

COMMAND POST OF THE FUTURE: SUCCESSFUL TRANSITION OF A SCIENCE AND TECHNOLOGY INITIATIVE TO A PROGRAM OF RECORD

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This article outlines how the Command Post of the Future (CPOF) program was successfully transitioned from the Defense Advanced Research Projects Agency (DARPA) to the U.S. Army. Use of a tailored DoD 5000 acquisition strategy allowed the new CPOF technology to be fielded as a technology insertion into the Army Battle Command System (ABCS). Key to the success of this transition included the use of risk management techniques to drive the program forward, use of early and sustained feedback from the user community, maintaining transition funding stability, and honest and open communication between all stakeholders. The DoD 5000 acquisition strategy was tailored to fix the risks over time, rather than trying to develop the perfect product in one delivery.

Keywords: *Command Post of the Future (CPOF), Battle Command, Science and Technology (S&T) Initiative, Risk Management, Tailored Process, Army Battle Command System (ABCS)*



CPOF

Command Post of the Future

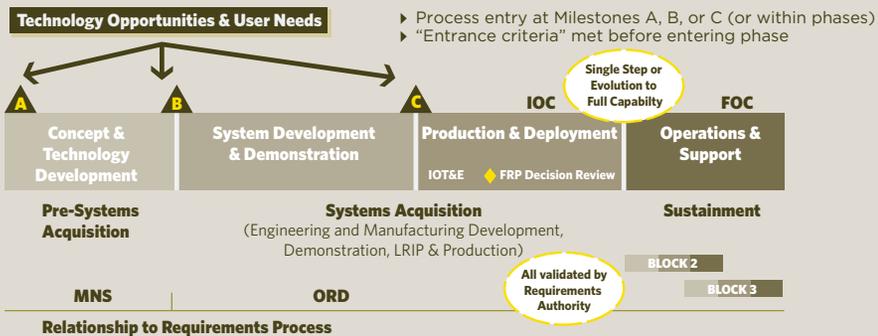


Collaboration at the thought process level.

Background

In 1999, Under Secretary of Defense for Acquisition, Technology, and Logistics Jacques Gansler tasked [then] Director, Defense Research and Engineering (DDR&E) Hans Mark to find out how many Service Science and Technology (S&T) programs make it from research into development and acquisition. This tasking was part of the under secretary's effort to develop a plan for Acquisition Reform. After conducting a comprehensive workshop, the participants determined that for all the Services only about 25 percent of all S&T programs transitioned. One of the major issues was technical maturity of the S&T results, which often caused cost growths and schedule slips while the program manager tried to fix problems during the development cycle. The result was a complete rewrite of the 5000 series (Department of Defense, 2000), as illustrated in Figure 1, which clearly shows that S&T products can be inserted throughout the entire process. The intent was to get more products transitioning from the S&T community to acquisition programs.

FIGURE 1. DEVELOPMENT AND ACQUISITION PROCESS (AS OUTLINED IN DOD 5000.2)



As part of this new process, the rewrite team recognized that technical maturity must be addressed up front. Usually, technology was not tested thoroughly; rather, it was often transferred to acquisition without knowledge of how well the technology worked or what improvements were needed to build a reliable product. In response, the minimum entrance requirement for any S&T products at Milestone (MS) B was a Technology Readiness Level (TRL) 6. The TRL 6 entrance criterion for Milestone B was chosen because it provided the government with confidence that the proposed technology would not require multiple test cycles. This requires some developmental-like testing prior to MS B, as well as some Limited User Tests (LUTs) to minimize risk.

This article outlines how the CPOF program was initiated, executed, and transitioned. By documenting our experiences, we hope to provide

the research, development, and acquisition communities an example of best practices that actually worked. Specifically, we seek to show readers how to successfully transition S&T products to create new capabilities for the Army of the future.

WHAT IS CPOF?

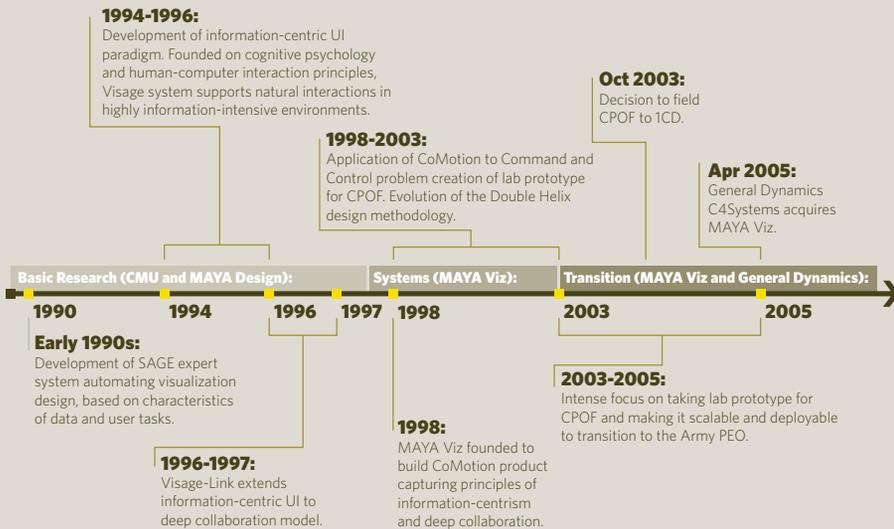
Command Post of the Future is a planning and mapping tool intended for collaboration between multiple echelons in a tactical environment (Myers et al, 2002, pp. 343–348). In 1997, the Defense Advanced Research Projects Agency (DARPA) began developing the CPOF, using a team of retired senior officers and experts in cognitive psychology, human-computer interfaces, and computer technology. The team developed the CPOF as a commander-centric software environment. CPOF is an intuitive and easy-to-learn system that supports 2D and 3D visualization that can be uniquely tailored to suit the user's individual requirements. It was specifically developed to enable distributed, collaborative, command and control, rather than simply allowing applications to share information. CPOF supports deep collaboration—collaboration at the thought process level that literally allows commanders, subordinates, and key battle staff to see what the commander is thinking.

