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TRADOC Analysis Command-Fort Leavenworth (TRAC-FLVN)
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ARMY TACTICAL COMMAND AND CONTROL SYSTEM (ATCCS) BENEFIT ANALYSIS

VOLUME I: MAIN REPORT WITH EXECUTIVE SUMMARY AND APPENDIXES A-H

Larry Tolin
Sara Tisdel

ACN 62630

Approved by:

DONALD W. KROENING
Director, Force Analysis Directorate

ROBERT LA ROCQUE
Director, TRAC-FLVN

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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. This document is the technical document for the benefit 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 benefit analysis was designed to determine and compare various ATCCS automation alternatives, determine relative benefits, and determine a relative ranking. The benefit analysis will be combined with an ATCCS cost analysis for final rank ordering of the alternatives, conclusions, and recommendations.

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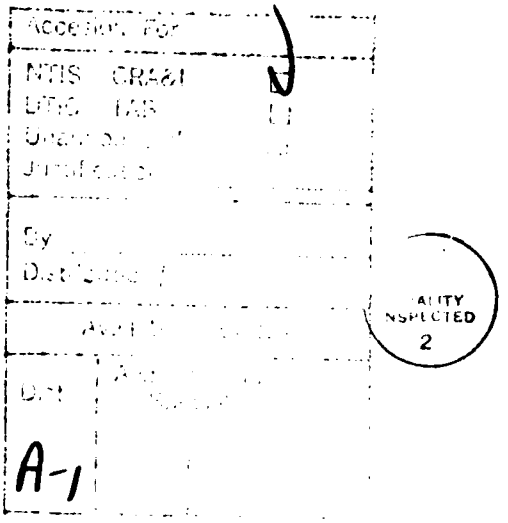
DISCLAIMER

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.



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ABSTRACT

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. This document is the technical document for the benefit analysis. The ATCCS CBA is required to determine the extent to which an ATCCS common hardware and software (CHS) strategy is implementable and to determine associated costs and benefits. The ATCCS CBA is required to support a designated acquisition program (DAP) milestone III procurement decision for ATCCS CHS.

The benefit analysis was designed to determine and compare various ATCCS automation alternatives and to determine relative benefits and a relative ranking. The benefit analysis will be combined with an ATCCS cost analysis for final rank ordering of the alternatives, conclusions, and recommendations.

Results of the ATCCS benefit analysis are based on system descriptions, the Army Command and Control Master Plan, and the ATCCS family requirements and operational capability document. Analysis, conclusions, and recommendations are presented in two ways: literary and quantitative.

Analyses of discriminators and similarities associated with each alternative are presented as well as resultant conclusions and recommendations. The analysis of the alternatives provides information on potential interim Active and Reserve component systems. Conclusions and recommendations present impact of the alternative on the Army as a whole and describe the associated risks and capabilities.

The figures associated with the benefit analysis are duplicated in volume II so that the figures may be more easily referenced while reading the text. Figures in the executive summary are not duplicated in volume II.

SUMMARY

1. Introduction: In January 1987, the Command, Control, Communications and Intelligence (C3I) Directorate of the Combined Arms Combat Development 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. The benefit analysis presented in this technical document was performed to assist CACDA in the cost/benefit comparison analysis.

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). 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 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 fear of some of the BFA proponents has been that common components may not meet all functional requirements. The costs associated with a common system were also questioned. The assumption 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.

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

a. Determine ATCCS automation alternatives.

b. Determine relative benefits among the alternatives.

4. Assumptions. Due to the length of the list of assumptions deemed necessary for this study, the list is not presented here. Assumptions are listed in paragraph 4 of the main report.

5. 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.

(2) Ability to exchange equipment.

(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 an automated maneuver control system and 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 C2 through automated interface with BFA C2 systems.

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

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

6. Alternatives. ATCCS automation alternatives were developed and approved by the study advisory group (SAG). Figure S-1 diagrams each objective system and each interim system. An alternative includes both the interim and the objective system. There are five alternatives numbered as follows: 1, 2, 3T/P, 3T, and 4. Three alternatives are based on the establishment of the IFLCS using the tactical computer terminal (TCT) and the tactical computer processor/analyst console (TCP/AC), the remaining two rely on a later solution for FLCS.

a. Interim systems descriptions.

(1) Interim T/P. Under interim system T/P, the TCT and the TCP/AC are fielded to all BFA HQ within the division to establish an IFLCS capability. The interim system based on the TCT/TCP configuration will be established as follows:

(a) Force-level (FL). The 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 automated and manual systems 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.

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

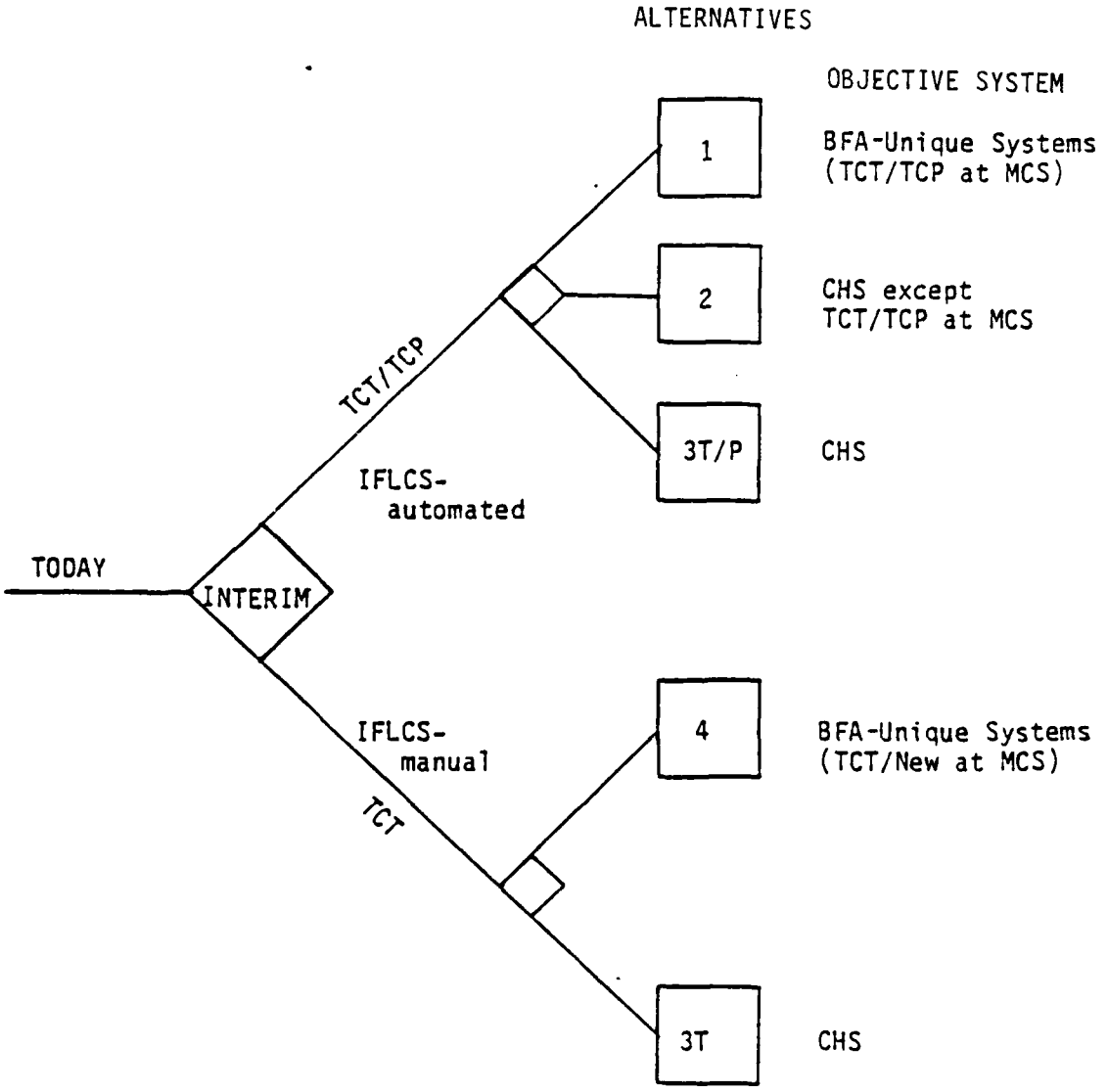


Figure S-1. ATCCS automation alternatives

(2) Interim T. Under interim system T, only the TCT will be available. The interim system based on the TCT configuration will be established as follows.

(a) FL. TCT will 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 will 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).

(3) Objective systems. Reference figure S-2 for a diagram of each of the following objective system alternatives.

(a) Alternative 1 objective system.

1. FL. The BFA-unique hardware is fielded to all BFAs. (TCT and TCP/AC will be fielded at maneuver.) MCS software is converted to operate on all unique BFA hardware in order to provide an automated FLCS.

2. BFA. BFA-unique HW/SW systems will be developed for the management of all BFA technical and staff information.

3. Reserve components. The RC maneuver forces will field additionally purchased TCP/AC. Air Defense (AD) and Intelligence/Electronic Warfare (IEW) BFAs will be fielded with residual TCP/AC which become available after fielding Fire Support (FS), Combat Service Support (CSS), AD, and IEW unique equipment in the active component. RC FS and CSS BFAs will receive applicable unique systems.

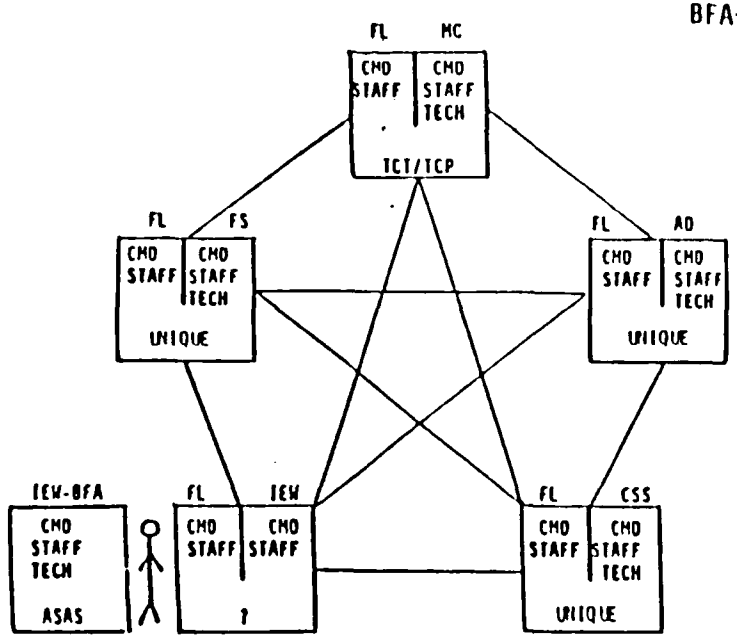
4. Interim. Interim T/P.

(b) Alternative 2 objective system.

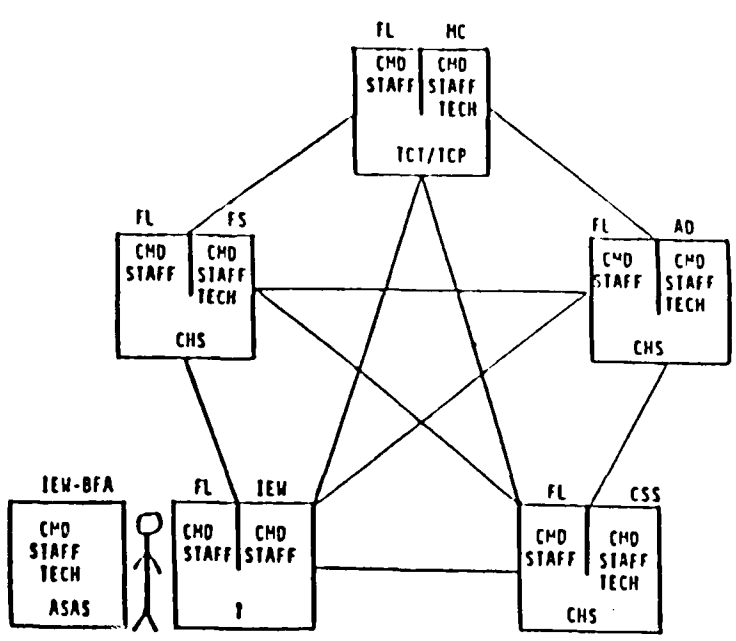
1. FL. MCS software is ported to common HW to allow BFA automated systems to execute the MCS software to provide an automated FLCS.

2. BFA. BFAs will develop and port BFA technical/unique software for use on common hardware. Maneuver will use TCT and TCP/AC. CHS is fielded to all BFA except maneuver.

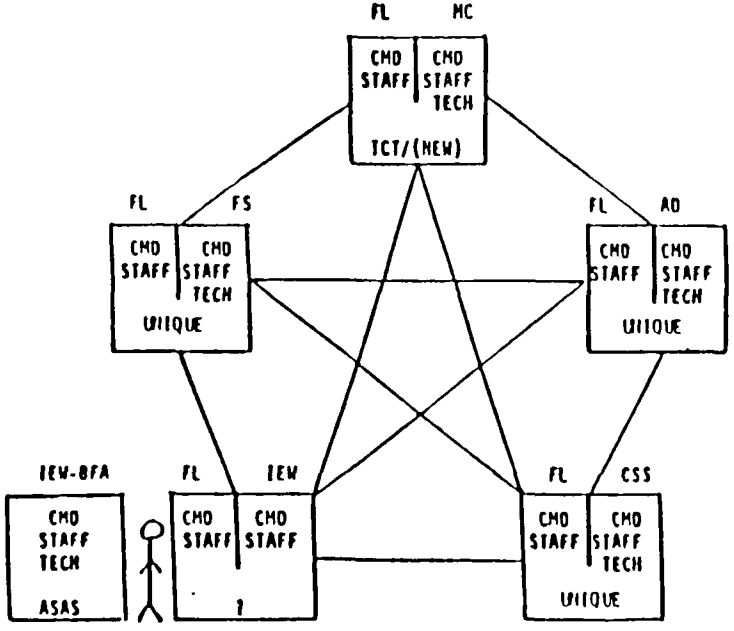
3. Reserve component. The RC maneuver forces will field additionally purchased TCP/AC. AD and IEW BFAs will be fielded with residual TCP/AC which become available after fielding FS, CSS, AD, and IEW common HW in the active component. RC FS and CSS BFA will receive common HW.



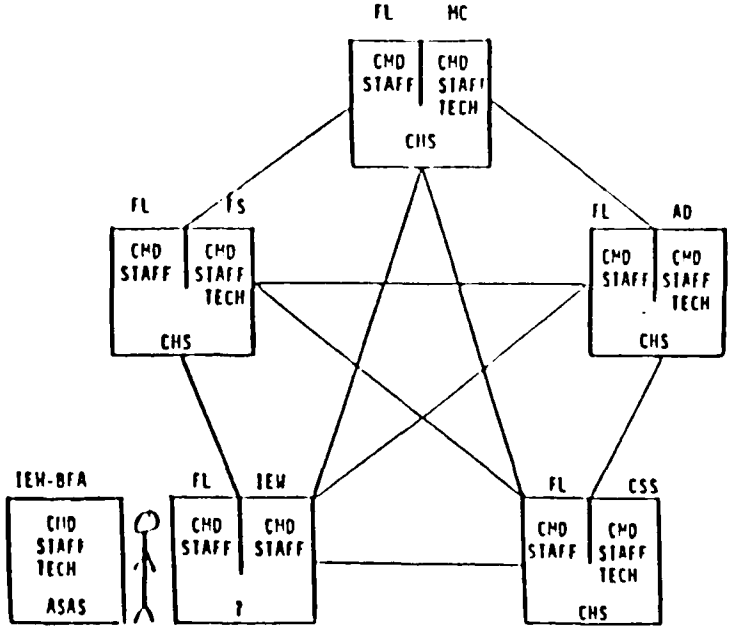
Alternative 1



Alternative 2



Alternative 4



Alternatives 3T/P and 3T

Figure S-2. Objective system descriptions

4. Interim. Interim T/P.

(c) Alternative 3T/P objective system.

1. FL. All FL automation will be through the CHS system.

2. BFA. All BFA-unique automation will be through the porting of BFA technical/unique software to the common HW system.

3. Reserve component. Maneuver forces will receive residual TCT and TCP/AC displaced from active component maneuver forces. AD and IEW will receive residual TCP/AC which become available after fielding FS, CSS, AD, and IEW common HW in the Active component. FS and CSS will receive CHS.

4. Interim. Interim T/P.

d. Alternative 3T objective system.

1. FL. All FL automation will be through the CHS system.

2. BFA. All BFA-unique automation will be through the porting of BFA technical/unique software to the common HW system.

3. Reserve component. Maneuver control (MC) will receive residual TCT as well as CHS. FS and CSS will receive CHS. No displaced equipment will be available for RC AD and IEW forces; therefore, the FLCS proponent must supply the CHS equipment necessary to establish FLCS at division level.

4. Interim. Interim T.

(e) Alternative 4.

1. FL. MCS software will be ported to each of the BFA-unique systems to provide a FLCS.

2. BFA. BFA-unique HW/SW systems will be developed for the management of all BFA technical and staff information. TCT will be retained for MC. A "new" system would be developed to provide TCP/AC functions.

