THE FUTURE COMBAT SYSTEM

What Future Can the Army Afford?

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Summary

Each military service faces a common challenge: Creating an affordable procurement program that can deliver overall force modernization that meets its time lines, force goals, and performance needs. However, no service currently links the vague conceptual goals in its unclassified strategy documents to a well defined force plan, procurement plan, program budget, or net assessment to validate its requirements.

What is all too clear, however, is that every service now faces a cost containment crisis. Procurement costs have escalated, delivery has been delayed, major programs are unstable, and performance is uncertain. The Army is no exception but it is far more difficult to identify the risks and cost benefits in a broad, integrated program like its Future Combat System (FCS).

The FCS program now drives the modernization of the US Army and many of its procurement expenditures. Since its development start in 2003, however, there have been significant adjustments to the program mostly due to budgetary constraints. The program was restructured and four of eighteen core systems were cancelled while its cost remained roughly the same.

Over the first four years of development, the Army estimated a total acquisition cost growth from $91.4 billion to $160.9 billion. Independent estimates, however, were considerably higher and situated the total program cost between $203.3 billion and $233.9 billion in May 2006. In addition, Government sources expect the largest growth in costs still to occur while we enter a climate of economic recession, growing mandatory spending, and two ongoing wars.

Despite recent successes, it is uncertain whether the program can sustain the Congressional confidence needed to fund it, accelerate development and field needed capabilities. The Army has to make a strong case to convince lawmakers and appropriators of the benefits of its largest modernization in 50 years.

The future of the FCS seems likely to depend heavily on having a high degree of success in containing costs, avoiding slips in schedule, and identifying and eliminating technical risk. This analysis does not attempt to predict the outcome of such an examination, or to judge whether the FCS program should or should not be funded. It does, however, raise issues in terms of mission, cost and affordability, and feasibility that need careful examination in making such decisions.

This paper is part of a series of reports by the Burke Chair in Strategy that monitors the modernization and acquisition efforts of all military services, based on a comprehensive analysis of the US defense budget. The individual reports can be downloaded from the CSIS website at:

http://www.csis.org/media/csis/pubs/080822_naval_equipment_acquisition.pdf
http://www.csis.org/media/csis/pubs/081001_aircraft_modernstudy.pdf
http://www.csis.org/media/csis/pubs/090205_fcsarmy.pdf
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I. Introduction

Each military service faces a common challenge: Creating an affordable procurement program that can deliver overall force modernization that meets its time lines, force goals, and performance needs. This challenge has reached the crisis point in each of the four services, although the level of this crisis is difficult to measure.

No service currently links the vague conceptual goals in its unclassified strategy documents to a well defined force plan, procurement plan, program budget, or net assessment to validate its requirements. This lack of transparency has been compounded by an equal lack of detail in the strategies advanced by the Office of the Secretary of Defense, and the failure of key documents like the Quadrennial Defense Reviews to tie equally vague concepts and recommendations to clearly defined force plan, procurement plan, program budget, or net assessments.

Such data may exist in various forms at the classified level, although there is no clear national security justification for such classification and most of the necessary reporting was provided in unclassified reporting in the past. It is far from clear, however, that the mix of documents and plans that exist at the classified level now represent an effective, integrated approach.

What is all too clear, however, is that every service now faces a cost containment crisis: procurement costs have escalated, delivery has been delayed, major programs are unstable, and performance is uncertain. The Army is no exception. The elements of this crisis are clearer in the case of shipbuilding and aircraft than in the case of the US Army. It is relatively easy to measure the problems in given programs. It is far more difficult to identify the risks and cost benefits in a broad, integrated program like the US Army’s Future Combat System.

The Army’s Future Combat System (FCS) program now drives the modernization of the US Army and many of its procurement expenditures. It consists of an integrated family of advanced, networked combat and sustainment systems; unmanned ground and air vehicles; and unattended sensors and munitions intended to equip the Army’s new transformational modular combat brigades. The system-of-systems architecture includes 14 principal systems and other supporting systems connected to achieve information superiority and survivability. It is intended to equip a transformed force into a more rapidly deployable and responsive organization based on modular combat brigades that substantially differ from the large division-centric structure of the past.

The current program has evolved out of a new Army strategy developed in 1999 under General Eric Shinseki’s tenure as Chief of Staff of the Army. The intention was to transform all of the Army’s divisions into a lighter and more modular but interconnected force that could “outsmart and outmaneuver heavier forces on the battlefield.” The goal was to deploy a brigade in four days, a division in five days, and five divisions in 30 days. At these rates, the FCS Brigade Combat Team (BCT) would be sixty percent more strategically deployable than current heavy BCTs.
Since its development start in 2003, however, there have been significant adjustments to the program mostly due to budgetary constraints. Among several other adjustments, four of eighteen core systems were eliminated while the cost remained roughly the same. The annual production rate was also reduced and the production phase stretched out by over five years, according to a GAO report that assesses the program development between 2003 and late 2006.  

Only 2 of the program’s 44 technologies were fully matured by late 2006, according to the GAO and it warned that “[a]ll critical technologies may not be fully mature until the Army’s production decision in February 2013.” In addition, some enabling systems, such as communications capabilities, have experienced significant delays.

The Army’s estimated total acquisition cost grew from $91.4 billion to $160.9 billion between May 2003 and December 2006. Independent estimates, however, were considerably higher and situated the total program cost between $203.3 billion and $233.9 billion in May 2006. A GAO report criticized that the Army still lacked a “solid knowledge base from which to make confident cost estimates.” The FCS program is in its complexity and integration unlike traditional acquisition programs. Traditional methods and metrics may not be suited to measure its progress. What remains constant, however, is the limitation of resources, which are under increasing pressure and the need to adapt to today’s warfighter needs.

The program offers important benefits but it also involves significant risks. These risks include questions as to whether the program can meet enough of its scheduling and performance goals, and whether the overall effort will be more affordable than the aircraft and shipbuilding procurement programs. In 2009 the Army will have spent 6 years and $18 billion into a system of interconnected weapon systems and warfighting software that are still largely developmental.

These costs pose a problem because the Army faces major challenges in funding its overall budget. These cost burdens go far beyond the FCS. They interact with other procurement programs, current warfighting needs, the cost of “reset” to compensate for past wartime wear and losses, and the expansion of its manpower strength.

There are technology risks because some subsystems will not be tested on prototypes before important production decisions are made. There are also operational, organizational and cost hurdles that must be cleared to fully field the system. If any of these problems create major new cost, schedule, and performance problems, it is uncertain whether such a complex program can sustain the Congressional confidence needed to fund the program, accelerate development and field needed capabilities. The Army has to make a strong case to convince lawmakers and appropriators of the benefits of its largest modernization in 50 years in a climate of economic recession, growing mandatory spending, and two ongoing wars.

Although there is speculation about new Government stimulus packages to fight the economic crisis, it is uncertain that this will benefit expensive weapon system programs such as the Future Combat System. Combat operations in Afghanistan and Iraq and the recent resurgence of the Taliban in Afghanistan may draw funding away from procurement programs. Secretary of Defense Robert Gates has repeatedly advocated a stronger focus on fighting and winning these ongoing operations. This could lead the
Army to focus on repairing and replacing war-torn equipment to maintain the Army’s readiness, and growing the force in troop numbers.

Warfighting costs and increases in end strength compound these pressures. The new administration plans to deploy additional 30,000 troops to Afghanistan by the summer of 2009. The Army’s grow the force plan is right on track and will increase active-duty troop levels to 547,000, up 65,000 from before the wars. However, this increase may not be enough to sustain the current and planned operations. Army officials have called for an additional 30,000 troops to cope with the manpower-intensive tasks of stability operations in Afghanistan. “We have five to 10 new missions, and we are already stretched now. … You can't do what we've been tasked to do with the number of people we have,” Undersecretary of the Army Nelson Ford said.  

The Army already adopted a $70 billion plan to increase its end strength from 1,037,000 to 1,112,000 active and reserve soldiers by FY2013. A further increase in end strength may be necessary to sustain the current operations and maintain readiness. At an average salary of $120,000 annually – the highest level in the Army’s history – personnel accounts may squeeze funds out of procurement programs. Maintaining the Army’s readiness also means repairing and replacing damaged or lost equipment from ongoing operations. Finally, the transformation of the strategic reserve into an active reserve requires increased spending on upgrading Army Reserve and National Guard equipment and replacing outdated materiel. Among these most urgent needs, expensive weapon systems procurement programs might be pushed to the end of the waiting line.

All services will be affected. With the switch to a spin out fielding plan for FCS equipment, the Army has succeeded in changing many appropriators’ minds about the need to fund the FCS budget. The complex system of systems appears to be modular enough to provide the flexibility and responsiveness to cater to the needs of current wars. This flexibility may lead it through the looming budgetary storm.

