

# CRS Report for Congress

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## **The Army's Future Combat System (FCS): Background and Issues for Congress**

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# The Army's Future Combat System (FCS): Background and Issues for Congress

## Summary

The Future Combat System (FCS) is the U.S. Army's multiyear, multibillion-dollar program at the heart of the Army's transformation efforts. It is to be the Army's major research, development, and acquisition program to consist of 18 manned and unmanned systems tied together by an extensive communications network. FCS is intended to replace such current systems as the M-1 Abrams tank and the M-2 Bradley infantry fighting vehicle with advanced, networked combat systems. 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 so that FCS-equipped units can function as intended.

The FCS program exists in a dynamic national security environment which could significantly influence the program's progress. The wars in Iraq and Afghanistan, proposed and possible defense budget cuts, and the upcoming Quadrennial Defense Review will each likely play a role in shaping the FCS program. The revised FCS program timeline — including four "spirals" whereby equipment is to be tested first by a FCS evaluation brigade and then introduced into the current force — has extended the program's timeline by four years and has added additional funding requirements, but it has also served to reduce some of the risk associated with this admittedly high-risk venture.

The overall FCS program budget has risen steadily since the program's inception and because the program is still in its early stages, its full costs are not yet known. The FCS program is managed by a lead systems integrator group consisting of major defense contractors Boeing and Science Applications International Corporation (SAIC). Although widely criticized, the Army adopted this program management approach largely because it did not have enough acquisition, scientific, and engineering staff to manage a program of this complexity and scope. In addition the program's use of an Other Transaction Authority (OTA) agreement in lieu of a more structured Federal Acquisition Regulation (FAR) contract raised a number of concerns regarding program oversight and protecting the taxpayer's interests. Partly due to Congressional pressure, the Army recently decided to change from an OTA to a more traditional contract, although specific details at this point are few.

The FCS is experiencing a number of program development issues in its Joint Tactical Radio System (JTRS) program as well as in the manned and unmanned ground vehicle programs. Congress, in its authorization, appropriation, and oversight roles may wish to review the relevancy of the FCS program in terms of current and potential future threats, the overall viability of the program, program management and contractual agreements, and program "off ramps" into the current force should the FCS program be modified or curtailed. This report will be updated as the situation warrants.

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# The Army's Future Combat System (FCS): Background and Issues for Congress

## Issues for Congress

The Future Combat System (FCS) is the Army's multiyear, multibillion-dollar program which is considered to be at the heart of the Army's transformation efforts. It is to be the Army's major research, development, and acquisition program to consist of 18 manned and unmanned systems tied together by an extensive communications network. FCS is intended to replace such current systems as the M-1 Abrams tank and the M-2 Bradley infantry fighting vehicle with advanced networked combat systems. 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 so that FCS-equipped units can function as intended.

The primary issues presented to Congress are the necessity and viability of the FCS program and the likelihood, given a myriad of factors, that the Army will be able to field its first FCS-equipped brigade by 2014 and eventually field up to 15 FCS-equipped brigades. Key oversight questions for consideration include

- Is the FCS relevant to current and future security challenges?
- Is the FCS program, as currently envisioned, viable?
- Are FCS program management and types of contractual agreements appropriate?
- How will program "Off Ramps" and integration into the current force be managed?

Congress's decisions on these and other related issues could have significant implications for U.S. national security, Army funding requirements, and future congressional oversight activities. This report will address a variety of issues including the program's timeline, budget, program systems and subsystems, as well as current program developmental issues and challenges.

## Background

### FCS Program Origins

In October 1999, then Chief of Staff of the Army (CSA) General Eric Shinseki introduced the Army's transformation strategy which was intended to convert all of the Army's divisions (called Legacy Forces) into new organizations called the

Objective Force.<sup>1</sup> General Shinseki's intent was to make the Army lighter, more modular, and — most importantly — more deployable. General Shinseki's deployment goals were to deploy a brigade<sup>2</sup> in four days, a division in five days, and five divisions in 30 days.<sup>3</sup> As part of this transformation, the Army adopted the Future Combat System (FCS) as a major acquisition program to equip the Objective Force.<sup>4</sup>

This transformation, due to its complexity and uncertainty, was scheduled to take place over the course of three decades, with the first FCS-equipped objective force unit reportedly becoming operational in 2011 and the entire force transformed by 2032.<sup>5</sup> In order to mitigate the risk associated with the Objective Force and to address the near-term need for more deployable and capable units, the Army's transformation plan called for the development of brigade-sized units called the Interim Force in both the active Army and the Army National Guard. These six brigade sized units,<sup>6</sup> known as both Interim Brigade Combat Teams (IBCTs) or Stryker Brigade Combat Teams<sup>7</sup> (SBCTs), are currently being fielded and some have served in Iraq — with the last brigade due to be fielded in 2010.<sup>8</sup>

General Shinseki's vision for the FCS was that it would consist of smaller and lighter ground and air vehicles — manned, unmanned, and robotic — , and would employ advanced offensive, defensive, and communications/information systems to

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<sup>1</sup> Many experts consider the Army's 1999 controversial Task Force (TF) Hawk deployment to Kosovo and Albania as the event that triggered the Army's transformation. Reportedly, the Army deployed a unit consisting of units from different divisions that had never trained together commanded by a command and control organization that was unable to conduct joint operations. The most often cited criticism was that it took more than 30 days to deploy TF Hawk, centered on 28 Apache attack helicopters, from bases in Germany to Albania; and, when they finally arrived, they were unable to conduct combat operations due to training and equipment deficiencies. The task force also consisted of mechanized maneuver and support elements competing for limited air lift insertion capabilities.

<sup>2</sup> According to Department of the Army Pamphlet 10-1, "Organization of the United States Army," dated June 14, 1994, a brigade consists of approximately 3,000 to 5,000 soldiers and a division consists of approximately 10,000 to 18,000 soldiers.

<sup>3</sup> Frank Tiboni, "Army's Future Combat Systems at the Heart of Transformation," *Federal Computer Week*, Feb. 9, 2004.

<sup>4</sup> James Jay Carafano, "The Army Goes Rolling Along: New Service Transformation Agenda Suggests Promise and Problems," *Heritage Foundation*, Feb. 23, 2004, p. 5.

<sup>5</sup> Bruce R. Nardulli and Thomas L. McNaugher, "The Army: Toward the Objective Force," in Hans Binnendijk, ed. *Transforming America's Military*, (National Defense University Press, 2002), p. 106.

<sup>6</sup> The Army currently plans to field five active and one National Guard Interim Brigade Combat Teams.

<sup>7</sup> The Stryker is the Army's name for the family of wheeled armored vehicles which will constitute most of the brigade's combat and combat support vehicles.

<sup>8</sup> "Stryker Brigade Combat Team," *GlobalSecurity.org*, updated May 19, 2004, [<http://www.globalsecurity.org/military/agency/army/brigade-ibct.htm>].

“outsmart and outmaneuver heavier enemy forces on the battlefield.”<sup>9</sup> In order to initiate the FCS program, General Shinseki turned to the Defense Advanced Research Projects Agency (DARPA), not only because of their proven ability to manage highly conceptual and scientifically challenging projects, but also because he reportedly felt that he would receive a great deal of opposition from senior Army leaders who advocated heavier and more powerful vehicles such as the M-1 Abrams tank and the M-2 Bradley infantry fighting vehicle. In May 2000, DARPA awarded four contracts to four industry teams to develop FCS designs and in March 2002, the Army chose Boeing and Science Applications International Corporation (SAIC) to serve as the lead systems integrators to oversee the development and eventual production of the FCS’ 18 systems. On May 14, 2003, the Defense Acquisition Board<sup>10</sup> (DAB) approved the FCS’ next acquisition phase and in August 2004 Boeing and SAIC awarded contracts to 21 companies to design and build its various platforms and hardware and software.

In August 2003, the newly designated CSA, General Peter Schoomaker, changed the Army’s transformation plan. General Schoomaker redesignated the Objective Force as the Future Force, emphasizing the fielding of useful FCS program capabilities as soon as they became available instead of waiting a decade or more before they could be integrated into other FCS platforms and technologies under development.<sup>11</sup> Some suggest that this was an attempt to deploy relevant technologies to forces actively involved in combat operations as opposed to the abandonment of General Shinseki’s transformation program. Under General Schoomaker’s plan, the Army restructured the FCS program to place the emphasis more on the various networks linking Army forces together, as well as with units from the other services, than on the actual FCS platforms themselves.<sup>12</sup>

## **FCS and the National Security Environment**

The FCS, like all other major, multi-year defense programs, is subject to the changing demands of the national security environment. No matter how successful the FCS is on a programmatic level, whether or not the Army eventually achieves its 15-brigade FCS force is highly dependent on the influences of the current and future national security environment.

**The Wars in Iraq and Afghanistan** . In 1999, a peacetime Army introduced the FCS program as the centerpiece of its transformation plan. At that time, the Army

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<sup>9</sup> The following description of the early stages of the FCS program is taken from Frank Tiboni’s *Army’s Future Combat Systems at the Heart of Transformation*.

<sup>10</sup> The Defense Acquisition Board (DAB) is the Defense Department’s senior-level forum for advising the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) on critical decisions concerning DAB-managed programs and special interest programs.

<sup>11</sup> James Jay Carafano, p. 6.

<sup>12</sup> Ibid.

reportedly planned on “a few more years of relative tranquility to pay for the FCS”<sup>13</sup> Most agree that the wars in Afghanistan and, particularly, Iraq have significantly altered this expectation, resulting in not only a shift of the Army’s focus to dealing with the day-to-day challenges of fighting a multi-front war, but also a total restructuring of the Army’s combat forces. In what the Army describes as the “most significant Army restructuring in the past 50 years,” the Army is redesigning its current 10 active duty division force to a 43 or 48 brigade-level unit of action or UA force by FY2007.<sup>14</sup>

The wars have also resulted in a congressionally-mandated end-strength increase for the Army.<sup>15</sup> Under the provisions of PL 108-375, the Ronald W. Reagan National Defense Authorization Act for FY2005, the active Army’s current authorized end-strength of 482,400 soldiers will grow by 20,000 by the end of 2005. The act authorizes the Secretary of Defense to increase it by 10,000 more in FY 05-09.<sup>16</sup> The Army’s primary concern is how to pay for these 30,000 soldiers in the future since Congress used supplemental appropriation funds to pay for initial end-strength increases. The Army reportedly estimates that it will cost \$3.6 billion dollars annually in pay and benefits for the additional soldiers while the Congressional Budget Office reportedly puts the figure at about \$2.6 billion annually.<sup>17</sup> Some experts, who assume that the Army’s budget will not increase permanently to support the end-strength increase, suggest that these end-strength related costs will be borne in part by the Army’s procurement account and suggest that FCS procurement funds are “the biggest target” to pay for these end-strength increases.<sup>18</sup> In addition to paying for end-strength increases, some analysts believe that FCS program funds might also be used to pay for rising operational and maintenance costs, particularly if the Iraq war continues at this or at a greater pace over the next five to ten years.<sup>19</sup>

**Defense Budget Cuts.** The Department of Defense (DOD) has reportedly been asked by the Administration, as part of its deficit reduction campaign, to reduce its spending plans over the next six years by \$30 billion.<sup>20</sup> These budget cuts are

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<sup>13</sup> Megan Scully, Christopher P. Cavas, Laura M. Colarusso, Jason Sherman, “Top Defense Programs: How Secure are they as Pentagon Budgets Tighten?” *Armed Forces Journal*, Dec. 2004, p. 27.