CPOF integrates government-developed software with Commercial-Off-The-Shelf (COTS) software to provide a workspace tool containing various frames such as charts, tables, and customized appliances specific to the application. Further, it supports parallel, synchronous and asynchronous, cross-functional planning and execution; and provides for bi-directional interoperability with Army Battle Command System (ABCS) and other Department of Defense (DoD) systems.

The sharing and collaboration of intelligence and other information via voice and visualization techniques, within a distributed architecture, is also supported by CPOF. It also provides the capability to simultaneously collaborate and share data and information horizontally among operators at the same echelon and vertically between operators at other echelons in real-time. The ability to collaborate among analysts at an echelon, between echelons, and with battalions is key to achieving information dominance. And information dominance is critical to the ability of the CPOF systems to provide the warfighting commander with an enhanced local and multi-echelon situational awareness, which promotes synchronized operational planning and execution.

PROGRAM HISTORY IN DARPA

Figure 2 shows an overview of the history of the CPOF program. It started in the early 1990s as a research effort on expert systems design. Development continued under the auspices of DARPA, concentrating on the

FIGURE 2. HISTORY OF CPOF PROGRAM

design of a user interface that would be intuitive in an information-intensive environment like that found in tactical Army Command and Control.

The history of CPOF at DARPA is broken out into four very distinct phases, which were led by three different program managers; the program endured at DARPA from 1997 until it fully transitioned to the Army in 2006.

During the initial phase of the program, DARPA invested in exploring rich display technologies, artificial intelligence agents, learning technologies, and inference engines. This phase looked toward the future command post—a high tech theater where commanders would be assisted by intelligent agents in making battlefield decisions, and where holographic and high resolution displays would turn the Tactical Operations Center (TOC) of today into a command theater.

With Phase I complete, DARPA received some very specific guidance from senior officers in the Army and Marine Corps about the efforts to create a high tech command theater. During this phase, retired military advisors led technologists through a series of decision support exercises, including field exercises. The intent of this phase was to bring military operators and technologists into the same environment, creating an atmosphere where the technology and operations could co-evolve.

The CPOF interface was developed and refined during the third phase of the program. Working in conjunction with the Marine Corps Warfighting Lab and active duty units from the Army and Marine Corps, a unique development environment was created. It tightly coupled operators and technologists as they explored the possibility of radical changes in the way operators perform their jobs with new technologies.

In the fall of 2003, CPOF was introduced to [then] MG Peter W. Chiarelli, USA, commander of the 1st Cavalry Division (1CD). MG Chiarelli requested that CPOF deploy with his division to Iraq. In this phase—42 systems and servers—a team of technical and operations subject matter experts were deployed in-theater. In March of 2004, working with MG Chiarelli, the DARPA team deployed systems throughout the division headquarters and to each of the brigade headquarters. The deployment team was able to work with operators to incorporate CPOF into part of their daily battle rhythm.

With the early success of CPOF and its deployment with 1CD, an agreement was codified in a Memorandum of Agreement (MOA) between DARPA and the Department of the Army. This agreement called for continuing the deployment of CPOF to Iraq as an experiment, and furthering the experiment by fielding CPOF to two additional divisions in subsequent years. It also provided for a subsequent decision on transition of CPOF to an Army Program of Record (POR). Transition was dependent on three measures:

- The ability to scale CPOF to 200 users
- Demonstration of the use of CPOF over standard tactical communications
- Demonstration of interoperability with the ABCS.

OPERATIONAL, TECHNICAL, AND PROGRAMMATIC COLLABORATION

With the 1CD deployment into Iraq underway, a collaborative effort between DARPA and the Army began in earnest. DARPA's efforts to date had been focused on creating the most intuitive collaborative interface. Very little work had been conducted to harden the system for operations in a tactical environment. Together, a team that included a Marine Corps program manager from DARPA, soldiers from the Army's Training and Doctrine Command (TRADOC) and 1CD, and acquisition professionals from PEO C3T (Program Executive Officer, Command, Control, and Communications-Tactical) and Army G-8, worked to put in place a 2-year plan to cover operational, technical, and programmatic concerns. Senior leadership of the division took ownership of the test-fix-test process, allowing warfighters to dictate the requirements. MG Chiarelli understood the technical issues that needed to be conquered, and was willing to accept the risk to see CPOF successfully integrated into the division.

