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Improving the future of the Army's future combat systems program

Pettus, William; Lazar, Arbi

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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

JOINT APPLIED PROJECT

Improving the Future of the Army's Future Combat Systems Program

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June 2009

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The Future Combat Systems (FCS) program is the U.S. Army's ambitious attempt to modernize its forces in a systematic way, so that everything interoperates properly. This "system of systems" approach contrasts with the "stove-pipe" solutions of the past in which individual systems were designed to meet specific requirements, but with much less thought about how they would interact in the overall force. The "stove-pipe" approach has worked well enough in the past because the self-contained requirements were more important than how well a platform could interact with other platforms. But as we move further in the digital age where information superiority and speed of action are such key enablers of the force, it has become increasingly critical to tie the entire force together. The Army has gambled that the best way to do this is to design the future force holistically, fielding a sum that is greater than its parts. However, the enormity of the task was not originally apparent to its designers. This fact is becoming increasingly clear to Congress as the Army has been forced to increase funding requests and extend timelines several times. In reaction, Congress is considering a number of actions including the cancellation of the program. This paper examines the status of the FCS program and provides several recommendations on how the FCS program office could reduce risk while still bringing critical new technology to the U.S. Army in a timely manner.

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IMPROVING THE FUTURE OF THE ARMY'S FUTURE COMBAT SYSTEMS PROGRAM

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IMPROVING THE FUTURE OF THE ARMY'S FUTURE COMBAT SYSTEMS PROGRAM

ABSTRACT

The Future Combat Systems (FCS) program is the U.S. Army's ambitious attempt to modernize its forces in a systematic way, so that everything interoperates properly. This "system of systems" approach contrasts with the "stove-pipe" solutions of the past in which individual systems were designed to meet specific requirements, but with much less thought about how they would interact in the overall force. The "stove-pipe" approach has worked well enough in the past because the self-contained requirements were more important than how well a platform could interact with other platforms. But as we move further in the digital age where information superiority and speed of action are such key enablers of the force, it has become increasingly critical to tie the entire force together. The Army has gambled that the best way to do this is to design the future force holistically, fielding a sum that is greater than its parts. However, the enormity of the task was not originally apparent to its designers. This fact is becoming increasingly clear to Congress as the Army has been forced to increase funding requests and extend timelines several times. In reaction, Congress is considering a number of actions including the cancellation of the program. This paper examines the status of the FCS program and provides several recommendations on how the FCS program office could reduce risk while still bringing critical new technology to the U.S. Army in a timely manner.

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EXECUTIVE SUMMARY

The Future Combat Systems (FCS) program is the U.S. Army's ambitious attempt to modernize its forces in a systematic way so that everything interoperates properly. FCS delivers multiple integrated systems consisting of Manned Ground Vehicles, Unmanned Ground Vehicles, Unmanned Air Vehicles, Sensors, and a Network designed to seamlessly tie all these new platforms and capabilities together into one modern fighting force that, together, will yield a sum (in terms of combat capability) much greater than its individual parts. In theory, this is the way to go. But as with many recent large Department of Defense programs, the task has ended up being much more complicated than originally estimated, resulting in cost and schedule overruns. As a result, the Army has been facing enormous pressure from Congress to cancel or restructure the FCS program.

Since the program's inception, the wars in Iraq and Afghanistan have dramatically changed the playing field: Today's fight against irregular forces in urban environments is completely different than fighting a conventional engagement and makes some question the urgency of developing the weapons and systems of the "future." In addition, the idea of using a commercial contractor to oversee government development – the Lead Systems Integrator (LSI) concept – has fallen out of vogue. Many lawmakers now see the LSI concept as leaving the "fox in charge of the henhouse." In the face of these pressures, the Army has stayed flexible, trying to meet the demands of many of its detractors by making multiple changes to the program. But we believe that this formula may be insufficient and puts this entire groundbreaking program at risk.

Army leadership is starting to appear as the proverbial Dutch boy with too few fingers to stop all the leaks that are emerging. By trying to respond to the many pressures and do so without raising their cost estimates, the Army is beginning to lose its credibility. Some specific recent actions by the Army include:

- Planning to deploy equipment (the Non-Line of Sight [NLOS] cannon) before it is ready so that it can appease some of its detractors

- Reducing the number of platforms from 18 to 14 so that it can control spiraling costs
- Keeping their cost estimate for the program pinned at $161 Billion, even though estimates from independent groups (the Cost Analysis Improvement Group [CAIG] and the Institute for Defense Analysis [IDA]) show costs growing to as high as $300 Billion
- Acknowledging that its own estimate for the number of required software lines of code has grown by 50 percent, but then insisting that costs will not grow

These actions smack of desperation and send the message to Congress that, rather than managing the program in a pro-active and upfront manner, the Army has chosen to defend their current course of action regardless of mounting evidence or pressures.

We therefore conclude that it is time for the Army to conduct a major program restructuring in order to protect the concept of a long-term modernization program that can steer the development and integration of new systems into the Army.

In particular, we recommend that the Army create a Future Combat Systems Integration (FCSI) office. This Army-managed and staffed office would be charged with planning for the integration of new systems into the panoply of Army systems. This office would replace the current FCS management structure and, in particular, the LSI.

Rather than trying to plan everything we need or want in a single stroke of genius, as was attempted in 2003, the FCSI office will:

- Work on the incremental improvement of the Army by identifying the systems that are needed in the short-term. The FCSI office would work with the Army Material Command (AMC) to ensure that these systems receive appropriate prioritization and funding in the POM
- Development of individual systems would be managed by Army Project Managers, as it has traditionally been done. However, the FCSI office would be intimately involved in the initial engineering to ensure that the system(s)

would fit properly into the System of Systems. In addition, the FCSI office would serve as a member of the Integrated Product Team (IPT) for each new or evolved system, and would support test and integration efforts

The writing is on the wall that the Army will not be able to afford to focus on both its needs in Iraq and Afghanistan and its long-term vision of the future as if they were largely separate entities. We believe that this recommendation would help to bring these two views back into a single, focused vision in which the Army develops the items it needs now, while working to integrate each new development into this single, cohesive force where the interoperability of each item has been considered and planned for from the start by an office that is specifically charged with this function.

In terms of short-term priorities, we recommend that the new FCSI office:

- Handoff responsibility for all detailed development of systems to the appropriate Army project managers while maintaining overall responsibility for setting priorities, defining requirements and planning integration.
- Delay development of all the new FCS manned vehicles except for the NLOS Cannon.
- Field the Class I UAV (a small soldier-launched UAV) as soon as practicable because it can assist in current operations in Afghanistan and Iraq. Terminate FCS development of the Class IV UAV.
- Field the Small Unmanned Ground Vehicle (SUGV) (a small soldier-operated robot) as soon as practicable because it can assist in current operations in Afghanistan and Iraq. Delay further development of the Multi-Functional Utility Logistics and Equipment (MULE).
- Continue to fund FCS network efforts.
- Terminate development of the NLOS Launch System.
- Continue work on Unattended Ground Systems.

We believe that these steps will keep the FCS program viable, allowing it to continue its long-term task of transforming the Army while integrating the program into the existing Army structure so that it can better leverage the programmatic expertise in existing Army project offices while accelerating efforts to assist our soldiers in the field with FCS technologies

I. INTRODUCTION

Future Combat System (FCS) is the multiyear, multibillion-dollar program at the heart of the U.S. Army's transformation efforts. It is the Army's major research, development, and acquisition program for the foreseeable future and is to consist of 14 manned and unmanned systems tied together by an extensive communications and information network. FCS is intended to replace such current systems as the M-1 Abrams tank and the M-2 Bradley infantry fighting vehicle. The FCS program has been characterized by the Army, Congress, and the press as a high-risk venture due to the advanced technologies involved as well as the challenge of networking all of the FCS subsystems together.[1]

As with many large Department of Defense (DoD) programs, FCS has both its problems and its detractors. The cost for the FCS program has grown from initial estimates and delivery schedules have been delayed. This has led Congress to look very closely at the FCS program. The program does have some significant support in the Pentagon and in Congress. But the Government Accountability Office, the Congressional Research Service, and the Congressional Budget Office have raised many serious issues about the program. The Army still fully supports FCS, but the decisions that Congress makes on the program may delay or cancel the program, regardless of the Army's support. The perspective of the GAO and Congress on these issues could have significant implications for the future of the program, so it is critical that the Army carefully consider these issues in its plan. However, it will also be evident that input from the many concerned parties is often conflicting or attempting to hold the FCS program to unreasonable standards. In order to protect this transformational program, the Army has to find the middle ground between knee-jerk reactions to unfortunate suggestions and reactionary dismissal of all outside input.

This paper examines the primary issues facing the FCS program, analyzes a number of alternative approaches for the Army to take, and presents our recommendations on the best way forward. The paper is organized as follows:

- The background section focuses primarily on the plans of the FCS program.
- The data section provides in-depth examination of the issues facing the FCS program. These issues include cost, schedule, technology readiness, reliance on other programs, management approach, and relevance in the current/future security environments. Each issue is examined from the perspectives of the various involved parties including Congress, the Department of Defense, the FCS Program, and individual soldiers.
- The analysis section presents several possible alternatives for the Army to pursue regarding the fielding of FCS and examines the benefits of each.
- The conclusions and recommendations section provides our recommendations on the steps that should be taken by the Army in order to provide the FCS program its greatest probability of success.

II. BACKGROUND

A. FCS PROGRAM ANATOMY

The FCS program was first conceived by then-Army Chief of Staff, General Eric Shinseki, as a way to enable Army units to react to overseas crises quickly and with overwhelming combat power. Units with significant firepower—so-called heavy units—can take weeks to deploy overseas. By contrast, light units lack heavy weapons but can be transported quickly. To correct those deficiencies, the Army initiated the FCS program to develop a new generation of combat vehicles.[2]

In initiating the FCS program, the Army made a major break from traditional Army development practices by adopting a concept that was in vogue at the time, the use of a Lead System Integrator (LSI). The LSI is a commercial interest, in this case the Boeing Corporation with Science Applications International Corporation (SAIC) as a principle subcontractor. The LSI is basically charged with completing the entire effort, from doing the planning, concept development and engineering, to acting as the prime for the building and fielding all the equipment. Under the LSI concept, Boeing and SAIC have assumed many of the roles that traditionally are fulfilled by the government.

Fielding for the first full FCS Brigade is slated for fiscal year 2015, but FCS technology is being accelerated to the Army's modular brigades through "Spin Outs." These Spin Outs will allow Soldiers to utilize FCS equipment and technology as it becomes available. Recently, the Army announced that this Spin Out 1 equipment will be provided to soldiers of the Infantry Brigade Combat Teams (BCT) beginning in 2011. Spin Out 1 consists of FCS (BCT) Battle Command capability, Joint Tactical Radio System (JTRS), Unattended Ground Sensors, the Non Line of Sight-Launch System, the Small Unmanned Ground Vehicle (SUGV), and the Class I Unmanned Air Vehicle.[3]

After the fielding of the first brigade, the Army plans to equip its combat brigades with FCS components at a maximum rate of 1.5 brigades per year, purchasing 15 brigade sets of equipment as part of the first installment—or "increment"—of the FCS program.

