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ARMY TACTICAL COMMAND AND CONTROL SYSTEM (ATCCS) COST BENEFIT ANALYSIS

FINAL REPORT

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The Army Tactical Command and Control System (ATCCS) Cost Benefit Analysis (CBA) is a three-part study: benefit analysis, cost analysis, and a cost/benefit comparison analysis. The ATCCS CBA is required to determine the extent to which an ATCCS Common Hardware and Software (CHS) strategy is implementable, as well as associated costs and benefits. The ATCCS CBA is required to support a Designated Acquisition Program (DAP) Milestone III procurement decision for ATCCS CHS.

The cost/benefit analysis was designed to determine and compare various ATCCS automation alternatives, determine relative costs and benefits, and determine a relative ranking based on a comparison of the costs and benefits.

Results of the ATCCS CBA are based on system descriptions, the Army Command and Control Master Plan, the ATCCS Family Requirements and Operational Capability Document, Battlefield

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COST BENEFIT ANALYSIS (CBA)

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The Army Tactical Command and Control System (ATCCS) Cost Benefit Analysis (CBA) is composed of three parts: A Cost Benefit Analysis Executive Summary, a Benefit Analysis (Annex A), and a Cost Analysis (Annex B).

This abbreviated analysis was directed by the U.S. Army Training and Doctrine Command, Fort Monroe, VA and completed by the U.S. Army Combined Arms Combat Developments Activity, Fort Leavenworth, KS with technical and analytical support provided by TRADOC Analysis Command, Fort Leavenworth, KS and TRADOC Analysis Command, White Sands Missile Range, NM. Cost data to support the cost analysis was provided by the U.S. Army Communications Electronics Command, Fort Monmouth, NJ.

This CBA concluded that the alternative which provides an ATCCS at the lowest cost and risk with the greatest confidence of success on the high intensity battlefield is the procurement of common hardware and software (CHS) for the total force.

This abbreviated analysis was reviewed and approved by the ATCCS Study Advisory Group (SAG), certified by TRAC-FLVN and approved by Commander, Combined Arms Center and Fort Leavenworth.

COST BENEFIT ANALYSIS

MAIN REPORT

1. Introduction. In January 1987, the Command, Control, Communications, and Intelligence (C3I) Directorate of the Combined Arms Combat Developments Activity (CACDA) was tasked to conduct an abbreviated analysis (AA) of the Army Tactical Command and Control system (ATCCS) common hardware and software (CHS). The analysis was required "to determine the extent to which a common computer strategy is implementable, and to determine the associated costs and benefits". The AA is required to support a Designated Acquisition Program (DAP) Milestone III procurement decision for ATCCS CHS.

2. Background.

a. The Army requires an integrated family of interoperable computer systems which supports commanders at the tactical levels in commanding and controlling their forces and which assists the staff in controlling their functions in support of the commander. Several alternatives exist to obtain this integrated family of interoperable systems, one of which is the fielding of Common Hardware/Software (CHS) across the ATCCS. Under the CHS alternative, common hardware (HW) would be fielded to each of the Battlefield Functional Areas (BFA) except I/EW. Common software would be used at each of the BFA for force level command and control (C2) (command and staff information). Functional area unique software (SW) would be ported (modification of functional area software in such a manner that it is compatible with the operating system software) to the common hardware to perform BFA C2 and technical functions. This alternative intuitively has some advantages over the fielding of numerous types of computers; however, the concern of some of the BFA proponents has been that common components may not meet all BFA functional requirements. The costs associated with a common system were also questioned. The belief was that the cost of a common system incorporating all BFA requirements would be significantly lower than the second alternative: unique hardware/ software systems designed to meet unique requirements and to interoperate with one another.

3. Objectives. The analysis documented in this report was performed to:

a. To define the ATCCS automation alternatives.

b. To quantify Battlefield Functional Area (BFA) and force level (FL) Hardware requirements. (Hardware alternatives will be in terms of: hand-held, portable, and transportable; in commercial and ruggedized versions).

c. To determine the advantages and disadvantages of each of the ATCCS automation alternatives.

d. To determine comparative life cycle cost for the alternatives.

e. To quantity, to the greatest extent possible, the advantages and disadvantages of each alternative.

f. To compare the alternatives.

g. To draw conclusions and make a recommendation concerning which automation alternative is preferred in terms of costs and benefits.