Nevertheless, all services will face increasing budgetary pressure. Many Government officials have been quoted recently that tough choices will have to be made in defense procurement plans. “We’ve got to fund the wars we are in” and that “puts an awful lot of pressure” on decreasing spending on weapon modernization and the repair of war-torn equipment, Admiral Mullen, Chairman of the Joint Chiefs of Staff was quoted while Secretary Gates warned that “the spigot of defense spending that opened on 9/11 is closing”. The FCS program is no exception. It already receives close attention because of its size and cost and faces the risk of serious cutbacks and delays.

This analysis does not attempt to predict the outcome of such an examination, or to judge whether the FCS program should or should not be funded. It does, however, raise issues in terms of mission, cost and affordability, and feasibility that need careful examination in making such decisions.
II. The FCS Mission

The Army’s Future Combat System is a key part of the largest most comprehensive reform of the Army in over 50 years. It is not only a weapon system but the practical implementation of a new doctrine, which emphasizes on joint network-centric warfare.

Future Warfare

The broad structure of the FCS program is shown in Figure 1. It is important to note, that many of the benefits of the program are not dependent on a specific architecture or hardware. They consist of the ability to execute new tactics and establish a new level of situational awareness at every level of the battlefield. Similarly, the advances necessary to field many items of equipment can be applied to other designs and adapted to new warfighting needs as they develop.

Any Analysis of the Future Combat System’s relevance, performance and cost must consider this flexibility and adaptability. It is impossible to predict exactly how much the entire FCS will cost and when it will be operational. Any projection of cost and deliverability must address the system’s responsiveness to the new threat picture and its compatibility with the reorganization of the Army’s force structure for the long term.

The Threat and Doctrine

There is no current agreement within the Department of Defense or outside it as to the exact nature of the threats the Army will face in the future. A broad debate has emerged over how much the US should focus on the needs of current wars, future conventional wars that may eventually involve peer threats, and irregular wars that can range from counterinsurgency and counterterrorism to armed nation building. This debate also focuses on whether US forces will have to deter or defeat a conventional and nuclear-armed regional competitor, or fight largely non-linear and unconventional counterinsurgency wars and conduct stability operations.

The classic risk that the US military may prepare to fight the last war is also compounded by the risk that it may focus too much on fighting the present wars in Iraq and Afghanistan or prepare for a future enemy it will never face. Military planners have always faced the problem that the cumulative probability of one of many low probability scenarios actually occurring may be higher than the more probable scenarios they focus upon. This risk is now much higher than during the Cold War, particularly given the 20 to 30 year life cycle of the equipment the FCS program must equip the Army to fight with.

This means that there is no safe way to rigidly suboptimize the FCS, or any aspect of Army planning, around a given set of threats. The Army must prepare to deal with a range of threats that include terror and subversion, irregular and insurgent warfare, the proliferation of weapons of mass destruction, conventionally armed ballistic missiles, information warfare capabilities, anti-satellite weaponry, high-speed cruise missiles and other threats from hostile and potentially unstable nuclear states, such as Iran, North Korea, and Pakistan.
Indeed, the flexibility of the FCS in dealing with unpredictable threats at every level of conflict may be the most critical single test of its value. The United States military must structure and equip its forces commensurate to this reality and all the threats mentioned above. The current efforts of force transformation to a modular and lighter force address the structure of the future force, while the FCS provides the equipment to counter future threats. It must do so knowing that adversaries may focus their principal effort on exploiting any asymmetric weaknesses or gaps in US capability to their advantage, whether they are non-state actors like radical Islamist insurgents or states with large conventional armies like China or Russia.

At the same time, the FCS has come under fire at a doctrinal level from critics who question the effectiveness of technological dominance in asymmetric warfare and urban combat, where troops are concerned with a lack of armor rather than a lack of connectivity.¹⁴ Both stability operations and counterinsurgency doctrines emphasize the importance of developing key local relationships and exploiting human sources.
Figure 1: FCS “System of Systems”

Figure 2 illustrates the Army’s adaptation to the new threat environment and new doctrines that include counterinsurgency as well as stabilization operations. A personnel increase of 65’000 troops is intended to make the Army more deployable and able to endure drawn out stability operations, such as the ones in Iraq and Afghanistan. The current Pentagon leadership has repeatedly emphasized the importance of aerial
surveillance and intelligence operations in the ongoing operations in Iraq and Afghanistan.

This emphasis is clearly represented in the shifts the Army’s capability areas shown in Figure 2. The figure also reflects the increased need for capabilities to support other aspects of stabilization operations, such as military police or psychological operations and Special Forces operations. Finally, it reflects some of the shifts necessary to address the requirements for non-linear and unconventional warfare, including intelligence operations and aviation and a reduced focus on artillery or air-defense capabilities.

**Figure 2: Shifts in Army Active and Reserve Component Capability Areas (in Percentage of Manpower)**

![Chart](chart.png)


On an organizational level, the transformation will increase maneuverability by abandoning divisions as the Army’s largest fixed maneuver force and creating a Modular Force. The modularity initiative envisions 48 Brigade Combat Teams (BCTs) and an additional 28 National Guard BCTs.¹⁶

Figure 3 shows the structure and organization of the three different types of BCTs in the modular force, Heavy BCTs, Infantry BCTs, and Stryker BCTs.
The Army hopes to increase combat power by 30 percent or higher through this modular organization. This restructuring directly addresses the requirements of irregular warfare. The Army counts on the effect of force multipliers, such as modular force BCT’s Armored Reconnaissance Squadron and its Reconnaissance, Surveillance, and Target Acquisition (RSTA) Squadrons. These units should offset a net loss of maneuver companies, which will drop in numbers by 22 percent through the modular transformation. The CSBA warns that “[t]he loss of ground maneuver capability — “boots on the ground” — seems at odds with the Service’s ongoing irregular warfare operations, which are often manpower-intensive.”

The brigades of the Modular Force include organic combat support and service capabilities, designed to deploy independently on a rotational basis. They are also designed to be supported by the major advances the FCS mix of software and hardware in the US Army’s situational awareness and intelligence capabilities, communications systems, command and control capabilities, and ability to manage combat arms and individual weapon systems. This increases the flexibility of the Army.

The Army is split, however, between those who want a specialized force, trained and equipped for particular missions and those who favor a full-spectrum force. Commensurate to the threat, the Army will need to be able to perform a variety of missions ranging from irregular warfare and large-scale stability operations to traditional
power projection operations, including regime change, major theater war and major regional conflict.

**Equipment**

The Future Combat System responds to the requirements of the Army’s force modernization initiative with increased agility, connectivity, and flexibility. “It is barely an exaggeration to say that the FCS is the Army’s modernization program.” Army officials have confirmed that the FCS is roughly 30 percent of the Army’s total modernization effort. An initial requirement for the system was that none of its components weighs more than 20 tons, so that it could be air transported by C-130-type aircraft.

However, some of the FCS vehicles have surpassed the 20-ton mark as well as limitations on volume. Particularly affected are the main ground combat vehicles of the FCS, “designed to be as survivable and lethal as the Army’s seventy-ton M1A2 Abrams main battle tank. … Mandating a 70 percent reduction in weight from the Abrams tank and a 50 percent reduction in internal volume … to accommodate C-130 cargo capacity limitations runs directly counter to the historical trends of ever-increasing size, weight, and volume in ground combat vehicles.” It is unclear what the consequences for deployability and the required airlift capability will be.

Critics like the Center for Defense Information also link such comments to the equipment being developed as part of the FCS, “it remains unclear if FCS data is capable of discerning enemy insurgents planting an improvised explosive device (IED) from a group of men working alongside a road.” IEDs do seem certain to become more sophisticated and advanced anti-tank weapons like those the Hezbollah used against the IDF may well become common holdings for non-state actors in theaters like Afghanistan and Iraq.

The Army has so far reacted through the acquisition of Mine Resistant Ambush Protected (MRAP) vehicles to replace the light High Mobility Multipurpose Wheeled Vehicle (HMMWV). A central feature of the FCS vehicles is however their lightweight to make them easily transportable. The question is whether such vehicles can cost-effectively provide armor advanced enough to deal with the future advances in asymmetric threats. Trading lightness for armor is clearly a trend that will continue. The Army has abandoned the initial 20-ton requirement to adapt to the lessons and the needs of current conflicts.

**Sustainability**

There are still numerous questions about the sustainability of the system of systems. It is unclear what the implementation of the FCS means for the Army’s personnel planning and management in the long term. Particularly, the Army’s future personnel costs, education and training, and structure will pose challenges to the FCS beyond its fielding.

The implementation of the Future Combat System in the Modular Force will bring significant changes in the Army’s personnel and training structure. The FCS subsystems demand new manpower to operate the new technology. The Army’s grow the force plan does envision to enlist 65,000 additional troops until 2012, but it has had difficulty to stem the decline in Service member quality since the onset of the Iraq war in 2003.
This is true despite the fact that the total compensation for the active-duty Service member is at an all-time high of $120,000 a year.\textsuperscript{24} The FCS is already the most expensive modernization program in the Army’s history and will require high-skilled Service members who may be hard to recruit and entail soaring additional personnel costs.