In parallel with MG Chiarelli's use of CPOF in-theater, the Army and DARPA decided to look at how best to continue CPOF development. DARPA and the Army came to an agreement, documented in the 2004 MOA. DARPA would continue to fund the advanced technology research needed to harden the system and exploit technical lessons learned. The Army would fund the operational support and hardware procurements

necessary to execute the continued fieldings. During this collaborative phase of the program, DARPA provided \$13.5 million of funding, and the Army provided \$37.5 million. DARPA would maintain primary control of the program for 2 years. The MOA also called for CPOF fieldings to three Army Divisions (Operation Iraqi Freedom 2 through 4) and technological improvements to CPOF software in the areas of scaling, satellite communications, and ABCS integration.

Some hurdles, however, needed to be overcome—none of which were insignificant in the way the acquisition community procures new systems.

- DARPA's involvement with and funding of CPOF was scheduled to end at the conclusion of the 1CD rotation in Iraq.
- CPOF was not in the Army Program Objective Memorandum for funding, nor was there an office established that would be able to take on a new program with many technical challenges still ahead.
- No approved requirement document was in place calling for a stand-alone system like CPOF.
- CPOF needed to meet the requirements imposed by the acquisition regulations and laws.
- Significant risks—namely scalability, performance, and ABCS interoperability—still needed to be reduced to enable a broader use of CPOF.
- CPOF had minimal capability to interoperate with other Army and Joint systems.

To tackle these hurdles and maintain the momentum of the CPOF program, the PEO C3T and DARPA joined forces.

The Army Acquisition Executive (AAE) assigned CPOF management authority to PEO C3T, and directed that the designated program management office enter into an agreement with DARPA to support the transition of CPOF technology to the Army. PEO C3T gave responsibility for CPOF to PM Battle Command. In October 2004, the Army opened a small program office for CPOF.

The 2 years' leadership overlap, from 2004 to 2006, between DARPA and the Army allowed time for relationships to develop, for technology transfer to occur, and for the acquisition steps necessary for an Army POR to be developed and approved. The Army PM shop integrated CPOF requirements into the Maneuver Control System (MCS) Capabilities Production Document (CPD), wrote a Test and Evaluation Master Plan (TEMP), and obtained the necessary Army and Joint approvals necessary to field and sustain a POR.

Formal transition of CPOF to the Army occurred in April 2006, and is documented in PEO C3T's CPOF Decision Point 1 (DP1) Acquisition Decision Memorandum (ADM).

Ongoing Development

MODELING AND SIMULATION

CPOF developers relied on modeling and simulation as well as heavy experimentation to quickly grow CPOF into a successful theater-wide system. CPOF had three major technical challenges to overcome in the near term: scalability, system stability, and ABCS interoperability. To meet these challenges, new technologies and data management strategies were modeled for their impact on the architecture. For example, a mid-tier server concept was introduced to ease the bandwidth utilization over tactical networks. Through modeling and experimentation, CPOF was able to demonstrate significant bandwidth reduction.

The first step in any effort to develop software is to get consensus from the user community, including the direct users, on a concise set of requirements. Often this can be difficult, but since CPOF was fielded to select users as a commander's tool in 2004, direct user feedback was readily available. The user and Field Support Representative (FSR) feedback was the primary source used to define and refine the requirements. Each time a new capability was added, it was evaluated and feedback was again given by the end-users and the FSRs. This constant feedback loop provided gradually increased capability by allowing the software developers to focus directly on the issues identified by the users. It produced a higher quality, more useful end product in a very short period of time.

The use of experimentation reduces program risk by continually testing out new functionality and incorporating real-world feedback. Resources are not applied against a capability—either hardware or software—until the users and support people concur that it is worth the cost and additional risk.

SPIRAL DEVELOPMENT

The employment of end-user and FSR feedback in an “experimentation” mode allowed a tighter or faster spiral development process to occur (vice the traditional software waterfall development). Following is a description of the key capabilities of the first two major spirals in the CPOF development, each about a year apart.

CPOF version 2.4 was the version resulting from the spiral development that was occurring in-theater. Some characteristics of this version are:

- Operates with latency of up to 1400 ms
- Bandwidth use up to 18–28 Mbps during peak usage to support a division fielding

At this point CPOF had met the Army criteria for transition from DARPA to the Army in the April 2004 MOA. In parallel with the DARPA-sponsored spiral development work in-theater, the Army program office developed an acquisition strategy to transition the program into a POR.