3. Reserve components. Maneuver forces will receive additionally purchased "new" equipment. RC FS and CSS will receive unique HW. No displaced equipment will be available for RC AD and IEW forces; therefore, the FLCS proponent must supply the "new" equipment necessary to establish the FLCS at division level.

4. Interim. Interim T.

7. Comparison of Alternatives. Figure S-3 summarizes the attributes of the alternatives. Figure S-4 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). The weights were used to determine the relative importance of the decision criteria. This was used to aid in the comparison of alternatives.

ALT	MEASUREMENT OF CHARACTERISTICS, CAPABILITY, PERFORMANCE, AND EFFECTIVENESS	FIELDING TIMES			RESERVE COMPONENT CAPABILITIES	BFA CONCERNS
		AUTO MCS	AUTO IFLCS	AUTO FLCS		
1	POOR	87	88	93	TCP/UNIQUE	NONSTANDARDIZATION
2	FAIR	87	88	92	TCP/CHS	NONSTANDARDIZATION PROCESSING SPEED
3T/P	GOOD	87	88	92	TCP/TCT/CHS	PROCESSING SPEED
3T	GOOD	87	--->	92	TCT/CHS	PROCESSING SPEED
4	POOR	87	--->	93	TCT/NEW/UNIQUE	NONSTANDARDIZATION

Figure S-3. Summary of alternatives' attributes

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

Figure S-4. Generalized summary of alternatives' attributes

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 S-3 and figure S-4. 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. Because of the extreme importance of the CCPE relative to the other decision criteria, alternatives which received a poor rating in this category may be considered unacceptable.

b. Fielding times. Fielding times are shown in the second major column of figure S-3. 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. Alternatives 3T and 4 are considered unacceptable based on this risk.

c. RC capabilities. The third column in figure S-3 shows the systems to be fielded to the RC for each alternative. The RC systems were each compared to the CCPE. In figure S-4, 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. [Capabilities of an RC fielded with 100 percent CHS would be the greatest. Though this option was not considered as an alternative, it is recommended. Initial analysis shows that the cost of CHS for RC may be cost effective when compared to refurbishment and maintenance costs of TCT and TCP/AC. This determination will be made during cost analysis.]

d. BFA concerns. The concerns expressed by the BFA proponents are listed in the last column of figure S-3. Proponents expressed most concern over the nonstandardization of equipment in alternatives 1, 2, and 4. BFA proponents expressed some concern over processing speeds in CHS as shown for alternatives 2, 3T/P, and 3T. A generalization of the concerns is reflected in the final column of figure S-4. [The IEW BFA proponents also expressed concern over the inabililty of the systems to process special compartmented information. This deficiency is present in any inter-BFA or force-level C2 system; therefore, this BFA concern is not listed as it is nondiscriminating between the alternatives.]

8. Conclusions.

a. Alternative 3T/P is ranked first overall. It provides a high rating against the CCPE, fields MCS, IFLCS, and FLCS at the earliest possible time, and provides TCT/TCP/AC to the Reserves at the earliest possible date. The continuity of operations (CONOPS)/integration logistics support (ILS)/training capability for the RC are slightly degraded as compared to alternative 3T because more different types of equipment are in use. This difference is not significant enough to lower the relative rank of alternative 3T/P based on the

importance of the other decision criteria. [The capabilities of the RC would be improved by purchasing CHS for all BFAs. Based on increased capability afforded the total Army, this analysis indicated that the benefits gained by the fielding of CHS outweighs any initial cost savings of retaining TCT/TCP/AC. Further tradeoff analysis will be conducted in the cost/benefit comparison analysis.] Alternative 3T/P does reveal a concern from the BFA regarding processing speed; however, a method for solving this problem is streamlined software.

b. Alternative 2 is ranked second. Alternative 2 receives a fair mark against the CCPE. The impetus for the fair mark is the nonstandard equipment; this also shows up in the BFA concerns. This analysis implies that the increased benefits of having an entirely standard system outweigh any potential cost benefit for retaining TCT/TCP/AC in the Active component (considering refurbishment and maintenance concerns). Further tradeoff analysis will be conducted in the cost/benefit comparison analysis.

c. Alternative 3T, though rated high under the CCPE, is disqualified due to the lack of an IFLCS or FLCS until 1992. (The FLCS would not be complete for five years.) [Alternative 3T shows enhanced RC capabilities, but not of significant enough proportions to make up for the late fielding of an IFLCS capability.]

d. Alternatives 1 and 4 are ranked last. They are unacceptable due to the poor rating against the CCPE. CCPE represent the ability of the system to function effectively in the field. To be rated poorly here is unacceptable. Alternative 4 is further disqualified based on the lack of an IFLCS capability until the fielding of FLCS in 1993.

e. An additional finding is the potential for much improved C2 with the fielding of common hardware for subordinate systems. This conclusion is based on logistics considerations, CONOPS considerations, and training considerations as documented in the CCPE for the control systems investigated in this study. Based on unit cost considerations, the potential exists for cost savings. However, this subject is beyond the scope of this study and will not be addressed in more detail.

9. Recommendation. The members of this study team recommend the implementation of alternative 3T/P and that CHS be fielded to the RC in total.

DRAFT

MAIN REPORT

1. Introduction. In early January 1987, C3I, 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. The benefit analysis presented in this technical document was performed to assist CACDA in the cost/benefit comparison analysis. All figures, with the exception of those in the executive summary, are duplicated in volume II of this report so that figures may be more easily referenced while reading the text.

2. Background.

a. Definitions.

(1) "Command and control" is defined in Joint Chiefs of Staff Publication 1 as "... the exercise of authority and direction by a designated commander over assigned forces." Command and control is the process by which commanders employ and sustain combat power. Through command and control, commanders transform potential combat capabilities into applied combat power.

(2) "Command" is described as a process for planning, organizing, directing, and coordinating combat power.

(3) "Control" is a process for ensuring that subordinate and supporting units' activities remain consistent with the will of the commander. This is done through situation and status reports.

(4) The intelligence system is the conduit for information to the commander and staff concerning the enemy, terrain, and weather. It does so through the processing of information obtained through reconnaissance or surveillance by "sensors," in the broadest meaning of that term.

(5) The control system is the system by which control is maintained by the commander. Situation and status reports provide a feedback loop to the command system.

(6) The command system uses the inputs from the control and intelligence systems to make estimates, determine actions, and direct combat power.

(7) The communications system provides the means by which intelligence, control information, and command orders are exchanged.

(8) The U.S. Army command and control system (ACCS) includes C2 systems from the foxhole level through the theater army level for the employment and sustainment of US Army forces.

(9) The Army tactical command and control system (ATCCS) includes the C2 systems at corps and below for employment and sustainment of Army operating forces. ATCCS has evolved from eight loosely related programs (automation and communication systems) tied together in concept into a system of systems involving more than 30,000 tactical computers in the Army.

(10) The command, control, and subordinate systems (CCS2) architecture is the name of the three-level architecture for the ATCCS. Reference figure 2-1.

(a) The commander and his staff at each echelon constitute the command portion of the architecture. The command system, also called the force-level control system (FLCS), is where horizontal (figure 2-2) integration and synchronization of the force occurs.

(b) Next, there are the functional control systems which perform vertical and lateral integration of the five battlefield functional areas (to be discussed below).

(c) At the lowest level, there are the numerous automated and manual subordinate systems providing technical information and support to the control systems.

(11) Integral to the CCS2 concept is a recognition of different categories of information and their relevance in decision making. While the actual information content is dynamic, the categories of information are static. Three distinct types of information are processed in operational facilities (OPFACS): technical, staff, and command related.

(a) Technical information is normally associated with the majority of automated systems. Technical information is exemplified by BFA-unique data such as sensor input or the results of predetermined algorithms such as target data and accounting data which accompany requisition processing. Technical information is the essence from which decision-making information is eventually created. Normally, if technical information is to be of value in other than the technical mission of the functional area, it must be processed into a higher-order information product which, in this concept, is called staff information.

(b) Staff information is compiled from technical data which has been classified, grouped, and applied to problems currently requiring staff or command attention. Staff information allows the staff to support the commander. It is used to develop alternative courses of action for a commander's consideration. It also serves as decision-making information for actions within the functional area.

(c) Command information is processed staff information. Command information allows the commander to view his force in perspective as a complete system.

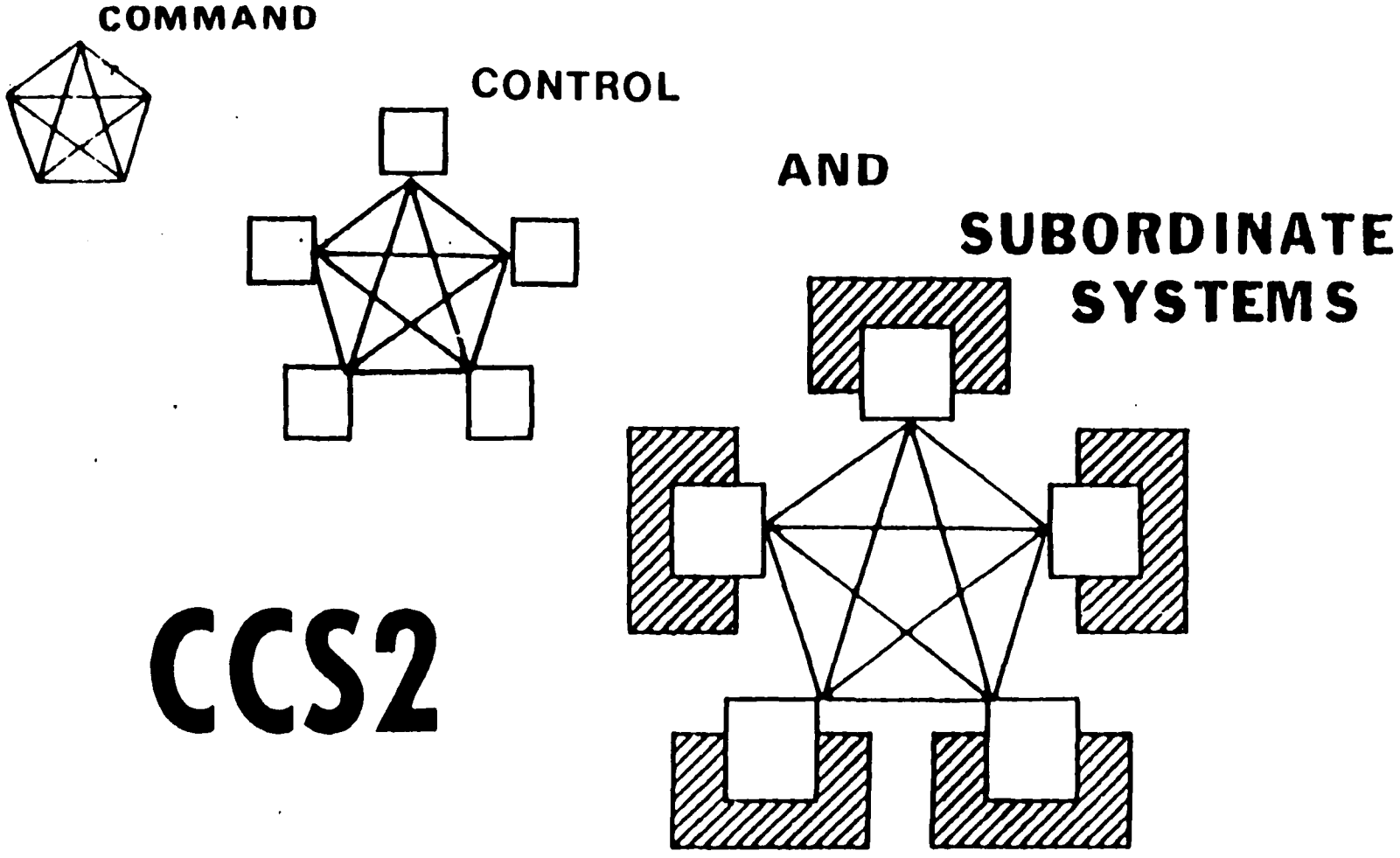


Figure 2-1. CCS2 architecture

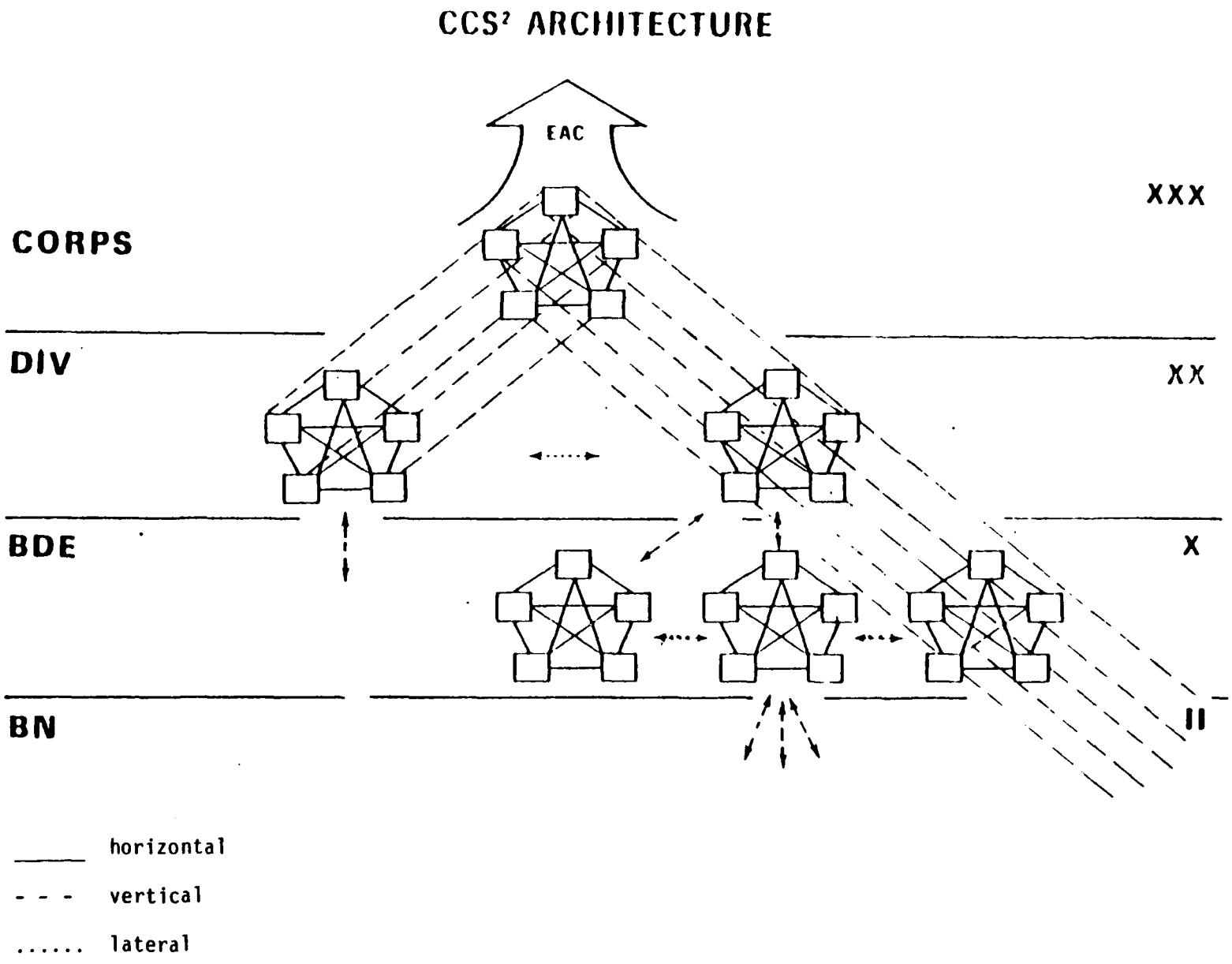


Figure 2-2. Information flows

b. Automation implementation. ATCCS is the automation, communication, personnel, and equipment that will implement the CCS2 architecture.

(1) CCS2 views the battlefield as a set of discrete functional areas of responsibility readily identifiable by the battlefield functions performed. The five battlefield functional areas (BFA) are maneuver control (MC), air defense (AD), combat service support (CSS), intelligence/electronic warfare (IEW), and fire support (FS). The functional control systems which support the BFAs are:

(a) The maneuver control system (MCS) supports maneuver operations through the maneuver S3s and G3s and the commanders. It includes automated and manual subordinate systems for signal, aviation, engineer, and chemical units.

(b) The air defense control system is the forward area air defense command, control, and intelligence system (FAADC2I) providing detection of enemy aircraft and control of friendly short range air defense (SHORAD) unit targeting and fires.

(c) The combat service support control system (CSSCS) provides efficient sustainment and accurate accountability of the force.

(d) The IEW control system is the all-source analysis system (ASAS) providing intelligence collection, fusion, and dissemination.

(e) The FS control system is the advanced field artillery tactical data system (AFATDS) providing efficient centralized control and decentralized execution of the fire support mission.

(2) The force-level control system (FLCS) is a specialized software application that will reside on the hardware of the five BFA control systems to support the commander and staff.

(a) FLCS consists of two key portions, the data base and the commander's situation report:

1. The command data base consists of the commander's critical information requirements (CCIR). The full data base will only be replicated in total at the three primary command posts (CP) within the command, such as the division rear, main, and tactical CPs. Subordinate CPs within the command will maintain their echelon's portions of the data base.