Under the current schedule, equipment for the 15th brigade would be purchased in 2023, which would allow it to be fielded in 2025.[4]

Program Overview: The FCS program plans to deploy fourteen new systems plus the network. As depicted in Figure 1, the fourteen systems consist of: eight Manned Ground Vehicles (MGV), two Unmanned Ground Vehicles (UGV), two Unmanned Aerial Systems (UAS), Unattended Ground Sensors (UGS), and the Non-Line-of-Site Launch System (NLOS-LS).[5]

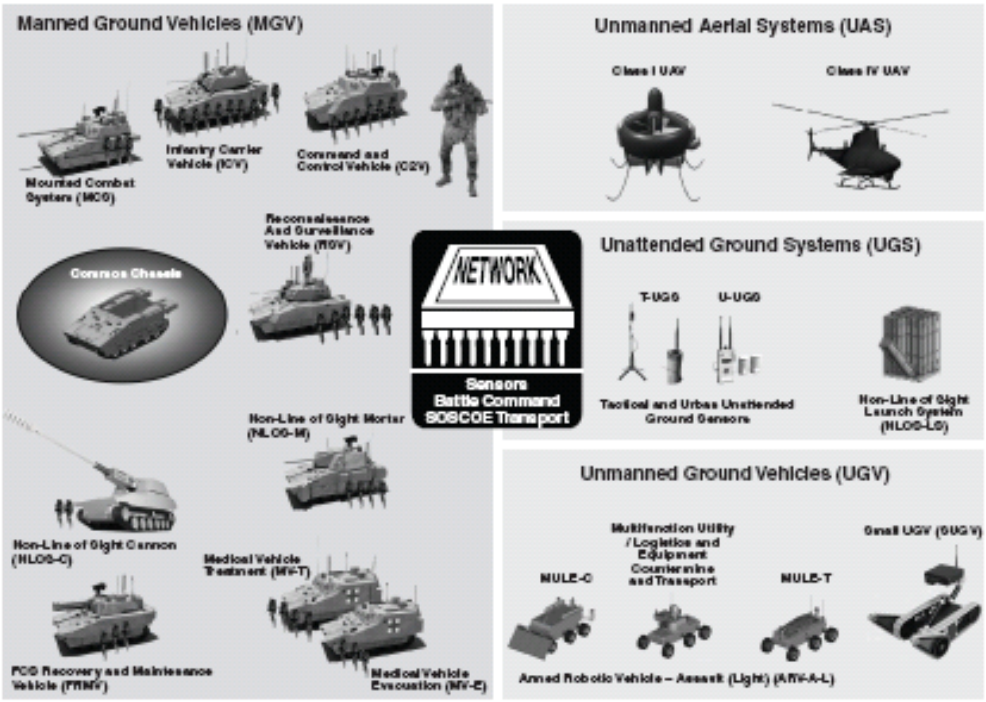


Figure 1. FCS Core Systems

Manned Ground Vehicles:

The eight varieties of Manned Ground Vehicles that FCS plans to deploy are designed to replace basically all the vehicles in the Army's current inventory. The vehicles are to be designed using a common chassis and engine to improve logistic supportability. Improved fuel efficiency is also a core goal. Initially, the vehicles were all going to be designed to be transportable on an Air Force C-130, which would have

required that the vehicle weigh less than 20 tons. However, this constraint has since been relaxed to 24 tons.[7] The 8 manned FCS Vehicles are depicted in Figure 2 below.

Figure 2. Varieties of Manned Ground Vehicles

Mounted Combat System (MCS). The MCS is equipped with a 120 millimeter (mm) gun capable of destroying targets at a range of 8 kilometers (km) and is designed to replace the M1A2 Abrams tank. However, the MCS will weigh one-third as much as the Abrams, making it more deployable and much more fuel efficient.[8]

Infantry Carrier Vehicle (ICV): The ICV can carry up to nine soldiers and two crew members and is designed to replace the Bradley fighting vehicle. The ICV is armed with a 30 mm cannon that is more powerful than the Bradley's 25mm, but weighs 25% less, again providing increased fuel efficiency.[9]

Non-Line-Of-Sight Mortar (NLOS-M): The NLOS-M will be equipped with a mounted mortar capable of firing precision-guided mortar rounds. The NLOS-M is actually heavier than the unit it replaces: the M113 based mortar carrier. [10]

Non-Line-Of-Sight Cannon (NLOS-C): The NLOS-C replaces the M109 self propelled howitzer. The NLOS-C will provide a faster rate of fire and faster road speeds than the M109. The M109 is the oldest vehicle in the Army's arsenal.[11]

The FCS program office has the following to say about NLOS-C: "The NLOS-C is much different than all the other combat vehicles produced by the Army thus far. Advanced NLOS-C technology such as an automated loading system and improved accuracy through a projectile tracking system, coupled with the power of the FCS network and sensors, provides the NLOS-C's two-man artillery crew with capability to quickly deliver highly accurate sustained fires for close support and destructive fires for standoff engagements. This networked capability is important during both counter insurgency and conventional fights. 'After receiving situational awareness reports from the FCS network, the NLOS-C will be able to put precision fires on target in less than thirty seconds,' stated Lieutenant Colonel Robert McVay, Army Product Manager for NLOS-C, 'This is especially important in counter insurgency warfare as it will deprive the enemy of the ability to 'shoot and scoot,' while allowing Soldiers to put precise rounds into urban environments that will help reduce collateral damage.'[12]

Reconnaissance and Surveillance Vehicle (RSV): The RSV features a suite of advanced sensors to locate and identify enemy targets in all weather conditions, day and night.[13]

- **Command and Control Vehicle (C2V):** The C2V will provide commanders with the information and command and control resources needed to direct the battle. It replaces the M113-based command and control vehicle. [14]
- **Medical Vehicle (MedV):** The MedV is being designed to provide advanced life support to critically injured soldiers while they are being evacuated from the battlefield. It will provide an enormous improvement in capability as compared to the current M113-based ambulance.[15]
- **Recovery and Maintenance Vehicle (RMV):** The RMV is designed to transport repair crews around the battlefield and to recover disabled vehicles. It replaces the M88A1 Recovery Vehicle. The RMV is 60% lighter than the M88A1, which had to be heavier in order to haul the Abrams. With the FCS vehicles being so much lighter, the recovery vehicle can also be lighter. [16]

Unmanned Ground Vehicles:

As depicted in Figure 3, the two varieties of Unmanned Ground Vehicles (UGV) that FCS plans to deploy are the:

- Multifunctional Utility, Logistics, and Equipment (MULE), which is a 2.5 ton robotic vehicle that will come in two variants: a transport version which can carry up to 2,400 pounds; and a countermine version, which would detect, mark, and defuse mines. [17]
- Small Unmanned Ground Vehicle (SUGV), which is a lightweight robot designed to be man-portable and to be able to scout ahead of the soldiers. [18] The FCS website (fcs.army.mil) quotes a SGT Matt Sena (C Company, 2nd Cav, 1st Armor Division) as observing that: "In Ramadi, we could have used the SUGV to easily identify IEDs [Improvised Explosive Devices] on a squad or platoon level instead trying to secure the whole area for up to 4-5 hours waiting for EOD [Explosive Ordnance Disposal]. Definitely would help by giving you an early warning with possible IED positions and in buildings in hostile areas." [19]

Figure 3. Unmanned FCS Ground Vehicles

Earlier, there was a third variety of UGV, the Armed Robotic Vehicle (ARV), which would be a much larger scouting vehicle capable of either combat or improved Intelligence, Surveillance, and Reconnaissance (ISR), however, this vehicle was recently removed from FCS planning as part of the re-structuring of the program.

Unmanned Aerial Systems:

In its original plan, the Army planned to deploy four classes of Unmanned Aerial Vehicles, identified as Classes I through IV, with Class I being the smallest and to Class IV, the largest. Recent changes have deferred Classes II and III.[20]

The unmanned FCS Aerial System vehicles are depicted in Figure 4.

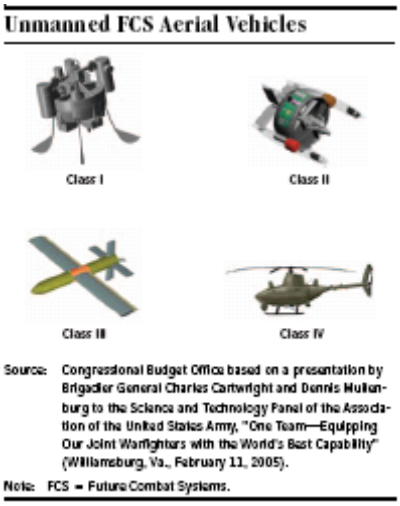


Figure 4. Unmanned FCS Aerial Vehicles

The Class I UAV is being designed for use by an individual soldier. Weighing in at less than 15 pounds, it will be man-portable and able to provide real-time intelligence data back to soldiers operating at the platoon level. The Class I will be able to take off and land vertically, have a range of 8 km and be able to stay aloft for almost an hour.[21]

The Class IV UAV is at the opposite end of the spectrum from the Class I. Weighing in at over 3000 pounds and requiring a team to maintain it, the Class IV UAV

has a ceiling of 20,000 feet, a payload of up to 700 pounds (for short range missions) and the capability to stay aloft for up to 8 hours (with a reduced payload).[22]

Other Unmanned Ground Systems:

As depicted in Figure 5, FCS includes two additional classes of unmanned systems: Unattended Ground Sensors (UGS) and the Non-Line of Sight Launch System (NLOS-LS). FCS previously included the Intelligent Munitions System, but this has recently been broken out into its own independent program.[23]

There are two basic variants of Unattended Ground Sensors: Tactical UGS (T-UGS) and Urban UGS (U_UGS). T-UGS are further divided into Intelligence, Surveillance, and Reconnaissance UGS (IRS-UGS) and Chemical, Biological, Radiation, and Nuclear UGS (CBRN-UGS).

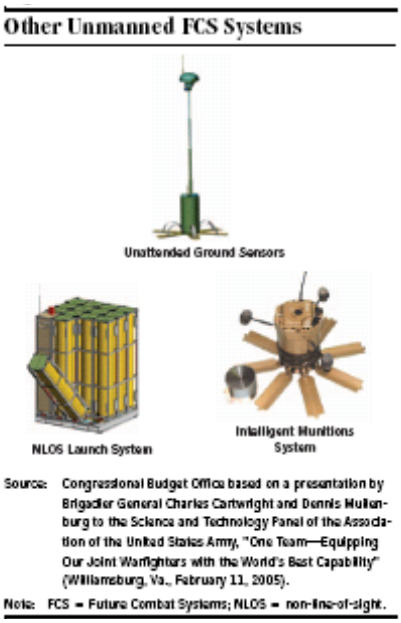


Figure 5. Other Unmanned FCS Systems

In each of their various forms, the UGS are designed to be set up and left behind to be able to report information via radio on their locality. For instance, a field of ISR-UGS might be used to provide situational awareness for a mountain pass that has been bypassed by the main force to ensure that forces can be vectored there if the enemy attempts to use the pass to infiltrate troops into our rear area. CBRN-UGS can provide

early warning to the troops of the presence of these lethal threats. Urban UGS can be utilized by soldiers to provide situational awareness on blocks and houses that have already been cleared so that the focus can be on what is in front of the troops while greatly reducing the risk from the rear.[24]

As depicted in Figure 6, the NLOS-LS is basically a box containing 16 slots: 15 individual missile canisters and a canister of electronics to control them and communicate with the outside world. The intent is to set these boxes up in the area of operations to allow other components of the FCS force to be able to rapidly call in precision fire support via network communications. Originally designed to host two different missiles, the Precision Attack Missile (PAM) and the Loiter and Attack Missile (LAM), the complement has temporarily been reduced to just the PAM. The PAM is a 117 pound missile with a range of 40 km. It includes Imaging Infrared/semi-active laser with automatic target recognition and terminal homing. It is also networked so that it can be re-targeted in-flight.[25]

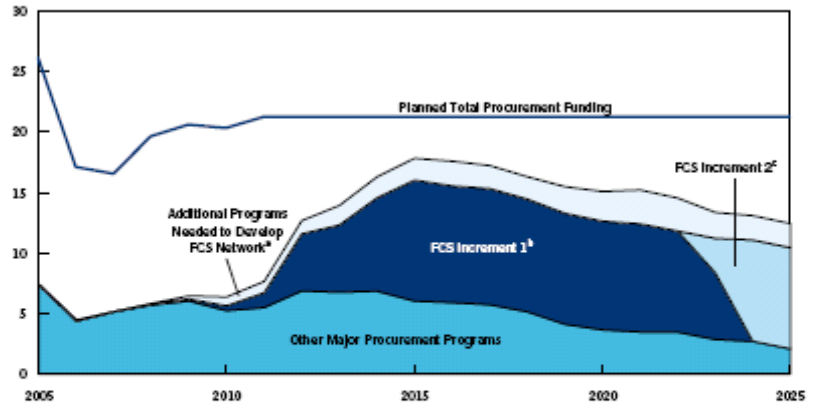
Figure 6. NLOS-LS Box Containing 16 Slots

Cost of the Army's FCS Program. The FCS program represents by far the largest single investment that the Army is planning to make for the next 20 years. The research and development (R&D) portion of the program is scheduled to extend through 2016 and require a total of $21 billion from 2007 to 2016. The Army estimates that total procurement costs for the first 15 brigades' worth of systems will be just over $100 billion, which translates into an average unit procurement cost of $6.7 billion per brigade. With the planned purchase of 1.5 brigades per year to begin in 2015, the FCS program

will require $8 billion to $10 billion annually starting in that year and for as long as the program continues yearly purchases at that rate (see Figure 1).[26] As depicted in Table 1 and Table 2, the current cost estimate is more than twice the initial estimate.[27]

The Army's Major Procurement Programs and Budget Through 2025

(Billions of 2006 dollars)



Source: Congressional Budget Office based on Office of the Secretary of Defense, *Selected Acquisition Reports*, various systems (September 30, 2005, and December 31, 2005).