4. Assumptions. Assumptions are listed in paragraph 4 of the Benefit Analysis, and paragraph 5 of the Cost Analysis. For conciseness of the summary they are not repeated here.

5. Guidance.

a. The Department of the Army Assistant Deputy Chief of Staff for Operations and Plans, Force Development in correspondence approving the Required Operational Capability (ROC) for the Family of Army Tactical Command and Control Systems (ATCCS) dated 8 December 1987, directed that a Cost and Operational Effectiveness Analysis (COEA) be forwarded to Headquarters, Department of the Army by February 1987.

b. Commander TRADOC, by message 022045Z Jan 87, Subject: Army Tactical Command and Control System (ATCCS) Common Hardware/Software, directed CACDA to conduct an abbreviated COEA and that the analysis would, as a minimum, include two alternatives. One required alternative would retain unique BFA systems and provide necessary software to support command and control; the other required alternative would field ATCCS common hardware/software with added BFA unique software.

c. Verbal guidance from the Under Secretary of the Army (USofA), 24 February 1987, Request for Proposal, Common Hardware/Software Briefing, stated that the intent was to get automation to the field quickly.

d. During an August 1987 visit to Fort Leavenworth, USofA also directed consideration of an alternative in which earlier fielded MCS hardware would not be refurbished but instead be replaced with additional quantities of new common hardware.

6. Alternatives. ATCCS automation alternatives were developed and approved by the Study Advisory Group (SAG). Figure 1 diagrams each objective system and each interim system. An alternative includes both the interim and the objective system. The SAG approved five alternatives numbered: 1, 2, 3T/P, 3T, and 4 in the figure. Three alternatives are based on the establishment of the Initial Force Level Control System (IFLCS) using the Tactical Computer Terminal (TCT) and the Tactical Computer Processor/Analyst Console (TCP/AC); the remaining two rely on a