2. The commander's situation report software automates the reports and map displays produced manually today. It provides the "common view of the battlefield" including the map and overlays, intelligence summaries and status, and key readiness information critical to decentralized command and control.

(b) The initial FLCS is designed to acquire information from the five BFA (vertical/lateral) control systems (figure 2-2) and incorporate that information into the command database thereby facilitating decision making. [Ultimately, the Army needs decision aids exploiting artificial intelligence and expert systems to assist the commander and staff in determining and wargaming appropriate courses of action.]

(3) All of these automated and manual command, control, and subordinate systems require communications. There are three basic communications systems:

(a) The area common user program is a generic name covering both the current multichannel pulse code modulation (PCM) system as well as the new mobile subscriber equipment (MSE). This is primarily a voice system, but it also supports data transmissions.

(b) The army data distribution system supports real-time and near-real-time data exchange requirements. It consists of two communications systems:

1. The joint tactical information distribution system (JTIDS) will exclusively support air defense data needs (real-time).

2. The enhanced position location and reporting system (EPLRS) will provide data distribution to all users as well as near-real-time position/location information.

(c) The combat net radio system has primary focus on single channel ground and airborne radio system (SINCGARS) for jam-resistant, secure, and reliable voice communications.

3. Problem.

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 BFAs. Common software (SW) would be used at each of the BFAs for force-level C2 (command and staff information). Functional area unique software would be ported to the common hardware at the BFAs for functional C2 (technical/staff information). This alternative intuitively has some advantages over the fielding of numerous types of computers; however, the fear of some of the BFA proponents has been that common components may not meet all functional requirements. The costs associated with a common system were also questioned. The assumption was that the cost of a common system incorporating all BFA requirements would be significantly lower than the second alternative: unique HW/SW systems, each designed to meet unique requirements.

b. In order to address concerns stated above, as well as to support the designated acquisition program (DAP) milestone III decision, the issues of the ATCCS CBA have been set as follows by HQ TRADOC.

(1) What are the noncost qualities/assets of each of the ATCCS automation alternatives?

(a) What are the integrated logistic support (ILS) considerations?

(b) What are the continuity of operations (CONOPS) considerations?

(c) What are the training implications?

(2) What are the costs associated with fielding each of the ATCCS automation alternatives?

(a) What CHS is required by each user in terms of the handheld, portable, and transportable versions?

(b) What is the cost of porting already developed BFA software to common hardware?

(c) What is the cost of unique hardware?

(d) What is the cost of porting FL software to unique hardware?

c. The benefit analysis presented in this technical document addresses the noncost topics of the problem and issues described above. The benefit analysis was performed to assist CACDA in a cost/benefit comparison analysis.

4. Assumptions. The following assumptions were deemed necessary for this study.

a. The command, control, and subordinate system (CCS2) architecture will satisfy the Army's tactical C2 requirements.

b. There will be no significant military construction costs.

c. The ATCCS CHS will interface with MCS block I (tactical computer terminal - TCT), and MCS block II (tactical computer processor/analyst console-TCP/AC).

d. The usable life of computers is 10 years (includes technological obsolescence, wear and tear, and useful life).

e. BFAs will develop functional unique software for BFA technical/staff requirements (requirements not met by force-level (common) software).

f. Current or projected Army communication systems will be adequate for all automation alternatives. Costs of the communication systems are common to all alternatives.

g. SW fielded by a CHS system will meet common BFA control-level SW requirements.

h. Performance thresholds specified in requirements documents are met by each alternative.

i. There will be a manual interface between the IEW SCI data base and all automated devices.

j. Life-cycle software support (LCSS) considerations (other than costs) are equal for each of the alternatives.

k. BFA-unique systems are of unique equipment types.

l. The effects of BFA subordinate systems remain essentially constant across the alternatives.

5. Discussion.

a. Mission needs, deficiencies, and opportunities.

(1) The U.S. Army requires an integrated family of interoperable systems which supports commanders at all levels in commanding their forces and which assists the staff in controlling their functions in support of the commander. The composite ATCCS family system will provide a hierarchy of systems operating within the five BFAs and processing the three categories of information as an integral part of, and in support of, the total system. The system will provide aggregation, processing, transmission, and display of information within the BFA, and it will facilitate the information flow between the BFAs.

(2) The family of ATCCS contributes to solving 14 deficiencies identified in the TRADOC Battlefield Development Plan (BDP), 1985. These 14 deficiencies are numbers 3, 8, 35, 42, 45, 50, 109, 153, 196, 229, 263, 322, 329, and 346. Solutions to these deficiencies will satisfy the ACCS capability requirements which are derived from the BDP deficiencies and incorporated into the Army Command and Control Master Plan (AC2MP).

b. Threat and operational environment.

(1) Threat forces of the Warsaw Pact represent the most serious opposition likely to be faced by the U.S. Army in the foreseeable future. These forces have long enjoyed numerical superiority over the NATO forces as well as other theater forces. The margin of this numerical superiority is increasing and will continue to increase into the next decade. The continuing introduction of advanced-technology threat weapon systems constitutes an increasingly significant qualitative and technological advantage. Of particular concern are threat improvements in the command, control, and communications (C3) of their numerically superior and modernized maneuver and fire support forces.

(2) ATCCS and the shelters and command centers in which it will be operated are threatened by surface-to-surface missiles, tactical aircraft, airborne/airmobile forces, and similar unconventional warfare or special operations forces. ATCCS is also vulnerable to radio-electronic combat (REC) including radio frequency weapons, if developed, as well as electromagnetic pulse (EMP). The employment of chemical and biological agents by threat forces remains a constant hazard. Specific threats to subordinate systems and communications are stated in system required operational capabilities documents (ROCs).

(3) ATCCS will be operated in a wide range of environmental conditions. ATCCS will be exposed to a wide range of temperatures and humidity as well as dust, sunlight, and shock as outlined in the ROC.

c. Constraints. The constraints of the study are as follows.

(1) Not all data desired have been available.

(2) The extent to which the systems and their interfaces are defined is limited.

(3) Limited time prevents the development or modification of a model to compare the effectiveness of the ATCCS automation alternatives.

(4) Limited resources have been assigned to this study.

d. Specific functional objectives. A statement of the functional objectives of any ATCCS system can be found in the ATCCS ROC. The clear expression of functional objectives is important as a basis for the development of the measures of effectiveness (MOE). However, because these specific performance requirements are required of any ATCCS alternative chosen, MOE were not used to determine differences in the effectiveness of the various alternatives. Instead, the benefits of the alternatives were based on a subset of attributes of the alternatives determined to be discriminators. These attributes are as follows:

(1) Capabilities for continuous operations (CONOPS).

(2) Simplicity of integrated logistics support (ILS).

(3) Simplicity of training.

(4) Simplicity of management on the battlefield.

(5) Ease of implementation in the battlefield.

(6) Level of attainment of BFA requirements.

(7) Automation capabilities for the Reserve components (RC).

(8) Timeliness of the implementation of the automated systems.

e. Alternatives. ATCCS automation alternatives were developed and approved by the study advisory group (SAG). Figure 5-1 diagrams each objective system and each interim system. An alternative includes both the interim and the objective system. There are five alternatives numbered as follows: 1, 2, 3T/P, 3T, and 4. Three alternatives are based on the establishment of the IFLCS using TCT and TCP/AC, the remaining two rely on a later solution for FLCS.

(1) Interim systems descriptions.

(a) Interim T/P. Under interim system T/P, the TCT and the TCP/AC are fielded to all BFA headquarters within the division to establish an IFLCS capability. The interim system based on the TCT/TCP/AC configuration will be established as follows:

1. FL. The MCS TCT and TCP/AC will provide the HW/SW system for the management of all FL (command and staff) information across all BFAs.

2. BFA. Existing BFA-unique automated and manual systems will be used for the management of all BFA technical and staff information.

3. Interface. A manual interface will be used to transfer information between the FL system and the BFA-unique system.

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

(b) Interim T. Under interim system T, only the TCT will be available. The interim system based on the TCT configuration will be established as follows.

1. FL. TCT will provide only minimal maneuver vertical and lateral automated information flows (Reference figure 2-2). The critical horizontal automated information flow to synchronize the BFAs will not be available.

2. BFA. Existing BFA-unique automated and manual systems will 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.

3. Interface. Not applicable.

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

(2) Objective systems. Reference figure 5-2 for a diagram of each of the following objective system alternatives.

(a) Alternative 1 objective system.

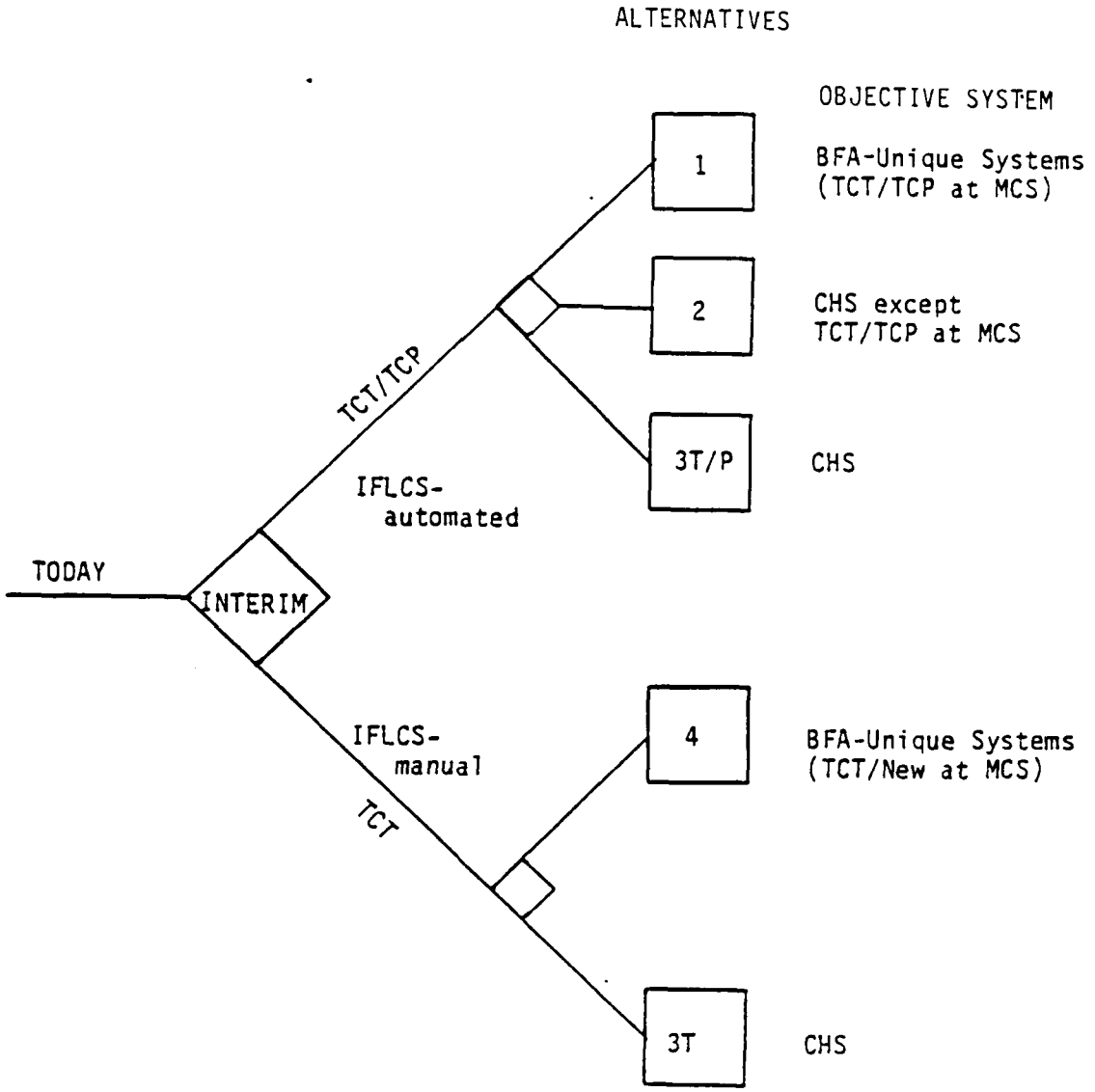
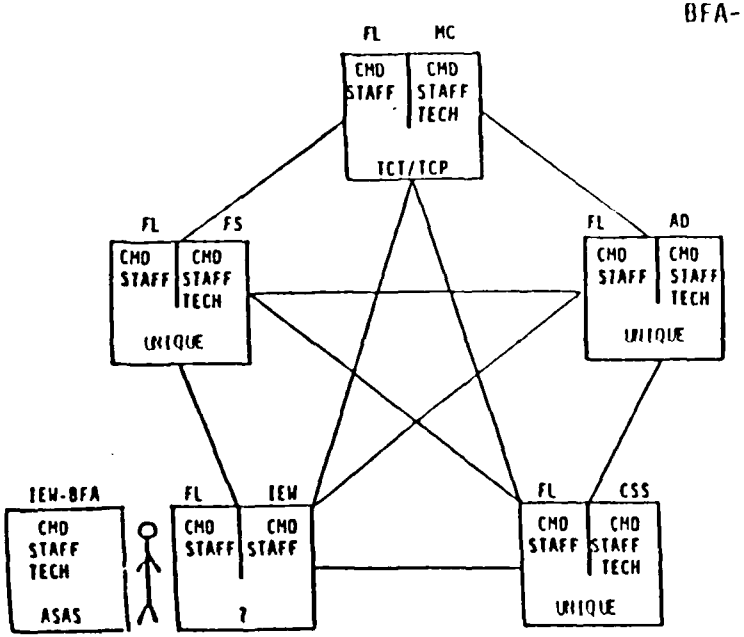


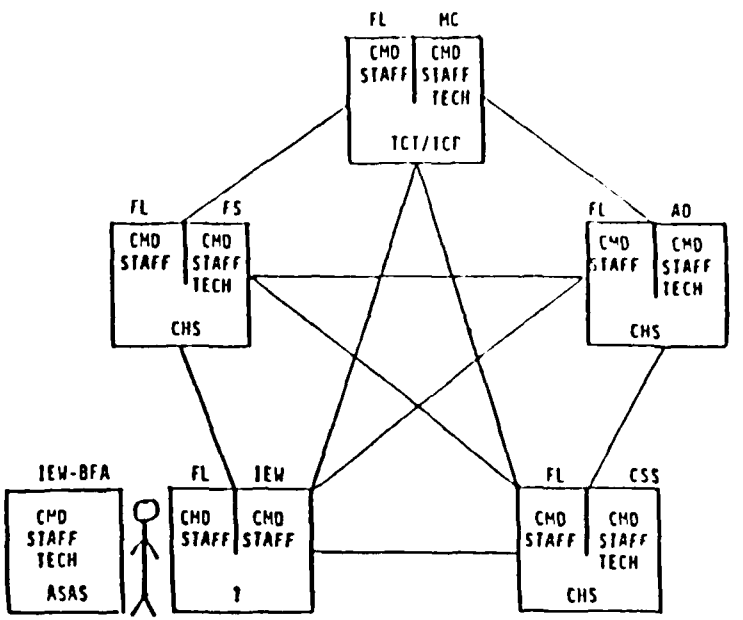
Figure 5-1. ATCCS automation alternatives

BFA-Unique

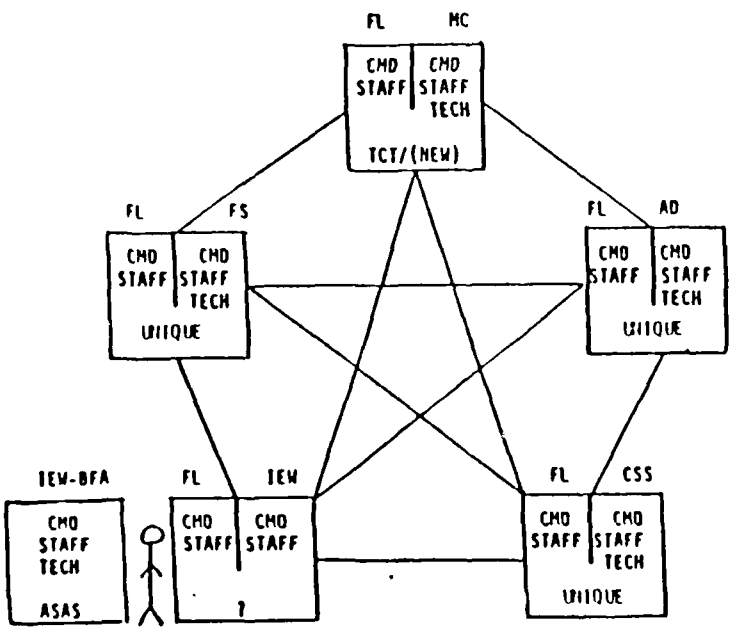


Alternative 1

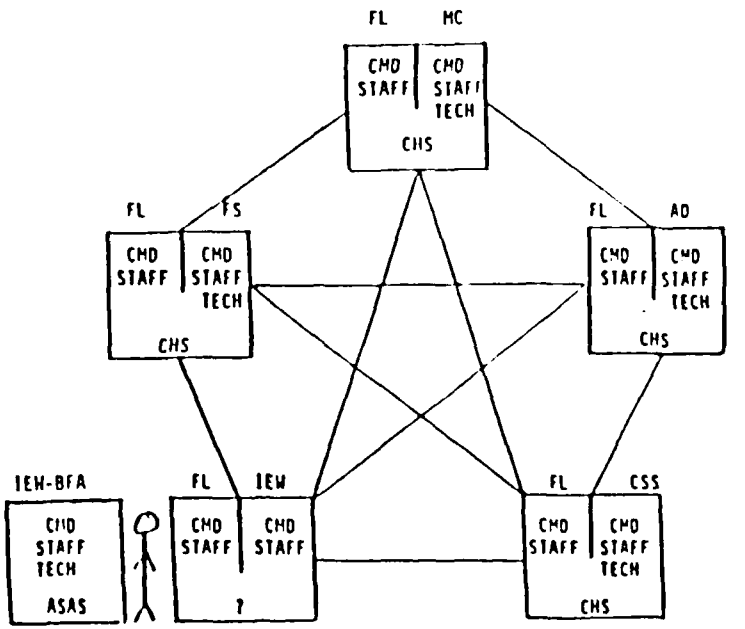
CHS



Alternative 2



Alternative 4



Alternatives 3I/P and 3I

Figure 5-2. Objective system descriptions

1. FL. The BFA-unique hardware is fielded to all BFAs. (TCT and TCP/AC will be fielded at maneuver.) MCS software is converted to operate on all unique BFA hardware in order to provide an automated FLCS.