Notes: Major procurement programs are those for which the Army is required to submit Selected Acquisition Reports to the Congress.

FCS = Future Combat Systems.

a. Includes the Joint Tactical Radio System Clusters 1 and 5 and the Warfighter Information Network-Tactical program.

b. Under this phase of the FCS program, the Army would purchase a total of 15 brigades' worth of FCS equipment at a rate of 1.5 brigades' worth per year.

c. During this phase, the Army would continue to purchase 1.5 brigades' worth of FCS components annually through 2025.

Table 1. Current Cost Estimate vs. Initial Estimate

Table 3: Comparison of the Original Cost Estimate and Recent Cost Estimates for the FCS Program (in billions of dollars)

	May 2003 Army estimate	December 2005 Army estimate	May 2006 CAIG estimate	December 2006 Army estimate	April 2007 IDA assessment
Base-year 2003 Dollars					
Research, development, testing, and evaluation	$18.1	$26.4	$31.8 - 44.0	$25.1	Approx $38.1
Procurement	$59.1	$92.8	$118.7	$87.5	N/A
Total	$77.2	$119.2	$150.5 - 162.7	$112.6	N/A
Then-year Dollars					
Research, development, testing, and evaluation	$19.8	$30.6	$36.8 - 52.7	$29.3	N/A
Procurement	$71.8	$133.1	$166.7 - 181.2	$131.6	N/A
Total	$91.4	$163.7	$203.3 - 233.9	$160.9	N/A

Source: U.S. Army, Office of the Secretary of Defense, IDA (data); GAO (analysis and presentation).

Table 2. Comparison of Original Cost Estimate

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III. DATA

The data section provides an in-depth examination of the issues facing the FCS program. These issues include cost, schedule, technology readiness, reliance on other programs, management approach, and relevance in the current/future security environments. Each issue is examined from the perspectives of the various involved parties including Congress, the Department of Defense, the FCS Program, and individual soldiers. These perspectives are garnered from a multitude of open source documents including Congressional Budget Office studies, Government Accountability Office reports, the reports of Congressional Committees, the FCS website, and the articles of various news organizations.

The data are extracted from published papers and reports by numerous sources, such as the Office of Secretary of Defense (OSD), the Congressional Research Service (CRS), the Government Accountability Office (GAO), the Department of Defense (DoD) Cost Analysis Improvement Group (CAIG), the Institute for Defense Analysis (IDA), the Program Manager, Future Combat System (PM FCS), the Program Executive Officer, Joint Tactical Radio System (PEO JTRS), and the Program Manager, Warfighter Information Network—Tactical (PM WIN-T).

A. PROGRAM RISKS & CONSTRAINTS

According to the Department of Department (DoD) and the Congress, the Future Combat System (FCS) program is characterized as a high-risk venture due to the advanced technologies involved, the aggressive system development schedule, and the challenge of networking numerous FCS subsystems together so that all future FCS-equipped Army Brigade Combat Teams (BCTs) can function in an interoperable, networked fashion, as intended. Furthermore, the recent streams of federal fiscal policies have placed budgetary constraints on the FCS program with several consecutive annual budget cuts and the recent major restructuring of the program from 18 systems to 14 systems. [28]

The Army started the FCS program in May 2003 before having defined what the systems were going to be required to do and how they would interact. The Army moved ahead without determining whether the concept could be successfully developed with existing resources, i.e., without proven technologies, a stable design, and available funding and time. The Army projects the FCS program will cost $160.9 billion. Given its cost, scope, and technical challenges, the program is recognized as being high-risk and needing special oversight mandated by Congress, requiring the GAO to report annually on the FCS program. [29]

1. Congressional Position

CRS and GAO have been tasked by Congress to provide independent assessments on the FCS program and have published numerous reports to address a variety of FCS program issues to include the program's timeline, current program developmental risks and challenges, program management issues, and FCS relevance in the current and future security environments. The following sections provide detailed Congressional positions on all FCS program issues, challenges, and concerns.

a. Program Schedule Concern: Misalignment of Key Decision Points with Key Knowledge Points

The GAO was concerned that the FCS design and production maturity are not likely to be demonstrated until after the production decision is made. As depicted in Table 3, the FCS program timeline, the Critical Design Review (CDR) will be held much later than on other Army programs of record. Therefore, the Army will not be building production-representative prototypes to test before production. The first major test of the FCS networking capability will not take place until near the FCS production decision and much of the testing will involve simulations, technology demonstrations, experiments, and single-system testing. Historically, testing is considered the most expensive during the production phase. GAO suggested since most of the problems that will be discovered during the pre-production test will not be resolved in time for the production decision, more testing will be required to take place in the production phase. [30]

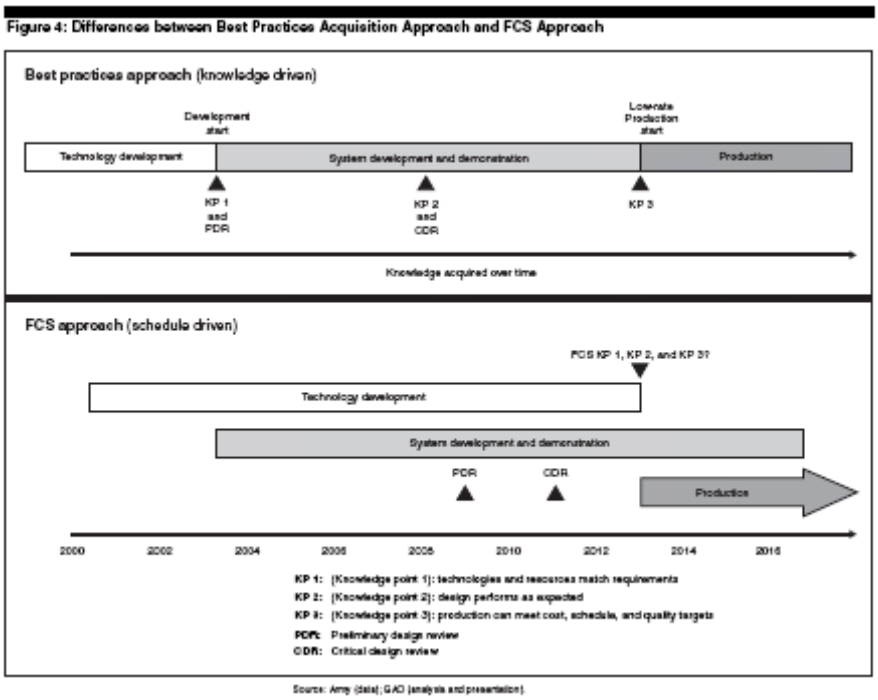


Table 3. Best Practice Acquisition Approach

Excerpted from: Defense Acquisitions, 2009 is a Critical Juncture for the Army's Future Combat Systems; United States Government Accountability Office, Mar 2008. [31]

The FCS Capabilities will not be demonstrated until after key decision points. The three knowledge points key to a successful government acquisition are technology maturation, system integration and demonstration, and pre-production planning. The Army will demonstrate the FCS system of systems capability after the FCS production decision in 2013, which precludes opportunities to change course if warranted by test results. The late demonstration will increase the likelihood of costly discoveries and fixes late in development or during the production stage, since the program cost and schedule will become less forgiving than in earlier development stages. According to the government acquisition best practice, production-representative prototypes should have been demonstrated and tested prior to a low rate production decision. Therefore, the issue lies in the misalignment of the program's normal progress with the key events that are used to manage and make decisions. Under the FCS Program, key decisions are being made well before sufficient knowledge is attained. [32]

According to best practices recommended by the GAO, the most important part of the knowledge-based approach occurs at program start when product development begins. At that point, a timely match of requirements and resources is critical to successful product development. When a customer's needs and developer's resources are matched before a product's development starts, it is more likely that the development will result in a successful product that is able to meet cost, schedule, and performance objectives. When this match takes place later, after the product development is underway, problems will occur that can significantly increase the expected time and cost as well as result in performance shortfalls. [33]

b. Technology Risks: Requirements, Designs, and Technologies

According to the GAO, the definition, development, and demonstration of the capabilities will finish late in the FCS program schedule. The Army ideally should have entered development in 2003 with firm requirements and mature technologies. Nevertheless, as depicted in Table 4, the FCS program will be challenged to meet these goals by the time of the Preliminary Design Review in 2009. To make thing worse, the Army has only recently formed an understanding of what will be expected of the FCS network. It will be years before demonstrations validate that the FCS will provide full System of Systems capabilities. [34]

Table 1: FCS Critical Technology Maturation—Actual and Projected

	Development Start	August 2006	July 2007	2009 Preliminary design review	2011 Critical design review	2013 Production decision
TRLs ≥ 7	0	1	2	2	5	44
TRLs = 6	10	34	30	41	39	0
TRLs ≤ 5	42	11	12	1	0	0

Source: U.S. Army (data); GAO (analysis and presentation).

Table 4. FCS Technology Maturation

Table excerpted from: Defense Acquisitions, 2009 is a Critical Juncture for the Army's Future Combat Systems; United States Government Accountability Office, Mar 2008.[35]

While the Army should have had firm requirements at the outset of its development program, it is now facing a challenging task to complete this work by the 2009 Preliminary Design Review, a full 6 years into the 10-year development schedule.

Many of the FCS requirements are almost certain to be modified as the program approaches these reviews. The major FCS program restructure in 2007 that reduced the set of systems from 18 to 14 has resulted in requirement modifications, deferrals, and redistributions that affected the requirements balance among the remaining systems. While the program implements these adjustments, further requirements changes to the systems and network could be required. The Army will continue to make design trade-offs to accommodate space and weight restrictions, power constraints, and technical risks such as transport requirements for manned ground vehicles. Furthermore, the crucial FCS software development is also hampered by incomplete requirements and designs for the information network. [36]

As depicted in Table 5, the critical technologies for FCS remain at low maturity level. According to the Army's latest technology assessment, only two out of the 44 critical technologies have reached a level of maturity that should have been demonstrated at program start, based on the best practice standard. Even by applying the less rigorous Army standard, only 73 percent of the critical technologies can be considered mature enough to begin system development today. Many of these critical technologies may have cumulative adverse effects on key FCS capabilities such as survivability. [37]

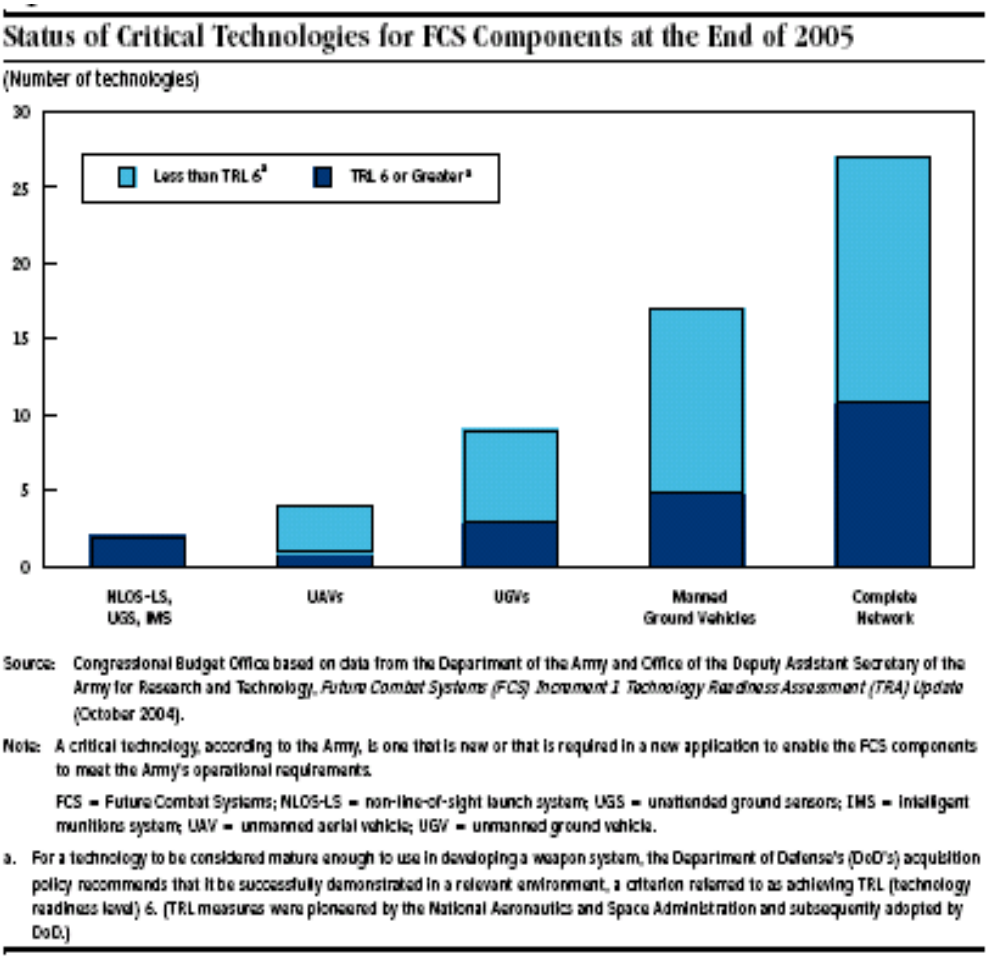


Table 5. Critical Technologies for FCS Components

Excerpted from: Defense Acquisitions, 2009 is a Critical Juncture for the Army's Future Combat Systems; United States Government Accountability Office, Mar 2008.[38]

