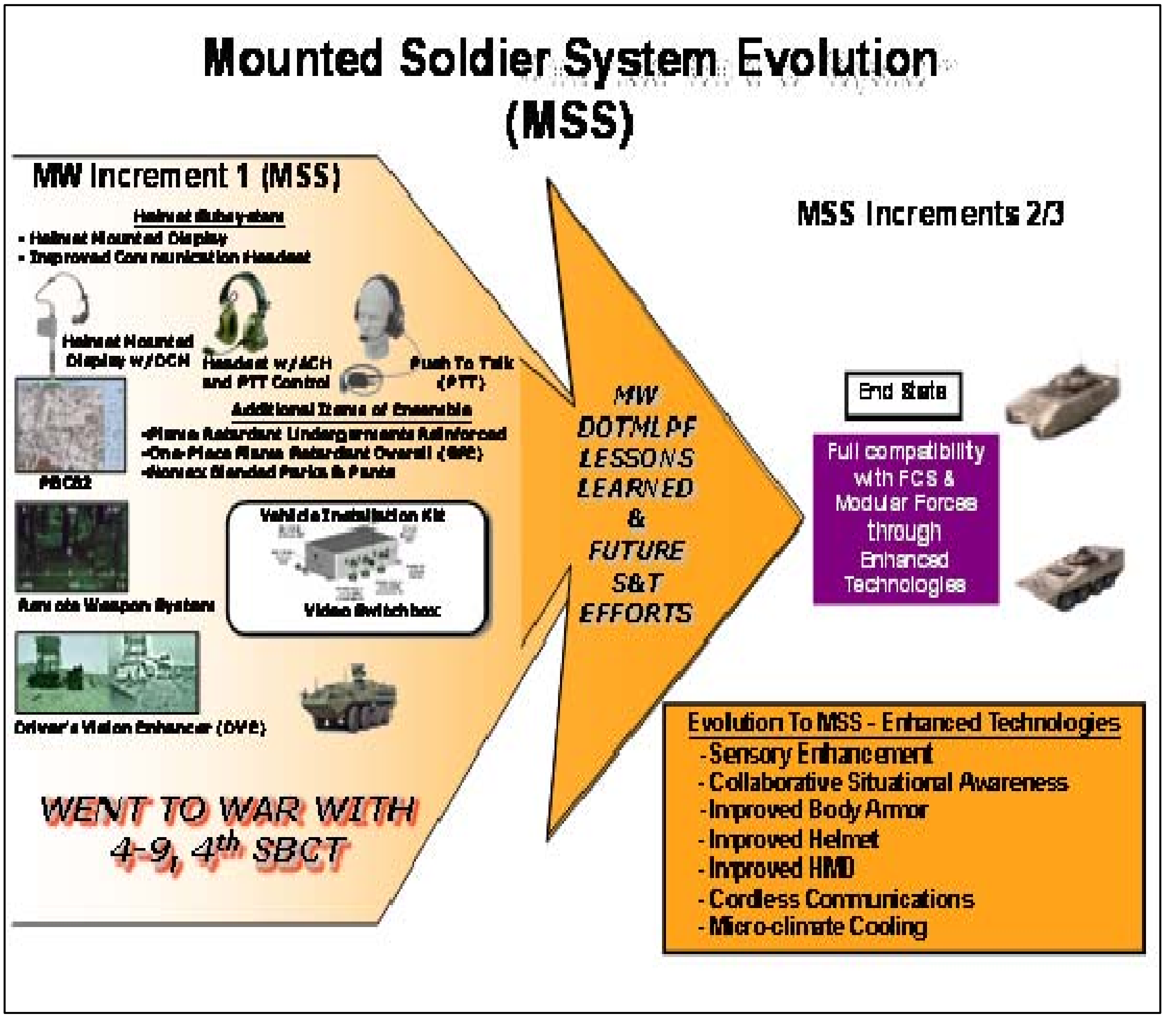

Figure 43. Mounted Soldier System Evolution
(Castillo, 2008)

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Appendix I. Ground Soldier System (GSS) Program Description

Ground Soldier Ensemble(GSE)

<u>Description</u>: An integrated dismounted Soldier situational awareness (SA) system for use during combat operations that consists of:
- a hands free display to view information
- a computer to process information/populate screen
- an interface device for user-screen interaction
- a system power source
- a SW operating system for system functionality
- tactical applications and battle command (FBCB2)
- a networked radio transmitter/receiver device to send/receive information

<u>Capabilities</u>: GSE provides unparalleled SA/understanding to the Dismounted Leader (Team Leader and above) allowing for faster, more accurate decisions in the tactical fight and connecting the dismounted Soldier to the Future Combat System (FCS) Spinout as a complementary program.

<u>Incremental Acquisition Approach</u>:
GSE Increment 1: SA to dismounted leaders, position location information/voice communications at the rifleman level (capabilities increase with increased rank). P3I: Incorporates JTRS HMS SFF-B radio with SRW when available.
GSE Increment 2: Increases capabilities, i.e., voice control, Warfighter Physiological Status Monitor, networked lethality, and full interoperability with FCS assets (e.g. Tactical Unattended Ground Sensors, Unmanned Aerial Vehicles (UAV)), using Unified Battle Command.

<u>Program Objective:</u> Integrate GSE components while leveraging emerging technology to provide overmatching capabilities that increase small unit SA, BC, lethality, mobility, survivability, sustainability, & integration with FCS.

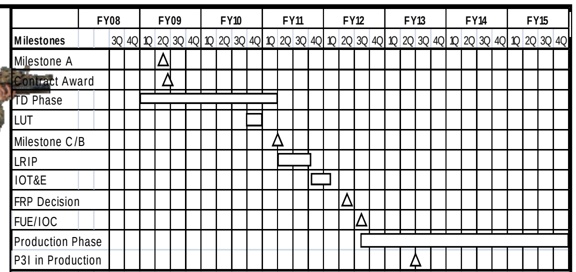
<u>Authorization:</u> JROC-validated SaaS ICD, 21 Oct 05

<u>AAO</u>: Initially 18 IBCTs pending further analysis

<u>% AAO Funded:</u> 0.0%

<u>% of AAO Fielded:</u> Fielding scheduled to begin in FY12

<u>Joint:</u> Interest (USMC)



Funding (POM 10 DAB/Pre-OIPT/OIPT V7.3)

	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15
RDTE ($M)	0.0	25.5	57.9	37.1	27.1	18.9	37.8	45.3
OPA ($M)	0.0	0.0	2.0	118.0	243.0	285.0	289.0	294.0
OMA ($M)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Quantities

	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15
Production	0	0	0	4598	9196	9196	9196	9196
Fielding	0	0	0	0	4598	9196	9196	9196

2299=1x IBCT

<u>Status</u>
- GSE Defense Acquisition Board (DAB) – TBD
- Award of 3 competitive prototyping contracts by 31 Mar 09
- CDD AROC-validation by 2QFY09; JROC-validation by 1QFY10
- Milestone C/B scheduled 1QFY11
- Procurement funds 18 IBCTs at Team Leader and higher

<u>Issues</u>
- No RDT&E funding in FY08; $4.8M Reprogramming/New Start Request at Congress
- MDA Delegation to Army as ACAT 1C
- BOI and AAO determination
- Paper DAB based on approved TDS and ADM required for contract RFP Release
- Milestone A delayed due to Section 2366a certification requirement.

1

<u>POC:</u> Mr. Jeff Witherel, SFAE-SDR-SWAR, DSN 654-3860

Figure 44. Ground Soldier System Program Description
(Witherel, 2008)

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Appendix J. Recommended Further Reading and Supporting Studies

Burch, G.L. (2001, April). *An examination of Land Warrior's contribution to combat power on the battlefield.* Washington, DC: United States Army.

Centric, J.H., Wampler, R.L., Dyer, J.L., & TRW Systems and Information Technology Group. (2000, January). *Observations of infantry courses: Implications for Land Warrior training* (ARI Research Note 2000-04). Arlington, VA: US Army Research Institute for the Behavioral and Social Sciences.

Douglas, R., Downing, W., & Steele, M. (2001a, November). *The objective force soldier/soldier team—Volume II: The science and technology challenges* (Army Science Board 2001 special study final report). Washington, DC: Army Science Board.

Douglas, R., Downing, W., & Steele, M. (2001b, November). *The objective force soldier/soldier team—Volume III: Background and context* (Army Science Board 2001 special study final report). Washington, DC: Army Science Board.

Dyer, J.L. (1999, November). *Training lessons learned on sights and devices in the Land Warrior weapon subsystem* (Research Report 1749). Arlington, VA: US Army Research Institute for the Behavioral and Social Sciences.

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Dyer, J.L., Singh, H., & Clark, T.L. (2005, September). *Computer-based approaches for training interactive digital map displays* (Research Report 1842). Arlington, VA: US Army Research Institute for the Behavioral and Social Sciences.

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General Dynamics Decision Systems. (2004, October). *Advance soldier wearable embedded training system final report*. Orlando, FL: GD Battle Management Systems Division.

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Krausman, A.S., Boynton, A.C., Harper, W.H., Ortega, S.V., Jr., & Wilson, R.M. (2004, July). *Human factors evaluation of Land Warrior, Version 1.0.* Adelphi, MD: Army Research Laboratory.

Marth, R.B., Sr., et al. (1998). The integrated navigation capability for the Force XXI Land Warrior. In *Proceedings of the Position, Location and Navigation Symposium, IEEE*, *20*(23), 193-200.

Ralph, J.R., O'Neil, H.F., Drenz, C.F., Freeman, M., & Hoffman, M. (2001, June). *Manpower and personnel for soldier systems in the objective force* (Army Science Board 2001 special study final report). Washington, DC: Army Science Board.

Salter, M.S. (1993, June). *Soldier integrated protective ensemble: The soldiers' perspective* (Research Report 1640). Arlington, VA: US Army Research Institute for the Behavioral and Social Sciences.

Sherman, P., & Holmes, S. (2005, October). *Personal navigation.* Cambridge, MA: Draper Laboratory.

Singh, H., & Dyer, J.L. (2002, October). *The computer backgrounds of soldiers in Army units: FY2001* (Research Report 1799). Arlington, VA: US Army Research Institute for the Behavioral and Social Sciences.

Appendix K. Top Ten Process and Unit System Integrator

Top Ten Process

- The Top 10 Process is the vehicle for information exchange between the Soldier, Combat Developer and Materiel Developer.
- Top Ten facilitates the sharing of real-time information with the unit, program office, and materiel developer resulting in significant cost-savings and schedule compressions. The immediate incorporation of user feedback reduces time-to-delivery by providing a more accurate picture of user requirements.
- It is an iterative process that effectively captures, analyzes, and prioritizes user inputs regarding potential system improvements and further technology integration
  - Once the input is prioritized, the materiel developer, in coordination with DPM LW, USIs, and PM SWAR Engineers, develops a capability modification plan that will incorporate the recommended modifications
  - The user is updated regularly on the status of their requested improvements.
- The Top Ten Process is crucial to capturing and delivery solutions for the operational needs and capabilities demanded by today's Soldiers. LW is successful because it is a system designed BY Soldiers, FOR Soldiers

Figure 45. Top-ten Process
(Augustine, 2008b, p. 2)

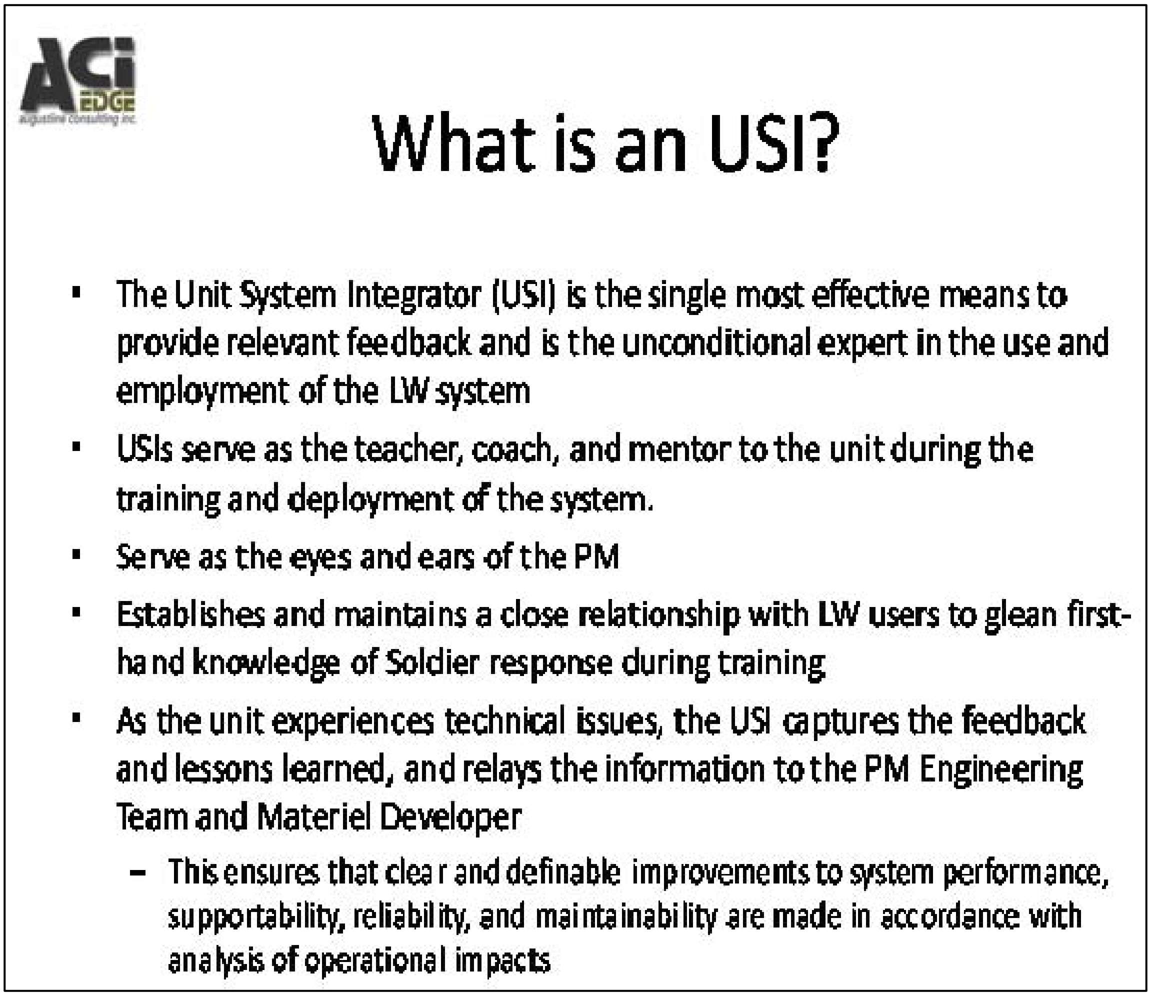

Figure 46. Unit System Integrator Description
(Augustine, 2008b, p. 3)

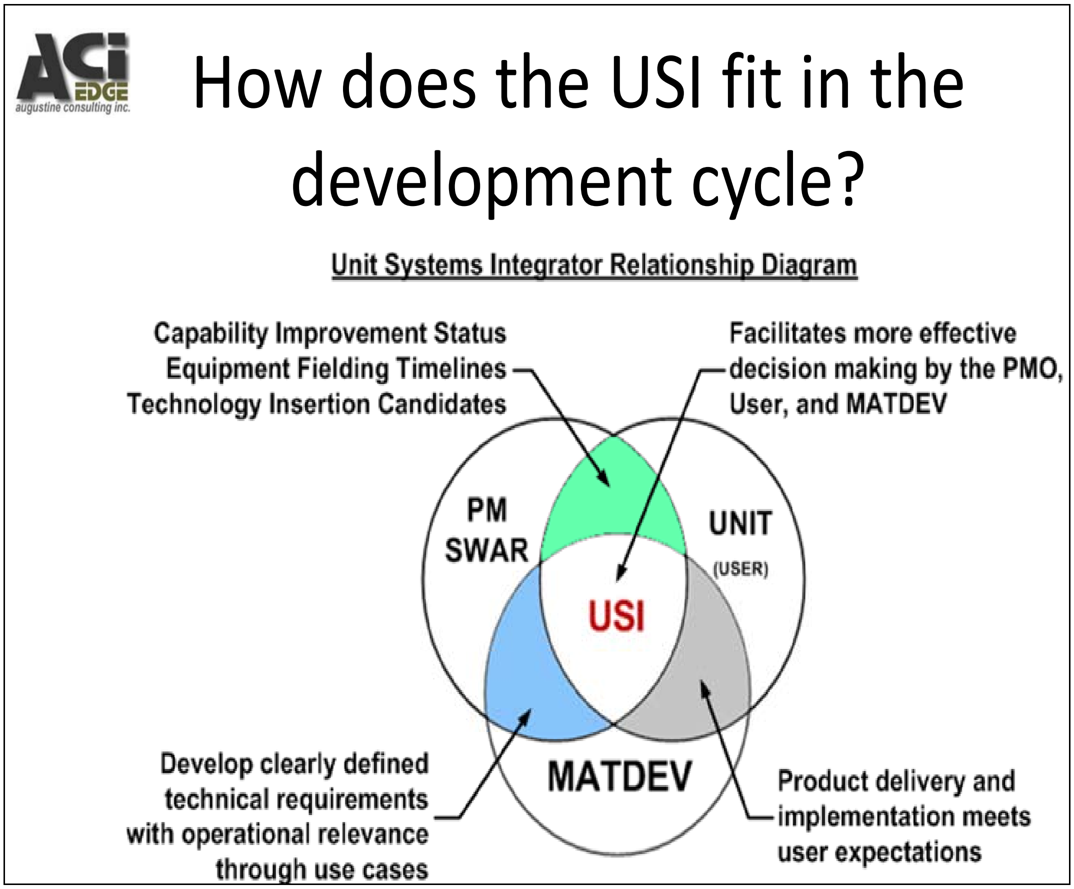

Figure 47. Unit System Integrator in the Development Cycle
(Augustine, 2008b, p. 4)

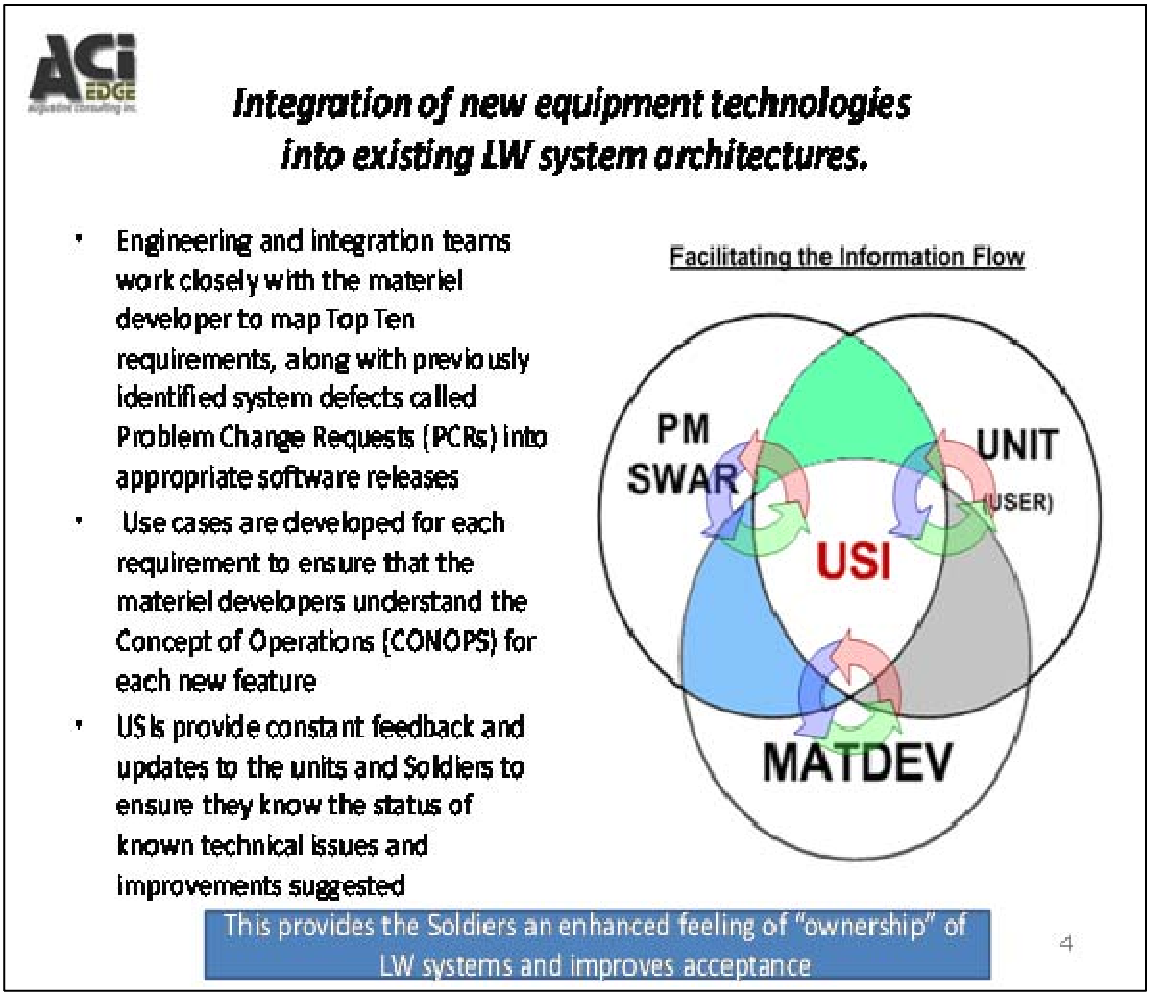

Figure 48. Integration of New Technologies
(Augustine, 2008b, p. 5)

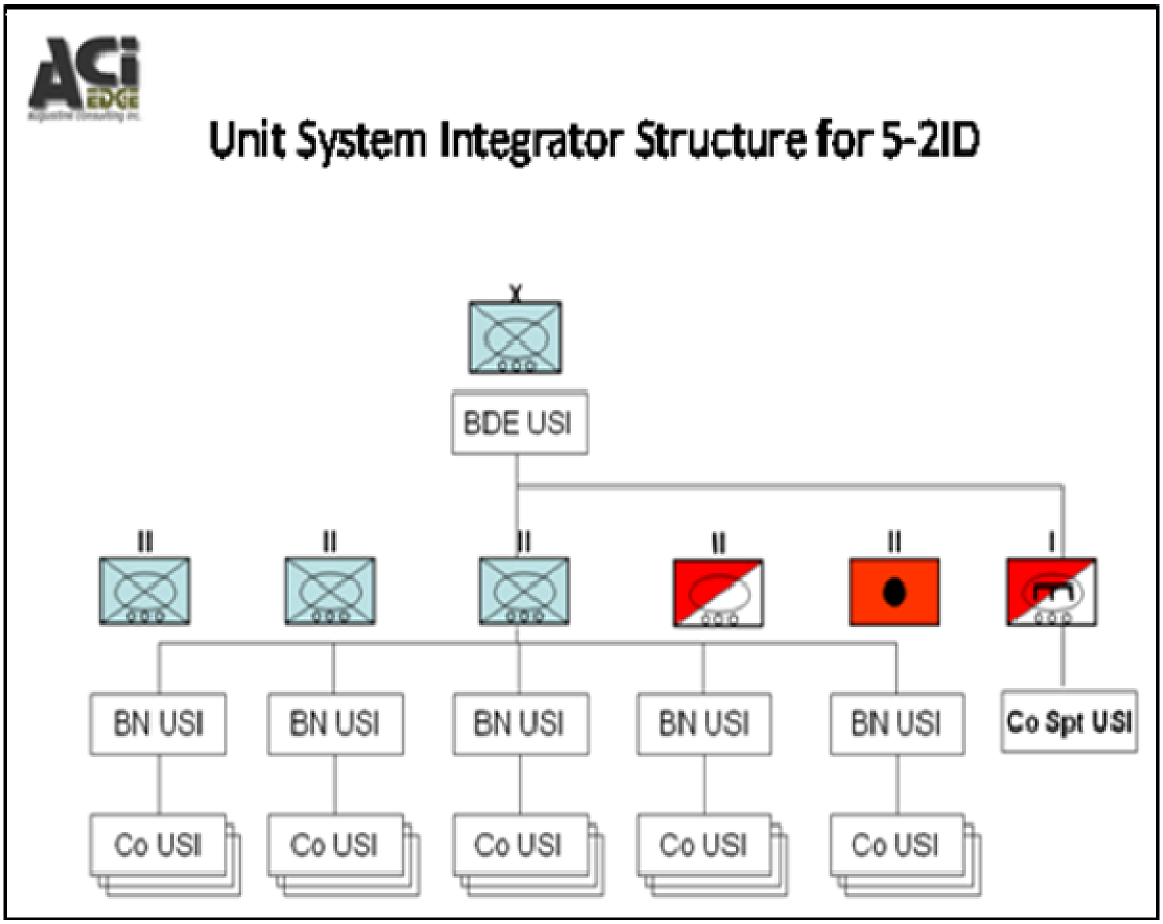

Figure 49. Unit System Integrator for the 5-2 Stryker Brigade Combat Team
(Augustine, 2008b, p. 6)

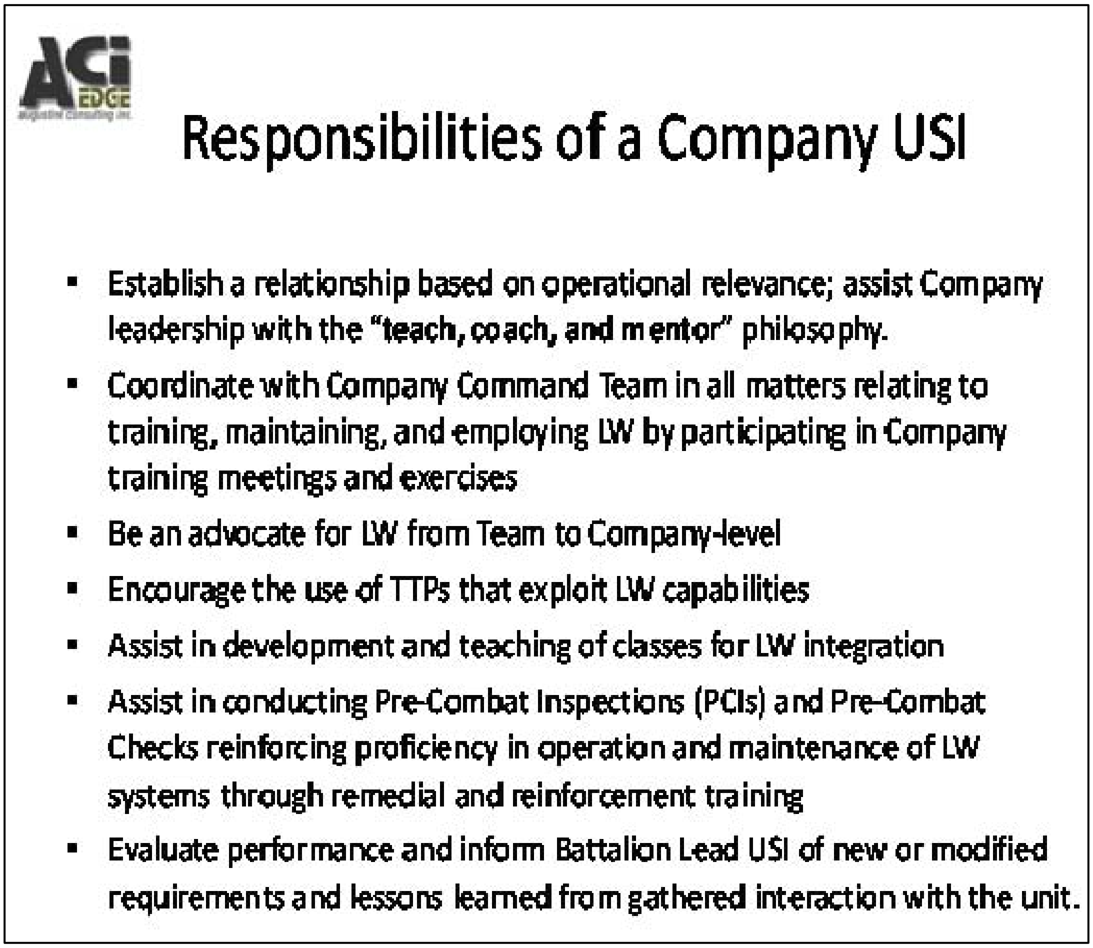

Figure 50. Responsibilities of a Company Unit System Integrator
(Augustine, 2008b, p. 7)