2. BFA. BFA-unique HW/SW systems will be developed for the management of all BFA technical and staff information.

3. Reserve components. The RC maneuver forces will field additionally purchased TCP/AC. AD and IEW BFAs will be fielded with residual TCP/AC which becomes available after fielding FS, CSS, AD, and IEW unique equipment in the Active component. RC FS and CSS BFA will receive applicable unique systems. [For further discussion on RC capabilities, reference paragraph 5.h. below.]

4. Interim. Interim T/P.

(b) Alternative 2 objective system.

1. FL. MCS software is ported to common HW to allow BFA automated systems to execute the MCS software to provide an automated FLCS.

2. BFA. BFAs will develop and port BFA technical/unique software for use on common hardware. Maneuver will use TCT and TCP/AC. CHS is fielded to all BFA except maneuver.

3. Reserve component. The RC maneuver forces will field additional purchased TCP/AC. AD and IEW BFAs will be fielded with residual TCP/AC which become available after fielding FS, CSS, AD, and IEW common HW in the active component. RC FS and CSS BFA will receive common hardware. [For further discussion on RC capabilities, reference paragraph 5.h.]

4. Interim. Interim T/P.

(c) Alternative 3T/P objective system.

1. FL. All FL automation will be through the CHS system.

2. BFA. All BFA-unique automation will be through the porting of BFA technical/unique software to the common HW system.

3. Reserve component. Maneuver forces will receive residual TCT and TCP/AC displaced from active component maneuver forces. AD and IEW will receive residual TCP/AC which become available after fielding FS, CSS, AD, and IEW common HW in the active component. FS and CSS will receive CHS.

4. Interim. Interim T/P.

d. Alternative 3T objective system.

1. FL. All FL automation will be through the CHS system.

2. BFA. All BFA-unique automation will be through the porting of BFA technical/unique software to the common HW system.

3. Reserve component. MC will receive residual TCT as well as CHS. FS and CSS will receive CHS. No displaced equipment will be available for RC AD and IEW forces; therefore, the FLCS proponent must supply the CHS equipment necessary to establish FLCS at division level. [For further discussion on RC capabilities, reference paragraph 5.h.]

4. Interim. Interim T.

(e) Alternative 4.

1. FL. MCS software will be ported to each of the BFA-unique systems to provide a FLCS.

2. BFA. BFA-unique HW/SW systems will be developed for the management of all BFA technical and staff information. TCT will be retained for MC. A "new" system would be developed to provide TCP/AC functions.

3. Reserve components. Maneuver forces will receive additionally purchased "new" equipment. RC FS and CSS will receive unique HW. No displaced equipment will be available for RC AD and IEW forces; therefore, the FLCS proponent must supply the "new" equipment necessary to establish the FLCS at division level.

4. Interim. Interim T.

f. Benefit analysis decision criteria.

(1) General. Measures of system characteristics, capabilities, performance, and effectiveness (CCPE) are used in AAs to measure the contribution of the alternatives to operational effectiveness. Major cost and operational effectiveness analyses (COEAs) use measures of effectiveness (MOE), however, in the case of AAs, when force-on-force models are not available, CCPE are used. The data concerning each alternatives' contribution to the CCPE are derived from system descriptions. Other comparative criteria were also considered, such as fielding times.

(2) CCPE definitions.

(a) Ability to exchange operators. Ability to exchange operators between functional areas and still maintain automated C2 capabilities.

(b) Ability to exchange equipment. Ability to exchange equipment between functional areas and still maintain automated C2 capabilities. Ability to quickly replace faulty system components.

(c) Ease of setting up hardware. Ability to set up the computer system and all of the associated hardware and software quickly and easily (assume frequent movements).

(d) Ease of training. The simplicity of the training program and the time necessary to teach operators and supply personnel the system(s) and its requirements (force-level C2 SW and low-level applications, i.e., spreadsheet, WP, DBMS, E-mail).

(e) Ease of personnel management. Simplicity of managing trained computer operators and trained computer supply personnel (in the field or in garrison). Management by military occupational specialty/additional skill identifier (MOS/ASI).

(f) Ease of maintenance management. Simplicity of managing direct exchange (DX) components, and transporting faulty and repaired items between direct support (DS) battalions and contractor maintenance facilities. (DS maint DX facility to contractor.)

(g) Ease of software management. Ease of replacing or updating software in the field. (Fielding revisions of FL C2 SW on an annual basis.)

(3) Other factors based on the functional objectives determined important for comparison of the alternatives that are not included in the CCPE are shown below.

(a) Timeliness of the implementation of an IFLCS.

(b) Timeliness of the implementation of a FLCS.

(c) Automation capabilities of the RC.

(d) BFA concerns regarding the capability of the alternatives to meet their requirements.

g. Benefit analysis results. The following is a description of the ability of each ATCCS automation alternative to address each of the benefit analysis decision criteria. Decision criteria addressed here are: CCPE, RC automation capabilities, fielding timeliness, and BFA concerns. Also provided is a list of other significant findings associated with each of the alternatives, as well as a comparison of the alternatives.

(1) ATCCS alternatives' CCPE.

(a) General. Each alternative was scrutinized to determine its contribution to the CCPE. The following descriptions are supported by a quantitative assessment shown in appendix G. Each alternative's active component objective system is considered. Alternatives 1 and 4 are considered together, as are alterntives 3T/P and 3T due to similarities in their objective systems' attributes. Alternative 2 is discussed singularly.

(b) Alternatives 1 and 4. As described in paragraph 5.e., the Active components would field BFA-unique systems in the objective system for alternatives 1 and 4. The uniqueness of the computer system involved allows limited contribution to the CCPE.

1. The ability to exchange equipment across BFA is nonexistent because BFA HW would have different physical characteristics, operating systems, and operating procedures. The lack of this ability could severely impede CONOPS on the high-attrition battlefield.

2. The ability to exchange operators across BFA is poor due to the different operating procedures and physical characteristics of unique computers and nonstandard training.

3. The implementation of unique systems causes the parallel (and possibly redundant) development of nonstandard training support packages (TSP) and extension training materials (ETM). The establishment of training in professional development courses for staff users (e.g., Noncommissioned Officer Education System (NCOES), Sergeants Major Academy, Combined Arms and Services Staff School (CAS3), Command and General Staff College (CGSC), and War College) would be stymied by the overhead requirements associated with the procurement and maintenance of many different equipment suites.

4. Maintenance management of several unique computer systems would be extremely complex. Separate stockages of each type of replacement would be necessary. Organic, intermediate direct support, and intermediate general support maintenance would be greatly complicated by the use of several unique systems.

5. Ease of hardware setup will be impaired with the fielding of up to five unique hardware systems. Each hardware system could require the connection of interface devices to facilitate interoperability among all systems. With differing configurations and connections, it is possible that the operator for one system would become the expert on the setup of that system while not knowing how to set up any other system in his CP. The end result would be a requirement for a different operator to set up each computer system, thus increasing the length of time required to get a CP into full operation and increasing the amount of confusion in a CP as a result of the excessive number of people trying to get computers operating. In addition to unique hardware setups, the software used to configure each system could be different and require modification if the equipment configuration is changed or it could require a trial-and-error approach to the connection of peripherals.

6. Management of personnel involved in operating and maintaining a battlefield C2 system would involve increased time and increased difficulty as the number of different systems (and, therefore, different operating and maintaining personnel) increases. For example, if one common system exists with one common type of operator required, then any available operator can be assigned to any operational position. If there are five different systems, then there would be five factorial, or 120, different possible permutations for assigning the five corresponding operators. Only one of these permutations assigns the correct operator to the correct system in all five cases. This situation would cause a significant increase in the time and effort expended in personnel management. (The effects described above are not as significant as they first appear because BFA software will be unique. However, the described effect is present when pertaining to general C2 procedures).

7. Software management involves replacing and updating software. Where unique systems are involved, FL SW would be modified to run on each system. When this SW requires update, configuration

uniformity and interoperability could be extremely difficult to maintain. Each SW version would require individual revision resulting in a high-level, time-consuming effort. Training SW to support each unique system would contribute to the high level of effort required for periodic revisions.

(c) Alternatives 3T/P and 3T. As described in paragraph 5.e., the active component would field CHS for all FL and BFA functions in the objective. The uniformity of the computers across the battlefield in the objective system enhances the contribution of both of the above alternatives to each of the CCPE.

1. Alternatives involving exclusive use of CHS allow an absolute contribution to the ability to exchange equipment across BFA. In emergency situations, this capability augments capabilities for CONOPS so crucial to the dynamic high attrition battlefield.

2. The ability to exchange operators to perform C2 functions across BFA increases as the number of different types of systems fielded decreases. Though BFA technical software will be unique, operating procedures and FL software will be the same across BFAs. Therefore, operators exchanged across BFAs will be capable of fully operating all FL software and may be able to provide minimal assistance with BFA software. The ability to support training software development in terms of standardized scenarios for all training categories would contribute significantly to the ability to exchange operators across BFA.

3. Though BFA technical software will be unique, operating procedures, general characteristics of HW and SW, and the FL software will be the same across all BFAs. This provides the ability to develop standard TSP and ETM in support of new equipment, displaced equipment, and institutional and unit training. This also would allow the establishment of standard professional development blocks of instruction for staff users. These alternatives would contribute significantly to training standardization in all BFAs and at all echelons in supporting CONOPS.

4. Maintenance management of one computer system would be a comparatively simple matter. Only one type of float and one type of stockage would be necessary. Organic, intermediate direct support and intermediate general support maintenance would be much easier to manage.

5. Under alternatives 3T and 3T/P, common hardware and software is used to implement all automated command and control systems. Since the equipment would be identical for each C2 system in a CP, the operator of one system would be capable of setting any system up and getting it operating quickly. Software used in system initiation would be the same and diagnostics and trouble shooting would be identical. Therefore, a single operator could initialize several different systems, thus increasing the efficiency in the CP and freeing other operators to perform other duties.

6. Management of personnel involved in operating and maintaining a battlefield C2 system would be relatively simple. One computer type would require one type computer maintainer/repairer. One type

operator could execute FL software anywhere on the battlefield. [Execution of BFA technical software may also be possible in a degraded mode.]

7. Software management would be greatly enhanced by the use of one type computer. Modification of FL software could be completed without loss of configuration uniformity and interoperability. Modification of only one set of software would be required.

(d) Alternative 2. As described in paragraph 5.e., the active components would field CHS at every BFA except at maneuver. TCT and TCP/AC would be fielded and maintained for FL and BFA C2 at maneuver. MCS software would be ported to CHS for FL C2.

1. The ability to exchange equipment across BFA is hampered only in maneuver forces. MC could not accept replacements from, or provide replacements for, other BFA. The lack of this ability can impede CONOPS.

2. The ability to exchange operators across BFA is hampered by different operating procedures and different hardware for the TCT/TCP/AC than for the CHS.

3. The ease of training is hampered by the unique aspects of the MCS. This is significant when considering the number of proponent mission areas which will use the MCS HW/SW. This alternative would require the parallel and coordinated development of two standardized training programs - one for CHS and one for MCS. The training to support CONOPS at FL and BFA C2 at maneuver would be simpler than alternatives 1 and 4, but more complex than alternatives 3T and 3T/P.

4. Maintenance management would be complicated with the use of more than one system. Separate stockages and floats would be required. Organic, intermediate direct support, and intermediate general support maintenance would be complicated by the use of more than one type of computer.

5. Hardware setup is simplified when compared to alternatives 1 and 4 as there is a maximum of three different sets of computer equipment to be set up in selected CP under this alternative. Two sets of computer equipment would support one automated system, MCS, while all other control systems would be supported by common equipment. This implementation would result in the operator for the MCS equipment being the expert on its setup while any operator of the other control systems could set up the common hardware. The end result is increased efficiency in CPs where more than one automated system is in use because the common equipment could be put into operation by a single operator. Use of common equipment for all but one control system also simplifies the software configurations which would be used in the systems. Diagnostic requirements are reduced because connections and operation are common.

6. Management of personnel involved in operating and maintaining a battlefield C2 system is complicated as the number of types of computers increases. (Reference paragraph g.(1)(b)6.) The management of personnel for three types of computers in the field for this alternative will require significantly more time and

effort than would the management associated with one type of computer. The training of maintenance personnel for one type of computer would be simpler than the training of maintenance personnel for three or more computer types.

7. Software management is enhanced as compared to alternatives 1 and 4 but is not as simple compared to alternatives 3T/P and 3T. Considerations of configuration uniformity and interoperability for more than one set of software increases the level of effort significantly.

(2) Reserve component (RC) automation capability.

(a) The level of fielding of C2 automation equipment is the same regardless of which alternative is selected. The proponent for force-level C2 has determined that a FLCS capability must exist in the RC regardless of the alternative selected. Therefore, the MCS will require sufficient equipment to provide the RC an automated force-level capability down through the division level where BFA fielding does not support the capability. The comparisons among the alternatives for RC automation capability are CONOPS, ILS, cost, and approximately one year earlier fielding of alternatives 2, 3T/P, and 3T.

(b) There will be a 100 percent automated force-level C2 capability down through division level in the RC for each alternative. A difference in RC hardware will be determined by the Active component objective system and residual hardware of the selected alternative. (Reference figures 5-3 and 5-4.)

1. Alternative 1. Active component interim force-level control system (IFLCS) TCPs will be available to provide an automated FLCS at the maneuver, AD, and IEW BFAs. The TCP/ACs will interface with FS and CSS unique hardware to provide the RC automated FLCS.

2. Alternative 2. Active component IFLCS TCPs will provide an automated FLCS at the manevuer, AD, and IEW BFAs. The TCP/ACs will interface with FS and CSS CHS to provide the RC automated FLCS.

3. Alternative 3T/P. Active component IFLCS TCTs and TCP/ACs will be available to provide an automated FLCS at the maneuver, AD, and IEW BFAs. The TCTs and TCP/ACs will interface with FS and CSS CHS to provide the RC automated FLCS.

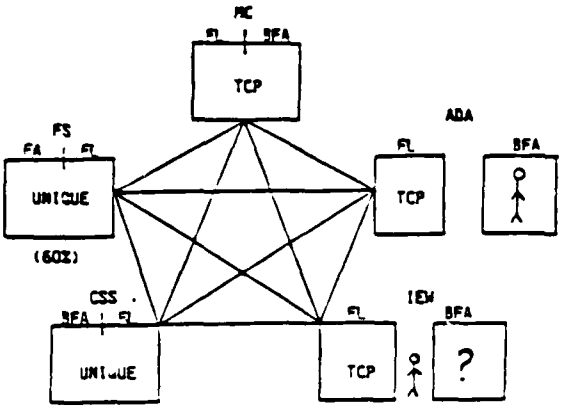
4. Alternative 3T. Active component TCTs (at the maneuver BFA) and additionally purchased CHS for all five BFAs will be available to provide the RC automated FLCS.

5. Alternative 4. Additionally purchased "new" hardware at the maneuver, AD, and IEW BFAs and unique hardware at the FS and CSS BFAs will provide the RC automated FLCS.

(c) Each RC BFA will have the following C2 capabilities for <u>each</u> alternative (reference figure 5-4.)

1. There will be a 100 percent MC capability for each alternative by purchasing additional hardware for all but alternative 3T/P.