Upon close examination of survivability, one finds that the FCS concept for survivability breaks from tradition because it involves more than just heavy armor to protect against impacts from enemy munitions. Instead, FCS survivability involves a layered approach that consists of detecting the enemy first to avoid being fired upon. If fired upon, an active protection system is used to neutralize incoming munitions before they hit the FCS vehicle. Finally, the vehicles have sufficient armor to deflect those munitions that make it through the preceding layers. Each of these layers depends on currently immature technologies to provide the aggregate survivability needed for FCS vehicles. Many of these technologies intended for survivability have experienced

problems in development or have made little progress in maturity over the five years of the FCS program. The cumulative effect of these multiple technology risks is a reduction in the overall survivability of FCS vehicles. [39]

c. FCS Networking and Software Challenges

According to GAO, there are significant challenges to developing and demonstrating the FCS network and software, which is at the heart of the FCS concept. These significant challenges are owed more to the program's complexity and immaturity than the software approach. These risks include:

- network scalability and performance,
- immature network architecture, and
- synchronization of FCS with the Joint Tactical Radio System (JTRS) and the Warfighter Information Network – Tactical (WIN-T) programs, which have significant technical challenges of their own.

The recent estimate of the software code required for FCS network and platforms nearly triples the size of the original 2003 estimate, which at 95.1 million lines is, by far, the largest software effort for any weapon system. Furthermore, the lines of code have grown as requirements have become better understood. This is due to the program's poorly-defined requirements, which is a key indicator of its immaturity. Although the Army insists that the software development cost will not change significantly, the independent cost estimates have differed sharply from the Army's, particularly in the area of FCS software development.40

Although the Lead System Integrator (LSI) implements disciplined software practices, the program's immaturity and its aggressive development schedule have delayed requirements development at the software developer level. For instance, software developers for the five major FCS software packages have complained that the high-level requirements provided to them were poorly defined, omitted, or late in the development cycle. These poor or late requirements have forced the software developers

to do rework or defer functionality to future builds and created a cascading effect which caused other software development efforts to be delayed.[41]

It is unclear when or how the Army and the Lead System Integrator (LSI) can demonstrate that the FCS network will work as needed, especially during the key program milestones. For instance, the network requirements may not be well defined and the design may not be completed at the 2009 Preliminary Design Review. The network demonstration for network performance and scalability is expected to be very limited during the milestone review later that year. The limited user test in 2012, which is the first large scale FCS network demonstration, will take place at least a year after the Critical Design Review and only a year away from the start of FCS production. Pushing this testing to late in the program poses risks on the FCS ground vehicle development, since the designs depend so heavily on network performance. Finally, a full demonstration of the network with all of its software components will not be conducted until FCS production starts.[42]

d. Impacts of Past Program Restructuring and Budget Cuts

Over the past three years, Congress has cut funding on the FCS program. In response, the Army took two basic actions:

- Reducing the number of platforms to be fielded from 18 to 14. Specifically, the Army eliminated the company (Class II) and battalion (Class III) level UAVs, deferred the Armed Robotic Vehicle until the FY2010 POM and separated the Intelligent Munitions System from the FCS program.
- Reducing the production rate from 1.5 Brigades per year to one brigade per year. This has resulted in a five-year delay to the completion of production. Previously, the full complement of 15 FCS brigades would have been outfitted by 2023, but now it will not be completed until 2028.

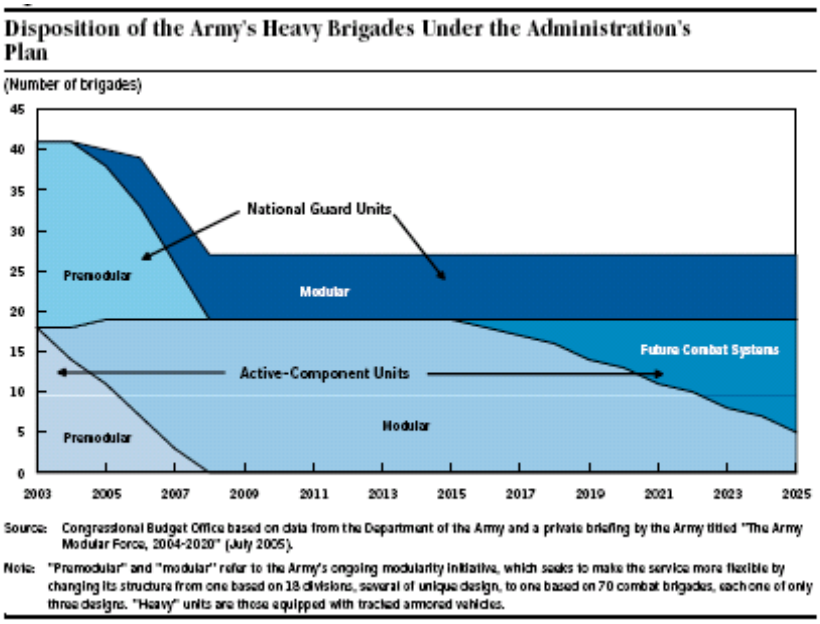


Table 6. Disposition of the Army's Heavy Brigades

Although the Army claims that it will save some $3.4 billion over the next six years, a question has been raised whether this restructuring compromises the full tactical and operational potential envisioned for FCS. Furthermore, extending the procurement over a longer time period will obligate the Army to request additional funds in the future in order to keep the FCS production lines open longer. [43]

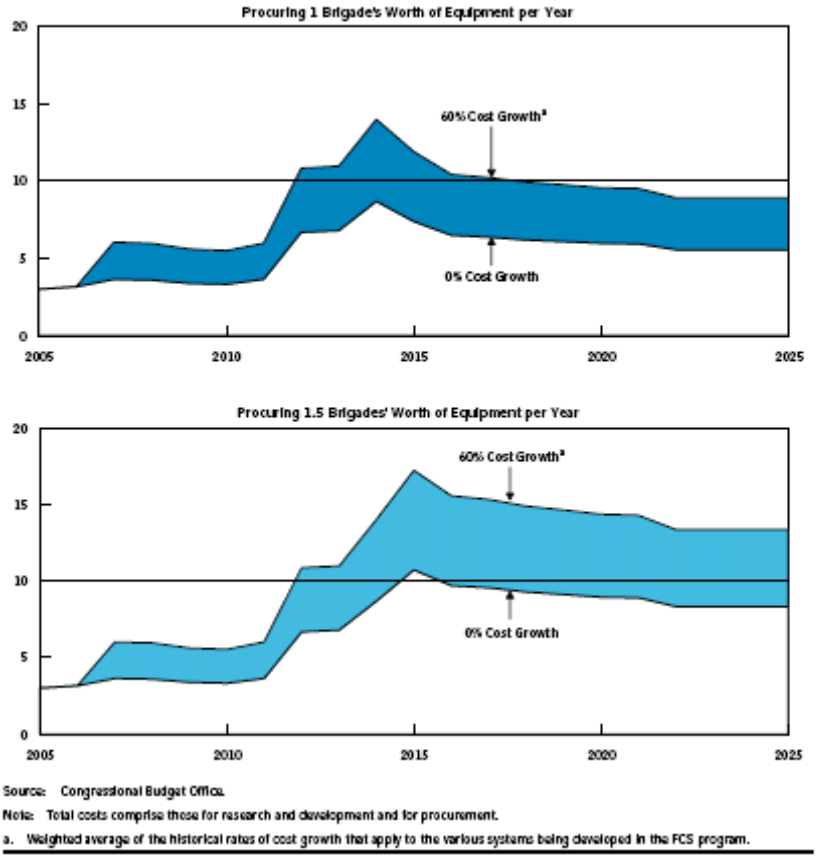
e. FCS Cost Estimates and Its Cost Growth

The Army estimated in 2003 that the total cost of FCS would be $80 Billion (in 2003 dollars). In 2004, the Army raised this estimate to $108 Billion. By April 2006, this estimate had risen to $230 Billion. In April 2008, the Army estimated the cost of FCS to be $159 Billion (then year dollars). These estimates are still below the independent estimate provided by the Department of Defense's Cost Analysis Improvement Group (CAIG), which estimated in July 2006 that the cost for FCS would rise to over $300 Billion.[44] The estimated total annual cost for the FCS program is depicted in Table 7.

Figure 3-7.

Estimated Total Annual Costs for the Future Combat Systems Program Including Potential Cost Growth

(Billions of dollars)



Source: Congressional Budget Office.

Note: Total costs comprise those for research and development and for procurement.

a. Weighted average of the historical rates of cost growth that apply to the various systems being developed in the FCS program.

Table 7. Estimated total Annual Cost of the FCS

This may mean a reduction in capabilities of the FCS program and may also mean a reduction in the Army's buying power on FCS. Both the CAIG and the IDA estimated higher costs for FCS, primarily due to the higher costs for FCS software development resulting from a recent increase in estimated lines of code. They use historical growth factors in the estimates based on their experiences on analysis of weapons systems and on the low level of knowledge attainable at the time on the FCS program. This analysis is based on the fact that there is no firm foundation for a confident cost estimate due to the FCS program's relative immaturity in terms of technology, requirements definition, and demonstration of capabilities to date. Nevertheless, the Army maintains that if it becomes necessary despite the program's

uncertain cost estimate, the FCS scope will be further reduced by trading away requirements or changing the concept of operations, in order to keep costs within available funding levels.[45]

f. Early Commitment to Production

According to the GAO, the Army commitment to FCS production will come early, even though the FCS development will finish late in the program schedule. For example, production funding for the first spin-out of FCS technologies and the early version of the FCS cannon has already begun, even though the program has not even completed Preliminary Design Review (PDR). Under a more traditional approach, PDR and Critical Design Review (CDR) would both be complete before any production money was spent. Furthermore, the Army will request production funding for the core FCS systems beginning in February 2010, just months after the 'go/no-go' milestone review and before the stability of the design is determined at the Critical Design Review. By the time the FCS enters the production decisions in 2013, a total of about $39 Billion (including both research and development and production funds) will already have been appropriated for the program.[46]

Significant commitments to production will be made before FCS capabilities are demonstrated. In 2004, the Army changed its acquisition strategy to field selected FCS technologies to current forces via Spin Outs, while the core program development is underway. The first spin out is being tested and evaluated in 2008 and a production decision is planned in 2009. However, surrogate subsystems are used in the testing instead of fully developed subsystems, such as the fully functional JTRS radios or associated software. The surrogate subsystems may not provide quality measurements to gauge system performance and may need JTRS radio redesign if they have different form, fit, and function than expected.[47]

In response to the congressional appropriations mandate, the production for FCS Non Line Of Sight – Canon (NLOS-C) vehicles will begin sooner than expected. The Army has begun procuring long lead production items in 2008 and will deliver 6 units per year in fiscal years 2010 through 2012. Several key technologies will not be

mature for several years, and much requirements and design work remains on the manned ground vehicles, including the NLOS-C. However, these early NLOS-C vehicles will be used as training assets for the Army Evaluation Task Force. Building the industrial base early for the NLOS-C vehicle production can create a future need and pressure to sustain the core FCS industrial bases, even if the manned ground vehicles are not ready for production. Consequently, the Under Secretary of Defense for Acquisition, Technology, and Logistics recently took steps to separate the NLOS-C early production from FCS core production, by making it a special interest program.[48]

