Future Combat Systems (FCS) and Evolutionary Acquisition

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ABSTRACT

The US Army is in transition into an era of lighter-weight, rapidly deployable, highly lethal forces. The FCS system-of-systems program will develop new material solutions critical to the Army's Objective Force ability to "See First, Understand First, Act First and Finish Decisively" at the strategic, operational, and tactical levels. The FCS program is an Evolutionary Acquisition effort that will consist of a series of spirals/increments leading to realization of objective capability. The paper gives FCS program overview and describes FCS Increment 1 and spirals. It also talks about Increment 1 baseline, UA systems, FCS Critical Technologies, Complementary Programs, and others.

1.0 FCS PROGRAM OVERVIEW

The US Army is in transition into an era of lighter-weight, rapidly deployable, highly lethal forces. The FCS system-of-systems program will develop new material solutions critical to the Army's Objective Force ability to "See First, Understand First, Act First and Finish Decisively" at the strategic, operational, and tactical levels. FCS-equipped forces will be strategically responsive and tactically dominant at every point on the spectrum of military operations. FCS will operate as part of a joint team, and its joint operational architecture will provide an enhanced C4ISR capability for dominant situational awareness and precision strike. The FCS will be a networked system of systems made up of a family of manned and unmanned air and ground platforms, fielded with ground-based maneuver, and maneuver support/sustainment systems (see Figure 1). The FCS Increment 1. The Increment 1 Initial Operating Capability (IOC) will occur in FY10.

Paper presented at the RTO AVT Symposium on "Functional and Mechanical Integration of Weapons and Land and Air Vehicles", held in Williamsburg, VA, USA, 7-9 June 2004, and published in RTO-MP-AVT-108.