ALTERNATIVE 1



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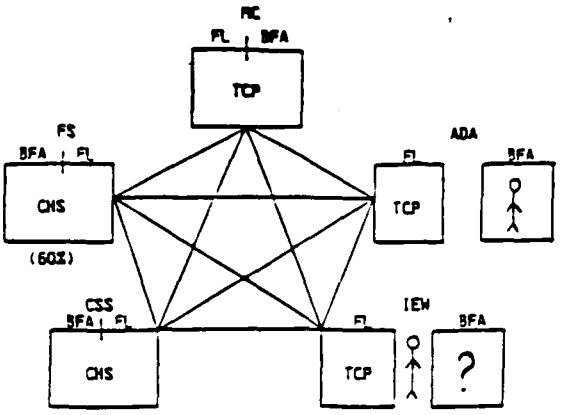
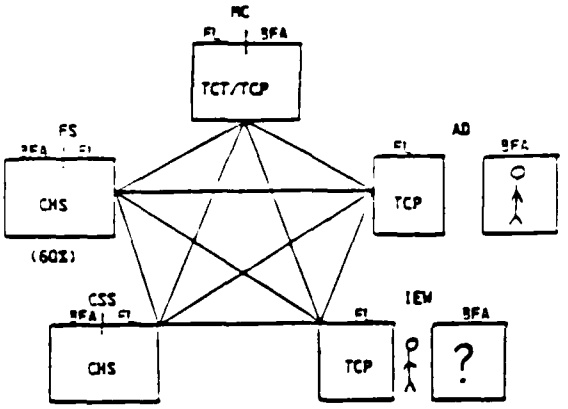


ALTERNATIVE 3T/P



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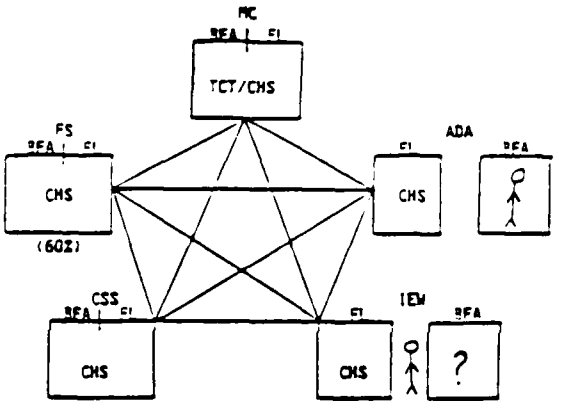
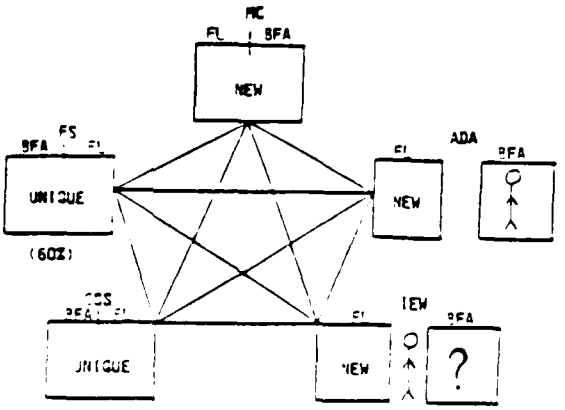


ALTERNATIVE 4



: MANUAL INTERFACE

: MANUAL SYSTEMS

Figure 5-3. Reserve component configuration

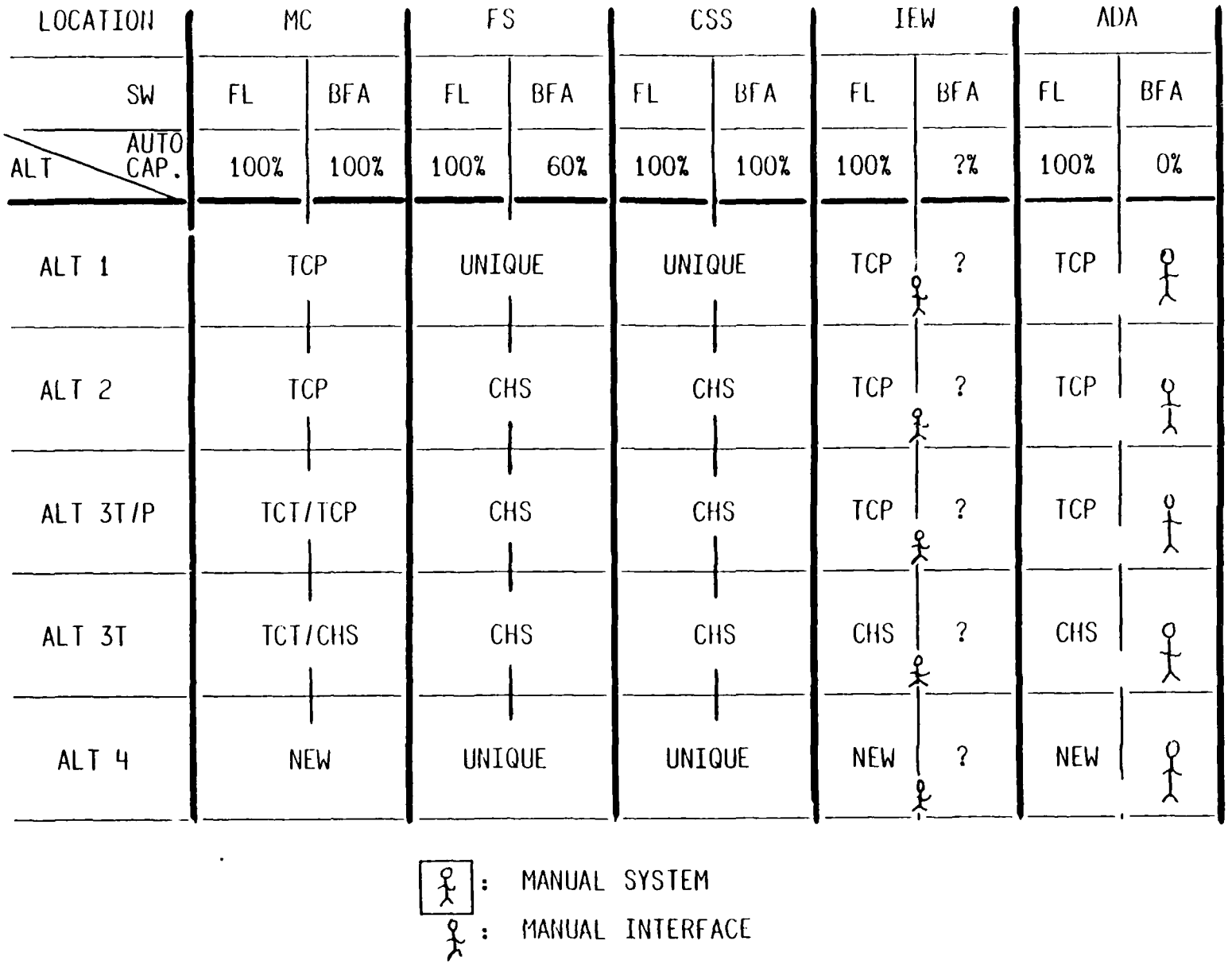


Figure 5-4. Reserve component capabilities

(Additionally purchased hardware is not necessary in alternative 3T/P, residual hardware from the Active component will be used.)

2. All field artillery units will be issued approximately 60 percent of their automation requirements.

3. There will be no AD BFA technical automation capability in the RC.

4. All CSS units will be fielded with 100 percent of their automation requirements.

5. The IEW functional C2 automation will be provided to the RC.

(d) The cost of additional purchases for hardware and refurbishment of residual Active component hardware is being determined by Army Materiel Command (AMC). The cost comparisons of the alternatives will include RC costs.

(e) Fielding time of RC automation is dependent on Active component fielding time, as residual or additional hardware is required for all RC alternatives. Since unique hardware will require a one-year longer development time compared to CHS, alternatives 1 and 4 will be potentially available one year later than alternatives 2, 3T/P, and 3T.

(f) Conclusions regarding RC automation.

1. Alternative 3T is clearly the least complex (fielding CHS at all BFAs, with TCTs as part of the MCS). This alternative would simplify training and logistics. Simplicity is sorely needed in the RC due to their limited available training days per year.

2. Since alternative 3T has CHS for all except a portion of MCS, a comparison of cost to refurbish TCTs vs cost to buy additional CHS should be made. The purchase of a common system for the total Army would enhance interoperability, CONOPS, survivability, training, and logistics, and may be less expensive. Further, a similar comparison should be made for alternative 3T/P, as it may be more cost effective to buy CHS in lieu of refurbishing TCT and TCP/AC.

(3) Alternatives' fielding timelines.

(a) General. Figure 5-5 illustrates the projected fielding schedules for each alternative. A description of the chart shown in figure 5-5 follows.

1. Column one lists the alternatives.

2. Column two lists the years in which the first Active component corps will receive a portion of the MCS. Partial automation is provided by the TCT in each case. The TCT provides: automated C2 between TAC and main CPs; automated maneuver C2 vertically (stovepiped) from corps to division to maneuver brigade and back up; and automated C2 laterally across corps, division, and brigade headquarters. TCT fielding does not provide an automated C2 capability among the BFA.

1	2	3	4	
			FLCS	
			a	b
ALTERNATIVE	PARTIAL AUTO MCS ONLY (TCT)	IFLCS (TCT & TCP)	FIRST CORPS	LAST CORPS
ALT 1	87	88	93	97
ALT 2	87	88	92	96
ALT 3T/P	87	88	92	96
ALT 3T	87	NA	92	96
ALT 4	87	NA	93	97

Figure 5-5. Fielding schedule

3. Column three lists the years in which the initial corps for alternatives 1, 2, and 3T/P will receive an automated interim force-level control system (IFLCS). An automated IFLCS is achieved through the use of TCP/AC and supporting software. An IFLCS provides a full automated MCS and an automated FL C2 capability at the other four BFA. IFLCS does not include an automated interface with BFA control systems.

4. Column 4a shows the year the initial corps and its subordinate units will be fielded with a force-level control system (FLCS) for each alternative. A FLCS provides all the capabilities provided by the IFLCS plus the added capability for an automated interface with BFA C2 systems which interface with their respective subordinate automated and manual systems (i.e., the full CCS2 capability).

(b) The TCT will be fielded in 1987. Therefore, as shown in figure 5-5, each alternative will have a partially automated MCS in 1987.

(c) Alternatives 1, 2, and 3T/P each begin receiving TCP/ACs in 1988. Alternatives 3T and 4 never receive a TCP/AC nor a replacement for the TCP/AC and, therefore, never have an automated IFLCS.

(d) Alternatives 1 and 4 receive a FLCS in the initial corps in 1993. This is an optimistic estimate of the fielding date for a system based on BFA-unique hardware/software. Based on the fielding schedule of approximately one corps per year, fielding should be complete in 1997.

(e) In accordance with the anticipated CHS fielding schedule, alternatives 2, 3T/P and 3T receive CHS and all required BFA and FL software (and therefore an automated FLCS) in the initial corps in 1992. The last corps will be fielded completely in 1996.

(4) BFA concerns. To determine the concerns of BFAs for each of the alternatives, questionnaires were sent out to each of the schools requesting their input. The concerns presented here are a result of that survey. Concerns determined to be nondiscriminating between the alternatives are addressed in paragraph 5.g.(5)(b) below.

(a) Alternatives 1 and 2. The concern expressed by BFA surveys was the lack of standardization. Surveys reflected a concern that nonstandardized systems would overload logistics.

(b) Alternatives 2, 3T/P, and 3T. Processing speed has been expressed as a concern for each of the alternatives requiring CHS. Particularly, air defense has been concerned that CHS would not fulfill their requirement for high processing speed. However, by streamlining software, the software could be made more efficient and equally as effective.

(c) Alternative 4. Same concerns as alternative 1.

(5) Other significant findings. Throughout the conduct of the ATCCS benefit analysis, significant information was uncovered which either did not necessarily fit into any of the categories for the comparison of the

alternatives or it was determined to require further emphasis. This information is provided here in two categories: alternative discriminators and nondiscriminators.

(a) Alternative discriminators.

1. CHS.

a. CHS will be achieved by proven, off-the-shelf, nondevelopmental items, thus reducing developmental and testing requirements. This is expected to result in significantly lower cost and reduced fielding times.

b. The predicted reduced logistics tail produced by commonality of components in CHS is a result of reduced stockage levels; training requirements; acquisition, testing, and evaluation needs; software configuration management costs and time; and communications adaptability (protocols) needs.

c. CHS enhances field reconfiguration capabilities. When special protocols are not a consideration in networking (as they would be if using unique systems) reconfiguration can occur much easier to reflect either updated CP configurations or new CP configurations made necessary by losses during battle.

d. The use of common hardware increases the amount of common software usable by all functional areas. Though BFA technical software will be unique, there will be some common software applications even here (e.g., USMTF parsing routines).

e. Interoperability implementation and testing will be much simpler with CHS.

f. CHS could lock the government in to one contractor (sole source). While examining proposals, care must be taken to analyze not just the costs of fielding, but all lifetime costs and potential costs to replace losses incurred in battle.

g. CHS is possibly not the best solution for each BFA taken in isolation. The potential for CHS to fail to satisfy a BFA requirement (e.g., processing speed) exists. However, no BFA proponent reflected a great concern over this potential, but they showed more concern over a potential for nonstandard equipment.

2. TCP.

a. TCPs provide an initial FLCS. Without TCP/ACs, there will be no automated FLCS until the objective system is in place (1992 or 1993)--a wait of five to six years for the first corps fielded and up to ten years for the last corps fielded. This incurs risk for the Army, which might be forced to enter battle both outnumbered and without the automation assistance necessary for rapid C2 needed to support the synchronization required to execute AirLand Battle doctrine.

b. TCP/ACs provide a training instrument for soldiers. Even though an objective system will likely have different operating procedures, the existence of a computer in tactical units now will play an essential part in training preparation for the objective system in two ways:

- Eliminates fear of computers from soldiers who may have had few previous experiences with computers.

- Establishes a basic understanding of the way in which computers operate.

c. TCP/ACs could begin the evolutionary change in the structure of the tactical staff organization which may take place to increase the efficiency of the staff by maximizing the capabilities of the automated equipment.

3. Unique systems.

a. Unique systems should meet all BFA-unique and specific requirements.

b. Unique keyboards could be specifically designed to simplify the conduct of certain BFA functions.

c. Unique programming languages may simplify the coding of software for BFA technical functions.

d. Unique systems create networking and communication protocol problems. Joint and combined interface requirements will impose complicated communication protocol problems.

e. BFA-unique systems, though potentially maximizing efficient automation of BFA-unique requirements, do not approach the C2 problem systemically. If the goal is to maximize the capabilities/efficiency of the total Army, a systemic rather than a parts approach is much more likely to achieve that goal.

(b) Alternative nondiscriminators.

1. Maintenance system. Under the proposed maintenance system, the lowest replacement unit (LRU) at the organizational maintenance level would be the entire computer (30 to 60 pounds, 10 to 15 cubic feet). Maintenance would be provided at the contract maintenance facility. This maintenance concept means that when a computer system stops working, the user exchanges the inoperative LRU for a functional LRU at the direct support maintenance unit. The DS maintenance unit then evacuates the inoperative LRU through maintenance channels to the contractor maintenance facility. This maintenance concept has the potential for greatly overloading the logistics system because of the requirement to move large units back and forth from a contractor maintenance facility. In a mature theater, such as Europe, a contractor facility may presently or quickly become available close enough for land transport. However, in contingency theaters, such as Southwest Asia, aircraft will be

required to transport the LRU back and forth from contractor maintenance. Requirements for aircraft will greatly increase the cost to the Army for the maintenance of the system. Also potentially hinged on the contractor maintenance concept is the issue of operational floats. Given the turnaround time for an entire computer to travel to the contractor facility and then back to the DS maintenance unit, that maintenance unit may need more operational floats than would normally be needed under current electronic maintenance concepts. A maintenance concept which allows someone in the maintenance chain prior to the contractor to replace faulty components would greatly reduce the above described stress on the logistics system. Replacing some computer components is not a terribly difficult task and could be completed by DS maintenance unit soldiers currently performing electronic maintenance.

2. There will be no C2 equipment built to military specification (MILSPEC). This definitely reduces the cost. However, this equipment will be on the front line of a battle. The computers will be exposed to all the condition extremes found on the battlefield. Though outside the scope of this study, the lack of MILSPEC C2 equipment on the battlefield has been the cause for much concern.

3. None of the alternatives have FAADC2I fielded to the RC. The effects of this void on the effectiveness of the total force has not been determined and has been a source of concern.

4. An additional finding is the potential for much improved C2 capabilities by the fielding of common hardware for subordinate systems. This conclusion is based on logistics considerations, CONOPS considerations, and training considerations as described in the CCPE. Improvements in C2 generated by fielding common hardware for subordinate systems are much the same as those improvements made by fielding common hardware across the BFAs and in the RC. Also, based on considerations of unit cost, the potential exists for costs savings. However, because this subject is beyond the scope of this study, it will not be addressed in more detail.

(6) *Comparison of alternative benefits.*

(a) General. Based on discussions in previous chapters, a comparison of the alternatives is presented here. Reference figure 5-6 for a summary of the attributes of the alternatives. Reference figure 5-7 for a generalization of the attributes of the alternatives. The decision criteria on which the alternatives are being compared have been assigned weights by the ATCCS CBA study advisory group. Though those weights will not be used here in a quantifiable fashion, the relative importance of the decision criteria will be used to make the comparison between the alternatives. (Reference appendix G for the quantitative assessment).