Furthermore, the early commitment to production has also complicated the Lead System Integrator (LSI) involvement with the Army, which has heightened the FCS program oversight challenges. The April 2007 decision by the Army to contract with the LSI for the FCS production has made an already close relationship closer, which represents a change from the Army's original rationale for using an LSI. The LSI was originally intended to focus on development activities that the Army judged to be beyond what it could directly handle. The Army leadership believed that by using an LSI that would not necessarily have to be retained for production, the Army could get the best effort from the contractors during the development phase while making it profitable for them. However, the Army reliance on the LSI has been growing over time as well as the LSI's involvement in the production phase, in which the current LSI development contract has extended almost two years beyond the 2013 production decision. Most importantly, by committing to the LSI for early production, the Army effectively surrendered a key point of leverage it had held, which is open competition for source selection. This decision has also created a heightened burden of oversight in that there is now a need to guard against additional pressure to proceed through development checkpoints prematurely.[49]

g. FCS Lead System Integrator (LSI) Issues

In a March 2008 Government Accountability Office (GAO) report, a serious concern was raised over the increasing role of FCS Lead System Integrator (LSI). The FCS LSI was originally contracted to help the FCS program office in leading and

integrating a complex and large System of Systems (SoS,) which was comprised of numerous developmental efforts in the System Development and Demonstration (SDD) phase, primarily due to the lack of Army resources and capabilities to manage the program by themselves at the time. To further safeguard against unethical business conducts, the Army has incorporated the organizational conflicts of interest clause in 2005 to the FCS contract in order to preclude the LSI from competing for any new contract. Nevertheless, the GAO has noticed that the LSI's involvement in the production phase has grown. Since the first equipped FCS brigades would not have the full operational capabilities, the Army believed that further involvement of LSI for future FCS enhancements in the production phase is necessary in order to fill the capability gaps. GAO also suggested that the LSI will likely play a significant role in the sustainment phase, which would virtually put LSI in a permanent role throughout the FCS life cycle. GAO reported that it is important for the government to achieve a greater degree of oversight within the program. This is because the complex relationship that the LSI has created in FCS would increase the burden of oversight and pose risks for the Army's ability to provide independent oversight over the long term. For instance, the Army can become increasingly vested in the results of shared decisions and thus runs the risks of being less capable to provide oversight. The Army's performance may also affect the LSI's ability to perform, which poses accountability problems. Furthermore, it may be difficult for the Army to separate its own performance from that of the LSI when exercising contract award fees.50

h. Complimentary Programs: The Program Issues and FCS Synchronization Challenges

Most of the complimentary programs, necessary to the success of the program, have not yet fully synchronized with the FCS schedule. They are also facing schedule delays, funding, and technical challenges. Furthermore, the Army has raised concerns about the likelihood that the complimentary system will deliver the required capabilities when needed. In some cases, the complimentary programs have been adversely affected by FCS demands while others are due to the lack of coordination between FCS and complimentary program officials.[51] The Army describes the Joint

Tactical Radio System (JTRS) as the complimentary program to the FCS since the JTRS forms the backbone of the FCS Network by providing voice, video, and data communications to FCS ground and aerial vehicles. The JTRS is therefore essential to the success of the FCS program. One of the main issues was raised by the former Assistant Secretary of the Army for Acquisitions, Logistics, and Technology, Claude Bolton. He was concerned that there may not be enough radio bandwidth to support the FCS network within the next five years, which could have a significant operational impact on FCS. This is because FCS is heavily dependent on continuous, and near real-time data from a wide range of sources for not only its combat effectiveness - but its survival on the battlefield. Furthermore, the industry officials also suggested that the Army leadership has become addicted to video teleconferencing, which is why the Army is currently experiencing difficulty in keeping up with information demands. The FCS program has been asked to investigate how FCS will perform if the network is degraded by lack of radio bandwidth availability and network failure.[52]

The Air Force's Transformational Satellite Communications (TSAT) program will provide the FCS with the space tier communications backbone that has far more bandwidth than current military satellites and better secured communications for FCS with low probability of jamming and intercepting by enemy forces. However, the TSAT program is has also suffered from delays, restructuring, and cost cuts. It seems unlikely that the first TSAT satellite will be launched in 2016 as planned, and the viability of the entire program is currently in jeopardy. While the FCS program officials contend that they could make ends meet with current military and commercial satellites in the interim, one defense expert warns that the FCS network will be comprised of the less secure networking capabilities. As FCS survivability depends so heavily on the network, this is troubling. [53]

The Warfighter Information Network – Tactical (WIN-T) program is described as the Army future communications backbone in a three-tier network architecture which comprises of the ground links, the airborne links, and the space links which, someday, will also be able to leverage the Air Force TSAT satellite. Its most unique capability is to provide high speed data communications to a dispersed and highly

mobile force. The continuing delays in the WIN-T program has forced the Army to extend the Joint Network Node (JNN) program, which is a interim program that employs Commercial-Off-The-Shelf (COTS) networking technology to provide improved data communications to the Army in Iraq. Although the JNN does provide many of the capabilities that are envisioned for WIN-T, it does not provide the mobile networking capability. In March 2007, the Army notified Congress that the WIN-T program has exceeded its approved program baseline by more than 25 percent. Consequently, the Congress passed the law to restructure the WIN-T program by merging it with the JNN in order to eliminate redundancy and to accelerate the fielding of WIN-T in four increments.[54]

2. DoD & Army Position on Program Risks and Constraints

In its pamphlet entitled "Army Assessment of Government Accountability Office Reports," the Army states in its summary retort to three GAO reports (GAO-08-408, GAO-08-409 and GAO-08-467SP):[55]

- Government Accountability Office (GAO) reports adequately point out risk to the Future Combat Systems program, but not program results. Thus far, potential problems identified by GAO have not materialized.
- FCS is the critical part of the Army's modernization strategy focused on conflicts we face today and in the future. The Army strategy takes a balanced approach dealing with the requirements of the current force and developing and procuring capabilities required by the future force to defeat future adversaries.
- The FCS Brigade Combat Team (FBCT) is an ambitious effort developing holistic brigade sets of capabilities that will defeat any future threats. FCS is the Army's premiere modernization program that provides the country the required land force capabilities by replacing the Cold War armored vehicles with state of the art technologies. FCS empowers Soldiers and Leaders with 14 manned and unmanned air and ground systems connected by a network.

- Many critics of the FCS Program, including the GAO, continue to view the FCS Program through a single system procurement prism that equates the program to a platform rather than a family of systems with an integrated network.

The pamphlet goes to assert that reducing FCS funding would slow the delivery of much needed capability. The FCS program has sustained multiple years of funding cuts, but the cumulative effects are taking a toll. Consistent funding remains the key to delivering needed FCS capabilities to Soldiers.[56]

Getting into further detail, the pamphlet responds to individual to points made in GAO Report GAO-08-408, Defense Acquisitions:

- In response to the point that the knowledge gained on the FCS program is "commensurate with a program in early development" even though the program is more than halfway through its R&D phase, the Army states: "The Army and the GAO disagree about what constitutes a sound business case for weapons systems acquisition programs. In 2004, the Army restructured the program, largely based on GAO assessments and recommendations, to pursue a phased-development approach to the program. The integration phases inherent in the revised approach were specifically designed to reduce program risk and concurrency, provide for more experimentation and systems' verification, and principally to build knowledge not only on the progress of each developmental phase, but also to inform subsequent developmental phases. GAO continues to assess risk using single system development metrics as benchmarks for assessing the FCS program. This approach does not give credit to the fact that verification of integration activities are occurring within each integration phase, which minimizes cost and risk later in the program." [57]
- In response to the point that "FCS requirements are not yet fully defined and system designs are not yet complete," the FCS Program office states: "One of the key tenets of FCS from Concept Technology Demonstration was to accept the reality that FCS will continually refine requirements. The GAO has a knowledge-based model that is at odds with this type of acquisition, and FCS is being judged

against that yardstick, whether it applies or not. FCS has deferred some requirements definition in order to use some of the initial test data for clarification and refinement. The GAO assessment does not acknowledge the value of this approach, nor concede that this is a benefit from the decision to formalize the phased approach which will reduce risk. Requirements will be refined in the Capability Development Document that will be published this year."[58]

- In response to the GAO observations that: "Forty-four critical technologies are approaching the basic maturity needed to start a program, but are immature for a program halfway through its scheduled development. Most FCS technologies may not be fully mature until after 2009." The Army states that: At this time, all critical technologies are maturing on schedule. As of Mar 08, the Program Manager has assessed thirty-one (31) of the current 44 critical technologies as Technology Readiness Level 6; and, that the 13 remaining technologies will meet Technology Readiness Level 6 by Preliminary Design Review (PDR) in FY09. For all remaining Critical Technologies, risk mitigation plans to include Technology Readiness Level 6 events are scheduled and funded. The Technology Integrated Product Team under the direction of the Director of Defense Research and Engineering will continue to monitor Critical Technology maturity. [59]

- In response to the GAO assessment that "FCS costs are likely to be higher than current Army estimate," the Army states: "The FBCT program employs an integrated cost containment strategy to ensure that life cycle costs are managed. While cost estimates from multiple agencies have differed, many times these differences stem from accounting for different elements inside and outside the program. The Army's cost estimates have been consistent and updated as the program added or removed systems."[60]

- Responding to GAO Report GAO-08-409, Defense Acquisitions: Significant Challenges Ahead in Developing and Demonstrating FCS Network and Software, which states "Almost 5 years into the program, it is not yet clear if or when the information network that is at the heart of the FCS concept can be developed, built, and demonstrated by the Army and Lead System Integrator." The Army

states “The FCS, System of Systems software strategy uses an incremental approach to software development allowing the program to more easily manage the content and integration of the FCS. The program will do this by partitioning the extensive FCS software systems into smaller builds. This incremental approach provides opportunities for the program to learn from each previous build and to apply what is learned to the subsequent builds. As a result, FCS can adjust relatively quickly to changes in technology, changes in operational needs, or changes in priority. The FCS incremental approach to software development reduces program risks by allowing Soldier input while the software is being developed. As software increments are built, the Soldiers can begin evaluations and feedback on the increments. The primary benefit to this approach is that Soldiers will get a final product that can be used as is; the Army will not have to make costly and time-consuming revisions. This approach is a new way of doing business and offers many benefits for FCS and future programs.” [61]

- The GAO also makes the point that “Future Combat Systems software is about four times larger than the next two largest software-intensive defense programs.” The Army responds to this by stating: “The FCS Program is being compared to individual systems like the Joint Strike Fighter (22.0M Equivalent Source Lines of Code) and Multi-Mission Maritime Aircraft (24.5M Equivalent Source Lines of Code). This is not a fair comparison as Future Combat Systems delivers multiple integrated systems consisting of Manned Ground Vehicles, Unmanned Ground Vehicles, Unmanned Air Vehicles, Sensors, Network to include Battle Command, Training and Logistics. In addition, the GAO cannot confirm that the data for the other systems, e.g., Joint Strike Fighter, includes operating system software and non-deployed simulation software as does the Future Combat Systems software estimate. The overwhelming majority of the software required for FCS exists and comes from mature commercial-off-the-shelf (COTS) or government-off-the-shelf products. Additionally, the Army employs small incremental software builds to greatly reduce the potential programmatic risks vice a high risk big bang approach. While wary of the aggressive pace of the

program, the GAO acknowledged 'the Army and LSI have implemented disciplined software practices for developing the network and software.'"[62]

- In GAO-08-467SP, Defense Acquisitions: Assessment of Selected Weapons Programs, the GAO states that "The Joint Strike Fighter and Future Combat Systems (FCS) are expected to be developed on a cost-reimbursable basis for 12 years. As of fiscal year 2007, DOD anticipates having to reimburse the prime contractors on these two programs nearly $13 billion more for their work activities than initially expected. Eight development programs within the scope of our review that use cost-reimbursement type contracts have experienced or anticipate significant increases to initial contract prices." In response, the FCS Program Office states: "GAO shows a Future Combat Systems contractor cost growth of 40%. This is a correct statement if you consider the Future Combat Systems program at Milestone B consisted of 13+1 systems. Since then, the Army increased from 13 to 18 systems. This increased the contract value form $14M to $20M. In the FY08-13 POM, the program returned back to 14+1 systems. This reduction was offset by additional network requirements, e.g., Joint Tactical Radios. Thus, the GAO contractor cost growth is real due to contractor Statement of Work growth and program requirements growth." [63]

The risks associated with the FCS program are immense. But the reward is equally large. One of the goals of FCS "is to let every soldier in the field get real-time reconnaissance imagery from any drone or human comrade who is in the network." [64] At a recent test event, "the commander of the field-testing task force, COL Emmett Schaill remarked admiringly, "If I'd had that thing [FCS Micro Air Vehicle], I probably wouldn't have gotten shot [in Iraq, where COL Schaill was wounded in an ambush]." [65]