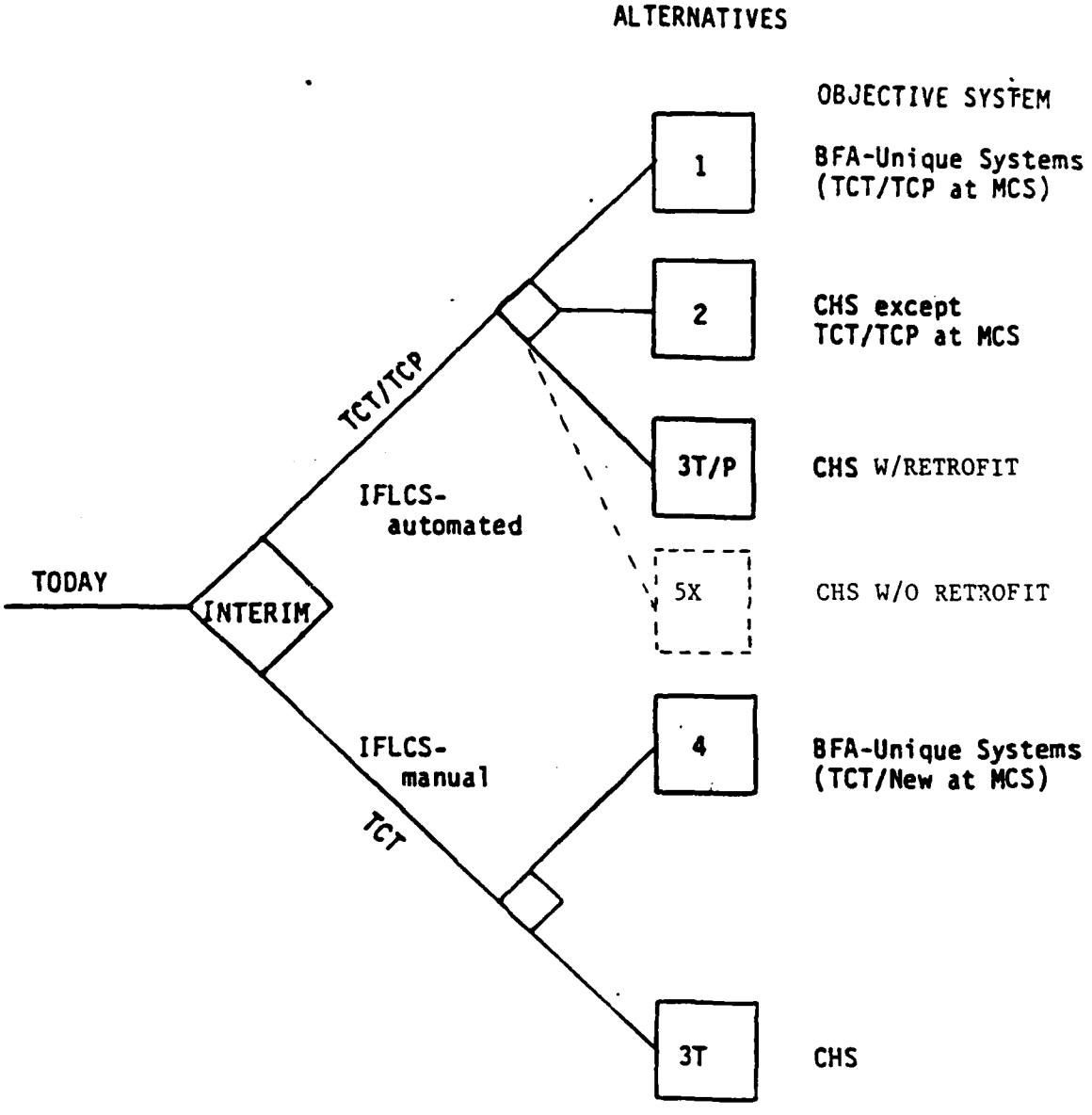

Figure 1. ATCCS automation alternatives

later solution for the Force Level Control System (FLCS). In September 1987 Alternative four was eliminated from further consideration by the SAG chairman on the basis that PM OPTADS indicated that the hardware he would select would necessarily be the TCP/AC which makes this identical to alternative 1.

a. Interim systems descriptions.

(1) Interim T/P. Under interim system T/P, the TCT and the TCP/AC are fielded to all major BFA HQ within active component divisions to establish an automated IFLCS capability. This is in fact the program to which the Army has become committed with the letting of the contract to buy MCS NDI (TCP/AC). When the study was initiated, however, this was not an established fact and hence alternatives were developed both with and without the TCP/AC. The interim system based on the TCT/TCP configuration will be established as follows:

(a) Force-level (FL). The Maneuver Control System (MCS) TCT and TCP/AC will provide the HW/SW system for the management of all FL (command and staff at an echelon) information across all BFAs.

(b) BFA. Existing BFA-unique systems (usually manual) will be used for the management of all BFA technical and staff information.

(c) Interface. A manual interface will be used to transfer information between the FL system and the BFA-unique system and vice-versa.

(d) Objective systems. The objective systems possible after interim T/P are alternatives 1, 2, 3T/P, and 5X (to be discussed below).

(2) Interim T. Under interim system T, only the TCT would be available to active component divisions. This alternative became overtaken by events in July 1987 when the contract was let to purchase TCP/AC equipment for MCS. The interim system based on the TCT configuration would be established as follows.

(a) FL. TCT would provide only minimal maneuver (vertical and lateral) automated information flows. The critical horizontal automated information flow to synchronize the BFAs will not be available.

(b) BFA. Existing BFA-unique automated and manual systems would be used for the management of all BFA technical and staff information. TCT will be used for the management of selected maneuver staff and technical information.

(c) Interface. Not applicable.

(d) Objective systems. The objective systems possible after interim T are alternatives 3T and 4 (to be discussed below).

b. Objective systems description. Below is a short description of each objective alternative. A complete description can be found beginning on page 10, paragraph (2) of the Benefit Analysis (Annex A).