<sup>14</sup> See CRS Report RL32476, *U.S. Army’s Modular Redesign: Issues for Congress* for a detailed examination of the Army’s restructuring efforts.

<sup>15</sup> See CRS Report RS21754, *Military Forces: What is the Appropriate Size for the United States?*

<sup>16</sup> P.L. 108-375, Sec. 401-403.

<sup>17</sup> Megan Scully, “Analysts: U.S. Soldier Boost Could Cut Material,” *Defense News*, June 28, 2004.

<sup>18</sup> *Ibid.*

<sup>19</sup> Loren B. Thompson, “QDR Targets Weapons Programs; FCS, JSF Likely Hit,” *Defense Today*, Dec. 10, 2004.

<sup>20</sup> Rowan Scarborough, “Pentagon Cost-Cutting Aimed at New Gear,” *Washington Times*, Dec. 20, 2004 and Jason Sherman, “Pentagon Slashes \$30 Billion from Major Navy, Air (continued...)”



supposedly outlined in DOD's Program Budget Decision (PBD) 753 dated December 23, 2004, that was obtained by the press. These cuts will not affect personnel and operations and maintenance (O&M) accounts but will come instead from procurement accounts. While Navy and Air Force programs are being subjected to a variety of cuts, the Army will receive an additional \$5 billion a year for the Army's modularity program.<sup>21</sup> Many observers believe that this not only marks the end of an almost decade-long military build up but sets the stage for future budget cuts which could not only help to reduce the deficit but also to fund non-military programs such as homeland security. Some are questioning if the FCS program can survive in such an environment. While the first round of budget cuts fell almost exclusively on DOD, Navy, and Air Force programs, at some point in the future, the Army may be asked to contribute its "fair share."

**Quadrennial Defense Review (QDR).** The QDR is the Administration's statement on defense strategy, programs, and spending and is published every four years and submitted to Congress no later than the date on which the President submits the budget for the next fiscal year to Congress.<sup>22</sup> The FY2005 QDR is scheduled to be submitted to Congress in early November 2005 and, according to a number of reports, may have implications for the FCS program.

According to one report, the 2005 QDR is expected to emphasize unconventional and asymmetric threats which could result in "major changes in investment patterns for the military, particularly with respect to air and land forces."<sup>23</sup> Analysts also suggest that the 2005 QDR will need to confront the issue that "the Army is simply too small to perform all the missions assigned to it."<sup>24</sup> Most agree that funds needed to address QDR initiatives will likely come through cuts in the Service's procurement programs. Some, however, believe that FCS "is less likely than other major weapons systems programs to be targeted during the QDR because

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<sup>20</sup> (...continued)

Force, Missile Defense Programs," *InsideDefense.com*, January 2, 2005.

<sup>21</sup> For further information on modularity, see CRS Report RL32476, *U.S. Army's Modular Redesign: Issues for Congress*. The Army describes modularity as the "most significant Army restructuring in the past 50 years," whereby the Army intends to redesign its current 10 active duty division force to a 43 or 48 brigade-level unit of action or UA force by FY2007. Figures cited here are from an unofficial version of DOD's Program Budget Decision (PBD) 753, Dec. 23, 2004, from the *Navy Times*, [<http://www.navytimes.com/content/editorial/pdf/dn.pbd753.pdf>]. See p. 1 for the \$5 billion figure.

<sup>22</sup> The Defense Authorization Act for FY1997 (P.L. 105-85) established the QDR, but only as a one time requirement. Congress established the QDR as a permanent recurring requirement (10 U.S. Code, 118) in the National Defense Authorization Act of FY2000.

<sup>23</sup> Keith J. Costa, "Review Expected to Consider Unconventional Threats - Zakheim: QDR Could Alter Investment Patterns for Air, Land Forces," *Inside the Pentagon*, Dec. 9, 2004, p. 1.

<sup>24</sup> Dave Ahearn, "Defense Review May Help Decide Which Programs Thrive: Analysts," *Defense Today*, Dec. 6, 2004, p. 2.

of its recent restructuring plan” which was approved by the Secretary of Defense.<sup>25</sup> Officials suggest that the primary reason that the FCS program might be considered is because “there’s a lot of money in FCS,” — estimated at \$157 billion for research, development and procurement through 2022.<sup>26</sup> Some analysts suggest that despite FCS’s “protected position,” its large price tag might make it vulnerable to budget cuts resulting from the QDR.

## The FCS Program

### Program Overview <sup>27</sup>

The Army describes the proposed FCS as a joint (involving the other services) networked “system of systems.” FCS systems are to be connected by means of an advanced network architecture that would permit connectivity with other services, situational awareness and understanding, and synchronized operations that are currently unachievable by Army combat forces. FCS is intended to network with existing forces, systems currently in development, and systems that will be developed in the future. The FCS is to be incorporated into the Army’s brigade-sized modular force structure.

FCS would include the following:

- Unattended ground sensors (UGS);
- Non-Line-of-Sight Launch System (NLOS-LS) and Intelligent Munitions System (IMS);
- Four classes of unmanned aerial vehicles (UAVs) which will be organic to platoon, company, battalion,<sup>28</sup> and other echelons;
- Three classes of unmanned ground vehicles (UGVs): the Armed Robotic Vehicle (ARV), the Small Unmanned Ground Vehicle (SUGV), and the Multifunctional Utility/Logistics and Equipment Vehicle (MULE);
- Eight types of manned ground vehicles;
- The network, and
- The individual soldier and his personal equipment and weapons.

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<sup>25</sup> Anne Plummer, “QDR Expected to Impact Major Programs: Services Offer Pentagon Suggestions on How to Focus Upcoming QDR,” *Inside the Army*, Dec. 20, 2004, p. 10.

<sup>26</sup> *Ibid.*

<sup>27</sup> Information in this section is taken from the Army’s official FCS website [<http://www.army.mil/fcs/factfiles/overview.html>].

<sup>28</sup> According to Army Pamphlet 10-1, *Organization of the United States Army*, 1994, a battalion/squadron (an equivalent sized cavalry organization) consists of from 300 to 1,000 soldiers and is commanded by a lieutenant colonel, a company, battery (an equivalent sized artillery organization), or troop (an equivalent sized cavalry organization) consists of from 62 to 190 soldiers and is commanded by a captain, and a platoon consists of 16 to 44 soldiers and is led by a lieutenant.

The FCS is to serve as the core building block of the Army's Future Force. FCS-equipped UAs (brigades) are to consist of:

- Three FCS-equipped Combined Arms Battalions<sup>29</sup> (CABs);
- One Non-Line-of-Sight (NLOS) Cannon battalion;
- One Reconnaissance, Surveillance, and Target Acquisition (RSTA) squadron;
- One Forward Support battalion (FSB);
- One Brigade Intelligence and Communications company (BICC), and
- One Headquarters company.

For a more detailed description of FCS subsystems, see Appendix A.

## FCS Program Timeline

FCS is currently in the System Development and Demonstration (SDD) phase of the Defense Acquisition System Life Cycle. The SDD phase is the third life cycle phase which focuses on reducing integration and manufacturing risk, ensuring operational supportability, and demonstrating the system through prototypes or engineering development models.<sup>30</sup> FCS entered the SDD phase in May 2003 despite GAO warnings that the program was entering the phase with "more risk than recommended by best practices or DOD guidance."<sup>31</sup>

On July 21, 2004, the Army announced a major restructuring of the FCS program. Some have maintained that this restructuring was intended to address the risks and other issues raised by external agencies such as GAO. The primary objectives of the restructuring included

- Fielding FCS technologies to the current force in four discrete "spirals" starting in FY2008;
- Address Congressional language on the Non Line of Sight Cannon (NLOS-C);<sup>32</sup>
- Field all 18 systems (only 14 were funded under previous program);
- Increase schedule by four years; and
- Designate an evaluation brigade to test spiraled FCS capabilities.

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<sup>29</sup> See previous footnote for organizational definitions.

<sup>30</sup> "Glossary of Defense Acquisition Acronyms and Terms," Defense Acquisition University, Fort Belvoir, Virginia, 11<sup>th</sup> Ed., Sept. 2003, pp. B-136 - B-137.

<sup>31</sup> GAO-03-1010R, *Issues Facing the Army's Future Combat System*, Apr. 2003, p. 39.

<sup>32</sup> Sec. 8109 of Report 108-622, Conference Committee Report, *FY2005 Defense Appropriations*, July 20, 2004, requires the Army to field the Non Line of Sight Cannon (NLOS-C) and its resupply vehicle by 2010 as well as deliver 8 combat operational preproduction NLOS-C systems by the end of CY2008.

**Restructured Program.** At present, the FCS program is operating under the schedule depicted below:

### Restructured FCS Program Schedule

Event	Date (FY)	Event Description
Milestone B Update	May 2005	Milestone B approves entry into System Development and Demonstration Phase (SDD).
Preliminary Design Review	2008	A technical review to evaluate the progress and technical adequacy of each major program item. It also examines compatibility with performance and engineering requirements. (Part of SDD Phase)
Critical Design Review	2010	A technical review to determine if the detailed design satisfies performance and engineering requirements. Also determines compatibility between equipment, computers, and personnel. Assesses producibility and program risk areas. (Part of SDD Phase).
Design Readiness Review	2011	Evaluates design maturity, based on the number of successfully completed system and subsystem design reviews. (Part of SDD Phase).
Milestone C	2012	Milestone C approves the program's entry into the Production and Deployment (P&D) Phase. The P&D Phase consists of two efforts - Low Rate Initial Production (LRIP) and Full Rate Production and Deployment (FRP&D). The purpose of the P&D Phase is to achieve an operational capability that satisfies the mission need.
Initial Operational Capability (IOC)	2015	IOC is defined as the first attainment of the capability to employ the system as intended.(Part of the P&D Phase).
Full Operational Capability	2017	The full attainment of the capability to employ the system, including a fully manned, equipped, trained, and logistically supported force.(Part of the P&D Phase).