Responsibilities of a Battalion USI

- Responsible for train and integration support to BN HQ and specialty platoons (e.g. Recon, Mortars, BN Personal Security Detachment (PSD)
- Coordinate with Battalion Command Team and S3 by participating in all Battalion Training Meetings to ensure all LW related needs are met
- Develop integration plan for all additional LW equipment and peripherals
- Provide training recommendations that incorporate LW and peripheral equipment
- Evaluate performance, gather feedback and inform Brigade Lead USI of operational use of LW and related systems in order to generate lessons learned, Soldier acceptance, Tactics, Techniques, and Procedures (TTPs), and Top Ten Lists
- Ensures Company USIs are delivering a consistent level of support and continuity of effort across entire Battalion

Figure 51. Responsibilities of a Battalion Unit System Integrator
(Augustine, 2008b, p. 8)

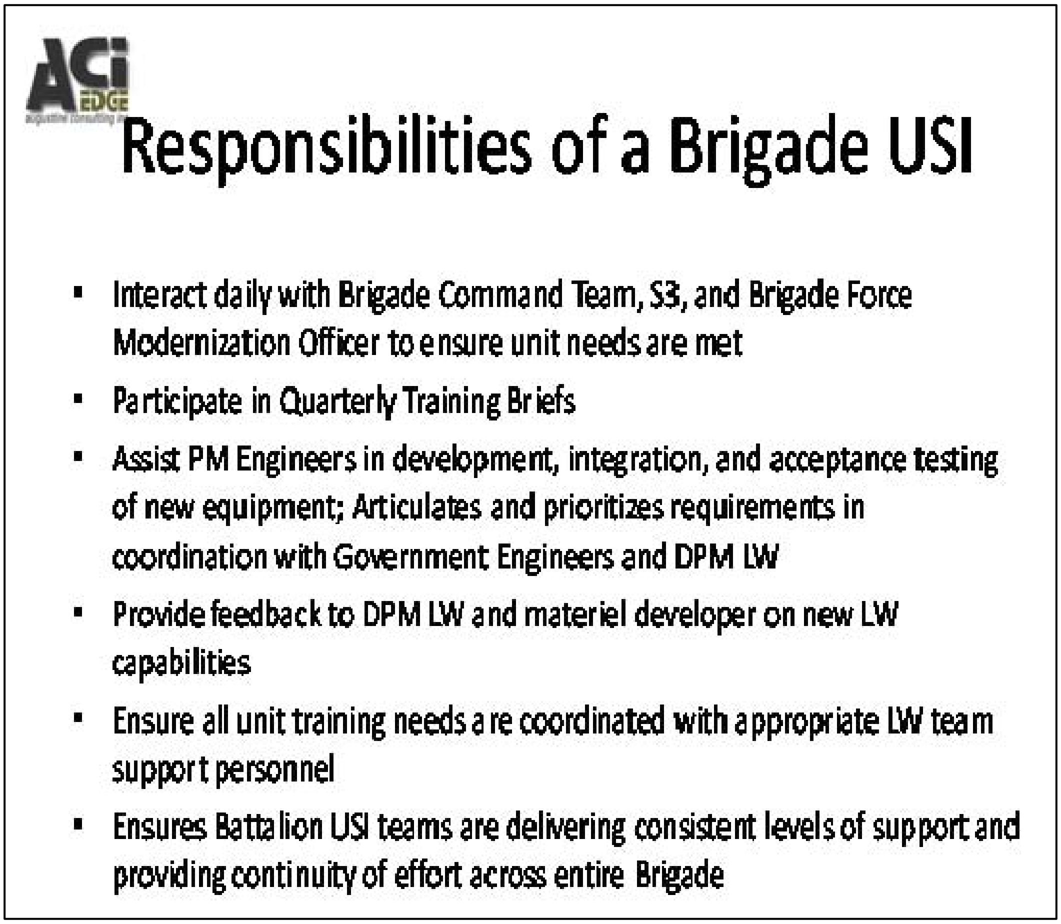

Figure 52. Responsibilities of a Brigade Unit System Integrator
(Augustine, 2008b, p. 9)

Appendix L. Program Manager Land Warrior Support Plan and Net Operational Views

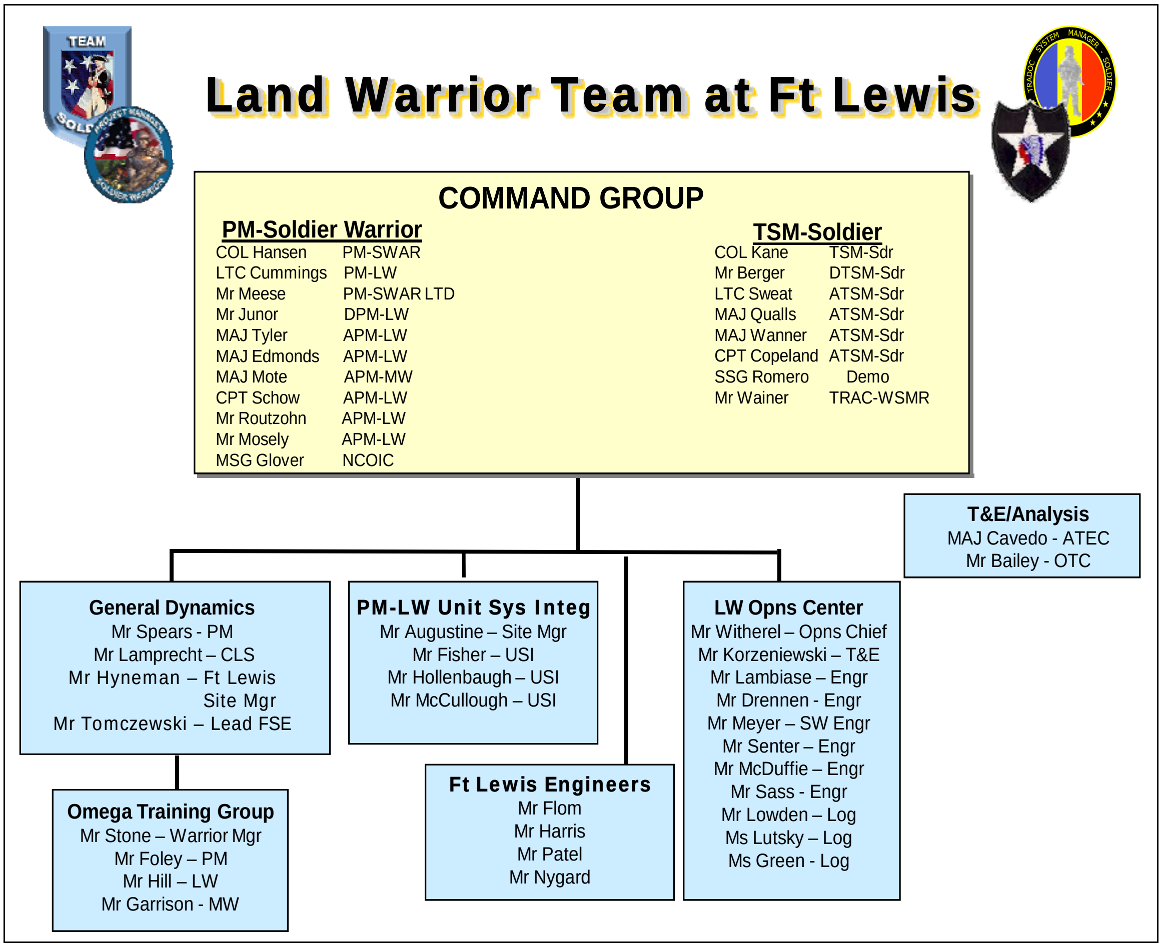

Figure 53. Land Warrior Equipping and Assessing Team Organization
(Cummings, 2008, September 22)

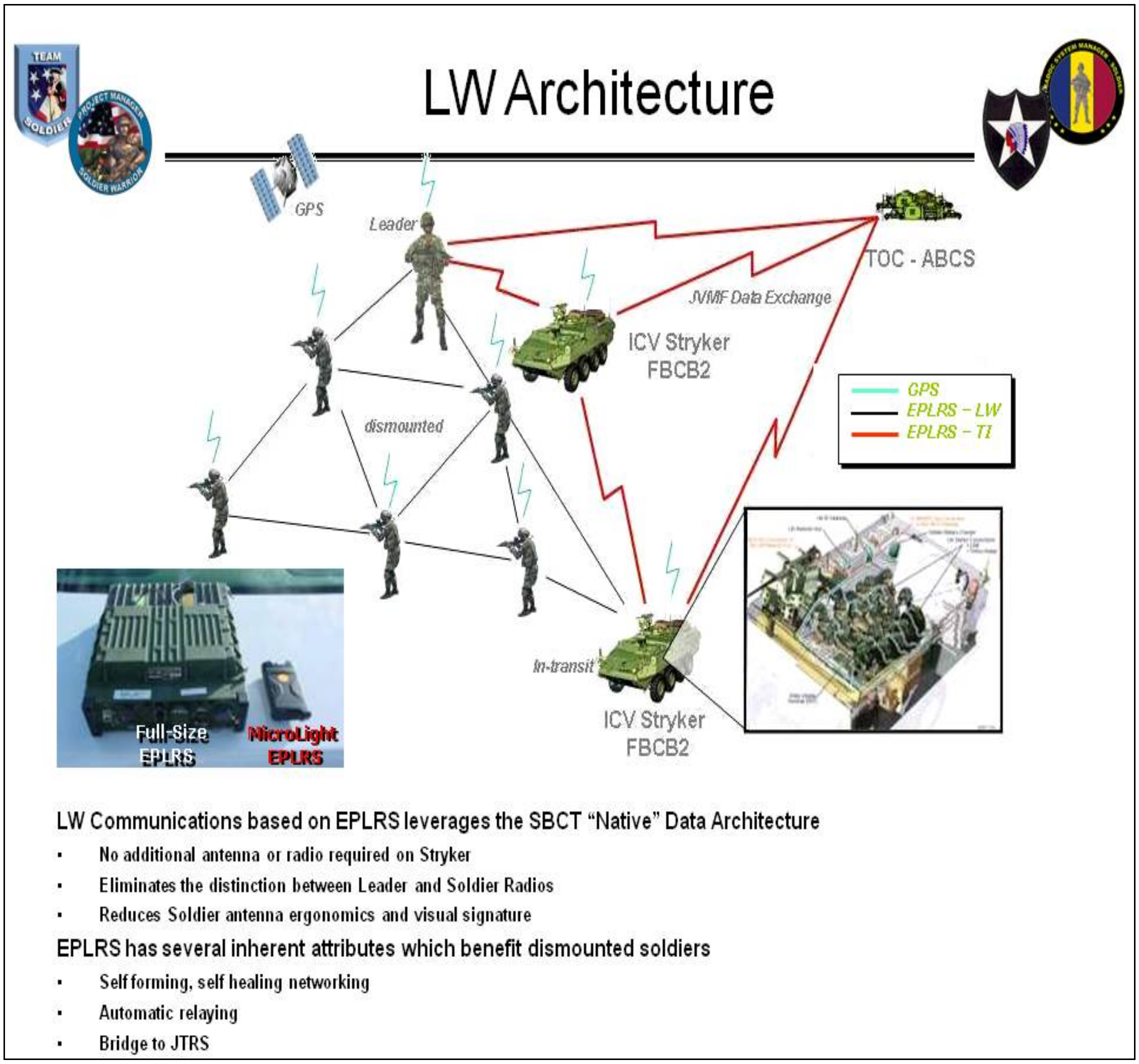

Figure 54. Land Warrior NET Architectural View
(Witherel, 2008)

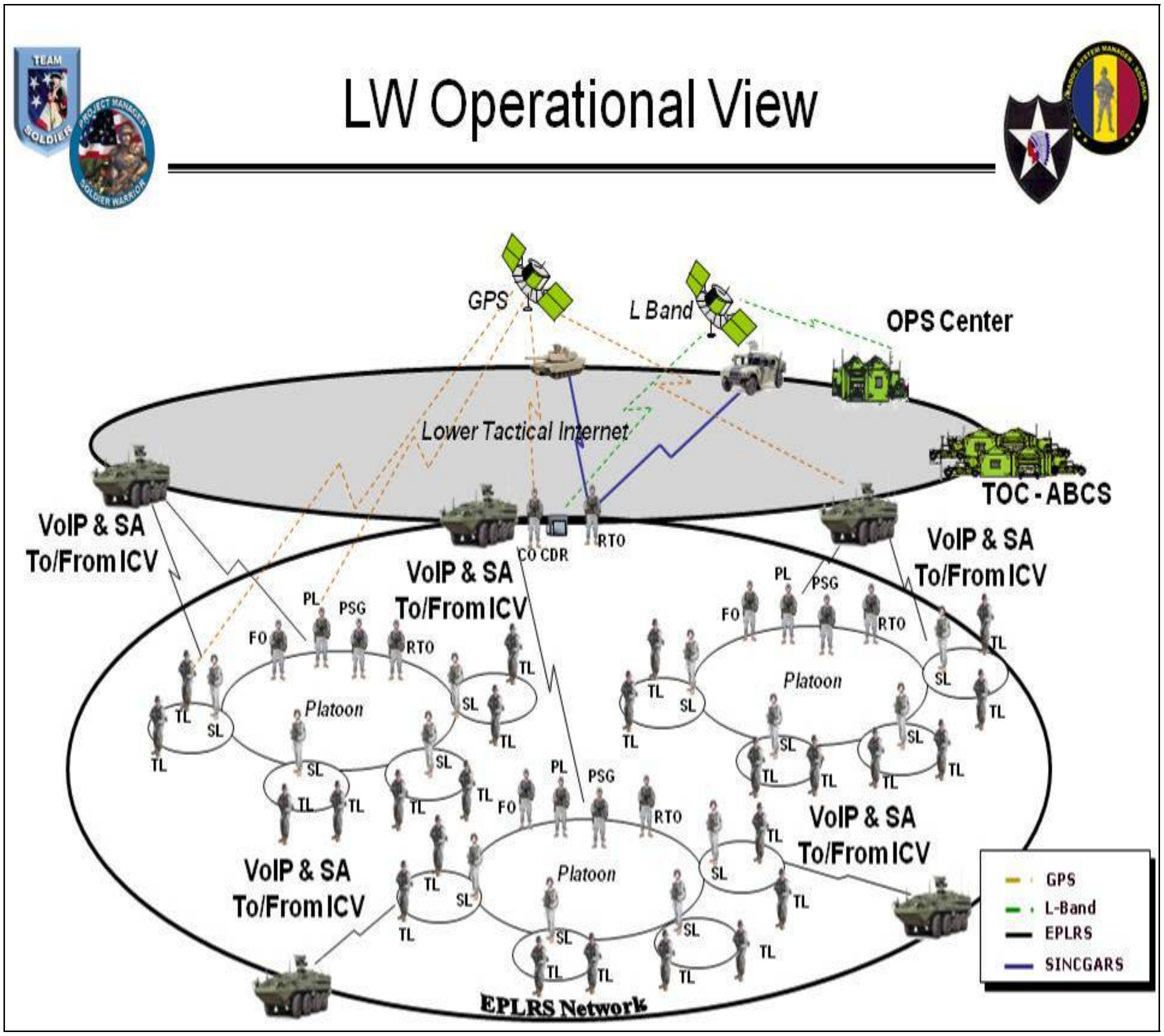

Figure 55. Land Warrior NET Operational View
(Witherel, 2008)

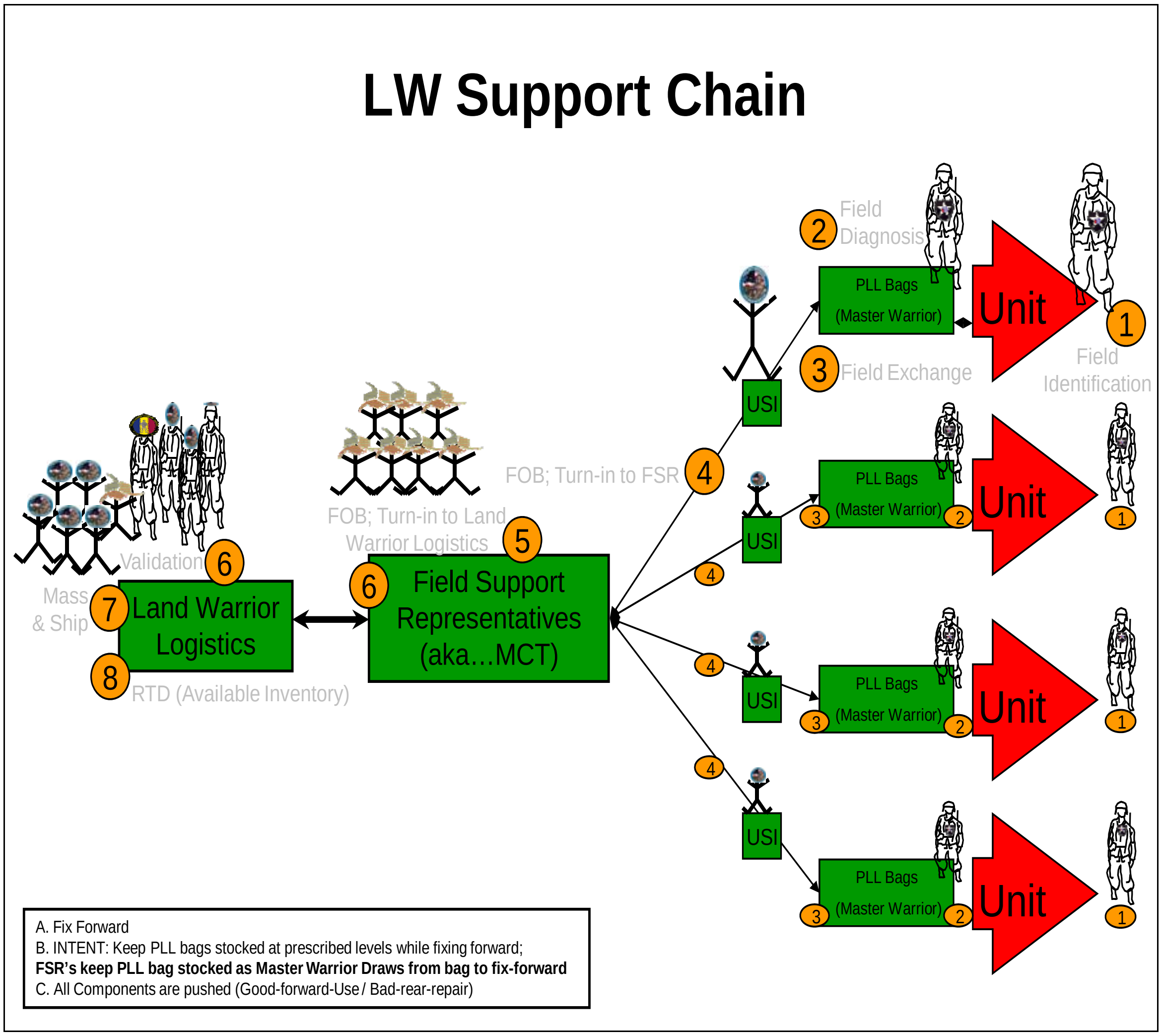

Figure 56. Land Warrior Support Chain
(Witherel, 2008)

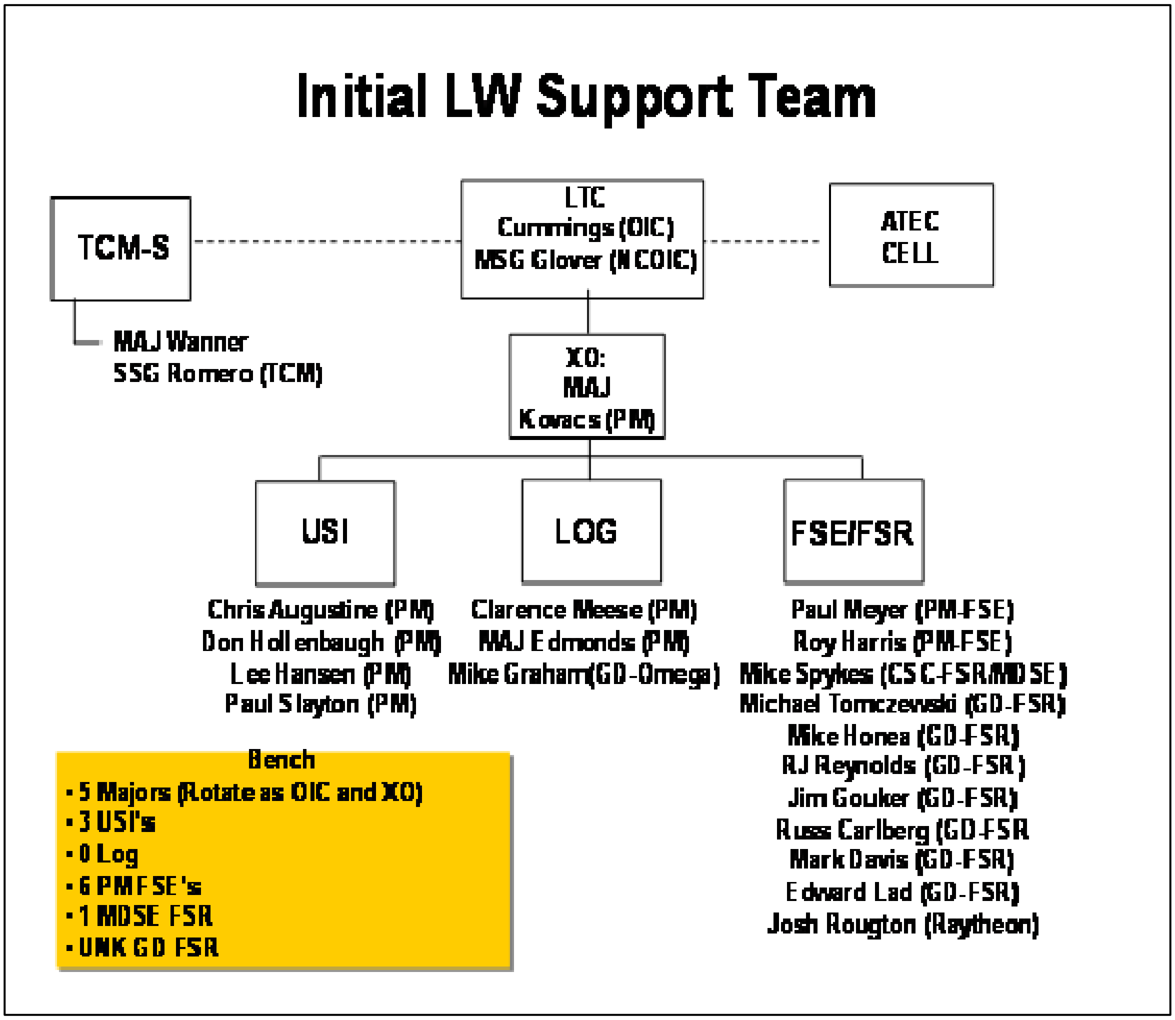

Figure 57. Land Warrior Support Team
(Witherel, 2008)

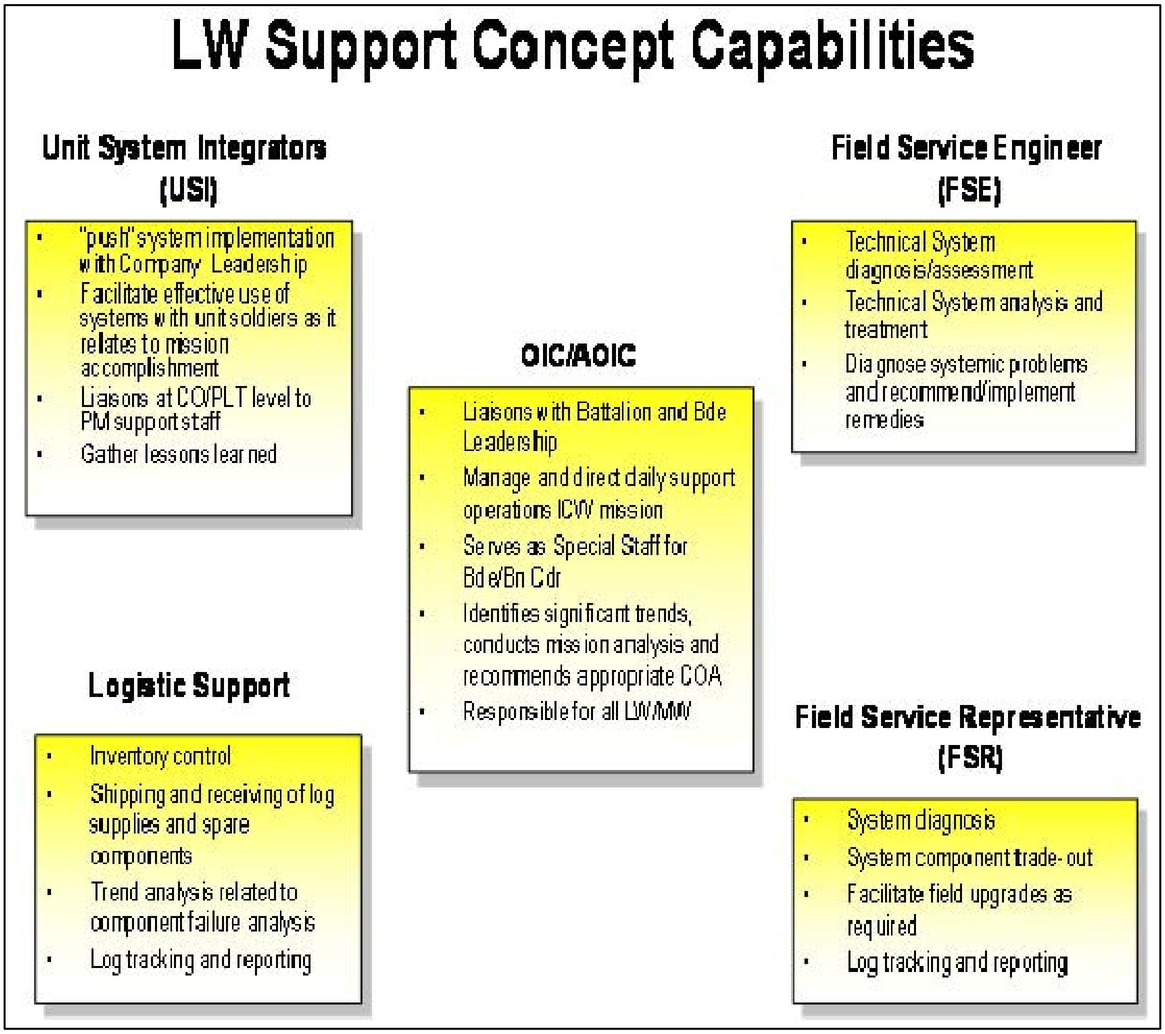

Figure 58. Land Warrior Support Concept Capabilities
(Witherel, 2008)