(b) CCPE. In paragraph 5.g., the alternatives were each compared to the CCPE. Based on this discussion, a rating of good, fair, or poor was assigned for each alternative and is shown in figure 5-6 and figure 5-7. Both alternatives 3T/P and 3T are rated good in the CCPE column as they both

ALT	MEASUREMENT OF CHARACTERISTICS, CAPABILITY, PERFORMANCE, AND EFFECTIVENESS	FIELDING TIMES			RESERVE COMPONENT CAPABILITIES	BFA CONCERNS
		AUTO MCS	AUTO IFLCS	AUTO FLCS		
1	POOR	87	88	93	TCP/UNIQUE	NONSTANDARDIZATION
2	FAIR	87	88	92	TCP/CHS	NONSTANDARDIZATION PROCESSING SPEED
3T/P	GOOD	87	88	92	TCP/TCT/CHS	PROCESSING SPEED
3T	GOOD	87	--->	92	TCT/CHS	PROCESSING SPEED
4	POOR	87	--->	93	TCT/NEW/UNIQUE	NONSTANDARDIZATION

Figure 5-6. Summary of alternatives attributes

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

Figure 5-7. Generalized summary of alternatives' attributes

compared very well against the CCPE. The CCPE were determined to be the most important of the criteria. CCPE were determined to be so relatively important that ratings of poor, as in alternatives 1 and 4, are considered unacceptable.

(c) Fielding times. Fielding timeliness of an IFLCS was considered second in importance to CCPE. Obviously, a line can easily be drawn through the alternatives which separates the alternatives into two categories--one which receives an IFLCS in 1988 and one which does not receive an IFLCS capability but must wait until the fielding of the FLCS in 1992 or 1993. As previously discussed, this lack of an automated IFLCS over such an extended period of time is considered to impose great risk upon the Army. Alternatives 3T and 4 are unacceptable based on this risk.

(d) The automated C2 capability of the RC for alternative 3T is fair to good, for alternative 2 and 3T/P is fair, and for alternatives 1 and 4 is poor based on CONOPS, ILS, training considerations, and fielding times as discussed in paragraph 5.h.

(e) BFA concerns provide little distinction between the alternatives and are rated relatively low when compared to the other decision criteria. The lack of standardization has been previously addressed in the CCPE. The problem of processing speed may be remedied through the streamlining of software. [The IEW BFA proponents 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 system; therefore, this BFA concern is not listed as it is nondiscriminating between the alternatives.]

6. Conclusions.

a. Alternative 3T/P rates relatively highest in every category except RC capabilities. It provides a high rating against the CCPE, it fields MCS, IFLCS, and FLCS at the earliest possible time, and it provides TCT/TCP/AC to the reserves at the earliest possible date. The CONOPS/ILS/training capability for the RC are slightly degraded as compared to alternative 3T because more different types of systems are in use. This difference is not significant enough to lower the relative rank of alternative 3T/P based on the importance of the other decision criteria. [The capabilities of the RC would be improved by purchasing CHS for all RC BFAs. Based on increased capability afforded the total Army, this analysis indicates that the benefits gained by the fielding of CHS outweighs any initial cost savings of retaining TCT/TCP/AC. Further tradeoff analysis will be conducted in the cost/benefit comparison analysis.] Alternative 3T/P does reveal a concern from the BFA regarding processing speed; however, a method for solving this problem, streamlining software, has already been addressed.

b. Alternative 2 is ranked second. Alternative 2 receives a fair mark against the CCPE. The impetus for the fair mark is the nonstandard equipment; this also shows up in the BFA concerns. This analysis implies that the increased benefits of having an entirely standard system outweigh any potential cost benefit for retaining TCT/TCP/AC in the Active component (considering refurbishment and maintenance concerns). Further tradeoff analysis will be conducted in the cost/benefit comparison analysis.

c. Alternative 3T, though rating the highest possible under the CCPE, is disqualified due to the lack of an IFLCS until 1992. (The IFLCS would not be

complete for five years.) Alternative 3T shows enhanced RC capabilities, but not of significant enough proportions to make up for the late fielding of the IFLCS.

d. Alternatives 1 and 4 are ranked last. They are unacceptable due to the poor rating against the CCPE. CCPE represent the ability of the system to function effectively in the field. To be rated poorly here is unacceptable. Alternative 4 is further disqualified based on the lack of an IFLCS until 1993.

e. The fielding of common hardware for subordinate systems will provide the same types of improvements in C2 capabilities as the fielding of common hardware across BFAs and to the RC.

7. Recommendation. We recommend the implementation of alternative 3T/P and that CHS be fielded to the RC in total.

APPENDIX A

STUDY TASKER

SGS _____	CGSC X	35ID _____
GCOR _____	TRAC X	9020 _____
ISC X	USDB _____	CID _____
CACDA X	AMMO _____	REDDAC _____
CATA _____	SSO _____	DENTAC _____

FEAD PAGE 01
FA49
Dir, R&AD
Adj
Dir, TRAC-FLVN
V/G
STSD
SAD
RMD
Dir, TRAC-WSMR
TRAC-MTRY
TRAC-LL

RTTUZYUW RUCLAIA1601 0022150-UUUU--RUWTFHA.
ZNR UUUUU
R 0220452 JAN 87
FM CDR TRADOC FT MONROE VA //ATCD-CC//
TO RUWTFHA/CDR COMB ARMS CBTDEV ACTV FT LEAVENWORTH KS //ATZL-CAC-CC//
RUWTFHA/CDR TRAC FT LEAVENWORTH KS //ATRC-FS//
INFO RUEADWD/DA WASHDC //SAUS-OR/DAIM-ADC-A/DAMO-FDR//
RUKLDAR/CDR AMC ALEX VA //AMCDE-S/AMCDE-E//
RUWTFHA/CDR TRAC FT LEAVENWORTH KS //ATRC/ATRC-TD//
RUWJMTA/DIR TRAC WSMR NM //ATRC-WC/ATRC-WS//
RUEOAGE/CDR USALOGC FT LEE VA //ATCL-SC//
RUWTROA/CDR USAFAC FT SILL OK //ATSF-TSM//
RUWTKDA/CDR AD ARTY CEN FT BLISS TX //ATSA-TSM-F//
RUKGNTE/CDR OTEA WASH DC //CSTE-ZA//
RUCLFUA/CDR USAAVNC FT RUCKER AL //ATZQ-CD//
RUCLDIA/CDR SIGCEN FT GORDON GA //ATZH-CD//
RUCLDNA/COMDT INFSCH FT BENNING GA //ATSH-CD//
RUCIHAA/CDR USAARMC FT KNOX KY //ATZK-CD//
RUCLBWA/COMDT MPSCH FT MCCLELLAN AL //ATZN-MP-C//
RUCLHWA/COMDT CMLSCH FT MCCLELLAN AL //ATZN-CM-C//
BT
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0000
SUBJECT: ARMY TACTICAL COMMAND AND CONTROL SYSTEMS (ATCCS) COMMON HARDWARE AND SOFTWARE

1. PURPOSE. THIS MSG TASKS CACDA TO DO AN ABBREVIATED ANALYSIS (AA) FOR THE ATCCS COMMON HARDWARE AND SOFTWARE. THE ANALYSIS WILL SUPPORT A DESIGNATED ACQUISITION PROGRAM (DAP) MILESTONE III PROCUREMENT DECISION.
2. BACKGROUND. THE ROC WAS APPROVED AT HQ DA ON 8 DEC 86 WITHOUT A COEA. ALTHOUGH THE ARMY HAS DECIDED TO FIELD THE ATCOS COMMON HARDWARE AND SOFTWARE, HQ DA REQUIRES AN ANALYSIS PRIOR TO INITIATION OF THE FINAL PROCUREMENT ACTION.
3. PROBLEM. THE ARMY REQUIRES BASIC BUILDING BLOCKS OF COMPUTER HARDWARE AND SOFTWARE FOR THE MCS, CSS CONTROL SYSTEM, FAADS C2I, AND BFATUS. ASAS IS NOT INCLUDED INITIALLY. AN ANALYSIS IS NEEDED TO DETERMINE THE EXTENT TO WHICH A COMMON COMPUTER STRATEGY IS IMPLEMENTABLE, AND THE ASSOCIATED COSTS AND BENEFITS. COMMON COMPONENTS MAY NOT MEET ALL FUNCTIONAL REQUIREMENTS. THEREFORE, BATTLEFIELD FUNCTIONAL AREA (BFA) SYSTEM PROPONENTS ARE TO IDENTIFY

ROUTINE

AND PLAN FOR SPECIAL REQUIREMENTS ON A SYSTEM-BY-SYSTEM BASIS IN THE INDIVIDUAL ANNEXES TO THE CAPSTONE ROC. THE AA WILL NEED TO

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CONSIDER USER REQUIREMENTS FOR HANDHELD, PORTABLE, OR TRANSPORTABLE SYSTEMS (COMMERCIAL OR RUGGEDIZED) TO DETERMINE THE QUANTITIES OF EACH TO BE COSTED.
4. ISSUES.
A. WHAT COMMON HARDWARE AND SOFTWARE IS REQUIRED BY EACH USER IN TERMS OF THE HANDHELD, PORTABLE, AND TRANSPORTABLE VERSIONS (INCLUDE IDENTIFICATION OF COMMERCIAL OR RUGGEDIZED REQUIREMENTS)?
B. WHAT ARE THE BENEFITS OF EACH ALTERNATIVE FROM AN ILS, CONOPS, AND TRAINING PERSPECTIVE?
C. WHAT ARE THE COSTS ASSOCIATED WITH FIELDING THE COMMON SYSTEM VERSUS THE COST OF FIELDING BFA UNIQUE SYSTEMS?
D. WHAT ARE THE COST AND PROGRAM IMPLICATIONS OF PORTING ALREADY DEVELOPED BFA SOFTWARE TO COMMON HARDWARE?
5. SCOPE. THE AA WILL BE LIMITED TO A COST AND BENEFIT ANALYSIS WHICH INCORPORATES THE IDENTIFICATION OF ATCCS COMMON HARDWARE/SOFTWARE REQUIREMENTS. THIS IS A NON-MAJOR STUDY. CACDA CSI IS THE STUDY AGENCY. TRAC HAS IDENTIFIED TRAC-FT LEAVENWORTH TO PROVIDE GENERAL ANALYTICAL SUPPORT AND QUALITY ASSURANCE. TRAC-WSMR WILL PROVIDE COST ANALYSIS SUPPORT. STUDY ADVISORY GROUP (SAG) IS NOT REQUIRED.

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6. ALTERNATIVES. AS A MINIMUM, THE ANALYSIS WILL CONSIDER THE FOLLOWING ALTERNATIVES:
A. RETAIN UNIQUE BFA SYSTEMS AND PROVIDE NECESSARY SOFTWARE TO SUPPORT COMMAND AND CONTROL FUNCTIONS.
B. FIELD ATCCS COMMON HARDWARE AND SOFTWARE AND DEVELOP OR PORT BFA-UNIQUE SOFTWARE.
C. THE STUDY AGENCY MAY DEFINE OTHER ALTERNATIVES IN THE STUDY PLAN.
7. MILESTONES. PREVIOUSLY ESTABLISHED MILESTONE FOR FINAL REPORT TO HQ DA HAS BEEN EXTENDED SINCE THE AA WILL SUPPORT THE MILESTONE III DECISION CURRENTLY PROJECTED FOR SEP 87.
A. TASKER: 28 DEC 86.
B. STUDY PLAN: 30 JAN 87.
C. FINAL REPORT TO HQ TRADOC: JUN 87.
D. FINAL REPORT TO HQ DA: JUL 87.
8. HQ TRADOC POC IS MR. POYNTER, AUTOVON 680-3466. TRAC MONROE POC IS MR. MURRAY, AUTOVON 680-2208.
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#1601

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ROUTINE

APPENDIX B

ESSENTIAL ELEMENTS OF ANALYSIS

*1. What alternatives exist for implementation of an automated ATCCS?

2. What are the BFA hardware requirements by:

a. Quantity and battlefield location?

b. Handheld, portable, and transportable?

c. Commercial and ruggedized?

*3. What are the benefits of each alternative?

a. What benefits are realized by equipping the USAR with the MCS block I?

b. What are the interoperability (across BFA systems and BFA system to FL system) benefits associated with each alternative?

c. How does each alternative contribute to continuity of operations (CONOPS)?

d. How does each alternative contribute to an integrated logistics support plan (ILSP)?

e. How does each alternative contribute to survivability?

f. What are the benefits of converting existing BFA technical/unique software to operate with common hardware?

g. What is the benefit to the Army of equipping the Active components with MCS block I and block II as an interim measure prior to the fielding of an objective HW/SW system.

4. What are the life cycle and comparative costs of each alternative?

a. What is the estimated cost for the fielding of the hardware?

b. What is the estimated cost for the software for each alternative?

(1) What are the FL/common software costs?

(2) What are the BFA technical/unique software costs?

c. What are the estimated maintenance costs associated with each alternative?

d. What are the estimated training costs associated with each alternative?

*5. What other nonquantifiable properties (benefits and disadvantages) are associated with each alternative?

a. What are the capabilities, within each alternative, for smooth transition by a commander from one node to another? (As if forced by command post (CP) destruction.)

b. How efficient for use is the equipment associated with each alternative, particularly under the heat of battle?

c. What are the lost capabilities (force effectiveness, interoperability, C2, etc.) associated with an interim system without the MCS block II?

d. What are the nonquantifiable attributes of equipping the Active Army components with only MCS block I as an interim measure?

e. What loss is there to the RC if the MCS block II is not available for their use?

**6. What conclusions/recommendations can be drawn from a comparison of the alternatives?

**7. What is the relative ranking of the alternatives?

**8. What is the recommended alternative based on the CBA?

* Indicates EEA addressed by the benefit analysis.

** Indicates EEA partially addressed by the benefit analysis. Final assessment will be made in cost/benefit comparison analysis.

APPENDIX C

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14. United States General Accounting Office. Fact Sheet for Congressional Requesters, "Battlefield Automation - Status of the Army Command and Control System Program." Washington, DC: August 1986.

APPENDIX D

DISTRIBUTION

	No. of Copies
US Army Combined Arms Combat Development Activity ATTN: ATZL-CAC-D Fort Leavenworth, Kansas 66027-5000	1
Defense Technical Information Center ATTN: DTIC-TCA Cameron Station Alexandria, VA 23314	2
US Army Library Army Study Documentation and Information Retrieval System (ASDIRS) ANRAL-RS ATTN: ASDIRS Room 1A518, The Pentagon Washington, D.C. 20310	1 1
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APPENDIX E

ROC/O&O PLAN ANALYSIS

1. A review of the December 1987 required operational capability (ROC) for the family of Army tactical command and control systems (ATCCS) was performed. The ROC contains the following annexes:

a. Coordination.

b. Operational and organizational (O&O) plan for the family of ATCCS.

c. ROC for the family of ATCCS common hardware and software.

d. Maneuver control.

e. Fire support.

f. Air defense.

g. Intelligence and electronic warfare.

h. Combat service support.

2. The following comments are provided.

a. Paragraph 5.b.(3). This paragraph states the requirement for horizontal flow of information among the battlefield functional areas (BFAs). Nowhere in this document nor the July 1985 O&O plan for the MCS is there a direct requirement for vertical and lateral flow of information for the BFAs. Since vertical and lateral flows of information are key concepts of the command, control, and subordinate systems (CCS2) architecture, these information flow requirements should be specified in this ROC.

b. Paragraph 5.b.(21). The term "graceful degredation" is used frequently and loosely when describing Army command and control systems. The term should be defined in a requirements document.

c. Paragraph 5.b.(9). Along with the described software requirements, the user should be allowed to set individual thresholds. The thresholds would send a message to the screen to warn the user that a resource capacity has gone below its threshold. This should be individually set because each commander has unique decision points.

d. Paragraph 5.b.(16). Data regarding the enemy should also be saved for use in trend/projection analyses. This is similar to watching 4 to 6 hour snap shots of weather fronts to predict future weather patterns. This could be extremely useful to predict future enemy action.

e. Annex B, paragraph V.A: C2 functions should either be described here or referenced where they may be found.

f. Annex B, paragraph V.B: BFA C2 requirements should either be described here or referenced where they may be found.

g. The five BFA annexes have not been published. Since these are integral to the ATCCS, they should be required by the end of CY 87 to be available for review and preparation of the March 1988 ATCCS CHS milestone III decision.

h. Three additional annexes should be added: the three communication systems that are also integral to ATCCS.

APPENDIX F

ATCCS CBA STUDY METHODOLOGY

1. General. Figure F-1 shows the flow of the ATCCS CBA study methodology. A brief description of each step within the methodology is provided below. The benefit analysis encompasses up to and including step 11. The follow-on steps will be conducted in a later effort.

2. Develop a study plan. A study plan was written to document the problem and to describe the ATCCS CBA objectives and methodology. The study plan was approved by the SAG, Director C3I CACDA, Director TRAC-FLVN, and Commander CAC.

3. Literature sea·ch. A literature search was conducted focusing on analytical comparison techniques, past COEA/CBA/AA, contents of CBA, and histories of each of the C2 systems addressed in each of the alternatives.

4. Define ATCCS automation alternatives. Based on the historical perspective gained during the literature search, several different ATCCS automation alternatives were developed. Though the tasking message expressed only two alternatives, the study agency was allowed to develop other alternatives as appropriate. The two alternatives expressed in the tasking message were 1) all unique systems and 2) a common hardware and software system. The study team developed five alternatives considering both interim and objective systems. The alternatives were approved in the study plan and by the SAG. The alternatives are discussed in paragraph 5.e. in the main report.

