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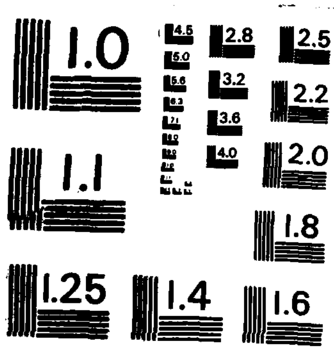
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REQUIREMENTS DEFINITION FOR FORCE LEVEL COMMAND AND CONTROL IN THE TACTICAL AIR CONTROL SYSTEM: AN EVOLUTIONARY APPROACH TOWARD MEETING NEAR TERM AND FUTURE OPERATIONAL NEEDS

by

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B.S., Memphis State University, 1979

A report submitted to the Faculty of the Graduate School of the University of Colorado in partial fulfillment of the requirements for the degree of

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ABSTRACT

This ~~report~~ focuses on command and control (C^2) system capabilities at the force management level within the Air Force contingency Tactical Air Control System (TACS). An investigation of the primary force level C^2 system identifies serious deficiencies impacting on the Air Force Forces ~~(AFFOR)~~ commander's ability to manage tactical air forces in a conflict environment. This system can meet neither the commander's present nor his projected future operational needs.

This report outlines an evolutionary acquisition approach toward fielding a replacement system in the near term and providing a core C^2 system upon which future capabilities must evolve as technology and requirements change. A test bed based Requirements Definition Study Period (RDSP) project, managed by Headquarters, Tactical Air Command (HQ TAC), is specified as the solution to the rapid, accurate, and intelligent specification of core system requirements.

The exploitation of the proven capabilities of evolving Army and Marine tactical C^2 operational test bed systems, studied in this report, is

considered basic to the RDSP undertaking. The recommended strategy is aimed at not only fielding an effective, adaptive tactical C_u^2 system but at addressing both TACS and joint architecture definition.

Through the RDSP HQ TAC will be able to begin seriously defining its TACS architecture. Identifiable, visible progress in the definition of joint architecture can be made through "hands-on" exercise, test, and evaluation of user requirements, employing the systems described in this report. Meaningful progress in solving the interoperability problem will not be made until joint architecture requirements are better defined. Paper studies and laboratory experiments will not by themselves suffice.

"He" in this report is used in the generic sense.

ACKNOWLEDGMENTS

From July 1985 to December 1985 scores of individuals contributed to this report. Four individuals, whose names appear on the approval page of this document, stand out in their contribution. I would like to express my very deep gratitude to each.

Dr. Harvey Gates, gifted innovator, teacher, and friend, provided the original idea that began this 5-month study. His encouragement and guidance have been continuous. From Dr. John Hershey I have profited from his brilliant engineering knowledge and from a practical philosophy: that which does not kill you makes you stronger. Col David Ledbetter, Tactical Air Command's Director of Command and Control Systems, is one of the Air Force's new command and control managers, an architect whose many endeavors will influence the way tactical commanders fight on future battlefields. The opportunity to work for Col Ledbetter during September and October (a short, but extremely dynamic period), gather firsthand information from "the field," and participate in

ABSTRACT

This report focuses on command and control (C^2) system capabilities at the force management level within the Air Force contingency Tactical Air Control System (TACS). An investigation of the primary force level C^2 system identifies serious deficiencies impacting on the Air Force Forces (AFFOR) commander's ability to manage tactical air forces in a conflict environment. This system can meet neither the commander's present nor his projected future operational needs.

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future planning has been a marvelous educational experience. Brig Gen Duncan Campbell, USAF (Ret.), a gentleman whose consultation I first sought in August, has given his time generously throughout this study (and at times when the demands of position have weighed heavily). He is a gentleman of integrity, one whose wealth of information systems, acquisition, and organizational knowledge has made a lasting impression on me.

Several gentlemen at HQ TAC deserve special mention and thanks. Col Albert Edmonds, Deputy Chief of Staff for Information Systems at TAC willingly funded my 73-day temporary duty from Boulder, Colorado to Langley AFB, Virginia. Col Willie Cowan, Commander of the 1912th Information Systems Support Group at Langley, went out of his way to see that I was well taken care of. He and his deputy commander, Lt Col (Col Sel) Michael Ondrasek, regularly consulted with me. Col Jack Ezzell, Director of the Tactical Air Forces Interoperability Group, shared numerous ideas and observations that helped shape the development of this report, particularly in regard to interoperability considerations and system program management. Col Keith Berry, who directs information systems plans and requirements at TAC,

provided several very good inputs to this report, perhaps only a few of which will be recognizable.

Mr. Robert O'Donohue, Jr., the Chairman of the highly respected Armed Forces Communications and Electronics Association (AFCEA) study on C^2 system acquisition, willingly gave his valuable time to discuss evolutionary acquisition (EA). Likewise, BGen Edward Hirsch, USA (Ret.), provided invaluable information. BGen Hirsch and a small team at the Defense Systems Management College have drafted EA guidelines to be signed by the Joint Logistics Commanders.

It has been a pleasure to work with Maj David Warren, USA (Army Development and Employment Agency) and Maj Dennis Jackson, USMC (TCO Development Office). These energetic men are among the comparatively few drivers of EA; the results they have helped produce are apparent.

User needs provide the basis for C^2 system acquisition, and it was at the 9th and 12th Air Force headquarters and operational units that I filled tablets with user comments, observations and, definitely, needs. I would like to thank Col Rhyne, Col Rush, Col Wallace, Col Doughty, Col Duane, Col Bosse, Lt Col Johnson, and Lt Col Leek for their candid feelings.

Col Martin Kallighan, USAF (Ret.) provided information on the establishment of the Computer Assisted Force Management System that could not be discerned from any extant documents. The dose of "how the real world operates" is appreciated from both Col Kallighan and Col David Webb (HQ USAF).

Mr. Patrick Riedl, Vice President of Command and Control Systems, The BDM Corporation, personally reviewed this report for the technical accuracy of test bed systems studied. Mr. Riedl is a busy executive, and I thank him for this review.

Again, many people were involved in this study; they know who they are, and this report would not have been possible without their assistance.

One last mention: Wendy and Louis at Phantom Court Services, Inc., Boulder, CO, are gratefully acknowledged for the magic they have worked on handwritten manuscript.

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CHAPTER I

INTRODUCTION AND OVERVIEW

> The greatest challenge we face is continuing to deter Soviet aggression across the conflict spectrum--from conventional through strategic nuclear. On the conventional side, we're strengthening deterrence by improving the readiness and capability of our forces.
> --Gen Charles A. Gabriel

The Conflict Bandwidth

The rate of advancement of information systems technologies renders command and control (C^2) systems that cannot evolve to keep pace with their change quickly obsolete. C^2 systems that are too inflexible to adapt to the range and dynamic nature of a commander's operational needs are worse than inferior: they are themselves potential killers.

Conventional Conflict

Modern technology has produced a land and air battlefield that is on one hand greatly expanded due to the range of modern weapons; on the other hand, the decision cycle of the commander has been dramatically compressed by the speed and accuracy of modern delivery platforms. Analyses of the future conventional battlefield sketch an environment even more fluid and destructive than that imaginable today. The importance of salient operational features (e.g., survivability, flexibility, and reliability) of C^2 systems will increase concomitantly with the requirements for more powerful and complex C^2 system capabilities.

The Subconventional Arena

The so-called "conflict bandwidth" has widened within the last 20 years, the battlefield mentioned above being only one scenario. Figure 1.1 depicts this changed nature of conflict.[1]

Subconventional conflict, though appreciably less threatening to the United States' security than either conventional or nuclear conflict, is shown to be far more likely to occur. Shows of force (deployments to Egypt and Sudan), terrorism (Iran and Beirut), counter-insurgency operations (Central America) and low intensity operations (Grenada) all exemplify the types of scenarios in which the U.S. has had to operate in very recent years.

Missions on this end of the conflict band have typically been time-sensitive and highly visible. During operations in areas of the world not having extensive U.S. information systems (e.g.,

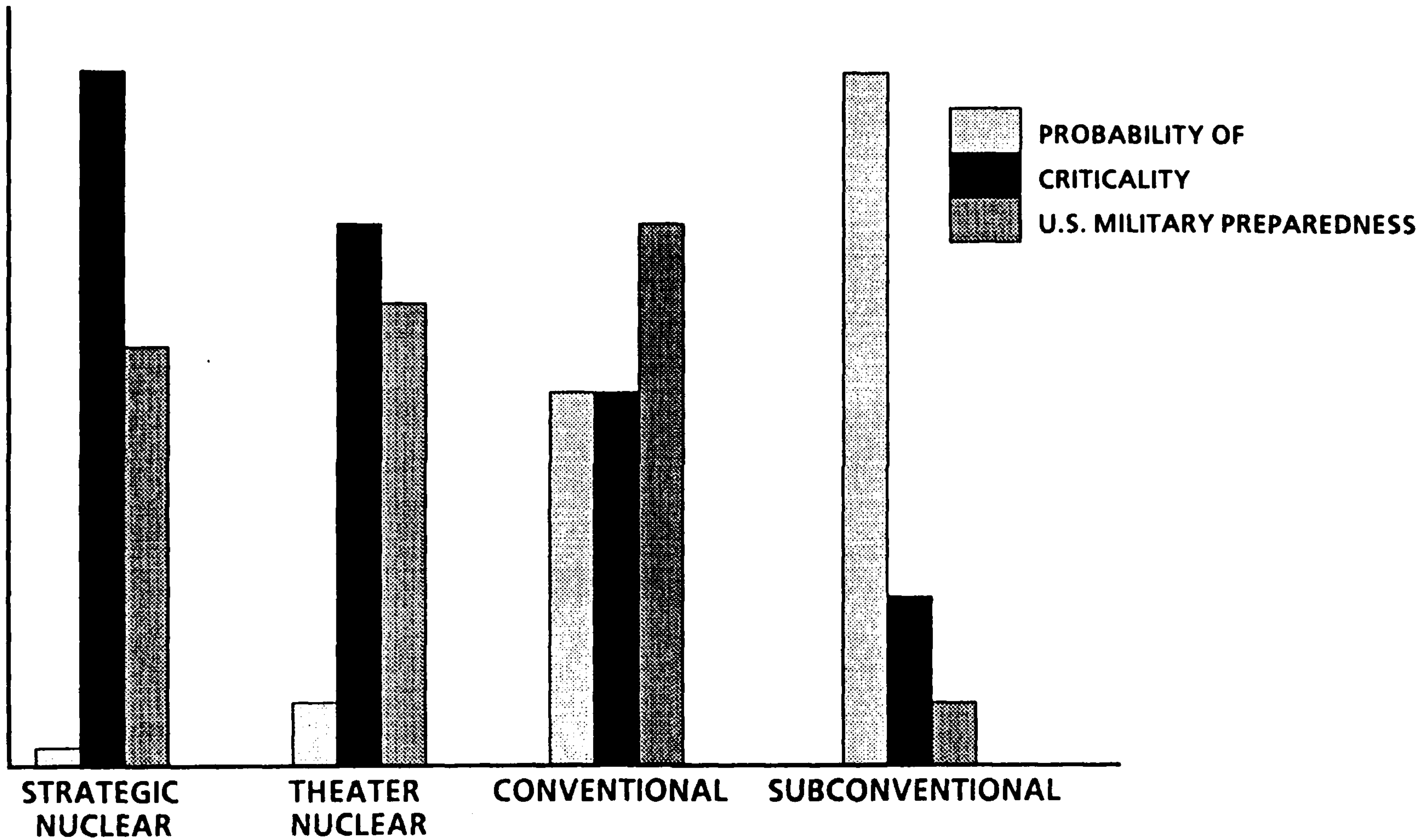

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FIGURE 1.1 THE CONFLICT BANDWIDTH

in the U.S. European and Pacific Command regions), C^2 has immediately emerged as an overriding issue in force management. C^2 inadequacies, to include interoperability failures, have also, unfortunately, surfaced in the aftermath of such operations. General Robert Herres stated in 1984:

> A well managed crisis is no more than a brief incident, while a badly managed situation inevitably results in tragedy and conflict. The planning aids, communications devices and other tools our leadership uses to deal with these tense situations can be the difference between these extremes.[2]

C^2 systems have not been fielded to adequately support an Air Force Forces (AFFOR) commander's management of contingency tactical air forces.

C^2 and the Tactical Air Control System

C^2 Systems

This report, using the Armed Forces Communications and Electronics Association definition, defines Command and Control systems as:

> Those systems that augment the decision-making and decision-executing processes of operational commanders and their staffs. The central, essential ingredient in any command and control system is the commander or decision maker himself.[3]

This definition differs from that of the Department of Defense (DoD), which has excluded the commander in its definition (see glossary).

C^2 systems are generally distinct from weapons systems and must be acquired differently. Reputable studies, feelings among senior military leaders, and the egregious consequences of acquiring C^2 systems through traditional processes amply support this fact. C^2 systems, for example:

1. Are characterized by rapidly evolving technology.
2. In many cases must be tailored to specific environments, be one-of-a-kind, support individual commanders, and be required to readily adapt to changing operational needs.
3. Above all, are systems whose operational essence and costs are dominated by an intangible--software.

An evolutionary approach is the appropriate strategy through which to acquire C^2 systems.

This report examines, in the following chapter, an evolutionary acquisition (EA) model and present guidance and policy from the DoD and the Air Force.

Force Level C^2 in the Tactical Air Control System

The Tactical Air Control System, or TACS, is an integral and inseparable part of the AFFOR commander's fighting force. It is the Air Force system through which he exercises centralized command and decentralized force control.

The senior element within the TACS is the Tactical Air Control Center (TACC), the AFFOR commander's tactical command center. C^2 functions within the TACC are, in 1985, still predominantly manual, inefficient, and very labor-intensive.

The most critical document in the TACS is the Air Tasking Order, or ATO. The ATO (previously called the "frag") is, basically, a mission tasking order, directed to the commander's subordinate elements, detailing the types of missions to be performed and the targets to be attacked.

Excluding automated support employed by the intelligence functions within the TACC, the only automated assist to the AFFOR commander's decision-making and decision-executing processes is the Computer Assisted Force Management System (CAFMS). Its principal use is to assist the operations and planning functions in "building" and disseminating the ATO.

CAFMS can meet neither the commander's present nor his future operational requirements.

This report finds CAFMS to be marginally deployable, inflexible, unsustainable, highly vulnerable and of questionable reliability. Further, CAFMS has never achieved Initial Operational Capability, yet it is the force level C^2 system in the TACS. Chapter III reports on an inspection of CAFMS.

There are no funded programs to address this serious deficiency.

TACS Architecture

Billions will be spent over the next several years to acquire and field various elements of the TACS. A piecemeal system of "things" is currently destined to transpire, and these thing-oriented programs have been retroactively fitted into an ill-defined, complex, and very confusing "roadmap" to the future (see Chapter IV).[4] There is presently no realistic TACS architecture, as such; it is more a collection of individual systems.

Headquarters, U.S. Air Force has, since spring 1985, directed the development of technical and functional information systems architectures to guide development and integration of information systems. Table 1.1 highlights the general trends that will affect Air Force information systems.[5]

Defining future TACS architecture (see "architecture" in glossary) will be a difficult and complex undertaking. The "mixed bag" of present and planned programs within a 1960s-vintage TACS, the characteristics of C^2 systems, and the extreme difficulty in articulating future requirements, in addition to these "general trends" are a few complicating factors.

Architecture development for the TACS must begin at the force management level.

This Report

Recommendations

The thrust of this report is a series of recommendations in Chapter IV through VIII:

1. To correct, in the near term, force level operational readiness and C^2 system deficiencies.

2. To articulate the requirements of a "core" force level C^2 system into which future improvements can and must be integrated.

3. To establish a starting point for and begin definition of TACS architecture.

TABLE 1.1

OVERALL TRENDS INFLUENCING AIR FORCE

INFORMATION SYSTEMS

1. Mission-essential information requirements are growing rapidly.

2. The increasing stresses of modern combat adversely affect the capability and capacity of information systems to satisfy essential requirements.

3. Technology continues to advance at an extremely high rate.

4. Total funds spent on information systems are rising due to the high increase in the rate of applying automation to previously manual processes and upgrading previously automated processes; the increase in total user requirements more than offsets the declines in unit cost resulting from technology advances.

5. Systems are becoming too complex to permit radical change; evolutionary improvements are required.

A decisive EA strategy is the essential means through which this may be accomplished, with a requirements definition study period (a test bed) as the precursor of the fielded system. This report examines, in Chapter VI, EA approaches toward requirements definition for Army and Marine, tactical C^2 test bed systems (and a planned Air Force system in Europe). Software, hardware, and system capabilities are discussed.

This report considers the exploitation of the proven capabilities of these systems to be sine qua non to the timely establishment of an effective system in the near term.

A Case for Addressing Interoperability

When VAdm Jon L. Boyes, USN (Ret.) reported in the November 1985 SIGNAL the threat from Senator Goldwater (R-AZ) to restrict money for communications equipment "until meaningful progress" was made in interoperability, he conveyed an unmistakable message from Mr. Goldwater: DoD must begin fixing interoperability.[6]

Serious effort in tackling the dynamic, increasingly complex interoperability problem began only last year with the creation of the Joint Tactical Command, Control, and Communications Agency (JTC^3A), under the command of Major General

Archibald, USA. JTC^3A's job is to ensure interoperability of tactical C^3 systems; its primary mission has been, as a means to achieve this goal, joint architecture development. The "generic joint mission area architecture," a baseline architecture currently under development, is a synthesis of the various service planning guides, such as TAC's present "roadmap."[7]

Paper studies and laboratory experiments by themselves will not provide "meaningful progress" toward solving the problem.

This report suggests that, through "hands-on," user-controlled exercise, test, and evaluation of the systems described in Chapters VI and VII, a genuine leap toward defining Unified Command architectural requirements could be made in the near term. The immediate benefit, as the reader will note, will go to the United States Central Command.

The test bed systems examined in Chapter VI are the beginning of "innovation and common sense" in C^2 requirements definition and architecture development.[8]

JTC^3A can gather invaluable data from such an approach. Other benefits include more realistic operations planning and doctrine/procedures development.

REFERENCE NOTES

CHAPTER I

[1]Gregory D. Foster, "Conflict to the Year 2000," Air University Review 36 (September-October, 1985): 26.

[2]Lt Gen Robert Herres, USAF, "C^3I in Crisis Management: Secure Voice Capability," SIGNAL, May 1984, p. 38.

[3]Armed Forces Communications and Electronics Association (AFCEA), Command and Control System Acquisition Study Final Report (Falls Church, VA, 1 September 1982), p. I-10.

[4]The term "things" has been borrowed from VAdm Jon L. Boyes, USN (Ret.), who discusses the procurement of "things" vs. procurement of systems in "The Need to Discipline C^3I User Requirements," SIGNAL, May 1985, p. 20.

[5]U.S. Department of the Air Force, Headquarters, U.S. Air Force, Air Force Information Systems Architecture, Volume I--Overview (Washington, D.C., 8 May 1985), p. 1-1.

[6]VAdm Jon L. Boyes, USN (Ret.), "Tactical C^3I Interoperability and the Somme," SIGNAL, November 1985, p. 16.

[7]William J. Blohm and Lt Col William R. Brown, USAF, "Joint Tactical C^3 Architecture," SIGNAL, November 1985, p. 53.

[8]"Innovation and common sense" may be found under "Acquisition Strategy" in appendix C, Extracts from Defense Acquisition Circular 76-43.

CHAPTER II

EVOLUTIONARY ACQUISITION

> Men alone, or machines alone, do not spell success: how men use machines in the combat environment and the spirit of leadership, that guides that use, spell victory or defeat.
>
> --Basic Areospace Doctrine

General Definition of Evolutionary Acquisition

Growing concern among senior military leaders that command and control systems are different from, and should be acquired differently than, weapons systems is beginning to be reflected in DoD and Air Force guidance and policy. Evolutionary Acquisition, or simply EA, is an alternative strategy that recognizes the uniqueness of C^2 systems. Creditable studies have articulated these unique characteristics. No command and control systems acquired via the traditional, serial approach have been considered successful. The nature of C^2 systems, the rate of changing technology and requirements, and the glacial speed of "business as usual" are but a few reasons for this.

Evolutionary Acquisition is a system acquisition strategy in which the user identifies an overall system requirement in general, functional terms. A detailed description of a "core increment" is developed, and the system is fielded within a flexible framework allowing for evolutionary growth. EA is thus an adaptive strategy. As experience is gained from the operational use of the core increment the subsequent increment is defined, funded (within an overall system budget), developed, fielded, and user-tested. The process goes on; it is iterative.

> Subsequent increments or "blocks" are defined sequentially, based on continuing feedback provided from lessons learned in operational usage, concurrent evaluation of adequacy of hardware/software configuration, and judgments of improvements or increased capabilities that can result from application of new technology, where feasible.[1]

EA and Pre-planned Product Improvement (P^3I) are different concepts, the basic difference being that P^3I does not require the user to accept significant responsibility in system acquisition. The similarities and differences between EA and P^3I are revealed in appendix C.[2]

The EA Model

Figure 2.1 indicates a basic EA model, depicting EA's incremental (and overlapping) process, as extracted from the September 1985 article in SIGNAL by BGen Edward Hirsch, USA (Ret.).[3]

The user is continuously involved throughout the life of the C^2 system, as new capabilities are fielded and the system evolves. One of the fundamental differences between EA and traditional methods is that the C^2 user is recognized as a significant-to-dominant player in the requirements process, and the results of user testing are fed into specifications of all increments.

With EA the requirements definition process extends throughout a system's lifetime. Implicit in this approach is a much closer and less formal, containing relationship among user, development, and testing communities, throughout the ongoing process.

To summarize the basic EA model:

1. The user describes an overall, general, functional C^2 requirement. Working with the developer he defines the specific requirements of a core increment. The basis of this may be a test bed or

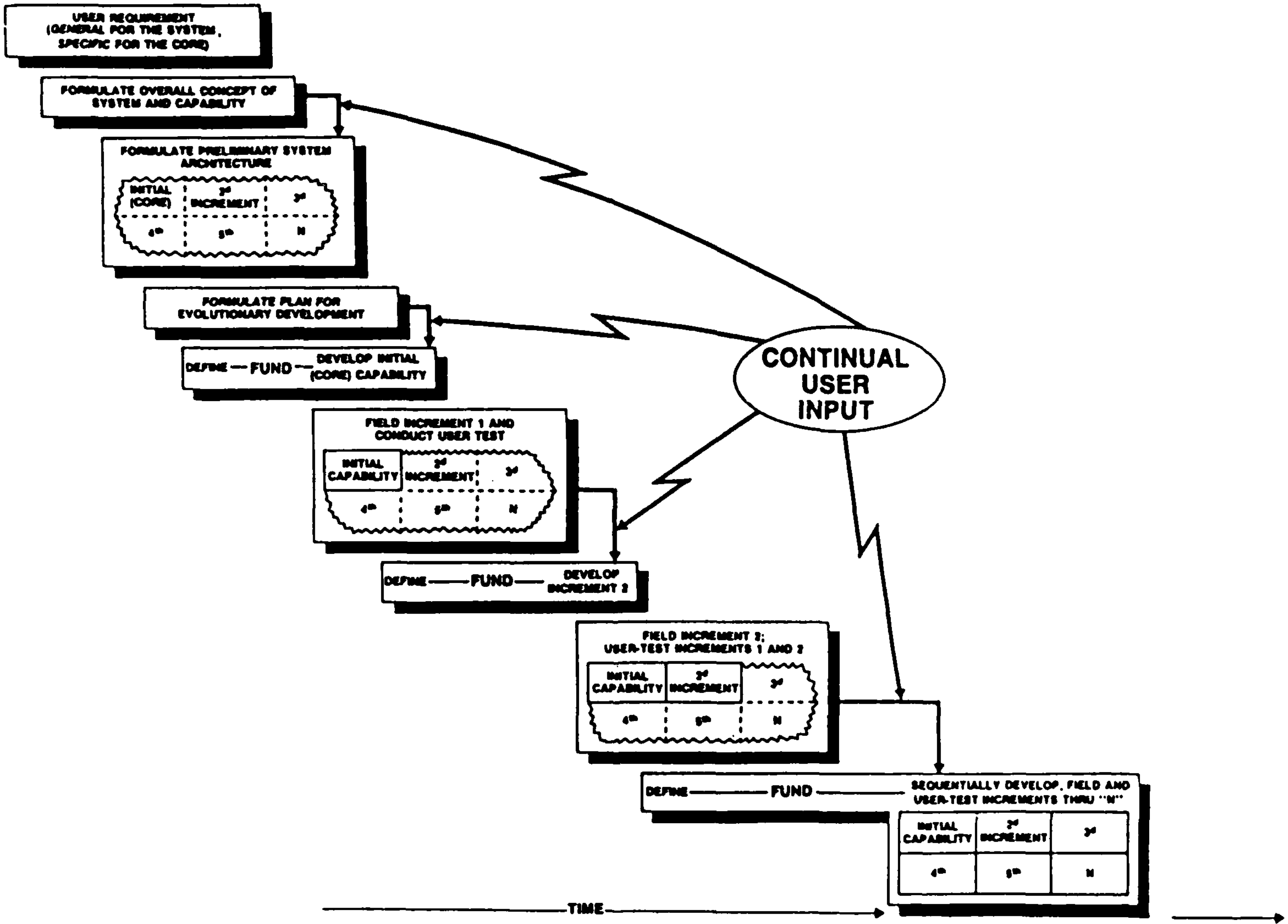


FIGURE 2.1 THE BASIC EA MODEL

prototype. The core is an operationally usable system.