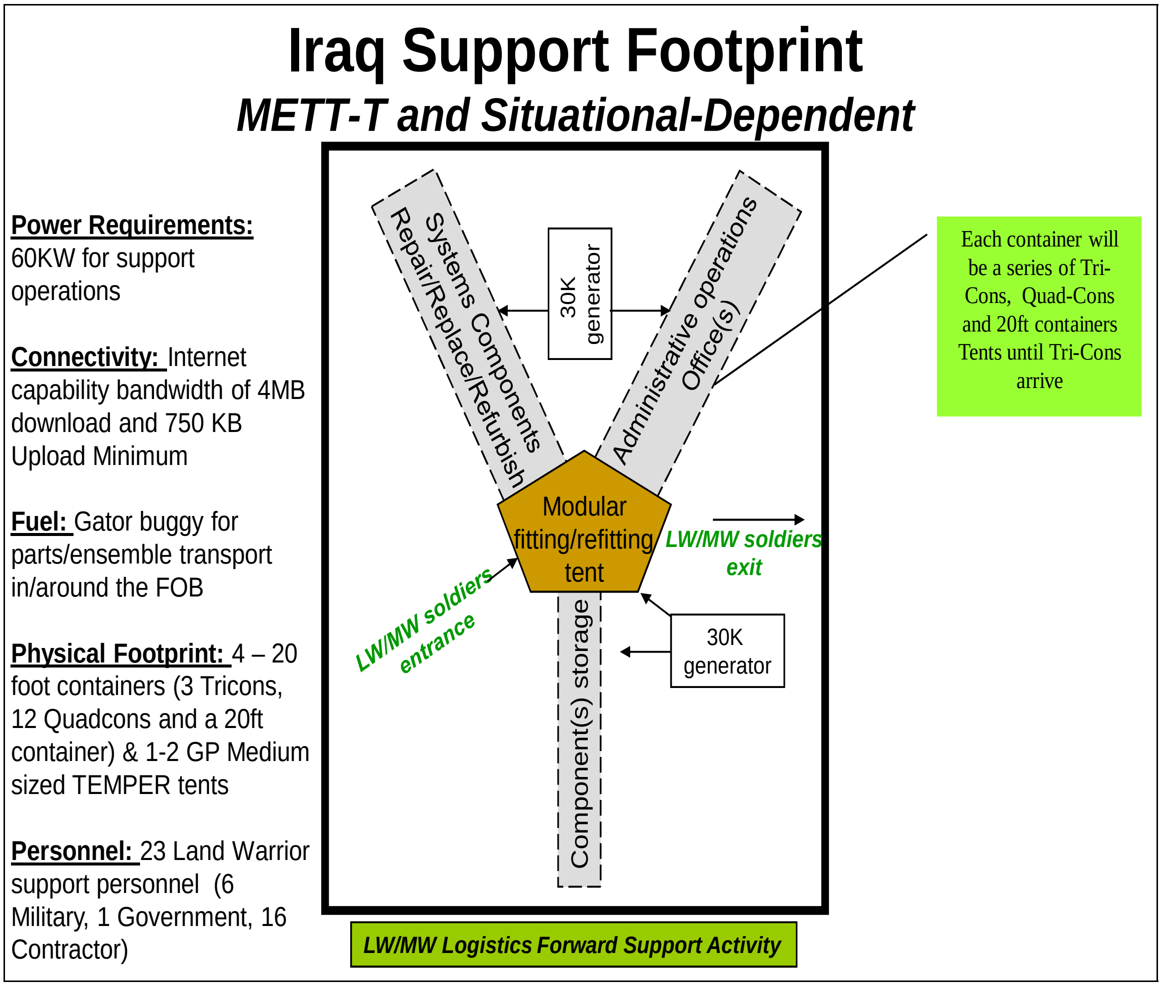

Figure 59. Land Warrior Deployment Support Footprint
(Witherel, 2008)

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Appendix M. TRADOC Capability Manger Organizational Chart

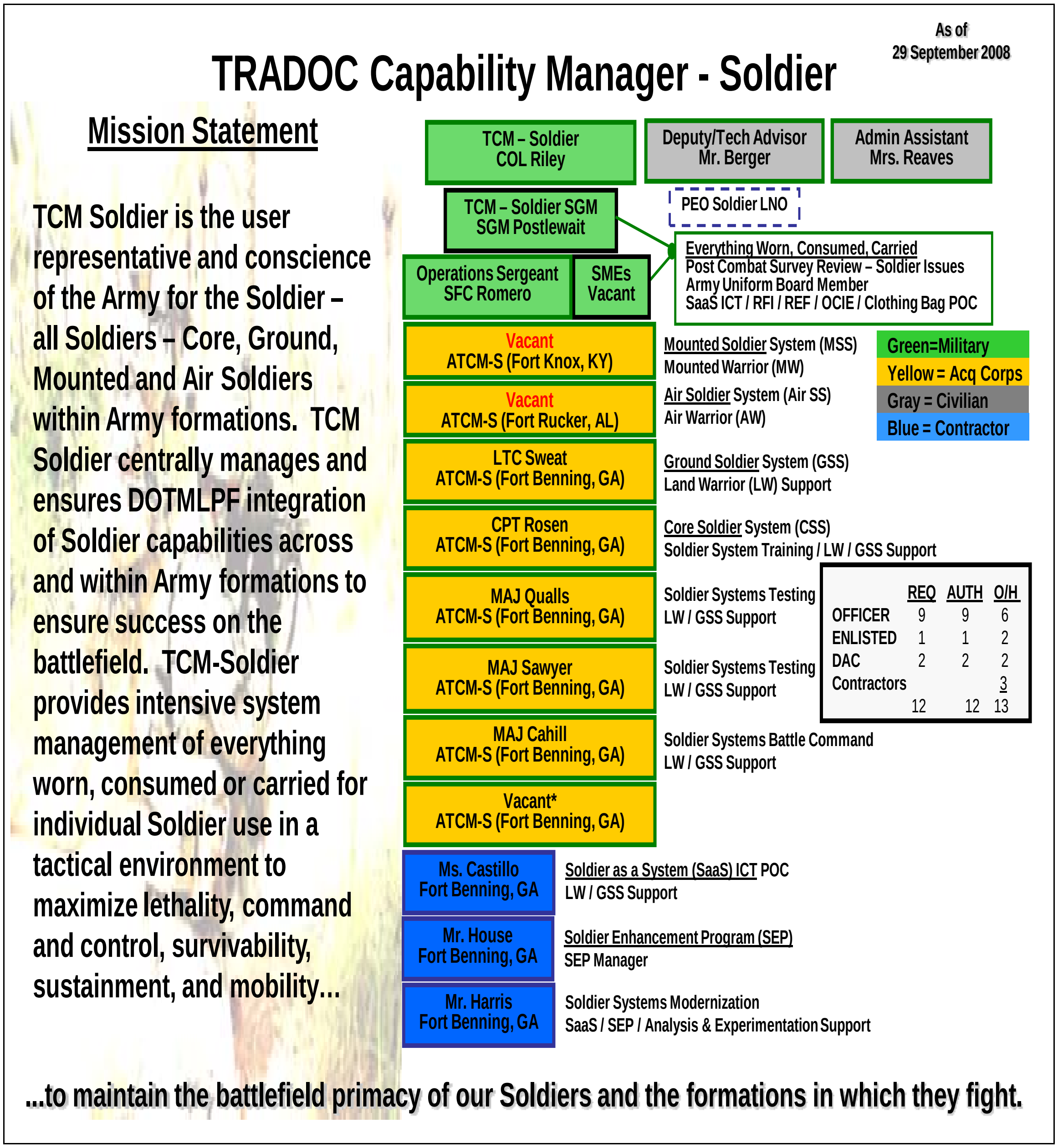

Figure 60. TRADOC Capability Manager Organizational Chart
(Berger, 2008)

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Appendix N. DOTMLPF Assessment and Limited User Test Results

The following is reprinted from “Stryker Unit Deploys with Land Warrior—Getting Dismounted Soldiers in the Future Network” and “Land Warrior DOTMLPF and LUT Results” by MAJ Doug Copeland (2007, May-June, *Infantry, 96*(3), 23-30).

TRADOC Capability Manager (TCM) Soldier conducted a full DOTMLPF (doctrine, organization, training, materiel, leadership, education, personnel, and facilities) assessment of the Land Warrior System with 4-9 Infantry at Fort Lewis, Washington, over the past 18 months. In conjunction with the TCM Soldier assessments, the Army Test and Evaluation Command conducted an independent limited user test (LUT) in September and October of 2006. Land Warrior proved to mitigate 13 of the 19 TRADOC Analysis Command (TRAC) White Sands Missile Range (WSMR) US Army Small Unit Capability Gaps. Land Warrior proved to provide increased capabilities to small units and their leaders. The most significant impacts were in the areas of lethality, battle command, voice communications, and situational awareness.

Lethality

Day and night vision enhancements are integrated through thermal imagery, image intensification, and daylight video. Land Warrior provides the capability to engage targets by viewing through the helmet-mounted display while exposing hands and arms only (reduced exposure firing technique). This integrated capability is not found on the battlefield today. This technique has proven to reduce Soldier exposure to hostile fire by up to 82 percent.

The Land Warrior-integrated Multi-Function Laser (MFL) also allows Soldiers to quickly determine the accurate location of targets as well as their own location and send accurate, digital calls for fire or target descriptions (e.g., sniper or improvised explosive device locations). Land Warrior was not used as a sole source for clearance of fires, but was another tool for the fires clearance authority to use to verify the situation and help alleviate fratricide.

Land Warrior provided increased small unit lethality through controlled, efficient maneuver combined with a greater ability to mass combat power (direct and indirect) at the proper point and time. Similar to the effect FBCB2 has on mounted warfare, Land Warrior provided added situational awareness to dismounted and mounted personnel. This is a current capability gap that FBCB2 does not fill for dismounted personnel. Mounted personnel have enhanced situational understanding of where dismounted Soldiers are located and how they are arrayed on the battlefield. Dismounted personnel have increased situational understanding of where other dismounted and mounted elements are located and how they are supporting their maneuver. Digital, real-time reporting creates a common, easily accessible medium for all to monitor enemy and friendly situational updates. This combination of information enhances situational awareness and fosters greater understanding for mounted and dismounted leaders, which enables efficient, coordinated maneuver to the decisive point.

The MFL provides the user with the ability to call for fire by using its integrated functionality of laze, auto fill, call for fire, or terrain association and verification on the helmet-mounted display using a host of maps and imagery (1:50,000, 1:25,000, satellite imagery, pictures, etc). This capability provides a bridge to controlling precision fires, another current capability gap for the small combat unit. Call-for-fire missions using the MFL have proven to provide more responsive and accurate fire missions. Clearance of fires procedures are reduced due to two factors: increased situational awareness and enhanced communications between initiator and clearance-level authority with the additional capability to interface with digital call-for-fire procedures. These additional procedures support the “see first, understand first, and act first” philosophy. The combination of these capabilities in a unit equipped with Land Warrior results in a more agile and responsive unit that leverages all enablers available to the force.

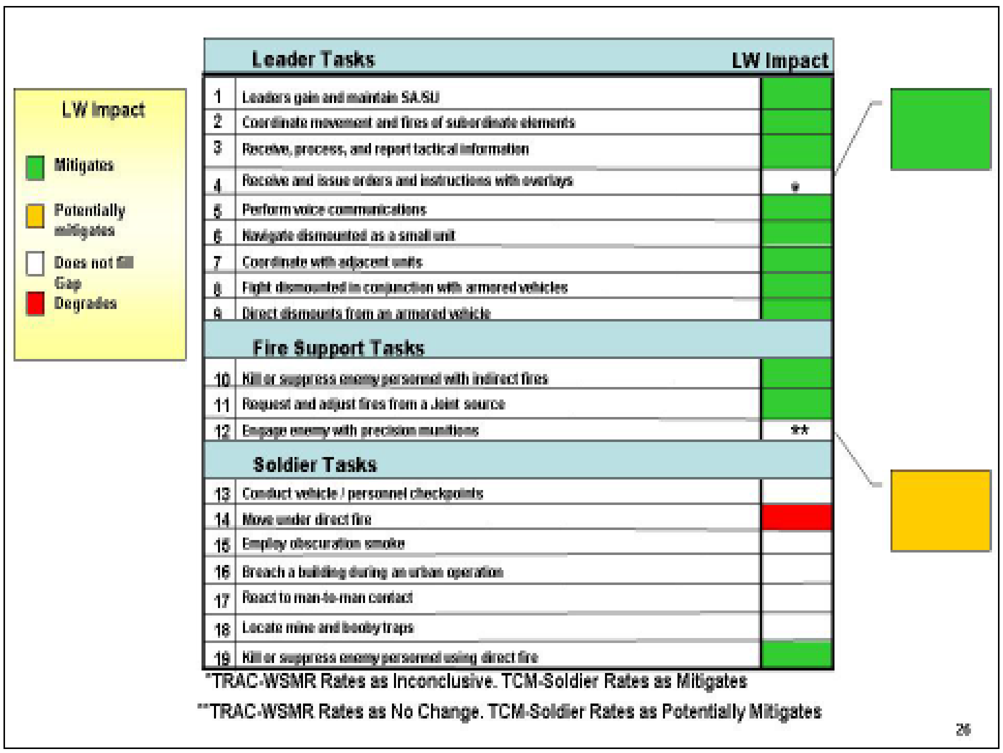

Figure 61. US Army Small Unit Capability Gaps
(Copeland, 2007)

Battle Command

Command and control is greatly enhanced by the ability to communicate orders to all elements simultaneously. Precise unit locations on the digital map that show the relationship of friendly and known hostile elements on the battlefield help reduce the fog of war created by voice-only situation reports. Situational awareness allows leaders to track the progress of subordinate elements as they maneuver, allowing them to make corrections or changes as necessary. Warning orders, fragmentary orders, and operations orders are digitally transmitted to higher, subordinate, attached, and supporting units and greatly reduce the time and error associated with an otherwise lengthy analog process. Land Warrior provides the user with a greater degree of situational awareness than ever before available.

Land Warrior situational awareness provides every Soldier the capability to view his position on the digital map and show his relationship to other friendly and known hostile elements on the battlefield. This enhanced SA capability also allows the leader to track the progress of subordinate elements as they maneuver allowing for on-the-move corrections as necessary. Situations that previously could take considerable time and effort to overcome are now streamlined to a common, accurate medium that facilitates informed individual and collective synergy. Real-time communications and employment of accurate supporting fires give forces the ability to maintain an unprecedented operational tempo.

Voice Communications

Land Warrior provides voice communications between mounted and dismounted leaders and Soldiers. Land Warrior-equipped users are able to monitor up to three nets simultaneously, a feature that currently only resides in mounted forces. Mounted Soldiers are able to monitor internal and external communications within their vehicle and have the additional capability to monitor Land Warrior communications through a gateway. The Land Warrior Vehicle Integration Kit creates this gateway and allows GPS tracking and normal radio communication between mounted and dismounted forces on the move. This eliminates the need for an intercom headset and the associated communication lapse prior to dismounting. The Land Warrior Soldier radio and noise-reducing headsets facilitate briefing all Soldiers prior to dismounting. Each Soldier’s ability to refer to his own helmet-mounted display and map products further enhances comprehension of the leader’s plan. Real-time, secure voice communications bolster efficient vertical and horizontal digital communications. The coupling of these two mediums allows users to report quickly, exchange critical information between mounted and dismounted forces and discuss the situation while looking at a real-time depiction of the operational environment (friendly and enemy). A more holistic individual and collective understanding allows collaboration. This results in faster maneuvering and accurate, coordinated supporting and organic fires with less risk of fratricide. This ability to collaborate creates momentum within an organization. Coordination can be made on a common waveform for pick-up, drop-off, supporting fires, maneuver, etc., without having to repeat orders or change frequencies. Fifty percent of mounted leaders reported an increased ability to coordinate with mounted squads before they dismount (35 percent report “about the same” and 15 percent report a decreased ability).

When mounted, leaders are generally limited to monitoring radio traffic through a dedicated headset because current squad radios are incapable of receiving or transmitting through armored vehicle hulls. Monitored radio traffic provides leaders with a general understanding of the larger scale tactical situation, but provides little information on their immediate surroundings upon dismounting. When available, FBCB2 displays provide additional detail and terrain products, allowing general analysis of the terrain near the dismount point. This allows the leader to identify enemy positions and plan a tentative route for his assault. Currently, mounted leaders prepare their units for dismount by providing a verbal briefing of the expected situation upon dismounting. This can be difficult in the loud, dark, and cramped confines of a moving armored vehicle, and Soldier comprehension of detailed briefings in this environment can be limited. Squad leaders receive a general description of the situation and a direction to move when they are ordered to dismount, but this can still be insufficient to overcome the disorientation that accompanies exiting an armored vehicle in unfamiliar terrain. Immediately prior to dismounting, the leader must also remove his vehicle intercom headset. This prevents communication between the leader and the remainder of the platoon (including the vehicle crew) until the leader is outside of the vehicle. This can be particularly dangerous when dismounting in contact, as the leader has no means to receive reports of changes in the enemy situation. During dismount, the squad leader must rapidly assess his surroundings, identify terrain references for orientation, and find a covered position for his unit. He must accomplish all of these tasks before he can begin any offensive action. In a Land Warrior-equipped unit, this can all be accomplished before dismount.

Digital Communications

Land Warrior connects the dismounted leader and Soldier to the digital battlefield. Users send and receive digital messages (SALUTE reports, situational reports [SITREPs], unit position reports, known and suspected enemy positions, calls for fire, medical evacuations [MEDEVAC]), which are fully interoperable with FBCB2 and the entire suite of the ABCS. Digital graphics that are created, shared and leveraged are extremely beneficial. A picture is worth a thousand words to users and can be shared instantly to all members of a unit without having to print and distribute manually. Using mission data support equipment, units can distribute black, grey and white list pictures to checkpoints and patrols in a digital package that can be quickly referenced. In addition, Soldiers and leaders can send messages in a free text or preformatted message format. These messages streamline otherwise busy verbal radio communications. While inputting free text messages can be a lengthy process, they are effective. Radio silence can be maintained and purely digital messages can take their place. Creating pre-formatted digital messages prior to a mission has proven to speed up the process of reporting during movement. Phase lines, rally points, operational schedules and call-for-fire messages that are preformatted prior to crossing the line of departure can be sent much like an instant message on e-mail. This method accelerates operational tempo during mission execution. Land Warrior-equipped units have proven that when voice communications fail, digital communications are still possible. In one instance, an entire brigade's voice communications were inoperable, and a Land Warrior-equipped battalion was able to take control of the fight using their Land Warrior systems. Lastly, users can send an automated call for medic digital message, depicting their exact location on the battlefield. Medics equipped with Land Warrior can maneuver directly to the location of the injured Soldier. This streamlines the process if the Soldier is incapacitated and in a hard-to-find location.

Situational Awareness

Soldiers and leaders can view the current location of all Land Warrior-equipped personnel in the helmet-mounted display. The display allows the user to view a digital map, imagery, position location information, as well as view sight picture in thermal and daylight modes. The Soldier or leader views his common operating picture on a screen that replicates a 17-inch monitor. The helmet-mounted display allows the user to view information while maintaining light discipline during hours of limited visibility. He can move the display out of the way when he doesn't want to view it and rotate it in front of his eye when he needs to check his position or his unit's friendly and/or enemy situation. The user checks his situation in a similar manner to conducting a map check; however, unlike using a protractor and map, he can get digital updates while on the move. Real-time position location information provides improved, accurate and efficient knowledge of locations of all mounted and dismounted personnel. The shared common picture of geo-referenced maps and images enhances battle tracking, streamlines reporting and drives efficient application of combat power. Small units have greater maneuverability and can cover greater distances due to shared, accurate position location information. Accurate situational awareness allows all users to efficiently control fire and maneuver with increased dispersion. Shared, accurate fire control, position location information and real-time enemy situation updates facilitate efficient battlespace management. Users better understand and execute plans and orders because of collaborative understanding of the total picture. Leaders can mass and prioritize fires with less risk of fratricide while retaining the flexibility of better informed maneuver. Land Warrior's automatic execution of these reports enables more consistent reporting. Based on questionnaire data collected from the Land Warrior experimental unit, 60 percent of leaders reported a "better" or "much better" ability to monitor the activity of their own unit, and 63 percent reported "better" or "much better" ability to monitor the activity of adjacent units when using Land Warrior. Land Warrior is continuously updated and its use as a common reference mitigates the effects of adverse conditions or geographic dispersion on the unit's situational awareness. Sixty-six percent of leaders and 48 percent of non-leaders surveyed reported a "better" or "much better" understanding of other unit members' position. In addition, 38 percent of leaders and 26 percent of non-leaders reported that Land Warrior provided a "better" or "much better" ability to avoid situations of fratricide. The greater perceived benefit reported by leaders is likely due to their greater awareness of this issue and their application of greater significance to it.

Digital Mapping and Topographic Capability

Land Warrior-equipped Soldiers and leaders fight using recent, relevant imagery, rather than outdated maps, rough sketches, piles of acetate and/or memorization. Users can choose the map, map scale and imagery to use in current operations and have the ability to store these products for reference in the future. Land Warrior-equipped leaders can manipulate digital maps during the conduct of an operation to facilitate FRAGOs and/or follow-on OPORDs while on the move. Common graphic formats such as Falcon View, geo-referenced satellite images, Microsoft Office products, pictures and FBCB2 overlays can be loaded through the Land Warrior mission data support equipment. Land Warrior-equipped mounted personnel are also able to view all of these products.

Survivability

Land Warrior aids overall unit survivability. When leveraged by a unit, Land Warrior functionalities increase speed and accuracy of collective maneuver and allow greater tactical dispersion during a variety of dismounted and mounted missions. Land Warrior equipped squads demonstrate enhanced movement and more accurate navigation as compared to Rapid Fielding Initiative equipped units. Opposition forces and subject matter experts' observations concluded that the Land Warrior-equipped unit was less detectable than a standard modified table of organization and equipment (MTOE) unit. These same observers concluded that the observed unit could do extremely difficult, dispersed missions during hours of limited visibility and in difficult terrain with unprecedented success, while other observed non-equipped units took hours longer to conduct the same missions. The combination of these effects increases unit survivability because the unit can get the job done faster with total unit understanding and reduced tactical confusion. This constitutes a decrease in massed unit exposure to enemy direct and indirect fires during deliberate offensive operations. Land Warrior-equipped personnel survivability is enhanced by increased situational awareness, call-for medic function, reduced exposure fire and observation capabilities.

Land Warrior allows for better situational awareness through the common operating picture displayed in the helmet-mounted display. The COP shows mounted and dismounted friendly locations, known and suspected enemy forces and known and suspected friendly and enemy obstacles and hazards. In addition, the ability to manipulate situation reports and geo-referenced graphics, pictures and overlays allows for real time situational understanding on current visual products. Land Warrior-equipped personnel can avoid potential hazards, such as known or suspected IEDs. Known or suspected enemy locations can be taken into consideration during planning and execution. Updates to the situation are reported digitally and are not relayed by grid and plotted on the map using a protractor. Land Warrior-equipped personnel conducting operations over large areas do not have to carry around large sets of maps. Land Warrior-equipped leaders do not have to copy several sets of graphics that may or may not lose accuracy in translation that in the past has contributed to confusion and in some cases fratricide. Multiple maps, overlays and paper documents can fall into the hands of the enemy and may be used against friendly forces. This creates a substantial operational security issue for our forces. Instead, Land Warrior data is stored digitally in the Soldier's computer subsystem. Operational security is enhanced because Land Warrior-equipped personnel can purge their data if they feel imminent compromise. In addition, Land Warrior systems can be remotely purged by others. All equipped users have instant access to all materials that are relevant (because of messaging filters), accurate (real time) and tailorable (leaders can distill higher-level graphics and make their part of the plan without loss of accuracy of the overarching order). The synergistic effect of having these materials has the potential to decrease fratricide and increase survivability and overall force effectiveness.

Land Warrior-equipped Soldiers also have the ability to remotely call for medical assistance using a digital message. This message can either be sent by pressing the call-for-medic button on the Soldier Control Unit or by text message. If a Soldier is wounded, he can press his call-for-medic button and send an instantaneous report to his leadership and medical personnel. If his buddy is incapacitated, he can send a preformatted call for medic. This streamlines the casualty evacuation process which takes up precious time and radio messages over the command net. A Soldier that is wounded and unable to move can be located more quickly on the battlefield by the aid and litter teams, medics or the platoon sergeant since the wounded's position is instantly available to all on the common operating picture. These support personnel are better informed as to the situation around the casualty thereby setting the conditions for safe extraction.

Land Warrior-equipped Soldiers in covered and concealed positions utilizing the Daylight Video Sight (with image displayed in the helmet-mounted display) for observation have a considerable reduction (40-80 percent) in individual vulnerability or exposure to direct fire survivability. The Daylight Video Sight can magnify 1.5x, 6x, and 12x. This capability has shown utility when scanning for snipers, obstacles, improvised explosive devices and other battlefield hazards by both infantrymen as well as sniper teams. Land Warrior-equipped personnel can conduct detailed reconnaissance of the surrounding terrain using the reduced exposure observation capability only exposing their hands and a portion of their arms. Soldiers using their naked eyes or binoculars in the current fight must expose their heads, upper torso, hands and arms to the enemy. While reduced exposure observation improves

Soldier survivability during stationary reconnaissance, he is still subject to detection due to the additional time required to scan a comparable area. This is due to the limited Daylight Video Sight field of view (1x, 18.91 degrees horizontal; 6x, 4.69 degrees horizontal; 12x, 2.4 degrees horizontal). This could increase scanning times and the enemy's chances of visually detecting the Soldier. Land Warrior also offers improved survivability while conducting reconnaissance before beginning individual movement under direct fire, but, again this advantage may be partially negated by a possible increase in likelihood of detection by the enemy.

Figure 62. Views with and without Land Warrior
(Copeland, 2007)

Mobility

Mobility, as relayed by a 4-9 IN company first sergeant, is the balance between added capability to the Soldier/Unit and added weight to the Soldier/Unit. The Land Warrior Capabilities Production Document threshold for Soldier fighting load is 77 pounds. Recent additions to Soldier-worn body armor have increased the Soldier fighting load to 80.8 pounds. The total Manchu configuration ensemble fighting load is 96.6 pounds, 19.6 pounds over the threshold. The currently configured Land Warrior system has reduced weight from 34 pounds (FY 1998) to 15.8 pounds (FY 2007). A future weight reduction of 3 pounds is planned for FY 2008. This would equate to a total reduction in weight of 150 percent. At the same time, Individual Body Armor (IBA) has gone from 12.5 to 33.2 pounds — a 145-percent increase. The Land Warrior system offsets current Soldier equipment. The 15.8 pounds of added Land Warrior equipment offsets the need to carry a GPS, binoculars, separate aiming light (PAQ 2 or PEQ 4) and almost half of 22 separate batteries. The functionalities of Land Warrior replace the need to carry these items. This integration of functionalities renders a net gain of 9.3 pounds of equipment for the Soldier. Soldiers and leaders all agree the 15.8 pounds of Land Warrior equipment increases weight and degrades mobility. They also agree that 31 pounds of body armor increases weight and is restrictive when it comes to mobility.

The Soldiers load issue is an Army issue and not just a Land Warrior issue. Modularity changes to the Land Warrior ensemble have shown improvements in weight reduction, distribution and an overall increase to Soldier acceptance. Initial findings indicated Soldiers associated Individual Body Armor and Land Warrior weight as one. The unit was fielded both at the same time therefore no differentiation was made between the two. As Soldiers became more accustomed to the Land Warrior ensemble and more reliant upon its added capabilities, the added weight became tolerable. During the land navigation experiment, Land Warrior-equipped units maneuvered more rapidly and accurately than units without Land Warrior. It should be noted that every other Soldier system has increased Soldiers' load in a modular fashion with little regard to integration. Land Warrior has provided an integrated Soldier system that has decreased in weight and volume over time. See weight comparatives chart above.

As stated, the Land Warrior system replaces approximately 8 pounds of current equipment, generating a net gain of 9 pounds. This represents a 14-percent increase in equipment weight compared to the average RFI-equipped Soldier's fighting load. This is an increase when one considers that it equates to degradation in Soldier agility of 10-15 percent and a 20-percent increase in energy required for movement. Sixty-two percent of Soldiers surveyed reported that Land Warrior made their ability to move tactically under direct fire "worse" or "much worse." Land Warrior will affect the individual Soldier's ability to move under direct fire under some circumstances. The increase in the weight of Land Warrior-equipped Soldiers' basic fighting load will have the most significant consequences. While Soldier conditioning will compensate for this weight increase during limited-duration missions, current operations have shown that Soldiers' mobility will suffer greatly when their fighting load is excessive. Soldiers engaging in extended operations are likely to find the increased weight of Land Warrior to be an encumbrance.

Weight Comparatives	2002	2004	2006	2008
Land Warrior	26.12 lbs	16.62 lbs	15.83 lbs	*12.83 lbs
IBA	9 lbs	25.70 lbs	31.00 lbs	TBD

* Subject to General Dynamic Fusion efforts: CSC, NAV Box, HIA and SCU in one LRU.