Many of today’s more sophisticated weapon and IS&R systems are already operated or supported by contractors, since trained and qualified Service members are simply lacking. The FCS will require even more skilled and qualified contractor personnel to field, train, and operate the systems. The CRS and the GAO are currently studying the implications of a large contractor workforce. But it is clear that it will be more difficult to recruit contractor personnel to operate systems in conflict zones and more costly to pay them.

Program officials believe that the impact on Army personnel will be minimal and that training and operation will become less costly than with current systems. User testing and experimentation with FCS equipment have demonstrated that soldiers learn quickly how to use and operate FCS unmanned and unattended systems, according to the program officials. They argue that FCS controls are very similar to current video game consoles and that Windows-based interfaces reveal intuitive learning processes for the soldiers.\textsuperscript{25}

Either way, it is likely that such dramatic changes in equipment and force structure will require equally fundamental changes in the personnel structure of the Army. At this point, however, it is unclear what the transformation into FCS BCTs means for personnel planning, in terms of number of required troops, cost, quality, and time of education and training, personnel structure, and cost of troops.
III. Cost and Affordability

We face a defense-wide crisis as a result of years of poor procurement planning and escalating costs. Questions about the value, cost, and affordability of the FCS have provoked divided reactions from experts, Government officials and lawmakers. Although the FCS prevailed in the FY2009 budget debate and was fully funded, the pendulum may swing to the other end with a new administration. As Government expenditures come under increasing pressure from mandatory programs and economic rescue plans, some perceive advanced complex weapon systems as a luxury.

Costly sophisticated weapon systems have come under increased criticism. Secretary Gates has long been an advocate of funding the current wars and equipment needs. The FCS has faced opposition from members of the House Armed Services Committee, which has repeatedly advocated budget cuts. Representative Neil Abercrombie (D-HI), who heads the Air and Land Forces subcommittee said, after a visit to Fort Bliss where FCS systems are being tested, “[t]here’s no connection between FCS and the necessities of right now that I can see.”

Others, however, believe that there is enough modularity and flexibility in the FCS program to keep harvesting ready technology to fight the current wars, and still move forward in implementing a comprehensive program. Secretary Gates has also called repeatedly for an acceleration of FCS technologies that could be use in Iraq and Afghanistan. Representative John Murtha, chairman of the House Appropriations Defense Subcommittee, who long opposed funding the FCS also changed his mind after a visit to Fort Bliss where FCS components are currently being tested.

Secretary Gates has noted that “[g]iven that resources are not unlimited, the dynamic of exchanging numbers for capability is perhaps reaching a point of diminishing returns.” Transition officials of the incoming administration are reported to have struck a similar tone and engaged in talks about “significant cuts in high-priced weapon systems.” Savings from such cuts would help offset budget deficits and be used to fund weapon programs that directly support the operations in Iraq and Afghanistan, both common themes among officials from the incoming administration.

There is no way to know how serious the cost pressures will be on the FY2010 and future defense budgets and US military procurement programs at this point in time. Some feel the current global financial crisis will lead to increased federal spending. Others feel it may increase the pressure to limit US defense spending.

Nevertheless, the future of the FCS seems likely to depend heavily on having a high degree of success in containing costs, avoiding slips in schedule, and identifying and eliminating technical risk. The Preliminary Design Review and the Defense Acquisition Board Review in 2009 may be crucial for the survival of the FCS. Should it fail to demonstrate significant progress and technologically mature programs that are affordable, the modernization program will be further questioned and funds reduced if not cancelled.
The Mandatory Budget Squeeze

Defense spending, as the largest part of discretionary expenditures, is under increasing pressure as mandatory Government programs – such as Social Security, Medicare, and Medicaid – will continue to grow and squeeze resources out of the discretionary account. At the height of the Cold War, defense spending had increased to $557 billion in 1985. After the end of the Cold War it contracted by almost $200 billion, or 36 percent, by 1998.

Since then defense funding has climbed back up to $656 billion in 2008 and will continue to grow in FY2009. With discretionary appropriations of nearly $1 trillion to weather the economic crisis, many in Congress may look to defense spending for potential cuts and savings. Figure 4 and Figure 5 illustrate the pressures mandatory programs put on defense spending. “If we use history as a guide, defense spending will come under increased pressure. … [T]here’s gonna be less defense spending,” Representative John Murtha (D-Pa), chairman of the House Appropriations Committee on Defense told experts at the Center for American Progress on 10 December.

Budget-Driven Realities

Even if defense budgets do rise, it is unlikely that the rise will be enough to fund the combination of war fighting costs, added manpower and rising manpower costs, wartime expenditures, reset costs, and procurement programs in the current Future Year Defense Program (FYDP). Modernization of the forces may not be affordable the way current plans suggest. The Army has come to realize this fact and made significant changes to the program. “The adjustment to the FCS program is driven entirely by the fiscal realities of today’s budget environment,” an official Army information paper states.

This situation is unlikely to change even when the global financial crisis eases. Steadily growing mandatory spending programs squeeze funds out of discretionary accounts, where economic rescue plans are currently seen as a priority and demand further thrift in defense spending. The Army’s modernization program will come under increasing pressure from competing acquisition priorities, such as MRAPs or surveillance assets needed to support the current operations in Iraq and Afghanistan. Moreover, the cost for these ongoing operations, resetting war-damaged and lost materiel, funding the increase in manpower, and the upgrades and transformation of the strategic reserve into an active reserve will drain resources from modernization accounts.
Figure 4: CBO Baseline Projections for Defense, Social Security, Medicare, and Medicaid Outlays

![Graph showing CBO Baseline Projections for Defense, Social Security, Medicare, and Medicaid Outlays](chart)


Figure 5: Rising Mandatory Spending Depresses Discretionary Spending

![Graph showing Rising Mandatory Spending Depresses Discretionary Spending](chart)

**Warfighting Priorities**

The FCS and other modernization programs already face heavy competition from maintenance, reset and war costs within the future defense budgets. Even with an agreement of the status of US forces in Iraq and a planned withdrawal of troops by 2011, it is clear that financial commitment to rebuilding Iraq and the follow-on cost for replacing war-damaged or lost materiel will extend well beyond 2011.

Savings from a reduced presence in Iraq might be offset by a surge of troops in Afghanistan and increased efforts towards Pakistan. Events such as the December 7th, 2008 attacks on NATO and US war supplies that destroyed over 160 vehicles in a Pakistani transport terminal incur costs and indicate that increased efforts and funds might be necessary to sustain the war in Afghanistan.\(^{33}\)

Past budget trends provide a warning. Roughly $858 billion had been appropriated for the wars in Afghanistan and Iraq by September 2008. Some 90 percent\(^{34}\) was in supplemental funds added on to the baseline budget. Of the total war appropriations, $810 billion have been appropriated for defense operations in both theaters. Appropriations averaged $93 billion between 2003 and 2005, rose to $120 billion in 2006, $171 billion in 2007, and $186 billion in 2008.

Figure 6 shows the historic growth of appropriations to support war-related activities in discretionary Government spending since 2001, and illustrates the level of competition with modernization programs. Supplemental warfighting funds, which are usually granted in several bills, are currently estimated to be $68 billion for the first part of 2009 by the CBO.\(^{35}\) News sources have mentioned $80 billion supplemental requests to be expected for 2009.\(^{36}\)

These pressures raise additional questions as to whether increasingly more expensive FCS can prevail in the competition for federal funds. As has been touched upon earlier, Secretary Gates has been an advocate of funding the current wars rather than development for future capabilities. These priorities are unlikely to change in Gates’ next term. “My fundamental concern is that there is not commensurate institutional support – including in the Pentagon – for the capabilities needed to win today’s wars and some of their likely successors.”\(^{37}\) Recently, Secretary Gates has also expressed interest in accelerating some FCS technologies which can be fielded quickly to fight the current conflicts.

Gates also warns, however, about the dangers in trying to fund ever costlier, technologically complex weapon systems that take ever longer to build and which are straining limited resources. He clearly favors the accelerated procurement of specialized low-tech equipment that is better suited for stability and counterinsurgency missions, such as up-armored HMMWVs, MRAPs, and intelligence, surveillance, and reconnaissance (ISR) assets. The initial procurement of over 10,000 MRAPs was funded through a special $16 billion MRAP fund in the FY2008 emergency supplemental appropriation. Competition for FCS funds might even increase when such war-related procurements are included in the base budget, as Gates demands. “It is time to think hard how to institutionalize the procurement of such capabilities [up-armored HMMWVs, MRAPs, ISR] and get them fielded quickly.”\(^{38}\)
The FCS has already faced repeated cuts to free resources for more urgent needs related to the ongoing activities in Iraq and Afghanistan. The Vice Chairman of the Joint Chiefs of Staff, General James E. Cartwright, captured the increasingly widespread opinion that “the military must end its quest for ‘exquisite’ weapon systems that are too costly, take years to design and build, and don’t reach troops fast enough.” At the same time, the Army reports that some $18 billion have been spent on FCS and 160 Army systems have been terminated over the past decade to pave the way for the future system. This imposes major risks if the FCS program is underfunded or cancelled. The Army will be 160 systems short in case the FCS fails to deliver the promised capabilities, but it is unclear how the Army will mitigate the considerable risk of a potential shortcoming in the FCS. There are currently no alternative plans to the FCS.