"The technological challenge is immense. A hundred different contractors are working on an estimated 95 million lines of computer code, four times as much as needed to operate other large weapon systems, such as the Air Force's F-35 Joint Strike Fighter. Overall, the FCS involves some 44 'critical technologies;' 26 of those are directly related to the functioning of the network, and the Government Accountability Office rated only

two set of technologies 'fully mature' in March 2008." "But if—if—the Army can get the technology to work, it will give every single squad what [COL Emmitt] Schaill lacked on the day that he got shot: the capability to receive pictures and … even video, across a high-speed mobile network." [66]

B. PROGRAM AFFORDABILITY AND RELEVANCY TO PRESENT NATIONAL SECURITY

1. Congressional Position

The FCS program is living in an ever-changing national security environment which can easily alter the current course of the program. It has experienced a few program restructurings since its program inception in 2003. Some doubts have been raised, particularly from the Congress, on whether the original FCS concept, which it was designed to combat conventional land forces, is still working effectively in the "Long War" against terrorism, which features counterinsurgency and stabilization operations. According to the GAO report, the Army's case for FCS relevancy in the present counterinsurgency operations at Iraq and Afghanistan might be overstated. This is because the Army is placing undue emphasis on theoretical FCS capabilities, which were originally designed for excelling in conventional combat operation and have yet to be fully matured for fielding. For instance, the Army argued that the FCS Mounted Combat System, a much lighter armored vehicle with more efficient fuel consumption, would achieve similar survivability as the heavily armored Abrams tank by avoiding the enemy rounds using the active protection system and by exploiting superior knowledge of enemy activities. However, the threat in Iraq has come primarily in urban settings from individually launched weapons to Improvised Explosive Devices (IED). Therefore, the ability to identify the attackers' locations in these conditions may be beyond the technologies that are currently available in FCS. Some Army officers who served in Iraq questioned the FCS relevancy in fighting this new kind of war. Some suggested that the effective counterinsurgency operations are characterized by less of a function of superior technology and firepower but more of cultural awareness, interpersonal relationships, and security provided through human presence.[67]

Furthermore, there have been questions raised about FCS affordability and the legitimacy of the Army cost estimate on FCS against the higher cost estimates developed by the Department of Defense (i.e., CAIG) and the non-profit organization (i.e., IDA). According to Secretary of Defense Gates, the fundamental issue appears to be the overall affordability of the FCS program as it is currently structured. He suggested to the Senate Armed Services Committee in February 2008 that the Department of Defense might not be able to afford to complete the FCS program.[68]

Deployability: Although a major impetus behind the FCS program was the Army leadership's desire to make units equipped with armored vehicles easier to deploy overseas, the current plan to replace the Army's armored vehicle fleet with FCS vehicles will not significantly reduce deployment time. Whether equipped with current-force or FCS components, the Army's heavy units comprise hundreds of tracked vehicles and hundreds more trucks and trailers (see Table 2). Deploying such units by air requires hundreds of aircraft sorties. Yet the lack of extensive paved surfaces for receiving and unloading aircraft at most airfields in the world (excluding large U.S. military facilities such as those in Germany and South Korea) limits the number of daily sorties by Air Force transport aircraft that those airfields can support. For example, each C-17 transport plane can carry less than 0.3 percent of a brigade equipped with armored vehicles over long distances. As a result, limiting the number of aircraft sorties, in turn, limits the amount of equipment that can be delivered overseas in one day during the initial surge (the first 45 days) of a military operation to about 5 percent of a heavy brigade or 1 percent of a heavy division. After the first 45 days, even less cargo is likely to be delivered daily. CBO estimates that given those constraints, transporting a brigade equipped with the Army's current armored vehicles overseas by air might take 23 days; moving an entire division similarly equipped might take more than four months (see Table 3). In contrast, ships can easily transport very large amounts of the Army's current equipment. Indeed, one or two of the U.S. Military Sealift Command's (MSC's) large ships can transport an entire brigade's worth of equipment, and eight of those vessels can transport an entire division overseas. Most coastal regions of the world have at least one large port capable of receiving MSC's ships. And even though some of the equipment

associated with a heavy division might have to be loaded onto some of the command's slower ships, it would still take far less time to deliver a full heavy division by sea—27 days—than it would take by air. Replacing the Army's current armored vehicles with FCS vehicles does not tip the balance in favor of airlifting those systems. In fact, it makes very little difference. To transport an FCS brigade by air using C-17 aircraft would require 340 to 380 sorties—a process that would take 19 or 20 days—to any overseas destination without an extremely large airport (see Table 3). That compares with the roughly 410 sorties needed to move a heavy brigade equipped with current systems. Thus, replacing the Army's current fleet of tracked vehicles with FCS components would yield, at most, a 17 percent reduction in the airlift sorties (and time) needed to deploy a heavy brigade-sized unit overseas. Because brigade-sized units are rarely deployed alone, however, it is useful to examine the time needed to deploy larger formations, such as divisions. A division equipped with FCS vehicles could weigh roughly 20 percent less than a heavy division equipped with current armored vehicles—95,000 tons compared with 120,000 tons. Even so, transporting such a division overseas by air would take at least 115 days. Transport by sea could be accomplished solely by the MSC's fastest sealift ships and would require 23 days rather than the 27 days needed to transport a similar division equipped with current vehicles (see Table 8). [69]

Time Needed to Deploy Equipment of Combat Units to East Africa

(Days)

	Airlift[a]	Sealift
Brigade-Sized Units		
Premodular Armored Brigade Combat Team with Existing Armored Vehicles	23	25
Modular Heavy Brigade with Existing Armored Vehicles	23	25
FCS-Equipped Brigade	18-20	25
Division-Sized Units[b]		
Three Premodular Armored Brigade Combat Teams with Existing Armored Vehicles	110	27
Four Modular Heavy Brigades with Existing Armored Vehicles	135	27
Four FCS-Equipped Brigades	115-130	27

Source: Congressional Budget Office based on data from the Department of the Army; Military Traffic Management Command Transportation Engineering Agency, *Deployment Planning Guide: Transportation Assets Required for Deployment*, MTMCTEA Pamphlet 700-5 (May 2001); and Department of the Air Force, *Air Mobility Planning Factors*, Pamphlet 10-1403 (December 18, 2003).

Notes: Units would be moved from the continental United States. The data do not reflect the time needed to move sustaining units or supplies.

"Premodular" and "modular" refer to the Army's ongoing modularity initiative, which seeks to make the service more flexible by changing its structure from one based on 18 divisions, several of unique design, to one based on 70 combat brigades, each one of only three designs.

FCS = Future Combat Systems.

a. The number of daily sorties constrained by the capacity of the airfield in East Africa, based on average airlift payloads per brigade of 60 tons for heavy units and 50 tons to 55 tons for FCS-equipped units.

b. Besides combat brigades, divisions include headquarters and other support units.

Table 8. Time Needed to Deploy Equipment to East Africa

2. Army Position

The Army is currently exploring options to accelerate the FCS program, in part due to congressional concerns over current readiness and the availability of future program funds. The Congress has suggested that the Army should be more aggressive in inserting FCS technologies into the Army's current fleet of vehicles, eliminating some FCS systems, and completing the FCS program in four to five years. Preparations are underway for the first "Spin Out" of FCS capabilities to units in the field. The Army Evaluation Task Force (AETF) at Fort Bliss, Texas, is currently assessing these Spin Out technologies in the field environment prior to full deployment to the units.[70]

Army Secretary, Pete Geren, has indicated that he expects the service will continue to make changes to Future Combat Systems, the cornerstone of its modernization efforts, to better position the Army to counter changing threats. Speaking at the Association of the United States Army's annual meeting, Geren said the Army's current plans for the program are a "good way ahead now." But any long-term transformation program such as FCS is "going to evolve as the threat evolves," the former Texas House member said. "That is the nature of the beast."[71]

In June 2008, the Army announced that it would focus on fielding FCS first to infantry brigades, marking a major departure from initial plans that called for sending the first batch of war-fighting technologies to heavy units. Infantry brigades, which have been used heavily in Iraq and Afghanistan, will begin receiving pieces of FCS in 2011—three years earlier than planned. FCS is a system of manned and unmanned air and ground vehicles tied together by a complex electronic network.[72]

Both Geren and Army Chief of Staff, George Casey, emphasized that the Army remains committed to the FCS program, the largest and most expensive development program in the service's history. FCS has been met with some criticism on Capitol Hill, particularly within the House, where several key lawmakers have raised concerns about the cost and feasibility of the program.[73]

But it appears that the Army's recent changes to the program, especially its focus on infantry brigades, have helped assuage some congressional concerns. In September 2008, Congress approved a spending bill that increases the Pentagon's $3.6 billion request for FCS by $26 million, marking the first time in years the program's budget has not been trimmed. [74]

Meanwhile, the Army is evaluating its legacy force, with leaders now in discussions over how to handle a fleet of tanks and other vehicles that have been in service for decades. Casey said one of the toughest decisions before the Army is to decide when it should stop updating its older systems. The goal, Casey said, is to build a force that is affordable and able to counter the asymmetric threat posed by terrorists and insurgencies.[75]

Any move to prioritize the Army's future programs over its current fleet could run into stiff opposition on Capitol Hill. Recently, Democratic and Republican leaders of the House Armed Services Committee expressed concerns about any efforts to divert funding for older systems, such as the Abrams tank and Bradley Fighting Vehicle, to pay for FCS.[76]

"We feel that reducing investments in these programs, which constitute the core of the Army's armored combat vehicle fleet, before the Army even begins to test realistic prototypes of FCS vehicles in the 2012-2015 timeframe, could place our future forces at risk if achieving the FCS program's aggressive schedule is delayed, or FCS manned vehicles cost more than is now forecast," they wrote in a letter to Defense Secretary Gates. [77]

The Department of Defense clearly showed its support for the FCS approach in a July 2008 report from the Under Secretary of Defense for Acquisition, Technology and Logistics (USD AT&L). The report, which was written by a Defense Science Board Task Force led by Dr. Jacques Gansler, states that the: "DoD will need to accelerate the acquisition of net-centric systems–of –systems, and other next generation equipment, that anticipates the evolution of asymmetric warfare, so that the nation will have the needed 21st Century military force structure and capabilities… DoD also needs to modify its acquisition efforts to focus on information-based warfare…. R&D investments will need to shift to net-centric relevant architectures, software and Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) systems which must be optimized for performance and cost as 'systems-of-systems.'"[78]

The Office of the Under Secretary of Defense for AT&L report goes on to remove any doubt that the specific approach and implementation of the FCS program is not only something that it approves of, but something that it wants other programs to model themselves on, when it states: "A government systems architecture/engineering manager on each major program should be required. Experienced government program management and systems engineering oversight capability on systems-of-systems should become the norm (e.g., Future Combat System (FCS))."[79]

In a large organization, such as the U.S. Government, it is perhaps unsurprising that opinions run both ways. In response to the USD AT&L report, Philip Coyle, senior adviser with the Center for Defense Information, a security policy research organization in Washington, agreed with the systems-of-systems strategy, but disagreed with their choice of the Future Combat Systems program as a model, saying: "It's not a good example, as FCS is way over budget and way behind schedule." Coyle, who served as assistant secretary of Defense and director of Defense's Operational Test and Evaluation Directorate from 1994 to 2001, said the department should not try to integrate too many disparate functions into one system. For example, a household system of systems linking an alarm clock with a microwave oven and phone lines could be cobbled together, he said, but if the goal merely was to make cooking breakfast easier, then that approach would be too complicated.[80]

One problem with the CBO Study on FCS Program Alternatives is that it appears to assess the new FCS vehicles as if they are simply equipment replacements for the current fleet of vehicles. What this does not take into account is that the Army expects the new vehicles to provide a quantum leap forward in capability. Army Vice Chief of Staff, Gen. Peter W. Chiarelli, stated recently that the FCS Manned Ground Vehicle "is a platform designed for the full-spectrum fight. The self-sufficient nature of the system has a vast array of networked capabilities that will literally change the game in favor of the Soldier." One misperception, according to the general, is that the FCS vehicles are simply new tanks. But since the Army already has the most powerful and effective tanks in the world, people are skeptical that the Army requires new FCS vehicles. Chiarelli harkened back to history to explain that not all tanks are equal; and he looked to the future to explain that something more than tanks are required if U.S. Soldiers are to "dominate, not survive, in a full-spectrum operating environment."[81] So replacing the old vehicles is not an apples-to-apples replacement. The intent of the FCS Program is that this will be more like replacing a World War II fighter plane with a modern jet.