DEVELOPMENT OF THE BATTLE COMMAND VISION FOR THE FUTURE

The Battle Command Migration Plan was developed and refined to map out the development, fielding, and finally, retirement path for ABCS for the near- and long-term future. It was developed in the context of the current Army environment—the Army at war in Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF), the need for increased Joint interoperability, and Future Combat Systems/Net-Enabled Command Capability (FCS/NECC) schedules. The plan took into account the need for technology insertions due to the rapidly changing available commercial products, and the need to upgrade existing software to better use the technologies that are available. The goals of the Battle Command Migration Plan included lowering life cycle cost by moving to a smaller footprint; making the systems easier to use, train, and configure; and fielding a single standard capacity to every unit that provides the basis for their unique tailoring needs.

CPOF was one of the first technology insertions into the existing ABCS 6.4 System of Systems. The Battle Command vision is to leverage the CPOF technology, including its collaboration services and graphical user interface, as a front end for all Battle Command applications/users and possible transformation into the single visualization system for Battle Command. Key development tasks are planned to enable this, including:

- Defining an open set of Application Program Interfaces (APIs) and a Third Party Development Kit (3PDK) to enable multiple vendors to build CPOF-enabled modules for specialized Battle Command functionality
- Leveraging DoD standard mapping services, such as the Commercial/Joint Mapping Tool Kit (C/JMTK), to provide a richer set of mapping capabilities, including common symbology and maps
- Leveraging common Active Directory services for common user management and authentication across CPOF and the Battle Command infrastructure
- Leveraging a future PEO-provided Tactical Enterprise Voice Over Internet Protocol (VOIP) solution; Warfighter Information Network-Tactical (WIN-T) is the targeted POR to provide this capability.

One of the key ideas in this vision is leveraging the capability in CPOF to which the soldiers in the field consistently give high marks—ease of use and ease of training. This common platform provides a consistent map and set of graphics, greatly enhancing interoperability.

Reducing Risk

All of the above—the experimentation in-theater, spiral development, and development of the vision for the future—was done in parallel. The goal of all of this was to get the fullest capability to the soldier rapidly, while laying the groundwork for future development—all while reducing program risk.

RISK MANAGEMENT

Risk management was one of the major project management tools for CPOF development, test, and fielding. The CPOF effort is continuously evaluated to determine exposure to risk and how to best handle such exposure. Specifically, the risk management aspect of the CPOF aims to allow CPOF to be fielded to the user community with as many risks identified, mitigated, or categorized as acceptable, as possible (Thomas & Cook, 2005).

The Product Manager, Tactical Battle Command (responsible for CPOF), and the contracted development team are both responsible for performing risk management activities. The contractor is responsible for assigning appropriate parties and/or organizations for enforcing and performing risk management activities.

An example of a risk matrix is shown in Figure 4. It identifies risks, categorizes them, and suggests possible mitigation. One of the things that makes this management tool so effective is that the risks and possible mitigation paths are publicly discussed. In this way, the entire community comes to a similar understanding of the capabilities and limitations of the product. The acquisition strategy was directly tied to the risk analysis. The events and decisions were based on the identified risks. Major risk areas identified were:

- Scalability
- Interoperability
- Supportability
- Full-Spectrum Operations
- Architecture

Development efforts were designed to address these major risk areas.