Figure 63. LW Weight Comparatives
(Copeland, 2007)

During the equipping and conduct of the DOTMLPF assessment, dismounted Soldiers fighting within task organized infantry companies, selected battalion command and staff personnel, and selected Soldiers in direct support of maneuver elements employed Land Warrior systems. Upon completion of the DOTMLPF assessment (September 06) and following subsequent program decisions, 4-9 Infantry asked to take the system with them to combat. The unit is currently conducting offensive, defensive, and stability and support missions across the full spectrum of military operations in theater now. Some of 4-9 Infantry's key likes and dislikes of the system:

Likes

- Friendly, enemy and environment SA when dismounted;
- Multi-functional Laser (MFL);
- Graphics on the move; and
- Stryker integration to the dismounted Soldier

Dislikes

- Daylight Video Sight (DVS) as a weapon sight;
- Cables; and
- Space requirement on IBA

Fundamental principles of doctrine form the basis upon which Army forces guide their actions in support of national objectives. Throughout past analysis events and the Land Warrior DOTMLPF assessments there have been no indication that the capabilities provided by these systems will have any impact on these principles. The observations and analysis conducted during the Land Warrior DOTMLPF assessment indicate that there will be little or no impact on the basic way the Army conducts its missions. These systems' capabilities have the greatest doctrinal impact in the areas of techniques and procedures. Doctrinal impacts to terms and symbols are minimal. Two symbols were added to depict areas of interest and Soldier locations. These symbols are recognized by FBCB2 and are subject to further development by units as they incorporate them into their own standard operating procedures. All other Land Warrior symbols are doctrinally accurate and all Land Warrior messages are in compliance with Joint Variable Format Message standards and architecture.

Land Warrior Soldier systems have evolved over time and are continuing to evolve based on the current fight and current technology. These systems are not revolutionary, but evolutionary in their approach to answering evolving Soldier capability gaps based upon an asymmetrical and fluid threat. How the Army intends to conduct operations in the future, and the capabilities required to execute those operations, may determine the need for further doctrinal review, design, and/or development. Draft recommendations for techniques and procedures have been developed, but require validation through their use in an operational environment. To accomplish this, TRADOC Capabilities Manager-Soldier is conducting further assessment during combat operations in Iraq with 4-9 IN. This portion of the assessment will determine Land Warrior's impact to small units in combat, with a particular focus on fightability, lethality, survivability, battle command and situational awareness from squad to company-level operations. All unit leaders (from team leaders through battalion commander) are equipped with Land Warrior. TCM Soldier teamed with the Computer Science & Information Assurance Department of the Samuel Ginn College of Engineering at Auburn University to create a dynamic, "change-on-the-fly" database for this operation. This database is a compilation effort from input received from TCM Soldier, the US Army Infantry Center Directorate of Combat Developments, TRAC WSMR, TRAC-Monterey, Army Research Institute (ARI), Program Manager Soldier Warrior and Product Manager Land Warrior. This information will provide valuable DOTMLPF insights regarding dismounted Soldier requirements, will inform future Army procurement decisions, as well as inform the Ground Soldier System and FCS.

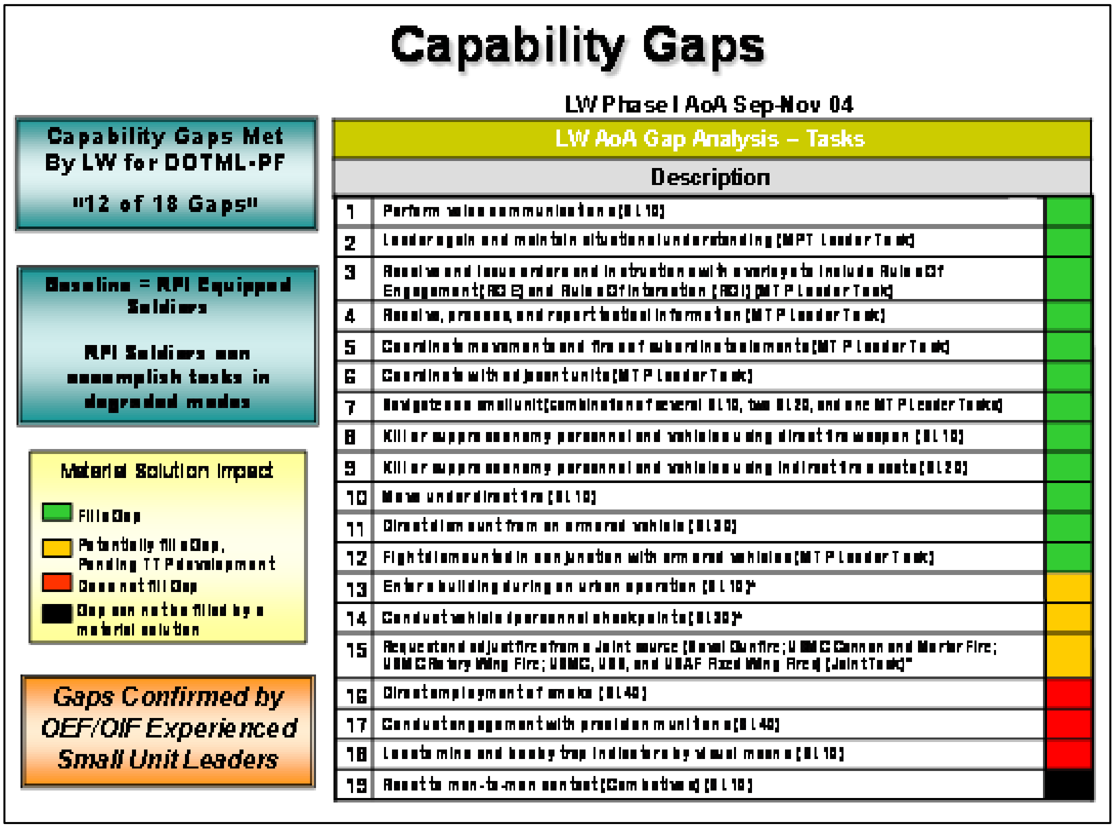

Figure 64. Land Warrior AoA Capability Gaps
(Copeland, 2007)

DOTMLPF Assessment
Mission / Purpose

Mission

- Team Soldier Equips One Battalion of 2ID (4th SBCT) At Ft. Lewis, WA In 3rd and 4th Q/FY06 To Conduct A Land Warrior (LW) / Mounted Warrior (MW) Stryker Battalion DOTMLPF And TTP Assessment

Purpose

- Evaluate Doctrine, Organizations, Training, Materiel, Leadership And Education, Personnel, And Facilities (DOTMLPF) And Tactics, Techniques, and Procedures (TTP) Considerations In An SBCT Equipped Land Warrior (LW) / Mounted Warrior (MW) Stryker Battalion.
- Inform the Milestone Decision Authority (MDA) on Basis of Issue (BOI) for a LW MS C decision.
- Inform the MDA on Ground Soldier (GSS) and Mounted Soldier Systems (MSS) on MS B decision issues.

Figure 65. DOTMLPF Assessment Mission
(Copeland, 2007)

DOTMLPF Objectives

- Identify and/or demonstrate new operational techniques, doctrine, tactics, and support concepts that enhance combat effectiveness or reduce vulnerabilities.
- Identify requirements for individual, leader, institutional, and unit training. Also identify new training strategies, training facility requirements, and training device requirements.
- Validate the LW and MW modularity concepts.
- Identify operational and support hazards through observation.
- Validate human factors analysis of operational tasks by observation.
- Identify additional operational tasks that arise from new operational techniques.
- Determine force effectiveness implications of fielding LW and MW.
- Determine logistics impacts of fielding LW and MW.
- Provide data to improve life cycle cost estimates for LW and MW.
- Determine Gaps mitigated or eliminated in TTP of unit.
- Determine how LW and MW impact on small unit capability gaps.

Figure 66. DOTMLPF Objectives
(Copeland, 2007)

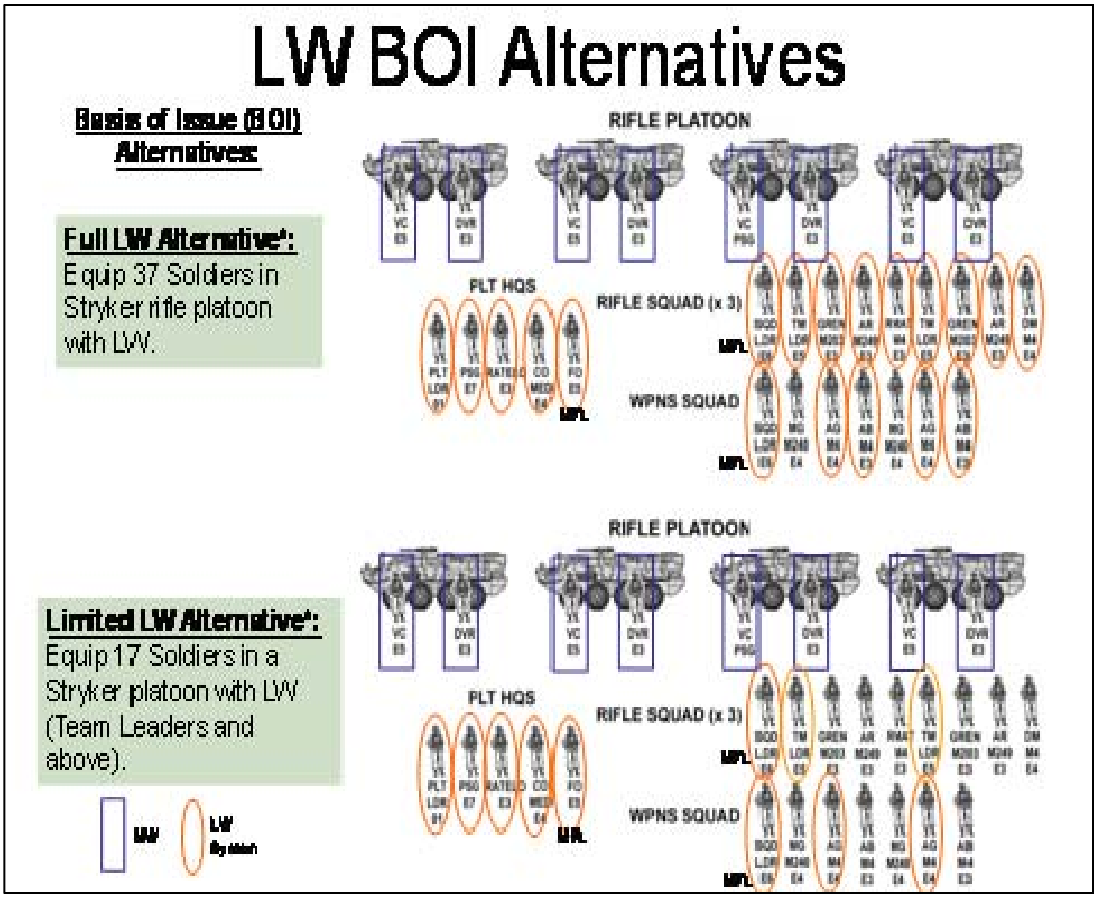

Figure 67. Land Warrior Basis of Issue Alternatives
(Copeland, 2007)

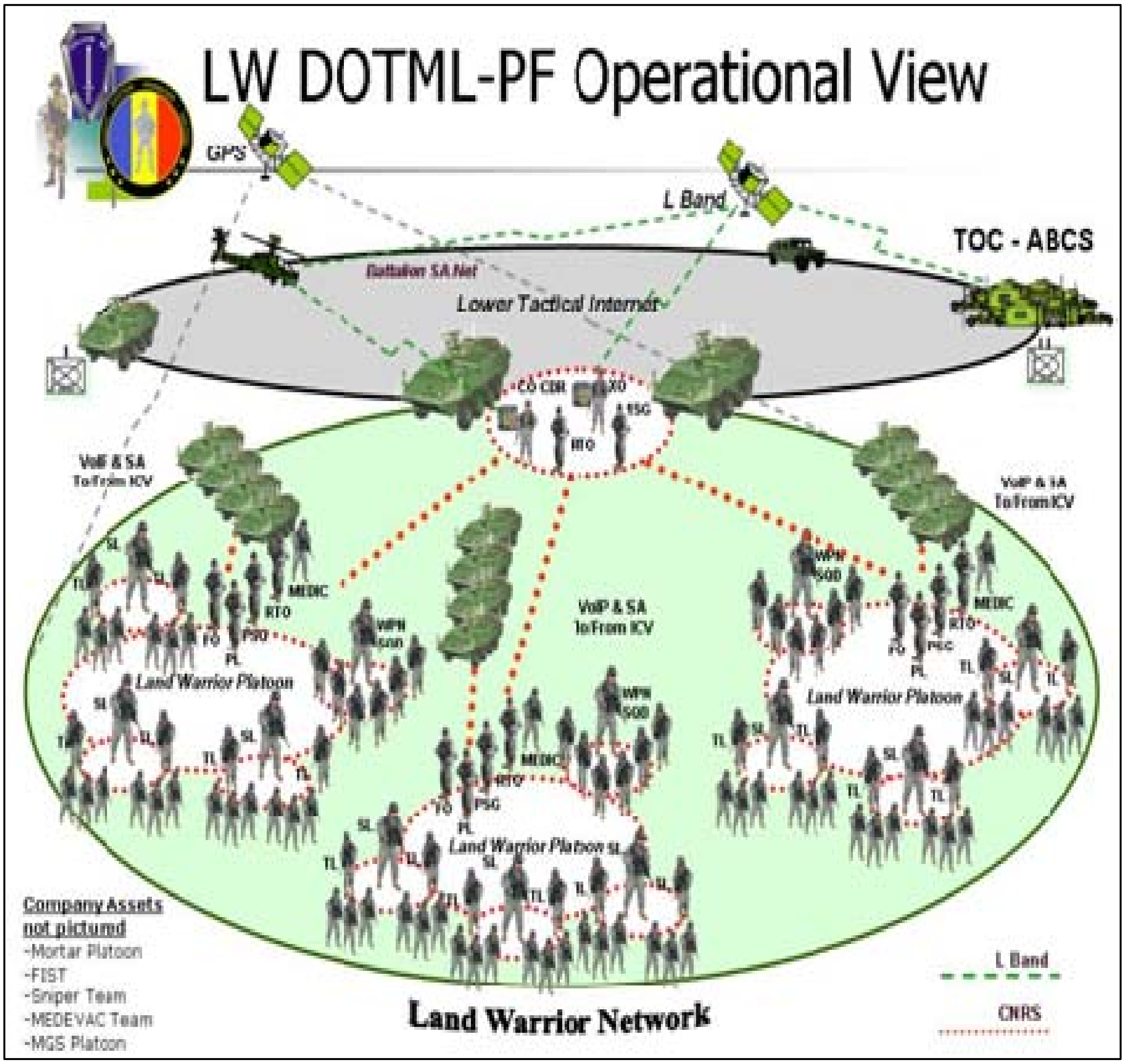

Figure 68. Land Warrior DOTMLPF Operational View
(Copeland, 2007)

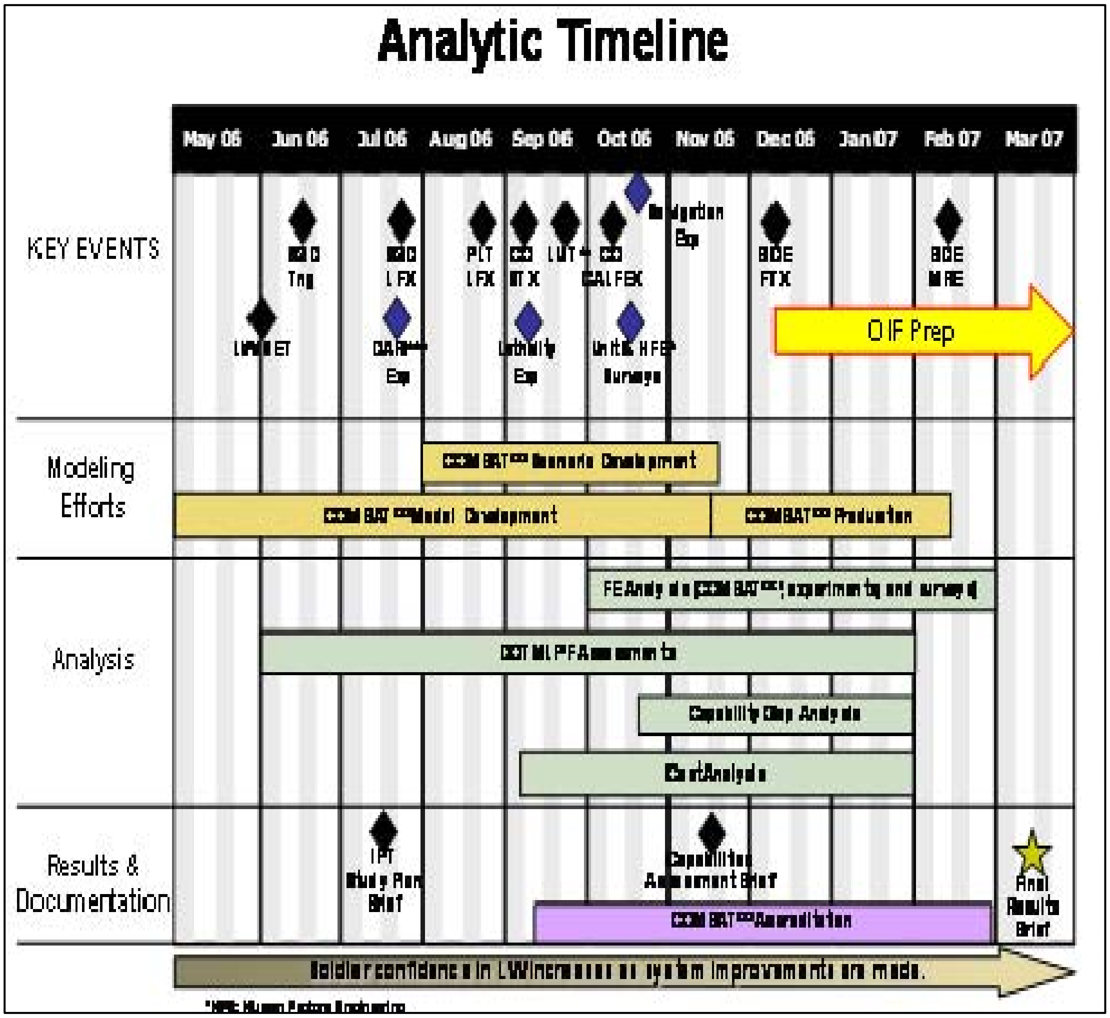

Figure 69. Land Warrior Analytic Timeline
(Copeland, 2007)

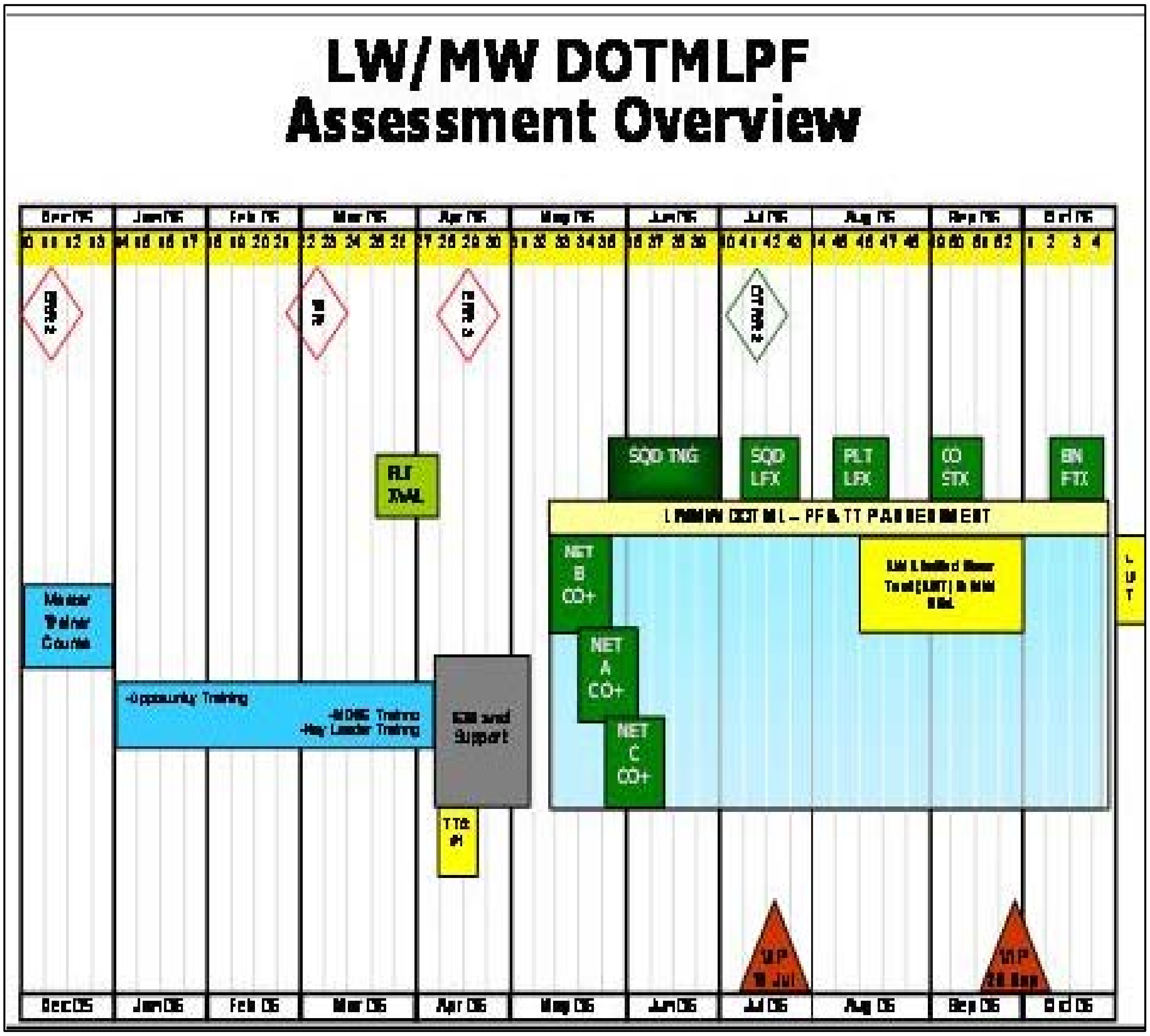

Figure 70. Land Warrior DOTMLPF Assessment Overview
(Copeland, 2007)

DOTMLPF Assessment Summary

	Agency	Data Source	Key Findings
Doctrine	TCM-S	Literature search, surveys, training observation, Professional Military Judgment (PMJ).	• LW and MW ***will require changes*** to small unit ***techniques and procedures***. • Benefit of emerging techniques demonstrated in M&S platoon deliberate attack. • TCM-S will continue to evaluate/document impact during unit deployment to OIF.
Organization	USAIS OIP	Survey results and PMJ	• Under current LW/MW Contractor Logistics Support (CLS) concept, no organizational changes are required. • Will monitor and respond to lessons learned from unit deployment.
Training and Leader Development	ARI	NET Assessment findings and Subject Matter Expert (SME) input.	• LW NET as executed was not sufficient. NET did not leave the unit with the capability to conduct sustainment training. • Recommend ***expanding training time*** to four weeks, combining MW and LW NET, and development of separate leader and Soldier tracks with culminating collective training event.
Materiel and Logistics	PM SWAR & TRAC-Lee	Capabilities Production Document req., Logistics Impact Assessment and SME input.	• LW System ***demonstrated a high system reliability*** (despite negative Soldier perception possibly related to NET sufficiency and over-reliance on CLS). • Contractor Logistic Support concept minimizes unit maintenance and support requirements.
Personnel	USAIS OIP	Survey results and PMJ.	• No requirement for new ASIs or SQIs. • Recommend assigning Project Development Skill Identifier for LW trained Soldiers.
Facilities	PM SWAR	Survey results, daily user comments, observations, and SME assessment.	• A maximum of ***9 containers per Bn for Full LW*** and ***4 containers per Bn for Limited LW*** are required. • Mobile storage container concept proved viable for the Test Unit (one container is 40' x 9'). • Containers are easily portable and securable.

Figure 71. Land Warrior DOTMLPF Assessment Study
(Copeland, 2007)

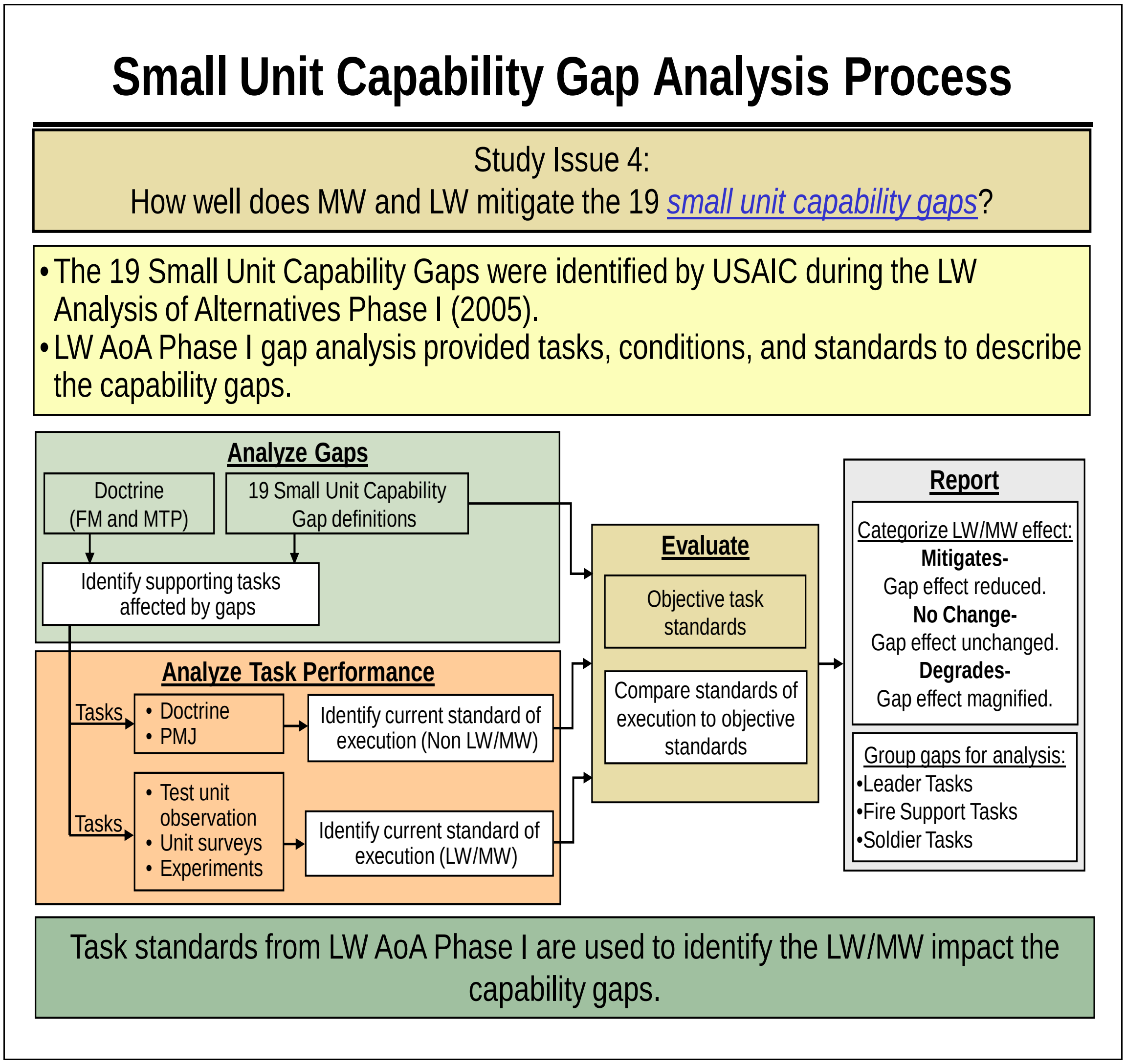

Figure 72. Small Unit Capability Gap Analysis Process
(Copeland, 2007)

Small Unit Capability Gap Summary

- 11 of the 19 small unit capability gaps may be mitigated by the current LW system (10 of the mitigated gaps are leader tasks).
- Leader tasks are most improved by LW Friendly and Threat tracking, digital messaging, and navigation.
- The increased weight of LW reduces Soldiers' ability to move under direct fire.
- Gaps categorized as 'No Change' may require new materiel solutions.