(1) Alternative 1 Objective System. Each Battlefield Functional Area (BFA) would use uniquely developed hardware with the Maneuver BFA using the Tactical Computer Terminal/TActical Computer Processor (TCT/TCP). The Maneuver BFA software would be converted to operate on all unique BFA hardware in order to provide an automated FLCS.

(2) Alternative 2 Objective System. The Fire Support (FS), Air Defense (AD) and Combat Service Support (CSS) BFA's would field the Common Hardware and Software (CHS); The Maneuver Control BFA would use the already purchased TCT/TCP and port its software to the CHS to provide an automated FLCS.

(3) Alternative 3T/P Objective System. All four BFAs (e.g., FS, AD, MC, CSS) would field CHS in the Active Component with the residual TCP/AC refurbished and fielded to the Reserve Component.

(4) Alternative 3T Objective System. All four BFAs receive CHS with TCP/AC never having been fielded. Once the TCP/AC production contract was let, this alternative became infeasible.

(5) Alternative 4 Objective System. All four BFAs use unique systems with TCP/AC never having been fielded. Once the TCP/AC production contract was let, this alternative became infeasible.

(6) Alternative 5x Objective System. CHS is used for all four BFAs in both AC and RC. (Note: This is the same as alternative 3T/P except that TCP/AC are not refurbished for issue to the RC).

7. Battlefield Functional Area (BFA) and Force Level (FL) Hardware Requirements. Table 1 depicts the BFA hardware requirements.

	HTU	TCP/AC	PCU V1	PCU V2	TCU V1	TCU V2
MC	---	567/1079	889	1457	304	303
FA	3255	---	190	2715	97	518
ADA	2094	---	---	85	---	172
IEW	---	---	---	---	---	---
CSS	---	---	1191	---	---	---

Table 1. Battlefield Functional Area (BFA) and Force Level Hardware Requirements.

8. Decision Criteria. Decision criteria were developed to discriminate among the alternatives. The decision criteria are as follows.

a. Measures of system Characteristics, Capabilities, Performance, and Effectiveness (CCPE). CCPE are used in place of measures of effectiveness in abbreviated analyses. The CCPE used in the ATCCS benefit analysis follow.

(1) Ability to exchange operators (among BFA).

(2) Ability to exchange equipment (among BFA).

(3) Ease of setting up hardware.

(4) Ease of training.

(5) Ease of personnel management.

(6) Ease of maintenance management.

(7) Ease of software management.

b. Timeliness of equipment fielding.

(1) Timeliness of an Interim Force-Level Control System (IFLCS). IFLCS provides a force level C2 capability among the BFA through the manual interface between the automated maneuver control system (MCS) and automated/manual BFA control systems.

(2) Timeliness of a Force-Level Control System (FLCS). A FLCS provides force level C2 through automated interfaces among BFA control systems.

c. Automated C2 capabilities of the Reserve Component (RC).

d. BFA concerns regarding the capability of the alternatives to meet their requirement.

9. Comparison of Alternatives Based on Decision Criteria. Figure 2 summarizes the attributes of the alternatives in general terms. The decision criteria on which the alternatives were compared have been assigned weights by the ATCCS CBA Study Advisory Group (SAG). (See Annex A, Benefit Analysis, page 6-8, paragraph 6 for a discussion of decision criteria weight assignments). The weights were used to determine the relative importance of the decision criteria, which in turn were used to aid in the comparison of alternatives.

a. Measure of system Characteristics, Capabilities, Performance, and Effectiveness (CCPE). CCPE were determined to be the most important of the decision criteria. The results of the comparison of the alternatives to each of the CCPE are shown in the first column of Figure 2. Generally, the more types of systems fielded the lower the score the alternative exhibits against the CCPE. Proliferation of different types of equipment inhibits operator and equipment exchanges and complicates hardware setup, training, personnel management, maintenance management, and software management.