**Note:** Event descriptions in this table are taken from the Defense Acquisition Acronyms and Terms Glossary published by the Defense Acquisition University, Fort Belvoir, Virginia, 11<sup>th</sup> Ed., Sept. 2003.

While GAO acknowledges that the restructured program is an improvement, it still believes that the FCS program is “at significant risk for not delivering planned capability within budgeted resources,” primarily due to the program’s technical

challenges and low level of demonstrated knowledge.<sup>33</sup> One of GAO's concerns is that under the current program schedule, the actual performance of the completely integrated FCS will be demonstrated very late in the program and could result a significant cost increase. According to GAO, the Critical Design Review ideally should occur in the FCS program in 2008 in order to "confirm that the design is stable enough to build production representative prototypes for testing."<sup>34</sup> GAO notes that the FCS Critical Design Review instead occurs in 2010 which is only two years before the Army decides on whether or not to enter into production and that the Army does not expect to conduct a preliminary demonstration of all the elements of FCS until sometime in 2013 — one year after the production decision.<sup>35</sup> GAO maintains that the Army's current program schedule makes FCS susceptible to "late cycle churn" whereby problems discovered through testing late in a product's development cycle result in significant investments in additional time, effort, and funds to overcome the problem — a phenomenon that GAO notes "is a fairly common occurrence" in DOD programs.<sup>36</sup>

## FCS Program Budget

The FCS program budget has risen steadily since the program's inception in 1999 as the program has evolved. According to the Congressional Budget Office (CBO), "Because the FCS program is still in the early stages of development, its full costs are not yet known."<sup>37</sup> Despite this ambiguity, CBO reports that "the costs from 2006 through 2020 to develop and purchase the first increment, which would equip 15 — or about one-third — of the active Army's combat brigades, could approach \$90 billion." This \$90 billion price tag would make FCS the largest and most expensive program in Army history. Others suggest that FCS research and development and procurement costs through 2022 could run as high as \$157 billion.<sup>38</sup> The DOD FY2006 budget request calls for \$3.4 billion dollars for research, development, testing and evaluation (RDT&E).<sup>39</sup> This is an increase from \$1.68 billion in FY 04 and \$3.2 billion in FY 05.<sup>40</sup>

Independent program costs estimates from the Army and the Office of the Secretary of Defense's Cost Analysis Improvement Group are due at Milestone B Update in May 2005, but GAO notes that past and current program cost estimates do

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<sup>33</sup> Government Accountability Office, *Future Combat Systems Challenges and Prospects for Success*, GAO-05-442T, Mar. 16, 2005, p. 2.

<sup>34</sup> *Ibid.*, p. 17.

<sup>35</sup> *Ibid.*

<sup>36</sup> *Ibid.*

<sup>37</sup> Congressional Budget Office, *Budget Options*, Feb. 2005, Sec. 3, National Defense, p. 2.

<sup>38</sup> Jen DiMascio, "McCain Questions FCS Commercial-Item Procurement Strategy," *Inside the Army*, Mar. 7, 2005.

<sup>39</sup> Department of Defense Comptroller's Office, *President Bush's FY2006 Defense Budget*, Feb. 7, 2005, p. 5.

<sup>40</sup> Department of the Army, *Fiscal Year 2005 Army Budget: An Analysis*, June 2004, p. 50.

not include the costs of some 157 complementary programs — some of which, like the JTRS and WIN-T programs (expected to cost around \$35 billion combined), are substantial.<sup>41</sup> Program delays could further add to total program costs, with GAO suggesting that a one year delay late in the FCS development cycle could cost over \$3 billion.<sup>42</sup>

## Spiraling

“Spiraling” or Spiral Development is defined as a process in which:

A desired capability is identified, but the end-state requirements are not known at program initiation. Requirements are refined through demonstration, risk management and continuous user feedback. Each increment provides the best possible capability, but the requirements for future increments depend on user feedback and technology maturation.<sup>43</sup>

As previously noted, the restructured FCS program consists of four “spirals” that are to introduce FCS technologies and systems to the current force. These fielding spirals are slated to occur in 2008, 2010, 2012, and 2014 and the Army plans to field its second fully-equipped FCS brigade by 2015 and two more each year after 2015, up to a total of 15 FCS-equipped brigades. The primary reason cited for the adoption of spiraling by the Army is to increase the chances of program success which had been criticized by a variety of individuals and organizations — particularly GAO. According to General Schoomaker, prior to spiraling, the FCS program had only a 28 percent chance of success but, with spiraling, had in excess of a 70 percent chance of success.<sup>44</sup> It is not clear how the Army defines program success, nor what methodology was used to determine the percentage chances of success. The Army also reportedly adopted spiraling to get relevant technologies into the hands of soldiers fighting in Iraq and Afghanistan as soon as they became available as opposed to letting them sit on the shelf until they could be integrated into other systems.

Critics of spiraling note that full completion of the FCS program was delayed four years due to this decision and the overall program costs were increased by an estimated \$ 28 billion.<sup>45</sup> Those who are supportive of spiraling believe that in addition to getting technologies to warfighters more quickly, spiraling will help to reduce risk by permitting technologies to “mature” through additional development and testing and that the overall program will benefit by the Army’s plan to establish a dedicated test brigade — to be stood up in 2006 — to serve as the overall FCS field

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<sup>41</sup> Government Accountability Office, *Future Combat Systems Challenges and Prospects for Success*, GAO-05-442T, Mar. 16, 2005, p. 22.

<sup>42</sup> *Ibid.*, p. 23.

<sup>43</sup> Defense Acquisition Acronyms and Terms Glossary published by the Defense Acquisition University, Fort Belvoir, Virginia, 11<sup>th</sup> Ed., Sept. 2003, p. B-51.

<sup>44</sup> Nathan Hodge, “Restructured FCS Program has Higher Probability of Success: Army Chief,” *Inside Defense*, July 22, 2004.

<sup>45</sup> *Ibid.*

evaluation force.<sup>46</sup> Major equipment and technologies currently planned to be fielded to the FCS evaluation brigade during the spirals includes the following:<sup>47</sup>

- Spiral 1 (2008): System-of-Systems Common Operating Environment (SOSCOE); Unattended Ground Sensors (UGS); Non Line of Sight Launch System (NLOS-LS); Intelligent Munitions System (IMS); Non Line of Sight Cannon (NLOS-C) pre-production model;
- Spiral 2 (2010): SOSCOE Update; Unmanned Ground Vehicles (UGV); Battle Command (BC) system components;
- Spiral 3 (2012): SOSCOE Update; Battle Command (BC) system components, communications relays for Unmanned Aerial Vehicles (UAVs); and
- Spiral 4 (2014): Network Update; remaining Battle Command system; all remaining FCS systems, all remaining Manned Ground Vehicles (MGVs).

It is important to note that these spiral dates are dates when these systems are fielded to the FCS evaluation brigade — not units in the field. As envisioned, the FCS evaluation brigade will test and evaluate these items for two years before they are given to units in the field.<sup>48</sup> Therefore Spiral 1 systems will reach units in the field in 2010; Spiral 2 in 2012; Spiral 3 in 2014; and Spiral 4 in 2016.

## Program Management

Some maintain that one of the most controversial aspects of the FCS program is its management. As previously noted, in March 2002, the Army chose Boeing and Science Applications International Corporation (SAIC) to serve as lead system integrators (LSI) for the FCS program. Under this arrangement, Boeing is the prime contractor and SAIC is working as a subcontractor to Boeing. Both companies could reportedly be paid a total of almost \$15 billion for their role in the program's management.<sup>49</sup> Boeing and SAIC oversee the program, and they also select other defense contractors to supply the program's technologies and systems. According to an August 26, 2004 Army briefing — aside from Boeing and SAIC — 16 defense contractors located in 29 states and 106 congressional districts were developing

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<sup>46</sup> Matthew Cox and Alexander Neill, "New Field Evaluation Brigade for FCS to be Announced," *Army Times*, Feb. 18, 2005.

<sup>47</sup> Program Managers Unit of Action Schedule, as of Dec. 15, 2004, provided to CRS by the Army Staff.

<sup>48</sup> "Future Combat Systems (FCS) 18+1+1 Systems Overview," *U.S. Army Program Manager for Units of Action*, Ver. 12, Jan. 18, 2005, p. 2.

<sup>49</sup> Susan Kerth, "SAIC, Boeing Add Workers to Staff Future Combat Systems," *St. Louis Business Journal*, Nov. 12, 2004.

systems and technologies for the FCS program, and the number of defense contractors was expected to grow over the program's duration.<sup>50</sup>

Despite having a dedicated Acquisition Corps who receive advanced education and certification to manage research and procurement programs, the Army opted for the LSI program management model from the outset of the FCS program. While the LSI concept has come under criticism from a variety of sources, the Army likely had little choice. While the Army has publicly acknowledged the complexity of the FCS program as a reason for choosing an LSI management approach, Army officials also suggested the Army does not have sufficient military or Department of the Army Civilian (DAC) scientists, engineers and technical managers to adequately manage all aspects of the FCS program.<sup>51</sup> Some suggest that this problem is not just an Army problem but DOD-wide. One report maintains that DOD needs to hire more than 14,000 scientists and engineers in 2005 to fill new and vacated positions, which could prove to be a difficult if not impossible task.<sup>52</sup> The primary reasons cited for this potential difficulty are 1) more than half of the science and engineering graduates from American universities are foreign nationals who are supposedly "off limits"<sup>53</sup> to federal agencies; 2) a declining number of students entering the science and engineering fields; and 3) stiff competition from the private sector for these graduates.<sup>54</sup>

**Criticisms of the Lead System Integrator Approach.** The two main criticisms of the lead system integrator approach are the Army's potential lack of control over the program and Boeing's past ethical difficulties. Some critics contend that Boeing has too much authority in choosing which subcontractors will build FCS components as well as how much these subcontractors will be paid.<sup>55</sup> Some fear that the Army will assume a secondary role in the program and lose program expertise, thereby making itself less capable of adequate oversight of Boeing's operations.<sup>56</sup> Boeing's past ethical problems in its dealings with DOD — e.g., the Air Force tanker lease scandal, an ongoing investigation over misappropriation of Lockheed Martin Corporation documents during a 1990s missile competition, and Boeing's disbarment by the Air Force from competing for space contracts<sup>57</sup> — have also been a source of criticism.

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<sup>50</sup> See FCS 2005 Flipbook, dated Aug. 26, 2004.

<sup>51</sup> CRS discussions with the Army's System of System/FCS Department of the Army Systems Coordinator office, Feb. 11, 2005.