5. Determine costs for each alternative. Two basic types of costs were required. The life cycle cost estimate (LCCE) for the unique systems and the LCCE for the CHS. CHS costs were requested from CECOM. Unique system costs were requested from the individual system PMs (AFATDS, FAADC2I, CSS/CS, MCS). These costs were generated based on the following assumptions.

a. The Army tactical command and control system (ATCCS) common hardware/ software (CHS) program has been terminated; the individual PMs (OPTADS, AFATDS, FAADC2I, ASAS, and CSSCS) now have to develop their own systems using state-of-the-art computers and the Ada programming language.

b. Each individual PM is responsible for acquiring their own computers, writing their own software, and ensuring that their system will interoperate with the other four systems. Additionally, each system must work on existing or planned tactical communications systems.

6. Determine comparison methodology.

a. Three basic comparison methods must be employed in the ATCCS CBA. They are quantitative comparison of benefits, verbal comparison of benefits, and cost/benefit comparison. Following is a brief discussion of each.

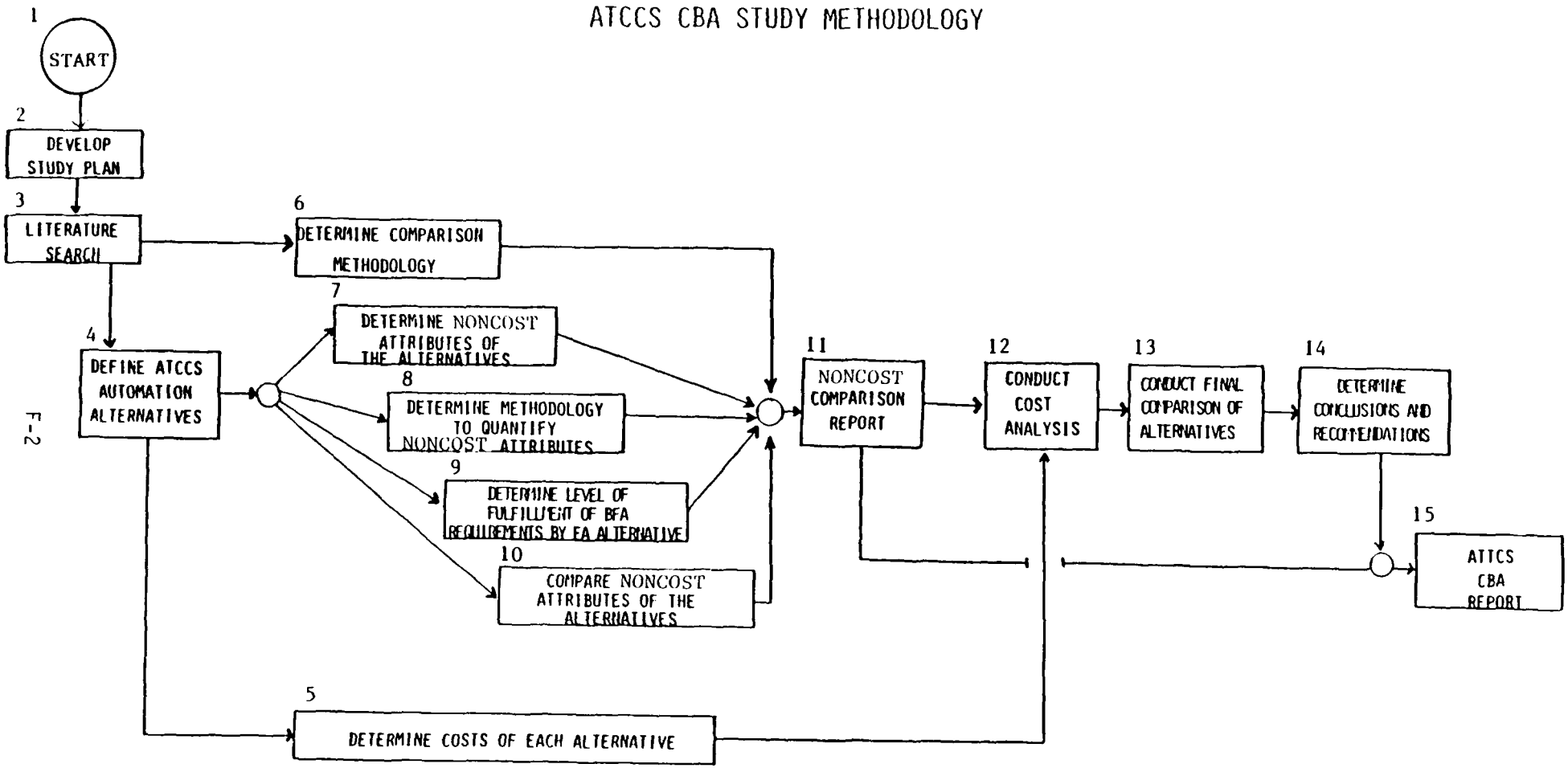

Figure F-1. The ATCCS CBA study methodology

b. Initially, the method by which the alternatives were to be compared was through a subjective quantification of the alternatives' contribution to each of the noncost decision criteria. To accomplish this, all noncost attributes were quantified through the TRADOC-approved methodology of pairwise comparisons. The SAG determined that the quantitative comparison should not reside in the main body of the report; therefore, a thorough description of the methods used and the results may be found in appendix G.

c. The verbal method of comparison is found in the main body of the report. This method displays all pertinent noncost information, describes the comparison, and presents the conclusions and recommendation in a literary manner. This method was determined best by the SAG for presentation in the main report. The basis of the verbal comparisons is the quantitative assessments.

d. Cost/benefit comparison. The projected methods by which the costs and benefits may be integrated are as follows. [The following methodologies were not employed in the benefit analysis, but will be employed in the follow-on cost/benefit comparison.]

(1) If the rank order of benefit and cost analyses are the same, then the CBA rank order is obvious.

(2) If rank orders are different, a tradeoff assessment of costs and benefits will be conducted and presented at the final SAG meeting for a decision.

7. Determine noncost attributes of the alternatives. Contributions of alternatives, in an AA such as the ATCCS CBA, are measured against system characteristics, capabilities, performance, and effectiveness (CCPE). The CCPE were determined based on the tasking message and the ATCCS umbrella ROC. The CCPE were approved by the SAG. Other noncost attributes were determined to be relevant to the decision: fielding times, RC capabilities, and fulfillment of unique BFA requirements. This information was gathered through the BC2SR, system descriptions, BFA proponent fielding strategies, and surveys of BFA proponents.

8. Determine methodology to quantify noncost attributes. The noncost attributes were quantified in order to allow a mathematical comparison of the alternatives. The methods employed are the eigenvector method and multi-attribute decision theory. A description of the methods and results may be found in appendix G.

9. Determine level of fulfillment of BFA requirements. BFA schools and centers were tasked to supply lists of requirements unfulfilled by each of the alternatives. Response may be found in paragraph 5.g.(4) in the main report.

10. Compare NonCost attributes of the alternatives. Comparisons were conducted in two ways: quantitatively and literally. Comparisons were based on the decision criteria established in paragraph 5.f. in the main report. The quantitative comparison is found in appendix G. This step in the methodology is the last to be documented in this report.

11. Noncost comparison report. The benefit analysis is documented in this technical document.

12. Conduct cost analysis. TRADOC Analysis Command-White Sands Missile Range (TRAC-WSMR) will provide a cost analysis on the cost data. A cost analysis ensures consistency and determines cost drivers and sensitivities. [Published separately.]

13. Conduct final comparisons of alternatives. The final comparison of alternatives combines costs and benefits for the final examination. [Published separately.]

14. Determine conclusions and recommendation. Final conclusions and recommendations are drawn based on the final comparison. [Published separately.]

15. ATCCS CBA report. A final report will document the above processes and results. [Published separately.]

APPENDIX G

QUANTITATIVE ASSESSMENTS

1. General. This appendix documents the quantitative assessments which support the literal discussion of the ATCCS automation alternatives in the main body of this report. The steps taken to quantify the comparison of the alternatives are listed below with a discussion of the methods employed and a presentation of the results.

2. Measures of systems' characteristics, capabilities, performance, and effectiveness (CCPE). As discussed in paragraph 5.g., CCPE are used in place of MOE in abbreviated analyses (AA) such as the ATCCS CBA. The CCPE are used to compare objective systems only. RC capabilities and interim systems are considered separately. Because the alternatives' contribution to the CCPE cannot be determined through a force-on-force simulation (due to restrictions imposed by the definition of an AA), these data are drawn from system descriptions and expert judgment. To determine a "CCPE score" for the objective system within each alternative, first, the alternatives were assigned scores representing contributions to each CCPE. Second, weights were assigned to the CCPE representing relative importance. To compute the CCPE score for each alternative, multiattribute decision theory was applied.

a. Alternatives scored against CCPE. Requests were sent to all SAG members for input. Figure G-1 shows the comparison matrix as well as the rating scale to be used. All SAG members were to complete the matrix using the rating scale. Also included was a description of the alternatives and the definitions of the CCPE. An example was also provided to ensure a thorough understanding of the process. All SAG members replied. SAG members were assumed to have equal expertise concerning the alternatives and the alternatives' capability to contribute to the CCPE. Therefore, an equal weight is implied for each of the SAG members' scores. The set of scores assigned by the SAG members for each matrix cell were averaged (arithmetic mean) to obtain the score for each cell of the matrix. The average scores are shown in figure G-2.

b. CCPE weighted. To combine the scores shown in figure G-2, the CCPE were weighted using the eigenvector method in which normalized (relative) weights are determined (references 1 and 4). The eigenvector method begins with a pairwise comparison of the CCPE. A panel of experts on battlefield C2 (both civilian and military) was convened. Military backgrounds of the participants were AG/MI, IN, FA, EN/AV. (Some participants were civilians with Army Reserve or National Guard experience.) All participants have C2 analysis experience, ranging from 3 to 17 years. A modified delphi technique was employed in conjunction with the eigenvector method. An initial pairwise comparison was conducted with each of the five experts. The results of all the pairwise comparisons were provided back to the experts who then convened again as a group to generate a consensus group score. The matrix of consensus results and the scale used for the pairwise comparison is at figure

CONTRIBUTION SCORE MATRIX

MEASURES OF SYSTEM CCPE

ALTERNATIVES	ABILITY TO EXCHANGE OPERATIORS	ABILITY TO EXCHANGE EQUIPMENT	EASE OF HW SETUP	EASE OF TRAIN	EASE OF PERS MGMT	EASE OF MAINT MGMT	EASE OF SW MGMT
ALT 1							
ALT 2							
ALT 3T/P							
ALT 3T							
ALT 4							

Rating Scale

Values	Description
0	- This alternative provides no contribution to this criteria
1	- This alternative provides a very weak contribution to this criteria
2	- This alternative provides a weak contribution to this criteria
3	- This alternative provides a moderately weak contribution to this criteria
4	- This alternative provides a moderately strong contribution to this criteria
5	- This alternative provides a strong contribution to this criteria
6	- This alternative provides a very strong contribution to this criteria
7	- This alternative provide an extreme (absolute) contribution to this criteria

Figure G-1. Matrix for scoring of alternatives against CCPE

	EXCH OPS	EXCH EQUIP	HW SETUP	TRNG	PERS. MGMT	MAINT MGMT	SW MGMT
ALT 1	2.15	1.44	3.08	2.35	1.85	1.33	1.65
ALT 2	4.06	3.65	3.67	4.00	3.73	4.15	3.92
ALT 3T/P	5.71	5.42	4.48	5.46	5.04	5.52	5.58
ALT 3/T	5.71	5.38	4.54	4.92	4.90	5.67	5.58
ALT 4	2.25	1.23	2.92	2.35	1.81	1.64	1.71

Figure G-2. Average individual CCPE scores

G-3. The "Expert Choice" software (reference 1) was used to generate the weights through the use of normalized eigenvalues. Reference figure G-4 for the resulting weights.

c. Final contribution score determined. To determine the final contribution score for each alternative, multiattribute decision theory was applied. For each alternative, the scores were multiplied by the weight of the corresponding CCPE and then added. The resulting number is the final contribution score. Reference figure G-5 for the results. Note that alternatives 3T/P and 3T are very close in score and are clearly the preferred choices. The slight difference in the score is attributed to the lack of understanding, on the part of the respondents, that only the objective systems under each alternative were being addressed. Actually, the two scores should be identical since the objective systems under 3T/P and 3T are the same (both are CHS). Alternative 2 is clearly a third choice with a score significantly less than alternatives 3T/P and 3T. Alternatives 1 and 4 are clearly last in contribution to the CCPE. Their contribution scores are significantly lower than alternative 2. Recall that alternatives 1 and 4 are very similar (both use unique systems), the only difference being that under alternative 4, a new replacement for TCP is fielded. A generalization of the contribution scores is provided in the last column of the matrix in figure G-5. The generalized scores were used in the combination of decision criteria information for each alternative to develop a final score and rank for the alternatives.

d. Sensitivity of contribution score. The assignment of weights to the criteria (in this case the CCPE) is the area of most controversy when developing contribution scores. Therefore, the sensitivity of the contribution scores to fluctuations in the weights of the CCPE is addressed below.

(1) Alternative 3T/P and 3T are very close in score. Fluctuations in the weights of the CCPE will affect their contribution score and relative rank. Looking across the individual scores (in figure G-5) assigned for 3T/P and 3T, the CCPE under which 3T does better than 3T/P are the 2nd and 6th across the top. If these CCPE were arbitrarily assigned much higher weights than the other CCPE, 3T could raise in score above 3T/P. However, as discussed before, this is immaterial since 3T and 3T/P have the same objective system and therefore should have the same contribution score here.

(2) Addressing the relative contribution score of alternative 2, the individual scores for alternative 2 are consistently well above alternatives 1 and 4 and well below alternatives 3T/P and 3T. Therefore, fluctuations in weight will not affect the relative rank of alternative 2.

(3) As discussed in paragraphs (1) and (2), alternatives 1 and 4 will always rate lower than alternatives 2, 3T/P, and 3T. However, the relative position of alternative 1 to alternative 4 may be changed. Alternative 4 has slightly higher individual scores for the last three CCPE than does alternative 1. Therefore, by arbitrarily making the weights of the last three CCPE higher than the other four CCPE, the contribution score for alternative 4 may be made higher than that of alternative 1. However, the rank of both alternatives 1 and 4 will remain lower than the other alternatives.

	EXCH OPS	EXCH EQUIP	HW SETUP	TRNG	PERS. MGMT	MAINT MGMT	SW MGMT
EXCHANGE OPS		(3.6)	(5.5)	(2.6)	(2.9)	2.2	3.6
EXCHANGE EQUIP			3.8	4.9	5.1	6.0	5.7
HARDWARE SETUP				4.0	3.2	5.7	6.4
TRAINING EASE					3.4	3.7	4.0
PERSONNEL MGMT						3.1	5.3
MAINTENANCE MGMT							4.8
SOFTWARE MGMT							

RATING SCALE * **

1 - EQUAL IMPORTANCE
3 - FIRST CCPE MODERATELY MORE IMPORTANT
5 - FIRST CCPE STRONGLY MORE IMPORTANT
7 - FIRST CCPE VERY STRONGLY MORE IMPORTANT
9 - FIRST CCPE EXTREMELY MORE IMPORTANT

* PARENTHESES DENOTE AN INVERSE (USED WHEN SECOND CCPE MOST IMPORTANT)

** ALL VALUES BETWEEN 1 AND 9 MAY BE USED

Figure G-3. CCPE pairwise comparison results

CCPE	Weight (Relative Importance)
Ability to Exchange Equipment	.39
Simplicity of Hardware Setup	.25
Simplicity of Training	.13
Simplicity of Personnel Management	.09
Ability to Exchange Operators	.06
Simplicity of Maintenance Management	.05
Simplicity of Software Management	.03

* CR = .118

* The consistency ratio (CR) is a comparison of the consistency of the judgments made to total randomness. A CR of less than or equal to .1 is considered acceptable. Obviously CR = .118 is slightly above the acceptable amount. A change in the weights of the CCPE will be addressed under sensitivity.

Figure G-4. CCPE weights

	EXCH EQUIP: .39	TW SET: .25	TRNG: .13	PERS. MGMT: .09	EXCH OPS: .06	MAINT MGMT: .05	SW: .03	CONTRIBUTION SCORE*	GENERALIZED SCORE
ALT 1	1.44	5.08	2.35	1.85	2.15	1.33	1.65	2.05	1
ALT 2	3.65	3.67	4.00	3.73	4.06	4.15	4.92	3.80	2
ALT 3T/P	5.42	4.48	5.46	5.04	5.71	5.52	5.58	5.18	3
ALT 3T	5.38	4.54	4.92	4.90	5.71	5.67	5.58	5.11	3
ALT 4	1.23	2.92	2.35	1.81	2.25	1.64	1.71	1.95	1

GENERALIZED CONTRIBUTION RATING SCALE

3 - GOOD
2 - FAIR
1 - POOR
0 - NONE

CR = .118

*SCORE RANGE: $0 \leq S \leq 7$

Figure G-5. Interim contribution score determined

3. Timeliness of fielding. In the quantitative assessment of the alternatives, the first year of IFLCS and the first year of FLCS are considered. To allow integration of the decision criteria to determine a final score and rank of the alternatives, a generalized relative score of 3, 2, 1, 0 (good, fair, poor, none) was again used. These scores were subjectively assigned based on relative fielding times. Reference figure G-6.