The majority of the 11 capability gaps mitigated by LW/MW capabilities are *leader* tasks.

Small Unit Capability Gaps	LW Effect
Leader Tasks	
Leaders gain and maintain SA/SU	Mitigates
Coordinate movement and fires of subordinates	Mitigates
Receive, process, and report tactical information	Mitigates
Receive / issue orders and w/ overlays	Inconclusive
Perform voice communications	Mitigates
Navigate dismounted as a small unit	Mitigates
Coordinate with adjacent units	Mitigates
Fight dismounted ICW armored vehicles	Mitigates
Direct dismounts from an armored vehicle	Mitigates
Fire Support Tasks	
Kill or suppress enemy with indirect fires	Mitigates
Request and adjust fires from a joint source	Mitigates
Engage enemy with precision guided munitions	No Change
Soldier Tasks	
Conduct personnel and vehicle checkpoints	No Change
Move under direct fire	Degrades
Employ obscuration smoke	No Change
Breach a building during an urban operation	No Change
React to man-to-man contact	No Change
Locate mines and booby traps	No Change
Kill enemy using direct fire	Mitigates

Figure 73. Small Unit Capability Gap Summary
(Copeland, 2007)

Findings

- Both the Full and Limited BOI alternatives accomplished the mission with greater tempo and increased lethality.
- The impact of LW and MW on the DOTMLPF domains remains proportional to the number of systems procured, most notably in:
  - Facilities, space required for the mobile storage containers.
  - Training, resources required for NET.
- The both LW BOI alternative mitigate 11 of the 19 capability gaps.

Appropriation Cost Summary

FY07 M$ Constant	Full LW	Limited LW
RDTE	$74	$74
OPA	$781	$517
MCA	$0	$0
OMA	$431	$288
MPA	$8	$8
TOTAL*	$1,293	$886
# of Systems:	10,654	5117

Figure 74. Land Warrior DOTMLPF/ BOI Findings
(Copeland, 2007)

In-country DOTMLPF Results

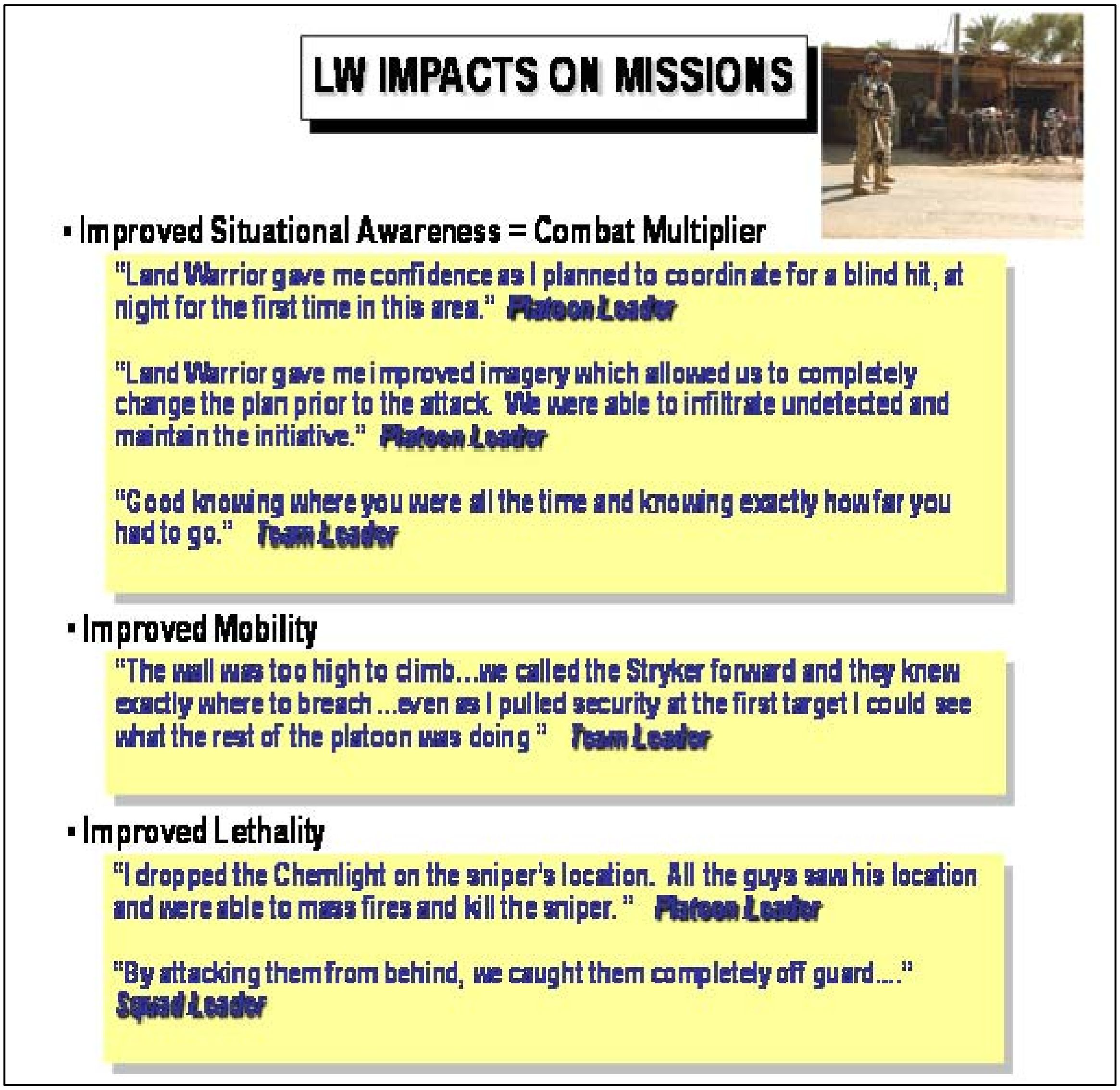

Figure 75. Land Warrior Impacts on Operations Missions
(Qualls, 2008)

Land Warrior Basis Of Issue

Month / Year / Event	Capability / Findings / Decision
MAR 05: Land Warrior (LW) / Rapid Fielding Initiative (RFI) Side-by-Side	Findings: All 9 squad members felt that only Soldiers in leadership positions **TEAM LEADER UP TO PLATOON LEADER** should have LW
JUN 05: Land Warrior Analysis of Alternatives	Findings: Soldier and Leaders indicated that the preferred LW BOI is to **TEAM LEADER AND ABOVE…HOWEVER, AT A MINIMUM A VOICE RADIO SHOULD BE PROVIDED TO EVERY SOLDIER**
MAY 06: LW DOTMLPF Assessment	New Equipment Training (NET) to 4/9 INF focused on equipping **ALL SOLDIERS AT BN LEVEL**
JUL 06: Land Warrior (LW) CPD	LW will be deployed within task organized Infantry Companies, selected Battalion Command and Staff personnel, and selected Soldiers in direct support of maneuver elements – **ALL SOLDIERS IN A RIFLE SQUAD**
SEP 06: LW Limited User Test (LUT)	B Co, 4/9 INF is equipped at **TEAM LEADER AND ABOVE** for conduct of the LUT
SEP 06: LW DOTMLPF VIP Day	BN CDR, 4/9 INF states "We want to take LW with us to War"; changing BN BOI to **TEAM LEADER AND UP; RF BEACON AND LW COMPATIBLE RADIO NEEDED AT SOLDIER LEVEL**
APR 07: LW DOTMLPF Assessment Report	Findings: Soldiers and Leaders indicate that the preferred LW BOI is to **TEAM LEADERS AND ABOVE…HOWEVER, AT A MINIMUM A VOICE RADIO SHOULD PROVIDED TO EVERY SOLDIER**
APR 07 – Present: Combat Operations	4/9 INF has been conducting combat operations in Iraq – **BOI REMAINS TEAM LEADER AND UP**, and selected others (BDE PSD, 2-1 CAV) and potentially 1/38 INF
18 NOV 07: BOI Survey – PL / PSG to SQD LDR / TM LDR (In Country Survey)	**88% of those surveyed recommended - TEAM LEADER AND UP** **12% of those surveyed recommended – ALL SOLDIERS**
JAN 08: Land Warrior Impacts to Task Force Operations Survey Results (In Country Survey)	- Need **"BEACONS"** or a way for leaders to see their subordinates who do not carry LW - Units not having **CNRS RADIO** hampers SA for BN level operations and also neighboring units in the BN to see and know placement of friendly forces - Organizations or attachments outside the TF need to be able to observe blue feed from the **LW SYSTEMS** – e.g., logistical units transitioning through the battle space… - If attachments had **LW** they would be better integrated into the unit fight

Bottom Line:

- **Preferred LW BOI – TEAM LEADER AND UP (Demonstrated in 10 Months of Combat Operations)**
- **Non-equipped Soldiers - VOICE COMMUNICATIONS and a POSITION INFORMATION reporting capability**

Figure 76. Land Warrior Basis of Issue
(Qualls, 2008)

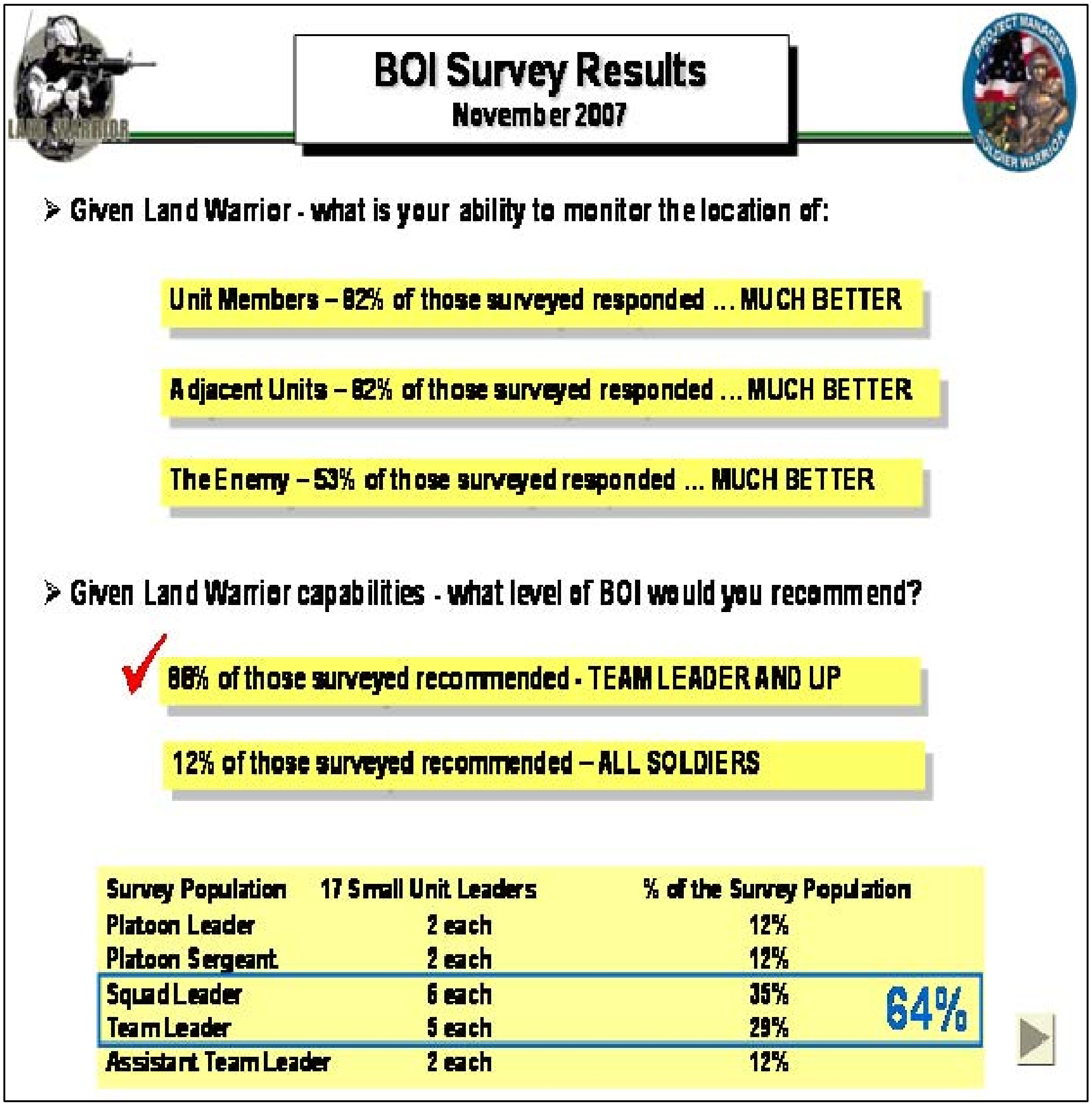

Figure 77. Land Warrior Survey Results
(Qualls, 2008)

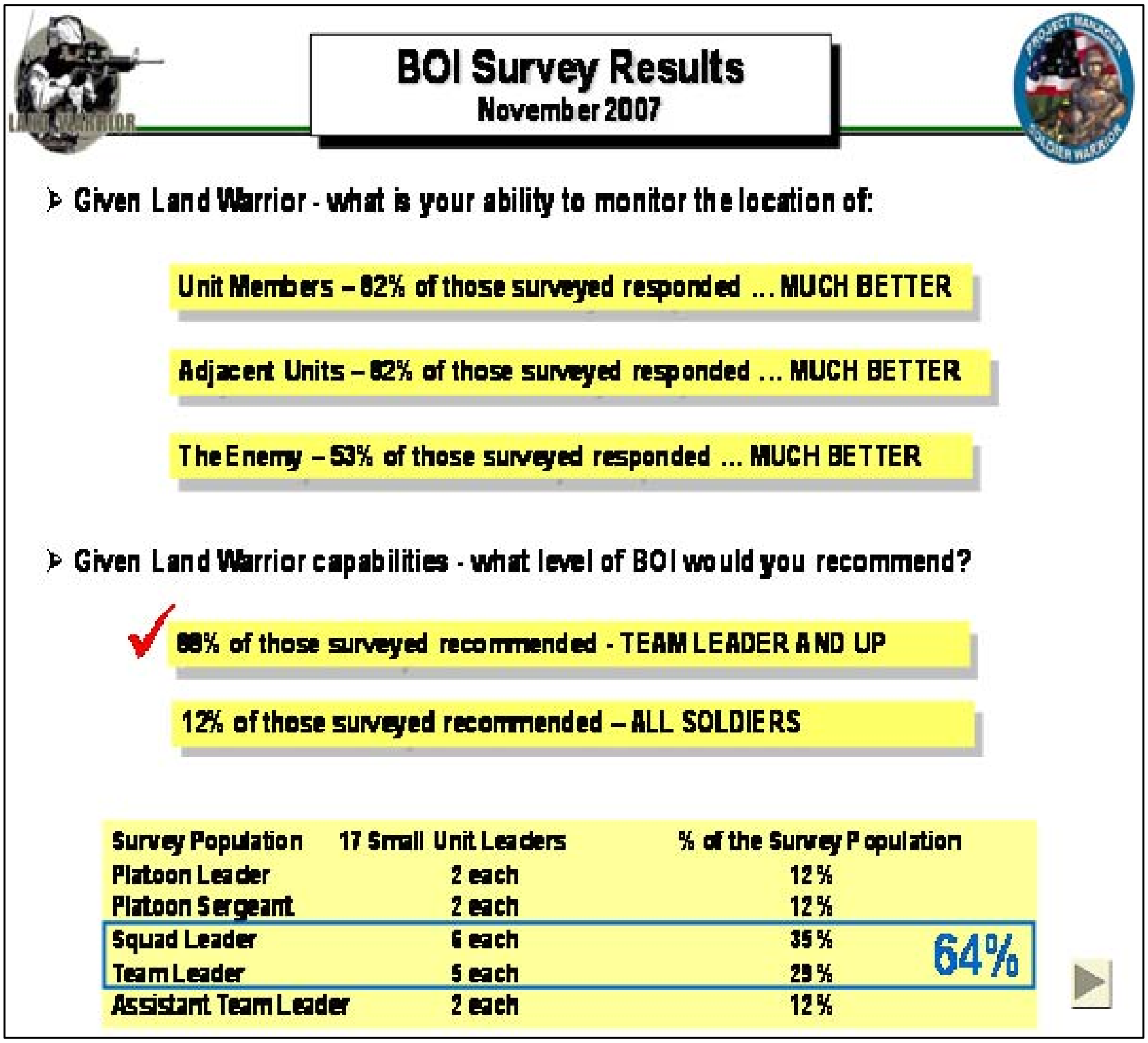

Figure 78. Land Warrior Potential Way Ahead
(Qualls, 2008)

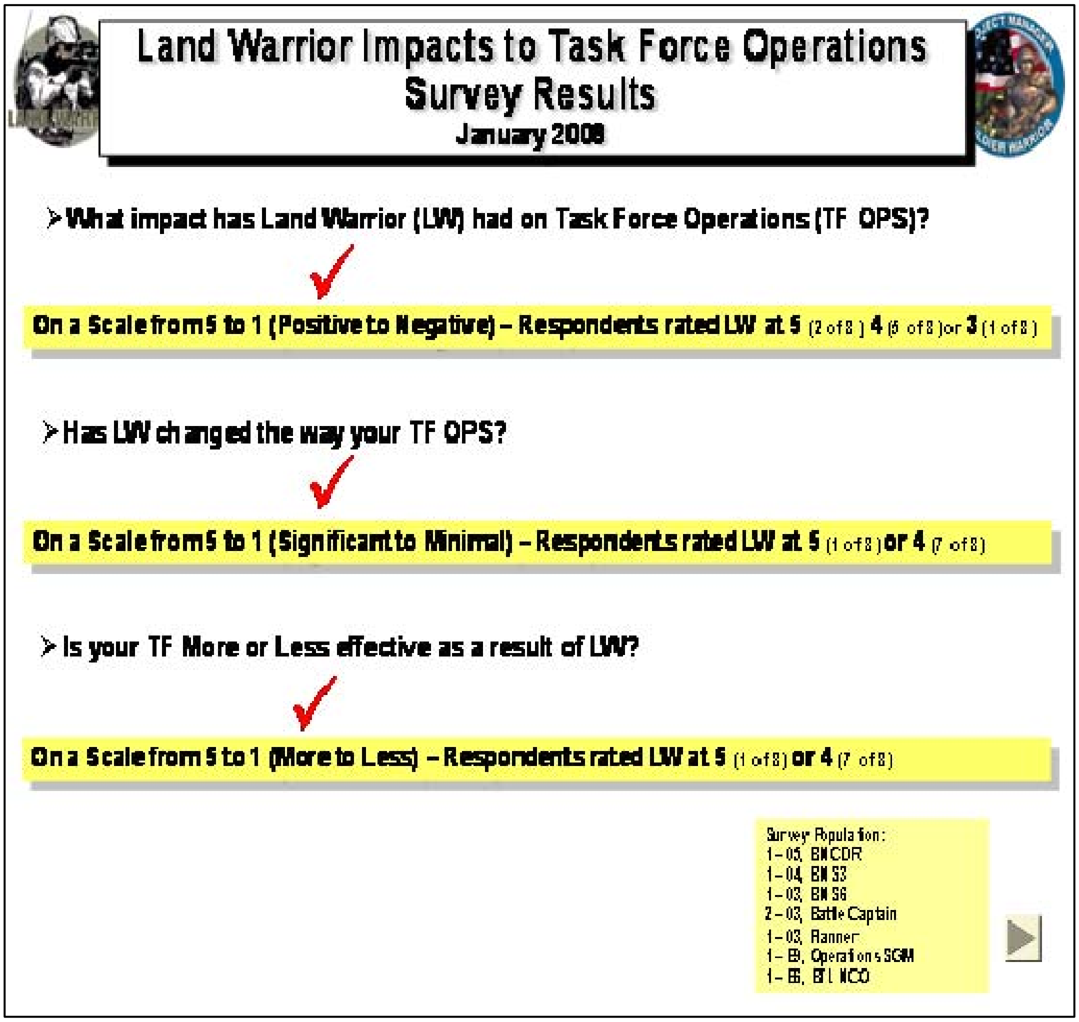

Figure 79. Land Warrior Impacts to Task Force Operations
(Qualls, 2008)

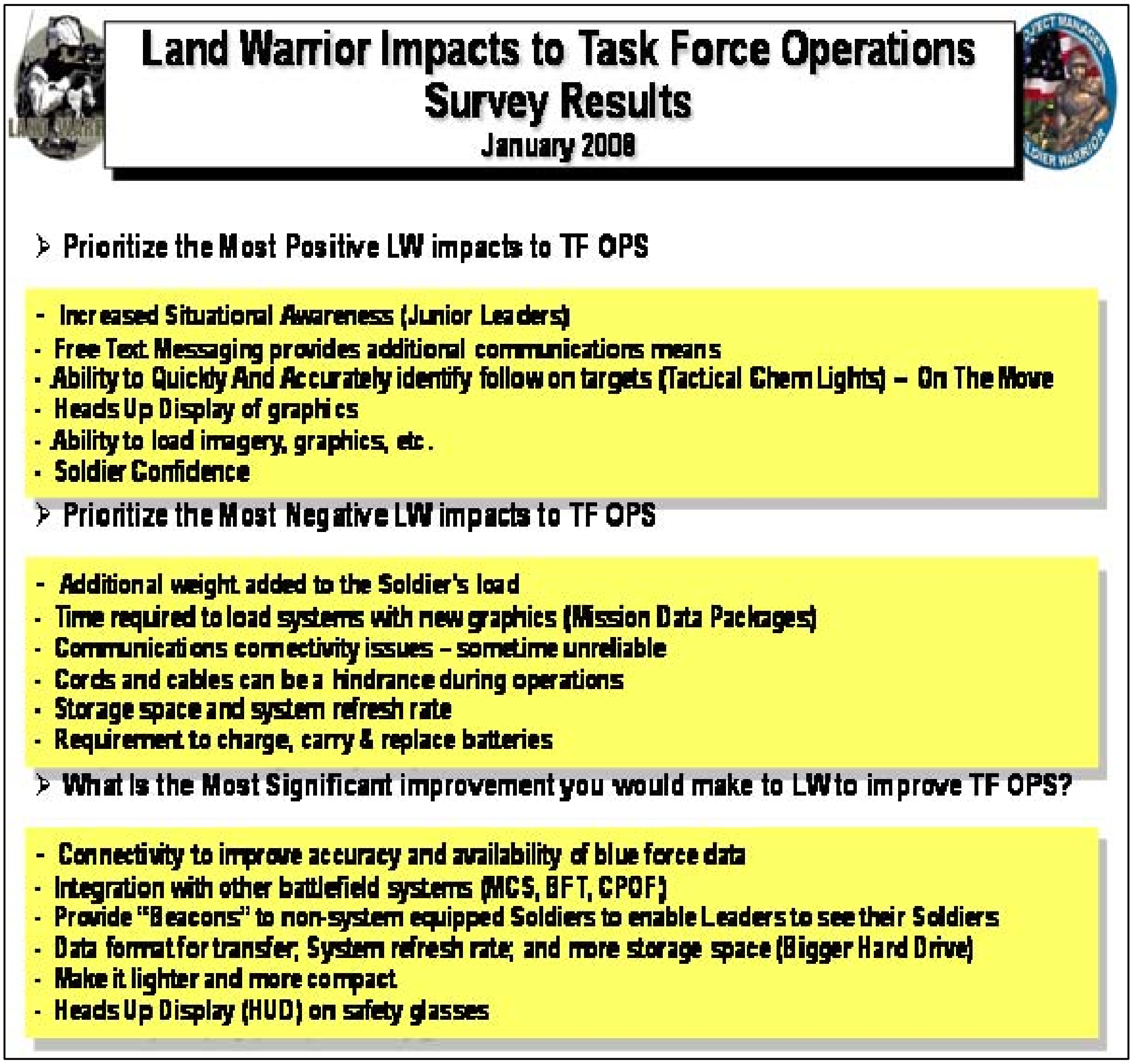

Figure 80. Land Warrior Impacts to Task Force Operations
(Qualls, 2008)

Land Warrior Impacts to Task Force Operations Survey Results

January 2008

➢ **Where would you want to see LW evolve to support TF OPS?**

- Increase unit involvement in operation and maintenance (ownership) – lessens reliance on contractors
- Correct connectivity issues – this would greatly increase capabilities of the system
- Greater operational range – especially in dismounted / air assault operations
- Smaller, lighter and more storage and data transmission capability
- Provide “Beacons” to every Soldier so the Leader can see his men
- Make weapon subsystem “better” - Soldiers will see benefit (cordless, photo capture, integrate night sights

➢ **Does LW impact integration of attachments and task organization changes?**

- TASKO changes not effected by LW – I do not consider LW a large factor in such decisions
- Major impact on integration of attached units – if they are not equipped it hampers SA at the BN level
- Attachments who don’t have LW may not be able to keep up

➢ **How would you improve LW to accommodate these changes?**

- However, whenever attachments can get LW – it helps to integrate them and makes unit more capable through robust network
- Attachments must be similarly equipped to improve TF OPS – SA and Battle Command
- Units outside of the TF (e. g., logistical units) moving through TF battlespace need same SA as the TF

Figure 81. Land Warrior Impacts to Task Force Operations
(Qualls, 2008)

% of Population:
PL = 12%
PSG = 12%
SL=35%,
TL=29%
ATL=12%

18 November 2007 BOI Survey – PL / PSG to SQD LDR / TM LDR

		CPT / PL	CPT / PL	SPC / PSG	SSG / PSG	SSG / SL	SSG / SL	SSG / SL	SGT (P) / SL	SGT / SL	SGT / SL	SGT / TL	SGT / TL	CPL / TL	SPC / TL	SPC / TL	CPL / ATL	SPC / ATL
Monitor Location of: Unit Members																		
N/A																		
Much Better	14 of 17 = 82%	X	X		X	X	X	X	X		X	X	X		X	X	X	X
Better	2 of 17 = 12%			X										X				
About Same	1 of 17 = 6%									X								
Worse																		
Much Worse																		
Monitor Location of: Adjacent Units																		
N/A																		
Much Better	14 of 17 = 82%	X	X		X	X	X	X	X		X	X	X		X	X	X	X
Better	1 of 17 = 6%			X														
About Same	2 of 17 = 12%									X				X				
Worse																		
Much Worse																		
Monitor Location of: Enemy																		
N/A																		
Much Better	9 of 17 = 53%		X		X	X	X	X			X	X	X		X			
Better	3 of 17 =18%	X							X	X								
About Same	5 of 17 = 29%			X										X		X	X	X
Worse																		
Much Worse																		
Given LW Capabilities – What level BOI																		
All Soldier	2 of 17 =12%										X						X	
TL and UP	15 of 17 = 88%	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X
SL and UP																		

Figure 82. BOI Survey
(Qualls, 2008)

Land Warrior Basis Of Issue

Month / Year / Event	Capability / Findings / Decision
MAR 05: Land Warrior (LW) / Rapid Fielding Initiative (RFI) Side-by-Side	Findings: All 9 squad members felt that only Soldiers in leadership positions **TEAM LEADER UP TO PLATOON LEADER** should have LW
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MAY 06: LW DOTMLPF Assessment	New Equipment Training (NET) to 4/9 INF focused on equipping **ALL SOLDIERS AT BN LEVEL**
JUL 06: Land Warrior (LW) CPD	LW will be deployed within task organized Infantry Companies, selected Battalion Command and Staff personnel, and selected Soldiers in direct support of maneuver elements – **ALL SOLDIERS IN A RIFLE SQUAD**
SEP 06: LW Limited User Test (LUT)	B Co, 4/9 INF is equipped at **TEAM LEADER AND ABOVE** for conduct of the LUT
SEP 06: LW DOTMLPF VIP Day	BN CDR, 4/9 INF states "We want to take LW with us to War"; changing BN BOI to **TEAM LEADER AND UP; RF BEACON AND LW COMPATIBLE RADIO NEEDED AT SOLDIER LEVEL**
APR 07: LW DOTMLPF Assessment Report	Findings: Soldiers and Leaders indicate that the preferred LW BOI is to **TEAM LEADERS AND ABOVE…HOWEVER, AT A MINIMUM A VOICE RADIO SHOULD PROVIDED TO EVERY SOLDIER**
APR 07 – Present: Combat Operations	4/9 INF has been conducting combat operations in Iraq – **BOI REMAINS TEAM LEADER AND UP**, and selected others (BDE PSD, 2-1 CAV) and potentially 1/38 INF
18 NOV 07: BOI Survey – PL / PSG to SQD LDR / TM LDR (In Country Survey)	**88% of those surveyed recommended - TEAM LEADER AND UP** **12% of those surveyed recommended – ALL SOLDIERS**
JAN 08: Land Warrior Impacts to Task Force Operations Survey Results (In Country Survey)	- Need **"BEACONS"** or a way for leaders to see their subordinates who do not carry LW - Units not having **CNRS RADIO** hampers SA for BN level operations and also neighboring units in the BN to see and know placement of friendly forces - Organizations or attachments outside the TF need to be able to observe blue feed from the **LW SYSTEMS** – e.g., logistical units transitioning through the battle space… - If attachments had **LW** they would be better integrated into the unit fight