2. The developer designs a preliminary, overall system architecture that facilitates <u>incremental growth</u> throughout the system's life.

3. The core increment is developed and fielded with near term funding. User, developer, and tester are involved in the acceptance of the system by the user.

4. Feedback is provided into the definition of the next increment, based on the user's exercise of the system in the operational environment.

5. Definition of the next increment, reports of user satisfaction, and overall program management provide the basis for funding (within an overall "fenced" budget) of the next increment. The process, rather than being sequential, is overlapping.

6. Architectures that cannot be defined with high specificity initially may have to be modified later. The architecture is an

essential element and must be given great care.

Background

Two major studies have provided the groundwork for present-day policy governing EA: one from the Defense Science Board (see glossary) Task Force on Command and Control Systems Management, the other from the Armed Forces Communications and Electronics Association.

The DSB Task Force

The DSB Task Force was commissioned in 1977 to examine whether or not the United States was acquiring command and control systems capabilities commensurate with weapons systems being deployed and with the United States' available technological and industrial base.[4] The major conclusion reached by the Task Force indicated a serious deficiency in C^2 systems acquisition, and its Command and Control Systems Management Report determined that the existing direction in systems acquisition was not applicable to command and control systems.[5] Command and control systems were found to differ in several critical respects from weapons systems, one of which is the "information rich," software dominant features of C^2 systems. The report stated "acquisition procedures based on hardware have little *a priori* applicability to command and control systems." Subsequent to the DSB's report DoD directives and instructions were modified to allow "special management" procedures in C^2 system acquisition.

The AFCEA Study

The Armed Forces Communications and Electronics Association Command and Control (C^2) System Acquisition Study was the first major effort to study what it is about C^2 systems that *are* different from weapons systems, what impediments had been preventing EA from being successfully implemented, and what actions were required to successfully implement EA.[6]

BGen Edward Hirsch, USA (Ret.) has stated:

> The credentials of the study group members are unassailable and impressive, the research effort is formidable; the arguments are articulately and lucidly presented, the logic of its conclusions is compelling; and the recommendations are sound.[7]

The key personnel involved in the AFCEA study are shown in Figure 2.2.

The study team found *no* successful C^2 programs where the traditional acquisition (Milestone I, Milestone II, etc.) process had been

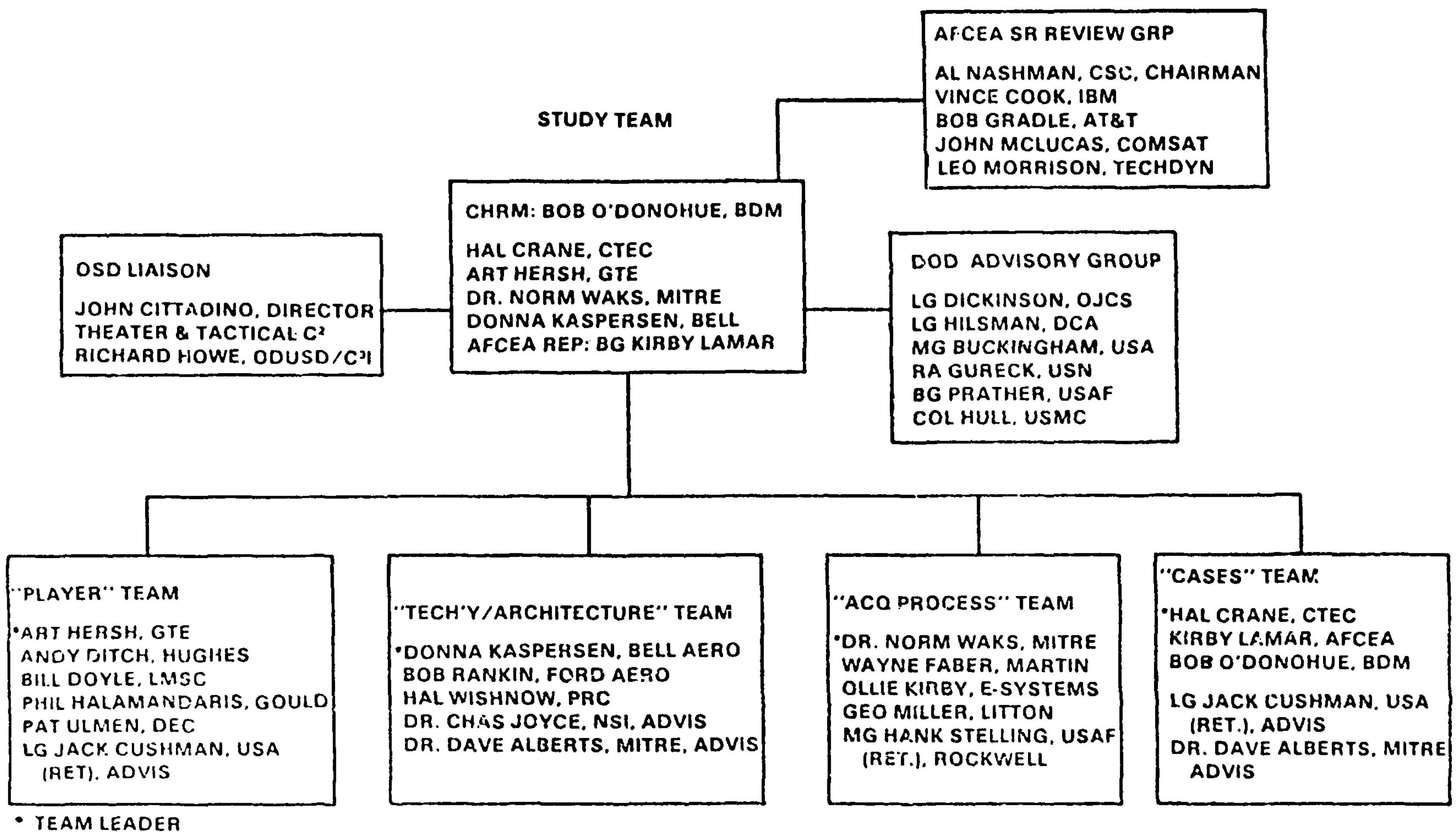


FIGURE 2.2 THE AFCEA STUDY TEAM

followed. Among the more obvious failures was a program to automate the Tactical Air Control Center, called TACC AUTO (see Chapter III). The team disclosed that EA had not been aggressively applied and that there was great resistance among the formal Research and Development (R&D) communities to deal with what the study team chairman has referred to as "deviant behavior."[8] Evolutionary Acquisition was also found to be not well understood, particularly among senior officers in the user arena.

The AFCEA study team's overall conclusions are shown in table 2.1.[9]

Characteristics of C^2 systems

Command and control systems, termed "mind extending" systems by the AFCEA study team, are actually decision support systems. C^2 must integrate the needs of a commander with the realities of his operational environment and help the commander decide various courses of action to take in the employment of his forces. The DSB Task Force report states:

> The absence of commonly understood concepts of command and control system performance and the existence of language barriers among technologists, policy analysts, planners, and commanders all underlie the fact that we in DoD lack any very useful conceptual framework for evaluating or specifying command and control systems.[10]

TABLE 2.1

MAJOR CONCLUSIONS OF THE

AFCEA C^2 SYSTEM ACQUISITION STUDY

1. Evolutionary Acquisition gives a much higher probability that a useful military capability will be fielded earlier.

2. Although Evolutionary Acquisition is policy for C^2 systems, its application is spotty and it is not well-defined and understood.

3. Evolutionary Acquisition will not work on a "business as usual" basis, yet acquisition support communities (e.g., requirements validation, budgeting, contracts, "ilities," test) discourage approaches deviant from the traditional approach.

4. Successful Evolutionary Acquisition requires continuous interaction among users, providers and testers and a more influential role by the real user.

5. A potential for chaos exists if C^2 system acquisition proceeds without an architectural framework, including flexibility to facilitate growth.

The dominant role of software. Command and control systems, unlike weapons systems, are software "intensive." Weapons systems are typically complex in hardware and usually employ special-purpose processors (requiring extensive development). Software costs, much more significant than hardware over a system's life cycle, typically comprise a lower percentage of a weapon system's overall cost than with C^2 systems. Table 2.2 differentiates some of the basic software characteristics of C^2 systems and weapons systems.[11]

Table 2.2 may rather conservatively portray the percentage of system cost attributable to software. In the February 1985 Information Technology R&D: Critical Trends and Issues report of the U.S. Congress' Office of Technology Assessment, an estimate of the relative cost of software exceeded 80 percent.[12]

Figure 2.3 would suggest that software costs within the Department of Defense double every five years, while computer hardware costs steadily decline.[13]

How does a commander know what software qualities will support his individual needs if he doesn't know what technology can, and will be able to do for him? This holds especially true in areas

TABLE 2.2

SOFTWARE DOMINATION OF C^2 SYSTEMS

Area	C^2 Systems	Weapons Systems
Hardware Development Status	Mainly Off-the-Shelf	Significant Development Required
Processors	General Purpose	Special Purpose
Software as % of Total	20-50	5-10
Operating Systems	Multi-Processor Multi-Program	Schedulers
Number of Simultaneous Users	Many (10-50)	Few (1 to 5)
Potential for User Change after Transition	High-Expected	Low-Exceptional

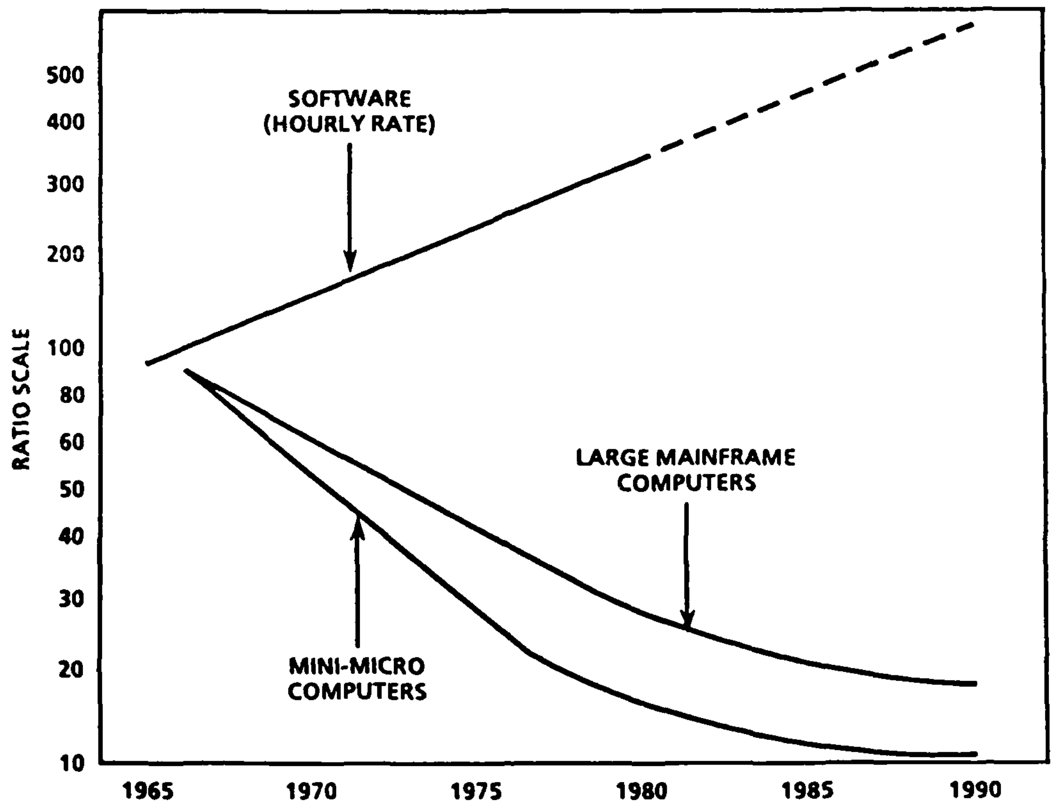


FIGURE 2.3 SOFTWARE VS. HARDWARE COSTS

where automation is introduced into previously manual operations.

<u>The requirements problem.</u> A commander's requirements are always changing, and the C^2 system must change to support these. Some variables include:

1. The threat. The gap in weapons and C^2 systems technology enjoyed by the U.S. is narrowing.

2. Geography. C^2 systems may be "coupled" with particular operational settings. CONSTANT WATCH (see glossary) is a good example of this.

3. Doctrine. Air Force doctrine as well as "joint" doctrine such as AirLand Battle steer the employment of C^2 systems. Doctrinal changes are influenced by variables such as the changing nature of the threat and the predicted future battlefield (air and land). Technology influences doctrine.

4. Rules of Engagement.

5. The scenario. Every unified and specified command plans for force employment in a variety of scenarios. USCENTCOM, for example, has planned for dozens of scenarios within its large Area of Responsibility. Plans usually provide only a start for an operation, because no one can plan for all factors. C^2 systems must accommodate these uncertainties.

6. Available systems. As new systems enter the inventory and old ones are retired (or still retained) the C^2 system supported by these systems must still do its job. Operational needs such as interoperability further complicate the need for complex interfaces. A C^2 system employed within the TACC is the crux of the TACS.

7. The commander. A C^2 system is employed to support the commander, who is an individual. Thus, it is required to meet his specific needs, which may be tied to all of the above.[14]

C^2 requirements definition and system acquisition in the formal, traditional process might be executed in the following way:

1. The user develops the requirements and hands them to the developer (for example, Air Force Systems Command).[15]

2. Seven to 10 years later, the technology supporting the requirement is obsolete (see "The Constraints," Chapter IV), user requirements have changed, and costs have escalated to the point where the program office runs out of acquisition money.

3. The resultant system ("thing") is tested not against current or real user requirements, but against contract compliance.

4. User needs are subordinated to contract compliance, irrespective of how well the contract meets his real needs.

5. The user gets an obsolete system that does not meet his needs when fielded.

User, Developer, and Tester Relationships

One of the study's major conclusions was that for an EA approach to be successful, the traditional "hands-off" relationship among these three must be altered. In the traditional acquisition process the user, after an end-to-end requirement has been validated and passed to the development community, usually does not see the system until it has been developed, tested, and fielded. In EA all communities are involved, to varying degrees, from the beginning.

In EA the "user" is the operational commander, the individual responsible for the planning and conduct of the war. He is the individual for whom the C^2 system is employed. The Commander, U.S. Central Command Air Forces (COMUSCENTAF), for example, is a user (see glossary). HQ TAC is also a "user," albeit a user-surrogate. It is axiomatic in EA that no one except the user (or user plus user-surrogate) can adequately state C^2 system requirements, and this must be mainly accomplished by system use and continuous redefinition.

The role of user and user-surrogate must be that of a partnership. The surrogate must consider the needs of all users of a system and try to fit them together harmoniously. The user-surrogate is responsible for integrating the evolving systems into other systems fielded. The user-surrogate must, therefore, ensure that one user's views are not unduly influential.[16] This user-surrogate responsibility will be seen to be quite applicable in this report's recommended EA strategy.

In the traditional approach, AFSC would "turn the system over" to Air Force Logistics Command (AFLC) upon fielding; AFLC would then manage its logistics requirements. In EA, the development community remains a player throughout the system's life, **since the requirements process is always ongoing.** The general roles of the developer in EA (although flexible) are to provide acquisition (non-traditional) expertise, technical (e.g., architectural) expertise, advocacy and timing of technology insertion.

There are no prescribed rules for this, and, like between the user and user-surrogate, the role of user and developer is that of a partnership.

Because under EA the user assumes a greater duty in system testing, the tradition of the tester (e.g., the Air Force Operational Test and Evaluation Center, AFOTEC) also changes to that of a partnership. Basically, in EA, the user's role is to test the system's operational utility; the tester retains responsibility for testing operational suitability. AFOTEC's responsibility in test and evaluation under an evolutionary approach might be the following:

1. Determining whether the "core" (or later increment to be tested) is sufficiently reliable and

maintainable to support operation in the user's field environment.

2. Providing expertise to the user and provider in the areas of experimental design, data acquisition, and data analysis.

3. Supporting the user/developer team as required during test operations in the user environment.

4. Conducting operational suitability testing and analysis in such areas as reliability and maintainability on suitable test models (not necessarily the "core").

5. Assessing whether the selected architecture has the capability to accomplish growth, change, and insertion of new technology.[17]

Post-AFCEA Study DoD Policy

The DoD did not mandate and direct the use of EA as the AFCEA study team had strongly recommended, consistent with the Reagan administration's policy to "decentralize government." Provisions under "Tailoring and Flexibility" in DoD Directive 5000.1, dated 29 March 1982, do support EA as an acquisition strategy.[18] Defense Acquisition Circular (DAC)

76-43, "Acquisition Management and Systems Design Principles," dated 28 February 1983, though not directive in nature, provides more specific guidance and direction in EA to the service. Two sections, "Acquisition Strategy" and "Command and Control (C^2) Systems," are distinctly relevant and have been extracted and included as appendix D.

JLC policy guidelines. The Defense Systems Management College (DSMC) has recently drafted guidelines on EA to be signed by the JLC, the Joint Logistics Commanders:

1. Richard H. Thompson
   General, USA
   Commander
   US Army Materiel Command

2. James P. Mullins
   General, USAF
   Commander
   Air Force Logistics Command

3. Lawrence A. Skantze
   General, USAF
   Commander
   Air Force Systems Command

4. T. J. Hughes
   Vice Admiral, USN
   Deputy Chief of Naval Operations
   (Logistics)

The basic purpose of these guidelines, currently in coordination, is to furnish guidance and, if necessary, assistance to subordinate commanders "in negotiating any special arrangements which might be required to successfully implement evolutionary acquisition."[19] This phraseology assumes special meaning when it is delivered from the four-star general level.

EA will not be mandated. It is a viable strategy in C^2 system acquisition and DoD has left the implementation in the hands of the military services.

EA, the Air Force, and 1985

The AFMAG Study

In 1984, under the auspices of the Air Force Inspector General, a 65-person Air Force Management Analysis Group (AFMAG) undertook a three-month, Air Force-wide study of data systems management and manpower impacts. The team collected and analyzed data, identified numerous specific problem areas and proposed solutions. **This document supports EA and, specifically, prototyping as a means to identify core system requirements.** The AFMAG report gets to the point.[20]

Air Force Information Systems Architecture

The AFMAG report, per se, did not cause Headquarters, U.S. Air Force (HQ USAF) to develop and publish the Air Force Information Systems Architecture (AFISA) Volume I--Overview; the document was under development during the AFMAG study. The senior AFMAG panel chief was in fact Brig Gen Denis Brown, the Deputy Assistant Chief of Staff for Information Systems, HQ USAF. The AFMAG study's findings, however, provide obvious support to Volume I.

Referencing the DSB Task Force study and the AFCEA report, the AFISA Overview states:

> The evolutionary acquisition approach was originally proposed to overcome difficulties with development of command and control systems . . . . It is equally applicable to complex systems supporting other users and will be adopted as the preferred strategy for acquisition of all major Air Force information systems.[21]

Volume I is the first of a family of documents that will provide guidance for the design, development, acquisition and implementation of information systems, supporting the objectives shown in Table 2.3.[22]

The message of the AFISA, signed by Lt Gen Robert H. Reed, Assistant Vice Chief of Staff, is clear:

> All information systems which have a requirement to interface or interoperate with other information systems will be guided by this architecture, irrespective of the acquisition methodology or governing series of Air Force regulations actually used.[23]

TABLE 2.3

OBJECTIVES OF THE AIR FORCE INFORMATION SYSTEMS ARCHITECTURE

1. Refocus the efforts of information systems organizations to provide better support to end-users.

2. Enhance information systems support to specialized functional requirements of the end-users to increase mission effectiveness or permit reductions in resource requirements (funds, people, equipment, etc.).

3. Provide end-users with powerful, flexible integrated information handling tools to improve responsiveness and reduce dependency on major system development efforts.

4. Enhance user-friendliness of information systems to reduce training requirements associated with their use and application.

5. Provide modern, machine-independent software engineering tools to expedite development of major systems to meet user requirements.

6. Achieve increased interoperability through "open systems" concepts and compatibility using established protocols and standards.

7. Eliminate the existing "air gaps" and technical barriers to the smooth and timely flow of information.

8. Eliminate or replace obsolete and labor-intensive systems to save manpower and lower operating costs.

9. Evolve to fully integrated digital communications networks supporting responsive movement of voice, data, text, graphics and imagery.

10. Achieve savings by minimizing duplication of effort and obtaining more effective use of common-user and shared resources.

11. Achieve increased competition in the acquisition of responsive and reliable system resources.

12. Provide information privacy, security and protection against unauthorized access, use/abuse, alteration/destruction or denial consistent with National and Air Force directives.

Discussion

An apparent sign that attitudes toward EA are changing, and will continue to change within the Air Force was reflected in a recent survey of general/flag officers having extensive C^2 and systems acquisition experience.[24]

Old habits don't break easily, though. Lt Gen Emmett Paige, Jr., Commander, U.S. Army Information Systems Command, recently expressed his concerns about the "business as usual" mentality and the present inhibitors to Nondevelopmental Item (NDI) acquisition. (NDI is an Army initiative to buy commercial products and adapt these products to fit military uses--a supposition in EA.)

> The lack of innovation in our integrated logistics support (ILS) concepts preordain that everything procured must fit into and conform to standard logistics practices. . . . There is little reliance on or use of vendor test data . . . . Finally, a greater emphasis on NDI often is mistakenly interpreted by our government labs as a de-emphasis and a loss of workload and jobs. . . . It's hard to push an NDI project through the R&D community. It's like trying to stop a train going downhill . . . .[25]

EA has been neglected to date in significant part due to propensity at levels below HQ USAF to apply increasingly <u>stringent</u> interpretation of policy and guidelines.

Program offices were found by the AFCEA study team to have to go to "extraordinary lengths to get their jobs done, because they have to 'negotiate truces' with each of the various functional groups outside the program office. . . ."[26] Subterfuge has achieved some success in implementing evolutionary strategies. This is accomplished mainly by "spoofing the system;" that is, establishing firm, specific requirements for the entire life of a C^2 system and "throwing out" remaining increments (and starting over) as each new increment is fielded.[27]

It is unlikely that the Air Force will mandate EA until it has accumulated at least a few achievements in its database.

The beginning of "innovation and common sense," to use the DAC 76-43 phrase, in C^2 systems acquisition is rooted in the AFISA. The guidance is there for commanders to use.

REFERENCE NOTES

CHAPTER II

[1]Armed Forces Communications and Electronics Association (AFCEA), Command and Control (C^2) System Acquisition Study Final Report (Falls Church, VA, 1 September 1982), p. iii.