The Army builds on commonality to mitigate the risks of a program that has no alternatives. All Manned Ground Vehicles will for example use the same chassis. Moreover, FCS program officials state that they are developing equipment with a look into the future. FCS vehicles will be required to carry and power a multitude of electronic devices. This trend will continue as the FCS evolves. Therefore, the FCS MGV will be able to generate roughly ten times the amount of electrical power than the M1 Abrams main battle tank.41 Army officials say they were able to reduce much of the technological risk of FCS systems. Risk reduction was named along with a program extension and added tests among the main drivers for a leap in program costs in 2004.

**Figure 6: Budget Authority for War-Related Activities and Other Discretionary Spending (US$ Billions)**

![Graph](image_url)

Much still depends on the unpredictable cost of two wars. The Department of Defense has never made any meaningful public attempt to estimate such costs, but the CBO has made budget projections based on two different scenarios, assuming a more or less gradual drawdown of troops in Iraq. The cost impact of these scenarios is shown in Figure 7.

These scenarios do not split the total projected cost between Iraq and Afghanistan. Projections are based on data and trends in both theaters, and do not foresee an impending surge in combat troops for Afghanistan. The Chairman of the Joint Chiefs of Staff, Admiral Michael Mullen most recently mentioned plans to deploy up to 30,000 additional US troops to Afghanistan by summer 2009.42

The ‘low alternate path’ scenario envisions a decrease in troop levels to 30,000 by FY2010 and accrues a cost of $440 billion in the next ten years between FY2009 and FY2018. The “high alternate path” simulates the drawdown of troops to 75,000 by FY2013 and costs another $865 billion over the next ten years.43

Figure 7: CBO Projections of Low and High Alternate Paths for Troop Drawdown in Iraq and Afghanistan


The Impact of Growing Costs for the Army Reserves and National Guard

Growing equipment costs for the Army Reserves and National Guard (ARNG) might also offset reductions in cost of Iraq operations. Since operations began in 2001, ARNG units
have been deployed on a regular basis to the war theaters. Transforming the ARNG from a strategic reserve into an operational reserve that deploys on a regular basis implies significant transformational costs. ARNG units were equipped with only 70 percent of the equipment level of active Army units before the war, according to the Center for Strategic and Budgetary Assessment (CSBA). Much of the ARNG’s equipment was also significantly older and outdated.44

The CSBA estimates that the Army will equip ARNG units with an additional 520,000 pieces of equipment at a cost of $22.5 billion in 2008 and 2009. This leaves the Army with competing priorities.

- First, the Army has to balance between upgrading the ARNG in a transformation from strategic reserve to active reserve to fight the current wars and funding modernization of the forces to fight and be prepared for possible future wars.
- Second, it will have to decide between transforming the entire Army (including ARNG) into a combat-ready and deployable ground force for the present need, or modernizing and equipping a small portion – 15 out of 48 Combat Brigade Teams – with a sophisticated Future Combat System. It is unclear what this partial modernization implies for the interoperability of a large number of deployed units with different equipment standards.

**Estimated Program Cost of the FCS**

These uncertainties interact with uncertainties in the cost of the FCS. Current plans envision 15 fully equipped FCS brigades, out of an Army that will have 48 combat brigades after the transformation. This means that only a third of the Army combat forces will be outfitted with FCS equipment. Even so, funding will be a major problem.

Based on these plans, the cost of providing one brigade with the full FCS outfit has increased by over 45 percent since the start of program development in 2003, according to the GAO.45 Instead of $5.9 billion, as initially estimated, the unit cost has reached $8.6 billion in late 2007. Figure 8 provides a graphic summary of this increase.

It is difficult to project a cost for the FCS Brigade. At this point, the Army has adjusted to current needs and switched its fielding plan to several Spin Outs. Spin Out Early will field the first set of equipment in 2011. The Spin Out equipment is also planned to go to 43 BSTs instead of 15 and will be introduced to those unit that deploy to combat zones, regardless whether they are active Army or ARNG.

Cost increases may still lie ahead. Budgetary constraints have already caused the deletion of four FCS systems in 2006, the price tag however, remained the same. Also due to budgetary limitations, the Army stretched out the production phase. The FCS has not yet passed its critical design review. Historically, it is after this review that the most important cost growth occurs.

A CBO estimate projects potential cost growth of 60 percent.46 The Army’s estimate of development costs is still considerably lower than independent estimates. Low-rate production decision is scheduled for 2013.47
A GAO report also questions the accuracy of the Army’s cost estimates. “The Army’s FCS development cost estimate depends on a number of assumptions. Historically, programs using such assumptions tend to underestimate costs.”

Press reports indicated in December 2008 that the Department of Defense now put the total lifecycle cost for FCS at around $300 billion, almost twice the amount estimated at development start in 2003. Program officials confirmed that they would not spend more in development than the current value of the development contract. Such cuts may be possible, The FCS program has already been cut from 18 to 14 systems due to budgetary limitations.

Program officials told GAO that in the future, projected cost overruns would continue to be eliminated by deleting requirements resulting in reduced capabilities for the user. The GAO in turn, concluded that cost growth was almost certain, due to the following factors:

- **Low maturity levels of critical technologies:** Only two of FCS’s critical technologies have reached a level of maturity that should have been demonstrated at program start to comply with best practices standards. This may have adverse cumulative impacts on key FCS capabilities, such as survivability. Additionally, FCS and complementary component developments are insufficiently coordinated and synchronized, creating further technical, cost, and schedule difficulties.

- **Delays in defining network and software requirements:** Network and software requirements were provided to contractors were poorly defined, omitted, or late in the process, due to the programs
aggressive pace. Thus, critical tests will only be performed after the designs have been set for the FCS ground vehicles. This could inflict more costs as the designs depend on the network’s performance.

- *Late demonstrations of key capabilities:* Changes in requirements, development and production will become more costly the later they are introduced in the development. The Army does however not plan to demonstrate the performance of the FCS system of systems to assess whether it fulfills the requirements until after the production decision for the core program in 2013. Manned ground vehicles, which depend on the performance of the network, will already be prototyped when the Army plans to execute large-scale network demonstrations.

- Similarly, the Army commits to the production of FCS spin out efforts in FY 2008 and FY 2009, years before the production decision for the core program in 2013. This corresponds to total production appropriations until 2013 of $11.9 billion and another $6.9 billion in requests.

Cost estimates of the FCS program by the DoD’s Cost Analysis Improvement Group (CAIG) and the Institute for Defense Analysis (IDA) are significantly higher than the Army’s estimates. The GAO finds there is no firm foundation for a confident cost estimate. The Army rejects these two independent estimates. Given the program’s technological immaturity and the lack of performance demonstrations of key components. The Army will have spent more than half of the development budget when it will have to build and test expensive prototypes.

Some of these issues may be resolved this spring when the FCS faces the Preliminary Design Review in May, or at the Critical Design Review in February 2011. Many of the system’s thousands of requirements are almost certain to be modified during this period, and the GAO estimates that all critical technologies may not mature until the Army’s production decision in February 2013. By that time the Congress will have appropriated about $39 billion, including R&D and production costs, with another $8 billion requested for the Army’s system of systems.

The GAO is also obligated by Section 211 of the FY2006 National Defense Authorization Act (P.L. 109-136) to report annually on the progress made in the development of the FCS and a range of other related aspects of the program. These reports have made a number of recommendations, including that “DOD identify viable alternatives to FCS as currently structured that can be considered if FCS fails to meet the criteria established for the 2009 FCS Milestone Review.”

### FCS Restructuring Costs

Costs and affordability may also be affected by further efforts to restructure the program. The FCS has sustained $825 million in congressional decrements over the last three years, according to the Army. As a result, it had to make adjustments that amount to a “major program change”. The Army cut the number of platforms it will develop and buy, delayed the timeline for the remaining systems, and reduced the cost of a single FCS BCT from $6.2 to $5.9 billion.