4. Reserve component (RC) capabilities. A synopsis of the information presented in paragraph 5.h. in the main report is shown in figure G-7. Implications are derived from a comparison of the RC alternatives to the CCPE. Subjective scores were assigned to each alternative based on those implications.

5. BFA concerns. Figure G-8 shows the BFA concerns expressed by the BFA proponents in response to requests for input. Subjective scores were assigned by the analysis team to each of the alternatives based on the BFA concerns.

6. Weighting the decision criteria. To quantitatively compare the alternatives, not only must the contribution of the alternatives to each decision criteria be quantitatively assessed, but also the decision criteria must be weighted in terms of relative importance. Weighting of the decision criteria was accomplished by the SAG members at the midpoint SAG meeting.

a. A matrix like that in figure G-9 was distributed to each of the SAG members. A pairwise comparison was conducted. For each comparison, a determination was made as to which decision criterion is most important. A letter of the most important criterion was placed in the cell for that comparison. An example completed matrix is at figure G-10. (The pairwise comparison results shown in figure G-10 are for example purpose only.)

b. The completed matrices were collected from the SAG members. The total number of times each criterion occurred in each matrix was determined. In figure G-11, the frequencies for each criterion for each respondent is shown in the top matrix. The first column of the bottom matrix in figure G-11 shows the total frequencies resulting from totaling the frequencies from each individual matrix. The relative frequency is determined by dividing each frequency by the total number of responses, in this case 100. The relative frequencies are shown in the second column of the bottom matrix of figure G-11. The relative (normalized) frequencies provide cardinal weights for the decision criteria. For example, the weight for the decision criterion "measures of system CCPE" is .37.

7. Comparison of the alternatives. Figure G-12 shows the generalized scores of the alternatives for each of the decision criteria as well as the relative weights of the decision criteria. Multiattribute decision theory is applied to determine the final score. (The general scores of an alternative are multiplied by the weights of the respective decision criteria and then added to give the final score.) The final scores are then translated to a relative rank based on the assumption that the higher the final score the better the alternative.

ALT	IFLCCS (MANUAL INTERFACE TO BFA CS)		FLCCS (CCS2 CAPABILITY)	
	FIRST YEAR	GENERALIZED SCORE	FIRST YEAR	GENERALIZED SCORE
ALT 1	88	3	93	2
ALT 2	88	3	92	3
ALT 3T/P	88	3	92	3
ALT 3T	NA	0	92	3
ALT 4	NA	0	93	2

Figure G.6. Fielding schedule

Alt.	Distinguishing Characteristics	Implications	Score
Alt. 1	FL C2 for MC, AD, IEW handled by TCP FL C2 for FS, CSS handled by unique BFA C2 for MC handled by TCP BFA C2 for FS, CSS handled by unique Fielding starts in 1993	Extremely complicated SW Mgmt, Logistics, Training, Personnel Mgmt, Maintenance Mgmt, and HW Setup. Low equipment exchange capabilities.	1
Alt. 2	FL C2 for MC, AD, IEW handled by TCP FL C2 for FS, CSS handled by CHS BFA C2 for MC handled by TCP BFA C2 for FS, CSS handled by CHS Fielding starts in 1992	Complicated SW Mgmt, Logistics, Training, Personnel Mgmt, Maintenance Mgmt, and HW Setup. Moderate equipment exchange capabilities.	2
Alt. 3T/P	FL C2 for AD, IEW handled by TCP/TCP FL C2 & BFA C2 for MC handled by TCP/TCT FL C2 for FS, CSS handled by CHS BFA C2 for FS, CSS handled by CHS Fielding starts 1992	Complicated SW Mgmt, Logistics, Training, Personnel Mgmt, Maintenance Mgmt, and HW Setup. Moderate equipment exchange capabilities.	2
Alt. 3T	FL & BFA C2 for MC handled by TCT/CHS FL & BFA C2 elsewhere handled by CHS Fielding starts in 1992	Relatively simple SW Mgmt, Logistics, Training, Personnel Mgmt, Maintenance Mgmt, and HW Setup. Relatively good equipment exchange capabilities.	2.5
Alt. 4	FL C2 for MC, ADA, IEW handled by NEW FL C2 for FS, CSS handled by unique BFA C2 for MC handled by NEW BFA C2 for FS, CSS handled by unique Fielding starts in 1993	Extremely complicated SW Mgmt, Logistics, Training, Personnel Mgmt, Maintenance Mgmt, and HW Setup. Low equipment exchange capabilities.	2

Scale

3 - Good
2 - Fair
1 - Poor
0 - Extremely Deficient (Unacceptable)

Figure G-7. Reserve component capabilities

ALTERNATIVE	BFA CONCERNS	SCORES
ALT 1	NONSTANDARDIZATION OF SYSTEM DESIGN	2
ALT 2	NONSTANDARDIZATION OF SYSTEM DESIGN PROCESSING SPEED	1
ALT 3T/P	PROCESSING SPEED	2
ALT 3T	PROCESSING SPEED	2
ALT 4	NONSTANDARDIZATION OF SYSTEM DESIGN	2

3 - GOOD

2 - FAIR

1 - POOR

0 - EXTREMELY DEFICIENT - UNACCEPTABLE

Figure G-8. Score of alternatives based on BFA concerns

	(A) CPPE	(B) TIMELINESS OF IFLCCS	(C) TIMELINESS FLCCS	(D) R.C. CAPABILITIES	(E) BFA CONCERNS
CCPE (A)					
TIMELINESS OF (B) IFLCCS					
TIMELINESS OF (C) FLCCS					
R.C. CAPABILITIES (D)					
BFA CONCERNS (E)					

Figure G-9. Pairwise comparison matrix of decision criteria

	(A) CPPL	(B) TIMELINESS OF IFLCCS	(C) TIMELINESS FLCCS	(D) R.C. CAPABILITIES	(E) BFA CONCERNS
CCPE (A)		A	A	A	A
TIMELINESS OF (B) IFLCCS			B	B	B
TIMELINESS OF (C) FLCCS				C	E
R.C. CAPABILITIES (D)					D
BFA CONCERNS (E)					

Figure G-10. Example pairwise comparison of decision criteria

Respondent	Decision Criteria Frequencies				
	A	B	C	D	E
N_1 :	4	3	2	1	0
N_2 :	3	2	4	1	0
N_3 :	4	1	3	2	0
N_4 :	3	4	2	1	0
N_5 :	4	3	2	1	0
N_6 :	4	2	1	1	2
N_7 :	4	3	0	1	2
N_8 :	4	3	2	1	0
N_9 :	4	2	3	1	0
N_{10}:	3	4	1	2	0
Totals	37	27	20	12	4

Criteria	Total Frequencies	Relative Frequencies (Weights)
A	37	37/100 = .37
B	27	27/100 = .27
C	20	20/100 = .20
D	12	12/100 = .12
E	4	4/100 = .04
Total	100	

N_i respondent i

A: Measures of system characteristics, capabilities, performance, and effectiveness

B: Timeliness of the IFLCS

C: Timeliness of the FLCS

D: Automated C2 capabilities of the RC

E: BFA concerns

Figure G-11. Results of pairwise comparison

DECISION CRITERIA / ALT / WT.	CHARACTERISTICS, CAPABILITY, PERFORMANCE, AND EFFECTIVENESS SCORE	RESERVE COMP. AUTO FL CAP	TIMELINESS OF IFLCS	TIMELINESS OF FLCS	BFA CONCERNS	FINAL SCORE*	RANK
	.37	.12	.27	.20	.04		
ALT 1	1	1	3	2	2	1.78	4
ALT 2	2	2	3	3	1	2.43	2
ALT 3T/P	3	2	3	3	2	2.84	1
ALT 3T	3	2.5	0	3	2	2.09	3
ALT 4	1	2	0	2	2	1.09	5

* RANGE: $0 \leq S \leq 3$

Figure G-12. Scoring of the alternatives

8. Translation of final score.

a. Scales of measure. The weights of the decision criteria are cardinal in nature (on a ratio scale with absolute zero). The cardinal scale allows multiplicative comparison. For example, the weight assigned to "CCPE" is .37. The weight assigned to "Reserve component capabilities" is .12. Therefore, the two criteria may be compared thus: "CCPE" (.37) are approximately 3 times as important as "RC capabilities" (.12). The general score (3, 2, 1, 0 or good, fair, poor, unacceptable) are on an ordinal scale. The ordinal scale allows no comparison as to the amount of difference in importance. A score of 3 may not indicate an actual importance/capability of 3 times that of a score of 1. Because the ordinal scale and cardinal scale are combined to determine the final score, the final score is on the ordinal scale. No determination may be made, based on the final score, that one alternative is twice as capable/good as another. The same scale as applied to the general individual scores may be applied so that 3 is good, 2 is fair, 1 is poor, and 0 is unacceptable. Therefore, alternative 3T/P is good, alternatives 1, 2, and 3T are each fair, and alternative 4 is poor. Obviously, among the fair alternatives, there are differences in scores, but a ratio comparison cannot be made. However, there is a significant difference in a score of 1.78 and 2.43.

b. Drivers/sensitivities.

(1) Alternative 3T, though at least as good in all but one category as alternative 3T/P, is ranked 3rd. This is due to the high relative importance of the "timeliness of IFLCS," to which alternative 3T makes zero contribution. However, alternative 3T has a higher score for RC capabilities. In order that alternative 3T rank higher than alternative 3T/P, the weight of RC capabilities would have to be greater than .334, dropping the weight of timeliness of IFLCS to less than .056. This is a very significant change. Therefore, we can say with a fair amount of certainty that alternative 3T is significantly less capable than alternative 3T/P.

(2) Alternative 2 can never be scored higher than alternative 3T/P because alternative 3T/P is scored as high or higher under every one of the decision criteria. Most of the difference in the scores of alternative 2 and alternative 3T/P may be attributed to the differences in scores of the two alternatives to the CCPE. Alternative 3T can be scored higher than alternative 2 by, again, arbitrarily raising the weights of the decision criterion "CCPE" and/or RC capabilities and/or "BFA concerns" and arbitrarily lowering the weight of "Timeliness of IFLCS." For instance, considering fluctuations in weights of "CCPE" and "IFLCS," "CCPE" would require a weight greater than .64 allowing "IFLCS" a weight of .16. This change is large, but coupled with small increases in the weights for "RC capabilities" and "BFA concerns," alternative 2 and 3T could change places in the ranking of the alternatives.

(3) Alternative 1 is only "good" in one category. The high weight of the corresponding decision criterion allows the final score of alternative 1 to approach "fair." Based on the individual scores assigned to alternative 1, it could never score above alternatives 2 and 3T/P. However, by arbitrarily

raising the weight of decision criteria "IFLCS" and allowing the weights of the other criteria to approach zero, alternative 1 could outscore alternative 3T and 4.

(4) Alternative 4 is better than alternative 1 under the decision criterion "RC capabilities" and better than alternative 2 under the decision criterion "BFA concerns." Under both cases, by arbitrarily lowering the weights of the other decision criteria and raising the weight of the one decision criterion by which alternative 4 scores better, alternative 4 may score better than alternative 1 or alternative 2.

10. Conclusion. Alternative 3T/P is the preferred alternative. The second choice is alternative 2. Alternative 3T/P could be made even more desirable by providing CHS to all RC BFA. The amount of cost increase is believed to be insignificant when compared to the increased cost of refurbishment and repair of TCP and TCT/AC. Also, the Army as a whole would have increased potential capability.

11. Recommendation. Implement alternative 3T/P with the increased fielding of CHS to the RC to include all BFA.

APPENDIX H

STUDY ADVISORY GROUP
AND
IN PROCESS REVIEW MEETING ATTENDEES

1. 2 February 1987 SAG meeting attendees.

ATTENDEE	OFFICE SYMBOL	AUTOVON
COL Dacunto, Chairman	ATZL-CAC	552-3323
Douglas Poynter	ATCD-CC	680-3466
Oscar Chappel, MAJ	ATZL-CAC-AT	552-4876
Tim Gibson, CPT	ATZL-CAC-AT	552-4876
Ron Aston	ATZL-CAC-AT	552-4876
Roland Groover	ATZL-CAC-D	552-4721
Sean MacKinnon	ATZL-CAC-I	552-4782
Charles Arvin, LTC	ATZL-TSM-MC	552-4721
Michael Hawrylak, MAJ	ATZL-CAC-CD	552-3137
Douglas Johnson	TRAC-WDA	258-3290
Mark Adams	TRAC-WDA	258-2651
Joe Hill, LTC	ATRC-F	552-4510
James T. Pittman, COL	ATRC-FS	522-3334
Larry Tolin	ATRC-FSC-I	552-4234
Sara Tisdel	ATRC-FSC-I	552-4234
William Derr, CPT	ATZL-TAS-P	552-2495
Barry Gardner, LTC	ATCL-SAA	687-4840
Steve Pappas, CPT	ATZB-CD-MC	464-5565

2. 12 March 1987 cost in-process review meeting attendees.

ATTENDEE	OFFICE SYMBOL	AUTOVON
Douglas Johnson	USA TRAC-WSMR CDA	258-3290
Charles Ream	PM-ADCCS-FAADC2I	AV 742-4476
COL Hitchcock	PM-ACCS	AV 995-4055
Mike O'Donnell	PM-ACCS-PB	AV 995-4055
Patricia Conley-Stone	PM-ACCS-PB	AV 995-4055
Camille De Santis	PM-OPTADS	AV 992-3649
Pam Matakevich	PM-OPTADS/Analytics	(201) 542-8383
Bob Walker	HQ AMC AMCRM-EV	AV 284-9101
Maryann Dominiak	HQ AMC AMCRM-EV	AV 284-9747
Walter Church, Jr.	PM-OPTADS	AV 992-3649
Henry Weltzien	PM-FATDS	AV 995-3991
LTC Frank Johnson	CECOM LO at CAC	AV 552-2241
Rob Hurd	PM TACMIS Supt Group (CECOM)	AV 992-5271
Celia Burgess	PM-TACMIS Supt Group (CECOM)	AV 992-5291
Sara Tisdel	TRAC-FLVN (ATRC-FSC-I)	AV 552-4234
Larry Tolin	TRAC-FLVN (ATRC-FSC-I)	AV 552-4234
Linda Johnston	PM-TACMIS Supt Group (CECOM)	AV 992-5271
George Brown	PM-ACCS-AMSEL-ACCS-I	AV 995-3815

ATTENDEE	OFFICE SYMBOL	AUTOVON
Lee Mueller	PM-ACCS-AMSEL-ACCS-I	AV 995-2820
Emery Messenger	PM-ACCS	AV 995-3869
William P. Dattilo	PM-ACCS AMSEL-PM-ACCS-PI	AV 995-3807
Earl Weaver	PM-TACMIS (CSSCS) ASBK-LMF-F	AV 992-1602
Rich Rizzo	TACMIS BR. AMSEL-ED-DS	AV 992-5271
CPT Jim Sample	HQ TRADOC ATCD-CC	AV 680-3466
Mark Adams	USA TRAC-WSMR WDA	AV 258-2651
Joseph E. Kernan	PM-ACCS	AV 995-3927
Wilbur C. Hogan	HQ TRAC-FM ATRC-RP	AV 680-2609
Chuck Campbell	Analytics/PM-FATDS	(201) 542-8383
Ted Bean	MITRE	(703) 883-6231
CPT Tim Gibson	CACDA, C3I	AV 552-4786
Howard Fine	HQ CECOM, AMSEL-CP-CA	AV 995-4575

3. 9 June 1987 midpoint SAG meeting attendees.

L. J. Dacumto, COL (Chair)	CACDA, C3I	552-3323
Douglas Sizelove	HQDA, SAUS-OR	225-0384
Dan Lazicki, LTC	HQDA, DAMO-FDC	223-2260
Robert F. Travis, LTC	HQDA, DISC-4	227-4393
Douglas Poynter	HQ TRADOC, ATCD-CC	680-3466
Bob Wallden	HQ AMC, AMCRM-EV	284-9101
George Brown	PM ACCS	995-3815
Lee Mueller	PM ACCS	995-2820
Pat Conley-Stone	PM ACCS	995-4055
Leon Godfrey	TRAC, TOD	552-5511
W. K. Tilmon	USALOGC, ATCL-SAA	687-1177
Sean MacKinnon	CACDA, C3I-IEW	552-3901/4782
Ralph Burton	Intel Center, ATSID-CD-SI	879-3325/3518
Dave D. Barry, MAJ	USALOGC, ATCL-OME	687-4331/2686
David O Colvard, CPT	Ft. Gordon, ATZH-CDC	780-3782
Ed Orlando, LTC	Ft. McPherson, AFOP-FC	572-2220/2425
Oscar Chappel, MAJ	CACDA, C3I	552-4786
Ronald Aston	CACDA, C3I	552-4786
Douglas Johnson	TRAC-WSMR	258-3290
Ron Fowler, LTC	TRAC-FLVN	552-3334
Larry Tolin	TRAC-FLVN	552-4234
Sara Tisdel	TRAC-FLVN	552-4234