FIGURE 4. RISK MATRIX

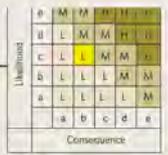
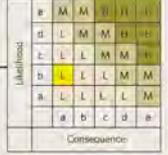
Category	Risk (RIN)	Mitigation (Handling)	Metric (Monitoring)	Risk Status	Risk Assessment
Supportability (Low/Moderate)	<p>FSR Support</p> <ul style="list-style-type: none"> Ability to support full Army fielding IAW PM Support concept (multifunctional FSRs) Stovepipe support structure Incorporation of FSR Experience into Design Process Downsizing of FSR Personnel 	<p>Simplify/Stabilize SW</p> <p>Automate maintenance function</p> <p>Cross-functional FSRs across BC</p> <p>Dev existing BC support base for CPOF</p> <p>Integrate into the Army Support Structure</p>	<p>FSR/Unit (DIV/BDE/BN, etc)</p> <p>Data Integration for Reporting and Reuse</p>	<p>The System of System (SoS) Migration Plan Implementation and the mandated FSR reduction requirement for FY08 drives this risk.</p>	
	<p>Software Supportability/Efficiency</p> <ul style="list-style-type: none"> Ability for CPOF software to aid in and provide a Stable CPOF Network Ability for CPOF to be upgraded and fixed as needed, on the fly and from a remote location. SW Documentation CM Processes Garbage Collection 64 Bit Backup Processes 	<p>Deploying 'SuperTech' developer to theater</p> <p>Implementation of Development Crisis Team</p> <p>Develop remote admin and distribution capabilities</p>	<p>Computer Resource Utilization/Available SW Quality Level</p> <p>Used Standards Metric</p> <p>Reliability (Fault Tolerance, recoverability)</p> <p>Maintainability (Stability, changeability)</p> <p>Operational Ability (Ao)</p>	<p>Current development tasks are designed to increase the ability of the baseline 3.0.2 Software to aid in the supportability area. Development remains on track but the technical difficulty of implementation drives this risk to be moderate.</p>	
	<p>Hardware Support & Acquisition Processes</p> <ul style="list-style-type: none"> Hardware Availability and Lead Time to support on-going ops End of Life Maintain multiple configurations 	<p>Buffer Supply of hardware to deploy as needed</p> <p>Leave behind hardware in Theater for next units to fall in on</p> <p>Use Spares to fill in gaps until hardware arrives</p> <p>UID</p> <p>CM Process, Documentation and Enforcement</p>	<p>Estimated vs. Actual Delivery Times</p> <p>Maintenance Downtime</p> <p>Repair Cycle Time</p> <p>Parts Availability</p>	<p>Contact is in place for the acquisition of hardware and support. The implementation of a Configuration Management process will be in place by FY07 thus helping reduce the risk.</p>	
	<p>Training</p> <ul style="list-style-type: none"> Training structures integrated into mainstream Battle Command Support Structures 	<p>Inclusion of an embedded trainer.</p> <p>Training and Support package for NET, TRADOC and Sustainment</p>	<p>Actual vs. Planned # of personnel attending</p> <p>Training Systems Available</p> <p>Student Proficiency /Skill Level</p> <p>Training Level vs. Proficiency</p>	<p>Logistics Products are currently being developed to improve current training and to meet the First Unit Equipped Date (FUED).</p>	
Technical (Moderate)	<ul style="list-style-type: none"> Incompatible Versions of Fielded Software Bug Fixes and Patch Upgrades Inadequate Evaluation of SW 	<p>Implementation of Multiple CPOF Networks</p> <p>PASS to Exchange Information</p> <p>Field New Units CONUS</p> <p>Evaluate and Determine Criticality of Bug Fixes and Patches. If possible Roll Up to decrease system upgrade times.</p> <p>Remote Admin push of small critical updates</p>	<p># and Version Type of CPOF Networks</p> <p># of Total SW Bugs vs. # Critical SW Bugs</p> <p>Percentage of Total Critical Bugs Fixed</p>	<p>Currently, Bugs are identified, evaluated and rolled up into fixes and patches based on prime 's processes. New implementation calls for GOV approval and structuring of Patches, Fixes and Smaller Releases to allow for identification of critical elements and establishment of acceptable timeframes.</p>	
	<p>Current Software Limitations</p> <ul style="list-style-type: none"> No Full spectrum Ops No Ruggedization Limited Interoperability Theater Requested Enhancements Marine Requested Enhancements 	<p>Expectation Management</p> <p>Customer Awareness</p> <p>Evaluate and Implement Important Theater/ Marine Requests using out Quick Reaction Theater Development Support and Prime SW Development Team</p>	<p># Theater/Marine Requests Outstanding</p> <p>Average Implementation Time of Theater/Marine Requests</p>	<p>Currently CPOF Block 2 Requirements do not provide complete Full Spectrum Capability to the Warfighter. Currently effective customer management by PO and FSR Personnel help to give Customers an understanding of when capability will become available. Most new requirements are processed and approved by the TSM.</p>	