The list below summarizes the adjustments made due to budget cuts in 2008:

- Reduces the FCS family of systems from 18 to 14.
- Slips Milestone C, initial operational capability, and full operational capability up to five months (Milestone C, second quarter of FY2013; initial operational capability, third quarter of FY2015; full operational capability, third quarter of FY2017).
• Reduces rate of production from 1.5 FCS BCTs per year to 1 FCS BCT per year.
• Increases rate of Spin Out production from four per year to six per year.
• Eliminates two classes of unmanned aerial vehicles (UAV class II and III). Increases number of class IV UAV from 24 to 32 per BCT. Reduces number of class I UAV from 108 to 54 per BCT.
• Reduces number of Non-Line-of-Sight Launch System (NLOS-LS) from 60 to 24 controller launch units.
• Increases number of Unattended Ground Sensors-Tactical (UGS-T) from 162 to 202 per BCT.
• Defers heavy armed robotic vehicle (assault and reconnaissance) and Class II and III UAVs indefinitely.
• Funds FCS unique munitions; mid-range munition beginning in FY2008 and advanced kinetic energy beginning in FY2012.
• Removes the Intelligent Munition System (IMS) from the FCS BCT.
• Eliminates the XM-307 (Advanced Crew-Served Weapon).
• Replaces Spin outs 2, 3, and 4 with Spin Out 3 only, consisting of the Class I UAV, Small Unmanned Ground Vehicle, Armed Robotic Vehicle-Light, Class IV UAV, and Army Battle Command System to battle command. Fields in FY2014.
• Reduces Warfighter Information Network-Tactical (WIN-T) points of presence from 136 to 101 (80 in FCS platforms).
• Changes radio mix (fewer 8-channel radios).

Despite these adjustments, defense analysts at the Center for Strategic and Budgetary Assessment warn of a “plans-funding mismatch” in defense plans on the order of $50 billion per year over twenty years, for a total of $1 trillion. The Pentagon’s needs to fund the FCS, which will likely surpass the $200 billion mark and possibly reach over $300 billion, do not match with the availability of funds for defense spending projected by the CBO. An August 2006 study by the CBO estimates total annual costs of the FCS to reach $16 billion, exceeding the Army’s estimate by $10 billion.
IV. Feasibility

The feasibility of a system as complex as the FCS is hard to assess, and depends on a wide range of factors. Indeed, the technological challenges to the realization of the system of systems are hard to understand for the layman. It is clear, however, that there are two central aspects of feasibility that require close attention: technical feasibility and operational feasibility. Both raise questions as to whether the FCS can be completed in its currently envisioned form and produce its planned capabilities.

Technology

There is a significant technical feasibility challenge. A GAO assessment has concluded that it will be hard for the Army to mature technologies by February 2009 for the Preliminary Design Review (PDR). Many of these processes should have been completed in 2003 when the program started. Most technologies will not reach a level of maturity that is sufficient for the PDR, according to the GAO.57

The PDR will seek to answer three central questions: “1) Are FCS capabilities relevant for current needs; 2) Can FCS be completed under the current schedule and budget; and 3) Should FCS be kept as is, restructured or limited?”58 The progress made by the time of the PDR can also be critical in shaping the outcome of the Milestone Review later in 2009. Whereas the PDR will assess technical adequacy of the systems and their compatibility with their performance and engineering requirements, the Milestone “Go or No-Go” Review may substantially cut or even terminate the program.

The Milestone Review is a serious challenge to the program, as most critical technologies have not even matured to the point where they can be tested on prototypes. The GAO summarizes the state of the program as follows: “In the key areas of defining and developing FCS capabilities, requirements definition is still fluid, critical technologies are immature, software development is in its early stages, the information network is still years from being demonstrated, and complementary programs are at risk for not meeting the FCS schedule.”59

Figure 9 shows the FCS program schedule in late 2008.

### Figure 9: FCS Program Schedule in Late 2008

<table>
<thead>
<tr>
<th>Event</th>
<th>Date (FY)</th>
<th>Event description</th>
</tr>
</thead>
<tbody>
<tr>
<td>System of Systems</td>
<td>2009</td>
<td>A technical review to evaluate the progress and technical adequacy of each major program item. It also examines compatibility with performance and engineering requirements.</td>
</tr>
<tr>
<td>Preliminary Design</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Review (PDR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCS Milestone “Go or</td>
<td>2009</td>
<td>A DOD review established by Section 214, P.L. 109-364 to determine if the FCS program should continue as planned, be restructured, or be terminated.</td>
</tr>
<tr>
<td>No GO” Review</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical Design Review</td>
<td>2011</td>
<td>A technical review to determine if the detailed design satisfies performance and engineering requirements. Also determines compatibility between equipment, computers, and personnel.</td>
</tr>
<tr>
<td>(CDR)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Assesses producibility and program risk areas.

<table>
<thead>
<tr>
<th>Design Review</th>
<th>Readiness 2011</th>
<th>Evaluates design maturity, based on the number of successfully completed subsystems and design reviews.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milestone C</td>
<td>2013</td>
<td>Milestone C approves the program’s entry into the Production and Development (P&amp;D) Phase. The P&amp;D Phase consists of two efforts – Low Rate Initial Production (LRIP) and Full Rate Production and Deployment (FRP&amp;D). The purpose of the P&amp;D Phase is to achieve an operational capability that satisfies the mission need.</td>
</tr>
<tr>
<td>Initial Operational Capability (IOC)</td>
<td>2015</td>
<td>IOC is defined as the first attainment of the capability to employ the system as intended. (Part of the P&amp;D Phase)</td>
</tr>
<tr>
<td>Full Capability</td>
<td>2017</td>
<td>The full attainment of the capability of the system, including a fully manned, equipped, trained, and logistically supported force. (Part of the P&amp;D Phase)</td>
</tr>
</tbody>
</table>


Prototypes for testing will not be available until after a production decision is reached in 2013. Comprehensive system tests will rely on simulations, technology demonstrations, experiments, and single system testing. Testing will thus occur close to the production phase, which means that problems identified in the testing will have to be resolved during the production phase. Once a system has reached its production phase, it will be most expensive to modify it. Less complex weapon systems have experienced up to a threefold cost increase due to design changes and reengineering during the production phase.

The Army relies on modeling and simulations to evaluate many aspects of the design, engineering, fabrication, assembly, and testing. Although the user community is confident that the FCS will deliver the expected capabilities, some experts are more doubtful. The Institute of Defense Analysis (IDA) found that, “…experience teaches that the simulated behavior of individual systems and system of systems almost certainly fails to capture important aspects of live behavior.”

The same IDA report notes that the Army has little experience in developing system of systems. The GAO further questions the FCS ability to deliver the expected capabilities after the restructuring of the program from 18 to 14 core systems. Even though the Army performed simulations and models of the program with both, 18 and 14 systems, it is unclear what the reduction of systems will entail in capabilities. There are no comparative studies available explaining the implications of the restructuring.

A lack of prototypes can be decisive regardless of the number of systems, since the capability of the system at all levels will only be known after tests and demonstrations on the actual physical assets. The GAO holds the user community’s optimism about the FCS capabilities therefore for premature.
The GAO particularly criticizes the Army’s acquisition approach for the FCS, which deviates clearly from a best practices approach. Figure 10 illustrates the difference between the knowledge-driven best practices acquisition approach and the schedule-driven FCS approach.

**Figure 10: Differences between Best Practices Acquisition Approach and FCS Approach**

The availability of testable prototypes is critical not only for the success of the individual system but also for the performance of the system of systems. The Army argues that for protection and survivability, the FCS systems will rely on a comparative advantage in knowledge about the enemy to make up for armor. But immature or under-performing technologies raise doubts about the overall survivability of the system. Consequently, the GAO concludes that if component technologies fail to mature, other key performance parameters of the system, such as lethality, sustainability, and network battle command, must be reassessed.

**Operational Feasibility**

Secretary of the Army, Pete Geren describes the Army’s main objective in fielding the FCS as follows: “We never want a fair fight, and with FCS, our Soldiers will have the ability to see first, understand first, and act first.” This superiority in information and
knowledge will be achieved through the FCS’s centerpiece, the network. The network connects computers, sensors, and radios on five layers, over all echelons, from squad to brigade.

The five main layers of the FCS network are shown in Figure 11.

Figure 11: The Five Layers of the FCS Network

The key point of this diagram is that all units and functions connected to the network must be able to communicate with each other during actual operations. This is intended to be true from the sensor layer, where information is picked up by manned and unmanned sensors, down to the individual soldier.

- Information will be continuously transmitted to the applications layer, where the information is assessed and used for planning. From this layer, commanders have access to all other layers and units in the network.
- The services layer provides interoperability with existing systems, effectively connecting all sources and recipients in the battle network. The services layer is also referred to as System of Systems Common Operating Environment (SoSCOE).
The transport layer provides seamless communication across the battlefield on the ground, and in the air and space. The terrestrial tier of the transportation layer is largely based on the Joint Tactical Radio System (JTRS) Ground Mobile Radio (GMR), which will be discussed below.

Finally, the standards layer establishes norms and procedures that enable the “seamless interoperability with combined and coalition forces for all National Security Systems and Information Technology systems.”

It is this network that combines the FCS subsystems into a system of systems. However, the development and maturity of the network technology raise questions about the feasibility of the integrative system.

A GAO report concludes that “[i]t is not clear if or when the information network that is at the heart of the FCS concept can be developed, built and demonstrated.” The report also highlights the risk of schedule delays and lag of a testable core network. “The first large-scale demonstration is scheduled for 2012, only one year before the Army plans to initiate production.