[2]Appendix C is an extract from AFCEA, Command and Control (C^2) System Acquisition Study, pp. I-22 - I-24. The reader will also find this treated in Norman Waks, "Inherent Conflicts in C^2 Systems Acquisition," SIGNAL, May 1983, p. 92. The reader will note in figure 2.2 that Dr. Waks, Chief Management Scientist at the MITRE Corporation, headed the "Acquisition Process" team in the AFCEA study.

[3]BGen Edward Hirsch, USA (Ret.), "Evolutionary Acquisition of Command and Control Systems," SIGNAL, September 1985, p. 41.

[4]U.S. Department of Defense, Office of the Under Secretary of Defense Research and Engineering, Report of the Defense Science Board Task Force on Command and Control Systems Management (Washington, D.C.: July 1978), p. 3.

[5]Ibid., p. iii.

[6]AFCEA, C^2 System Acquisition Study, p. iv.

[7]Hirsch, "Evolutionary Acquisition of Command and Control Systems," p. 39.

[8]Robert E. O'Donohue, Jr., "Paper on AFCEA C^2 Study Given to NSIA/AFCEA Vital Issues Symposium," 11 April 1985, p. 14.

[9]AFCEA, C^2 System Acquisition Study, p. II-2.

[10]Office of the Under Secretary of Defense Research and Engineering, Defense Science Board Task Force on Command and Control Systems Management, p. II.

[11]Alan J. Roberts, "Some Software Implictaions of C^2 Systems Acquisition," SIGNAL, July 1982, p. 21.

[12]U.S. Congress, Office of Technology Assessment, Information Technology R&D: Critical Trends and Issues (Washington, D.C., February 1985), p. 332.

[13]Col Richard J. DeBastiani, USA, Computers on the Battlefield: Can They Survive? (Ft. McNair: National Defense University Press), p. 81. Extracted from U.S. Department of Defense, "DoD Digital Data Processing Study," October 1980.

[14]Robert E. O'Donohue, Jr., "Paper on AFCEA C^2 Study Given to NSIA/AFCEA Vital Issues Symposium," p. 9.

[15]John C. Morgenstern, former Director of Strategic and Theatre Command and Control, Office of the Secretary of Defense, has explained that user-requirements cannot be taken "as gospel." Citing an example from his personal experience, he describes one case (apparently not an atypical case, if one visits a major command) where "the user," two junior officers in a requirements branch, "decided that 'it would be good' if stringent data processing requirements were met." The ramifications of this are discussed. The reader is referred to John C. Morgenstern, "C^2 Systems Acquisition: The Requirements Problem," SIGNAL, May 1983, p. 118.

[16]AFCEA, C^2 System Acquisition Study, p. IV-11.

[17]Ibid., p. IV-20.

[18]U.S. Department of the Air Force, Headquarters, U.S. Air Force, "Acquisition Program Management," Air Force Regulation 800-2 (Washington, D.C., 16 September 1985), p. 15. DoD Directive 5000.1 is included in this regulation as attachment 1.

[19]U.S. Department of Defense, Defense Systems Management College, Joint Logistics Commanders Guide for the Use of an Evolutionary Acquisition (EA) Strategy in Acquiring Command and Control Systems (Ft. Belvoir, VA, fall 1985). For Comment Draft.

[20]U.S. Department of the Air Force, Headquarters, U.S. Air Force, Office of the Inspector General, Air Force Management Analysis Group, Report on Data Systems Management and Manpower Impacts: Volume II, Findings and Recommendations (Washington, D.C., 1 September 1984). This is an Air Force Inspector General document of limited distribution.

[21]U.S. Department of the Air Force, Headquarters, U.S. Air Force, Air Force Information Systems Architecture Volume I--Overview (Washington, D.C., 8 May 1985), p. 3-13.

[22]Ibid., p. 1-3.

[23]Ibid., p. i.

[24]BGen Kirby Lamar, USA (Ret.), "Acquisition of Command and Control Systems is a Different Ball Game," paper presented to the 1985 Federal Acquisition Research Symposium (Washington, D.C., 20 November 1985). The gentlemen interviewed by BGen Lamar were: Maj Gen John Paul Hyde, USAF; Maj Gen John T. Stihl, USAF; Brig Gen Michael H. Alexander, USAF; RAdm George B. Shick, Jr., USN; and BGen Alan B. Salisbury, USA.

[25]Lt Gen Emmett Paige, Jr., USA, "Sustaining Members' Luncheon Address," SIGNAL, August 1985, p. 35.

[26]AFCEA, C^2 System Acquisition Study, p. III-12.

[27]Col Charles P. Cabell, Jr., USAF, "C^2 Systems Development." Symposium speech from Col Cabell when he served as Director, Combat Information Systems, Deputy for Communications and Information Systems, Electronic Systems Division, Hanscom AFB, MA.

CHAPTER III

THE COMPUTER-ASSISTED FORCE MANAGEMENT SYSTEM (CAFMS)

> Once the conflict settles down to a steady grind of mutual destruction, it is possible to get a fix on many of the interactions. More precise planning is then possible. Before that occurs, key factors are largely unknown.
>
> --James Dunnigan, How to Make War

The Computer-Assisted Force Management System (CAFMS, pronounced "kaff'ehms") is the primary automated support to the AFFOR commander--in the contingency TACS--in the exercise of force level C^2. It is a means through which the order tasking subordinate elements (e.g., the WOCs) is compiled and disseminated. It is an automated assist in the monitoring of his force status and air mission status. It is one of the systems supporting the functions within the AN/TSQ-92 transportable shelters of the TACC. There are serious problems today with CAFMS and its efficacy as a force management automated "assist." Unaddressed, these problems will even more seriously impact on an operational commander's future tactical C^2 capability. This chapter examines CAFMS.

Background

TACC AUTO

CAFMS was born out of the demise of a program, Tactical Air Control Center Automation (or TACC AUTO) which, after some 12 years and the expenditure of $80 million, was terminated "with prejudice" by Congress. TACC AUTO was, in fact, one of the programs examined by the AFCEA study team. It is one of the best cases of the utter failure of a traditional acquisition process to field an effective C^2 system. The AFCEA study cited:

> The absence of a strong user role throughout the program and the lack of flexibility to adapt to changing requirements were key factors in causing the program to fail. Difficulty in automating many functions, which under the traditional acquisition approach followed had to be done in one development cycle, resulted in prolonged delays and cost growth.[1]

The beginning of the TACC AUTO program was a Required Operational Capability (ROC) statement, dated 24 May 1967, that identified the following requirements of an automated C^2 system:

1. Increase capacity and accuracy in the display of the air situation and mission progress data.
2. Maintain status of forces and bases.

3. Decrease the time used in the routine and clerical tasks associated with mission planning.

4. Decrease the time required for preparation and transmission of the frag (the air tasking) order.

5. Automatically generate and disseminate status and summary reports.[2]

Providing this capability to the air component commander couldn't be done in 13 years for the basic reasons stated in the AFCEA study. The elementary requirements after TACC AUTO was killed however, remained similar to those listed in 1967: improve the timeliness, accuracy, and completeness of the mission planning and operations monitoring/assessment functions.

CAFMS Phase I

HQ TAC quickly prepared statement of requirement, named the required capability something not remotely resembling TACC AUTO (hence, CAFMS), and received Air Staff approval to acquire commercial Automatic Data Processing (ADP) hardware and software to field a "Phase I" operational capability.

The objectives of CAFMS, as outlined in TAC's June 1979 Data Automation Requirement were simply:

1. Construction and review of the Air Tasking Order (ATO).
2. Dissemination of the ATO via remote terminals, AUTODIN, and teletype.
3. Automatic generation of mission schedules.
4. Updating displays (tabular and graphic).
5. Reports generation.
6. Interfaces:
   a. TADIL-B.
   b. DC/SR.[3]

Phase I, begun in 1979, established TAC as the overall CAFMS Program Manager, with Headquarters, Electronic Systems Division (Air Force Systems Command) providing technical assistance in hardware and software acquisition, configuration management, engineering, and logistics.[4]

Much of the code written for applications supporting TACC AUTO was translated to CAFMS, and literally dozens of TACC AUTO software support personnel were available to develop CAFMS applications. The CAFMS project was established in two phases and began as an evolutionary effort.

Phase I activities were aimed at getting CAFMS into the hands of the users: Ninth Air Force (9th AF), Twelfth Air Force (12th AF), and the USAF Tactical Air Warfare Center (USAFTAWC). An additional system was delivered at HQ TAC to support software development and maintenance. Although HQ TAC acted on behalf of the "real users," there was during Phase I continual input from the field into CAFMS' development.[5] Phase II was designed to allow ESD to undertake a series of enhancements/upgrades to the CAFMS systems. The objective was to field two "fully deployable" systems, one software support facility and one test facility that were completely logistically supportable and Air Force maintained. Planned improvements included ruggedization of equipment, development of a full complement of war readiness spares, manpower allocation, and other improvements to establish a system baseline.

After all units were fielded, CAFMS was deleted from the HQ USAF Program Management Directive for Tactical Air Control Systems Improvements.[6] Since 1982, CAFMS has survived on end-of-year (fiscal year) fall-out funding. Ninth Air Force has been able to receive some operations and maintenance (O&M) funding from USCENTCOM for maintenance of its CAFMS. The Air Force Audit Agency Area Audit Office cited in 1984, among other problems, poor maintenance contractor performance and ineffective management of the CAFMS program.[7]

The CAFMS Program Review Organization (essentially a committee for CAFMS matters) was dissolved during the summer of 1985, and overall CAFMS responsibility was assumed by the Command and Control Systems Directorate (HQ TAC/DOY) along with all TACC matters.

The Generic CAFMS

The Hardware

The heart of CAFMS is a Perkin-Elmer model 3230 (PE 3230) 32-bit minicomputer. The Central Processing Unit (CPU) has access to 4 MB of primary memory and 320 MB of secondary memory located in four Trident T-80 disk units.

At the operating station of the system are a Centronics model 6600 600 LPM printer, one Perkin-Elmer 800/1600 BPI magnetic tape unit, a Perkin-Elmer model 1245 local terminal (operator station), and a Remex 6075 paper tape punch/reader.

The main processor is configured to support 18 local ("dumb") terminals (the Perkin-Elmer 1245) through standard two-line communications multiplexers.

CAFMS supports up to 12 remote terminals, which are located at the Wing Operations Centers (WOCs), the Control and Reporting Centers (CRCs), and the Air Support Operations Center (ASOC) (see appendix E). The remote terminal can be employed as a workstation and is comprised of the Delta Data model 7586 microcomputer, with dual 8" floppy disk drives and a dot matrix printer. Connectivity to the 3230 is via standard tactical or commercial systems. TSEC/KG-30 (soon to be fully upgraded to TSEC/KG-84) cryptographic equipment, table-top modems, and Micom error controllers provide for secure transmission between the host and remotes. The current modems for the system operate at 1200/2400 bps. Host to remote communications is four-wire. At present CAFMS cannot be supported by tactical high frequency/independent sideband (HF/ISB) radio. Early testing performed by the MITRE Corporation indicated problems with the MD 1061 HF modems supporting data communications following brief propagation losses. This is presently being studied. CAFMS also does not have a satellite communications capability.

The Software

CAFMS uses the Perkin-Elmer Operating System 32 (OS 32), version 6.2, the latest version, in current operation. This operating system has been designed to support up to 255 concurrent users.

The database management system (DBMS) supporting CAFMS is the original version, a version considered by 1985 standards to be incredibly slow and inefficient. Perkin-Elmer is said to be presently beta testing version 8.0.

CAFMS software is written in COBOL (approximately 90 percent), FORTRAN (about eight percent), and Assembler (two percent). Compilers used to support these applications are very early versions. Funding has never been made available to upgrade this software, and this has contributed greatly to poor system response times experienced by system users (especially the remote users).

Specific System Capabilities

The PE 3230 system has been designed to provide the user these basic capabilities:

1. A start-up function that initializes the system, sets up specific duty authorizations, assigns message addressee designators and locations, and "pre-stores" certain data base records.

2. An orderly shutdown function that completes the processing of any outgoing messages and allows the operator to remove the system and database disk packs prior to erasing the remaining computer memory and disk packs.

3. A message transmission capability that provides for off-line transmission and receipt of

paper tape (the upgrade to magnetic cassette media is in progress) to units not equipped with a remote terminal. Outgoing messages may be formatted in either JANAP 128 or JINTACCS message formats.

4. ATO generation. CAFMS software has been designed to allow up to 26 separate ATOs to be constructed/maintained concurrently. The user may review the ATO in either standard ATO format or in JINTACCS. Once the message is completed, units are notified and they may access the ATO from the database.

5. Mission and force status monitoring. CAFMS can maintain force status information (e.g., aircraft status, airfield status, munitions status) and display this information, once input by the user, on one of several "tactical displays." Mission schedules may be updated from either local or remote terminals and displayed in a variety of ways.[8]

The Software Support Facility

The 1912th Information Systems Support Group (1912th ISSG) is CAFMS' Software Support Facility (SSF). The 1912th, among other missions, provides software development and maintenance services for the TACS. At present there are 35 officer and enlisted personnel assigned to CAFMS support functions, which translates to 35 man-years per year of labor. As of October, 1985, 135 applications programs, written in COBOL, reside on software version 4.0. Not including system software, this accounts for approximately 350 thousand lines of code. Additionally, there are 125 Assembler programs (approximately 50 lines each) and 15 FORTRAN programs (approximately 2000 lines each). Ninety-six percent of usable memory is consumed before the user ever logs on.

The Contractor

All hardware logistics support and configuration management of CAFMS hardware has been contracted to IMR Systems Corporation. The cost of fiscal year (FY) 85 planned and remedial maintenance services was $683,802.[9] FY 86 maintenance costs are expected to exceed $700,000. Air Force Perkin-Elmer trained maintenance personnel assist IMR technicians at the field sites. IMR technicians routinely support CAFMS on deployments, both in the CONUS and overseas. Deployment options provided in the contract, to include deployments to hostile overseas areas, are to be "negotiated prior to each deployment."[10]

The Field Sites

In addition to the SSF, CAFMS is fielded at the 12th AF, Bergstrom AFB, Texas (602nd TACCS); the 9th AF, Shaw AFB, South Carolina (507th TACCS); and the USAFTAWC (727th TCS(T)) at Hurlburt Field, Florida. The hardware configuration is not standard among the three field sites. IMR Systems Corporation maintains and spares all CAFMS equipment at the sites. During spring 1985 IMR, at the request of the CAFMS Program Review Organization (PRO), developed a list of 60-day contingency spares ($670,000) required for the CAFMS sites.[11] This was one of the PRO's initiatives to "baseline" CAFMS. Funding was never allocated for this and all CAFMS sites remain contractor-dependent for most logistics matters. At present the 12th AF's CAFMS serves as the contingency spares supply for the 9th AF, and vice versa.

A 7 March 1985 PRO Assessment Briefing revealed that HQ USAF had "validated" but not funded computer maintenance (AFSC 305X4) personnel for CAFMS maintenance. All sites have taken personnel from authorized billets to work with IMR. Technically, however, Air Force personnel are not allowed to perform system maintenance.

There is no way that credible reliability statistics can be gathered. Until late 1984 there were no command level maintenance reporting requirements levied on CAFMS. There has been limited job control reporting at the site locations, and maintenance personnel candidly report that procedures are seldom followed. Lack of system visibility and contracted logistics support motivate few people to become concerned when equipment breaks. System reliability figures on CAFMS, while deployed on exercises, are conflicting.

Training of CAFMS operations personnel at the sites is nonstandard and has been judged inadequate by TAC. One of the basic problems is the almost extreme user "unfriendliness" of the system, according to CAFMS operators. All sites conduct in-station training but rely heavily on augmentation during exercises. Operations personnel (often clerk-typists) who have been fortunate enough to learn CAFMS to a subjective level of proficiency find themselves on what a few consider to be "more than their share" of exercises.

Bergstrom AFB. The CAFMS belonging to 12th AF is located in an S-560 "3:2" standard shelter that was obtained from salvage when CAFMS was introduced. The shelter leaks when it rains, so

602nd TACCS personnel cover it with a tarp. Humidity in the van and shelter leakage have caused corrosion on the Trident disk drives.

Hurlburt Field. CAFMS at Hurlburt Field is owned by the 727th TCS(T) and is used primarily to support exercises of the USAFTAWC Air-Ground Operations School (AGOS) and Blue Flag, a TAC readiness training program. CAFMS remains in an S-560, 3:2 shelter located adjacent to the Blue Flag building. Terminals are situated in the AGOS and Blue Flag buildings to support particular scenarios. AGOS utilizes CAFMS six times per year; Blue Flag utilizes CAFMS quarterly, but only one exercise per year supports a contingency TACS scenario (USCENTCOM). Such major exercises as JCS Exercise BOLD EAGLE 85 have been supported by the 727th.

The shelter at Hurlburt leaks, too, and humidity is a problem, but 727th personnel have taken creative maintenance measures:

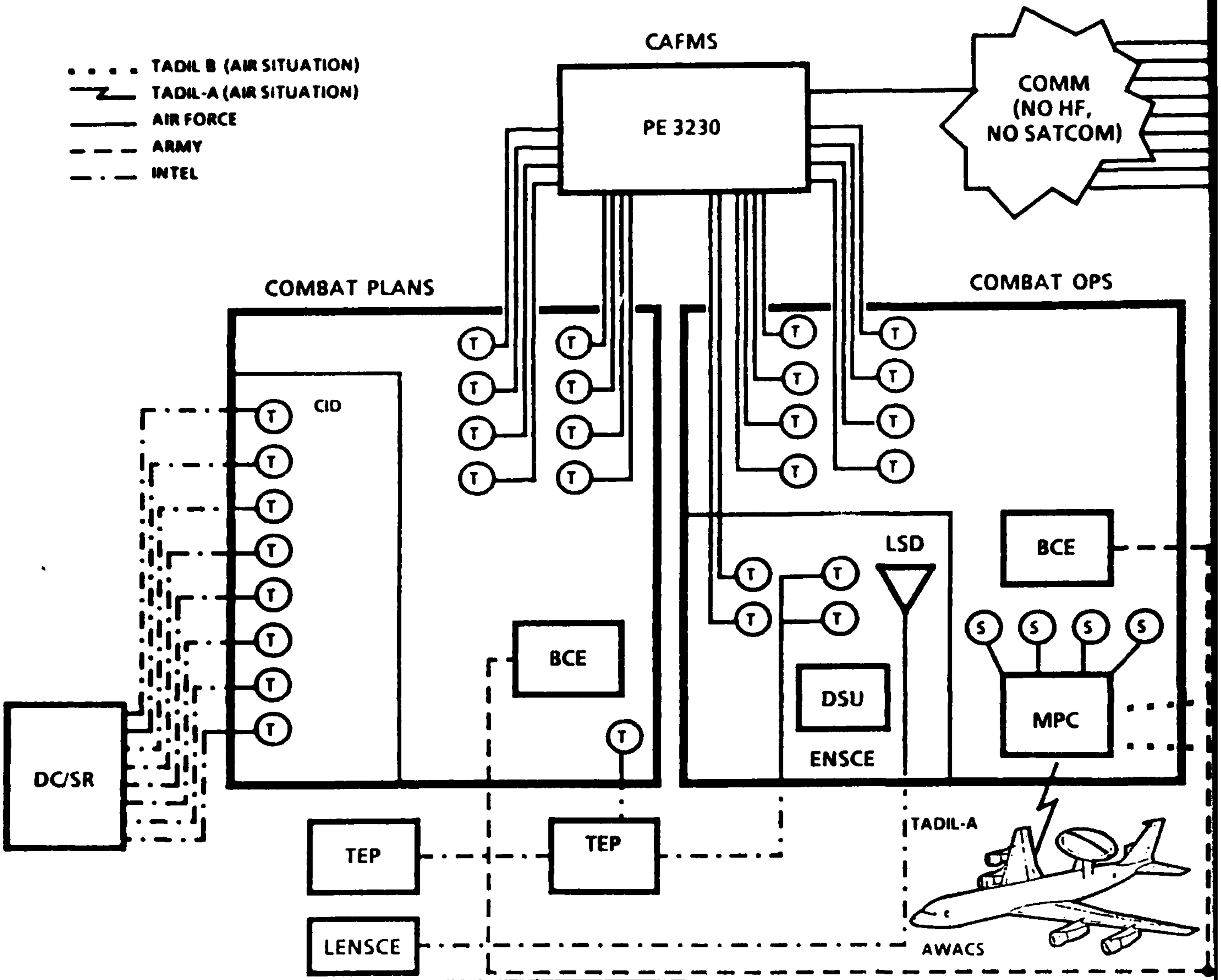
1. Caulking the leaks (five tubes of caulking).
2. Installing dehumidifiers in the van.
3. Painting the roof white to reflect the sun.

Shaw AFB. The 507th TACCS is considerably better off than its peers. CAFMS at Shaw is housed in an 8'x 8'x 20' shelter. This shelter, configured by the MITRE Corporation as a "prototype" shelter, was delivered in 1983. Unlike the other systems, 9th AF has a backup (though not an on-line backup) Perkin-Elmer 3230. The big problem with this van is that it weighs 18,500 lbs and cannot be tactically airlifted. The attached mobilizers (wheels) cannot safely support towed speeds exceeding 5 mph on smooth surfaces, and towing requires an aircraft tug (non-standard TACS equipment).[12] Thus, normal surface transportation for CAFMS is by 40' flatbed trailer.

A Typical Configuration

Figure 3.1 depicts a typical configuration of systems residing at the TACC.[13] In this case it is a 9th AF TACC (12th AF does not have a Message Processing Center, MPC). One develops a feeling for CAFMS' vulnerability after tracing a few lines from the WOCs, the CRCs, etc., to the 18,500 lb "Achilles' heel," the single point of system failure.

The TACC is supported by a miscellany of manual and automated systems developed under independent programs. Appendix E describes various elements represented in Figure 3.1.