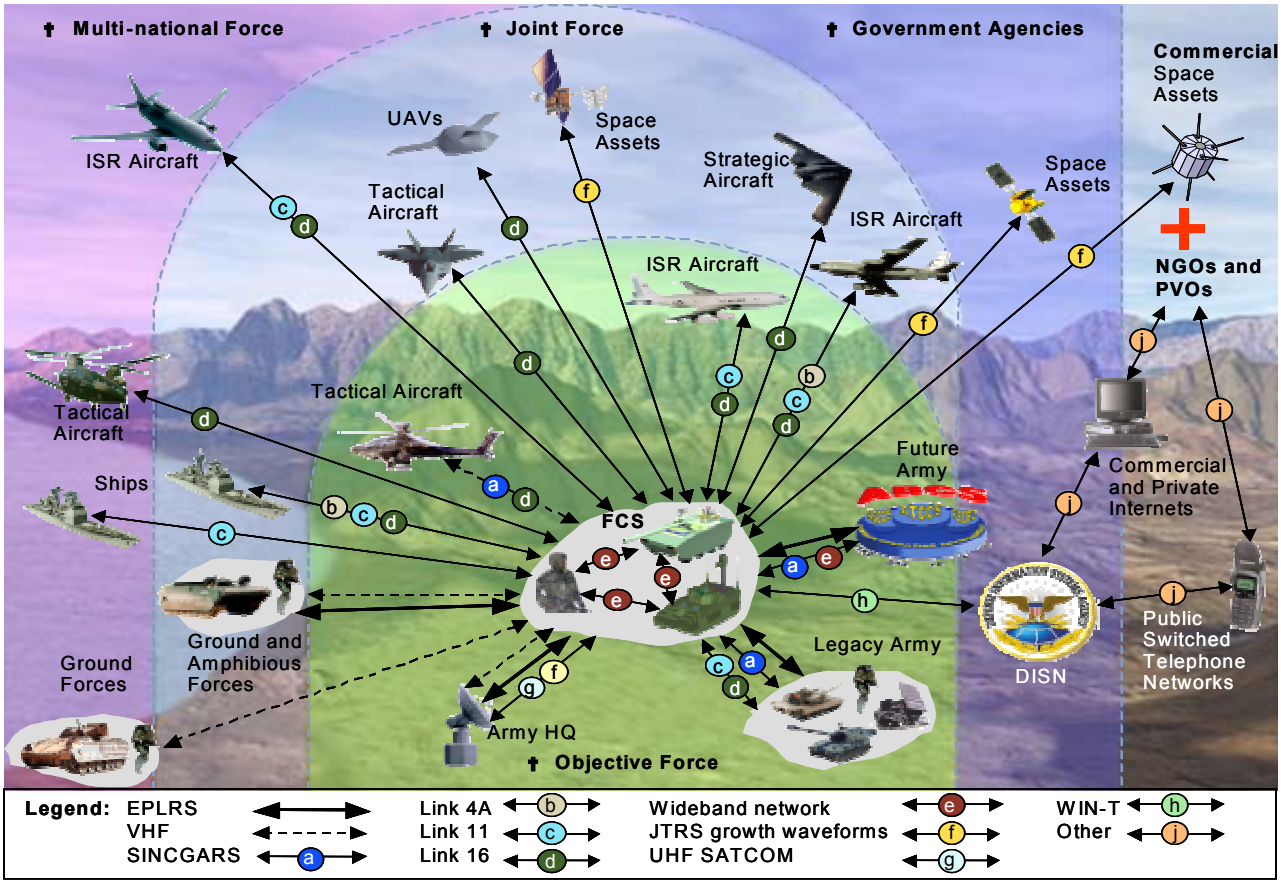

Figure 1: The FCS Increment 1

A main goal of Army Transformation is the creation and fielding of the Future Force. The Future Force will be strategically deployable and capable of performing all required missions across the spectrum of conflict. The Future Force is characterized by an innovative new force structure based on two organizational elements – the Unit of Employment (UE) and the Unit of Action (UA). The FCS -- a networked system of systems -- will serve as a core materiel building block within the UA. The program goals are to: acquire Future Combat Systems, equip Soldiers, and field UAs.

Evolutionary Acquisition (EA) is the US Department of Defense's (DOD) strategy for rapid acquisition of mature technology to the User. The FCS program has selected EA as our acquisition approach. EA delivers capability in increments, recognizing the need for future capability improvements. The objective is to balance needs and available resources, and to put capability into the hands of the User quickly. The success of the strategy depends on the consistent and continuous definition of requirements, and the maturation of technologies that lead to a disciplined development and production of systems that provide increasing capability toward a materiel concept. Evolutionary Acquisition and System-of-Systems Development Process is presented in Figure 2.