The GAO is also concerned that the Army will not attempt a large-scale demonstration of its battle network until after the FCS manned ground vehicles, whose effectiveness is highly dependent upon the network, are already designed and prototyped.”

The Army builds on an incremental approach to software development. The entire FCS software will be developed and produced in four steps and inserted with the Spin outs. Build 1 of the software is complete and will be fielded with Spin Out Early in 2011, according to program officials. The Army plans to conduct thorough tests and demonstrations with the entire software by 2012.

To mitigate the risk of technical feasibility, the Army seeks to learn from each software build and apply the lessons learned into the next incremental build. Thus, the Army hopes to adjust relatively quickly to changes in technology, operational needs, or changes in priority. This approach, although flexible and responsive, is likely to draw out the development phase of the entire network.

It is difficult to make projections about schedules and technological feasibility of a system that builds in place holders for potential and unpredictable changes. It is also difficult to assess the progress of a system with flexible benchmarks and partially undefined requirements. There are no clear and traceable development plans for the entire system. Clearly, this is the cost for the flexibility introduced by this new way of doing business. Responsiveness and adaptability to current needs, even if they come at the cost of schedule slips for the entire system, may well be what will keep the FCS above water through anticipated budget cuts.

Even if the network can be realized at an acceptable cost and within a reasonable schedule, some critics also question whether it will enhance the force effectiveness and increase survivability to make up for less armor. The achievement of this objective not only depends on a functioning network, but on the functioning and the interoperability of a number of crucial contributing subsystems.

**Multiple Systems – Multiple Schedules – Multiple Risk**

The FCS includes over 50 complementary programs. Some of those have their own schedules and budgets and are treated as individual programs in appropriations processes.
Synchronizing the schedule and the content of the FCS with its complimentary systems is another challenge that adds to the overall program risk of the FCS.

The failure of any core system to materialize, or even a major delay, could significantly limit the capabilities of the remaining systems. This adds to the already considerable risk caused by the technological challenge. A GAO report comments that the “FCS program has been characterized by the Army and others as a high-risk venture due to the advanced technologies involved as well as the challenge of networking all of the FCS subsystems together.”

**Spin Outs**

There will be other kinds of tests of technical and operational feasibility. The Army plans three series of “Spin Outs.” Spin Outs are enhanced capabilities, developed as part of the FCS program, made available to the current force through technology insertions. Spin Out Early is the first technology insertion and is scheduled to run between 2008 and 2010. The group of technologies that is currently being tested at Fort Bliss primarily includes communications capabilities and unattended sensors to detect enemy activity.

The Spin Out concept is largely the Army’s response to the Secretary Gates’ and other DoD officials’ call to equip the Army for its current operations and according to their current needs. It will benefit the deployed units with the latest in technology. The further development of the entire FCS will benefit from the feedback of units who have used the systems in actual combat.

Accordingly, the Army will field the Spin Out equipment in sets and by organizations. The first technology insertion, dubbed Spin Out Early, will equip one Brigade Combat Team in 2011. The equipment will be introduced to whichever BCT deploys at that time. The goal of this plan is to build density in the operational theater by equipping the deploying BCTs with the new technology that is then left in the theater and handed over to the next unit when the first returns. One set of equipment will remain in the US for training purposes. In 2012 two more sets are scheduled to be fielded and, depending on the number of units to deploy, up to six sets will be fielded in the following years.

Spin Out Early consists mainly of sensors and communication equipment. No ground vehicles will be fielded by the 2011 deadline. This makes the technology introduction easier. Insertion of heavier hardware may take longer than the speedy fielding of Spin Out Early. The introduction of the Stryker vehicle took around 12 months.

**Non-Line-Of-Sight Launch System (NLOS-LC)**

The Non-Line-of-Sight Launch System (NLOS-LC) is a Spin Out Early (formerly called Spin Out 1) system that has passed into a low-rate initial production phase. It can strike targets 40 kilometers away currently with laser accuracy and in the future with GPS accuracy. The missile transmits a real-time image of the target, which allows for visual targeting by the commander.

The rapidly deployable NLOS-LS consists of a networked container launch unit including 15 laser- and GPS-guided precision strike missiles. It can be moved on a tactical vehicle, flown on a C-130 or slung beneath a Black Hawk helicopter. Its greatest benefit is that it is platform-independent and can accept remote commands, which allows
it to operate without an attendant crew. It can operate autonomously on battery supply for up to 72 hours. However, it still has to be transported to its firing location.

It is unclear how the NLOS-LC, when fielded in 2011, will operate and how it will be integrated into existing units. The employment of the NLOS-LS on an existing platform is only planned for the Littoral Combat Ship (LCS). The NLOS-LS will be the ship’s core capability to counter coastal threats and enable it for fast in-shore attack. In this capacity it will support the protected access and rapid deployment concept of the FCS. It is however questionable, what the selection of the NLOS-LS for the LCS implies for the FCS spin out. The Littoral Combat Ship program was cancelled in late 2008 at the count of three ships.

The Challenge of Joint Warfare

The Future Combat System not only relies heavily on its central network and enabling component, it depends on major advances in joint warfare. The Army must depend on its sister services to enable key aspects of FCS operations. According to the CSBA, the Future Force concept of operations “includes important assumptions concerning joint C4ISR, to include operational and tactical sensor-shooter linkages, integrated logistics and strategic and operational lift.” Major assumptions by the Army also include the kind of support it will receive from the Navy and the Air Force for a “comprehensive joint force protection umbrella that includes air and missile defense”.

Air Force and Navy Enablers

This protective environment is critical to the operation of the system. It is necessary to provide “the security of air and sea ports of debarkation, and enables uninterrupted force flow, against a diverse variety of anti-access threats.” Without a protected access environment, the FCS Brigades might not be able to deploy as quickly and as easily as planned. Transportation itself is just as critical to the FCS concept. Ironically, the FCS will compete for budget allocations with long overdue modernization programs for the Air Force’s airlift capabilities.

Transformational Communications Satellite (TSAT)

The availability of complimentary systems poses a further challenge. The Air Force’s Transformational Communications Satellite (TSAT) is just one such complimentary system or enabler. “Besides creating a virtually jam-proof environment and providing much larger bandwidth, the TSAT’s internet protocol routing will connect end users through a network instead of the traditional and limiting point-to-point connections. This capability will make it the hub of joint communications architecture in the future.” It will also be 100 times faster than current military satellites.

The TSAT’s development has been anything but expeditious. It has experienced significant technical difficulties resulting in schedule slips and cost overruns. After a long history of these cost overruns and delays, the program has suffered repeated budget cuts of over 75 percent. Its contract award has most recently been shelved for another two years and current plans do not conceive launching the system before 2019, four years after the Army plans to deploy its first FCS-equipped unit.
This lack of congressional support has caused the program to be cut from five to four satellites and appropriations incrementally reduced from original estimates of over $20 billion to $6.5 billion. The contract award itself, slated for late 2008 was shelved until late 2010, until in late December the DoD decided to cancel the competition altogether and issue guidelines for a new, more scaled down contract.

FCS program officials feel, however, that the importance of TSAT for the fielding of the FCS must be kept in perspective. FCS does not require TSAT for its initial fielding, they say. However, it will be able to interface with TSAT as soon as it becomes available. The impact of a delay in TSAT will be minimal since there are currently no FCS SATCOM dependencies on TSAT.

TSAT will increase bandwidth and it will downsize in volume and weight the Warfighter Information Network-Tactical (WIN-T) on which the FCS relies primarily for seamless and integrated communication. It will enhance the flexibility, performance, and robustness of the warfighter through increased data rates and a lowered probability of interception. Besides bandwidth, it will add redundancy to the FCS communication network to make it more robust, survivable, scalable, and reliable. Satellite communications is however only one of three tiers of the FCS network transport layer.

**Joint Tactical Radio System (JTRS)**

The Joint Tactical Radio System (JTRS, pronounced *Jitters*) will provide voice, video, and data communications and link aerial and ground FCS vehicles. Although JTRS will form the communications backbone to the system of systems, the Army describes it as a ‘complimentary program’ to the FCS.

One of JTRS’s primary benefits is its capability to operate on multiple frequencies, which would allow it to talk to certain non-JTRS radios that are planned to stay in the Army beyond its FCS transformation. Production qualification tests will be conducted in 2009 and a production decision is scheduled for 2010.

JTRS is important to FCS but it is unclear if the system can be integrated into the existing communications infrastructure. There might not be enough bandwidth available for the massive increase in data flow due to a JTRS-equipped force. The CRS has called it an issue for congressional concern. It is also unclear what impact TSAT will have on bandwidth.