Bottom Line:
- **Preferred LW BOI – TEAM LEADER AND UP (Demonstrated in 10 Months of Combat Operations)**
- **Non-equipped Soldiers - VOICE COMMUNICATIONS and a POSITION INFORMATION reporting capability**

Figure 83. Land Warrior Basis of Issue Plan
(Qualls, 2008)

Land Warrior Impacts to Task Force Operations Survey Results

January 2008

➢ **Prioritize the Most Positive LW impacts to TF OPS**

- Increased Situational Awareness (Junior Leaders)
- Free Text Messaging provides additional communications means
- Ability to Quickly And Accurately identify follow on targets (Tactical Chem Lights) – On The Move
- Heads Up Display of graphics
- Ability to load imagery, graphics, etc.
- Soldier Confidence

➢ **Prioritize the Most Negative LW impacts to TF OPS**

- Additional weight added to the Soldier's load
- Time required to load systems with new graphics (Mission Data Packages)
- Communications connectivity issues – sometime unreliable
- Cords and cables can be a hindrance during operations
- Storage space and system refresh rate
- Requirement to charge, carry & replace batteries

➢ **What Is the Most Significant improvement you would make to LW to improve TF OPS?**

- Connectivity to improve accuracy and availability of blue force data
- Integration with other battlefield systems (MCS, BFT, CPOF)
- Provide "Beacons" to non-system equipped Soldiers to enable Leaders to see their Soldiers
- Data format for transfer; System refresh rate; and more storage space (Bigger Hard Drive)
- Make it lighter and more compact
- Heads Up Display (HUD) on safety glasses

Figure 84. Land Warrior Impacts to Task Force Operations
(Qualls, 2008)

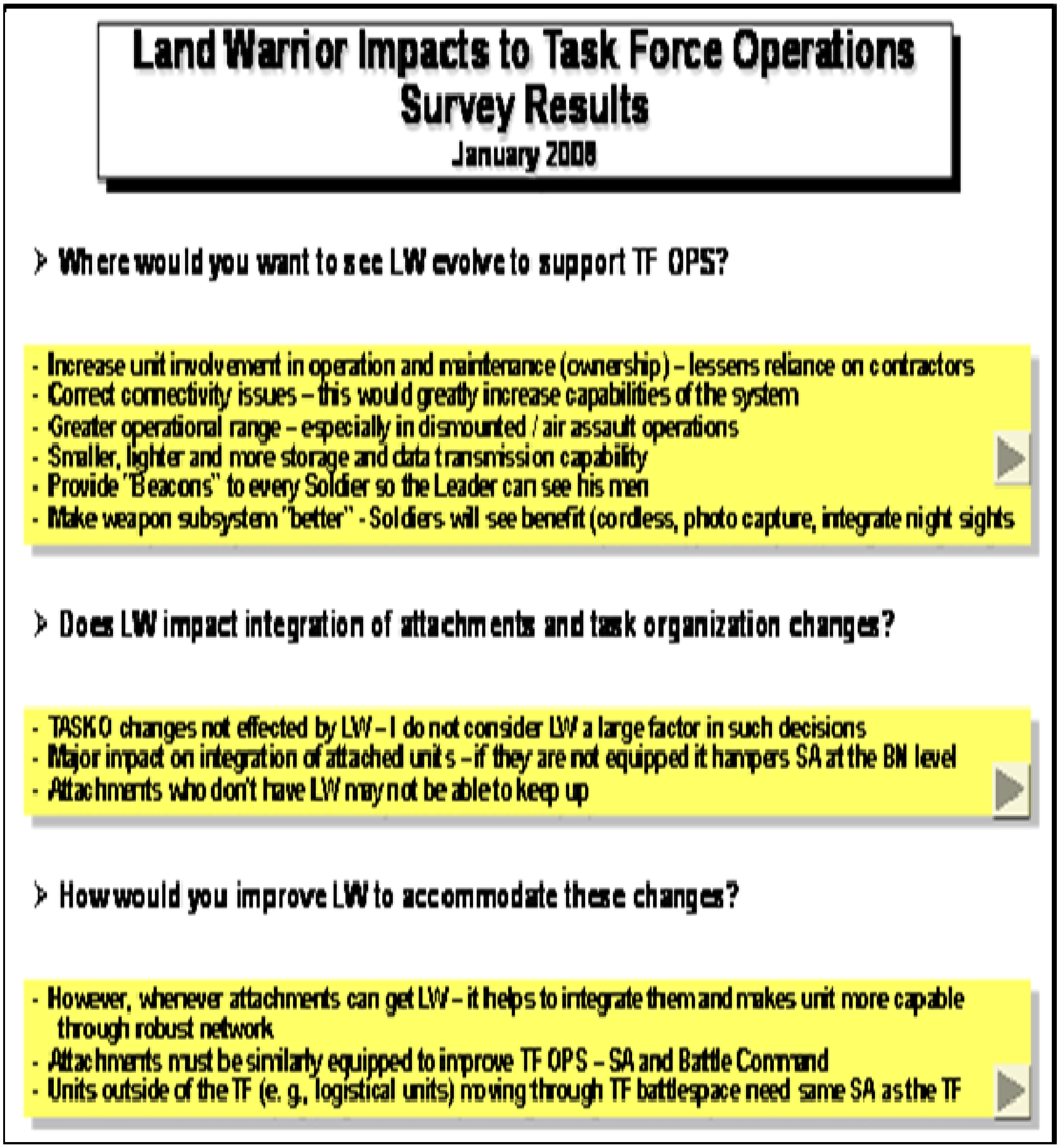

Figure 85. Land Warrior Impacts to Task Force Operations
(Qualls, 2008)

Land Warrior Impacts To Task Force Operations

What impact has Land Warrior (LW) had on TF OPS?	LTC BN CDR	MAJ BN S3	SSG BTL NCO	CPT BN S6	CPT Battle CPT	CPT Battle CPT	CPT Planner	SGM OPS SGM
Positive								
5	X							X
4		X		X	X	X	X	
3			X					
2								
1								
Negative								

Has Land Warrior changed the way your TF operates?	LTC BN CDR	MAJ BN S3	SSG BTL NCO	CPT BN S6	CPT Battle CPT	CPT Battle CPT	CPT Planner	SGM OPS SGM
Significant								
5				x				
4	X	X	X		x	x	x	x
3								
2								
1								
Minimal								

Is your TF more or less effective as a result of LW?	LTC BN CDR	MAJ BN S3	SSG BTL NCO	CPT BN S6	CPT Battle CPT	CPT Battle CPT	CPT Planner	SGM OPS SGM
More								
5				X				
4	X	X	X		X	X	X	X
3								
2								
1								
Less								

Figure 86. Land Warrior Impacts to Task Force Operations
(Qualls, 2008)

Land Warrior Impacts to Task Force Operations

Prioritize the most POSITIVE LW impacts to TF OPS	LTC BN CDR	MAJ BN S3	SSG BTL NCO	CPT BN S6	CPT Battle CPT	CPT Battle CPT	CPT Planner	SGM OPS SGM
1	Blue SA – Always knowing where your Soldiers and dismounted squads are	SA – especially Company & below	Placement of troops during operations	Increased SA for Leaders (Junior)	Increased SA – visibility of friendly forces and graphic control measures	Increased SA	Tactical SA	SA
2	Immediately available maps & imagery	Chem Light feature allows for speed of execution	The Chem Light feature	Added technical assistance to EPLRS network	Free text messaging provides an additional communication platform	Ability to quickly and accurately identify follow on targets (Tactical Chem Lights)	Operational SA	Heads Up Graphics
3	Ability to update and transmit graphics on the move (Chem Lights)	No Response	No Response	Added enablers – Dragon Ball/Pole, newer IOTV, sensors, etc.	The ability to load images (.jpg) of imagery, targets, etc.	Affords redundant communications platforms.	Soldier Confidence	Ability to modify graphics on the move (Chem lights)
Prioritize the most NEGATIVE LW impacts to TF OPS	**LTC BN CDR**	**MAJ BN S3**	**SSG BTL NCO**	**CPT BN S6**	**CPT Battle CPT**	**CPT Battle CPT**	**CPT Planner**	**SGM OPS SGM**
1	Increased Soldier Load (Weight)	Battery Life & size of the batteries	Bulky- getting in and out of hatch	Created situation where unit CDRs felt they could get all equipment requested	Additional weight added to Soldier's basic load	Time needed to load system with new graphics, etc.	Too much reliance on operational SA	Not enough hard drive space.
2	Requirement to charge, carry & replace batteries	Wave form – connectivity with A/C and other enablers	Field of Vision	Required large overhead of contractors (currently)	The time and difficulty in creating MDP	Weight added to the individual Soldier load.	Format of data that can be transferred	Too slow to refresh.
3	Somewhat more work required in TLP (PCIs & MDSE)	Current range of LW		Interruption of planning with contractors/officers who placed LW operations as higher requirement than those dictated by the unit	There remains connectivity issues – sometimes unreliable	Cords and cables can be a hindrance during operations	Weight	Radio is spotty – not very reliable.

Figure 87. Land Warrior Impacts to Task Force Operations
(Qualls, 2008)

Land Warrior Impacts to Task Force Operations

What is the most significant improvement you would make to LW to improve TF level operations?	LTC BN CDR	MAJ BN S3	SSG BTL NCO	CPT BN S6	CPT Battle CPT	CPT Battle CPT	CPT Planner	SGM OPS SGM
	Make it lighter and more compact	1 - Communications wave forms & 2 - maintain settings when booting up (Personal)	HUD on safety glasses	The major improvement is to push all patches/updates at once instead of multiple times in a deployment. This lowers the impact on combat operations.	From my perspective... Connectivity was the primary concern. There were several instances when accurate and updated blue force was unavailable. I would also improve the integration with other battlefield systems, i.e., MCS, BFT and CPOF.	Provide "Beacons" or a way for leaders to see all their subordinates who do not carry LW on the Leader's system.	Format of the data that can be transferred.	Rapid refresh and larger Hard Drive

Where would you want to see LW evolve in regards to supporting TF operations?	LTC BN CDR	MAJ BN S3	SSG BTL NCO	CPT BN S6	CPT Battle CPT	CPT Battle CPT	CPT Planner	SGM OPS SGM
	Make the weapon subsystem "better" & Soldiers will see the benefit...i.e., cordless, photo capture, integrate night sights	1 – Communications Range and Interoperability 2 – Reduce Bulk 3 – Increase Battery Life 4 – Easy On/Off switch. Think NODs.	Easier cursor and messaging	LW needs to fall into a similar support package as FBCB2. this requires more of the unit to get involved with its operation and maintenance. Because of the one GD Rep per company, Soldiers think they can tell a contractor that there system is broken and walk away without taking ownership	Correcting the connectivity and reliability issues would greatly increase the capabilities of the system	Greater operational range, especially in dismounted/air assault operations	Smaller, lighter,, and more storage and transmission capability.	Add Beacons to every Soldier so the Leader can see his men.

Figure 88. Land Warrior Impacts to Task Force Operations
(Qualls, 2008)

Land Warrior Impacts to Task Force Operations

	LTC BN CDR	MAJ BN S3	SSG BTL NCO	CPT BN S6	CPT Battle CPT	CPT Battle CPT	CPT Planner	SGM OPS SGM
Does LW impact the integration of attachments and task organization changes?	TASKO changes are really not effected by LW – I do not consider LW a large factor in such decisions	Yes – No	No Response	LW has a major impact on integration of attached units.	No Response	No significant impacts observed at my level.	NO	Attachments who don't have LW may not be able to keep up.
How would you improve LW to accommodate these changes?	**LTC BN CDR**	**MAJ BN S3**	**SSG BTL NCO**	**CPT BN S6**	**CPT Battle CPT**	**CPT Battle CPT**	**CPT Planner**	**SGM OPS SGM**
	However, whenever attachments can get LW ensembles it helps to integrate them and makes the unit more capable through a more robust network	Easy answer is in it's current configuration	No Response	In order for the attached unit to be seen on EPLRS network, the unit must be outfitted with some sort of EPLRS radio. The unit not having EPLRS hampers SA for BN level operations and also neighboring units in the BN to see and know placement of friendly forces.	From my perspective, the largest improvement would be for organizations or attachments outside the TF to be able to observe blue feed from the LW systems – e.g., logistical units transitioning through the battle space being able to see ambush positions/dismounted icons	No Response	They don't have LW.	If attachments had LW they would be better integrated into the unit fight.

Figure 89. Land Warrior Impacts to Task Force Operations
(Qualls, 2008)

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Appendix O. TRADOC Capability Manager Deployment Plan

Provided by Major Mike Cahill, Assistant TCM Soldier

TCM Soldier "Fightability" Concern

TCM Soldier's major concern regarding LW is its fightability.

TCM-S defines "fightability" as: the impact on performance of individual, leader and collective tasks at all leadership echelons.

Fightability encompasses HFE, MANPRINT, and the six combat domains: lethality, survivability, mobility, sustainability, command and control (C2)/situational awareness (SA) and training (Cahill, 2008, 15 July).

The assessment as planned will cover these 6 combat domains:

Fightability Criteria	Criteria Measure	Direct Assessment Coverage	General Assessment Coverage
HFE & MANPRINT	Can tasks physically and mentally be performed?	During Combat operations, identify any related issues caused by the LW equipment	• Does DOTMLPF/LUT results replicate CBT operational usage • What echelons are LW capabilities desired for task execution? • How do the users employ LW tasks from TM Ldr to battalion level? • How does LW affect execution of those tasks that are problematic for the force? • What effect do CBT Ops have on how the Soldier employs LW • Capability Gaps filled
Lethality	Does Land Warrior make me better ?	Follow the development of TTPs and unit performance as they become more familiar with added capabilities	
Survivability		Leader ability to see troops and understand unit dispersion	
Mobility	How do results differ from Ft Lewis DOTMLPF ?	Soldier load-vs-LW STKR Soldier load	
Sustainability		Maintenance plan, Soldier trouble shooting.	
C2 / SA		Leader ability to see troops and understand unit dispersion	
Training	Can tasks be trained?	Replacement Soldiers and refresher tng plan	

Figure 90. TCM Soldier "Fightability" Concerns
(Cahill, 2007)

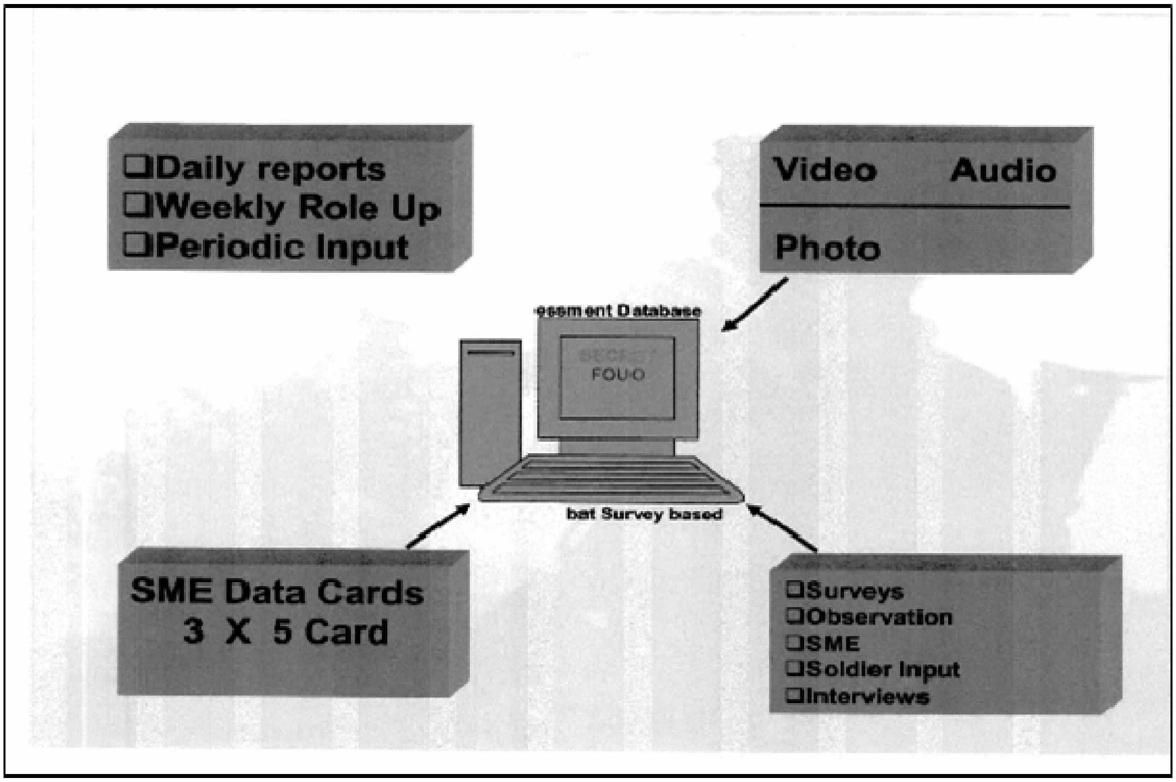

Figure 91. Assessment Products
(Cahill, 2007)

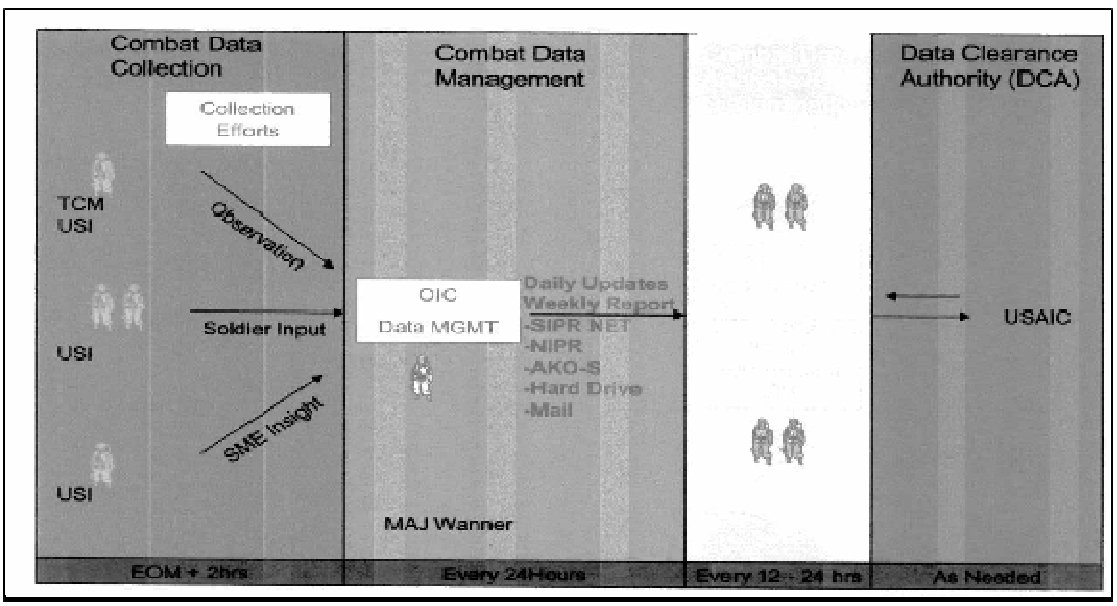

Figure 92. Assessment Data Flow
(Cahill, 2007)

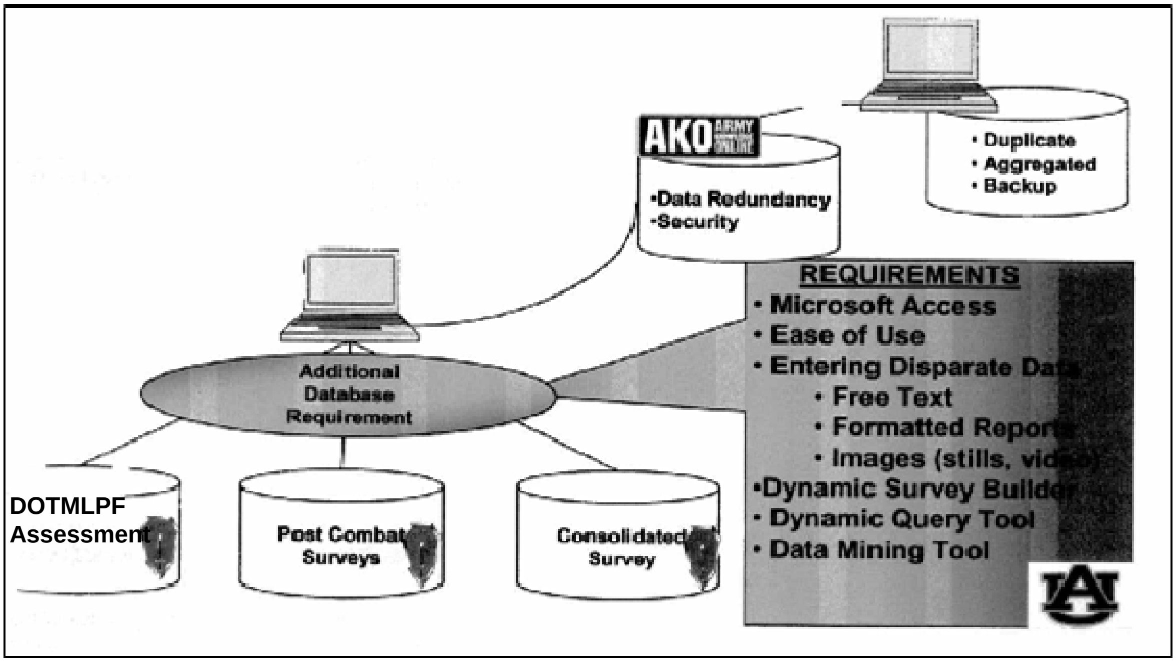

Figure 93. Collection System
(Cahill, 2007)

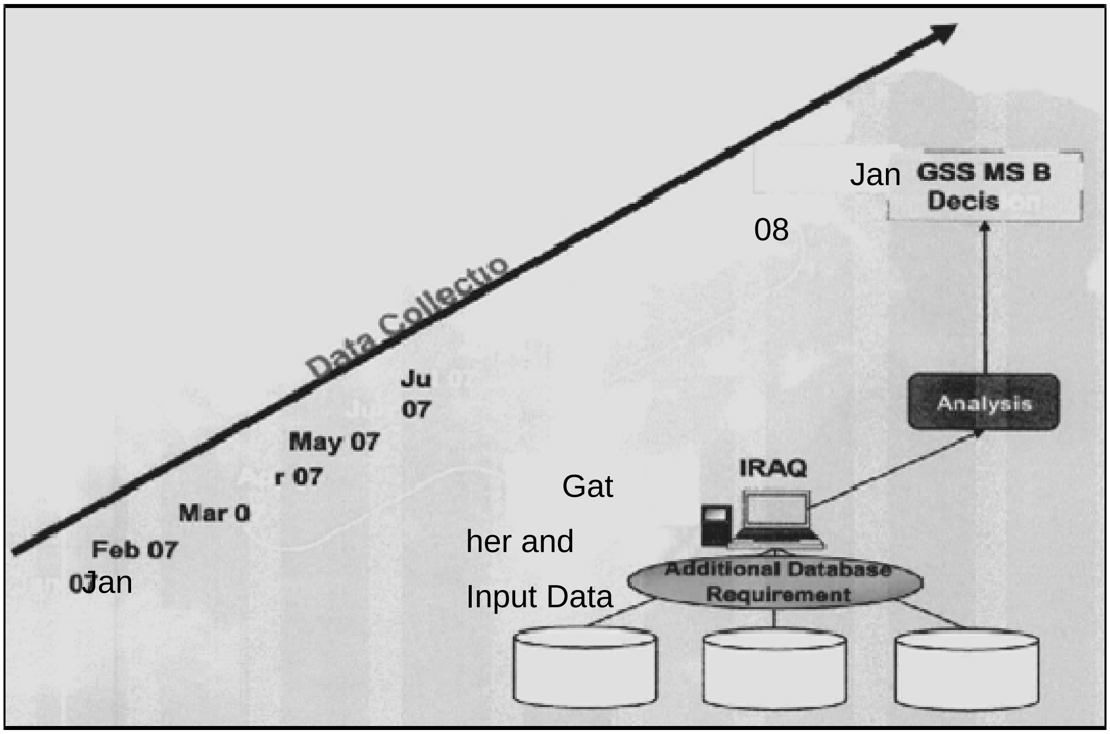

Figure 94. TCM Soldier Assessment Timeline
(Cahill, 2007)

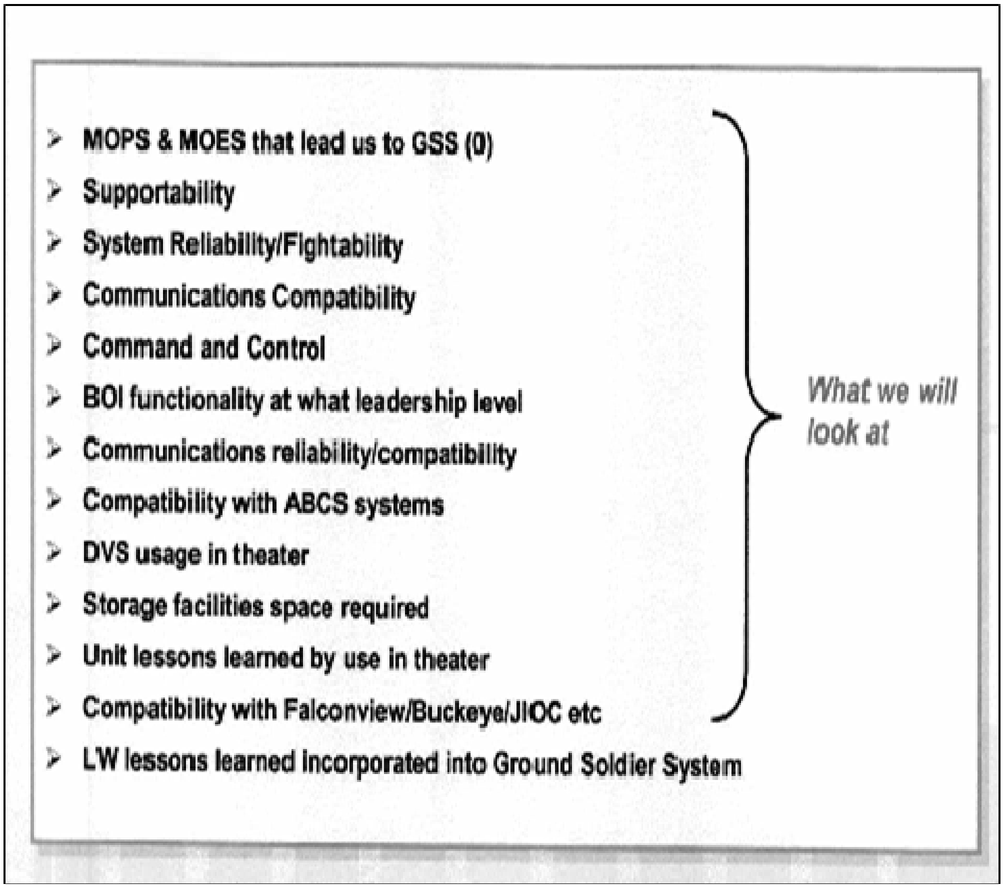

Figure 95. Areas of Interest
(Cahill, 2007)