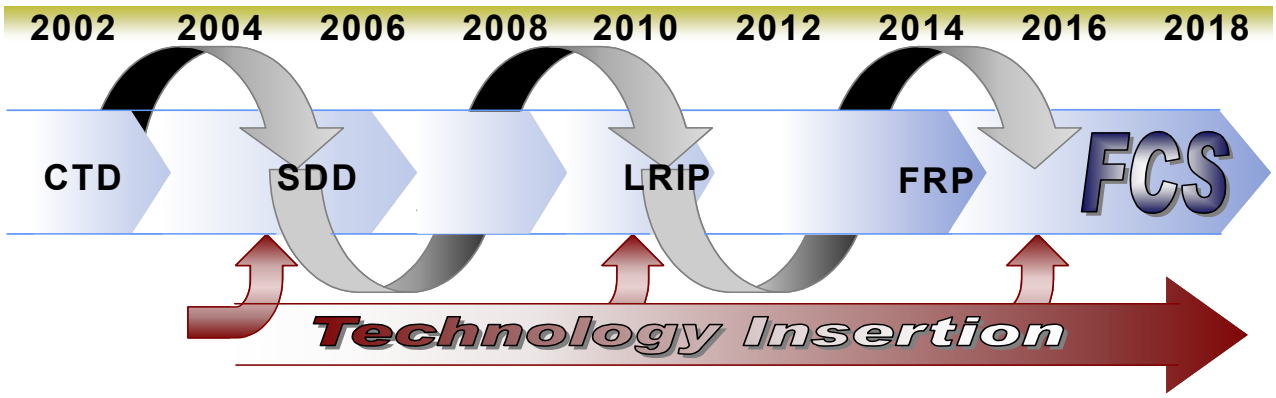

Figure 2: Evolutionary Acquisition and System-of-Systems Development Process

The desired end of FCS is known, and is expressed as a set of objective requirements in the Operational Requirements Document (ORD). However, analysis of available and emerging technologies, and predicted technology evolution indicates not all required technical capabilities are available to support an affordable, single system build to meet this desired end state. Therefore, FCS will employ incremental development to provide a phased approach for meeting objective SoS requirements. FCS will also use a technology spiral approach to provide phased deliveries of successively increasing capabilities from each spiral.

DOD 5000.2 identifies two approaches to evolutionary acquisition—incremental and spiral. In spiral development, a desired capability is identified, but the end-state requirements are not known at program initiation. Those requirements are refined through demonstration and risk management; there is continuous user feedback; and each increment provides the user the best possible capability. The requirements for future increments depend on feedback from users and technology maturation. With incremental development, a desired capability is identified, an end-state requirement is known, and that requirement is met over time by development Future Force several increments, each dependent on available mature technology. However, due to the complexity and SoS nature of FCS, a hybrid approach combining both increments at the SoS level and spirals below the SoS level will be used to implement FCS evolutionary acquisition.

2.0 Increments & Spirals

The FCS program is an EA effort that will consist of a series of spirals/increments leading to realization of objective capability. Increment I will provide the initial capability to the soldier at IOC. Subsequent Increments could address major architectural and capability upgrades that significantly affect FCS force configuration and "way to fight." The ORD defines objective capability to guide program development through the life cycle.

Spirals occur at the systems level, providing a means to mature systems capability within the increment currently being developed. Spirals also ensure that FCS systems remain sufficiently up-to-date to avoid obsolescence and associated sustainment problems. Critical software upgrades will be accomplished on a shorter cycle than hardware improvements and will be implemented through software blocking, consistent with Army policy and guidance.

3.0 FCS INCREMENT 1

The FCS Increment 1 program can be characterized as a capability baseline that implements an operational and technical architecture with multiple interfaces to external complementary programs. In this context, several evolving sources contribute to defining the technology content of Increment 1. Defining sources presently under development include the following:

- FCS System of Systems Specification, with Growth Appendix
- AAMSA Systems Book [Release 3.0, April 2003],
- LSI/Army Trade Space Analyses supporting Initial Baseline Reviews 1 and 2.
- Risk Mitigation Plans for [31] FCS Critical Technologies
- Spiral Development Programs summarized in this TDS

These sources are brought together in a series of FCS program reviews that gradually increase the depth and descriptive detail which define the materiel solution: the vehicle/platform hardware, applications software, information exchange requirements, networks, training, and sustainment infrastructure.

3.1 FCS System of Systems (SoS) Specification

The FCS SoS Spec has been derived and elaborated from the FCS ORD, with organization also influenced by the AMSAA Systems Book. The SoS Spec distributes ORD capability requirements across FCS platforms and networks, logistics and training systems, with additional derived performance metrics. The Spec contains over 9000 discrete performance requirements, along with a verification and test matrix that defines verification methodology for each.

Likewise, a subset of requirements within the SoS Spec has been allocated to the "FCS Growth Annex." These requirements are associated with seven named system platforms deferred from the initial FCS acquisition baseline by the Basis of Estimate implemented in the Army Cost Position (ACP) Memo of May 2003. Several lower-level subsystem capabilities are also deferred in the acquisition baseline. All of these capabilities are identified for "spiral forward" integration when funds and mature technology become available, within the overall architecture of FCS Increment I. Although the initial LSI contract scope does not include integration of these systems, the architecture itself must make provision for their eventual inclusion. Architecture gateways, network capacity, computing power and storage, vehicle space and weight allocations within the acquisition baseline must be consistent with deferred spiral development and integration programs.