ALT	MEASUREMENT OF CHARACTERISTICS, CAPABILITY, PERFORMANCE, AND EFFECTIVENESS	FIELDING TIMES			RESERVE COMPONENT CAPABILITIES	BFA CONCERNS
		AUTO MCS*	AUTO IFLCS	AUTO FLCS		
1	POOR	NONDISCRIMINATING	GOOD	FAIR	POOR	FAIR
2	FAIR		GOOD	GOOD	FAIR	POOR
3T/P	GOOD		GOOD	GOOD	FAIR	FAIR
3T	GOOD		POOR (NONE)	GOOD	FAIR/GOOD	FAIR
4	POOR		POOR (NONE)	FAIR	POOR	FAIR
5X	GOOD		GOOD	GOOD	GOOD	FAIR

Figure 2. Generalized summary of alternatives' attributes

* This sub-criterion was determined to be non-discriminating since the fielding time for all alternatives was 1987.

b. Fielding times. Fielding times are shown in the second major column of Figure 2. The most obvious difference is the lack of an IFLCS capability, for alternatives 3T and 4, until the fielding of a FLCS. This lack of automation for 5 to 6 years may impose great risk upon the Army. In the event of hostilities in the next 5 to 6 years, the Army would be forced to fight without the automation necessary to support the force synchronization required to execute AirLand Battle doctrine. Because of this risk, the timeliness of an IFLCS was determined second in importance only to the CCPE.

c. RC capabilities. In Figure 2, alternatives 1 and 4 both receive poor marks due to the proliferation of different types of systems. Alternative 2 and 3T/P both receive fair marks as fewer types of systems would be fielded. Alternative 3T receives a rating of fair to good as CHS is fielded exclusively in the RC except at MC where TCT are fielded along with CHS. Alternative 5X received a rating of good as the RC is fielded with 100 percent CHS.

d. BFA concerns. A generalization of the concerns is reflected in the final column of Figure 2. (The IEW BFA proponent also expressed concern over the inability of the systems to process special compartmented information. This deficiency is present in any inter-BFA or force-level C2 systems; therefore, this BFA concern is not listed as it is nondiscriminating among the alternatives.

10. Comparison of Alternatives Based on Cost Analysis. Table 2 depicts the hardware and software system costs* of each alternative.

		FY 88 ($Billions)		
Alternative	Cost Case**	HW	SW	Total
1		2.9	.9	3.8
2	Worst	2.6	.9	3.5
	Best	2.1	.9	3.0
3 TP	Worst	2.2	.9	3.1
	Best	1.5	.9	2.4
5X	Worst	2.1	.9	3.0
	Best	1.4	.9	2.3
3 T	Worst	1.9	.9	2.8
	Best	1.2	.9	2.1

Table 2. System Costs

*System Costs are life-cycle costs which exclude government furnished equipment, consumables, system/project management, fielding costs, and common Military Personnel Army costs.

**Best case estimates assume a basic award for quantities to satisfy all BFA control system requirements over a multi-year period. Worst case estimates assume both a basic award and year-by-year option invocations, in quantities of less than 1,000 items per device type per obligation.

a. Alternative 3T is least costly since it fields all CHS and has a lower cost interim system. However, it has become an infeasible alternative (para 6b(4)) and would have been unacceptable because it does not provide an automated IFLCS in the near-term.

b. Alternative 5X is somewhat more costly than alternative 3T due to the interim system T/P.

c. Alternative 3T/P has higher than alternative 5X estimated costs due to the retrofit of MCS equipment for the reserve component.

d. Alternative 2 incurs the higher costs of unique HW in the MCS system active and reserve components.

e. Alternative 1 is most costly due to unique hardware in all BFA control systems. The increased cost is primarily attributable to life cycle costs of multiple unique control systems.

11. Comparison of Cost Versus Benefits

ALTERNATIVE	BENEFIT RANKING	FY 88 ($Billions) COST	COST RANK
1	5	$3.8B	5
2	3	$3.5/3.0B	4
3T/P	2	$3.1/2.4B	3
3T (Infeasible)	4	$2.8/2.1B	1
5X	1	$3.0/2.3B	2

Table 3. Cost/Benefit Comparison

a. Alternative 5X rates relatively highest in every category except cost. It provides a good rating against CCPE, it fields IFLCS and FLCS at the earliest possible time and it provides CHS to the reserve components which results in a total force with the same common hardware/software system. We can not lose sight of the fact that commonality of equipment does not guarantee system interoperability; however, it does provide greater confidence that interoperability will be achievable. The risk associated with this alternative is considered to be relatively low.