While critics of the FCS program point to its high cost, FCS is the only Army program among the top 15 Pentagon weapons acquisition programs and currently

accounts for only 3.7% of the total Army budget. In the long term, FCS could save billions of dollars in maintenance, fuel, and personnel costs while reducing the number of troops in harm's way:

- The MGV design will enable crews to perform substantially more maintenance, reducing the required number of mechanics by half.
- The hybrid electric engine in FCS vehicles will consume up to 30% less fuel than current vehicles consume. Fuel is currently a major Army cost driver. In addition, reducing the number of required supply convoys would reduce manpower and casualties in what are widely acknowledged as some of the most vulnerable US forces in Iraq.
- Manpower costs are by far the Army's largest expense, accounting for 36% of the Service's 2008 budget. In addition to needing fewer mechanics and truck drivers, FCS brigades will require 500 fewer soldiers than today's heavy brigades because of other FCS efficiencies.[82]

C. PROGRAM OPTIONS & ALTERNATIVES

1. Congressional Position

According to the GAO, one of the main issues is the misalignment of the FCS program's normal progress with the key events used to manage and make decisions, in which key decisions are made well before sufficient knowledge is available. The next key milestone decision will occur in 2009 and the key knowledge must be attained to determine whether FCS capabilities have been demonstrated to be both technically feasible and militarily worthwhile. Otherwise, the DoD and the Army will need to have viable alternatives to fielding the FCS capability as currently envisioned, to include determining how to structure the remainder of the FCS program so that is attains high level of knowledge before key commitments. For instance, an alternative need not represent a choice between FCS and the current force, but could include fielding a subset of FCS, such as a class of vehicles, if they perform as needed and provide a militarily

worthwhile capability. The other aspect of the FCS program that warrants attention and should not wait until the 2009 decision is the Army decision to contract with the LSI for early production of FCS spin outs, the NLOS-C vehicles, and the low rate production for the core FCS program. GAO recommends that the Secretary of Defense to closely examine the oversight implications and take steps to mitigate the risks to include full range of alternatives for contracting for production. Furthermore, regarding the FCS network and software development and demonstration efforts, GAO recommends that the Secretary of Defense to direct the FCS program to stabilize network and software requirements with a clear set of criteria for acceptable network performance, to synchronize the network development and demonstration with other FCS elements, and to conciliate the differences between independent and Army estimates of network and software development scope and cost.[83]

If the reports from the GAO and CBO were only suggestions for improvement, they could be taken at their face value and used to the best practicable extent by the FCS Program Office. But they certainly seemed to cut deeper than that, suggesting mismanagement of the program and implying to Congress that serious oversight steps should be taken. This negative campaign has had its deleterious effects, as evidenced by comments from Congress including the following: "This thing gets more bizarre by the day,' fumed Rep. Neil Abercrombie, D-Hawaii, who chairs the House Armed Services subcommittee that oversees the FCS. 'They're delaying the test by a year—how the hell is that an acceleration?'"[84] This kind of public commentary is the starting position political backdrop that the Army is going to have to try to turn around.

2. DoD & Army Position

The Army has adopted a flexible approach to the development and deployment of FCS. Repeatedly, adjustments have been made to account for the changing national security picture. For example, "In June [2008], the Army announced the latest restructuring of the program: Instead of sending the first subset of FCS technologies to

heavy armored units, the program would now focus on equipping the light infantry, which has suffered the worst casualties in Iraq. Military officials touted this restructuring as an 'acceleration.'"[85]

This flexible approach appears to be the cornerstone of the Army's program management approach. The Army continues to manage the project under the basic credo that "only an all-in-one "system-of-systems" approach can ensure that all the individual gadgets work together." However, they have become more open to responding to the very real operational and political pressures that are part and parcel to managing a large, high-profile program: "Meanwhile, under congressional pressure to show near-term results, the Army has committed to fielding individual elements of the FCS piecemeal as each technology matures."[86]

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IV. ANALYSIS

Systems of systems (SOS) present some unusual analysis challenges that often are not explicitly addressed, yet can impact the resulting degree of system effectiveness. Potential risks associated with integrating a diverse set of systems and associated hardware/hardware, hardware/software, and software/software often exist. These are made all the more difficult by individual systems at different levels of maturity and potential risks that do not exist at the individual system level. Established risk management processes/analysis may be in place for different systems, yet process steps and associated tools and techniques may not be compatible. Therefore, as we have seen from the previous sections, the reality of the situation for FCS is very much a matter of perspective. In order to assess the best course for the future of FCS, it is critical that we do it from several perspectives. As we examine the situation with FCS, we must consider both sides (i.e., proponent and opponent) of the stories and weigh them against each issue that the FCS faces and then propose the best course of action. The final course of action may consist of the right combination of more than one alternative in order to achieve success for FCS.

A. ANALYSIS OF ALTERNATIVES

The purpose of the analysis of alternatives is to analyze possible courses of actions identified in the data section, above, for dealing with all FCS issues and risks. However, our analysis of alternatives will focus only on the key FCS issues. This is because there is always the constraint of how much resources are available for execution. Each of the issues or risks will be examined from both the positions of each of the various proponents and opponents. Consequently, based on our rationales, we will determine a set of course of actions that address all key issues and risks.

In the big picture, our recommended approach for the Army in dealing with areas where conflicts do exist between the Congressional position and the current Army position is to:

1. **Do the Right Thing**. That is, do not compromise on anything that is critical to the Army's mission or the survivability of soldiers.

2. **Take a Fresh Look**. FCS has done a good job of adapting and needs to continue doing so. Sometimes, good ideas come from outside an organization and the analyses from the CBO, GAO, CRS, etc., are full of great ideas. Our recommendation here is that it is critical to take the time to carefully consider their recommendations with an open mind so as to be able to assess them based on their merit.

3. **Separate the Wheat from the Chaff**. The Army can not make everyone happy on every issue. After careful examination of all the ideas, choose those that will truly help and get rid of the rest. That said, choose your fights carefully. Where there are choices that work well either way, choose the positions that Congress has indicated that they support.

4. **Market the Plan**. It is critical that people understand the plusses that FCS is bringing to the table in more concrete terms. As discussed in the last section, FCS is operating in the Political Decision Making Model, so it does not get to unilaterally choose its best course of action. Rather, it must work with the various stakeholders in order to garner support and consensus. An important factor in achieving and maintaining consensus is our ability to present positive data on the groundbreaking ways that FCS will transform and support the force. Data on important points such as the long term savings in fuel costs must be presented clearly and repeatedly to decision makers to improve the face of the FCS program. Right now, most of the press, data and analyses focus on FCS being expensive. This desperately needs to be turned around by providing concrete and simple information on the benefits of FCS. The Army has to accept the job of marketing FCS as something more than a collateral duty if it wishes this program to achieve its full potential.

5. **Implement the Plan**. Given all the above, implementation may seem the easiest part of bringing FCS to fruition. It is important, nonetheless, to continue to be flexible and pro-active. That is, the program office should understand that the changing requirements of the national security environment, technology development, etc., will drive changes to the program in the future. It is important that the FCS Program Office continue to work with the stake-holders to react effectively to these changes while not overreacting.

Issue 1: The Lead System Integrator (LSI)

We agree with the GAO that the Sectary of Defense should examine the FCS LSI oversight implications and the Army's decision to contract with the LSI for early production of FCS spin outs to include both NLOS-C vehicles and the low rate production for core FCS program. The original Army intent and usage for LSI was to take on the most challenging tasks of FCS complex system integration beyond what the Army can handle at the time for System Development and Demonstration Phase, in hoping to bring the best innovative minds from the industries while obtaining the best effort by making it profitable. By leaving too much program oversight to a LSI, the Army workforce will gradually lose most of its workforce's program management core competency and eventually yield most of the program oversight control to the hand of the LSI. Consequently, Congress has passed the FY 2009 Defense Authorization Bill Markup that prohibits DoD agencies from awarding new contracts for LSI functions in the acquisition of major systems. This is also partly due to the recent concerns of the DoD acquisition workforce skill erosion in System of System (SoS) program management. In order to ride out this storm for the long term, we recommend setting up a Future Combat Systems Integration office to replace the current FCS management structure, in particular, the LSI.

When FCS was first created, a major consideration was push-back and inertia from the existing Army. Transformational change (Kaikaku) is something that often requires a major break from the past in order to enact. The alternative of focusing on

small incremental changes (Kaizen) can result in arguments about each small change and, in the end, stifle the overall intent. It appears that, at the outset, the FCS program office took some drastic steps in order to side-step this inertia of "not the way we do things around here." Specifically, the FCS program office pointedly set itself completely apart from the rest of the Army, which it labeled "the legacy force." FCS went so far as to forgo traditional unit organization such as Brigades, Divisions, and Corps. Instead it identified new titles: The Unit of Action (UA) and the Unit of Employment (UE). This step was presumably taken in order to provide the FCS architects with more flexibility to design the overall system as they saw fit. Similarly, we believe that one of the underlying reasons for adopting an LSI was to bring in people who specifically were not tied to the status quo. Time has passed now and the original purposes of some of the devices created in the genesis of FCS are no longer needed. The terms UA and UE served their purposes for awhile but have now been dismissed, as FCS has returned to the traditional nomenclature of Brigades, Divisions, and Corps. Similarly, we believe that the LSI served its purpose in breaking the logjam of inertia against transformational change. But with the transformational changes now underway with their own measure of momentum, the concept of the LSI needs to be examined under a different light: Its plusses and minuses based on simple merit. Here, our basic contention is that it is in the Army's best interest to run its own program versus trusting a commercial corporation to do it for them. Given our analysis, the existence of the LSI, working as a second layer of management virtually in parallel with the FCS program office, adds unnecessarily to the overall cost and complexity of the program.

Similarly, our analysis indicates that the overall idea of maintaining FCS as a program unto itself and separate from the rest of the Army is an idea that has lost its raison d'être. Already, the FCS program office has taken a number of incremental steps of handing responsibilities back to Army project offices. Our analysis indicates that it is time to take the much larger step of handing development responsibility for all the systems over to individual Army PMs. The FCS program office would become an

overall architect and the LSI would cease to exist (though we anticipate that the companies involved would continue to support the Army in a more traditional advisory role).

Issue 2: Performance metrics/ approaches for System of System Procurement

The Army and the GAO disagree on what constitutes a sound business case for major weapon system acquisition programs. The Army FCS program office argued that GAO continues to assess FCS performance and risk through a single system procurement prism, equating to a single platform, rather than a family of systems within an integrated network. Our analysis leads us to agree partially with the Army in that it has restructured the FCS program in 2004 based on GAO recommendation to pursue a phased-development approach. This approach is supported by our findings and analysis because it is specifically designed for tackling a System of System procurement, in order to reduce risk and concurrency, provide for more experimentation and systems' verification, and principally to build knowledge not only on the progress of each developmental phase, but to inform subsequent developmental phases. Our analysis partially disagrees with GAO in that the FCS requirements are not yet fully defined and system designs are not yet complete, in which the GAO uses a knowledge-based model that is at odds with this type of acquisition. We agree with the Army that the phased approach allows FCS to defer some requirements definition in order to use some of the initial test data for clarification and refinement. Unlike the single system procurement, the System of Systems software strategy uses an incremental approach to software development, allowing the program to more easily manage the content and integration of the FCS. As a result, FCS can adjust relatively quickly to changes in technology, changes in operational needs, or changes in priority. As software increments are built, the Soldiers can begin evaluations and feedback on the increments. The primary benefit to this approach is that Soldiers will get militarily useful increments that can be used as is. This approach is a new way of doing business and offers many benefits for FCS and future programs.

However, our analysis does not support the Army position that only the all-in-one "system of systems" approach can ensure that all the individual components work together. Yet, ironically, the majority of the electronic communications capabilities

essential to linking the different FCS components are being developed outside the program by three other independent programs. Meanwhile, under Congressional pressure to show near-term results, the Army has committed to fielding individual elements of the FCS piecemeal as each technology matures. We agree that the system of system strategy should use a phase increment approach, but should not try to integrate too many disparate functions into one system. Otherwise, the approach would become overly complex and problematic to manage. Our findings agree with the GAO that the next key milestone decision will occur in 2009 and the key knowledge must be attained to determine whether FCS capabilities have been demonstrated to be both technically feasible and militarily worthwhile. Otherwise, the DoD and the Army will need to have viable alternatives to fielding the FCS capability as currently envisioned, to include determining how to structure the remainder of the FCS program so that is attains high level of knowledge before key commitments. For instance, an alternative need not represent a choice between FCS and the current force, but could include fielding a subset of FCS, such as a class of vehicles, if they perform as needed and provide a militarily worthwhile capability. Furthermore, regarding the FCS network and software development and demonstration efforts, our analysis supports the GAO recommendation that the Secretary of Defense to direct the FCS program to stabilize network and software requirements with a clear set of criteria for acceptable network performance, to synchronize the network development and demonstration with other FCS elements, and to conciliate the differences between independent and Army estimates of network and software development scope and cost.