3.2.1 AMSAA Systems Book

The Army FCS UA Systems Book is a by-product of AMSAA's support to the FCS AoA. One of AMSAA's primary missions is providing certified performance and effectiveness data for all major Army studies. The US Army Future Combat Systems (FCS) Unit of Action (UA) Systems Book is a configuration management tool maintained by AMSAA in coordination with the FCS Lead Systems Integrator (LSI) and the User Representative, the Unit of Action Maneuver Battle Laboratory (UAMBL), to support analytic efforts on the FCS program. It provides a single point of reference for:

- Key technologies and capabilities associated with FCS platforms;
- Platform concepts developed by the LSI (coordinated with and modified by the User) for which AMSAA provided performance and effectiveness data to the TRADOC Analysis Center (TRAC) for use in the FCS Analysis of Alternatives (AoA); and

- Selected data references that may assist program participants during the course of FCS development activities.

Information contained in this book is the result of an integration process that included inputs from the User, Materiel Developer, Army Science and Technology (S&T) base, LSI communities, and HQ DA leadership. The Army FCS UA Systems Book is a living document and will evolve as FCS proceeds through its development cycle.

3.3 Critical Technologies

FCS Increment I Critical Technologies (CTs) are defined and correlated with associated Key Performance Parameters (KPPs). Each CT has a set of key available technologies, programs and/or sources necessary to meet all aspects of them. The criteria by which a technology was judged to be "critical" are as follows:

- This technology is required to meet the System Operational Requirements for FCS
- Unit of Action effectiveness significantly degraded if technology not available
- Its absence results in significant impacts to the overall system-of-systems concept
- Technology or its application is either new or novel

A detailed process for evaluation of technology readiness level (TRL) and integration readiness level (IRL) has been developed and is being applied. FCS CTs are technologies presenting a balanced view of FCS SoS (for Increment 1) that capture key performance necessary to enable the FCS UA ORD at Threshold level. This criterion is further explained in paragraph 2.1.3 of the DOD's Technology Readiness Assessment Deskbook, dated September 2002.

3.4 Complementary and Associated Programs

FCS mission accomplishment hinges on the ability to align the cost, schedule, and performance of programs outside the control of the PM, FCS. These programs have been labelled complementary and associate (C&A). C&A Programs are required to meet the functionality and performance of the FCS UA Increment I Capabilities Specification.

A set of about 40 programs are officially approved and tracked by HQDA as complementary programs. Programs on this list are "fenced" during the PBES process to protect their funding. Additional programs, not on this list, but are required for the FCS to meet the FCS UA Increment I Capabilities Specification are called Associated programs.