Furthermore, JTRS will be essential to integrate FCS into the existing technology. However, the goal of making it ‘backward compatible’ with legacy radios “may be technologically infeasible,” according to a GAO report. As a backbone of the FCS network, JTRS will be deployed in many of the FCS’s vehicles. Since most of these vehicles are not yet developed, JTRS integration cannot be tested on its final battle platform and has to be placed in surrogate vehicles. Current issues of volume, weight, and power supply could aggravate the systems cost overruns when integrated into its final platforms.
FCS program officials feel that the GAO’s and CRS’s concerns may be excessive. However, they confirm the importance of JTRS for the FCS. It will give the entire family of ground vehicles a common communications capability. FCS Manned Ground Vehicles are still being developed. As opposed to JTRS, they are developed as integral part of the FCS. There are however no attempts to integrate JTRS development into the FCS program. FCS program officials say that communications problems had always been handled separately.

V. Lead System Integrators and Contract Support

The FCS is by far the largest and most complex and costly weapon program in the Army’s history. With a price tag over $200 billion, the number of companies involved, the people who work on it, the number of systems and the level to which they need to be integrated, and the number of lines of code that have to be written lack any comparison in DoD programs. All these factors go beyond the scope of traditional Government programs in terms of capacity and capability.

The Army draws on the experience of the private sector to coordinate and manage the development and acquisition of such a complex system of systems. In March 2002, it selected two companies – Boeing and Science Applications International Corporation (SAIC) – to serve as the lead system integrators. They were tasked to oversee certain aspects of the development of the FCS subsystems.

The companies then awarded contracts to 21 other companies to design and build the various platforms, hardware, and software for the FCS.

Experience has shown that the success of the lead system integrators, and their support contractors, is critical to both technical and operational feasibility. It has also shown that the risks can be high even when all of the parties involved are highly qualified. There is no clear way to quantify risk, but the sheer complexity of managing systems integration, and dependence on so many different contractors poses significant challenges. This is particularly true given the ambitious schedule, past cost escalation, and the fact that the FCS is not only the largest single software problem in US history, but the most complex integration of software and hardware.

Many of the challenges described in this section are not new to DoD acquisition programs and not unique to the FCS program. In the latter instance, the LSI model was chosen to address those challenges that are inherent in major integrated acquisition programs. The model’s success may lead the way for future DoD programs, but its failure may jeopardize the Army’s largest modernization effort.

Outsourcing Responsibility in Building Weapons

The growing complexity of weapon systems and hard-pressed defense budgets has steadily made program design more of a contractor responsibility since World War II. In the Lead System Integrator model, all four main tasks of building weapons have passed from Government to industry. The LSI sets functional requirements and system specifications, provides program technical direction, controls program management, and controls program technical execution. The TCM works with the Army Program Manager
and the LSI to ensure that these technical requirements meet the requirements in the official ORD.

Some tasks such as performing trade studies and making recommendations on technical trade-offs, have now passed from the military to the private sector. However, the Army still retains final decision making authority over these recommendations.

The role of the LSI in such a large and complex program is “crucial to managing the complexity, uncertainty, and distributed nature”\textsuperscript{83} of systems integration programs such as the FCS, according to an expert study of technology-intensive megaprojects. The same study concludes that the LSI role will ultimately result in a higher capability per unit cost for the customer. It concludes that the private sector agent seems better placed to deal with the program’s ambitious goals, the complexity of the system of systems and the capability and capacity to manage it.

The key reasons behind this shift are the growing complexity and scope of such systems while organic acquisition, systems engineering, program management resources within Government are getting scarcer. Clearly, there is a need for a new approach of building weapons for the future. Yet, the LSI model involves significant trade-offs that need to be vetted to identify a new division of tasks and responsibilities between the Government and the private sector. The Army intends to use the LSI to “manage trade-offs across individual warfighter communities and weapons systems, save cost, and accelerate delivery”.\textsuperscript{84}

The Army gave itself a very tight deadline of five and a half years at the start of the program to develop a system consisting of a number of individual weapons systems that rely heavily on a central network that had yet to be developed. Typically, traditional and less complex programs take longer than that. The challenges of integration and common operating environment are no less ambitious. The technology to be developed requires an unprecedented level of innovation and ingenuity. Finally, harnessing political support for a multi-billion dollar project that spans over an entire generation is in itself an ambitious goal.

\textbf{Management Capacity}

There are at least two organizational challenges to the development of such a large, complex, and integrated system as the FCS using traditional development contract processes. First, the system of systems involves and links together all of the Army’s traditional warfare communities, such as infantry, armor, artillery, and aviation. The FCS will depend on the functioning of the interfaces not both with the other services, and especially on the interfaces within the Army and between its communities. Traditionally, these communities would develop and produce their capabilities independently. A lead system integrator can integrate all of the communities as early as in the development phase, which has not been the case with traditional development processes. The Lead System Integrator can also bring the end user closer to the developer.

Previous problems of coordinating and integrating across the Army’s communities can be better addressed by the more flexible structure of an LSI than the rigid stovepipe structures of the Army. Experts have highlighted that private sector contractors bring a
generally high level of costumer understanding, whereas the military often “lacks confidence in its own laboratories’ responsiveness and customer understanding.”

The second challenge is the size and flexibility of the Army’s workforce. Army leaders found that the Army’s own workforce was not large and flexible enough to handle the multi-platform program. Typically, the Army would establish one Program Management Office (PMO) for each platform of the FCS system, which in this case would amount to over 20 PMOs. Its workforce is also stovepiped into organizations that accumulate expertise typical for their own organization’s needs. The FCS, however, demands expertise and structures that go beyond any of the traditional development and acquisition organizations within the Army. Previous experience with major integration efforts exposed the lack of coordination between developer and user.

In addition to the shortage of needed skills in the DoD workforce, the Army concluded that the number of acquisition personnel available was insufficient. The DoD civilian workforce has suffered significant cuts since the end of the Cold War. A GAO study documents the reduction of 38 percent between 1989 and 2002. The acquisition workforce is particularly affected by this decrease in numbers, while the budgets they manage get larger and the programs more complex. The Army barely has enough acquisition officers to meet its current demands and it would take up to 24 months to staff a PMO with enough qualified personnel.

An LSI can introduce considerable economies in human resources and increases in workforce capacity through the integrated management of the system of systems, as opposed to individual platform programs, which would all have their own acquisition and technical staffs. While the LSI approach clearly reduces staffs, it remains unclear whether the LSI approach can cut personnel costs. A GAO report is skeptical and mentions, based on data provided by FCS program officials, that “[t]he Army is paying the average LSI full-time equivalent about 25 percent more than the average cost of a federal employee in the senior executive service.” A conclusive personnel cost assessment must however take into account DoD’s cost in hiring and training the missing workforce and, two factors which are clearly not reconcilable with the FCS’s competitive timeline.

Management Capability

There are other issues involved. Unlike traditional Army systems development programs, the FCS heavily relies on software. The network functions as the backbone of the system of systems. A GAO study estimates that the FCS performance is controlled to 95 percent by software, the most ever for a weapons system. Such a specialized workforce is unavailable in the numbers needed within the ranks of the Army and the DoD. “The Army personnel system is even slower and more cumbersome when it tries to acquire talent from outside the Government,” according to experts.

As a consequence, the Army turned to industry to fill this capability gap. Industry sources say that they can offer the skills and expertise required for the program and more knowledge than the Government. More flexible hiring structures and shorter chains of command make private companies better suited to surge the specialized workforce needed and assemble the necessary expertise.
Precisely, the LSI can use a combination of three advantages to pull together this expertise. First, they have larger populations of human capital to draw from. Second, the recruitment and hiring practices of a private company can produce an operational and skilled workforce much quicker than the Government. Finally, they are not bound by the rules and regulations of the Government contracting process and can therefore award and manage multiple large technical support contracts for supplemental manpower.

**Risks**

Shifting traditional responsibilities from the Government, and from the end user of the product, to the profit-oriented private sectors does create significant risks. It is essential that Government maintain critical oversight and decision making authority. Detailed program reviews and veto rights over subcontractor selections, technical requirements, and other LSI decisions is one way the Army has attempted to address these risks.

Limited authority over determining requirements and selecting subcontractors raises concerns over the transparency of the LSI contract. A lack of transparency could lead – and has led in the past – to cost overruns, schedule slippage, poor product quality and inadequate system performance. The ability to provide oversight moves to the center of the Government’s responsibilities in the LSI concept. Eventually, the Government’s ability of exercise oversight and governance will largely determine the success of the LSI model.

Oversight and governance over the program are crucial to mitigate the risks posed by the competitive relationship of the LSI and its subcontractor, the LSI’s authority over development and testing, and potential conflicts of interest, inherent with the LSI approach.

A 2007 GAO report estimates that the FCS program will have spent 80 percent of the total cost of the LSI contract by the time of the program’s Critical Design Review in 2011. These funds will be paid mostly in the form of incentive fees for meeting performance and schedule benchmarks. However, the report notes that the most significant cost growth typically occurs after the design review, at a time when the program will be left with only 20 percent of its funds. The GAO studied 26 historic cases of major development programs and found that they experience an average 20 percent cost growth, with almost 20 percent after the critical design review.