LEGEND

ASOC	AIR SUPPORT OPERATIONS CENTER
AWACS	AIRBORNE WARNING AND CENTRAL SYSTEM
BCE	BATTLEFIELD COORDINATION ELEMENT
CID	COMBAT INTELLIGENCE DIVISION
CRC	CONTROL AND REPORTING CENTER
CTOC	CORPS TACTICAL OPERATIONS CENTER
DC/SR	DISPLAY AND CONTROL/STORAGE AND RETRIEVAL SYSTEM
DSU	DIRECT SUPPORT UNIT
ENSCE	ENEMY SITUATION AND CORRELATION ELEMENT
LENSCE	LIMITED ENEMY SITUATION AND CORRELATION ELEMENT
LSD	LARGE SCREEN DISPLAY
MPC	MESSAGE PROCESSING CENTER
S	SCOPE
T	TERMINAL
TEP	TACTICAL ELINT PROCESSOR

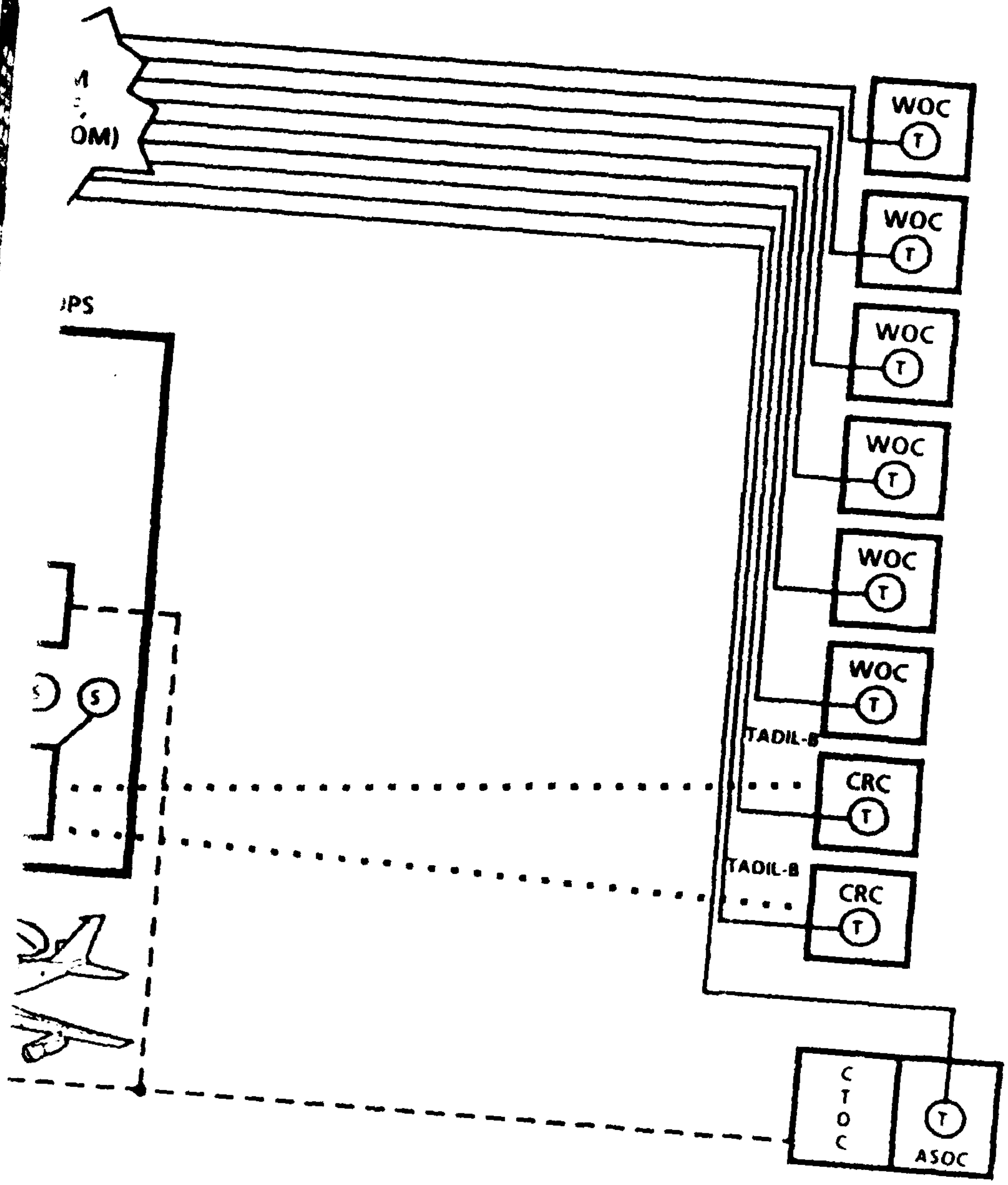


FIGURE 3.1 TYPICAL FORCE LEVEL C^2 CONFIGURATION (9TH AF TACC)

Air Tasking Order information can be passed to only 12 remote terminals. Intelligence and operations systems cannot share information for constructing or executing the ATO nor can the latest intelligence information be readily accessed by the Wings, the CRCs, and the ASOC. CAFMS information is received and updated by each Wing, CRC, and ASOC through a single terminal, creating a "choke point" for information at these levels. Units do not presently have any internal automated network to rapidly collect information required at the AFFOR headquarters, and tasking, intelligence, logistics, and flight planning information cannot be shared at the unit level.

There are no means, other than voice (radio) or manual (hand carry), to disseminate the ATO and its changes to the ABCCC (see glossary). The ABCCC, operated by the 7th Airborne Command and Control Squadron (7th ACCS), Keesler AFB, MS, functions as an alternate TACC and alternate/backup ASOC. There are no means to transmit digital data via HF/ISB radio or SHF SATCOM directly from CAFMS.

The Band-Aid to CAFMS

As an effort to improve CAFMS system performance, maintainability, and reliability, HQ

TAC, using O&M funding, has recently undertaken a project to:

1. Replace CAFMS local and remote terminals with TEMPEST certified Zenith Z-151 microcomputers.

2. Replace the non-TEMPEST Okidata printers with TEMPEST certified printers.

3. Acquire new disk drives (both fixed and removable) and disk controllers to eliminate the present input/output bottleneck and to increase system response time.

4. Replace the proprietary hardware (i.e., bootloaders) built and installed by the initial contractor.[14]

5. Replace the outdated software presently used with current versions.

6. Acquire a software maintenance package to receive future software editions.[15]

The plan is to acquire hardware and software to be used by the CAFMS SSF to test, modify, and develop applications compatible with this new hardware and software. A decision will be made at a later date to acquire this equipment for the three field locations. It is anticipated that CAFMS version 5.0 will be designed to operate on the new equipment, but it is unlikely that the new hardware and software will be installed prior to 1987. Not including manpower costs associated with the SSF, the total cost is estimated to exceed $1.5 million.

Summary

The evolution of CAFMS came to a grinding halt in 1982 when the program was deleted from the the PMD. Lack of management visibility on automation within the TACC, lack of user involvement in the CAFMS program since 1982, and the perception of CAFMS' usefulness are a few probable causes of its present status. It is doubtful that either the 9th or the 12th Air Force commander would seriously consider the deployment of CAFMS on anything short of a major conflict. The scarce availability of airlift would more than likely relegate CAFMS to the follow-on of follow-on forces. CAFMS has never been exercised during a "real-world" operation, anyway, and the current perception of its reliability is that it could take days (and it sometimes has taken days) to become operational.[16] The requirement for rapid reaction and flexibility in support of Operation Urgent Fury in Grenada ("Summary," Chapter VI) could not have been met using the present force level C^2 system.

Air Force Major General Prather, at the time he was serving as Director of Command and Control, and Telecommunications at HQ USAF, stated:

> Over the years, immediate availability of . . . C^3I services has been the expected norm. Experience has shown that the real time, real world crisis is a totally different animal.
>
> Typically we face a situation that is of national importance, time critical and totally without preplanning. The need for C^3I equipment is immediate, and decision makers must make do with what is available while real needs and C^3I equipment availability are identified.[17]

From the operational side, General Kingston, Commander in Chief of USCENTCOM last year declared:

> *I am concerned that our old equipment* just won't stand the test. USCENTCOM's goal is a responsive, interoperable system or network of systems that works from the ground up. New C^3I developments must be able to contribute to the overall mission of commanding and controlling my forces.[18]

The concept of employment of force level C^2 has already begun to change. The next chapter addresses the status of TACS systems planning and its impact on the operational community.

With no funded programs to replace CAFMS, the user does not have a system that can adequately meet his present or changing needs. That is the bottom line assessment for tactical force level C^2.

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[17]Maj Gen Gerald L. Prather, USAF, "C^3I in Conventional and Strategic Crisis Management: Prepare for the Unexpected," SIGNAL, May 1984, p. 54.

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CHAPTER IV

PLANNING FOR THE FUTURE

> We need to think war, develop wartime systems and then adapt them to peacetime use; and not develop peacetime systems and then try in vain to make them wartime capable, as we often have done in the past.
>
> --Maj Gen John T. Stihl

The Master Plan

The TAF C^2 Improvements Developers' Guide is the document most action officers at the headquarters use to try to make sense of how their particular programs fit into the overall development of TAF C^2 capabilities. The purpose of this guide is to incorporate two documents, the Tactical Air Forces Integrated Information System (TAFIIS) Master Plan and the Developers' Guide, into one somewhat concise document. The 1984 edition of the Developers' Guide contained 49 separate programs.[1] The August 1985 Tactical Air Forces Interoperability Group (TAFIG) Smart Book, sort of TAFIG's version of the Developers' Guide, summarizes 75 programs currently being staffed.

There are numerous programs, in various stages, designed to improve the AFFOR commander's command and control capabilities. The Modular Control Equipment (AN/TYQ-23) Project (MCE), for example, is planned to replace the C^2 operations centers (AN/TSQ-91, AN/TSQ-61) of the CRC, and the Message Processing Center. MCE is a $2.3 billion undertaking. This program and several others, such as the Ground Attack Control Center (see glossary), are either included in the HQ USAF Program Management Directive (PMD) for TACS Improvements or have their own Program Management Directives. The PMD is the implementing document for a program to enter the "Demonstration and Validation Phase" in the traditional acquisition process.

The Road Map

One document, the TAFIIS Master Plan, attempts to depict the relationships and interrelationships among the plethora of programs. It presents these in a manner intended to afford the staff officer a single multi-volume document containing the design for overall system growth, a framework for program development, a basis for acquisition inputs, a set of "road maps" depicting timetables and milestones of the various programs, and other nice to have information.[2]

The basic problem with the Master Plan has been its size, classification (most volumes are classified Secret), and complexity. Staff officers typically do not have the time, the patience, or the background knowledge to wade through the program "road maps" and descriptions contained in the Master Plan (which must be stored in a safe) to make sense of their particular program(s). The document has remained largely unseen, and particularly unread, at levels that really need the information it contains.

The Revised Master Plan

Beginning in the summer of 1985, the TAFIIS Master Plan underwent a major revision, the basic purpose of which was to produce a more practical document ("user friendliness" is not just a computer term). When it is completed (TechPlan, Inc. has been contracted to rewrite the plan) in January 1986, it should be a much smaller, better organized and synthesized document. A major effort has been made to make the plan understandable while supporting these goals:

1. Provide a framework for C^2 systems development.
2. Provide an approach for reduced duplication in R&D and procurement.

3. Support the TAF C^2 Improvements Plan and relate to several other documents, such as 21st Century TACS.

It is dubious that, at least in the near future, the Master Plan will be more than a basic reference guide. A paper study alone will not satisfy TAC's architectural requirements (see "The Transition to the Future," this chapter).

The Future TACS

Analyses such as those presented in AirLand Battle 2000, Air Force 2000, 21st Century TACS, and the Marine Corps Science Technology Objective (STO) 254 depict a future surface/air battlefield that is highly dynamic, deep, and very destructive. The "worst case" is usually presented in such reports, the worst case being a conflict scenario involving substantial Soviet and U.S. forces.

The time allowed the operational commander to command the air battle is compressed dramatically in such a scenario. Future C^2 will be characterized by extremely high data rates and processing speeds, decision support through AI and knowledge-based systems, networks designed for flexibility and survivability, and joint/combined operations under stress (electronic combat, nuclear, biological, and chemical warfare).

21st Century Tactical Command and Control Architecture. A large team comprised of 50 Air Force and industry experts recently concluded a year-long study sponsored by HQ USAF and the Defense Advanced Research Projects Agency (DARPA). The basic aim of the study, 21st Century Tactical Command and Control Architecture, was to address high level user requirements and describe a general future TACS architectural framework within which those requirements can be realized. The study received broad oversight from the HQ USAF Tactical C^2 Steering Group.[3]

The study breaks the future TACS into three functional subarchitectures: Air Surveillance Management and Control; Surface Surveillance Management and Control, and Force Planning. The general requirements, considered "dominant concerns" for a future architecture, are listed in Table 4.1.[4] Dispersal of elements, replication of databases supporting those elements, and distribution of functions supporting the Force Planning (FP) mission comprise the basic FP architecture in this 21st Century TACS.[5] Within this architecture operations

TABLE 4.1

GENERAL REQUIREMENTS OF THE FUTURE TACS

OPERABILITY

-24 HOUR OPERATIONS (AVAILABILITY)
-USER FRIENDLY
-DEPLOYABLE
-FLEXIBLE/ADAPTABLE GROWTH
-MINIMUM ATTENDANCE (LOW MANPOWER)

SURVIVABILITY

-MOBILITY
-NBC HARDENING
-DISTRIBUTED/DISPERSED OPERATION
-CAMOUFLAGE DECEPTION

SUPPORTABILITY

-MAINTAINABILITY
-SELF-SUSTAINING
-COMMONALITY

INTEROPERABILITY/COMPATIBILITY

-COMMUNICATIONS (SECURE, AJ)
-DATA BASES
-JOINT AND ALLIED
-OLD AND NEW

INHERENT TRAINING CAPABILITY

-SIMULATION/LIVE
-OPERATIONS/MAINTENANCE
-INTERNATIONAL/EXTERNAL
-INDIVIDUAL TEAMS

AFFORDABILITY

-BACKWARD COMPATIBLE
-MODULAR
-SIMPLE
-RELIABLE

TRANSPORTABILITY

-MODULAR
-SMALL SIZE
-LIGHTWEIGHT

ENVIRONMENTAL ADAPTABILITY

-ALL WEATHER
-DAY/NIGHT
-TERRAIN
-CLIMATOLOGY

and intelligence functions are highly interdependent.

At present the document is under consideration at HQ USAF to be the basic concept document for the future TACS architecture.

What's Going on in 1985

The Constraints

HQ TAC is presently working on a technical architecture for the TACS. The approach has been to identify the current system capability (e.g., equipment, connectivity) first, fit the currently funded programs (e.g., TRI-TAC, MCE) into this, and then identify the shortfalls.[6]

One immediate constraint in planning an architecture that resembles the one articulated in 21st Century Tactical Command and Control Architecture is the fielding of Joint Tactical Communications (TRI-TAC) program equipment (see glossary). The overall TACS architecture will be heavily influenced by the TRI-TAC program (which began in 1969) for a number of years, with its non-state-of-the-art equipment and inflexibility in accommodating changing requirements. The problems of providing overall network survivability have actually grown worse with TRI-TAC. Since the Army opted out of the program, lowered equipment production has caused prices to escalate. The Air Force cannot purchase the amount of equipment that it had originally planned to, so operations planning will be even more impacted from reduced connectivity and other user services.

The Frustration

Force management will show up as one obvious shortfall in TACS architecture development. It is a shortfall today. The concept of TACC employment is already changing to meet the operational missions of the Numbered Air Force commanders. Flexibility, reliability, survivability, modularity, etc., are not concepts that TAC can wait until 1995 to begin incorporating into its systems.

The expected scarcity of airlift during a Southwest Asia operation has already motivated the planning for reduced airlift reliance in TACC deployment. Mission Capabilities Statements (MISCAPs), dated 11 September 1985, forwarded to HQ TAC from 9th AF reflect a different method of taking the TACC to war. Ninth Air Force has reduced its airlift requirements by over one-third (down from 33 C-141B equivalent aircraft loads to 20) and has adopted an echeloned employment concept. The total

9th AF TACC package, including automated intelligence support (LENSCE), has been divided into three packages. The first is a quick response initial package and does not include CAFMS. The second is designed to bring the TACC to full operational capability. The third package is planned to arrive by sea and provide full road mobility and increased communications.[7] The second package (the TACC follow-on) calls for a 25,000 lb all-terrain forklift, or 20,000 lb capable crane and 40' flatbed, to position CAFMS.[8]

Users in the "requirements business." The method that 9th AF has used to develop an initial TACC capability is a result, clearly, of (1) their experience with CAFMS and a still predominantly manual TACC, (2) the 18-month lag time between software application identification and completion and the sense of futility experienced in making CAFMS operational, (3) operational requirements CAFMS cannot start to fulfill, and (4) increasing computer literacy among users. What 9th AF has done is taken their own initiatives. Using an assortment (a "kluge") of microcomputers (e.g., CROMEMCO CS-2s, Zenith Z-150s) and microcomputer software, a small group of PC afficionados has built a multiuser system capable of building a limited-sortie ATO and presenting force status information in user-friendly formats. They have, as they say at HQ TAC, placed themselves in "the requirements business."

Such behavior is not likely to be met with continued patience among those in senior staff positions at TAC, and for good reason. TAC <u>is</u> in the requirements business.[9]

The 9th AF is not alone in its frustration, however. Staff officers at the 1st Marine Amphibious Force (I MAF), Camp Pendleton, California, have resorted to similar measures. In a letter from the Commanding General, I MAF to the Commandant of the Marine Corps:

> What has changed rapidly is the environment in which this function [i.e., C^2] must be accomplished. The demand placed on C^2 systems by the modern battlefield greatly complicate what has never been an easy task. . . . <u>These increased C^2 demands bring new requirements for both procedures and supporting systems</u> [emphasis added]. The grease pencils, map displays, hand delivered messages and face-to-face C^2 coordination measures utilized within the Marine Corps will no longer suffice.[10]

<u>The Transition to the Future</u>

As the technical architecture for the post-1985 TACS is developed, TAC must work now to meet user requirements in the near term, validate/revalidate existing functional requirements within the TACC, articulate the technical and functional requirements for force management, and field a force level C^2 system that can evolve within an architecture as requirements and technology change. That is no small job.

Air Force Information Systems Architecture, Volume II (draft) provides the following direction in the transition from the existing situation to targeted capabilities:

> This strategy must be developed from the end user perspective. The techniques employed must be attainable. The strategy must be implemented in an evolutionary manner with small "doable" modules. The progress from existing capabilities to those of the target architecture must be clear.[11]

A statement of need. A Statement of Operational Need (SON), drafted at HQ TAC in August 1985, attempted to squeeze force level automation into a program (a Class IV modification) to replace the TACC's AN/TSQ-92 shelters with more supportable, smaller, expandable hard shelters.

This proposed program ($37+ million), would, for example:

1. Internet an intricate multi-level secure voice/data/video system of LANs using 24 shelters (12 for each Numbered Air Force).
2. Fully interconnect with all subordinate and lateral TACS elements (e.g., CRC, AWACS, ASOC, WOC, and ABCCC).

3. Employ gateways for full two-way data information exchange with Army, Navy, Marine, and allied forces tactical C^2, air defense, and fire control systems.
4. Provide AI based decision and task aids.
5. Incorporate all DoD standard protocols within the LANs.

Each shelter would have its own secure LAN, be tied to a medium area network, and be separated from adjacent shelters at distances up to 3000 feet. Each fiber optic LAN would support secure information exchanges among one 32-bit minicomputer, six microcomputers, six intercom telephones, four graphics workstations, one television monitor, and two large-screen displays within a shelter.

Prototype testing would be accomplished at Rome Air Development Center (RADC), with a final 3-month field test conducted at the 507th TACCS.[12]

The SON obviously missed the point; its processing was desisted when TACC matters were assumed by HQ TAC/DOY.

RECOMMENDATION. TAC SHOULD ADOPT AN EVOLUTIONARY STRATEGY IN THE DEVELOPMENT AND ACQUISITION OF A FUTURE FORCE LEVEL C^2 SYSTEM.

RECOMMENDATION. KEEP CAFMS ALIVE ONLY UNTIL A CORE SYSTEM CAN BE FIELDED: TARGET FOR EARLY 1987.

Summary

The Air Force FY 1986 procurement budget for Tactical Air Control System Improvements is $95.4 million. For FY 1987 it is $161.7 million. Over $52 million has been budgeted for the field testing of ASAS/ENSCE modules during FY 86 and FY 87, under the Joint Tactical Fusion Program. There are no funded programs, however, for tactical force level C^2. Programs such as MCE will continue to soak millions while users seethe over their existing state of readiness.

Operational commanders could not be expected to tolerate an obsolete, highly vulnerable system such as CAFMS anymore now than on the future battlefield.

It is the nature of command and control systems and the series of past failures experienced in attempting to detail C^2 requirements "up front" that have motivated a new way of thinking in command and control systems acquisition. EA embraces the idea that the user is a significant-to-dominant player in the acquisition process. The user who has

AD-A166 656 REQUIREMENTS DEFINITION FOR FORCE LEVEL COMMAND AND CONTROL IN THE TACTIC..(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH C J BOENSCH 1985 2/3

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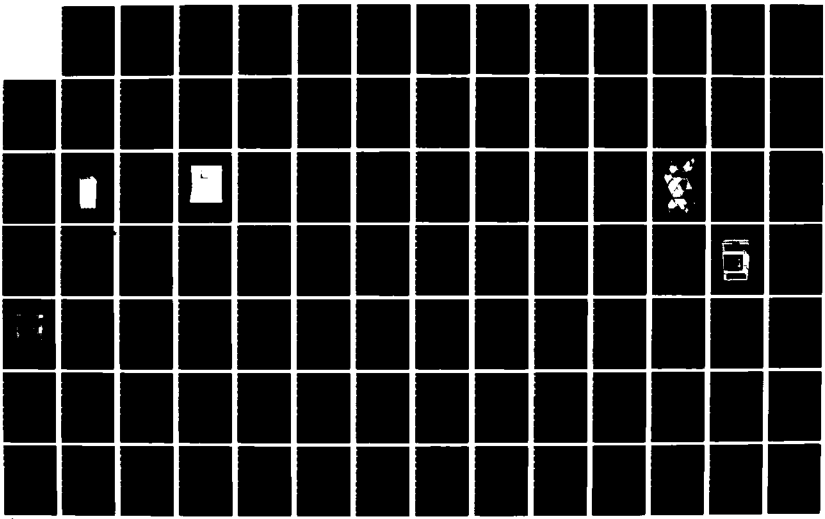

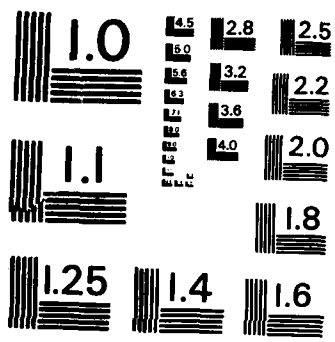

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

worked in the hectic, largely manual TACC operation, assisted by CAFMS doesn't know what functional requirements state-of-the-art technology can or should support until he has had a chance to understand the technology through operational use.[13]

A Solution

A Rapid Requirements Definition Capability (RRDC) is the solution to this. The AFCEA Study:

> In concept, RRDC can be assembled since it can be put together using off-the-shelf technology. The objective is to design an RRDC flexible enough . . . so that user "experience" can be quickly obtained, and a system concept, architecture, and a set of initial ("core") capabilities can be developed.[14]

Sub-recommendation. **A RAPID REQUIREMENTS DEFINITION CAPABILITY (RRDC) IS THE ESSENTIAL MEANS BY WHICH A CORE SYSTEM WILL QUICKLY, MORE ACCURATELY, AND MORE INTELLIGENTLY BE SPECIFIED.**

An RRDC is a test bed as well as a prototype in this document. There are technical differences, but too many reports, studies, and other documents have used these terms synonymously.

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CHAPTER IV

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[3]The HQ USAF Tactical C^2 Steering Group is a standing committee of senior officers who meet on a scheduled basis throughout the year at HQ USAF. Committee members represent HQ USAF, the TAF, HQ AFSC, HQ MAC, HQ AAC, HQ AFLC, HQ AFCC, HQ ESC, and TAFIG.

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[12]Headquarters, Tactical Air Forces Interoperability Group (TAFIG), "Proposed Statement of Operational Need (SON) for Air Component Commander and Tactical Air Control Center Automation," letter, with attached SON, from TAFIG/II to multiple addresses, Langley AFB, VA, 13 August 1985. SON responsibility was later assumed by HQ TAC/DOY.

[13]This, by the way, has been the stated feeling of several senior officers at both 9th and 12th Air Forces.

[14]Armed Forces Communications and Electronics Association (AFCEA), Command and Control (C^2) Systems Acquisition Study Final Report (Falls Church, VA, 1 September 1982), p. V-15.

CHAPTER V

REQUIREMENTS DEFINITION OF THE CORE INCREMENT: GENERAL STRATEGY

> Get hard data. Get it quickly. That's the key.
>
> --A Passion for Excellence

Program Management

This paper considers the RRDC to be the appropriate means from which an operational core is to be specified. This chapter discusses general considerations in the implementation of a test bed and recommends some reasonable criteria that the RRDC should fulfill.

The successful definition of the functional requirements for a core increment to be fielded is contingent upon a well-managed requirements definition study period.

> Experience has shown that even when individuals are capable of accurately envisioning how a system would operate (as a result of prior experience, education, and training) their ideas change substantially after "hands-on" experience.[1]

The TAF's experiences with CONSTANT WATCH, EIFEL, and CAFMS, with their varying degrees of success, will undoubtedly serve well during such a study, and the lessons learned during their stages of implementation should be actively considered. While the "hands-on" experiences with CONSTANT WATCH, EIFEL, and CAFMS may well allow a higher quality specification for a core increment, the limitations imposed by their architectures and the ways they are employed preclude any dominant influence.

Planning, Programming, and Budgeting

To adopt an evolutionary strategy in acquiring a command and control system is going to require program visibility and, especially, the emphasis from top-level management within the TAF.

An RRDC could be established in relatively short order with such emphasis. The basis for this decision would be a short statement of operational requirements and a general description of the functional capability desired for the full system, an obvious deviation from the norm.