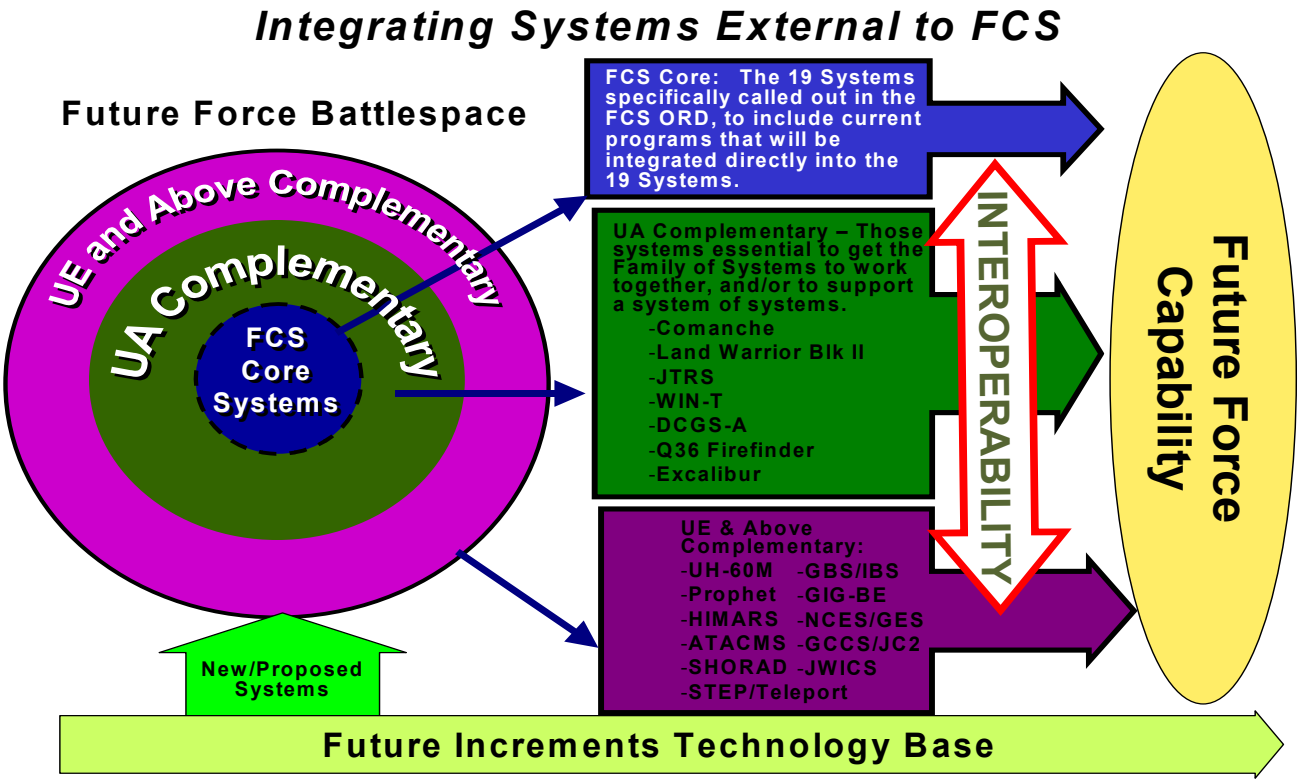

Figure 3

Complementary programs are important to the success of FCS-equipped FCS UAs, and the technology development strategies specific to individual programs must be coordinated between the respective government program managers responsible for all systems in the UA to unsure the entire UA meets the needs of the O&O. The Figure3 depicts relationships among the FCS Core Systems, UA Complementary and Associate Programs, and Unit of Employment and above Complementary.

4.0 SPIRAL INSERTIONS FOR INCREMENT 1: STRATEGY AND PROCESS.

FCS is using open system architecture to enable low-cost, low-risk iterative upgrades. The strategy is to conduct searches of Government, commercial, international, and academic research programs to identify leading edge candidate technologies applicable to FCS required to meet objective program capability needs. We then analyze these technologies to determine maturation roadmap, risk, and spiral development schedule. The technology insertion strategy balances the schedule, technical risk, and benefits to provide continuous high-payoff upgrades for future capability. Technology benefits are analyzed through M&S of force effectiveness and LCC. These results form the basis for technology insertion in concert with TRADOC requirements and evolving threats.

The FCS System of Systems architecture is structured to evolve over time. Given the time frame of the acquisition, such a process is inevitable and unavoidable. Starting from Milestone B approval in April 2003, FCS Increment I Systems Design and Development will produce Initial Operational Capability (IOC) in 2010,

with Full Operational Capability for the first FCS Unit of Action in 2012. Fourteen additional Units of Action will be deployed between 2013 and 2020. Over this 17-year cycle, technology will neither sit still, nor can its progress be fully predicted in advance. Likewise, force structure requirements may also change, as the nature of warfare and the particulars of specific threats evolve. Thus new technology and operational capabilities will be "spiralled into" the FCS architecture over time.