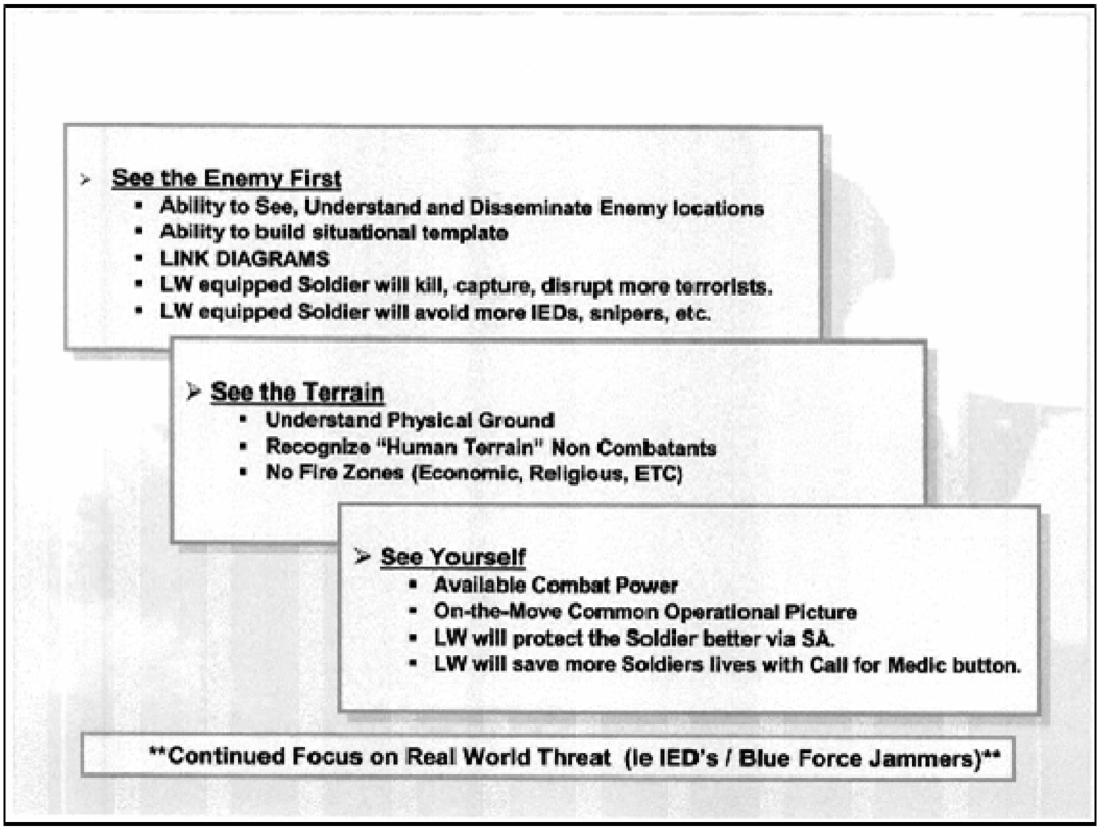

Figure 96. Areas of Interest Continued
(Cahill, 2007)

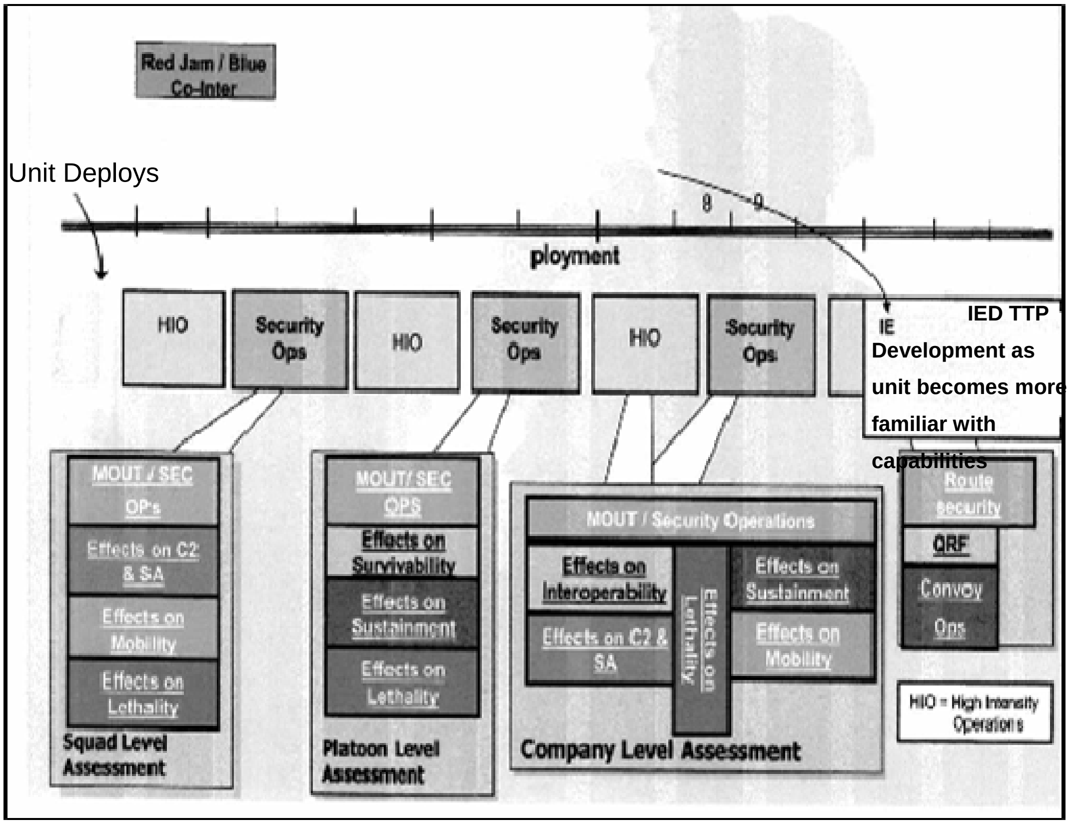

Figure 97. GSS Assessment Strategy
(Cahill, 2007)

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Appendix P. Evolution of the LW-SI (Block II) Improvements to the MANCHU and 4-9 Infantry Systems

Figure 98. Land Warrior System 4-9 Infantry Configuration
(Cummings, 2008, September 22)

Figure 99. Land Warrior System Configuration after User Input
(Cummings, 2008, September 22)

Figure 100. Land Warrior System Configuration during Deployment
(Cummings, 2008, September 22)

Figure 101. Land Warrior Improvements for 5-2 SBCT
(Cummings, 2008, September 22)

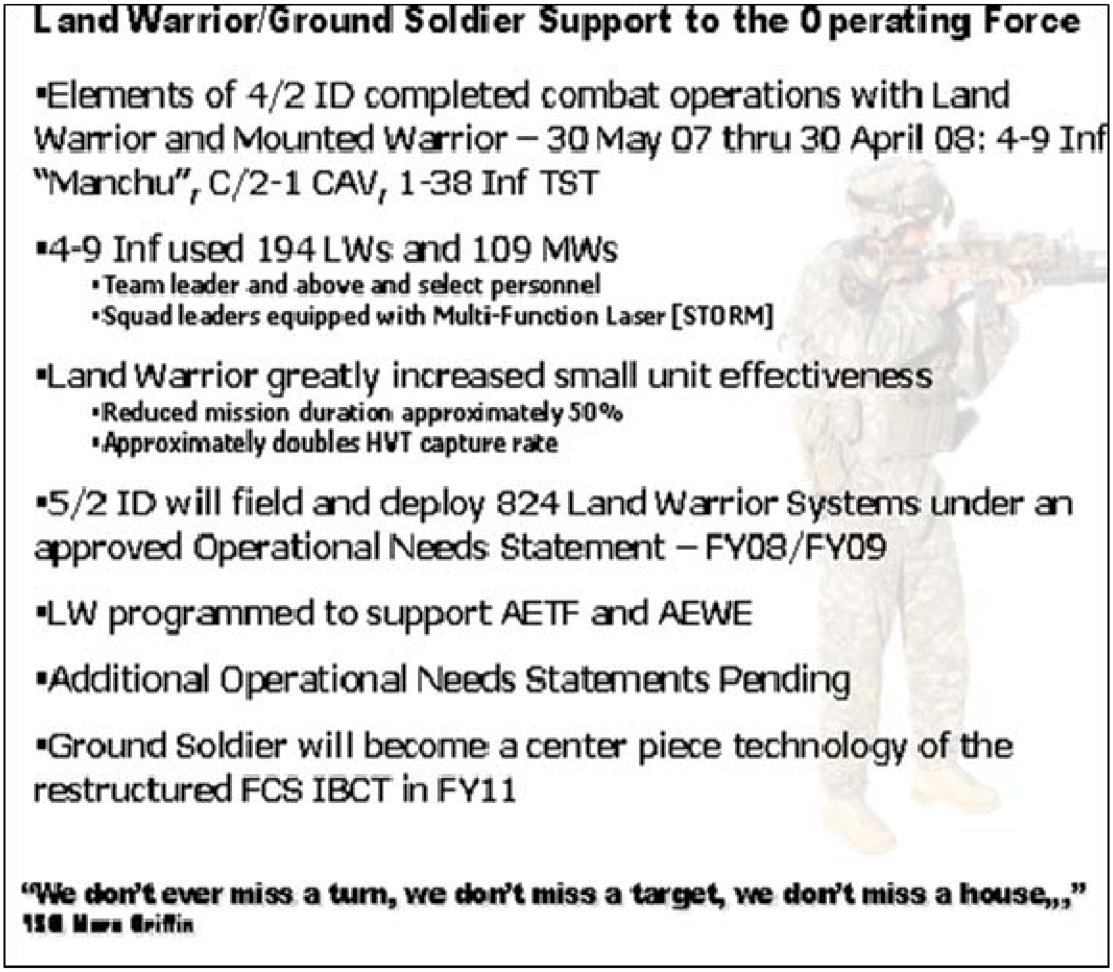

Figure 102. Land Warrior Support to the Operational Force
(Cummings, 2008, September 22)

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Appendix Q. Land Warrior Budget Breakdown

Below is a brief chart showing the appropriations, authorizations and conference report funds for the LW Program from 1996 to 2009. There were many smaller programs that were given appropriated and authorized funds for LW-related RDT&E work that are not reflected in the chapter above or in the chart below. These funds were excluded in order to keep the focus strictly on the RDT&E and procurement of the LW system as a whole.

	U.S. Army Request		Appropriations: House		Appropriations: Senate		Authorizations: House		Authorizations: Senate		House Conference Report	
	RDTE	Proc	RDTE	Proc	RDTE	Proc	RDTE	Proc	RDTE	Proc	RDTE	Proc
FY 1996	$ [illegible]	$ -	$ -	$ -	$ -	$ -	*	*	*	*	$ [illegible]	$ -
FY 1997	$ [illegible]	$ -	$ -	$ -	$ -	$ -	*	*	*	*	$ [illegible]	$ -
FY 1998	$ [illegible]	$ -	$ [illegible]	$ -	$ -	$ -	*	*	*	*	$ [illegible]	$ -
FY 1999	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ -	$ [illegible]	*	*	*	*	$ [illegible]	$ -
FY 2000	$ [illegible]	$ -	$ [illegible]	$ -	$ [illegible]	$ -	*	*	*	*	$ [illegible]	$ -
FY 2001	$ [illegible]	$ -	*	*	*	*	*	*	*	*	$ [illegible]	$ -
FY 2002	$ [illegible]	$ -	*	*	*	*	*	*	*	*	$ [illegible]	$ -
FY 2003	$ [illegible]	$ -	*	*	*	*	*	*	*	*	$ [illegible]	$ -
FY 2004 ([illegible])	$ [illegible]	$ [illegible]	*	*	$ 32.7	$ [illegible]	*	*	$ [illegible]	$ (21.3)	$ 32.7	$ [illegible]
FY 2004 ([illegible])									[illegible]			
FY 2005	$ [illegible]	$ -	$ [illegible]	$ -	[illegible]	$ -	*	*	*	*	$ [illegible]	$ -
FY 2005 ([illegible])					[illegible]							
FY 2006	$ [illegible]	$ [illegible]	$ -	$ -	$ -	[illegible]	*	*	*	*	$ [illegible]	$ [illegible]
FY 2007	$ [illegible]	$ [illegible]	$ -	$ -	$ -	$ [illegible]	*	*	*	*	$ -	$ [illegible]
FY 2008	$ -	$ -	$ -	$ -	$ -	$ -	*	*	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
FY 2009	$ -	[illegible]	$ -	$ -	$ -	$ -	$ -	$ [illegible]	$ -	$ [illegible]	$ -	$ [illegible]
All amounts are in $ Millions											TOTAL	$ [illegible]

* No data available
** Consolidated FFW & LW Programs
*** [illegible]
**** [illegible]
***** Supplemental

Figure 103. Land Warrior Budget Data
(Clifton & Copeland, 2008)

FY 1996

The breakdown of the requested FY 1996 funding was as follows:

- $10.4 million was spent to complete funding of the "Generation II Soldier" ATD, to begin risk reductions in weight of some of the advanced components like the radio packet and integrated sights, and to complete the technology-insertion plans for LW upgrades.

- $20.1 million was spent to initiate Engineering and Manufacturing Development (EMD), establish integrated product teams, complete preliminary design reviews and critical design reviews, perform iterative development incorporating user feedback and procuring prototype components for the helmet, digital radio, laser rangefinder and image intensifier, and perform LW EMD program management scheduling, program controls, program documentation and reviews of performance, cost and schedule, system analysis and logistics support (Office of the Secretary of the Army, DoD, 1997b).

FY 1997

The planned expenditures of the FY 1997 funding included:

- $15.5 million for the completion of risk-reduction designs, development and fabrication of advanced technology components, procurement of long-lead items for additional LW systems for evaluating advanced technology components and development of component enhancements based on early operational experimentation.

- $389,000 on small business innovation research and small business technology transfer programs to support LW system development (Office of the Secretary of the Army, DoD, 1997b).

FY 1998

No breakdown was found for FY 1998.

FY 1999

The breakdown of the RDT&E funding for Engineering and Manufacturing Development was as follows:

- $15.9 million to complete operational testing and fix deficiencies from operational testing.

- $250,000 dollars was budgeted to ensure system compliance with Joint Technical Architecture-Army.

- $6.8 million for program management and engineering support from other government agencies to provide oversight of the contractor's efforts and to conduct technical and program reviews to achieve a low-rate initial production decision (LRIP).

- $5.8 million to begin EMD on mature technology-insertion candidates for insertion into the LW production baseline.

- $8.7 million for contractor program management and contract award fee and $2.4 million for small business innovation research and small business technology transfer programs.

- $5.6 million for continued assessment and development of future technology insertions into LW and complete fabrication and completion of early user test items.

- $3.7 million to perform early user testing of LW systems, prepare documents for transitioning successful early user test advanced technology components to the LW system, and to demonstrate future component integration onto the LW system platform (Office of the Secretary of the Army, DoD, 1998b).

FY 2000

The breakdown of the requested funding for Engineering and Manufacturing Development was as follows:

- $1.0 million to complete LW fightability assessments.

- $12.7 million to complete LW software builds (LW V2.0), to build and integrate systems for development and operational testing.

- $10.6 million to procure long-lead materials for the first 500 LRIP systems to be used by one Airborne Battalion for IOT&E purposes.

- $10.2 million for program management, engineering and additional support from other agencies for overall program efforts. These efforts included evaluation of the LRIP proposal and document preparation and award fee for successful completion and delivery of prototypes.

- $11 million to evaluate and integrate LW enhancements to meet operational requirements.

- $18 million to initiate production tooling and establish an automated LW test bed (Office of the Secretary of the Army, DoD, 1999b).

The breakdown of the funding planned for FY 2000, ATD, Warfighter Advanced Technology were as follows:

- $4.1 million to upgrade seven LW systems with system voice control and integrated land-navigation upgrades, complete the Future Warrior (FW)

Architecture study and transition the system voice control and integrated navigation to the LW Engineering and Manufacturing Development program.

- $2.2 million to participate in the Military Operations in Urban Terrain (MOUT) Advanced Concept Technology Demonstration (ACTD) Advanced Concept Excursion (ACE) with upgraded LW systems, develop a LW interface with the Objective Crew-served Weapon (OICW) and develop transition documents for the transitioning of MOUT/OICW-related technologies into the LW system (Office of the Secretary of the Army, DoD, 2000b).

FY 2001

The breakdown of the requested $60.1 million for Engineering and Manufacturing Development was as follows:

- $36.4 million to fabricate 55 LW prototypes for a platoon Limited User Test (LUT), conduct confidence testing, functional qualification testing and production qualification testing.

- $9.7 million to complete the Single Channel Ground and Airborne Radio System (SINCGARS)-compatible Leader Radio Improvement program, complete the LW integration of the Embedded Battle Command (EBC) software into Windows NT, ensure interoperability with FBCB2 and the tactical internet, obtain National Security Agency (NSA) Communications Security (COMSEC) level one certification for the leader radio, incorporate Multiple Integrated Laser Engagement System and Combat Identification Dismounted Soldier, and incorporate the integrated navigation functionality. Completion of these areas would allow LW to meet system threshold requirements.

- $4.6 million to conduct airborne certification, user fightability assessments, obtain a safety release, update the training packages and manuals for the platoon LUT and transition the training packages and manuals to electronic format, develop interactive training scenarios, evaluate integrated training environment, and finally conduct training for a platoon-sized LUT.

- $9.4 million for program management and systems engineering support from other Government agencies, conduct technical and program reviews, as well as continue to conduct LW demonstrations to higher headquarters and other countries to demonstrate system capability and functionality and to support NATO Land Group 3 and other partnered countries to ensure compatibility with potential multi-national military operations (Office of the Secretary of the Army, DoD, 2000b).

The breakdown of the requested $6.3 million under Warfighter Advanced Technology, Future Warrior Technology Insertion (FWTI) was as follows:

- $3.2 million to develop and integrate advanced technology upgrades for LW systems, demonstrate and assess upgraded LW systems and perform user evaluations of upgraded systems.

- $3.1 million to perform experiments with emerging technologies and other related efforts to validate the performance of LW systems, and perform a baseline performance of production quality LW systems to aid in technology investment decisions (Office of the Secretary of the Army, DoD, 2000b).

FY 2002

A breakdown of the requested RDT&E finding for Engineering and Manufacturing Development was as follows:

- $42.2 million to fabricate the remaining 120 LW Block 1.0 spare prototypes for Operational Testing (OT) and conduct contractor acceptance testing and risk-reduction activities to improve the LW system functionality and integration prior to testing, provide contractor logistics support of hardware and software on units that were to be tested with the LW system.

- $7.5 million to complete Developmental Testing (DT) and OT on the LW system, conduct airborne certification, user fightability assessments, obtain necessary safety releases for the Airborne testing, develop interactive training scenarios and evaluate the integrated training environment, conduct tactics training, operators and leaders training, conduct maintenance training prior to OT and initiate IOT&E for the LW system.

- $12 million was budgeted for program management and systems engineering support from other Government agencies for overall program efforts, to conduct technical and program reviews, to continue to conduct LW demonstrations to higher headquarters and other countries to demonstrate system capability and functionality, and to continue to support NATO Land Group 3 and other partnered countries to ensure compatibility with potential multi-national military operations (Office of the Secretary of the Army, DoD, 2000b).

FY 2003

The breakdown of the requested Engineering and Manufacturing Development funding was:

- $35 million to continue to incorporate IOT&E software and hardware fixes into LW Block 1.0 and to begin LW Block IIA development, which addressed LW integration to meet key performance parameters (KPPs) for Army Battle Command System (ABCS) interoperability and provided an on-board power recharging capability in the interim force vehicle for LW-equipped soldiers.

- $10.7 million to conduct OT readiness reviews and finalize training materials and training packages, to continue to conduct IOTE and provide Contractor Logistics Support during DT and IOTE, and to conduct Government system assessment of the LW operational test results.

- $6.2 million to initiate procurement planning efforts for follow-on, full-rate production, full and open LW competition contract, to prepare for Source Selection Evaluation Board (SSEB) for production contract award, and to conduct technical and program reviews for In-Process Review (IPR) or Army System Acquisition Review Council (ASARC) reporting or briefings in preparation for a Milestone C Production decision.

- $8.8 million for program management and systems engineering support from other Government agencies (Office of the Secretary of the Army, DoD, 2002).

FY 2004

A breakdown of the requested RDT&E funding for RDT&E, SDD was:

- $1.6 million to fabricate LW systems to be used for development testing and operational testing for LW-IC, conduct contractor acceptance testing to validate system functionality and integration prior to formal government testing, provide contractor logistics support and obtain pre-production prototype Multi-function Laser Systems (MFLs) that will be Government-furnished Equipment (GFE) to support LW-IC systems.

- $26.7 million to incorporate software and hardware fixes from DT and IOT&E.

- $9.6 million to conduct airborne certification, user fightability assessments and to obtain necessary safety releases, conduct developmental tests to measure reliability and performance test reports, and complete the development of training programs of instruction, lesson plans and computer-based training and interactive multimedia instruction.

- $11.3 million to provide program management and systems engineering support for the program, initiate procurement planning efforts for follow-on LW competitive contracts, conduct a Source Selection Evaluation Board

(SSEB) for the production contract award, and continue LW demonstrations to other countries to demonstrate system capability and functionality (Office of the Secretary of the Army, DoD, 2003).

FY 2005

The breakdown of the requested RDT&E, SDD funding was:

- $2.2 million to obtain miniaturized Global Positioning System (GPS) Selective Availability Anti-spoofing Module (SAASM) Cards and other government-furnished equipment (GFE) to support the LW-SI Block II system.

- $52.4 million to transition from LW-IC, Block I, to a LW-SI, Block II design, and to begin LW-SI development (which addresses LW to Stryker integration to meet the KPPs for the Army Battle Command System (ABCS) interoperability with the Light Digital Tactical Operations Center), and to fabricate and conduct contractor testing on General Dynamics LW-SI systems that will be used for formal Government DT.

- $11.8 million to conduct user fightability assessment, obtain necessary safety releases, conduct limited operational assessments, conduct Government system assessment of operational test results, develop detailed test plans and OT threat instrumentation to support DT and OT, develop interactive training scenarios, evaluate integrated training environment, and develop training aids, devices, simulators and simulations.

- $20.3 million to provide program management and systems engineering support for overall program efforts, continue program development and execution of Memoranda of Agreements and support agreements with other Program Managers related to LW vehicle and communication integration kit activities, conduct technical and program reviews for Department of the Army Level, In-process Reviews, ASARC Milestone C preparations, and development, and report-out on required ACAT I program documentation requirements.

- $4.6 million to ensure continued small business innovative research and small business technology transfer programs (Office of the Secretary of the Army, DoD, 2004).

FY 2006

The breakdown of the requested RDT&E, SDD and was:

- $32.2 million to allow the prime contractor to continue development of both the engineering efforts for the Dismounted Battle Command System (DBCS) capabilities as well as the engineering efforts for the LW integrated ensemble systems for the Stryker Battalion.

- $7.2 million for OT for the DBCS efforts and for the LW integrated ensemble systems for the Stryker Battalion.

- $10.7 million for program management and systems engineering support for overall program efforts, continued program development, and execution of Memoranda of Agreement and support agreements with other program managers related to DBCS and FCS capabilities (Office of the Secretary of the Army DoD, 2005b).

FY 2007

A breakdown of the requested RDT&E, Soldier Systems-Warrior Demonstration and Evaluation was:

- $13.5 million for the prime contractor to continue development engineering efforts for the LW integrated ensemble for the Stryker Battalion.

- $7.5 million for continued testing for LW integrated ensemble system capability efforts, and to continue to train and support the LW integrated ensemble systems for the Stryker Battalion DOTMLPF assessment.

- $6.5 million to continue to support the program management and systems engineering for overall LW Program efforts (Office of the Secretary of the Army, DoD, 2006).

Appendix R. International Soldier Efforts

In the face of the challenges being faced in today's complex and ever-changing battlefield, the need for our NATO allies to upgrade their defense forces, equipment and network systems is a must and should not be put off for future consideration. Currently, many nations—with the backing of their governments—have spent years researching and developing ways to make their forces lighter, more mobile and more lethal—all the while providing greater command-and-control and connectivity. These modernization efforts are "capability focused," with an emphasis on risk and cost reduction (White, 2007). These efforts are based on NATO's lessons learned from deployments in Iraq, Afghanistan, the Congo and Kosovo. European soldier modernization efforts are a result of shortfalls experienced in the following areas: identification of enemy and specific targets in built-up areas, communicating with sections and platoons while operating in close terrain, the heavy weight soldiers were expected to carry for upgraded capabilities, night operations hindered by night-vision systems requiring ambient light, transition from combat operations to reconstruction efforts, and heat injuries due to harsh environments and additional weight (2007).

No one country can afford to tackle this effort alone. While the United States leads this effort, soldier system development has been a team effort as global breakthroughs are made in combat technologies, ideas are shared, principles are proven and lessons are learned. Every year, multiple trade shows, conferences, consortiums and meetings take place among the NATO allies, industry and academia to discuss new developments and to trade ideas on how and what to improve in future soldier systems. The intent in the end is to ensure compatibility as missions require—not only for joint operations but when implementing multi-partner coalitions.

The EDGE

One of the leading efforts assisting NATO nations in their soldier modernization is being conducted through the General Dynamics EDGE facility located in Scottsdale, Arizona (see Figure 80). The EDGE facility, originally opened in November 2006, is capable of developing and testing new capabilities and technologies. It is a facility formed out of a joint venture of academia, US Government and industry and is, to date, credited with supporting more than ten technology initiatives since it opened. The facility is free to users and is sponsored by the US Government and academic institutions (White, 2007). The EDGE is characterized as a one-stop-shop for soldier modernization programs and is described as a catalogue for tactical systems, accessories, software and components—all of which are open to coalition and international partners (2007). Mr. Richard Coupland, Warrior Systems business area manager for General Dynamics states:

> The EDGE provides an operating process that will bring cutting edge technology to the tactical edge of the battlespace faster. By aligning the innovations of EDGE members with requests and feedback from warfighters and warfighting programs, we can deliver capabilities quickly that are relevant, interoperable and responsive. (as cited in White, 2007, p. 2)

To date, countries such as Australia, Britain, and Canada have all used the EDGE facility, as have some high-profile modernization programs like the Land Warrior, Air Warrior and the Future Warrior Technology Insertion (FWTI). The EDGE has assisted with modifying Australia's Land Warfare Acoustic System (LWAS) into an advanced capability for the United States' Land Warrior Initiative or as a stand-alone component for other interested NATO countries (2007). In addition, the EDGE facility has assisted in work on Britain's Bowman tactical digital communication system, Australia's Battlefield Command System and the Royal Netherlands Navy's Integrated Marine Command Information Systems program (2007). The EDGE brings "commonality" to systems so multiple countries can benefit from current technology. The EDGE facility's common architecture allows customers to access a "plug and play" capability—making quick adaptation of new or emerging technologies and incorporation of the needs of the customer possible. The EDGE has proven its worth by greatly assisting the US's Land Warrior efforts by combining the existing computer subsystem, navigation module, helmet-mounted displays, communications, power application and soldier control unit into a single component called Fusion 1.0. The EDGE reduced the weight of the original Land Warrior computer subsystem from 4.2 pounds to 1.49 pounds and decreased the overall size of the component from 2000 cubic centimeters to 580 cubic centimeters. Because the EDGE facility was able to dramatically reduce the size and weight of the Land Warrior system, General Dynamics has been able to incorporate the "Fusion" principle into all future soldier technology (2007).