<sup>52</sup> Tickahorn Hill, "The Hardest-To-Fill Jobs," *Federal Times*, Feb.7, 2005.

<sup>53</sup> Most positions require a security clearance and few if any foreign nationals meet the stringent requirements for secret or higher security clearances.

<sup>54</sup> *Ibid.*

<sup>55</sup> Dave Ahearn, "Boeing Doesn't Eclipse Army Oversight of FCS: General," *Defense Today*, Oct. 27, 2004.

<sup>56</sup> *Ibid.*

<sup>57</sup> Renae Merle, "Boeing Hopes the Worst is Over," *Washington Post*, Feb. 9, 2005.



According to Army officials, the Army has its personnel involved with Boeing staffers at “every key point in the FCS program.”<sup>58</sup> In addition, the Army has been receptive to the involvement of other government agencies in the program such as GAO and the Army notes that “multiple audits of FCS [are] ongoing at all times.”<sup>59</sup> The Army reportedly plans to increase the use of the LSI approach in the future.<sup>60</sup> According to a senior Army acquisition official, much of the Army’s systems engineering expertise has “evaporated” and the Army must “outsource this engineering.”<sup>61</sup>

**Other Transactions Authority (OTA).** The FCS program is being administered under an Other Transactions Authority (OTA) arrangement. The Army’s use of OTA has been the subject of much criticism and has raised concerns in Congress.<sup>62</sup> OTA was established by Congress under Section 845 of the National Defense Authorization Act for FY1994 (10 U.S.C. Section 2371) for research, development, and prototyping, and was intended to permit the government to more readily interact with innovative companies who are not part of the traditional defense contracting community. OTA provides the government with the flexibility to negotiate tailored contracts that are not governed by the Federal Acquisition Regulation (FAR). As originally enacted, OTA was intended for companies that may not have the staff or resources to operate under the FAR which has numerous administrative and reporting requirements that may be beyond the capability of smaller companies. Based in part on Congressional concern, the Army has recently decided to restructure the FCS program under a FAR-based contract.<sup>63</sup>

Critics of OTA use for the FCS program argued that the OTA does not afford the government the protection that contracts provide, gives too much authority to the LSI team, does not provide sufficient opportunities for oversight, and does not have the type of strict cost accountability mechanisms found in traditional contracts.<sup>64</sup>

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<sup>58</sup> Dave Ahearn, “Boeing Doesn’t Eclipse Army Oversight of FCS: General,” *Defense Today*, Oct. 27, 2004.

<sup>59</sup> Ibid.

<sup>60</sup> Scott Nance, “Army Likely to Increase Use of Systems Integration Contractors,” *Defense Today*, Jan. 10, 2005.

<sup>61</sup> Ibid.

<sup>62</sup> Jen DiMascio, “Pentagon IG Investigates Acquisition Strategies:McCain Questions FCS Commercial-Item Procurement Strategy,” *Inside the Army*, Vol.17, No.9, Mar. 7, 2005; Renae Merle, “Hearings to Focus on \$ 100 Billion Army Plan,” *Washington Post*, Mar. 15, 2005; Jonathan Karp and Andy Pasztor, “Army Program Run by Boeing Faces Challenge by Sen.McCain,” *Wall Street Journal*, Mar. 15, 2005; Scott Nance, “McCain Proposes Procurement Study, Possible Reform,” *Defense Today*, Vol. 26, No. 51, Mar. 17, 2005; Renae Merle, “McCain, Auditors Question Army Modernization Effort,” *Washington Post*, Mar. 17, 2005.

<sup>63</sup> Renae Merle, “Army Will Restructure Modernization Contract,” *Washington Post*, Apr. 6, 2005, p. E5 and Jonathan Karp and Andy Pasztor, “About-Face: Army’s Decision on Boeing Changes Philosophy,” *Wall Street Journal*, Apr. 6, 2005.

<sup>64</sup> Jen DiMascio, “Pentagon IG Investigates Acquisition Strategies:McCain Questions FCS  
(continued...)

Critics also suggested that OTA use in the FCS program violated the intent of the OTA and that companies such as Boeing, SAIC, and many of the FCS subcontractors such as General Dynamics, United Defense, Lockheed Martin, Raytheon, and Northrop Grumman are more than capable to operate within the Federal Acquisition Regulation under a traditional contract.

The Army argued that the use of an OTA is necessary “because it did not have the resources or flexibility to use its traditional acquisition process to field a program as complex as FCS under the aggressive timeline established by the then-Army Chief of Staff [General Shinseki].”<sup>65</sup> While the Army was criticized for violating the “intent” of the OTA, DOD reportedly has a history of similar use for OTA. According to one report, between 1994 and 1998, 75 percent of the contractors using OTA were traditional defense companies or nonprofit universities and organizations.<sup>66</sup> OTA is also widely used in the Ballistic Missile Defense Program — a program arguably as technically challenging and complex as the FCS program — with Boeing and Lockheed-Martin reportedly receiving more the \$46 billion worth of missile defense contracts under the OTA.<sup>67</sup>

**The Institute for Defense Analysis (IDA)<sup>68</sup> Report on FCS Management.** While a variety of reviews and studies have been and continue to be done on the FCS program, the IDA Review of FCS Management, published in August 2004, is considered by some as one of the most comprehensive. The study — requested by DOD and the Army — was asked to examine the FCS program structure, practices, and contracting. The study’s major findings are summarized as follows:<sup>69</sup>

- “The Army-Boeing agreement does not anticipate future rounds of competition for FCS systems or components as the program transitions to production. Nor does it appear that the current

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<sup>64</sup> (...continued)

Commercial-Item Procurement Strategy,” *Inside the Army*, Vol.17, No.9, Mar. 7, 2005; Renae Merle, “Hearings to Focus on \$ 100 Billion Army Plan,” *Washington Post*, Mar. 15, 2005; Jonathan Karp and Andy Pasztor, “Army Program Run by Boeing Faces Challenge by Sen.McCain,” *Wall Street Journal*, Mar. 15, 2005; Scott Nance, “McCain Proposes Procurement Study, Possible Reform,” *Defense Today*, Vol. 26, No. 51, Mar. 17, 2005; Renae Merle, “McCain, Auditors Question Army Modernization Effort,” *Washington Post*, Mar. 17, 2005.

<sup>65</sup> Government Accountability Office, *Future Combat Systems Challenges and Prospects for Success*, GAO-05-442T, Mar. 16, 2005, p. 10.

<sup>66</sup> *Ibid.*

<sup>67</sup> Eric Miller, “Pentagon-Contractor Ties Tight as Ever,” *Defense News*, Apr. 12, 2004.

<sup>68</sup> Institute for Defense Analysis (IDA), [<http://www.ida.org>], is a non-profit corporation that administers 3 federally-funded research and development centers to assist the U.S. government with national security issues, particularly scientific and technical ones.

<sup>69</sup> “IDA Review of FCS Management,” Institute for Defense Analysis, Aug. 2004, pp. ES-1-7.

agreement provides the Army access to technical information sufficient to enable future rounds of competition.”

- “The Army-Boeing Agreement, although based on Other Transactions Authority, incorporates numerous standard defense contracting clauses, including termination rights, disputes resolution, cost accounting, and auditing, that are commonly viewed as protecting the government’s interests. The Army’s and Boeing’s conservative approach in creating this agreement diffuses concern that the use of an agreement based on OT authority has created special risks for the FCS program.”
- “One intended benefit of the OTA — attracting non-traditional suppliers — has not been realized to date; the initial rounds of subcontracts has gone almost exclusively to traditional defense suppliers. And, their subcontractors employ standard Federal Acquisition Regulations (FAR) and DFARS (Defense FAR Supplement) formats and clauses.”
- “The Army will need to demonstrate a business case for OTA *prior* to Congressional action to expand its applicability to the production phase of FCS. Building this case remains an uphill battle, given the Army’s conservative use of OTA for the System Design and Development phase, the fact that the program involves almost exclusively traditional defense contractors, and Boeing’s use of FAR-styled contracts for Tier I subcontractors.”
- “Boeing is taking demonstrable steps to “recapture the trust of its customers” following disclosure of its prior ethics violations on matters unrelated to FCS: they have commissioned independent external reviews, and are strengthening their corporate structures and policies. Formal ethics programs, whether in the government or industry, cannot guarantee that every individual who participates in the FCS program will behave appropriately; sound policies, attention to execution, and continued vigilance, however, can help to reduce the likelihood of inappropriate behavior or violation of law.”

The Army contends that many of IDA’s recommendations had been implemented by the time the report was made public.<sup>70</sup> Some maintain that the report found few problems with Boeing’s performance so far, noting Boeing’s efforts to prevent further ethical transgressions, and suggested that the Army adopt a “trust but verify” approach with Boeing.<sup>71</sup> In addition, the IDA report suggests that the OTA does not necessarily put the FCS program at risk as some have suggested, and that “there may be a savings in time and administrative costs in continuing with an OTA

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<sup>70</sup> Jen Di Mascio, “Army Already Implementing IDA’s Recent Recommendations on FCS,” *Inside the Army*, Nov. 1, 2004.

<sup>71</sup> Megan Scully, “Report: “Trust But Verify” Boeing’s FCS Oversight,” *DefenseNews.com*, Oct. 13, 2004.

agreement into the production phase”, although FAR-based contracts have a more substantial legal base to draw on.<sup>72</sup> Given the degree of disparity concerning the benefits and drawback to both the LSI and OTA approaches, it is likely that additional analysis will be required to aid both DOD and Congressional decision makers concerning contractual options as the FCS program approaches the production phase.

## Program Developmental Issues

While Army officials have testified to Congress that the FCS program is “on schedule, on cost, and on performance,”<sup>73</sup> a number of program developmental issues have been identified which could potentially change that assessment.

### Joint Tactical Radio System (JTRS)<sup>74</sup>

On January 18, 2005, the Army reportedly issued a partial stop-work order and halted the production of the engineering development models as well as low rate initial production of the JTRS Cluster One radios. JTRS Cluster One radios are software-defined radios that are to be used to provide voice, video, and data communications to ground and aerial vehicles. One of the touted primary benefits of JTRS is that it is being designed so that it can operate on multiple radio frequencies, permitting it to talk to certain non-JTRS radios that are expected to stay in the Army’s inventory. Under the original program schedule, Boeing<sup>75</sup> — the program’s lead contractor — was scheduled to begin low rate initial production (LRIP) in the third quarter of FY2005 and would equip its first unit with Cluster One radios in FY2007. JTRS is a joint program and therefore not considered part of the FCS program by the Army but it is to form the “backbone” of the FCS Network and therefore it is of critical importance to the program’s success. According to one report, the Pentagon has warned Boeing that it might terminate Boeing’s Cluster One

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<sup>72</sup> “IDA Review of FCS Management,” Institute for Defense Analysis, Aug. 2004, p. ES-3.