**Fees**

Should the LSI not succeed to achieve the needed capabilities, it will still be entitled to cost reimbursement and earn its full fee, given it has put forth its best efforts on the development. The fees come part in fixed fees, which are paid in annual installments, part in incentive fees, which are tied to certain pre-defined performance parameters.

The incentive fees are tied to the LSI’s best efforts in reaching performance criteria. Recent incentive fees included such items as updated force effectiveness analysis, updates and approval of program technical performance measures, and the completion of certain requirements and planning products. The fees are however, not conditional on achieving total program outcomes or meeting deadlines. Incentive fee events, such as the May 2009 Preliminary Design Review, which holds over $255 Million in incentive
rewards, do not specify the current status of technical performance measures or when and how the requirements process should be completed.

Figure 12 shows the distribution of fees over the entire development phase.

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**Figure 12: LSI Contractor Fees in $US Millions**

![Graph showing distribution of fees over the entire development phase.](source)

Oversight

The Army gives up much of its authority and influence to the LSI, compared to traditional programs where it staffs the project management offices. The GAO concludes that “input factors such as those used as criteria for the fee events in FCS are valuable, but they do not provide indications of success relative to the desired end result of the program.” However, the Army does retain a critical guidance and decisionmaking function.

Through a clear definition and communication of requirements and the adjustment of the contractual responsibilities of the LSI it can adapt and optimize the progress of a system as complex and developmental as the FCS. The incentive fee can be used for such guidance “because the criteria for each fee event are not set until the year the event occurs and payment of fee associated with each event is done incrementally based on accomplishment of specific criteria for each event.”

The GAO emphasizes the importance of DoD oversight and primacy in defining requirements. With the intermediary of an LSI, the Government’s role and responsibility in assuring oversight needs to be emphasized. In the LSI contract Pentagon program managers give up their command position and are reduced to an oversight role. Instead of leading the development process and making decisions, their tasks have switched to monitoring and reporting.

These activities are not on the forefront of traditional Government contracts. In an LSI contract, however, oversight becomes a critical task of the Government office and must be exercised carefully, instead of trying to compete for authority on executive decisions. FCS program officials mentioned that the GAO has auditors in the Program Management Office to guarantee access to critical information for oversight.

LSI-Subcontractor Competition

Some experts say that there is a “culture of mistrust” between the LSI and its subcontractors due to the competitive nature of their relationship. Some subcontractors complain that the LSI intentionally withholds information from them, acting as a gatekeeper. LSI officials, however, state that their “subcontractors are unwilling to coordinate with them on Congressional lobbying,” based on the same competitive relationship.

Such a dynamic is not surprising and not significantly different from traditional prime contractor contracts. It is the flipside of the same competition that assures quality of product in other programs. Contractors cannot be blamed for competing against each other but the LSI structure needs a strong mediator. It is in the end user’s best interest to perform this function very carefully.

Development and Testing

The LSI contract structure introduces another critical shift of responsibilities. In the LSI contract, the Army also relies on the LSI to conduct development, testing, and the production of prototypes to a larger extent than in traditional development contracts. The Army tests have been valued in the system development process for their independent
role and source of information on the development progress. With the LSI contract, this role is limited.

The LSI will build and test prototypes through the LSI contract and recommend the type and quantity of prototypes to be produced. Members of the Army test community are concerned with their curtailed role in this process and raise the question “whether the LSI is too involved with testing its own solution,” according to a GAO report.99

The authority over the production of prototypes and pre-production testing is an issue of debate between Government agencies and the LSI contractor. Experts blame the Army for failing to invest enough time up front “to define the FCS program specifications and LSI contractual statement of work to include the necessary checks and balances to retain proper Government control of the program.”100 According to these experts, the Army has simply not been able to keep pace with the LSI in the fast implementation of the program. Government agencies have found it impossible to “effectively engage” with the LSI, due to the fast pace.101

**Conflict of Interest**

Checks and balances may be another source of friction in the implementation of LSI concept. Observers have expressed concern about potential conflicts of interest between the LSI and its subcontractors that might lead to less-than-optimal solutions for the customer and higher costs. A GAO study further elaborates on the danger of self-certification by the LSI and the difficulty of re-competing the LSI contract.102

The GAO study notes that a conflict of interest can occur due to the LSI’s unchecked authority to determine system requirements and soliciting, evaluating, and hiring contractors. The LSI might be tempted to select subcontractors on the basis not of the best performance or product but of the flow of revenues. It might select its own subsidiaries over competitors, which could increase costs for the customer or reduce technological innovation. In the FCS contract, however, the LSI is precluded by Congressional language and Army direction from receiving or competing for any system or sub-system of the FCS system design and development program.

An LSI might also be tempted to self-certify its own products for meeting program requirements in the case of unchecked authority over the determination of system requirements and the testing process. Finally, the CRS mentions that it might be difficult to re-compete an LSI contract, even though a re-competition can happen every few years. The incumbent LSI’s acquired knowledge of the program and potential disruptions caused by a change of LSI leave the Government with “little real ability or leverage to use periodic re-competition to improve the performance of the LSI in a long-term acquisition program.”103

Potential conflicts of interest, self-certification, and limited ability to re-compete the LSI contract are inherent to the concept of LSI. It is unfair to fault the LSI for the competitive nature of its relationship with other contractors and subcontractors as it is unfair to fault the player for the nature of the game. However, experts confirm that the fear is real and reasonable that a manufacturer’s trade-off analysis might be biased toward an alternative that benefits the interests of the manufacturer.104
Conflicts of interest may be mitigated for some tasks by a third organization. Federally Funded Research and Development Centers (FFRDCs) could mitigate those risks, according to some experts. FFRDCs are specially chartered nonprofit corporations usually sponsored by a parent Government organization with a special interest. They receive long-term contracts but cannot compete for Government production contracts. The same experts highlight the FFRDCs’ quasi-academic status and their high-quality objective advice. A close relationship to the sponsoring organization also endows them with a high level of customer understanding.

**New Functions in Managing Large Government Programs**

The LSI model has major potential benefits, however, as well as risks. It could lead the way to the future of large Government acquisition programs. Although the FCS is not the only program that uses the LSI approach, it is by far the largest and most important LSI program. The lessons learned from this LSI experience will qualify the LSI model for future use in other Government programs. Whether the LSI is the best approach to develop the FCS is another question that must be assessed to decide over the continuation of the program, which may depend largely on positive program milestone events for congressional support. Legislation has limited the future use of LSIs but it remains unclear how the Government workforce will cope with the management of integrated programs in the near future.

The GAO report offers a number of broad and general recommendations. Similar to many other DoD acquisition programs, the GAO recommends that DoD “assert its own policy-based markers for progress, particularly in the areas of cost, technology maturity, design maturity, and production maturity.” Avoiding greater detail, it only suggests that DoD ensure that there is the “best link possible” between the fee events and actual FCS demonstrations. The GAO further recommends an assessment of the LSI experience and its broader implications for acquisition management.

Two closely related issues seem to be critical in both evaluating of the LSI’s performance in the FCS program and as a general model for managing future Government programs. First, the new division of responsibilities introduces a new relationship between the Government and the private sector. This includes not only shifting tasks but also creating new functions and adjusting the emphasis on existing functions on both sides. The Government’s dependence on the private sector is meanwhile inevitable.

Some experts believe that “[g]overnment officials cannot avoid being held responsible for the inevitable system failures – the huge cost overruns and missed time and performance targets – that such dependency encourages. Some backtracking toward stronger public management of large-scale system projects is highly probable.” While this is true for most major DoD contracts, the LSI model may benefit from an LSI contract that more adequately incentivizes the LSI contractor and shares key risks between the Government and the private sector.

Clearly, there has to be a balance that harnesses the vast industrial capability of the United States to a maximum while containing costs. Yet, certain functions the industry cannot perform. It was chosen due to clear advantages. These must be exploited but cannot go unchecked. Governance and oversight are functions a profit-oriented
organization cannot perform and must be emphasized in the Government’s share of responsibilities.

The second issue that needs thorough evaluation in the FCS LSI experience is the capacity and capability of the Government workforce. The shift in responsibilities and the recourse to the private sector for the FCS program management came largely as a necessity, given the withered size and capability of the Government’s acquisition workforce. As it turns out, the Government still has to make significant workforce adjustments to sufficiently live up to its responsibilities of governance and oversight. There need to be clear decisions and directives on what capability and capacity the Government wants to maintain in its workforce and what functions they will need to perform in the future.

A surge in Government workforce is unlikely in the current budgetary environment. The outsourcing model is meanwhile the most pragmatic solution to Government workforce scarcity, despite its checkered performance. Some experts believe that the inherent fears about conflicts of interest and profit bias with private contractors may be mitigated with FFRDCs, particularly with regard to oversight functions. An assessment of FFRDCs in such functions goes beyond the scope of this report. The success of the FCS program, however, depends much on a thorough vetting of the LSI model with all its components as well as its alternatives.
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