The FCS Spiral Insertion process involves several opportunities for capability growth:

- Product Improvements and software releases
- Opportunistic and breakthrough technologies
- Threshold to Objective capability growth
- Technology solutions in response to meet an urgent unforeseen threat.
- Insertion of ORD approved systems that were deferred at MS B

In any evolutionary acquisition program, spiral insertion can entail technology at several levels of program scale. Some insertions occur in the manner that has historically been called product improvements or engineering changes. Other insertions, particularly those implemented in software rather than hardware, may be called "Capability Releases" or "Version Releases." Both of these (overlapping) categories deploy a planned, gradually increasing suite of coordinated user capabilities over time. This process generally occurs within the structure of a multi-year Systems Design and Development contract. Both product improvement/engineering changes and Version releases are gradual [e.g. 'non-revolutionary'] in nature: they do not change the fundamental architecture of the FCS System of Systems.

Sometimes, an unanticipated technological breakthrough may offer an "opportunistic" capability that was not initially planned. Such a technology might be sourced from a DARPA program, generated by Academia, or developed in the US or International commercial sector that can meet a capability shortfall. Emerging technologies may substantially improve FCS force lethality, maneuver, command and control, sustainability, or some other fundamental force structure capability. For such programs, a process of evaluation and impact assessment will occur within the on-going FCS program. Operational capability payoff will be evaluated to justify both the investment and the force retraining that attend retro-fit of new capabilities into existing FCS vehicles and networks.

Another possibility for technology insertion solutions is response to meeting an unforeseen urgent threat that emerges over time. This includes both direct counter-threat technology solutions as well as technologies to deter the immediate threat. In this case, aggressive assessments are required of what technology may be already in the technology pool for acceleration to the field as well as technology developments in response to the threat.

A different category of spiral insertion unique to FCS are systems approved in the overall systems architecture but deferred, for whatever reason: technology maturity, cost, or other. For major deferred capabilities or Family of Systems platforms, program management and engineering are challenged to plan for the development and integration of these delayed capabilities. The FCS SoS Specification Growth Annex addresses requirements associated with such deferrals.

The seven major platforms defined in the FCS ORD that have been deferred from the initial program start are listed below:

- Loitering Attack Missile (LAM)

- Intelligent Munitions System (IMS)
- Armed Robotic Vehicle – RSTA and Assault
- Unmanned Air Vehicle Class II [UAV-II]
- Unmanned Air Vehicle Class III [UAV-III]
- Unmanned Air Vehicle Class IV-b [UAV-IV-b] [UAV-IV and UAV-III combined in one platform for Increment I]
- FCS Recovery and Maintenance Vehicle [FRMV]

Overlaying all categories of spiral insertion is the basic requirements structure of the FCS ORD itself, as reflected in the FCS SoS Specification. Both documents define requirements in terms of "Threshold" and "Objective" capabilities. Threshold requirements are associated with desired operational capabilities for the first FCS Unit of Action, planned to reach FOC in 2012. Objective requirements are recognized to involve technology capabilities that may be attained more gradually in later UA deployments, up through 2020. Provision is also required for retrofit of later spirals of technology and software to previously deployed UAs.

Spiral development for Increment 1 is intended to enhance the operational capability over the initial threshold of the FCS SoS FOC fielded in 2012 over time until the follow-on increment is produced and fielded. Each spiral insertion represents what is possible to develop and build within real world constraints of cost, schedule, and technology maturity in the time frame for Increment 1 (2012 – 2020). The FCS SDD design goal is the set of capabilities defined in the Operational Requirements Document (ORD)/Capability Development Document (CDD).

5.0 CONCLUSION

The FCS system-of-systems program will develop new material solutions critical to the Army's Objective Force ability to "See First, Understand First, Act First and Finish Decisively" at the strategic, operational, and tactical levels. EA delivers capability in increments, recognizing the need for future capability improvements. The FCS program is an EA effort that will consist of a series of increments leading to realization of objective capability. The system of systems ultimate capability delivered to the Soldier will be obtained through the development of multiple increments.