<sup>73</sup> Statement by Claude M. Bolton Jr., Assistant Secretary of the Army for Acquisition, Logistics and Technology to the House Tactical Air and Land Forces Subcommittee, *Future Combat Systems*, hearing, Mar. 16, 2005, p. 28.

<sup>74</sup> Information in this section is taken from Jen DiMascio, “Technical Challenges Affect Cluster One: Army Halts Initial Production of Joint Tactical Radio System Variant,” *Inside the Army*, Vol. 17, No. 6, Feb. 14, 2005; Marc Selinger, “Management to be Streamlined for Joint Tactical Radio System,” *Aerospace Daily & Defense Report*, Mar. 1, 2005; Scott Nance, “Army Sets Narrower Aims on Radio System,” *Defense Today*, Feb. 18, 2005; Jen DiMascio, “Analysis of Alternatives Also on Deck: Joint Staff Reviewing Impact of JTRS Delay on Other Programs,” *Inside the Army*, Vol. 17, No. 10, Mar. 14, 2004; and Jen DiMascio, “Both Face Technical Hurdles: JTRS and Manned Ground Vehicles Critical to Success of FCS, GAO Says,” *Inside the Army*, Vol. 17, No. 11, Mar. 21, 2005.

<sup>75</sup> Northrop Grumman Mission Systems, Rockwell Collins, and BAE are teamed with Boeing on the JTRS Cluster One program.

contract reportedly due to “Boeing’s anticipated failure to meet cost, schedule and performance requirements.”<sup>76</sup>

The Army’s decision to issue the partial stop-work order (the Defense Acquisition Board is to conduct a review in August 2005 to determine if the partial work stoppage should be lifted or continued) was reportedly based on a variety of factors including difficulties with the system memory and security concerns. According to an Army official, changing baseline requirements for the system as well as a need to interface with the Defense Department’s Global Information Grid<sup>77</sup> “aggravated an already extremely complex set of interdependencies that ultimately require adjustment.” According to GAO testimony, the Army has proposed delaying Cluster One development by two years and adding \$458 million to the development effort.<sup>78</sup>

Of critical concern is the impact of the JTRS delay on FCS core programs. Unmanned aerial vehicle contractors have predicated their production schedules on Cluster One’s fielding and the stop-work order will likely have a significant impact in terms of time and money. In addition, the fielding of Cluster One had previously been scheduled to support FCS Spiral 1 in FY2008. Because of these concerns, as well as the impact of the delay of Cluster One on the other services, the Joint Staff will reportedly review the entire JTRS program, in part to determine how the work stoppage will affect FCS and other program’s developmental timelines. GAO also has suggested that Cluster Five radios — radios for dismounted soldiers and weight-constrained platforms — are not likely to be available for FCS Spiral 1 fielding either, due to technological challenges, as well as a delay in the program’s start due to a contract bid.<sup>79</sup>

DOD reportedly will revamp its JTRS management structure. Instead of having a separate program manager for each cluster, sources say, a single program manager will oversee development of all the clusters. Congress in Section 213 of Report 108-354, the Conference Report for The National Defense Authorization Act for FY2004, H.R. 1588, P.L. 108-136 called for the Department of Defense to “adopt a program management structure that provides strong and effective joint management’ for the JTRS program. The Army has also reportedly narrowed its scope regarding JTRS. The Army originally intended for JTRS to essential be a “radio replacement” program for the Army. The Army is to instead field sufficient JTRS systems to enhance the network as required and then eventually replace current radios with JTRS as current radios wear out over time. Army officials note that sufficient

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<sup>76</sup> Renae Merle, “\$15 Billion Contract in Jeopardy,” *Washington Post*, Apr. 27, 2005.

<sup>77</sup> The DOD Global Information Grid (GIG) is the globally interconnected, end-to-end set of information capabilities, associated processes and personnel for collecting, processing, storing, disseminating, and information on demand to warfighters, policy makers, and support personnel. The GIG includes all owned and leased communications and computing systems and services, software, data, and security services.

<sup>78</sup> Government Accountability Office, *Future Combat Systems Challenges and Prospects for Success*, GAO-05-442T, Mar. 16, 2005, p. 19.

<sup>79</sup> *Ibid.*, p. 20.

resources do not exist to replace all current radios with JTRS and that it could not afford to throw away good existing technology [current radios not necessarily FCS compatible] just for the sake of replacing them with JTRS.

## Manned Ground Vehicles (MGV)

**MGV Transportability.** The MGV program is currently facing a major technological challenge concerning its air transportability. It has been widely reported that one of the Army's seven key performance parameters (KPP)<sup>80</sup> for MGVs is that they be transportable by the Air Force's C-130 transport aircraft.<sup>81</sup> This is not the case, however, as the Army notes that the MGV C-130 transport issue is not a KPP but instead a Critical Operational Issue and Criteria (COIC) which is a far less stringent requirement.<sup>82</sup> In general, in order to meet this criteria, the MGVs must first be capable of fitting inside of the C-130 — leaving at least one foot of space between the vehicle and the sides of the aircraft to permit emergency exit of the aircraft — and the MGV can weigh no more than 20 tons.<sup>83</sup>

Reports suggest that, to date, the best that industry has been to do in terms of MGV weight is more than 24 tons.<sup>84</sup> In order to meet the C-130 weight limit, this vehicle would need to be “stripped down” and it would require four to six hours per vehicle to reconfigure them with fuel, ammunition, and other supplies — which is significantly longer than the operational requirement that MGVs be converted to its combat configuration no more than 30 minutes after rolling off a C-130.<sup>85</sup> In addition, a second C-130 aircraft would be required for each MGV to carry the components and ammunition that had been stripped off the MGV so that it could meet the 20 ton limit.<sup>86</sup> According to one Army official, this would “add hours to intra-theater deployment times and tax the service's logistics tail because it would

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<sup>80</sup> According to the Defense Acquisition Acronyms and Terms Glossary published by the Defense Acquisition University, Fort Belvoir, Virginia, Eleventh Edition, September 2003, a key performance parameter (KPP) is “Those minimum attributes or characteristics considered most essential for an effective military capability.” KPPs are generally considered “absolutes” in system design and are therefore, rarely modified or disregarded.

<sup>81</sup> Megan Scully, “U.S. Army May Tinker with FCS C-130 Need,” *Defense News*, Nov. 15, 2004.

<sup>82</sup> Conversation with the Army's System of System/FCS Department of the Army Systems Coordinator office, Apr. 8, 2005.

<sup>83</sup> See Ashley Roque, “Band Track Used on Both Models: Transportability of Manned FCS Ground Vehicle Remains a Challenge,” *Inside the Army*, Vol. 17, No. 7, Feb. 21, 2005 and Megan Scully, “U.S. Army May Tinker with FCS C-130 Need,” *Defense News*, Nov. 15, 2004.

<sup>84</sup> Megan Scully, “Army May Not Require FCS Vehicles to Fit C-130,” *Army Times*, Feb. 7, 2005.

<sup>85</sup> Megan Scully, “U.S. Army May Tinker with FCS C-130 Need,” *Defense News*, Nov. 15, 2004.

<sup>86</sup> Ashley Roque, “Band Track Used on Both Models: Transportability of Manned FCS Ground Vehicle Remains a Challenge,” *Inside the Army*, Vol. 17, No. 7, Feb. 21, 2005.

significantly increase the number of sorties to move the force.”<sup>87</sup> The Army is also doubtful that even at the heavier 24 tons, that most of the MGV variants will meet the Army’s survivability requirements.<sup>88</sup> One solution to meet the C-130 weight and size constraints would be to develop lightweight composite armor which many consider not only extremely costly but also technologically challenging.<sup>89</sup>

There have been a number of reports suggesting that the Army is considering eliminating the MGV weight ceiling and that this issue is causing a rift between the development community and officials who fear that engineering MGVs to meet weight and size constraints could become cost prohibitive.<sup>90</sup> Aside from the transportability issue, some note that there are additional benefits to keeping the MGVs to less than 20 tons. Experts note that at 20 tons, MGVs should be able to move through narrow streets in urban areas as well as move across most bridges.<sup>91</sup> Another expert suggests that if the MGV weight ceiling that is required for transport on C-130s is eliminated, other constraints could possibly be removed or relaxed and that the MGVs could become too bulky or heavy for all but special transport — not unlike the Army’s Crusader artillery system which was cancelled because it no longer fit the Army’s transformation requirements.<sup>92</sup>

**MGV Engines.** On December 14, 2004, the contract for the MGV engine was delayed indefinitely — marking the fourth contract delay since requests for proposals (RFPs) were first issued in October 2003.<sup>93</sup> The decision to delay the contract was reportedly based on the Army’s desire to increase engine power from a 410 kilowatt power rating to a 440 kilowatt power rating in order to power heavier vehicles.<sup>94</sup> Decisions concerning where the engine will be placed in the MGV as well as whether or not it will be a hybrid-electric engine or a mechanical engine have yet to be made.<sup>95</sup> If the Army is to meet the congressionally mandated deadline for the NLOS

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<sup>87</sup> Megan Scully, “Army May Not Require FCS Vehicles to Fit C-130,” *Army Times*, Feb. 7, 2005.

<sup>88</sup> *Ibid.*

<sup>89</sup> Megan Scully, “U.S. Army May Tinker with FCS C-130 Need,” *Defense News*, Nov. 15, 2004.

<sup>90</sup> See Christian Lowe, “Acquisition Chief at Odds With Plan on FCS Weight,” *Army Times*, Mar. 28, 2005; Megan Scully, “U.S. Army May Tinker with FCS C-130 Need,” *Defense News*, Nov. 15, 2004; and Megan Scully, “Army May Not Require FCS Vehicles to Fit C-130,” *Army Times*, Feb. 7, 2005.

<sup>91</sup> Megan Scully, “Army May Not Require FCS Vehicles to Fit C-130,” *Army Times*, February 7, 2005.

<sup>92</sup> Megan Scully, “U.S. Army May Tinker with FCS C-130 Need,” *Defense News*, Nov. 15, 2004.

<sup>93</sup> Jen DiMascio, “Army Looks at Propulsion System as a Whole: Award for FCS Manned Ground Vehicle Engine is Delayed Indefinitely,” *Inside the Army*, Dec. 20, 2004.

<sup>94</sup> Jen DiMascio, “Army Asks if Power Output Could Increase,” *Inside the Army*, Vol. 16, No. 46, Nov. 15, 2004.