FIGURE 4. RISK MATRIX

Category	Risk (RMI)	Mitigation (Remedy)	Metric (Monitoring)	Risk Status	Risk Assessment
Support/Service (Low/Medium)	<p>Field Support</p> <ul style="list-style-type: none"> Ability to support full Army Fielding Mission Support (ongoing functional) Ability to support support structure Integration of S&T Experience into Design Process Completion of F&A Processes 	<p>Develop/Validate Dev</p> <ul style="list-style-type: none"> Automate maintenance function Class functional F&A across BC Dev existing BC support base to CPOF Integrate into the Army Support Structure 	<p>Risk Area (CV/Function) and Data Integration for Reporting and Baseline</p>	<p>The System of System (SoS) Migration Plan implementation and the maturation F&A reduction equipment for CPOF across the risk.</p>	
	<p>Software Supportability/Efficiency</p> <ul style="list-style-type: none"> Ability for CPOF software to add in and provide a robust CPOF network Ability for CPOF to be upgraded and fixed as needed, on the fly and from a remote location SW Documentation CM Processes Change Control Set SW Backup Processes 	<p>Developing Swat Test/ Developer to theater implementation of Development Crisis Team</p> <ul style="list-style-type: none"> Develop remote action and distribution capabilities 	<p>Computer Resource Utilization/Available SW Quality Level</p> <ul style="list-style-type: none"> Used Standards Metric Responsibility (Fault Tolerance, recoverability) Responsibility (Security, Cybersecurity, Downside Ability (AI)) 	<p>Current development tasks are designed to increase the ability of the baseline S&T software to add in the supporting area. Development teams are tracking the technical difficulty of implementation given the need to be resolved.</p>	
Hardware Support & Acquisition Processes	<ul style="list-style-type: none"> Hardware Availability and Lead Time to support ongoing ops Test of LRU Meet the multiple configurations 	<p>Buffer Supply of hardware to theater as needed</p> <ul style="list-style-type: none"> Lead Supply hardware to theater for test with no fill in on Use Spares to fill in gaps until hardware arrives LRU 	<p>Estimated vs. Actual Delivery Times</p> <ul style="list-style-type: none"> Maintenance Downtime Reactor Cycle Time Parts Availability 	<p>Contact is in place for the acquisition of hardware and support. The implementation of a Configuration Management process will be in place by FY07 thus helping reduce the risk.</p>	
	<p>Training</p> <ul style="list-style-type: none"> Training structures integrated into subsystem Battle Command Support Structure 	<p>CM Plans, Documentation and Deliverables</p>	<p>Actual vs. Planned # of personnel obtaining Training Systems Available</p> <ul style="list-style-type: none"> Student Proficiency (Skill Level) Training Lead vs. Proficiency 	<p>Logistics Products are currently being developed by Interservice support training and to meet the First Unit Deployed Case (FURD)</p>	
Technical (Medium)	<ul style="list-style-type: none"> Interoperable versions of Fielded Software Bug Fixes and Patch Approaches Redundant Evaluation of RFP 	<p>Implementation of Multiple CPOF Networks</p> <ul style="list-style-type: none"> Rolls to Exchange Information Field New Units CONUS Testable and Determine Criticality of Bug Fixes and Patches Response Roll out to decrease system upgrade times Remote Admin crash of small critical update 	<p># and Version Type of CPOF Networks</p> <ul style="list-style-type: none"> # of Total SW Bugs vs. # Critical SW Bugs Percentage of Total Critical Bugs Fixed 	<p>Current bugs are identified, evaluated and enter into the fix and patch process. New implementation calls for SWC approval and structuring of patches, Plans and Release Releases to allow for identification of critical patches and reestablishment of accessibility compliance.</p>	
	<p>System Software Limitations</p> <ul style="list-style-type: none"> No Full spectrum Ops No Interoperability Control Interoperability Theater Interoperability Marine Requested Enhancements 	<p>Expectation Management</p> <ul style="list-style-type: none"> Customer Assessment Equipable and implement important Theater Marine Requests using our Quick Reaction Theater Development Support and Prime SW Development Team 	<p># Theater/Marine Requests Outstanding</p> <ul style="list-style-type: none"> Average Implementation Time of Theater/Marine Requests 	<p>Current CPOF Block-2 Requirements do not provide complete Full Spectrum Capability to the Warfighter. Current effective customer management by F&A and F&A Response Step in open Customers in understanding of when capability will become available. Most new requirements are processed and approved by the TSM.</p>	

Specific tasks to address these risks have been developed and crosswalked with the TRADOC Capabilities Manager (TCM)-developed requirement. Then these requirements are balanced with the expected resource availability to develop the build plan.

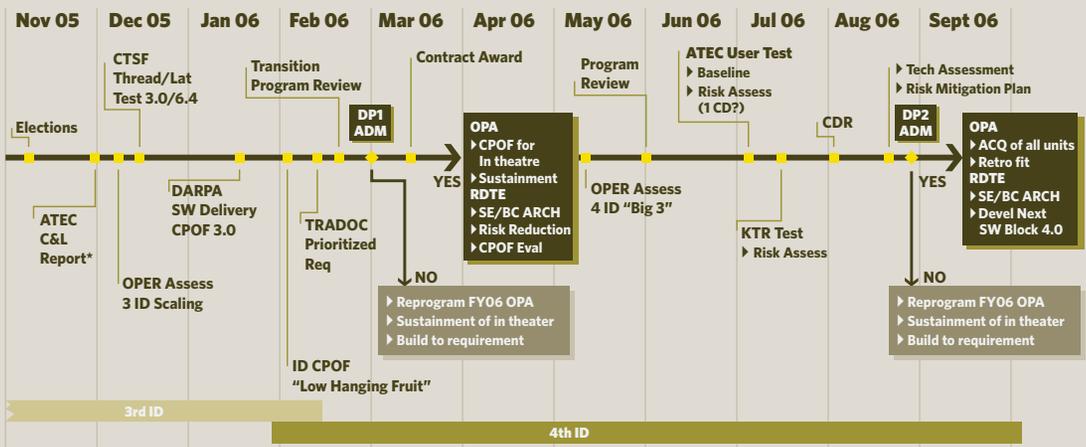
Risk assessments were done in parallel with the early DARPA development. It was clear that CPOF, while providing needed capability in-theater, needed work to become “productized.” Risks to the program—technical and programmatic—were identified. Then mitigation plans were developed openly for each risk. This in-theater feedback loop—shortfalls identified, fed back into the risk plan, mitigated, and fixes sent back in-theater—allowed incrementally better product to get into the soldiers’ hands quickly.

TAILORING ACQUISITION STRATEGY TO ACCEPT THE NEW TECHNOLOGY USING A SPIRAL PROCESS

The standard DoD 5000 acquisition strategy was tailored specifically to allow the new CPOF technology to make it to the field sooner rather than later. It was also tailored so that CPOF could be incorporated as a technology insertion into the ABCS System of Systems.