Issue 3: FCS Cost & Affordability

Due to the wide variations in FCS cost estimates since program inception, we agree that there has been lack of confidence by many government officials that the FCS program can be completed within cost. The current Army cost estimate of $160.9 billion is largely unchanged from the last year's estimate, despite the major program restructuring that reduced the number of systems from 18 to 14. However, the four additional systems are still needed: Three are just being developed and deployed by other Army programs using other Army money (Class II UAV, Class III UAV and Intelligent

Munition System), while the fourth (Armed Robotic Vehicle) is being deferred. This adds fuel to the Congressional fire as it appears that the Army is playing a shell game: Saying that they can keep the cost of FCS constant, but then shuffling costs to other programs in order to be able to maintain this pledge. Our analysis agrees with Secretary of Defense Gates that the fundamental issue appears to be the overall affordability of the FCS program as it is currently structured. We all know that the Department of Defense might not be able to afford to complete the FCS program due to the near-term and future national fiscal policies and in a time of fading global economy. Consequently, we like the recent Army decision for exploring options to accelerate the FCS program, in part due to congressional concerns over current readiness and the availability of future program funds. The Congress has suggested that the Army should be more aggressive in inserting FCS technologies into the Army's current fleet of vehicles, eliminating some FCS systems, and completing the FCS program in four to five years. Preparations are underway for the first "Spin Out" of FCS capabilities to units in the field. The Army Evaluation Task Force (AETF) at Fort Bliss, Texas, is currently assessing these Spin Out technologies in the field environment prior to full deployment to the units. In summary, we like this piecemeal approach in order to reduce overall program cost while warfighter still reaps the benefits in the near term before waiting for the full FCS development completion.

Issue 4: Reassess FCS capabilities to present national security

The greatest single driver in continuing analysis of the FCS program is changing national security environment. The huge expense of the current commitments in Iraq and Afghanistan and the nature of the threats being encountered there have caused many in Congress and the Army to question the existence and priorities of the FCS program.

Since its inception in 2003, FCS has undergone at least one major program restructure. We agree partially with the GAO analysis that questions whether the original FCS concept, which was designed to combat conventional land forces, is still valid in the "Long War" against terrorism with its counterinsurgency and stabilization operations. For instance, the Army has argued that the FCS Mounted Combat System, a much lighter armored vehicle, would provide survivability similar to that provided by the heavily

armored Abrams tank. The theory goes that the MCS would avoid being hit by exploiting superior knowledge of enemy activities with the Active Protection System providing an effective backup. However, the threats in Iraq have come primarily in urban settings from individually launched Rocket Propelled Grenades (RPG) and Improvised Explosive Devices (IED). As the GAO has pointed out, our ability to identify the attackers' locations in these conditions may be beyond the technologies that are currently available in FCS. In addition, we believe that the Active Protection System may not be usable in an urban setting. APS uses explosions to detonate weapons before they can hit the tank. But these explosions can kill friendly dismounted soldiers and civilians, so activation of the APS will have to be limited to very specific conditions, which will greatly curtail its utility.

We do understand that FCS is the Army's cornerstone of its long term modernization efforts to replace majority of its aging Army armored combat vehicle fleet. However, we believe that the FCS must look at both the long term and the near term requirements and restructure itself accordingly to spin out FCS systems that will primarily focus on current warfighter needs. Consequently, Army Secretary Pete Geren has indicated that he expects the service will continue to make changes to Future Combat Systems, the cornerstone of its modernization efforts, to better position the Army to counter changing threats. In June 2008, the Army announced that it would focus on fielding FCS first to infantry brigades, marking a major departure from initial plans that called for sending the first batch of war-fighting technologies to heavy units. Infantry brigades, which have been used heavily in Iraq and Afghanistan, will begin receiving pieces of FCS in 2011-- three years earlier than planned. This also has helped assuage some congressional concerns on how FCS capabilities will be fielded to current warfighters. In the meantime, we feel that the Army must also find the right balance and the right mix of investment on both the legacy systems prior to them being phasing out and the FCS systems while still maintaining the current warfighting capability to counter the current asymmetric threats. The Army is currently evaluating its legacy force, with leaders now in discussions over how to handle a fleet of tanks and other vehicles that has been in service for decades. General Casey said one of the toughest decisions before the

Army is to decide when it should stop updating its older systems. The goal, General Casey said, is to build a force that is affordable and able to counter the asymmetric threat posed by terrorists and insurgencies. However, the Army and the Congress are currently struggling with prioritizing all Army programs with limited budget to go around. Therefore, any move to prioritize the Army's future programs over its current fleet could run into stiff opposition on Capitol Hill. Both Democratic and Republican leaders of the House Armed Services Committee expressed concerns about any efforts to divert funding for older systems, such as the Abrams tank and Bradley Fighting Vehicle, to pay for FCS. On the other hand, FCS equipments such as the Unattended Ground Sensors, Small Unmanned Ground Vehicles, Unmanned Aerial Vehicle Class I (i.e., Micro Air Vehicle), and the FCS networking suite, should be fielded as soon as possible as they can help to save lives in Afghanistan and Iraq by providing access to real-time reconnaissance imagery and data.

In summary, we have critically analyzed FCS key acquisition tenets and proposed a plan that will refocus FCS on current warfighter needs, while delaying development of vehicles that are less critical in the short-term and still providing funding for long-term Army modernization. The details are discussed in the next section but will include the following for near term priorities in fielding IBCTs for OIF/OEF:

- Defer all MGV developments except for the NLOS-C
- Kill the development of UAV class IV
- Continue to fund the FCS Network efforts and the Soldier Systems
- Cease development of the NLOS LS
- Continue work on UGS
- Delay all development of UGVs except the SUGVs

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V. CONCLUSIONS AND RECOMMENDATIONS

The FCS program was designed to provide leap-ahead technology to the Army in a fully integrated fashion. However, the endeavor has proven to be much more complicated and expensive than originally envisioned. As a result, the Army has been facing enormous pressure from Congress to cancel or restructure the FCS program.

Since the program's inception, the war in Iraq has dramatically changed the playing field: Fighting irregular forces in urban environments is completely different than fighting a conventional engagement. In addition, the idea of using a commercial contractor to oversee government development—the lead systems integrator (LSI) concept—has fallen out of vogue, as many lawmakers now see it as "leaving the fox in charge of the henhouse." In the face of these pressures, the Army has remained flexible, trying to meet the demands of many of its detractors by making multiple changes to the program. But our analysis indicates that this formula will not work and will likely lead to the cancellation or evisceration of this groundbreaking program.

The Army leadership is starting to appear as the proverbial Dutch boy with too few fingers to stop all the leaks that are springing in the dyke. By trying to respond to the many pressures and do so without raising their cost estimates, the Army is beginning to lose its credibility. Some specific recent actions by the Army include:

- Planning to deploy equipment (the NLOS cannon) before it is ready so that it can appease some of its detractors
- Reducing the number of platforms from 18 to 14 so that it can control its spiraling costs
- Keeping their cost estimate for the program pinned at $161 Billion even though estimates from independent groups (CAIG and IDA) show costs growing to as high as $233 Billion
- Acknowledging that its own estimate for the number of required software lines of code has grown by 50%, but then insisting that costs will not grow

These actions smack of desperation and send the message to Congress that, rather than managing the program in a pro-active and upfront manner, the Army has chosen to defend their current course of action, regardless of mounting evidence or pressures.

We therefore conclude that it is time for the Army to conduct a major program restructuring in order to protect the concept of a long-term modernization program that can steer the development and integration of new systems into the Army.

In particular, we recommend that the Army create a Future Combat Systems Integration (FCSI) office. This Army-managed and staffed office would be charged with planning for the integration of new systems into the panoply of Army systems. This office would replace the current FCS management structure and, in particular, the LSI.

Rather than trying to plan everything the Army needs or wants in a single stroke of genius, as was attempted in 2000, the FCSI office will:

- Work on the incremental improvement of the Army by identifying the systems that are needed in the short term. The FCSI office would work with the Army Material Command (AMC) to ensure that these systems receive appropriate prioritization and funding in the POM
- Development of individual systems would be managed by Army Program Managers, as is traditionally done. However, the FCSI office would be intimately involved in the initial engineering to ensure that the system would fit properly into the System of Systems. In addition, the FCSI office would serve as a member of the Integrated Product Team (IPT) for each new or improved system, and would support test and integration efforts

The writing is on the wall that the Army will not be able to afford to focus on both its needs in Iraq and Afghanistan and its long-term vision of the future as if they were largely separate entities. Our recommendations would help to bring these two views back into a single focused vision in which the Army develops the items it needs now while working to integrate each new development into this single cohesive force where the

interoperability of each item has been considered and planned for from the start by an office that is specifically charged with this function.

In terms of short term priorities, we recommend that the new FCSI office:

1. Halt development of all the new FCS vehicles except for the NLOS Cannon. In general, the current generation of Army vehicles is doing the job in Iraq, as exemplified by the M1A2 and the Bradley. Combat conditions have forced the Army to take steps to improve or replace other vehicles, resulting in the up-armored HMWWV and the MRAP. There is no current FCS equivalent to these new vehicles. Nonetheless, as we look at long term equipping requirements for the Army, we do recognize a need to eventually field some of the advantageous new technologies that are being developed for FCS, including improved fuel efficiency, improved common logistics, and the new Active Protection System which is designed to protect the vehicles against incoming missiles and Rocket Propelled Grenades (RPGs). Therefore, it is our recommendation that the Army should proceed with a single prototype new vehicle. We are recommending the NLOS-Cannon as the best fit for two reasons: firstly, the M-109 Self Propelled Artillery (which NLOS-C is replacing) is the oldest vehicle in the current inventory; secondly, self propelled artillery is a stand-off weapon that will not be called on to fight in the streets of urban areas, so the immaturity of the Close In Protection System designed to protect FCS vehicles from RPGs and missiles will be less of a factor. The primary plusses for this recommendation are a short-term reduction in cost and a change to an incremental development strategy wherein development of future vehicles would benefit from lessons learned during the development of the prototype NLOS-C. Detailed management of this effort should be handed off to PM AFV.

2. Halt the development of the Class IV UAV while continuing the development of the Class I UAV. The Army currently has multiple UAVs of various sizes in development and production. All requirements for new

UAVs should be worked through PM UAV as would traditionally be done. PM FCSI would be charged with ensuring that current and new platforms are designed with a view toward holistic Army requirements and integrated communications. It will be significantly less expensive to modify the existing and emergent UAVs than develop the planned new FCS-specific UAVs. That said, the Class I UAV (the smallest UAV, which is deployable by a single soldier) provides a unique capability that none of the other services or UAVs offer and it can provide immediate assistance in Iraq and Afghanistan.

3. Continue to fund FCS network efforts. This area has the potential to provide a true asymmetric advantage over enemy forces, taking an area that is already a strength for US forces and improving it by another order of magnitude

4. Halt development of the NLOS Launch System. The Guided Multiple Launch Rocket System (G-MLRS) is a proven weapon system with virtually the same capability.

5. Continue work on Unattended Ground Systems, but hand detailed management of this effort over to the PM for Remote Unmanned Sensor Systems (PM RUSS).

6. Continue the development of the Small Unmanned Ground Vehicle (SUGV), but delay further work on the MULE. Development of the SUGV is fairly mature and can have immediate impact on current operations in Iraq and Afghanistan. Conversely, the MULE is neither ready nor is there an urgent need for the capabilities that it will bring to the battlefield. As with our other recommendations, we believe that the detailed development work should be handed off to an Army PM, in this case the PM for Unmanned Ground Vehicles (UGV).

VI. SUGGESTIONS FOR FUTURE RESEARCH

The FCS program is an ambitious and far-reaching effort to modernize the Army with "leap ahead" technology that is designed to optimize the integration of the entire "system of systems." This paper has provided a very high level overview of the program, taking a cursory look at some of the positions espoused by Congress, the Department of Defense, and the Army regarding the benefits and risks of this far-reaching program. Future research could look into any of the many specific areas within FCS or take a more in-depth look at the whole. In addition, each year brings with it great changes to the landscape within which any analysis is performed. For example, when we started writing this paper, the situation in Iraq was still very volatile, the situation in Afghanistan appeared to be under control, and George W. Bush was President. Over the course of the year that we spent on this paper, these three situations have changed dramatically, with the insurgence in Iraq quieting down significantly, that in Afghanistan heating up, and Barack Obama winning the Oval Office. So, simply revisiting the overall FCS program every two years would no doubt also provide fertile ground for follow-up work.

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