<sup>95</sup> *Ibid.*

prototype, a contract decision will be needed soon to allow for production of long-lead components.<sup>96</sup>

## Unmanned Ground Vehicles (UGV)<sup>97</sup>

The Pentagon's Director of Operational Testing & Evaluation (DOT&E)<sup>98</sup> reportedly has expressed concern that the Army is likely to face difficulties in creating large UGVs that can keep up with ground troops and respond to unexpected circumstances. While versions of lighter UGVs have been used successfully in both Iraq and Afghanistan, DOT&E maintains that the medium and heavy classes of UGVs will face greater technical challenges. The medium class includes the Multi Functional Utility Logistics and Equipment Vehicle (MULE) and its variants while the heavy UGV class includes the two Armed Robotic Vehicles (ARVs). The Army reportedly plans to build about 1,200 MULEs and about 675 ARVs, and both are planned to be introduced in Spiral 2 in 2010.

According to DOT&E, early versions of the medium and heavy UGVs have shown difficulty in responding to unexpected situations such as communications failure or when the UGVs need to extract themselves from dangerous situations. In addition, these UGVs have difficulties with situational awareness as well as avoiding fratricide. UGV mobility is also proving to be an issue of concern. In March 2004, DARPA sponsored a UGV race — Grand Challenge — in the Mojave Desert but none of the contestants were able to complete the 142 mile course. DARPA has reportedly scheduled a second Grand Challenge for October 8, 2005.

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<sup>96</sup> Megan Scully, "U.S. Army May Tinker with FCS C-130 Need," *Defense News*, Nov. 15, 2004;

<sup>97</sup> Information in this section is taken from Jen DiMascio, "According to DOT&E Report ... Rough Terrain and Surprises Challenge FCS Unmanned Ground Systems," *Inside Defense.com*, Jan.31, 2005.

<sup>98</sup> The Director, Operational Test & Evaluation (DOT&E) is the principal staff assistant and senior advisor to the Secretary of Defense on operational test and evaluation (OT&E) in the Department of Defense. DOT&E is responsible for issuing DOD OT&E policy and procedures; reviewing and analyzing the results of OT&E conducted for each major DOD acquisition program; providing independent assessments to the Secretary of Defense, the Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L)), and Congress making budgetary and financial recommendations to the Secretary of Defense regarding OT&E; and oversight to ensure OT&E for major DOD acquisition programs is adequate to confirm operational effectiveness and suitability of the defense system in combat use.



## Issues for Congress

### Is the FCS Relevant to Current and Future Security Challenges?

The Army has characterized the FCS as the core building block of its Future Force.<sup>99</sup> FCS-equipped Units of Action are intended to be the Army's future tactical warfighting echelon optimized for offensive action.<sup>100</sup> The Army has also stated that FCS-equipped Units of Action will have the ability to execute a full spectrum of operations and will improve the strategic deployability and operational maneuver capability without sacrificing lethality or survivability.

Outside of these statements, some suggest that the Army offers little to back up these assertions. The Army has not yet publically released even preliminary operational doctrine for FCS-equipped units. Professional journals, such as the Army War College's *Parameters* and the Command and General Staff College's *Military Review*, are almost devoid of essays or articles discussing how FCS-equipped units might be used in operations ranging from counterinsurgency to force-on-force operations. While some maintain that the Army does not know how FCS will be used operationally, an argument can be made that because FCS is so revolutionary in design and capability, that any attempts to develop doctrine or operational concepts at this early stage of the system's design would be speculative at best.

Some, both inside and outside the military, have questioned the relevancy of FCS in the current and future geostrategic environment. In *Relevancy and Risk: The U.S. Army and Future Combat System*,<sup>101</sup> the authors recommend that initial versions of the FCS be developed for low intensity conflicts, and, as technology matures, new FCS versions for high intensity combat. In making their case, Mait and Grossman offer the following:

- “That by relying upon a mobile, light, and distributed force structure, the Army is subjecting itself to far too many dangerous situations where large-scale heavy forces will be required. Lethal technologies and precision weaponry, while effective, may still prove incapable of defending the light weight platforms of the FCS against a determined enemy.”<sup>102</sup>
- “The Army ... may be walking into a strategic ambush. Critics are concerned that the new Army (FCS-equipped) will lack the staying

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<sup>99</sup> Future Combat Systems (FCS) 18+1+1 Systems Overview, U.S. Army Program Manager for Units of Action, Version 12, Jan. 18, 2005, p. 2.

<sup>100</sup> Ibid.

<sup>101</sup> Joseph N. Mait and Jon G. Grossman, “Relevancy and Risk: The U.S. Army and Future Combat Systems,” Defense Horizons - Center for Technology and National Security Policy, National Defense University, May 2002.

<sup>102</sup> Ibid., p. 13.

power to survive in faraway places where ... it must fight in situations where it is vastly outnumbered and distant from viable reinforcements.”<sup>103</sup>

In *An Alternative Future Force: Building a Better Army*,<sup>104</sup> the authors suggest that:

- “Only three plausible MCO (major combat operation)- type opponents come readily to mind: China, Iran, and North Korea. China is a special case, with much more military power than any other plausible opponent; U.S. decisionmakers would be extremely wary about trading blows with China, especially with American ground forces.”
- “Given the emergence of future MCO-class military opponents that are armed with nuclear weapons, a major issue is whether the key sensors and communications systems associated with the next generation of reconnaissance-strike and battlefield situational awareness systems will have to be made resistant to wide-area electromagnetic effects generated by high-altitude nuclear weapon use.”
- “One important lesson learned from Operation Iraqi Freedom is that existing U.S. military forces are more than adequate for major combat operations in a non-nuclear environment against forces with second-tier technology and questionable quality.”
- “The homogeneous Objective Force (now known as the Future Force), optimized for major combat operations, is not appropriate for the vast majority of lesser operations the Army will likely be called upon to execute in the coming decade or more. These more probable operations will be at the mid-to-low end of the conflict spectrum, analogous to post-Cold War operations in Somalia, Rwanda, Kosovo, Bosnia, and the occupation phases of Afghanistan and Iraq that are a part of the global war on terrorism.”

Given these and other factors, the authors suggest that FCS “should be redirected to become a program designed not to produce a family of universal fighting vehicles for the entire Army, but as a technology enabling program to inject

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<sup>103</sup> Ibid., p. 15.

<sup>104</sup> Peter A. Wilson, John Gordon IV, and David E. Johnson, “An Alternative Future Force: Building a Better Army,” *Parameters*, U.S. Army War College Quarterly, Winter 2003-2004, pp. 19-39.

new capabilities into a modernizing family of light, medium, and heavy combat systems.”<sup>105</sup>

Analysts outside of the military have also questioned the relevance of FCS. According to the executive director of the Center for Strategic and Budgetary Assessment, Andrew Krepinevich, the FCS “may be revolutionary but it may not be relevant.”<sup>106</sup> Krepinevich reportedly considers that the underlying focus of the FCS is on “fighting a conventional enemy in what the Army calls an open battle” and the problem with this is that the Army will likely not face this situation for “some time.”<sup>107</sup> In addition, he offers the following observations:<sup>108</sup>

- “The conceptual documents behind the FCS and the Army future force don’t contain much on urban warfare, stability operations, counterinsurgency, and other threats that the Army is dealing with.”
- “The Army teamed with the Air Force may already provide much of the capabilities promised by FCS.”
- “The program is still “woefully short of the bandwidth<sup>109</sup> required” for FCS systems such as JTRS and the Warfighter Tactical Information Network-Tactical (WIN-T).”

Given these and other considerations, Congress may decide to examine FCS relevancy in greater detail. While few question the relevancy of FCS in force-on-force combat, as well as the demonstrated ability of current non FCS-equipped forces to defeat such adversaries, there are numerous questions concerning the relevancy of FCS at the lower end of the spectrum of conflict. It is possible that Congress might explore these issues in greater depth not only with the Army, but also with the other Services and other defense and non-defense institutions. Such an examination could help the Army clarify and explain FCS’s relevancy in lower spectrum of conflict operations or, in instances where a deficiency is noted, suggest appropriate corrective actions.

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<sup>105</sup> Ibid., p. 29.

<sup>106</sup> Scott Nance, “Kreinevich: FCS Revolutionary But Irrelevant?” *Defense Today*, Vol. 26, No. 60, Mar. 31, 2005, p. 3.

<sup>107</sup> Ibid., p. 1.

<sup>108</sup> Ibid., pp 1-3.

<sup>109</sup> Bandwidth in electronic communications is the width of the range of frequencies that an electronic signal uses on a given transmission medium. Necessary bandwidth is the width of the frequency band sufficient to ensure transmission of information at the rate and with the quality required under specific conditions. Because of proposed FCS use of significant amounts of digital and analog data transmitted through a finite range of frequencies, some believe that there will not be sufficient necessary bandwidth to accommodate FCS.

## Is the FCS Program, as Currently Envisioned, Viable?

Congress might act to review the overall viability of the FCS program as currently envisioned by the Army — 15 FCS-equipped Units of Action, with the first brigade fielded in 2014 with two FCS-equipped Units of Action fielded each year after 2015. While the Army has stated that the program is “on schedule, on cost, and on performance,”<sup>110</sup> many have questioned the program’s viability in terms of overall risk, performance to date, and ambiguity concerning the program’s overall cost.

From its inception, the FCS program has been acknowledged by the Army as a high risk program. While some suggest a less risky approach, others note that with the lack of a peer competitor and the U.S. Army’s proven dominance in land warfare, the United States is in a position to embark on such a high risk venture which, if successful, could significantly enhance our future national security. While this argument has merit, critics note that the cost of failure, although not likely to endanger our national security, could come with a significant price tag as well as forcing the Army in the next decade to develop a replacement system for the FCS.

GAO has been involved with the FCS program extensively and has been asked to assess the prospects for delivering FCS within cost and scheduled objectives. In recent testimony to the Senate Armed Services Subcommittee on Airland, GAO found the following:

FCS is at significant risk for not delivering required capability within budgeted resources. Currently, about 9 1/2 years are allowed from development start to production decision. DOD typically needs this period of time to develop a single advanced system, yet FCS is far greater in scope. The program’s level of knowledge is far below that suggested by best practices or DOD policy: Nearly 2 years after program launch and with \$4.6 billion invested, requirements are not firm and only 1 of over 50 technologies is mature. As planned, the program will attain the level of knowledge in 2008 that it should have had in 2003. But things are not going as planned. Progress in critical areas — such as network, software, and requirements — has, in fact been slower, and FCS is therefore likely to encounter problems late in development, when they are very costly to correct. Given the scope of the program, the impact of cost growth could be dire.<sup>111</sup>

While these findings suggest that the FCS program may face significant future challenges, these findings are by no means unique. In a recent report to Congress titled “Assessment of Selected Major Weapons Programs,” GAO assessed 54 DOD programs including FCS, JTRS Cluster 1 and JTRS Cluster 5.<sup>112</sup> In this report GAO concluded that:

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<sup>110</sup> Statement by Claude M. Bolton Jr., Assistant Secretary of the Army for Acquisition, Logistics and Technology to the House Tactical Air and Land Forces Subcommittee during a hearing on Future Combat Systems, Mar. 16, 2005, p. 28.