The study period. Concurrent with system planning, a Requirements Definition Study Period (RDSP) based upon an acquired test bed system (the RRDC) would serve to define the specific requirements of a core system. These requirements, documented in a revised SON and stating also the general overall program requirements, would provide the basis for budgeting in such a strategy. System acquisition would then follow a "design-to-approved-budgeting" path, which is considered a better estimate of the system's actual cost than those taken in traditional approaches.[2]

Forward funding of the core increment and two subsequent increments would allow the implementation of the core system shortly following the RDSP and fill the present two-year PPBS gap. It would allow the fielding of an operationally usable, tactical battle management system in 1987 rather than in 1992. Money saved in the maintenance of CAFMS alone would pay for the initial system.

Funding strategy. The basic EA model calls for the sequential fielding of operational capabilities as the system evolves. If each increment were treated as a "release" within the overall requirement, decision for funding of future increments could be determined on:

1. Reports of system performance and user satisfaction, from 9th and 12th Air Force commanders,
2. Other measures of merit,

3. Definition of future increments, and
4. Management of the program.

Sub-recommendation. **A FORMAL MANAGEMENT ELEMENT, WHOSE PRIMARY MISSION IS THE OVERALL MANAGEMENT OF THE EA PROGRAM--TO INCLUDE THE RAPID REQUIREMENTS DEFINITION CAPABILITY--IS PARAMOUNT TO A SUCCESSFUL ACQUISITION STRATEGY.**

The Program Management Office

A Program Management Office (PMO) should be established at Headquarters, Tactical Air Command, under the auspices of the Deputy Chief of Staff, Operations. The PMO's formalization would logically be later contained in a Headquarters, USAF Program Management Directive. Headquarters, Tactical Air Command would thus be designated the implementing command and assigned overall program management for the project. Headquarters TAC would, through a designated Program Manager, have overall management responsibility for organizing, planning, directing, and controlling the project.

A combined program office. Actually, the PM would be in charge of a "combined program office."[3] Such an office would be comprised of the HQ TAC PM team with representation from the user, developer, and tester communities.

The roles and relationships among HQ TAC, AFOTEC, contractors, TAFIG, AFSC, AFLC, PACAF, USAFE, ATC, ESC, MAC, the Air Staff, and others possibly involved in the program must be negotiated early. Overall responsibility for defining the particular evolutionary approach to be taken would rest squarely with the PMO.

If an evolutionary acquisition strategy is to be implemented with any degree of success, it should be surmised from previous experience that the PMO is the cornerstone of its success. A cadre of experienced, highly proficient officers from a variety of backgrounds would be an intelligent selection decision. The most effective teams are those comprised of many disciplines.

Sub-recommendation. CONCERTED EFFORT MUST BE MADE TOWARD ASSEMBLING AN RRDC THAT IS RAPIDLY ACQUIRED. COMMERCIALLY AVAILABLE "OFF-THE-SHELF" SOFTWARE AND HARDWARE AND COMPETENT, AGGRESSIVE PROGRAM MANAGEMENT ARE FUNDAMENTAL TO THIS EFFORT.

The combined team would do well, in the beginning, to consider 12 basic questions posed by John C. Morgenstern, in the May 1983 issue of SIGNAL.[4] Such questions as "Are we pushing the state-of-the-art? Do we have to? Can we afford to?" would seem basic for a test bed project.

Acquisition planning, configuration management (software and hardware) planning, test bed development and maintenance, and system architecture planning are a few areas that contracted support would prove beneficial in an EA effort. This is revealed further in Chapters VI and VII.

Competition

Competitive acquisition of services and products should be used to the extent appropriate, given the requirement to maintain minimum disruption of the system's evolution. As normal contracting practices could cause unacceptable delays to be incurred, resulting in overall substandard system performance, it is imperative that government and contractor responsibilities, particularly in the areas of

1. Test bed development,
2. System architecture,
3. Acquisition planning, and
4. Configuration management

be determined at the project's inception. It must be emphasized that, in those areas continuing throughout the system's lifetime, frequent contractor changes would be disruptive and counterproductive.

RRDC Specification

Prerequisite Criteria

Software first. "Swallowing the elephant whole," "creating a many-humped camel," and "trying to do all things for all people" are three of the pejorative phrases Air Force officers use when describing requirements definition. It seems to be a natural tendency to add requirements to a system as documentation "floats" through staff coordination channels. An inexpensive twisted pair based data LAN thus ends up as a fiber optic based integrated voice, data, and video LAN. Chartering the PMO with the RRDC specification and adopting a "software first" perspective will mitigate this effect.

Sub-recommendation. START SMALL.

Affordability. The RRDC needs to be affordable. The expected benefit of a particular characteristic, hardware or software, must be subjectively evaluated against the expected value of its contribution to the core increment.

Criteria definition. The attributes of a viable prototype system have been synthesized from several sources:

1. Formal and informal statements of requirements from operational commanders at the Numbered Air Forces.
2. Current and future planned employment concepts.
3. Evaluations of presently fielded tactical C^2 systems (see Chapter VI),
4. Reasoned judgment.

Operational Criteria

Operational criteria are the "mind extending" attributes of a command and control system and are software critical.

The software. Software must be acquired commercially "off the shelf" or from government sources. All basic applications software must be fully integrated and judged "user friendly" without modification. Software shall be required to support, as a minimum, the following functions:

1. <u>Information Processing</u>:

   a. Message drafting and editing, the principle message being the Air Tasking Order.

   b. User-defined message format specification.

   c. User-defined display symbol specification.

   d. Message processing and switching:

      1) Multiple addressing of messages.

      2) Automatic routing, notification, and storage of inter- and intra-module message traffic.

      3) Automatic store and forward of message traffic.

      4) Automatic prioritization of messages by user-defined categories defined by the user (e.g., Flash precedence).

      5) Automatic notification and printing of priority messages.

      6) Automatic protocol and transmission medium conversion for specified protocols and links.

      7) Error detection and automatic retransmission.

e. Off-line local processing and programming capability.

   1) Workstation must be capable of running MS-DOS/PC-DOS applications.

f. Data base management:

   1) Automatic duplication of data base information (redundancy) at specified modules, partitioned according to job functions/ locations.

   2) Storage of force status information and messages (e.g., aircraft status, munitions status).

   3) Force information and message retrieval via query language or predefined queries.

2. <u>Information Exchange</u>:

   a. Net control/maintenance of primary and secondary network topologies.

   b. High speed intramodule throughput.

   c. Autodial/autoanswer modem capability with 1200 bps minimum modem speed.

d. On-line, system high encryption capability between modules, using Government Furnished Equipment (GFE).

3. Information Presentation:

a. Display of maps and situation outlays.

b. Selection of map size, type, and number of units to be displayed, as defined by the user.

c. Retrieval of unit information via selection of unit(s) from a screen display (i.e., "hooking capability").

d. Automatic preparation of automated briefing materials from information as it is received (in a user defined format).

e. Presentation of automated briefing via large screen display or monitor.

f. Capability to produce hard copy of messages, reports, other text, and graphics.

4. Performance Monitorability:

a. Automatic monitoring and reporting of system status.

b. System diagnostic routines.

System Criteria

Readiness. The test bed system must provide a viable operational capability. It should be configured to allow peacetime training, normal in-station office automation uses, and operational planning. The system must be capable of transitioning from peacetime use to meet contingency or other deployment conditions, as determined by the PMO. System readiness shall be considered an important system criterion in determination of core system requirements.

Flexibility. The system must be designed to allow ground elements to operate in existing fixed facilities (e.g., hangers, bunkers, buildings), mobile shelters, or tents at a deployed location. Modularity must be basic in the system design, allowing the system to be tailored to a given scenario and modularly expanded/decreased without disruption.

The RRDC should be configurable to interface initially with the LENSCE, the BCE, the ASOC, the WOCs, and the ABCCC.

Maintainability. Emphasis must be placed on acquiring test bed hardware of proven reliability, designed to require minimum field maintenance. "Remove and replace" Air Force maintenance will be considered a key logistics study area in the requirements definition study.

Supportability. Supportability is closely related to maintainability, and will be considered another key logistics study area in the requirements definition study. Supportability considerations might include the following:

1. Reduction in personnel requirements.
2. Reduced dependency on fossil fuels.
3. Design of individual modules for self-contained operation.
4. Lightweight organic power.

Special arrangements will be made during the study to ensure appropriate hardware and software support through commercial and government channels.

Reliability. Full military specifications (MILSPECs) will not be used as system criteria and would defeat the main acquisition strategy for the RRDC: to acquire affordable, commercially available hardware. Modifications of hardware will be made consistent with the operational and system criteria.

Mobility/Transportability. Certain elements of the system may be developed to support operations while mobile. All system hardware, to include power generation equipment, must be air transportable by C-130 and C-141. All system elements must be developed to be set up and operational, exclusive of non-organic communications, within one hour of arrival on site. Similarly, the RRDC must be capable of rapid tear-down and redeployment.

Survivability. The above criteria greatly impact on survivability. The following are some further areas to be studied in the test bed:

1. Ruggedization of system hardware.
2. Redundancy/partitioning of data and operations.
3. Dispersal of modules.
4. Site security.
5. Low Probability of Intercept/Low Probability of Exploitation of Communications.
6. Other passive defense measures:
   --Low noise, low infrared signature generators.
   --Site locations.

--Camouflage, concealment techniques.

--Mobility.

Training. Training is a chronic problem within the Tactical Air Control Center. The test bed will examine methods of reducing requirements for training; ease of learning software applications of the RRDC is essential. Possible areas in training to be studied include the following:

1. Built-in training routines.
2. Computer Assisted Instruction (CAI).
3. Interactive video.

An active search will undoubtedly uncover exciting uses of these training techniques. Contact should be made with the Air Force Human Resources Laboratory. RADC, Air Training Command, civilian contractors, and others, to assist in the study (see Chapter VII).

It is anticipated that initial training on the RRDC would be provided to selected HQ TAC staff personnel, PMO personnel, and selected users, both at Langley and at users' operating locations.

REFERENCE NOTES

CHAPTER V

[1]Armed Forces Communications and Electronics Association (AFCEA), Command and Control (C^2) System Acquisition Study Final Report (Falls Church, VA, 1 September 1982), p. V-13.

[2]Ibid., p. III-62.

[3]AFCEA, C^2 System Acquisition Study Final Report, p. III-71.

[4]John C. Morgenstern, "C^2 Systems Acquisition: The Requirements Problem," SIGNAL, May 1983, pp. 121-122.

CHAPTER VI

REQUIREMENTS DEFINITION IN THE ARMY AND MARINE CORPS: EA CASE STUDIES AND IMPLICATIONS FOR INTEROPERABILITY

> Military strategy that loses battles is no more disastrous than acquisition strategy that fields obsolete systems. The final outcome very well can be the same.
>
> --Lt Gen Emmett Paige, Jr., USA

The Test Beds

Two particular cases of evolutionary approaches to requirements definition and system implementation are reviewed in this chapter. The first involves efforts of the Army to develop and acquire a distributed tactical command and control system. Previously called the Distributed Command and Control System--now designated Maneuver Control System (MCS) 2.0--it has been cited as a "paradigm for future system acquisition and development."[1] MCS 2.0 is presently managed by the Army Development and Employment Agency (ADEA), Ft. Lewis, Washington. Together with the 9th Infantry Division (Motorized) and the Army Communications Electronics Command, Center for Systems Engineering and Integration, ADEA has, in less than 3 years, fielded an affordable, flexible, modular, transportable, survivable, automated tactical command and control system. It is the first such major, deliberate effort among the services to acquire and develop such a system, exploiting commercially available software and hardware as a basis.

The second system discussed is a recent initiative of the Marine Corps to acquire and field, under the auspices of the Marine Corps Development and Education Command, a command and control test bed at Camp Pendleton, California.

The Marine Corps program is called the Tactical Combat Operations (TCO) Test Bed, and is operationally supported by the 1st Marine Amphibious Force (I MAF) headquartered at Camp Pendleton. The TCO Test Bed is an attempt to validate and revalidate functional requirements of its formal TCO program (another lengthy formal program) through the acquisition of an operationally usable C^2 system. The TCO Test Bed system, which was formally accepted at Camp Pendleton during the first week in November, 1985, capitalizes on the developments of ADEA, the Defense Nuclear Agency, and the Army corps level Staff Planning and Decision Support (SPADS) System.

Essentially, the TCO Test Bed system is based on the evolutionary developments of existing C^2 systems.

MCS 2.0

The 9th Infantry Division

The Maneuver Control System (MCS) 2.0 is a recent redesignation of the Distributed Command and Control System (DCCS). The Distributed Command and Control System evolved in the High Technology Light Division (HTLD) program at the 9th Infantry Division (9th ID) at Ft. Lewis, Washington.

Meeting AirLand Battle requirements. Through the establishment of the Army Development and Employment Agency (redesignated from the High Technology Test Bed) at Ft. Lewis, the Army has built the mechanism to design and evaluate how a High Technology Light Division (i.e., the 9th ID at present) can meet the requirements of AirLand Battle (the Army's present fighting doctrine), and future AirLand Battle doctrine.

The division is being designed to possess the fighting power of a heavy division in the European theatre, but with the strategic and tactical deployability and sustainability of a much lighter force.[2] The 9th ID has been structured as a "task organized" unit, which is atypical of Army divisions. This structure, not unlike that of a Marine Air-Ground Task Force, lets fighting power be more readily tailored to a particular operation.

Requirements for survivability, synchronized combined arms attack, and a common perception of the battlefield in the AirLand Battle environment are a few requirements that the HTLD's tactical command and control system has had to be designed to support.

The DCCS (MCS 2.0), deemed the "most important" of the Ft. Lewis programs, was established in 1983 as a 3-year evolutionary acquisition effort toward the fielding of a division-wide system, and as a means through which to define, test, evaluate, and redefine command and control requirements among all functional areas (i.e., maneuver, fire support, intelligence/electronic warfare, combat service support, and air defense) of the SIGMA STAR (see glossary).

The system. The DCCS was designed as an integrated system of computer hardware and software, vehicles and shelters, communications equipment, trained personnel, and operating procedures. Its "building block" architecture (an evolution from the SPADS system discussed later in this chapter), enabling the flexible and modular deployment of system command and control elements, together with an integrated software package that supports numerous C^2 applications, are the foundation of the system. It is appropriate to examine the basic hardware and software used in MCS 2.0, particularly because MCS 2.0's evolved capabilities have been incorporated in the Marine Corps' TCO Test Bed system.

System Echelons

The upper echelon. MCS 2.0 is divided into Upper Echelon (brigade and above) and Lower Echelon module configurations. The division (Upper Echelon) Tactical Operations Center (TOC), for example, consists of 12 modules, each module (or node) configured as a multiuser system. The basic module consists of several terminals or smart workstations, a videographics subsystem, and a shared printer or plotter connected to a WICAT 160 computer.[3] Each WICAT is connected to its own communications interface unit (a gateway), providing connectivity to Upper and Lower Echelon modules. The Lower Echelon system, however, is where Local Area Network (LAN) technology has been combined with both rugged hardware and powerful integrated software to support

C^2 in the higher threat environment. Discussion of MCS 2.0 hardware will focus on the Lower Echelon, with exception of graphics displays and videographics, which are presently used only at brigade and division levels.

The lower echelon. The Lower Echelon MCS 2.0 extends automation to the 9th ID's Maneuver, Field Artillery, Air Defense Artillery, Military Intelligence, Signal, Engineer, and Support Battalions. The need for mobility and ruggedization of information systems supporting these functions at these levels becomes an even more important consideration in system design than for the brigade and division command elements. The Lower Echelon system, in terms of its rugged flyaway capability, hardware design, and software applications, is a much more impressive system.

Basically, the Lower Echelon MCS 2.0, as it is presently implemented at the 9th ID, provides the battalion commander two important capabilities:

1. To update brigade and division level data bases with a variety of data (e.g., force status).

2. To support his command and control requirements through shared data and software on his high speed LAN.

The Lower Echelon MCS 2.0

Basic hardware components. The Lower Echelon MCS 2.0 LAN is based on GRiD Systems Corporation hardware, the typical multi-station configuration depicted in figure 6.1.

The basic hardware components in this configuration are:

1. The GRiD Server. GRiD Server, the only commercial mobile file server on the market, is the heart of the LAN. Using an Intel 80186-based file server board, an Intel 80186-based communications server board, an Intel 8031-based diagnostics processor board, and an expansion unit that provides slots for additional server boards and future expansion, GRiD Server can accommodate up to 32 simultaneous users.

GRiD Server allows authorized users to select from a large menu of software programs, access shared storage, and obtain LAN communications to other users. Ten MB and 40 MB hard disk drives are added (up to 7 per server are possible at the 9th ID) as needed to provide additional shared storage for system users. Figure 6.2 shows the GRiD Server.

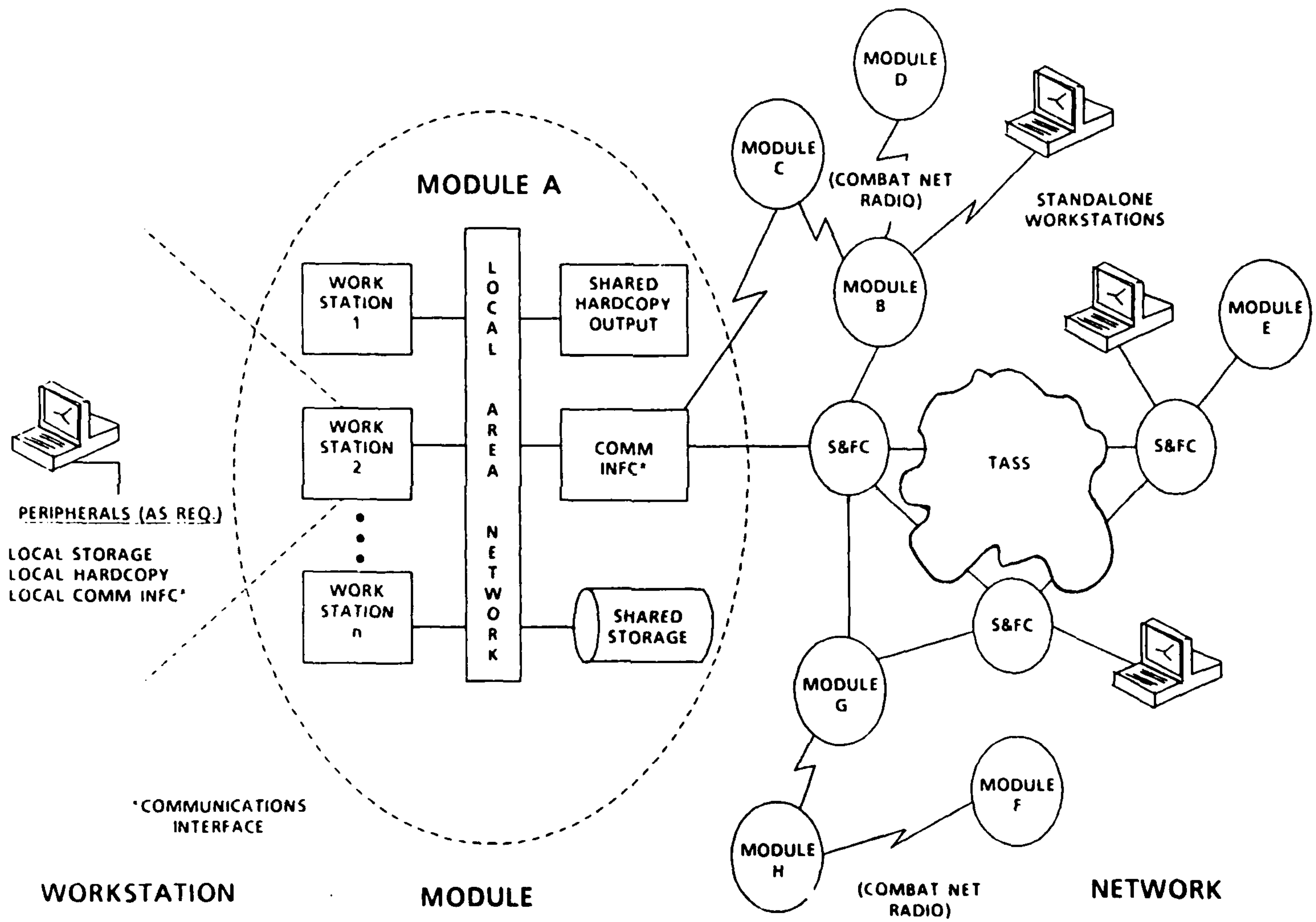

FIGURE 6.1 LOWER ECHELON MCS 2.0

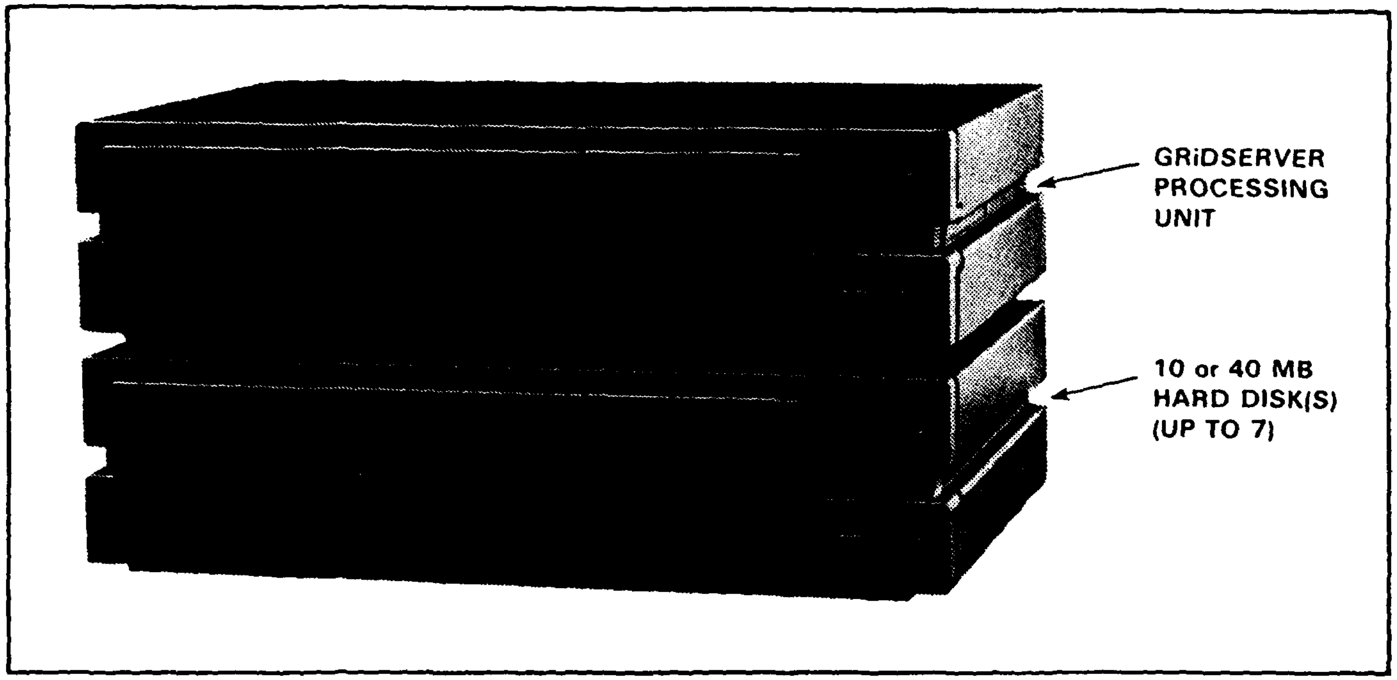

FIGURE 6.2 GRID SERVER WITH SHARED STORAGE UNIT

2. The GRiD Compass. A weight of only 10 lbs and the ability to withstand up to 65 G-factors on any axis are two of this microcomputer's distinct advantages over standard office equipment, when considering deployability and ruggedization requirements (see figure 6.3).

The basic GRiD Compass microcomputer used at the 9th ID has these features:

- --384K bytes of magnetic bubble (non-volatile) memory.
- --512K bytes of Random Access Memory (RAM).
- --128K bytes of Read Only Memory (ROM), expandable to up to 512K bytes.
- --An Intel 8086 16-bit main microprocessor and an Intel 8087 80-bit arithmetic co-processor.
- --RS 232-C and RS 488 ports to support connection with a number of peripherals.
- --An 80 x 25 character, shock-resistant, electroluminescent flat panel display.
- --User selectable 90V-140V or 160V-280V power, at 47-66Hz.
- --Compatibility with both MS-DOS and GRiD operating system-run programs.