b. Alternative 3T/P is ranked second. Alternative 3T/P is rated equal with alternative 5X except for RC capabilities. It provides a high ranking against CCPE, it fields IFLCS and FLCS at the earliest possible date and it provides TCT/TPC/AC to the RC at the earliest possible date. The CONOPS/ILS training capability for the RC is slightly degraded as compared to alternative 5X because more systems of different types are in use. This increases the complexity of establishing and maintaining interoperability among systems. This further impacts on the active Army because training programs as well as the ancillary equipment and systems expertise must be retained in order to provide training/support for the RC. This alternative is ranked third in terms of cost with a delta cost of +$.1 billion from alternative 5X. The risks associated with this

alternative are slightly higher than alternative 5X due to the fielding of multiple systems to the RC. We can not lose sight of the fact that commonality of equipment does not guarantee system interoperability; however, it does provide greater confidence that interoperability will be achievable.

c. Alternative 2 is ranked third. Alternative 2 receives no more than a fair mark against CCPE. The basis for this reduced score is non-standard equipment which could serve to degrade CONOPS to an unacceptable level. The alternative fields IFLCS and FLCS at the earliest possible date, and provides TCP/CHS to the RC. CONOPS/ILS training capabilities provided by this alternative would be slightly improved over alternative 3T/P, but multiple systems are retained. Alternative 2 is ranked fourth in cost with a delta cost of +$.5 billion Best Case and +$.7 billion Worst Case from alternative 5X. The risk associated with this alternative is increased due to multiple systems which increase the complexity of establishing and maintaining interoperability among systems. Confidence in the ability to achieve interoperability is reduced because there are two different types of equipment.

d. Alternative 1 is ranked fourth. Alternative 1 receives a poor mark against CCPE. The basis for the poor score is the preponderance of non-standard equipment which serves to degrade CONOPS to an unacceptable level. The alternative fields IFLCS and FLCS at the earliest possible time. The CONOPS/ILS training capability for the RC is significantly degraded as the result of multiple systems. This further impacts on the active Army training programs as well as the ancillary equipment and systems expertise which must be retained in order to provide training/ support for the RC. This alternative is ranked fifth in cost with a delta cost of +.8 billion from alternative 5X. Confidence in the ability to achieve interoperability is reduced because of the multiple types of equipment fielded. The risk associated with this alternative is considered to be significant due to the degradation of CONOPS.

e. Alternative 3T (Infeasible) is ranked fifth. Alternative 3T is rated equal to alternative 5X and 3T/P in terms of CCPE and provides common hardware/software to the total force with the exception of the RC maneuver system which will retain the TCT's that are replaced in the active Army by CHS. Even though only one battlefield system is issued multiple systems, the CONOPS/ILS training capabilities are degraded. The major risk associated with this alternative is the lack of a force level control system until 1992 at the earliest. In terms of cost, this alternative ranks first with a delta cost of -$.2 billion from alternative 5X. This analysis concludes, however, that alternative 3T has a significant fault in addition to being infeasible. It does not meet the Army leadership guidance to get a system fielded quickly (para 5c), and there would be no force level control system until 1992.

12. Conclusions

This analysis concludes that the major consideration in establishing the relative merits of any alternative must be based on the contribution of the alternative to operational effectiveness. This is demonstrated by the higher relative weight placed on CCPE by the SAG, as well as the timeliness in which an Interim Force Level Control System (IFLCS) could be fielded. The impact of fielding automated systems to the Reserve Component (RC) was also determined to be a significant consideration. Table 4 depicts the ranking of alternatives concluded by this analysis.

RANKING	ALTERNATIVE
1	5x
2	3T/P
3	2
4	1

Table 4. CBA Alternative Ranking

13. Recommendation.

That alternative 5x be selected as the preferred alternative to implement the Army Tactical Command and Control System (ATCCS). Alternative 5x provides the lowest affordable risk and the greatest confidence of success on the high intensity battlefield.