Figure 104. General Dynamics EDGE Facility
(General Dynamics, 2008)

Canada

The Canadian efforts in soldier modernization programs can be traced back as far as 1988 to the “Soldier of Tomorrow” initiative. This effort, now officially called the Canadian Forces Integrated Soldiers System Project (ISSP) (see Figure 105), is unique within NATO because it focuses on the human factors of soldier systems—specifically, the dynamics of giving junior-ranking soldiers information to make life-or-death decisions in tense, stressful situations (Gillespie, 2005). The Canadian ISSP effort also focuses on the key aspects of situational awareness, information gathering and command-and-control. Canada has spent $7-$10 million dollars conducting tests and trials to see if the idea of a fully integrated soldier makes sense. If soldiers cannot process and disseminate the flood of information coming to them, then—to the Canadian government—it does not make sense to spend millions of dollars to upgrade to the new ISSP system, as soldiers will not be able to take full advantage of all its capabilities. To date, Defense Research and Development-Canada has run 70 separate experiments and sent Canadian soldiers to Fort Benning’s McKenna MOUT site more than seven times to determine the best way to use existing technology to benefit the soldier (Gillespie, 2005). It has investigated various ways of displaying information to the soldier, either visually through an eyepiece, on the chest through a flip-down module or through a PDA-like device attached to the wrist or arm. It has also conducted tests to determine the best means of providing a soldier protection against a potential chemical or biological attack while wearing devices around the face or head. It has examined the effectiveness of placing “directional finders” on the shoulders and sides of soldiers to direct them to turn right or left when navigating through terrain at night (2005).

Following the Defense Research and Development Center’s successful solider testing and feedback, the Canadian ISSP program now plans to use three separate builds in order to fully integrate its ISSP capabilities into its armed forces: one in 2010, another in 2013, and the last increment in 2017. This incremental approach will allow for technology and systems refinements/upgrades based on soldier feedback and operational usage reports. Rather than waiting for one “perfectly designed” system to arrive, this incremental fielding will bring proven, ready technologies to the soldiers faster. The Canadian government has budgeted $310 million dollars for the ISSP. The Canadian government is now looking at the EADS Warrior 21 system, which is already currently in use with the German Army in both Kosovo and the Congo. Warrior 21 integrates radios, digital maps, and range finding into one system—all controlled by a palm-sized computer and linked to a global positioning system that integrates all soldiers together and can be tracked through the headquarters command center (“Canadian Troops,” 2008).

Figure 105. Canadian Soldier Using the ISSP Capabilities
("Canadian Troops," 2008)

Singapore

The Singapore armed forces began their solider modernization program in 2002 (after the testing of the United States Land Warrior system), calling it the Advanced Combat Man System (ACMS) concept and technology development program (see Figure 106). The ACMS is designed around the concept of a seven-man squad, two three-man teams (grenadier, light machine gunner and sharpshooter) and a squad leader (Pengelley, 2008). The squad leader will have the full complement of components that make up the ACMS, while the other squad members will have variations of the system based upon their particular job within the squad.

The ACMS is currently made up of: a computer command-and-control information system (CCIS), which processes data in real time; a helmet-mounted display, which transmits the data from the CCIS; weapons camera with sensors; and several individual units of soldier protective gear, such as the ballistic vest, goggles, hydration system and weapon (Pengelley, 2006). The personal weapon has an integrated hand-grip with a weapons activator, allowing the soldier to control several weapons functions without removing his hand from the weapon. The weapons activator also allows the soldier to activate the networking capabilities of the ACMS—including calling for indirect fire and controlling unmanned aerial vehicle imagery or several unattended sensors (2006). Under the ACMS system, each soldier will be issued an individual wireless radio system, enabling him to talk wirelessly to every squad member, while the squad leader is issued a UHF voice and data radio that has a range of 250-500 meters in urban terrain and up to 2000 kilometers in open terrain (2006).

Figure 106. Singapore Soldier Wearing the Advanced Combat Man System (Pengelley, 2006)

European Allies

The European efforts in areas of soldier modernization are forging ahead through shared cooperation, knowledge, and open architecture. These efforts are expected to almost double in value from 2006 through 2015, with the largest growth seen in the procurement of equipment to improve sustainability, survivability and mobility. Currently, C4I makes up 62% of the market and is expected to comprise 60% of the European market in 2015. For a breakout of soldier modernization market value by country, see Figure 83 below.

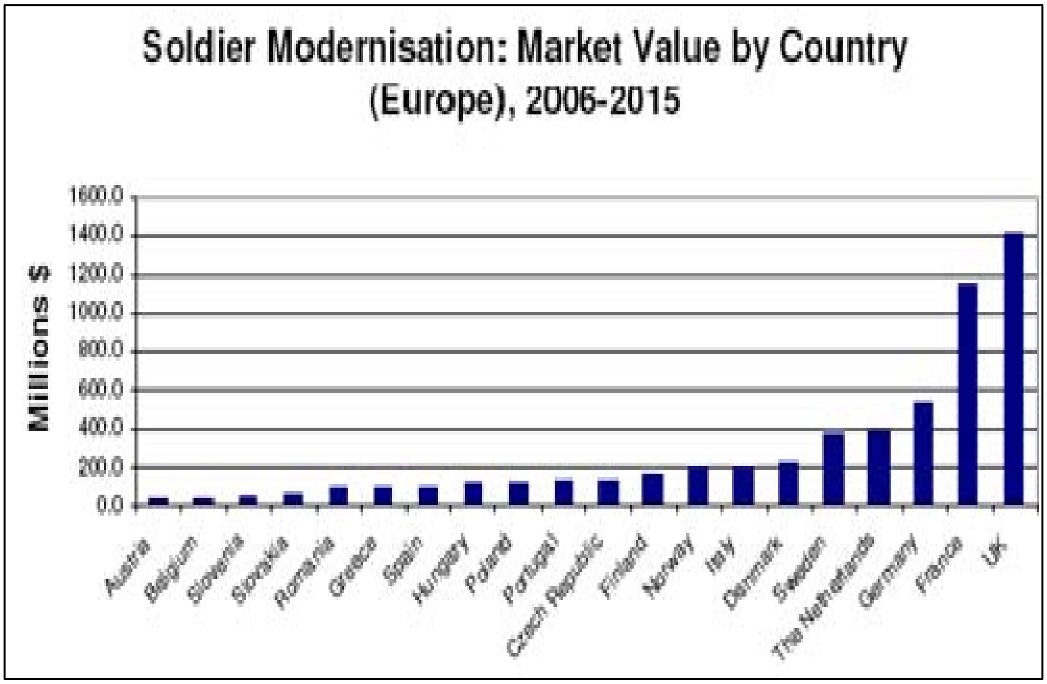

Figure 107. Projected Spending on Soldier Modernization Efforts
(Frost & Sullivan, 2007)

Britain

The UK is the biggest and perhaps the most ambitious NATO ally to pursue a soldier modernization program. Projections currently stand at $1.4 billion dollars to modernize its soldiers by 2015. The UK sees the challenges of modernizing in areas of weight reduction, usability and power management as key to its program: the Future Integrated Soldiers Technology, or FIST (see Figure 108). The FIST program will provide the UK soldier with significantly improved situational awareness, lethality and survivability. The UK has identified five main areas in its modernization program: C4I, lethality, mobility, survivability and sustainability.

When implementing the FIST program, the UK's Ministry of Defense has adapted an incremental approach to developing and fielding the FIST components. In the FIST program, technology is only introduced if there is clear benefit to the program and if the technology has been proven to withstand the harsh environments in which it is intended to operate (White, 2007). The FIST system is expected to enter service between 2015 and 2020.

Thales UK is the prime contractor developing the FIST. Thales is currently in the test and development phase of appropriate C4I and surveillance and target acquisition (STA) capabilities for the FIST Version 2, pending investment appraisal in 2008 (which could lead to a possible program procurement plan and the possibility of competing various systems) (White, 2007). The UK's "main gate" approval is expected in mid-2008, to be followed by the demonstration and manufacturing phase that will allow 29,000 soldiers to be equipped with FIST (2007). The initial operating capability is planned for 2010. In total, 35,000 FIST systems will be deployed throughout the British Army, Royal Air Force Regiment and Royal Marines.

Under the UK's FIST program, the infantry soldier is the key factor in implementing the UK network-enabled force. The FIST soldier will enable integrated communication above the company level and at the individual soldier level with his/her encrypted, line-of-sight, short-range radio. Voice, data communications, battlefield commands, and images from forward observers will be relayed to the soldiers via unmanned aerial vehicles. Soldiers will have a global positioning system, line-of-sight capability and graphic map displays that, when combined, will increase situational awareness (2007).

The UK is improving its lethality through the use of an enhanced sighting system that will be linked to the soldiers' helmet-mounted sight. The linked sighting system will enable the soldier to fire around corners while maintaining his protected position (2007). Another weapon enhancement available for the UK soldiers is the FIST laser rangefinder. This rangefinder will be able to transmit the range data to the weapon's munitions, enabling the round to detonate above the hidden target.

The FIST power requirement is estimated to be at least ten times that of current power needs. In 2004, the UK Ministry of Defense announced a bilateral information exchange with the United States, covering power cells, power management, fuel cells and batteries. Thales UK is closely monitoring the UK's three-year battery research and development program—a program aiming to develop the UK military's next-generation portable battery power system. The plan for the battery system is for it to be worn like the current Camelback water hydration system. Thales UK will try to integrate the future battery system when the technology is mature enough to determine if the fuel cells can operate in the extreme conditions in which the FIST equipment will be required to operate (White, 2007).

Cobham Defense Communications (CDC) Integrated Digital Soldier System (IDSS) is working closely with Thales UK to provide an integrated, self-contained, command-and-control unit that will provide the necessary capability and interfaces needed to build an overall soldier modernization ensemble. The IDSS system uses a suite of software that is designed to be scalable from command platforms down to the individual soldier level. The IDSS system runs on Windows XP and incorporates a single screen and stylus that enables the user to determine the receiving person or groups for messages, and then to send and receive messages. In addition, it has the capability of sending these messages wirelessly and will have a port to allow integration of a monocular device for night vision (2007).

Cobham Defense Communications is also completing work on 3D software that visualizes terrain high points to allow the soldier to view an image from any direction and then notionally allow him to "walk through" the image. Cobham has tested the IDSS with laser binoculars to potentially identify a target, geo-locate it on a map and send the information to headquarters. This particular software used by the geo-location technology can be set to update as fast as every three seconds, continuously providing soldiers and leaders with the most accurate and up-to-date information. The IDSS will also have a hub and USB interfaces so the soldier can update the system when mounted in a vehicle, giving him unlimited access to information (White, 2007).

Figure 108. United Kingdom Soldier Wearing FIST
(Army-Technology, 2008)

France

The French army was one of the first NATO nations in the early 1990s to sign on for the soldier modernization program. The French have taken the lead role in Europe in the fielding of modernization efforts, moving ahead with its Fantassin a Equipments et Liaisons Intergres system, better known as FELIN (see Figure 109). The FELIN system has four types of configurations: platoon leader, squad leader, rifleman and sniper. The FELIN system starts with the modernization of the uniform and nuclear, biological and chemical clothing. The uniform is made of water repellant, rip-proof, fireproof fabric with camouflage pattern to attenuate the user's visible and infrared signatures (Pengelley, 2008).

In the area of soldier protection, the French FELIN system has an upgraded modular ballistic vest, allowing modification for different types of missions. It includes an upgraded ballistic helmet with attachment points for light-intensification night-vision goggles, which can double as a data or imagery display for the C4I system, anti-laser goggles and anti-fragmentation jaw pads. The FELIN system requires two 14.8 V high-capacity lithium battery packs (each weighing 600 grams), with spare 7.4 V batteries used to power items that require standalone capabilities (Pengelley, 2008). For lethality, the French have modified their individual weapons with new front handles, three improved sights for both day and night use, as well as modifications on the top part of the weapons. These modifications allow the soldier to control all functions of the weapon—including acquiring a target, firing the weapon, using his personal radio, switching to remote observation, capturing images and video, altering the field of view from the weapon sight and switching between day and night functions of the weapons. The user can perform all these functions without removing his eyes from the target (2008).

At the platoon level, the FELIN offers a personal digital radio or Reseau d' Information FELIN (RIF). This RIF system consists of a wearable headband, can support 192 soldiers per network and has an encryption capability. The RIF can be used to send emergency signals, transmit images or videos and to monitor a soldier's location through the use of embedded GPS technology. The RIF network architecture allows for different configurations—allowing two networks to be monitored at the same time and for multiple sub-nets for squads and soldiers (2008). Another capability the FELIN has is the use of an Interface Homme Machine, or IHM. It is the display portion of the dismounted soldiers' control/management system. The IHM provides the means to compose and receive data messages and allows the monitoring of his and other squad members' positions (2008). A unique ability of the FELIN system is its ability to be purged remotely. In the event that a soldier is going to be captured or is killed, the soldier's system can be remotely turned off and wiped clean by the squad leader so information does not fall into enemy hands.

As of March 2004, Sagem Defense Securite is the prime contractor for development of the FELIN system. The French Defense Ministry tasked Sagem with delivering 31,600 FELIN systems: 22,600 for 20 infantry regiments and 9,000 more for the French armored cavalry, engineer and artillery units (Pengelly, 2008). All of the 20 infantry regiments are scheduled to be outfitted with the FELIN system by the end of 2010, with the other non-infantry units obtaining the system by the end of 2013.

Figure 109. French Soldier Wearing the FELIN System
(Pengelley, 2008)

Germany

The German military has been involved in the NATO working group for soldier modernization since the early 1990s; however, it left the working group to develop its own program in 1996 because of a fundamental shift in the German military doctrine that allowed it to deploy forces outside of European borders. That is when the Infanterist der Zukunft (IdZ) program was born (see Figure 110). Germany's focus on soldier lethality, situational awareness, survivability and operational capability became the foundation of the IdZ program. The IdZ consists of modular, easily upgradable body armor, integrated communications and night-vision equipment; it also includes a personal radio and handheld digital assistants that can send and receive imagery wirelessly (Kenyon, 2004).

Germany uses a base model system for the IdZ that can quickly be adapted and integrated with new technology as it is developed and proven in operational tests. The IdZ is built around the soldier, not the soldier around the technology. It is based on a 10-man mechanized infantry squad, with the squad armored personnel carrier being used to transport equipment, recharge batteries and provide data links and communication to higher echelons (2004). The squad is equipped with body armor, load-bearing vests, an integrated C4I system, laser rangefinder, observation gear, night-vision equipment and thermal sights.

The hub of the IdZ system is its C4I capability (called the navigation, information and communication system, or NAVICOM), which consists of a voice and data individual radio. The NAVICOM operates on an encrypted Bluetooth network, providing mapping and imagery data (Kenyon, 2004). The squad is issued one laser rangefinder, but—through the use of this wireless technology—data can be sent from the rangefinder to a soldier's NAVICOM and then shared with other squad members or with different units operating in the area (2004). In addition, the IdZ system has a digital camera that allows soldiers to take photographs and send the images wirelessly to other users. The IdZ digital camera allows three-dimensional digital pictures of potential objectives to be constructed for soldiers to better view the potential operating area during combat operations or preparations. In the future, the IdZ program leaders hope to incorporate micro-unmanned aerial vehicles and unmanned wheeled robots that can provide reconnaissance behind enemy lines, sending real-time streaming video data and digital imagery directly to the soldiers' NAVICOM.

Figure 110. German Soldier Conducting Operations with the IdZ
(Kenyon, 2004)

The Netherlands

The Netherlands' soldier modernization efforts, along with those of Germany, France and the United Kingdom, make up 62.8% of the soldier modernization programs in Europe (Frost & Sullivan, 2007). The Dutch soldier modernization program started in 1998 to integrate with ongoing programs within other NATO countries. The Dutch modernization program was tasked with improving the effectiveness and protection of soldiers due to the improved professionalism of its armed services, an increase in the mindset that high losses of personnel are not acceptable and to technological developments that have changed the perspective of decision-makers—urging them to view soldiers as a system and less as a person. The Netherlands views its soldier modernization program as a process rather than as a project with an end date to deliver a certain capability or system. This is because the Dutch modernization program is a Joint-Services program that has a very long timeframe and consists of various interrelated projects (Urlings, 2004). Initially, the Dutch modernization program only focused on upgrading combat soldiers, to include marines, air soldiers and ground-based Air Force personnel. However, after careful consideration, decision-makers determined that almost all soldiers are under the same type of conditions in the same harsh environments. Thus, the determination was made that the modernization program would encompass all Dutch military personnel; nonetheless, the equipment would be tailored to fit the individual soldiers' job position.

In June of 2000, the Netherlands hosted the "Soldier 2000 Demonstration." During that conference, it was decided that NATO would focus on "interoperability." Soon after, the NATO Topical Group I on Soldiers System Interoperability was established with the focus of ensuring that new or existing national soldier systems would be interoperable and be able to communicate with one another during major international operations (2004).

NATO has currently identified five areas that its members will focus on to improve soldier modernization programs: mobility, lethality, sustainability, survivability and command-and-control. The Dutch have taken these areas and modified them into five areas on which they are focusing their modernization efforts: clothing, equipment, communication and information, armament, energy and supply (2004). These five areas of focus have progressed into the current program, the Dutch Dismounted Soldiers System (D2S2). The main component of the D2S2 is the Communication and Information Module (CIM). The CIM has a wireless connection to the vehicle-arrayed Battlefield Management System, provides both the soldier and the commanding officer with a common operating picture, and enables communication between all soldiers. The CIM will contain an individual "soldier computer," a digital compass and a personal computer—all linked to a command-and-control center for complete situational awareness of soldiers in the nearby operating environment (2004). The Dutch will use the soldier as the center focus and build the system around him or her, basing it solely on the job the soldier performs.

The Netherlands has chosen an incremental approach to fielding the D2S2 system (see Figure 111). This approach allows for upgrades in technology, program process improvements and changes to other programs that the D2S2 might leverage from other NATO countries. Because the Dutch program manager has a restrictive budget, any new product introduced into the D2S2 program must be proven and integrated into the program within one year, or two years at the most.

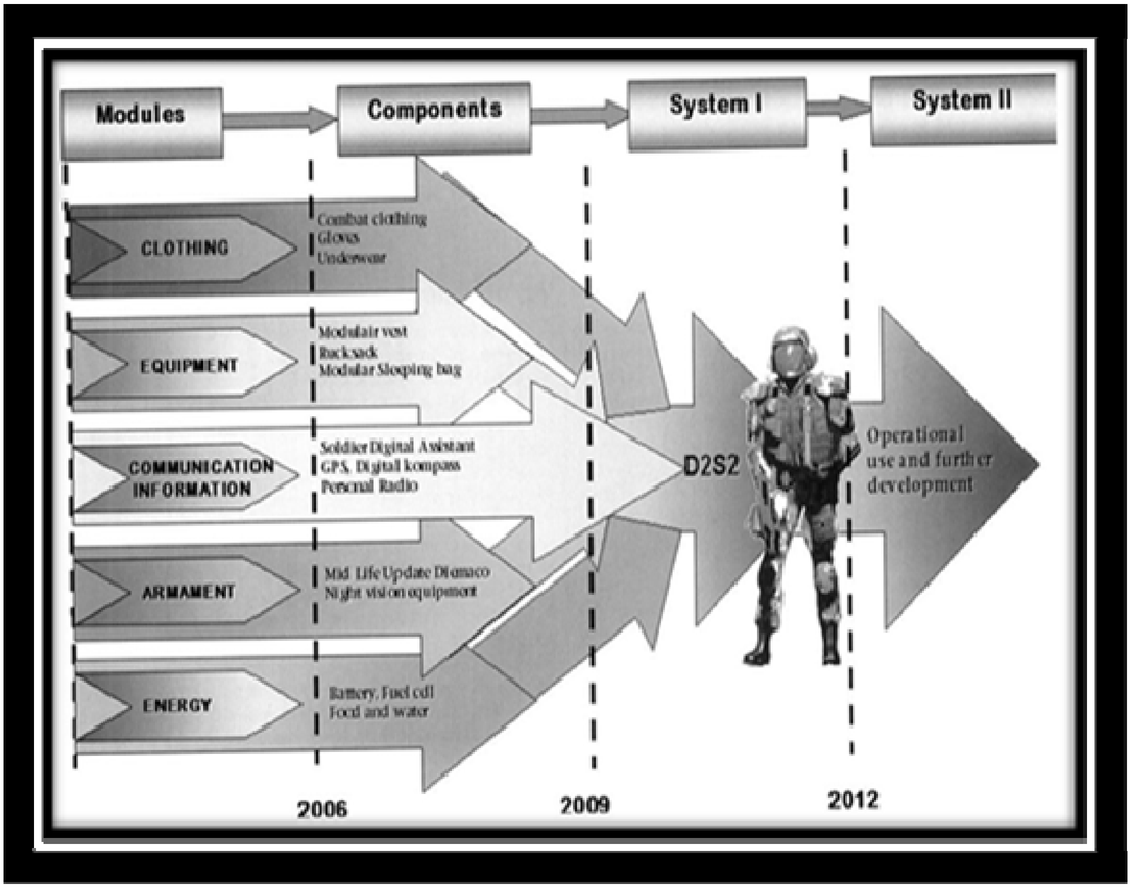

Figure 111. Dutch Acquisition of D2S2 Plan
(Urlings, 2004)

Denmark

The Danish military has participated in the development of the soldier modernization program through NATO, bilateral cooperation with other countries and participation in international defense conferences (Kiaerskou, 2007). The Danish military soldier modernization program uses a two-pronged approach: a long-term solution that will provide a fully integrated soldier system, and a short-term approach that will provide immediate capabilities for the current operational requirements. The short-term capabilities will be used to establish a baseline for the long-term capabilities that will complete the integrated soldier system program.

In June 2004, the Danish Parliament passed a new defense agreement covering the period from 2004 through 2009. The new defense agreement focuses on the transformation of operational capabilities to address the needs of warfighters in the 21st century; these capabilities include acquisition of modern crew-served systems, armored vehicles, as well as communication- and battle-management systems to secure an integrated network-enabled base for the individual soldier

(2007). Another project that came about after the defense agreement was the "future soldier" project. This project enables the military to pursue a system to enhance soldier protection and integration into Network-centric Warfare (Kiaerskou, 2007). This includes individual solider equipment, enhanced protection equipment, personal weapons (including those with nonlethal capabilities), radios, battle-management systems and logistics (2007). These initial focus areas are a direct response to short-term operational requirements and will serve as the foundation for the Danish long-term "future soldier" efforts.

The Danish military has focused its modernization program on five objectives: lethality, survivability, mobility, C4I and sustainability. It is using the incremental approach, allowing for fulfillment of capabilities needed for deployed forces while continuing to develop technologies that may not be ready for operational use. The Danish military has had some early success in four of its five focus areas. These successes include updating its small-arms family, using thermal cameras with laser range-finders, and procuring the following: new infantry fighting vehicles and reconnaissance and patrol vehicles with weapons stations, vehicle-mounted battle-management systems, field communications and data transmission systems between Tactical Air Control and aircraft, the unmanned aerial system (RAVEN), personal role radios for individuals and reconnaissance units, sniper location systems, ballistic protection and improved protection of wheeled vehicles (2007). Currently, the Danish military does not have any programs focused on improving soldier sustainability.

Italy

The Italian military has implemented the "Soldato Futuro" soldier modernization program; this involves two phases, the second phase consisting of three prototype system phases (see Figure 112).

The first phase consists of a 12-month technology demonstration phase, while the second phase consists of a 15-month operational test and evaluation phase. Currently, Italy's Soldato Futuro program is in the second phase of a three-month series of tests conducted at the Infantry School in Cesano (Po, 2007). If the operational tests are successful, they will lead to the initial production and deployment of 92 systems to light and mechanized Italian infantry units (2007). The Italians, like most of their NATO counterparts, have taken an open architecture, modular and incremental approach to designing and developing the "Soldato Futuro," ensuring its compatibility with other NATO nations' efforts.

The Italian army has identified six specific areas on which the "Soldato Futuro" modernization program is focusing: lethality, command-and-control, survivability, mobility and flexibility. It has identified three distinct configurations for the system: one for grenadiers, infantryman, and, finally, one for the squad leader (2007). The C4I component of the system has two aspects—one with the ability to communicate with the command-and-control systems at the Brigade and Regiment level and another with the ability to manage the command/control and navigation systems for their fighting vehicles. The communication system relies on a communications node unit that handles all network-centric communication and that separates intra- and inter-solider communication and data transfer (Po, 2007). All individual radio communication devices are voice and data and have a range up to 1300 meters. The system is equipped with a Wearable Personal Computer (WPC) with integrated Bluetooth technology, providing ease of data transfer and a wireless link to individual weapons systems. The system also features a GPS receiver that is woven into each soldier's load-bearing vest (2007). The system features an earpiece and microphone for the soldier to communicate with the squad; these are linked to a physiological sensor that monitors the soldier's heart rate and has the ability to erase all sensitive data from the soldier's system, as well as to remotely disable the communication device if he/she becomes a casualty (2007).

In addition, the Italians have modernized their individual weapon system. Their weapon has an adjustable stock, quick-change barrel and thermal imager. The thermal imager's image can be sent wirelessly through a Bluetooth link to other squad members. The "Soldato Futuro" system also has improved body armor, an improved ballistic helmet and improved lithium battery technology. In the future, the upgrades to the capabilities of the "Soldato Futuro" system will include a more powerful radio based on integrated software, increased compatibility and interoperability with NATO allies, advanced lithium batteries and improved situational awareness through the use of laser-based "identify friend or foe" technology.

Figure 112. Italian Soldier Wearing the "Soldato Futuro"
(Po, 2007)

Belgium

The Belgian Soldier Transformation, or BEST program, was started in 2002 as part of a study being conducted by the Belgian Defense Staff (see Figure 113). The study concluded that the Belgian defense forces needed an integrated, modular, open architecture program that aligned with other NATO nation programs in order to provide improved situational awareness, lethality and soldier protection in a quickly changing operational environment. The overall BEST strategy will focus on integrating capabilities gradually through mutual, open interfaces found in commercial off-the-shelf and military off-the-shelf (COTS/MOTS) technology. This will give the BEST program the flexibility to change and/or modify technology as improvements are developed (Coupe, 2004).

The BEST program managers perceive each soldier as an entire system rather than as an individual soldier and consider the entire unit as one weapons system. Thus, the objective of the Belgian program is to improve the soldiers' individual clothing, weapons systems and communication abilities.

The BEST program will focus on soldier-to-soldier communication—including network-enabled communications through the use of modular architecture. This will allow alternative radio solutions to be adapted and software to be designed and tailored for various missions and different levels of leadership (2004). Modular architecture can provide the capability of planning missions while on the move, providing enhanced operational flow and greater flexibility through the ability to upgrade technology using "plug and play" capability with new technology, and allowing quick upgrades to the system with minimal overall costs. The BEST network communications will provide a mix of voice/data technologies and communications abilities that will link the soldiers to other units—such as engineers, artillery and reconnaissance units—to include a multi-national interoperability capability (2004).

The BEST will improve the Belgian weapons system by providing advanced, lightweight, modular weapons and sensors with advanced fire-control systems, 24-hour, all-weather surveillance and target-acquisition capability—including a "blue force tracker" capability from a helmet-mounted display and an integrated weapons sight. The BEST will provide improved situational awareness through improved navigation and positioning systems that use laser range-finders, digital compasses and digital mapping technology (2004).

The Belgian military will continue to focus on an integrated, deliberate approach to modernizing its armed forces by taking advantage of the most recent COTS/MOTS technology, ensuring it maintains open cooperation and communication with fellow NATO nations, and by maintaining a continual improvement process for its soldiers.

Figure 113. Belgian Soldier Displays BEST System
(Coupe, 2004)

The types of current, ongoing warfighting operations around the world have proven the need for advanced solider situational awareness, lethality, mobility and survivability. To meet these needs, soldier modernization programs are progressing globally. The use of an iterative, modular, open architecture approach through cooperation, shared technology and integration of industry, Government, and academia will allow many of our NATO and European allies to develop systems that will add to our combined ability to promote peace and stability around the world.

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- Privatization-NOSL/NAWCI
- RFID (6)
- Risk Analysis for Performance-based Logistics
- R-TOC Aegis Microwave Power Tubes
- Sense-and-Respond Logistics Network
- Strategic Sourcing

Program Management

- Building Collaborative Capacity
- Business Process Reengineering (BPR) for LCS Mission Module Acquisition
- Collaborative IT Tools Leveraging Competence
- Contractor vs. Organic Support
- Knowledge, Responsibilities and Decision Rights in MDAPs
- KVA Applied to Aegis and SSDS
- Managing the Service Supply Chain
- Measuring Uncertainty in Eared Value
- Organizational Modeling and Simulation
- Public-Private Partnership
- Terminating Your Own Program
- Utilizing Collaborative and Three-dimensional Imaging Technology

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