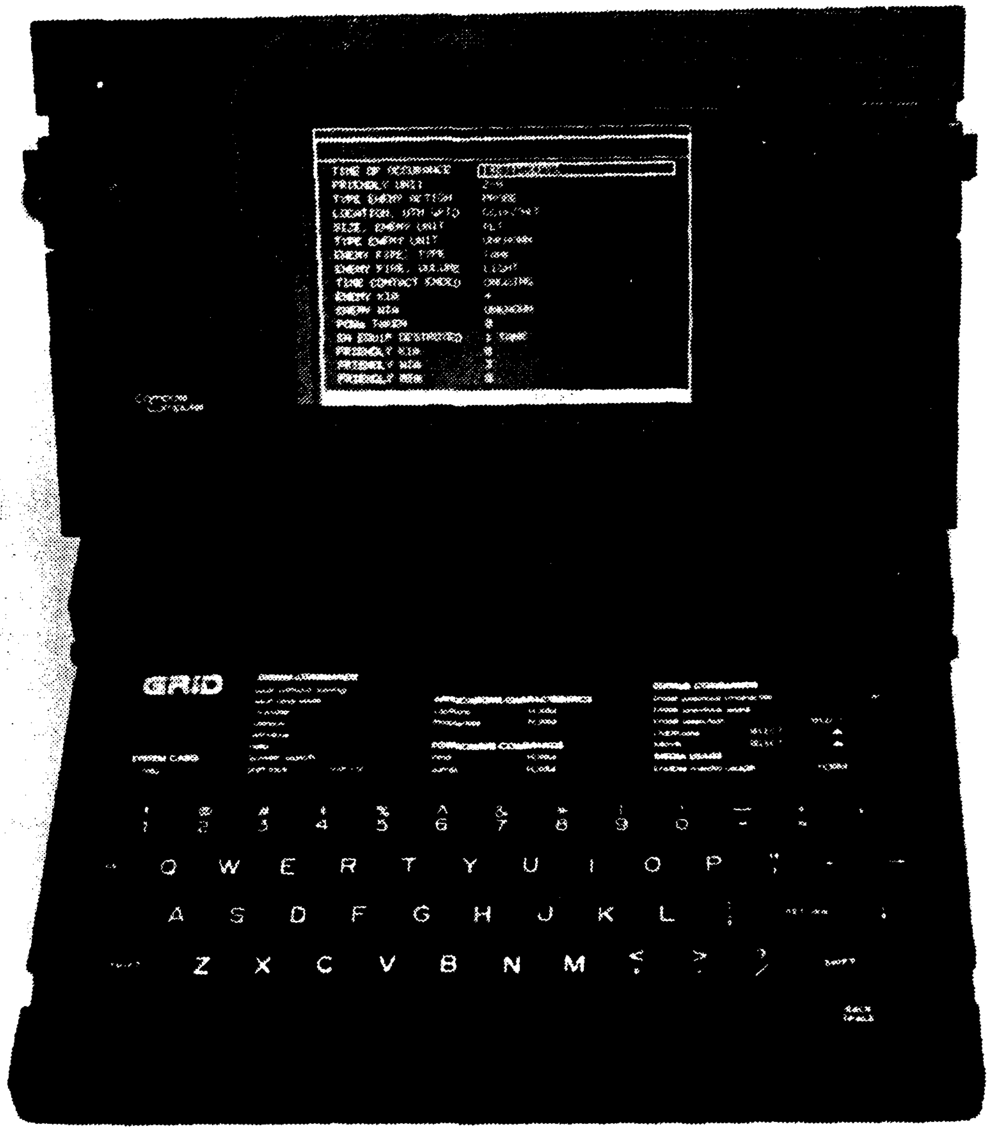

FIGURE 6.3 THE GRID COMPASS

--A built-in 1200/300 bps modem that provides access to GRiD Server/GRiD Compass over standard telephone lines.

3. GRiD Peripherals. At the workstation (i.e., GRiD Compass) level, rugged 360K byte floppy diskette drives and a 10 MB Hard Disk System (with a 360K floppy diskette drive) are used for additional storage. Typically, only selected GRiD Compass workstations use the 10 MB drive.

Other peripheral capabilities include local (i.e., workstation) printing and shared printing.

4. The Communications Interface Unit. The DCIU, standing for DCCS Communications Interface Unit, is a multiple link communications gateway processor. Originally designed to operate on the Space Shuttle, the DCIU is configurable in both rack mountable and "briefcase" versions. The DCIU, though presently programmed to service two 16 Kbps FM channels, one 1200 bps modem channel, and one 19.6 Kbps channel, is programmable to service almost all of current and proposed (e.g., TCP/IP) communications protocols.[4]

In addition to multi-station operations "standalone" configurations, or basic workstation configurations, are used. Standalone configurations support dispersed and highly mobile units, such as company level units. In the standalone mode of operation, the GRiD Compass is attached to a Single Channel Interface (SCI) unit or DCIU, an encryption device (i.e., the TSEC/KY-57), and a combat net radio for 16 Kbps secure burst transmission to higher echelons (see figure 6.4). Peripherals are attached to the Compass as needed.

The Videographics Subsystem

Videographics provide the commander the ability to see the AirLand Battle. MCS 2.0 software and hardware provide for the graphic integration of situation reports and standard military or specially prepared maps and photographs.

Database update. As tactical updates are received at the brigade and division levels, their data bases are automatically updated. Graphics software enables the commander to initiate a data base query to identify units, targets, or other desired information based on data received. The videographics system displays the selected map or photo image and the queried data is then overlayed (using user-identified icons) on the image.

Common perception of the battlefield. The commander is thus able to "see," for example,

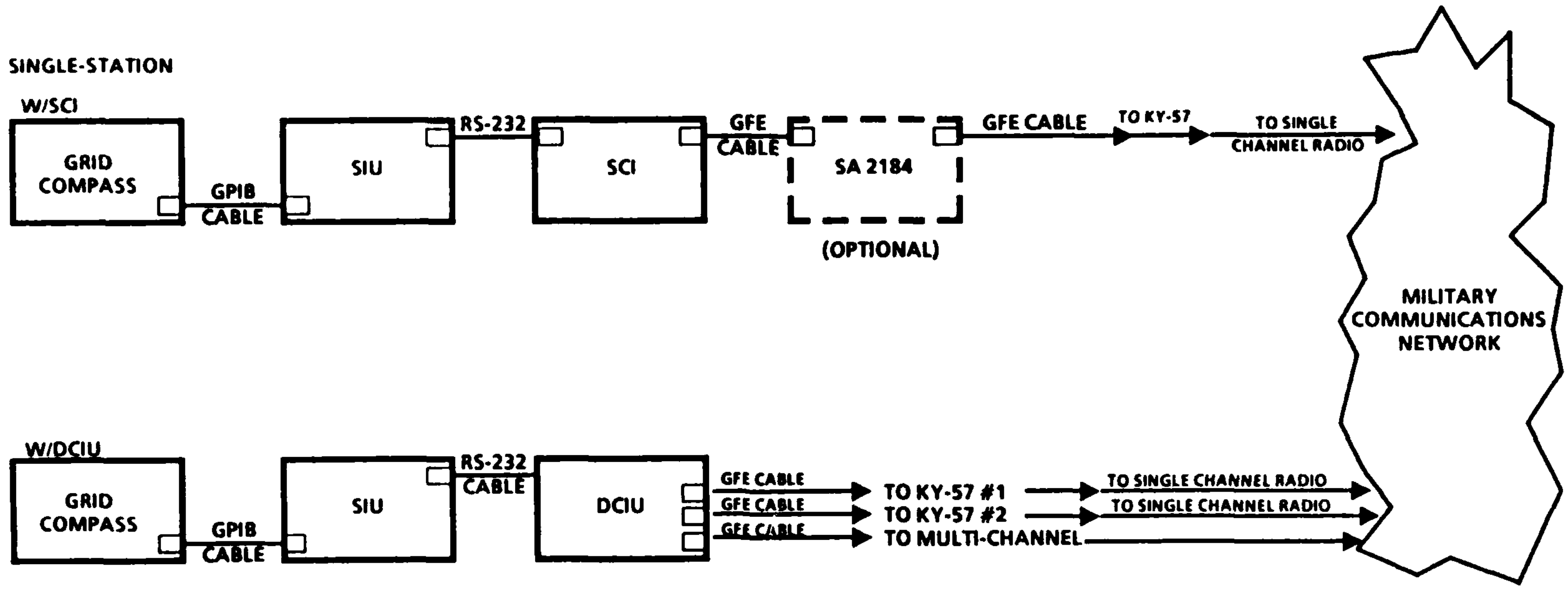

FIGURE 6.4 LOWER ECHELON MCS 2.0 STANDALONE CONFIGURATION USING SCI AND DCIU

accurate locations of friendly and enemy units. As data bases are automatically updated at every MCS 2.0 brigade and division node, a common picture of the battlefield may be viewed by commanders in widely dispersed locations.

In a recent ADEA summary of lessons learned, the following describes the value of color graphics in visualizing the AirLand Battle:

> Being able to visualize the battlefield, at multiple locations, as seen by the key decision maker in the CG's [Commanding General's] Battle Center provides the winning edge since other leaders or operations officers may rapidly appreciate the commander's intent and timing. This capability is the most significant of the combat multipliers for the division.[5]

Subsystem hardware. Hardware components of the videographics subsystem consist of an Aydin color monitor (there is a large screen display at the Commanding General's Battle Center), GraphOver 9500 video mixer, and a Sony videodisc player.

The Software

Lower Echelon MCS 2.0 software is fully integrated and provides an extremely easy to learn user interface.[6] Of the 17 integrated software applications packages offered by GRiD Systems Corporation, the lower echelon module employs six:

1. GRiDManager -- Applications manager
2. GRiDWrite -- Text editor
3. GRiDPlan -- Spreadsheet
4. GRiDFile -- Database manager
5. GRiDPaint -- Freehand graphics package
6. GRiDPlot -- Graphics tool (graph, pie chart)[7]

In addition to these GRiD packages, there are four specialized (integrated) packages:

1. The Computer-Assisted Message Generator (CAM-G).

2. The Automated Report Generator (ARGEN).

3. The Electronic Mail System (E-MAIL).

4. The Data Automated Video Display (DAViD) System.

These 10 packages comprise the core of all lower echelon C^2 functions.

The GRiD Compass computer has been designed to run programs written for the GRiD operating system (GRiD-OS) and the industry standard, MS-DOS, allowing the user a tremendous amount of flexibility in running applications. File transfer between both software environments is easily accomplished.

The Lower Echelon MCS 2.0 integrated software applications suite is described in appendix F.

The Integrated Command Post Concept

The idea of an Integrated Command Post (ICP) was conceived in early 1984 as a means of providing strategic and tactical mobility to the 9th ID, while reducing command post signatures through modular design.[8]

To date, 38 command posts, configured as standard, vehicle mounted modules, are used by the 9th ID, and have been selectively employed at division, brigade, and battalion levels.

ICP attributes. The ICPs were designed and built to incorporate the following attributes:

1. Accommodate AirLand Battle doctrine.
2. Be responsive to 9th ID DCCS (MCS 2.0) requirements.
3. Provide for protection of electronic equipment.
4. Be highly mobile.
5. Be capable of quick erection and march order.
6. Be modular to the maximum extent possible.
7. Have standard elements to the maximum extent possible.
8. Have reduced and common electronic signatures.

9. Have common visual profiles.
10. Incorporate human factors considerations.
11. Have adequate and reliable power.

Pending delivery and use of the Army's new High Mobility, Multi-Purpose Wheeled Vehicle (HMMWV), surrogate ICP vehicles have been fielded using the M886 field ambulance vehicle.

The goal of the ICP project was to take M886 vehicles, modify them as needed, and install standard command post modules. The idea behind the ICP project was that standardized vehicles could be clustered in varying numbers to provide command and control facilities tailored to the particular divisional function. For example, a Tactical Operations Center (TOC) would be comprised of 12 vehicles; a Brigade Tactical Command Post would consist of 4 vehicles. A typical ICP configuration is shown in figure 6.5.

ICP subsystems. Each ICP module is actually a collection of subsystems. A 1983 MITRE Working Paper on ICP configurations specified these requirements of a module:

1. Quick-erecting tent.
2. On-board 115V/60Hz generator
3. Uninterruptable Power Supply (UPS).

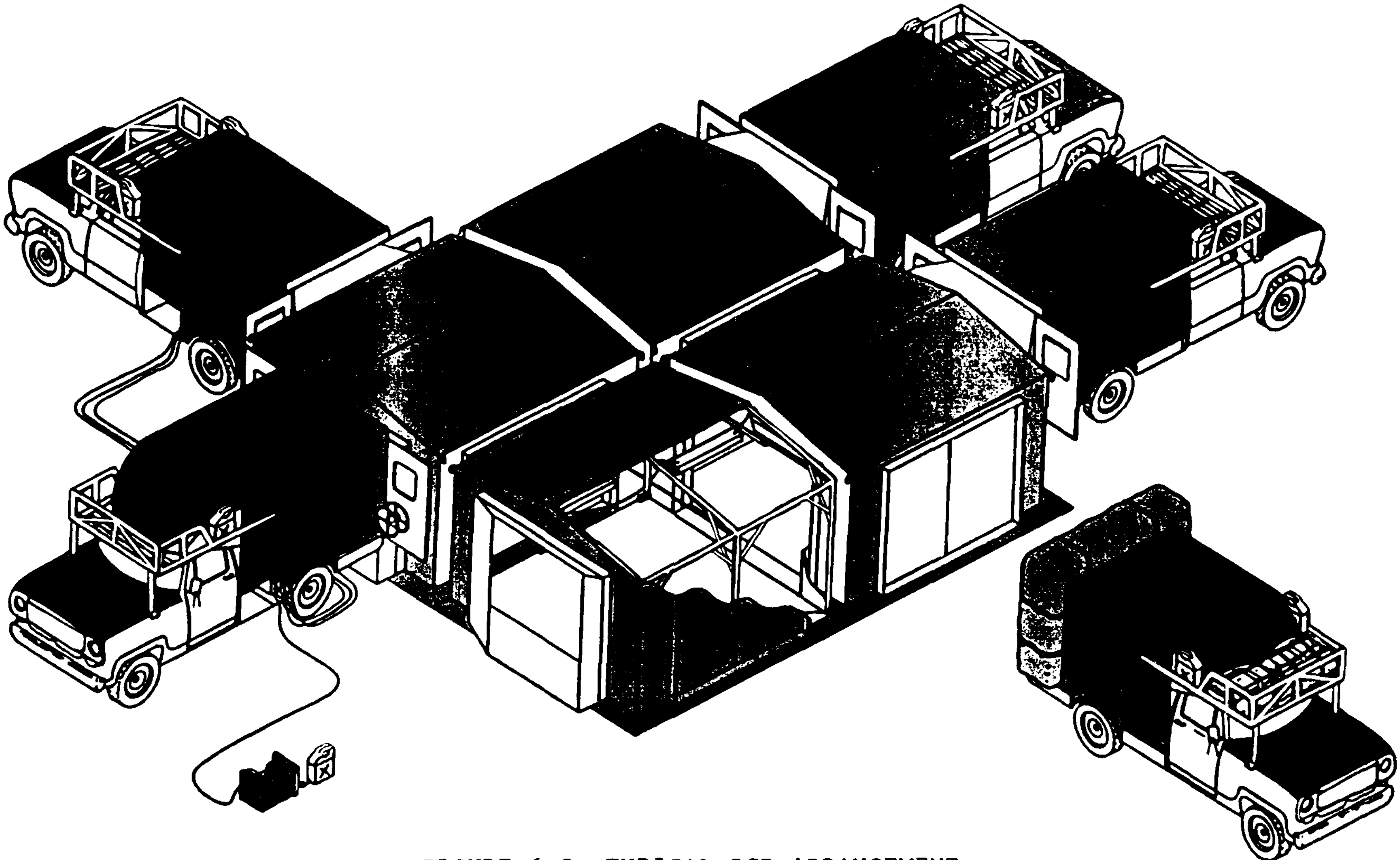

FIGURE 6.5 TYPICAL ICP ARRANGEMENT

4. Signal distribution subsystem.
5. Power distribution subsystem.
6. Intercom subsystem.
7. Electromagnetic Interference (EMI) rack.
8. Digital data distribution subsystem.[9]

The evolution of ICP subsystems will provide a ready solution to the problem of portable and reliable power generation, and power and signal distribution to support the test bed system outlined in the next chapter.

Test Bed Methodology

Since 1983 the Distributed Command and Control System (now MCS 2.0) has undergone a series of tests, in the hands of the 9th ID, from which improvements have been integrated into subsequent exercises of the system. Personnel from ADEA work closely with on-site contractors to provide solutions to problems. Informally, ADEA Project Managers attribute the system's rapid evolution to continuous interaction among 9th ID officers, competent and motivated contractors, and the ADEA staff.

The urgency. There is an obvious sense of urgency in the exercise, evaluation, and re-exercise effort at the 9th ID. Because the commander of the

9th ID is also the commander of ADEA, the same individual directs--and is responsible for--the total test bed effort. The present commander is Major General Pihl.

Although the various plans the 9th ID would be tasked to support are largely classified, it is safe to assume that the division would be deployed to support a Southwest Asia conflict scenario--irrespective of its present status as a test division. The 9th ID has been organized, and is being trained and equipped, to do so. This must surely contribute to the sense of purpose one feels among the men and women in the division.

Not unimportant, commanders in the 9th ID _feel_ that their role in the division's overall development is significant. There is an unquantifiable morale factor here, a force multiplier in itself.

Exercise, test, and evaluation. The 9th ID aggressively exercises MCS 2.0, on the average, quarterly. Division Command Post Exercise (CPX) CABER FLASH, conducted at Ft. Lewis and in the surrounding woods, was held in August 1985. Having gone through what is termed "wart removal," MCS 2.0 was exercised again in November, as part of CPX CASCADE PEAK. Two brigade level exercises will further test portions of MCS 2.0, between CASCADE PEAK and the February 1986 Division CPX.

Army division level architecture. MCS 2.0 architecture, after a successful demonstration of the system's capabilities during JCS Exercise BORDER STAR 85, has been recognized by the Army as the divisional force level control system architecture. Somewhat concurrent with this decision was the decision to redesignate DCCS as MCS 2.0, so as not to compete with the Army's formal Maneuver Control System program (under development since 1976). The scheme now is to "incorporate the best of both systems" and develop a force level control system that fully integrates

> that information from each point of the SIGMA STAR required by the commanders and presents a graphical description of the commander's status in maneuver, fire support, air defense, combat service, and IEW [Intelligence/Electronic Warfare].[10]

ADEA has now taken on the roles of Advanced Technology Test Bed (ATTB), SIGMA Test Bed, and MCS Test Bed. ADEA is presently undergoing reorganization to accomplish these roles with existing personnel and inbound personnel in planned billets.

The Advanced Technology Test Bed. The primary job of the ATTB team, a small cadre of primarily signal officers, will be to identify future technology enhancements for the present MCS 2.0, as part of the system's evolution. The team will also study and develop state-of-the-art capabilities for a follow-on "MCS 3.0." Some major interest areas being considered by the ATTB at this time are

1. Ruggedization requirements,
2. Super lightweight 32-bit machines,
3. Artificial Intelligence applications,
4. Large screen (higher resolution) displays,
5. Fiber optics applications,
6. Millimeter wave radio applications,
7. Command post survivability (IR, Radar, Ballistic, Nuclear), and
8. MCS 2.0 installations for helicopters and heavy forces.[11]

The MCS Test Bed. The MCS Test Bed will be primarily responsible for the infusion of MCS 2.0 software into the merged MCS. Also, the MCS Test Bed will debug and validate, through operational use at the 9th ID, MCS software as it is developed and released each July from the MCS software development facility at Ft. Leavenworth, Kansas. MCS software version 10, to be released in July, 1986, will reflect the first "merged" software.

By July 1986, as part of the evolution of MCS 2.0, the brigade and division level WICAT computers will be replaced with the Army standard Tactical Computer Processor (TCP), a ruggedized Hewlett-Packard model HP 9000. The HP 9000, a 32-bit microcomputer, will support the Ada programming language, the DoD standard. Brigade and Division level applications, written in C language, will be sent to Ft. Leavenworth for rewriting in Ada. MCS 2.0 and MCS software should be fully merged by 1987.[12]

It is also hoped that a quick reaction software development capability can also be established at the test bed. This is envisioned to "supplement" the normal 18-month software development and release of MCS software. Contracted software support and the use of end user tools have been discussed as options.

The SIGMA Test Bed. The SIGMA Test Bed will manage the integration of systems supporting the points of the SIGMA STAR (i.e., maneuver, fire support, combat service support, air defense artillery, and IEW) with the merged MCS. This test bed will also have the responsibility of studying the evolutionary acquisition of future Army programs as they relate to the SIGMA STAR.

The most rapid advances in SIGMA system integration have occurred in military intelligence. Sensor information from the Army's All Source Analysis System (ASAS) "Brass Board" was successfully passed to the 9th ID commander's display during JCS Exercise BORDER STAR 85.[13] The Lightweight TACFIRE (fire support) system will be integrated into MCS 2.0 by early 1986. Planning is presently underway to integrate the air defense command and control system (SHORAD C^2) with the merged MCS. Combat Service Support C^2 is still in a definitional stage and has not yet been actively addressed.[14]

The Tactical Combat Operations Test Bed

General

The Tactical Combat Operations (TCO) Test Bed is a Marine Corps initiative to field a test bed tactical C^2 system. The primary objective of the TCO Test Bed is simply to allow users to test and evaluate the types and extent of automated assistance required in tactical command and control. The strategy taken by Headquarters, USMC, has been to field an RRDC at the I MAF at Camp Pendleton, California. I MAF serves as the Marine Corps component of USCENTCOM and has been designated U.S. Marine Corps Central Command (USMARCENT).

A 13-month requirements definition period began officially on 1 April 1985 and is scheduled to end 31 May 1986. The study will culminate in a set of recommendations leading to further definition of C^2 automated support. These recommendations will be used to "guide development" of the Marine Corps' formal TCO system.[15]

The formal TCO System. The formal TCO system is a tactical command and control system concept to provide semi-automated support to the Marine Air-Ground Task Force (MAGTF). Consisting of components of the Marine Integrated Fire and Air Support System (MIFASS), and lower echelon components, the TCO system is being designed to provide a capability to receive, process, store, display, and transmit information to assist planning, operations, and intelligence functions. TCO system equipment will be employed at all ground and air command echelons of the MAGTF and is being designed to integrate with MIFASS, a fairly large, highly complex system.[16] The formal TCO system is thus an extension of MIFASS, a program that was essentially started in 1972 (the Required Operational Capability document was approved in 1975) from requirements generated in a non-operational test bed.[17] The AFCEA Study Team considered MIFASS as "tending less successful" on its array of programs studied.[19]

Background

During the last few years there has been a gnawing feeling among certain senior Navy and Marine Corps officers that the USMC TCO program has suffered from a "lack of consensus" concerning requirements for command and control automation, particularly from operational elements such as I MAF.

> One of the chief obstacles has been the lack of understanding on the part of the operational commanders as to how current technology can reasonably support their mission accomplishment. To overcome this deficiency Marine headquarters has directed that an evaluation by I MAF be made using existing DNA and Army sponsored state-of-the-art Command and Control Systems.[18]

Beginning in August 1983, liaison was established between the Marine Corps Development and Education Command (MCDEC), Quantico, Virginia, and the DNA. DNA had overseen the development and extensive use of the Staff Planning and Decision Support (SPADS) system by various corps and division level Army elements, under its Dispersed Command Post (DCP) C^2 concept. The DNA-sponsored SPADS system, based on commercial hardware and software, had, in 1984 already been employed by a number of Army units in support of U.S. and allied operations and training:

1. V Corps:
   --Dispersed Command Post concept.
2. Headquarters, U.S. Army Europe (HQ USAREUR):
   --USAREUR Distributed Decision Aid System (UDDAS).
3. XVIII Airborne Corps:
   --USCENTCOM Tactical Information Control System (TACTICS) flyaway system.
4. I Corps:
   --SPADS General Staff Support in Korea.
5. Command and General Staff College:
   --Training of brigade, division, and corps staff officers.
   --Familiarization of automated battlefield C^2.