The acquisition strategy was specifically designed around mitigating risks. An honest risk assessment was the first step—do the analysis of CPOF’s shortfalls and put mitigation plans in place for each identified risk. The development tasks fell out of the mitigation plans. For example, one risk was scalability in-theater; i.e., moving from 200 users to more than 1,000 users. The mitigation plan noted that the server architecture

FIGURE 5. ACQUISITION DECISION FLOW CHART



*Based on 4th Infantry Division Mission Rehearsal Exercise (MRX) (29 Jul-4 Aug), 1st Brigade Combat Team National Training Center Rotation (6 Sep-4 Oct) (and the 3rd Infantry Division Full Operational Assessment III in-theater—Tentative)

would not support that many clients (users). The redesign of the server architecture to add mid-tier servers was a key development task. The strategy was developed to fix the risks over time, rather than trying to develop the perfect product in one delivery.

The Acquisition Decision Flow Chart is shown in Figure 5. It shows two decision points (DP) where leadership had the opportunity to review the progress of the program and to decide if the program was ready to move forward as planned. Each of these decision points was linked to an event that could be used to demonstrate whether or not CPOF was ready to move ahead. These decision points enabled the leadership to evaluate program risk to determine the best path forward.

The acquisition strategy included two key decision points as shown in Figure 5. These were selected in advance at junctures in the program where go/no go-type decisions could be made. These decision points were not selected based on schedules, but rather on whether the program was capable of proceeding to the next step in the acquisition process, i.e., they demonstrated readiness for transfer and reduction of risk. Decision Point 1 (DP1) was held to determine if CPOF had met the transition goals for the Army to accept the technology from DARPA. DP2 was a Milestone C-like event to determine if CPOF was capable of being fielded as part of the software block to the entire Army. For Decision Point 2 (DP2), a brief was given to the community, including the General Officer (GO) leadership, showing that CPOF had the capability, certifications, documentation, and sustainment capability to support the decision for fielding.

The CPOF Addendum to the MCS Acquisition Strategy was signed by MG Michael R. Mazzucchi, USA (Ret.), in July 2005.

- CPOF is a technology insertion into MCS, which was in full rate production.
- To ensure that DARPA met the conditions of the Army-DARPA MOA and that CPOF was performing satisfactorily in unit operations, the Army conducted a Level I Development Test (DT) event and a series of Level II Operational Assessments of CPOF in fielded units. These assessments provided data for informed decisions at DP1 and DP2, respectively.
- DP1 was conducted in March 2006, and documented in the PEO C3T DP1 ADM dated April 2006. The purpose of this decision point was to accept transition from DARPA and approve Research, Development, Test, & Evaluation (RDT&E) funding to reduce risk and baseline/assess the CPOF system; and to approve Other Procurement, Army (OPA) funding to support theater and continental United States fielded units. DP2 included a CPOF Block II Milestone C to determine whether the current block of software/

hardware was suitable for fielding in accordance with the ABCS 6.4 schedule. DP2 also included CPOF Block III Milestone B to authorize research, development, and test activities for continued CPOF development.

- The CPOF acquisition strategy reflected the use of innovative solutions and utilized best practices in the following aspects:
 - Extensive use of integrated government-developed software and COTS software
 - Streamlined acquisition processes wherever appropriate
- Capability is to be provided incrementally, putting the best of 80 percent solution into the field quickly.
- Contracting Strategy
 - Software—Software development, software maintenance, fielding support, field service support, training, and documentation were procured via a 5-year sole source (i.e., a 1-year basic plus four 1-year options) basic ordering agreement with the software developer. Upon attaining a successful DP2, task orders were awarded on an annual basis as required to support additional fielding of the baseline CPOF product and related activities.
 - Hardware—Hardware and peripherals to support CPOF fieldings were procured via award of task orders on a competitively awarded hardware ordering contract. Hardware procurement included a 5-year warranty for all items.

Design and Program Reviews were also scheduled at regular intervals. These gave the leadership and the rest of the community an opportunity to evaluate CPOF. This helped ensure that CPOF development stayed in sync with the rest of the Army programs, and that the program risk was within acceptable limits. The acquisition plan also specified design reviews. These reviews were publicly held and covered technical, programmatic, and funding issues. They were intended to engage the community. Again, the philosophy is that the more that is known about a system's capabilities and limitations, the better the focus that can be brought to solve issues. This allows a more capable, useful system to make it to the field.

Lessons Learned: Best Practices for a Successful Transition

Inserting a new technology into an existing System of Systems is not a straightforward or easy task, but some key lessons were learned during the CPOF transition.

LEADERSHIP

Leadership of both the technology provider and the receiver must be fully engaged and supportive. The MOA helped ease the transition by providing a 2-year window, along with adequate funding, for the DARPA and Army teams to collaborate on how best to grow CPOF into a fielded system used by soldiers every day.

VISION

A vision, both near-term and long-term, greatly helps in both acquisition and technical issues. The vision to use CPOF as the common platform for collaborative services has stretched the original system to fill gaps left by the other ABCS system of systems. The vision provides the framework for breaking large strategic goals into smaller, more executable ones. It also helps prioritize efforts.