<sup>111</sup> Government Accountability Office, *Future Combat Systems Challenges and Prospects for Success*, GAO-05-442T, Mar. 16, 2005, Highlights page.

<sup>112</sup> Government Accountability Office, *Defense Acquisitions: Assessments of Selected Major Weapon Programs*, GAO-05-301, Mar. 2005.

The majority of programs that GAO assessed are costing more and taking longer to develop than planned. Most of the programs proceeded with less knowledge at critical junctures than suggested by best practices, although some programs came close to meeting best practices standards. For example, the technology and design for the F/A-22 matured late in the program contributing to a large cost growth and scheduled delays.<sup>113</sup>

This being the case, some maintain that although the FCS program's cost and schedule will likely grow over time — as do the majority of DOD weapons programs — that the FCS program could still achieve its intended aims.

Program performance to date, however, may suggest otherwise. As previously discussed, JTRS, and Manned and Unmanned Ground Vehicle programs have been suspended and delayed, not only impacting these specific programs but also related programs such as Unmanned Aerial Vehicles (UAVs). In addition, these and additional challenges could have an impact on Spiral 1 fieldings and subsequent testing by the FCS evaluation brigade.

Program cost is another aspect of overall program viability. While total life cycle FCS program costs have yet to be defined, GAO notes that research and development costs have increased almost 51 percent from 2003 to 2004 and that procurement costs are estimated to have increased by almost 32 percent.<sup>114</sup> It is unlikely that such a cost growth rate will be acceptable over the long-term. GAO's assessment that "the impact of cost growth could be dire" for the FCS program as well as speculation that further program delays lay ahead, have some speculating that a credible cost estimate for FCS and its complementary programs may be unachievable with any degree of confidence. With the Army under increasing budgetary pressure to fund equipment recapitalization<sup>115</sup>, modularity efforts, and possibly end-strength increases, some believe that it is inevitable that a financially ill-defined FCS program would be the bill payer for these more immediate operational requirements. The Congressional Budget Office (CBO) in its February 2005 Budget Options paper estimates that if the initial fielding date of the FCS was delayed by four years, that it would not only permit immature technologies to further develop, but would also result in a program savings of about \$ 7.5 billion over five years.<sup>116</sup> CBO further estimates that an outright FCS program cancellation would save \$ 71 billion over ten years.<sup>117</sup> Regarding the latter option, CBO cautions that FCS program cancellation might, however, "preclude transforming the Army in any meaningful way."<sup>118</sup>

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<sup>113</sup> Ibid., Highlights page.

<sup>114</sup> Ibid., p. 65.

<sup>115</sup> Equipment recapitalization refers to the Army's efforts to repair, upgrade or modify equipment presently in use so that it may continue to be used in the future.

<sup>116</sup> Congressional Budget Office, *Budget Options*, Feb. 2005, Sec. 3, National Defense, pp. 2-4.

<sup>117</sup> Ibid.

<sup>118</sup> Ibid.

## **FCS Program Management and Type of Contractual Agreement**

On April 6, 2005, it was reported that, based partially on Congressional concerns, the Army would restructure its OTA FCS contract to a more traditional contract.<sup>119</sup> While specific details of this change are still forthcoming, the Army did report that any additional costs that will be incurred will likely be administrative in nature. Congress might opt to examine the Army's proposed contract change in detail, taking into consideration how it will impact the program's budget and its developmental timeline, as well as the Army's ability to assume a greater role in managing the FCS program. Despite Army claims, some suggest that it is highly unlikely that this contract and, ultimately, management restructuring will have no effect on program timelines and budget. They argue that adding additional administrative and oversight requirements and changing the program's management structure and philosophy could have an impact both in terms of program structure, scheduling, and its budget. Of particular concern is the Army's ability to take on a greater management role — particularly given that the Army was compelled to adopt the Lead Systems Integrator approach at the program's outset because it lacked sufficient skilled program managers, scientists, and engineers.

## **Program “Off Ramps” and Integration Into the Current Force**

Congress may decide to examine the FCS program's “off ramps” in case the overall program either fails to meet criteria to advance to the procurement phase or if external circumstances — such as budget cuts — significantly modify or curtail the program. Many believe that FCS programs such as UAVs, UGS, UGVs, and aspects of the Network could be migrated to the current Abrams/Bradley force successfully, not only significantly enhancing the force's capabilities, but also justifying FCS program expenses occurred up to the point of migration. The Army reportedly plans to use M-1s and M-2s as surrogates in the FCS evaluation brigade until MGVs are available for testing, which will also permit the Army to evaluate how these systems could improve the current force's performance. Some suggest that such an “off ramp” plan would be a prudent risk-mitigation action, given the numerous challenges still facing the FCS program, as well as the program's reported progress to date.

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<sup>119</sup> Renae Merle, “Army Will Restructure Modernization Contract,” *Washington Post*, Apr. 6, 2005, p. E5 and Jonathan Karp and Andy Pasztor, “About-Face: Army's Decision on Boeing Changes Philosophy,” *Wall Street Journal*, Apr. 6, 2005.

## **Additional Reading**

CRS Report RL32476, *U.S. Army's Modular Redesign: Issues for Congress*, by Andrew Feickert.

CRS Report RS21754, *Military Forces: What is the Appropriate Size for the United States?*, by Ed Bruner.

CRS Report RS21195, *Evolutionary Acquisition and Spiral Development in DOD Programs: Policy Issues for Congress*, by Gary J. Pagliano and Ronald O'Rourke.

## Appendix A. FCS Subsystems

### Manned Ground Vehicles

FCS manned ground vehicles (MGVs) are a family of eight different prospective combat vehicles — with some having more than one variation — that are based on a common platform and are being designed to be transported by the U.S. Air Force’s C-130 Hercules transport aircraft and deployed straight into combat with little or no post-flight reconfiguration.<sup>120</sup> They are to be equipped with a variety of passive and active protection systems and sensors that the Army hopes will offer them the same survivability as the current heavy armor force.<sup>121</sup> Some believe that it will be difficult for the Army to develop this family of vehicles that will weigh only 20 tons — the weight limit for vehicles to be transported by current C-130s — and maintain the same lethality and survivability as current armored fighting vehicles.<sup>122</sup> In addition the Army intends for its MGVs to be highly reliable, require low maintenance, and have fuel-efficient engines.<sup>123</sup> Some note that many of these requirements may actually work against each other. For example, new weapons systems could increase the size and weight of the vehicles, possibly precluding their transport by C-130 aircraft.<sup>124</sup> The following are brief descriptions of MGV types and variants and all variants are intended to have a range of 750 kilometers and a top speed of 90 kilometers per hour (kph) — 55 miles per hour:<sup>125</sup>

**Mounted Combat System (MCS).** As envisioned, the MCS provides direct and beyond-line-of-sight (BLOS) fires, is capable of providing direct fire support to dismounted infantry, and can attack targets with BLOS fires out to a range of 8 kilometers. The MCS is intended to replace the current M-1 Abrams tank. The MCS is to have a crew of two and might also be able to accommodate two passengers. The MCS is to be armed with a 120 mm main gun, a .50 caliber machine gun, and a 40 mm automatic grenade launcher.

**Infantry Carrier Vehicle (ICV).** As planned, the ICV consists of four versions: the Company Commander version, the Platoon Leader version, the Rifle Squad version, and the Weapons Squad version. All four versions appear to be identical from the exterior to prevent the targeting of a specific carrier version. The Rifle Squad version is to have a two man crew and is to be able to transport a nine man infantry squad and dismount them so that they can conduct combat operations on foot. The ICV is to mount a 30 or 40 mm cannon.

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<sup>120</sup> “Manned Ground Vehicle” from GlobalSecurity.org, [<http://www.globalsecurity.org/military/systems/ground/fcs-mgv.htm>].

<sup>121</sup> Ibid.

<sup>122</sup> Ibid.

<sup>123</sup> Government Accountability Office, *Future Combat Systems Challenges and Prospects for Success*, GAO-05-442T, Mar. 16, 2005.

<sup>124</sup> Ibid.

<sup>125</sup> Information for these descriptions are taken from two Army sources: The Army’s *FCS 18+1+1 White Paper*, dated Oct. 15, 2004 and the *FCS 2005 Flipbook*, dated Aug. 26, 2004.



**Non-Line-of-Sight Cannon (NLOS-C).** The NLOS-C is to provide networked, extended-range targeting and precision attack of both point and area targets with a wide variety of munitions. Its primary purpose will be to provide responsive fires to FCS Combined Arms Battalions and their subordinate units. The NLOS is to have a two man crew and a fully automated handling, loading, and firing capability. It is not yet known what caliber the NLOS-C's cannon will be.

**Non-Line-of-Sight Mortar (NLOS-M).** The NLOS-M is intended to provide indirect fires in support of UA companies and platoons. The NLOS-M is to have a four man crew, mount a 120mm mortar, and also carry an 81 mm mortar for dismounted operations away from the carrier.

**Reconnaissance and Surveillance Vehicle (RSV).** As planned, the RSV will feature advanced sensors to detect, locate, track, and identify targets from long ranges under all climatic conditions, both day and night. The RSV is to have a mast-mounted long-range, electro-optical infra-red sensor, sensors for radio frequency (RF) intercept and direction finding as well as a remote chemical warfare agent detector. RSVs are to also carry four dismounted scouts, unattended ground sensors (UGS), a Small Unmanned Ground Vehicle (SUGV) with various payloads, and two Unmanned Aerial Vehicles (UAVs). In addition to the four scouts, the RSV is to have a two man crew and a defensive weapons system.

**Command and Control Vehicle (C2V).** The C2V is intended to serve as the "hub" for battlefield command and control. It is to provide information management for the integrated network of communications and sensors for the UAs. The C2V is to have a crew of two and carry four staff officers and also be capable of employing UAVs.

**Medical Vehicle - Evacuation (MV-E) and Medical Vehicle - Treatment (MV-T).** There are to be two versions of the MV — the MV-E and MV-T. The MV-E would permit combat trauma specialists to be closer to the casualty's point of injury as it is to move with combat forces and evacuate casualties to other treatment facilities. The MV-T is to enhance the ability to provide Advanced Trauma Management/Advanced Trauma Life Support forward in the battle area and both MV-E and MV-T would be capable of conducting medical procedures and treatments using telemedicine systems. Both would have four man crews and the capability to carry four patients.