A test bed approach to defining TCO requirements was studied by MCDEC, who considered it urgent that if a requirements definition study was to be undertaken that it be completed by early 1986. The formal TCO system Initial Operational Capability (IOC) date had been established for 1990, as part of the initial MIFASS buy, dictating a timely implementation of the test bed.[19] The following paragraph is extracted from a letter from the TCO Program Director at Naval Electronic Systems Command (NAVELEX) that explains their need to rapidly conclude an evaluation study:

> In accordance with reference (C) NAVELEX Acquisition Plan No. 79-13 , the production TCO System will "use many of the common modular hardware items and software modules of MIFASS." The MIFASS development schedule calls for finalization of production equipment quantities early in 1986 in order to allow a production buy in FY [Fiscal Year] 87. If the equipment for the TCO System is not included in the initial MIFASS production buy, significantly higher costs will be incurred by a separate procurement of TCO equipment.[20]

Based on recommendations from the DNA, and input from I MAF (and, at least informally, ADEA), the Commanding General, MCDEC, selected an RRDC that takes advantage of both the SPADS and DCCS evolutionary developments. HQ USMC concurred with the system during August, 1984.[21]

The System

Essential elements comprising the GRiD based Distributed Command and Control System (i.e., MCS 2.0) have been discussed. The SPADS element, as the Marine Corps plans to configure it in the TCO Test Bed, is discussed in this section.

The general configuration. SPADS is a combination of hardware and software designed by the BDM Corporation to meet a wide spectrum of tactical command and control needs of the military services. Originally developed in 1980-1981, SPADS first employed Apple II microcomputers and then-available peripherals to provide computational and video graphics capabilities, as well as automated data links among dispersed command post cells. Both hardware and software have been continually enhanced through EA methodology and SPADS has been rapidly adapted to meet the needs of a wide variety of new military C^2 users (see "Background," this chapter).

The present SPADS system represents a major upgrade (now called SPADS II) from the old 8-bit Apple system. SPADS software applications have been converted to run on the Corvus Concept 32-bit microcomputer, the GRiD Compass 16-bit microcomputer, and, recently, the Zenith Z-150/151 16-bit IBM-PC compatible microcomputer. In addition to greatly increased processing power and speed, video graphics equipment has been upgraded to provide for greater resolution of current situation and briefing graphics, as well as videodisc overlays.

SPADS, like the later GRiD based system, incorporates a completely modular design which allows a commander to reconfigure rapidly to meet his changing requirements. The module's backbone is a Corvus Omninet LAN. SPADS and DCCS modules are configured similarly, with each module containing a Mass Storage Station and a Communications Gateway, a number of Staff Duty Stations (workstations) with/without videodisc/color graphics subsystems, and an optional Shared Output Station (printer, plotter). Figure 6.6 depicts the general SPADS configuration.

All hardware is ruggedized and integrated into one or two man human engineered, transportable stations that can be rapidly set up and torn down to support mobility. Equipment is modified with special backplanes, connections, transport cases and other items to provide both ruggedization and simplified set-up appropriate for tactical use.

Communications Gateway Station (CGS). The CGS provides network control of data links within the module and fully automated data exchange (electronic mail, data base updates, graphics updates, etc.) among modules. At present its primary components are two Corvus Concept 32-bit

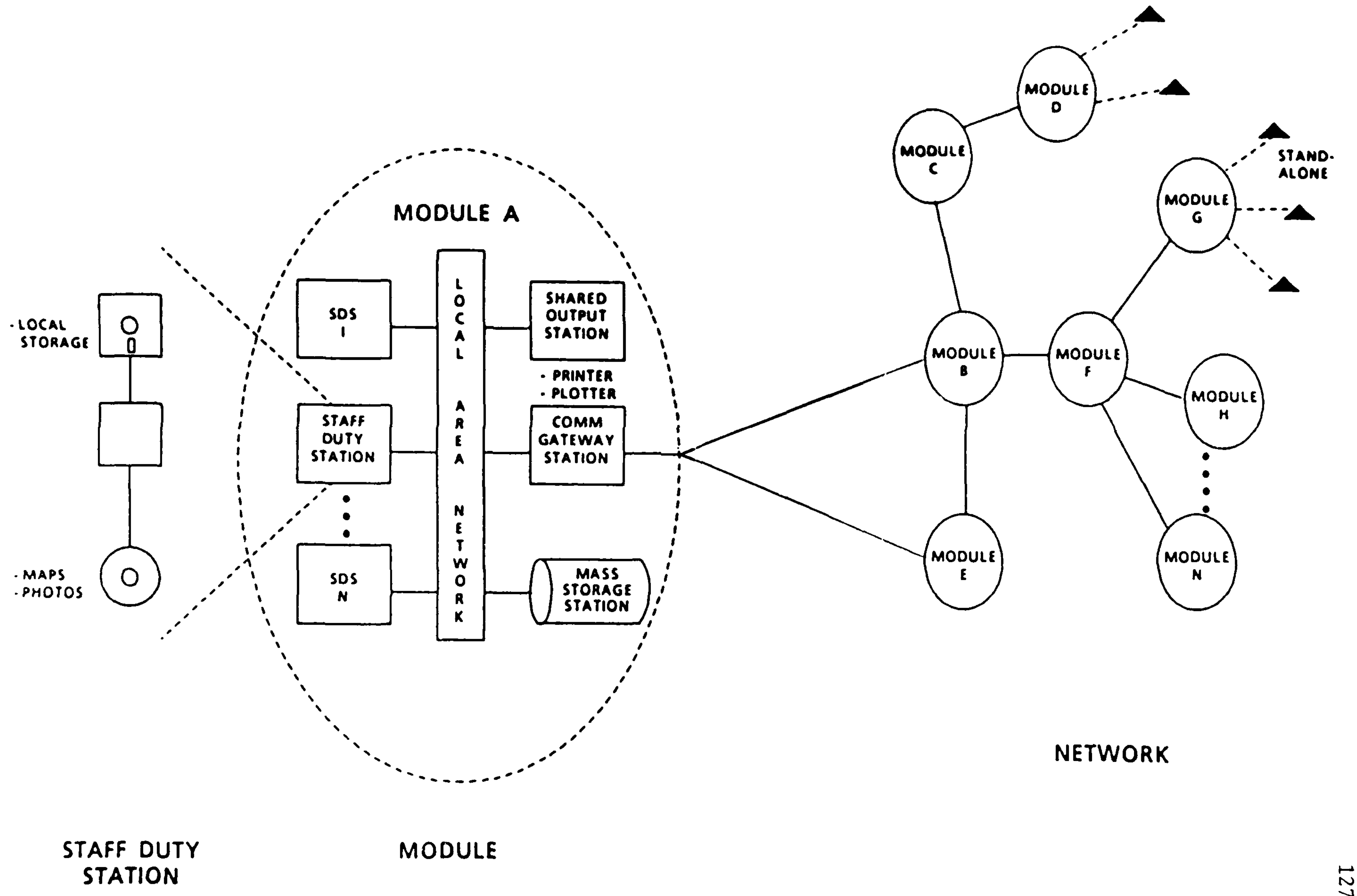

FIGURE 6.6 GENERAL SPADS CONFIGURATION

microcomputers, one functioning as Network Control Processor (NCP), the other as Communications Link Processor (CLiP). Both computers share a single keyboard and monitor. The NCP controls access to the LAN and performs all intra-module file transfers, updates, and electronic mail management. Unique addressing and automatic routing is provided to all users throughout the local and wide area networks. The CLiP manages eight intermodule data links simultaneously (expandable in increments of four), and the status of four data links may be displayed simultaneously. Other functions supported by the CLiP include the following:

1. Automated message precedence handling.
2. Management/conversion of multiple simultaneous protocols.
3. 300 bps through 16 Kbps data rate capability.
4. Host computer traffic storage during host moves and communications outages.
5. Network updating.
6. End-to-end acknowledgment of messages.[22]

The CGS is integrated into a single ruggedization/transport case with special cables and connectors to provide field reliability and rapid set-up/tear-down. Figure 6.7 illustrates the CGS.

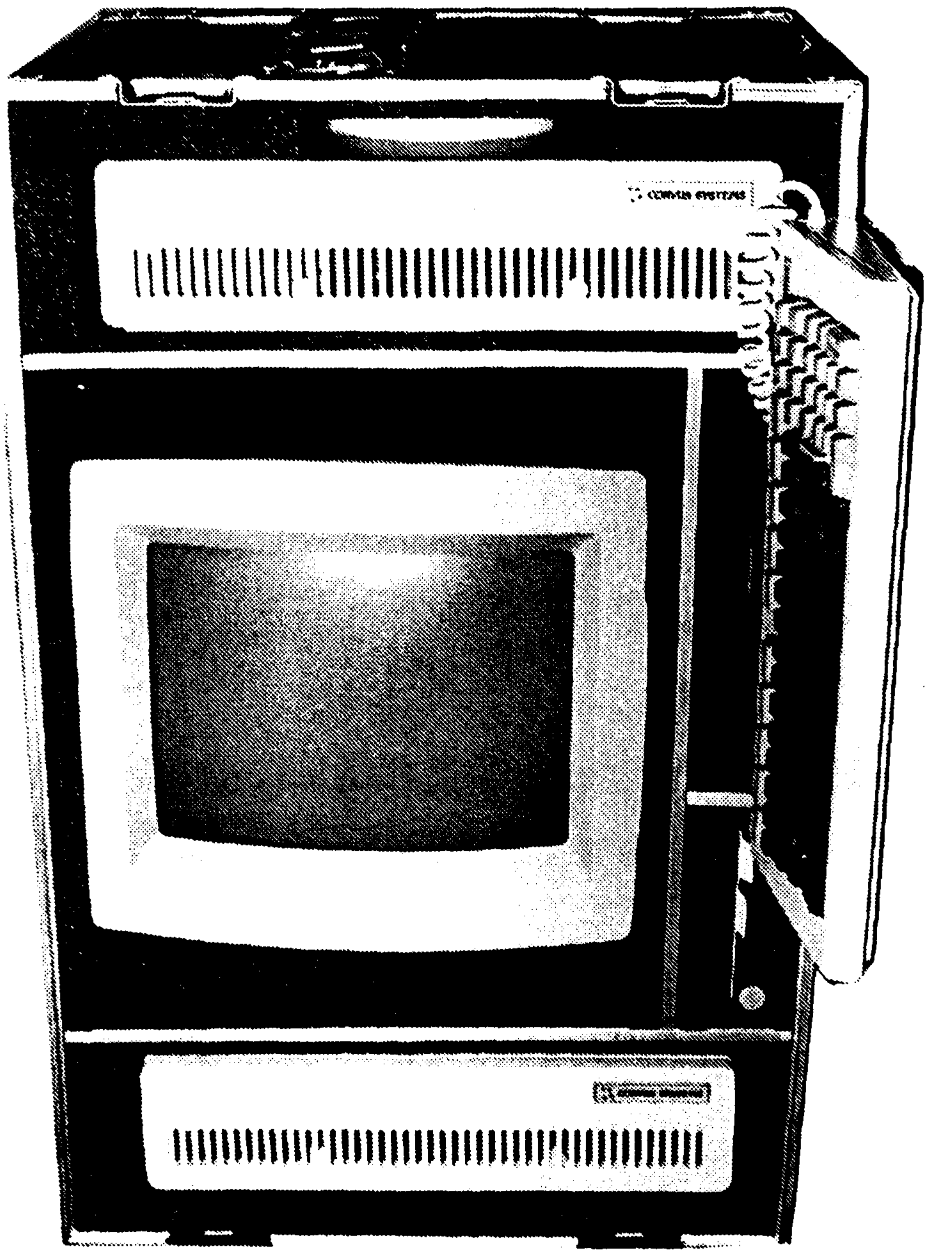

FIGURE 6.7 THE COMMUNICATIONS GATEWAY STATION

Staff Duty Station (SDS). The SDS provides each user with input/output, processing, and display capabilities through access to all SPADS software. On the Omninet a workstation may be the Corvus Concept 32-bit microcomputer or a Zenith Z-150/151 16-bit microcomputer (or other IBM-PC compatible machine). The Apple II is also supported, making SPADS "backward compatible" with earlier increments. Other components of the SDS include a local printer, local storage, and a videographics subsystem package. Figure 6.8 shows the SDS (a Corvus Concept microcomputer).

Mass Storage Station (MSS). The MSS provides data sharing and transfer within the module via the LAN. In SPADS' present stage of evolution, its primary components are a 20 MB or 40 MB (nominal) hard disk, a disk server, and an Uninterruptible Power Supply (UPS). A digital voltmeter provides constant monitoring of Omninet voltage so that problems may be detected before electronic components are damaged. These components are integrated into a ruggedization/transport case with special connections to the Omninet and for power.

Videodisc/color graphics package. Any SDS may be connected to a videodisc/color graphics

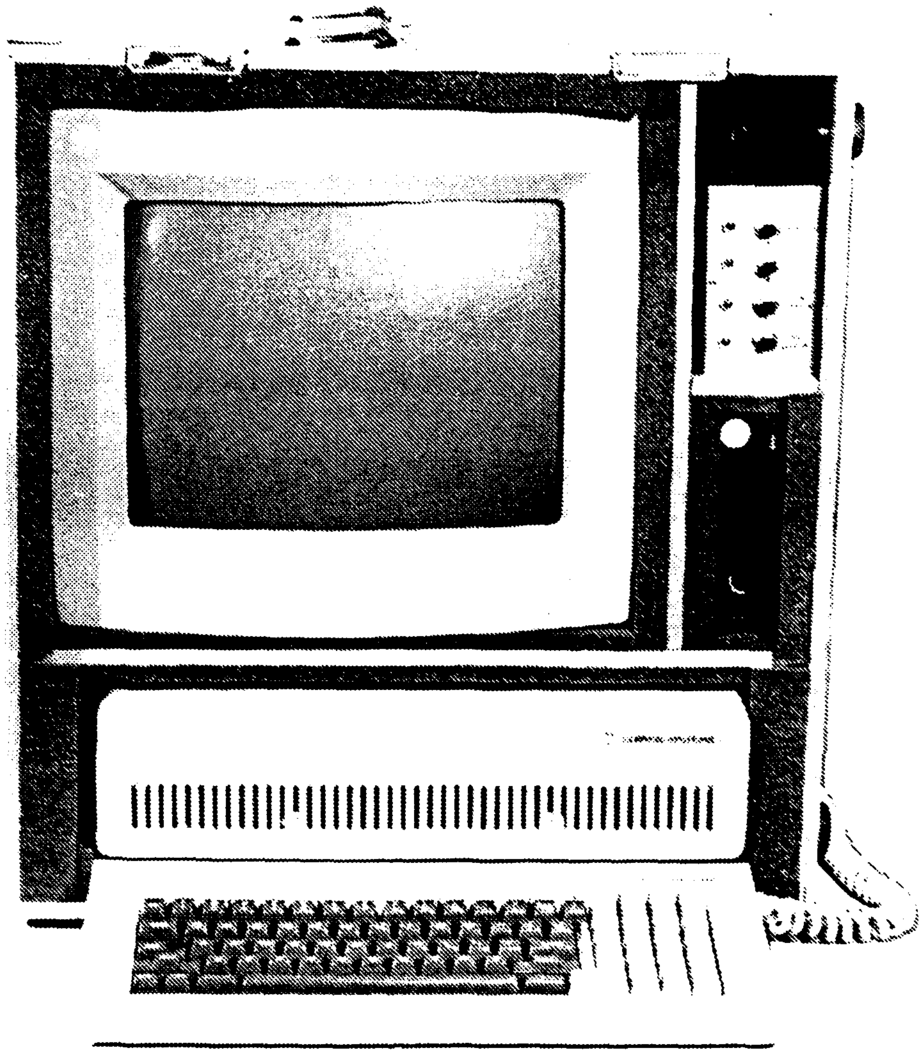

FIGURE 6.8 THE STAFF DUTY STATION

package to provide high resolution color graphics, including overlays on stored map frames and photographs. Major components are the GraphOver 9500 graphics mixer, an industrial quality videodisc player, appropriate interface mechanisms, and either a high resolution RGB color monitor or video projector with large screen display.

Shared Output Station (SOS). The SOS provides high speed/high quality printing (to include monochrome graphics) to all users within the module. Overlays and other large color graphics hard copy can also be provided through an optional plotter controlled by the SOS. The primary components of the SOS are a microprocessor which serves as a despooler and a printer (plus plotter if desired). Hardware and software interfaces allow for the automatic printing of designated items, such as Flash traffic, and audible notification of high precedence output.

SPADS software. SPADS software is very similar to the DCCS/MCS 2.0 software previously described. Like the Lower Echelon MCS 2.0 applications software, all SPADS software is fully integrated. Similar information exchange/processing and decision support capabilities exist in both systems. SPADS as a C^2 system is more mature than DCCS, and at present it provides the user certain features not available with the GRiD based system:

1. Common area maintenance of a multinode, multidrop network.
2. Fully automatic message routing.
3. Automatically triggered spreadsheet and graphics updates.

All SPADS applications have been written in PASCAL; Ada is clearly the future SPADS language, however.

TCO Test Bed Implementation

Program management. The TCO Test Bed, physically located at Camp Pendleton, is under the program management of the TCO Development Project Officer (DPO), MCDEC, Quantico, Virginia. The system user, I MAF, will maintain the dominant role in the test and evaluation of the system, under the direction of the I MAF Information Systems Management Officer, MCDEC's evaluation site representative. Headquarters, Fleet Marine Forces, Pacific, has given the TCO Test Bed an obvious priority and has willingly made available personnel and material resources to support its overall mission.[23] Contractor services were procured to meet the following general support requirements:

1. Procure, integrate, test, and deliver identified hardware and software.

2. Provide lessons learned from previous systems use to the Marine Corps Evaluation Team and technical assistance for the Marine Corps effort to develop evaluation requirements, objectives, procedures, and schedule.

3. Develop and deliver necessary system documentation.

5. Provide technical assistance needed to conduct the evaluation.

6. Perform hardware maintenance during the course of the evaluation.

7. Provide software maintenance during the course of the evaluation.

8. Provide software support during the course of the evaluation and modify basic software to support requirements definition.[24]

The cost-plus-fixed fee contract was awarded by the Navy's Space and Warfare Systems Command, on 31 July 1985.[25] TCO Test Bed hardware and software were delivered to I MAF and the initial field test was conducted during November 1985.

Software and modification. Modification of the electronic mail system (EMS), the database management system, and the communications software of SPADS has been performed to meet the peculiarities of the Marine Corps environment and to complete the integration of the SPADS and DCCS systems. EMS was modified to accommodate 10 particular Marine Corps forms. Latitude-longitude coordinates, in addition to UTM coordinates for any position around the globe, have been incorporated in the DBMS since April 1985. The communications software now allows transmission over communications systems presently employed by the Marine Corps.

The test configuration. Figure 6.9 depicts the TCO test configuration. As shown, modules are located at the Marine Amphibious Force (MAF), Marine Division, Marine Air Wing, Force Service Support Group (FSSG), and regimental headquarters levels. Commercial telephone networks are used, in addition to tactical communications, to provide connectivity among modules.[26]

System exercise test and evaluation is scheduled to begin in December 1985 and end 31 May

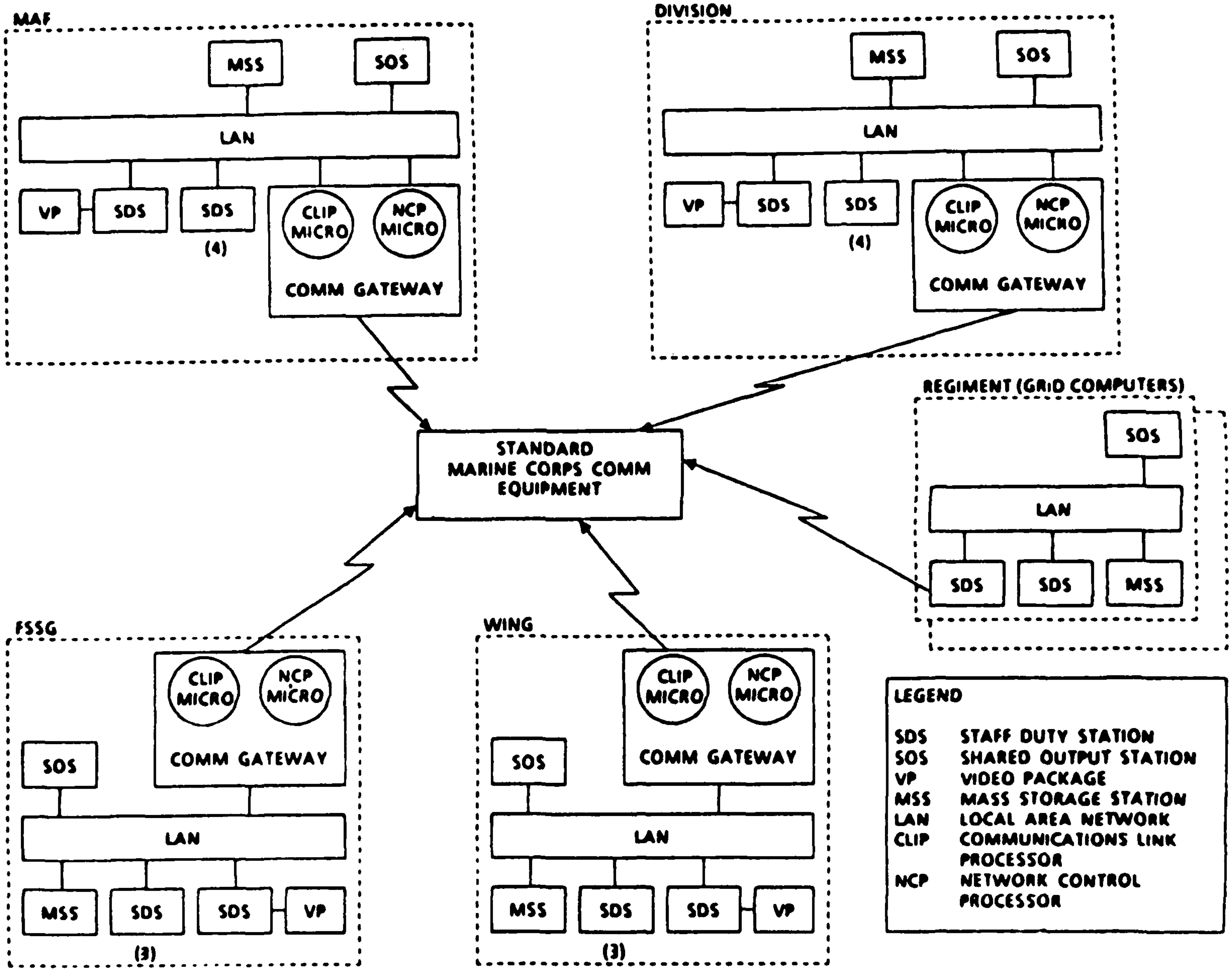

FIGURE 6.9 GENERAL TCO TEST CONFIGURATION

1986. At present, the plan is to employ the test bed system at three major exercises, including JCS Exercise GALLANT KNIGHT. The first exercise of the system is scheduled for 17-20 December 1985 at Camp Pendleton. It is considered likely that the system will be employed during JCS Exercise GALLANT EAGLE (August 1986), even though the contract period expires at the end of May 1986.

It is also considered likely that the TCO Test Bed will continue in existence long after the present contract expires.