EXPERIMENTATION

Experimentation is needed in developing a successful product. Exposing ideas to actual (vs. laboratory) conditions changes the way designers and developers view the system. Many improvements to CPOF were made because the system was deployed in-theater so early in its development cycle. Even after CPOF was integrated into the ABCS system of systems and had scaled to over 5,000 systems, experimentation continues. A concerted effort is underway to continually solicit and incorporate all user feedback into the system to make it relevant to the current fight. Experimentation must involve the user up front and early with a tight feedback loop with the developer.

EVENT-DRIVEN PROCESS

The spiral process used to insert CPOF into the ABCS POR was a tailored DoD 5000 process. It was event-driven, using regular, scheduled decision points to proceed. At each, the system was honestly evaluated to determine progress and to steer towards the optimal path forward.

MANAGING CHANGE

Any new system or technology will require changes or adjustments once exposed to real-world conditions. CPOF, in the years that it has been in the field, has changed significantly. It has been scaled up from just a handful of systems and now interfaces directly into ABCS. CPOF is an official part of the LandWarNet (LWN)/G3 software baselines that are fielded to Army. This has only been possible because all parties have embraced the new technology and worked hard to incorporate it and tailor it to best advantage. Accepting and managing the change have made this possible!

COMMUNITY RISKS

Most importantly, communicating risks and issues in an open, honest way helped manage expectations of soldiers, leadership, and technologists. Regular risk assessment and mitigation discussions at all levels helped focus resources where they were needed most. For example, one early technical risk was the concern about how the CPOF network would scale in-theater. The mitigation for this risk, which was actually executed, was to incrementally grow the network in-theater. This was successful and allowed the users and technical support to address smaller issues as they occurred.

Conclusions

The transition of CPOF from DARPA to the U.S. Army was successful for a number of reasons. Tailoring the DoD 5000 acquisition strategy allowed new CPOF technology to be fielded as a technology insertion into the ABCS. The keys to this successful transition can be linked to the efficient use of risk management techniques to drive the program forward, use of early and sustained feedback from the user community, maintaining transition funding stability, and honest and open communication between all stakeholders.

ACKNOWLEDGMENTS

The authors would like to thank LTC Richard Hornstein, USA, Product Manager, Tactical Battle Command, and his team for answering many questions and helping ensure the accuracy of the information. They would also like to thank Ms. Sheri Silverstein for assisting with the research.

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APPENDIX

List of Abbreviations and Acronyms

1CD	First Cavalry Division
3PDK	Third Party Development Kit
4ID	Fourth Infantry Division
AAE	Army Acquisition Executive
ABCS	Army Battle Command Systems
ACQ	Acquisition
ADM	Acquisition Decision Memorandum
API	Application Program Interface
BC	Battle Command
BCTC	Battle Command Training Center
BDE	Brigade
BN	Battalion
C2PC	Command and Control Personal Computer
C&L	Capabilities and Limitations
CDR	Commander
CHS	Common Hardware Systems
CGSC	Command and General Staff College
C/JMTK	Commercial/Joint Mapping Tool Kit
CM	Configuration Management
COTS	Commercial Off-the-Shelf
CPD	Capabilities Production Document
CPOF	Command Post of the Future
CTSF	Central Technical Support Facility
DARPA	Defense Advanced Research Projects Agency
DDR&E	Director, Defense Research and Engineering
Devel	Develop
DIV	Division
DoD	Department of Defense
DP	Decision Point
FCS	Future Combat Systems
Fldg	Fielding
FOC	Financial Operational Capability
FSR	Field Support Representative
GO	General Officer
Interop	Interoperability
IOC	Initial Operational Capability
IOT&E	Initial Operational Test and Evaluation
JROC	Joint Requirements Oversight Council
KTR	Contractor
Lat	Lateral

LRIP	Low Rate Initial Production
LUT	Limited User Test
LWN	LandWarNet
MCS	Maneuver Control System
MFE	Material Fielding Exception
MNC-I	Multi National Corps Iraq
MND	Multi National Division
MNS	Mission Needs Statement
MOA	Memorandum of Agreement
MS	Milestone
NECC	Net-Enabled Command Capability
NET	Network
NOSC	Naval Ocean Systems Center (Navy Laboratory)
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OPA	Other Procurement, Army
OPER	Operational
ORD	Operational Requirements Document
PASS	Publish and Subscribe System
PdM TBC	Product Manager, Tactical Battle Command
PEO C3T	Program Executive Officer, Command, Control, and Communications—Tactical
PO	Program Office
POR	Program of Record
QR1	Quarterly Release 1
RDT&E	Research, Development, Test, and Evaluation
Rel	Released
Repos	Repository
RIN	Risk Identification
S&T	Science and Technology
SE/BC ARCH	Systems Engineering/Battle Command Architecture
SoS	System of Systems
SW	Software
TBC (MCS) CPD	Tactical Battle Command (Maneuver Control System) Capabilities Production Document
TEMP	Test and Evaluation Master Plan
TRADOC	Training and Doctrine Command
UID	Unique Identifier
TRL	Technology Readiness Level
TSM	TRADOC Systems Manager
USMC	United States Marine Corps
Ver	Version