**FCS Recovery and Maintenance Vehicle (FRMV).** The FRMV would be the Unit of Action's recovery and maintenance system. The FRMV is to have a crew of three, plus additional space for up to three recovered crew members.

## Unmanned Aerial Vehicles (UAVs)<sup>126</sup>

Each FCS-equipped UA (brigade) is to have almost 200 UAVs ranging from small, platoon-level vehicles to larger, higher endurance aircraft.<sup>127</sup> While these UAVs are to provide a variety of capabilities to forces on the ground, some experts note that they could also present an air space management challenge to not only manned Army aviation assets, but also to Navy, Marine Corps, Air Force, and other nation's aircraft that might be providing support to Army ground operations. The following are brief descriptions of the Army's four classes of UAVs:

**Class I UAVs.** Class I UAVs are intended to provide Reconnaissance, Surveillance, and Target Acquisition (RSTA) at the platoon level. Weighing less than 15 pounds each, these Class I UAVs are intended to operate in urban and jungle terrain and have a vertical takeoff and landing capability. They are to be used to observe routes and targets and can provide limited communications transmissions relay. The Class I UAV are to be controlled by dismounted soldiers and can also be controlled by selected FCS ground platforms, and have an endurance of 50 minutes over an 8 kilometer area, and a 10,500 foot maximum ceiling.

**Class II UAVs.** Class II UAVs are intended to provide RSTA at the company level. The Class II UAV is to be vehicle mounted and have a vertical takeoff and landing capability. Its planned distinguishing capability is that it can designate targets both day and night and in adverse weather at a distance of 2 kilometers from the UAV, enabling the company commander to employ line-of-sight, BLOS, and NLOS fires. It can also provide limited communications relays. Class II UAVs are intended to have an endurance of 120 minutes over a 16 kilometer area and an 11,000 foot maximum ceiling.

**Class III UAVs.** Class III UAVs are to be multifunctional systems intended to be employed at the battalion level. A Class III UAV encompasses all capabilities found in the Class I and II UAVs but are planned to also provide an enhanced communications relay capability, mine detection, chemical, biological, radiological, and nuclear detection, and meteorological survey. The Class III UAV is to be able to take off and land without a dedicated airfield and is intended to be able to stay aloft for 6 hours over a 40 kilometer area with a maximum ceiling of 12,000 feet.

**Class IV UAVs.** Class IV UAVs are intended to provide the UA (brigade) commander with a long endurance capability encompassing all functions in Class I through Class III UAVs. It is intended to stay aloft for 72 continuous hours and operate over a 75 kilometer radius with a maximum ceiling of 16,500 feet. It is also planned to interface with other manned and unmanned aerial vehicles and be able to take off and land without a dedicated airfield.

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<sup>126</sup> Unless otherwise noted, UAV information for these descriptions are taken from two Army sources: The Army's *FCS 18+1+1 White Paper*, dated Oct. 15, 2004 and the *FCS 2005 Flipbook*, dated Aug. 26, 2004.

<sup>127</sup> Sandra I. Erwin, "Army to Field Four Classes of UAVs," *National Defense*, Apr. 2003.

## Unmanned Ground Vehicles (UGVs)<sup>128</sup>

**Armed Robotic Vehicle (ARV).** The ARV is intended to come in two variants — the Assault variant and the Reconnaissance, Surveillance, and Target Acquisition (RSTA) variant. The two variants are to share a common chassis. The Assault variant is to provide remote reconnaissance capability, deploy sensors, and employ its direct fire weapons and special munitions at targets such as buildings, bunkers, and tunnels. It is also intended to be able to conduct battle damage assessments, act as a communications relay, and support both mounted and dismounted forces with direct and anti-tank fire as well as occupy key terrain. The RSTA version is to have similar capabilities but is not intended to provide direct support fire to mounted or dismounted troops.

**Small Unmanned Ground Vehicle (SUGV).** The SUGV is a small, lightweight, manportable UGV capable of operating in urban terrain, tunnels, and caves. The SUGV will weigh 30 pounds, can operate for 6 hours without a battery recharge, and has a one kilometer ground range and a 200 meter tunnel range. Its modular design will permit a variety of payloads which will enable it to perform high-risk intelligence, surveillance, and reconnaissance (ISR) missions and chemical weapons or toxic industrial chemical reconnaissance.

**Multifunctional Utility/Logistics and Equipment Vehicle (MULE).** The MULE is a UGV that will support dismounted infantry. It is to come in three variants sharing a common chassis-transport, countermine, and the Armed Robotic Vehicle - Assault - Light (ARV-A-L). The transport variant is to be able to carry 1,900 to 2,400 pounds of equipment and rucksacks for dismounted infantry and follow them in complex and rough terrain. The countermine variant is to have the capability to detect, mark, and neutralize anti-tank mines. The ARV-A-L variant is to incorporate a weapons package and a RSTA package to support dismounted infantry operations. The MULE is intended to have a 100 kilometer road, and 50 kilometer cross country, range.

## Unattended Ground Sensors (UGS)<sup>129</sup>

UGS are divided into two groups — Tactical UGS and Urban UGS — and are described as follows:

**Tactical UGS.** Tactical UGS include intelligence, surveillance, and reconnaissance (ISR) sensors and Chemical, Biological, Radiological, and Nuclear (CBRN) sensors. These sensors are to employ a variety of sensing technologies and integrated into the overall FCS network. They are intended to be designed to be deployed by hand, by vehicle, or by robot and have a 48 hour endurance. These

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<sup>128</sup> Unless otherwise noted, information for these descriptions are taken from two Army sources: The Army's *FCS 18+1+1 White Paper*, dated Oct. 15, 2004 and the *FCS 2005 Flipbook*, dated Aug. 26, 2004.

<sup>129</sup> Ibid.

expendable, low-cost sensors can be used for such tasks as perimeter defense, surveillance, target acquisition, and CBRN early warning.

**Urban UGS.** Urban UGS can also be employed by soldiers, vehicles, or robots and are intended to provide situation awareness inside and outside of buildings for force protection and also for previously-cleared buildings and areas.

### **Non-Line-of-Sight Launch System (NLOS-LS) and Intelligent Munitions System (IMS).**

**NLOS-LS.** NLOS-LS is to consist of a family of missiles in a deployable, platform-independent, container launch unit (CLU), which can be fired in an unmanned and remote mode. Each CLU is to have a fire control system and 15 missiles consisting of Precision Attack Missiles (PAM) and Loitering Attack Missiles (LAM).

The PAM is to have two employment modes — a direct-fire and a fast attack mode or a boost-glide mode. The missile is intended to receive target information prior to launch and receive and respond to target location updates while in flight. The PAM can be fired in the laser-designated mode and transmit near real-time target imagery prior to impact. The PAM is intended to be used against heavily armored targets.

The LAM is to provide imagery for search, surveillance, targeting, and battle damage assessment (BDA) and can also serve as an airborne radio retransmission sight. LAMs are to be capable of flying long distances with significant loiter times. LAMs are intended to be re-programmed in flight and attack, high value, fleeting targets.

**IMS.** IMS is intended to be an unattended munitions system, consisting of a variety of lethal and non-lethal munitions and can be used for filling gaps, isolating enemy forces or objectives, and controlling non-combatant movement with nonlethal munitions. IMS is to have an on-off capability and can be recovered and re-employed if not used. It can also self destruct if required and is to have an anti-tamper capability.

## **The Network<sup>130</sup>**

The FCS network is considered the most crucial system of all 18 systems and, according to the CSA, General Schoomaker, “the toughest part of the program will be assembling the network that ties the system of systems together.”<sup>131</sup> The FCS network is to consist of four interactive components — the System-of-Systems Common Operating Environment (SOSCOE); Battle Command (BC) software; communications and computers (CC); and intelligence, reconnaissance and surveillance (ISR) systems.

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<sup>130</sup> Ibid.

<sup>131</sup> “House Moves to Double Stryker Budget in Effort to Help Reset the Force,” *Inside the Army*, June 21, 2004.

**System-of-Systems Common Operating Environment (SOSCOE).**

The SOSCOE is to enable the integration of a variety of software packages into the FCS network. It is intended to use commercial, off-the-shelf hardware and allow for the integration of critical interoperability packages that translate Army, Navy, Air Force, Marine Corps, and allied message formats into internal FCS message formats.

**Battle Command (BC) Software.** Battle Command mission applications are to include mission planning and preparation, situational understanding, battle command and mission execution, and warfighter-machine interface.

**Mission Planning and Preparation.** Consists of 16 different services that provide FCS units with the following automated capabilities:

- The development of deliberate, anticipatory, and rapid-response plans;
- The ability to perform plan assessments and evaluations;
- The ability to perform terrain analysis;
- The conduct of mission rehearsals; and
- The conduct of after action reviews.

**Situation Understanding.** This consists of 10 different packages that allow the user to better comprehend their surroundings. These packages employ map information and a variety of databases that help to determine enemy locations and capabilities, infer enemy intentions, and assess the threat to U.S. forces.

**Battle Command and Execution.** This package contains a variety of planning and decision aids to help commanders make rapid, informed, and accurate decisions during battle. These packages can also be used in the training and rehearsal modes.

**Warfighter-Machine Interface Package.** This package receives soldier-generated information and displays information across all FCS platforms for soldier use.

**Communications and Computer (CC) Systems.** The Communications and Computer network is intended to provide secure, reliable access to information over extended distances and complex terrain. This network is not intended to rely on a large and separate infrastructure because it is to be embedded in the FCS mobile platforms and move with the combat units. The communications network is to consist of a variety of systems such as the Joint Tactical Radio System (JTRS)<sup>132</sup> Clusters 1 and 5 (Cluster 1 radios are for vehicles — Cluster 5 are for dismounted soldiers and weight-constrained platforms); Wideband Network Waveform and Soldier Radio Waveform systems; Network Data Link; and the Warfighter Information Network Tactical (WIN-T).

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<sup>132</sup> The Joint Tactical Radio System program is not an FCS or Army -specific program but instead is a joint service program. JTRS is unique in that it allows the radio's capabilities to be improved through software upgrades as opposed to developing and purchasing new hardware.

**Intelligence, Reconnaissance and Surveillance (ISR) Systems.** The Intelligence, Reconnaissance and Surveillance System is to be a distributed and networked array of multispectral ISR sensors intended to provide timely and accurate situational awareness to the FCS force. In addition, the ISR system is intended to help FCS formations avoid enemy fires while providing precision, networked fires to the unit.

## **The Soldier**

All dismounted soldiers are to wear the Land Warrior combat ensemble which includes enhanced body protection, an embedded computer/communication system, and a family of new personal weapons.