The Seventeenth Air Force (17th AF)

The capabilities offered by the SPADS based USAREUR Distributed Decision Aid System (UDDAS) have been so impressive that plans are being made within USAFE/AAFCE to field an operational prototype within the Sembach Allied Tactical Operations Center (ATOC) and Sector Operations Center (SOC) III in Germany. Major General Breckner, 17th AF Commander has proposed a four-phase program to automate these command centers, using SPADS software and German (Diehl) hardware. Initially the LANs within the ATOC and SOC will be Corvus based, employ fiber optics, and use Zenith Z-151 workstations. The system will initially extend to 4ATAF/CENTAG, US V and VII Corps. As the system evolves it will interface with EIFEL and extend into the mobile TACS and Army air defense system, probably employing DCCS capabilities (similar to the TCO Test Bed system).

Appendix G contains a 30 May 1985 letter to General Donnelly, CINCUSAFE, from Major General Breckner. Attached to the letter is the basic acquisition plan for the system.

The next "generation" SPADS is foreseen to be a super-microcomputer, UNIX-based system supporting AI applications and very high resolution (1000x1000 line) graphics. To date, over 450 thousand lines of code have been developed for SPADS and DCCS, but DNA, Army, and Navy/Marine Corps funding for these systems has not exceeded $10 million since 1981.

Summary

Defense Nuclear Agency, Army, and Marine Corps/Navy efforts in the development of automated tactical C^2 systems strongly suggest that the evolutionary approach is working. SPADS, originally conceived by DNA to test the Dispersed Command Post concept in the NATO arena, will continue to evolve. Using commanders have been and are pleased with its capabilities, which have been tested and evaluated on numerous major exercises, such as WINTEX-CIMEX, REFORGER, CRESTED EAGLE, and BRIGHT STAR.

USAFE is now actively planning an evolutionary approach toward C^2 requirements definition within the U.S. and Allied air forces in Europe.

SPADS was employed in support of the XVIII Airborne Corps during Operation Urgent Fury (Grenada). Described as a "combat multiplier" by the Commander, 525th Military Intelligence Group, SPADS supported C^2, intelligence collection and collection management (HUMINT and SIGINT), and intelligence production activities on Grenada.[27]

At Ft. Lewis, Washington, in less than three years, a division level force control architecture has been developed, fielded, and validated as the Army standard. **And the evolution continues.** By the summer of 1986, for example, brigade- and division-level automation will be substantially upgraded, with replacement of the WICAT computer with the Army Tactical Computer Processor (TCP), the HP 9000. MCS 2.0 and MCS software will be fully merged during 1987. Total System Tactical Validation, the purpose of which is to fully integrate SIGMA STAR functions into a <u>fully</u> merged MCS, will begin formally in 1987. As the

Army seeks to identify a standard battalion level workstation, the present surrogate (the GRiD Compass) and the GRiD Server will continue to be fielded to all battalions of the 9th ID.

GRiD Compass and GRiD Server are expected to be commercially marketed by GRID Systems as full 32-bit machines by fall 1986.[28]

As both a cost-saving and test and evaluation measure, I MAF is using the Zenith Z-150/151 (purchased in mass by the Navy and Air Force) on its test bed system, in addition to Corvus SDSs. Both Type A (SPADS) and Type B (DCCS) modules will support these microcomputers and their applications. The Marine Corps has made considerable progress in running JINTACCS (Joint Interoperability of Tactical Command and Control System) Automated Message Preparation System--JAMPS--software on the MS-DOS.

<u>RECOMMENDATION</u>. EXPLOIT THE PROVEN CAPABILITIES OF EXISTING COMMAND AND CONTROL SYSTEMS AND AGGRESSIVELY TEST COMPATIBILITY AND INTEROPERABILITY IN "HANDS-ON" EXPERIMENTS.

The success of these programs, the proven capabilities of the systems they employ, the planned evolution of these systems, their affordability, the expanding knowledge and experience base being built through their employment, the potential benefits from the application of their software/hardware as TAC's RRDC, and the outstanding potential for actual "hands-on" experimentation, practice, and learning in multiservice/multinational environments are all very compelling reasons to take such action.

Sub-recommendation. ESTABLISH LIAISON WITH ADEA, THE TCO DEVELOPMENT OFFICE AND 17TH AIR FORCE. PLAN, EXERCISE, TEST, AND EVALUATE THE RRDC IN JOINT AND COMBINED EXERCISES.

Chapter I mentioned the progress that could be made in defining joint architectures through such an approach.

Sub-recommendation. INVITE THE ACTIVE PARTICIPATION OF JTC^{3}A IN THIS EFFORT.

Creative exercise planning will be able to accommodate this. It is likely that DNA would also welcome the opportunity to participate in a requirements definition study, based on their outstanding support to the Army and Marine Corps.[29]

For the first time such a system could be actively employed in exercise, test, and evaluation scenarios with the test bed tactical C^2 systems of other services, the command and control elements with whom the TAF will fight in a future conflict.

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CHAPTER VI

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[13]Ibid., p. 4.

[14]ADEA, "Information Briefing, C^3I Division," p. 6.

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CHAPTER VII

REQUIREMENTS DEFINITION OF THE CORE SYSTEM: MANAGEMENT IMPLEMENTATION STRATEGY

> User needs must drive implementation of all Air Force information systems.
> --*Air Force Information Systems Architecture*

The Test Bed Location

TAC can field an RRDC quickly and incorporate the large experience base of other EA approaches in the process of developing functional requirements for its future force level C^2 system. MCS 2.0, the TCO Test bed, and 17th AF systems will be "transportable" to meet TAC's RRDC.

TAC's approach would necessarily be different from that of the Army or Marine Corps, however. There are just two TACCs in the contingency TACS. The staffs at 9th and 12th Air Forces are relatively small, and it is doubtful that either could supply the required resources to conduct a test bed. The main disadvantage to designating a "lead user" of the two Numbered Air Forces is the potential bias imposed on the RDSP by such a user as well as the inadequate participation of the other user. TAC has a responsibility to the TAF, also, and must ensure that these interests are protected.

RECOMMENDATION. FORMALLY ESTABLISH THE PMO AT AND CONDUCT THE TEST BED EFFORT (RDSP) FROM HEADQUARTERS, TACTICAL AIR COMMAND.

A number of factors support this.

First of all, TAC Headquarters--albeit a surrogate user--is in the best position to consider, evaluate, and integrate user requirements, based on 9th AF, 12th AF, and 7th ACCS involvement (i.e, "hands-on" involvement), into a core system. It is incumbent upon HQ TAC to ensure that users

1. Are integrally involved in all portions of the study,
2. Receive training in RRDC operations, and
3. Test and evaluate the system in-station and while deployed on exercises.

This effort would be managed, however, by the PMO at TAC.

Secondly, TAC Headquarters has the resources to conduct such a test bed. A cadre of C^3I professionals could be assembled from the headquarters staff and headquarters support organizations to form a PMO. Facilities are available at Langley AFB. Several organizations reside at Langley that would be available to support the PMO. For example:

1. Tactical Air Forces Interoperability Group (Air Staff):
   --Newly formed TAFIG Tiger Team.
2. Operating Location E, Air Force Systems Command.
3. Army-Air Force Center for Low Intensity Conflict (see glossary).
4. AirLand Forces Applications Agency.
5. 1st Tactical Fighter Wing.
6. HQ TAC Staff Organizations (Operations, Requirements, Information Systems, Logistics, Intelligence, etc.).

Third, the planning function exists at TAC to schedule exercises of the test bed system in 9th AF (USCENTCOM), 12th AF (USAFSO/LANTCOM), Korean, NATO, and other joint/combined environments. Top management emphasis could see to it, if required, that overall evaluation objectives are met.

The Management Structure

The Management Directive

Top management involvement at TAC, and the issuance of a directive are important to ensure that an EA strategy--an almost completely novel event--remains uncorrupted. Such a directive would be seen to address the following:

1. The PMO Charter.
2. Establishment of roles and relationships among players (without increasing the bureaucracy).
3. Conduct of the EA strategy.

The official Program Decision Package handed down by the Air Staff would be foreseen to be consistent with this directive.

The PMO will drive the system acquisition and manage the requirements definition study. Selection of the Program Manager (PM) and the PMO staff should begin immediately. An 0-6 level selection committee is the best vehicle for this, with committee membership drawn from the HQ TAC staff.

The Program Manager

The PM should report to the Deputy Chief of Staff, Operations through the Assistant Deputy Chief of Staff, Operations.

PM qualifications. Reasonable job qualifications for the PM would include the following:

1. Be a Lieutenant Colonel.
2. Have operational experience as a pilot or command and control officer.
3. Have performed duties in a TACC and understand its present operation.
4. Understand telecommunications and data processing (i.e., information systems) technologies.
5. Have program management/acquisition experience.

The Program Management Office

Staff composition. The "combined program office" should be staffed with officers representing, as a minimum, these specialties:

1. Information Systems (Major, Assistant PM) -- SI
2. C^2 Systems, including airborne systems -- DO
3. Tactical Intelligence -- IN

4. Requirements --DR
5. Logistics -- LG
6. Interoperability -- TAFIG

<u>**Sub-recommendation.**</u> **REQUEST ON-SITE REPRESENTATION FROM AFSC, AFOTEC, AND AFLC. ALL SHOULD BE INVOLVED FROM THE ONSET. DEFINE OBJECTIVES, ROLES, AND RESPONSIBILITIES EARLY.**

The use of memoranda of agreement, such as the type used to establish CAFMS, could be a way to avoid counter-productive "turf" issues and get the job done.[1]

<u>**Sub-recommendation.**</u> **ESTABLISH LIAISON WITH USERS AND FUND FOR TEMPORARY DUTY (TDY) REPRESENTATION AT LANGLEY.**

The user is thus involved at the "field" level and at the PMO level.

The Contractor

The contractor is integral to the program management team. Procurement of contractor services will be required, obviously, prior to the start of an RDSP.

<u>Contractor team composition.</u> A suggested minimum contractor team composition is indicated

below, based on tasks to be performed and previous system usage.

1. Project Manager/Contractor Team Leader

a. Three to five years of project management experience in programs similar to the RDSP.

b. Undergraduate academic specialization degree in computer sciences, engineering, mathematics, or business administration with data processing specialization.

2. Assistant Project Manager/Assistant Contractor Team Leader

a. One to three years project management experience in programs similar to the RDSP.

b. Undergraduate academic specialization degree in computer sciences, engineering, mathematics, or business administration with data processing specialization.

3. System Analyst (two)

a. Undergraduate degree in computer sciences, engineering, mathematics, or business administration with data processing specialization.

b. Two years of systems analyst experience.

c. Familiarity with TACS functional organizations and their interfaces.

4. Functional Area Analyst

a. Familiarity with the TACS and its present functions.

b. Two years of analytical experience.

c. Five years of data automation experience.

5. Data Communications Senior Analyst

a. Five years experience in the engineering and development of computer communications systems.

b. Undergraduate academic specialization in mathematics, computer science, electrical engineering, or a related field.

c. Experience in assessing design impacts of system software and hardware interface issues.

d. Current familiarity with radio frequency (RF) and digital transmission technology.

e. Working knowledge of practical issues.

6. Data Communications Software Programmer

a. Three years experience in development of software (EPROMs or above) to support data communications interfaces.

b. Undergraduate academic specialization in mathematics, computer science, electrical engineering or a related engineering field.

c. Familiarity with (RF) transmissions technology.

7. Electrical Engineer

a. Three years experience in data communications field.

b. Undergraduate degree in electrical engineering.

c. Familiarity with the first three layers (physical, data link, network) of the International Standards Organization (ISO) Open Systems Interconnection (OSI) reference model.

d. "Hands-on" experience with the above mentioned layers.

8. Software Programmer (two)

a. Two years experience in software development efforts involving integration of such applications as word processing, database management, and spreadsheets on personal computers.

b. Experience with GRiD and Zenith software systems, including MS-DOS/multitasking operating systems.

The RDSP Plan

The RDSP should be a one-year undertaking. The plan assumes that a PMO could be established in less than three months.

The Test Configuration

Figure 7.1 depicts the recommended test bed system configuration.

The Evaluation Schedule

Five basic tasks, following the PMO organization period, comprise the one-year RDSP (see figure 7.2):

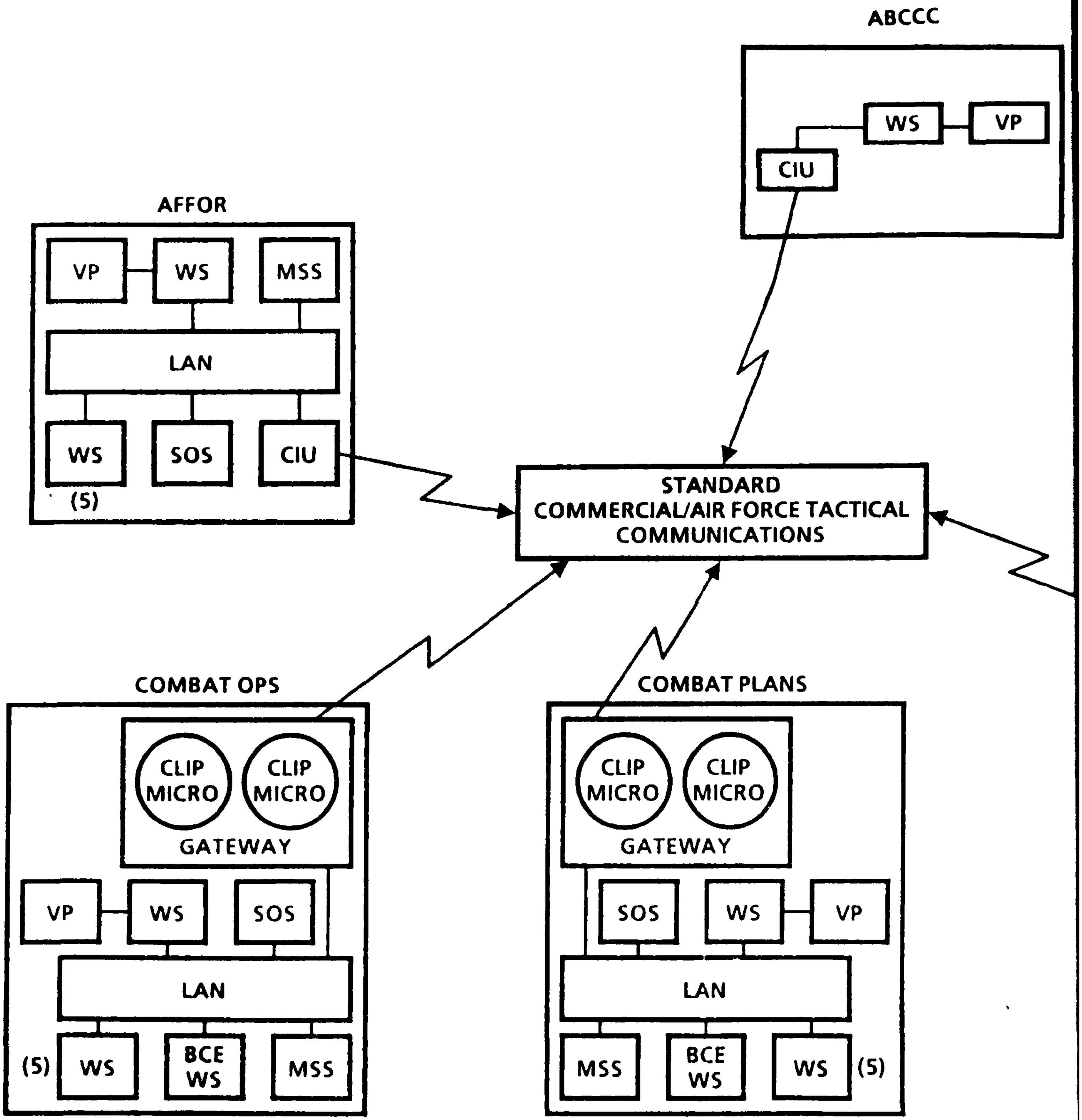
1. Pre-Contract--Organize PMO Activities. Activities to take place during this period include:

a. HQ TAC Activities

(1) Establish the PMO.

(2) Begin liaison with supporting organizations.

(3) Contract RRDC support.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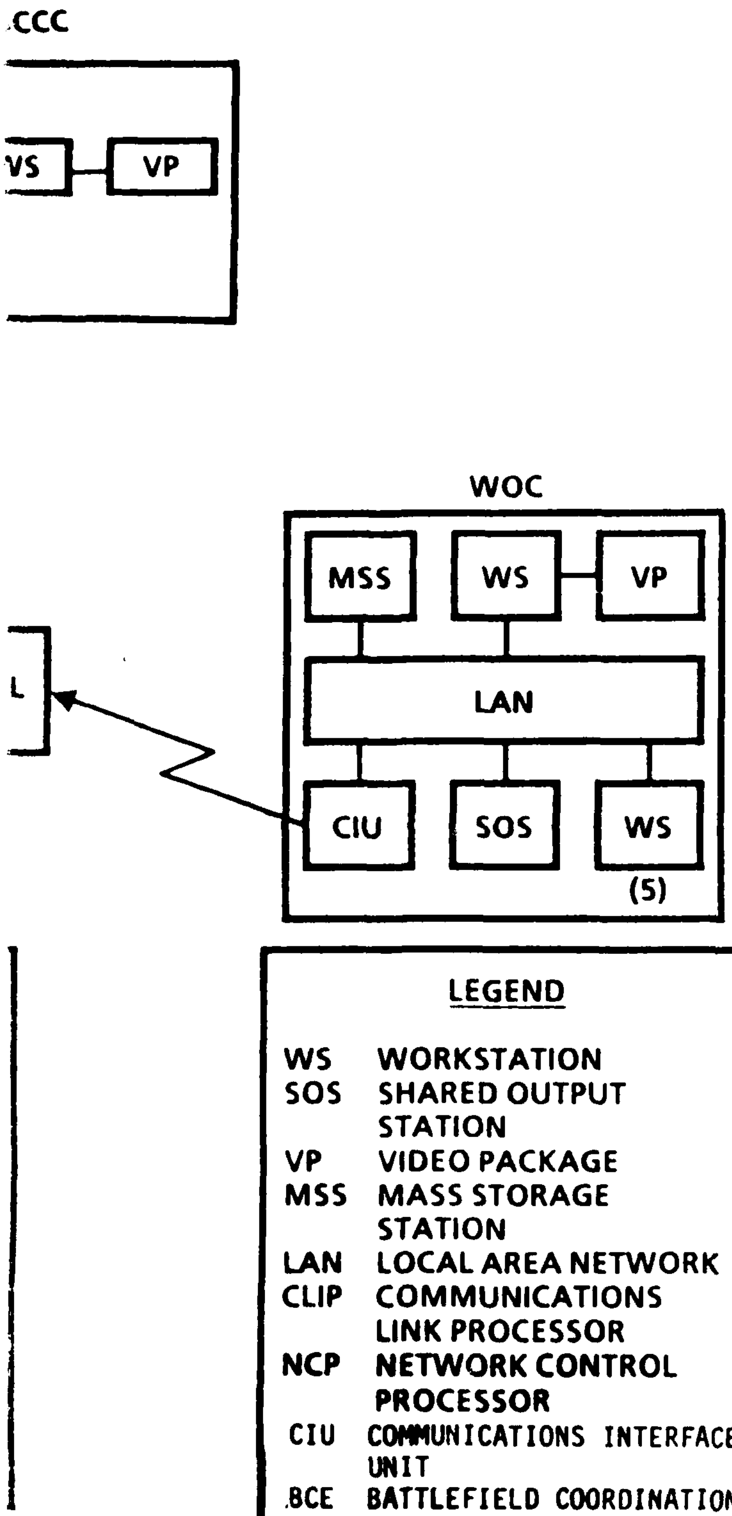
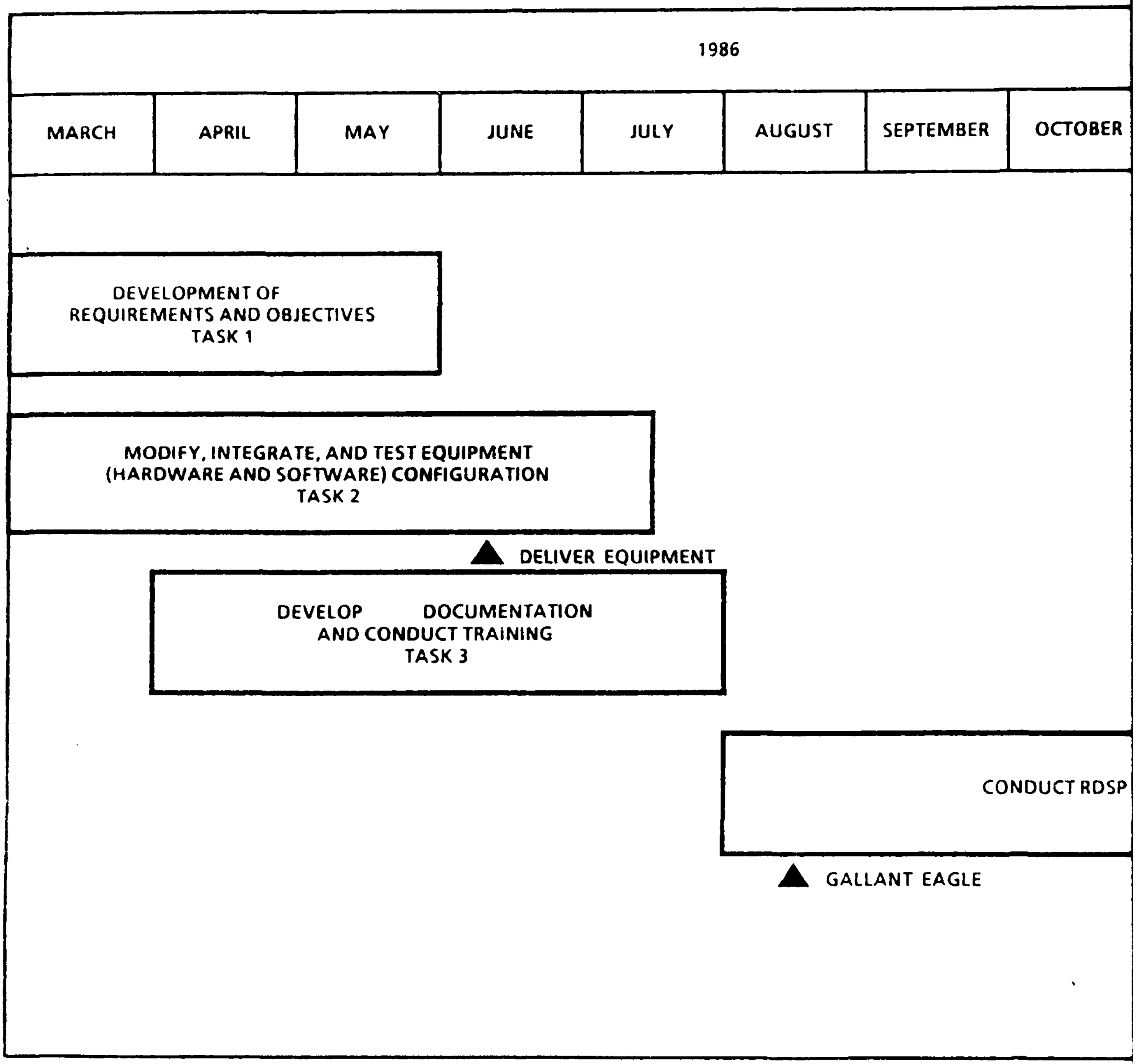


LEGEND

WS	WORKSTATION
SOS	SHARED OUTPUT STATION
VP	VIDEO PACKAGE
MSS	MASS STORAGE STATION
LAN	LOCAL AREA NETWORK
CLIP	COMMUNICATIONS LINK PROCESSOR
NCP	NETWORK CONTROL PROCESSOR
CIU	COMMUNICATIONS INTERFACE UNIT
BCE	BATTLEFIELD COORDINATION ELEMENT

FIGURE 7.1 THE RDSP TEST BED SYSTEM


1986
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
DEVELOPMENT OF REQUIREMENTS AND OBJECTIVES TASK 1
MODIFY, INTEGRATE, AND TEST EQUIPMENT (HARDWARE AND SOFTWARE) CONFIGURATION TASK 2
DELIVER EQUIPMENT
DEVELOP DOCUMENTATION AND CONDUCT TRAINING TASK 3
CONDUCT RDSP
GALLANT EAGLE

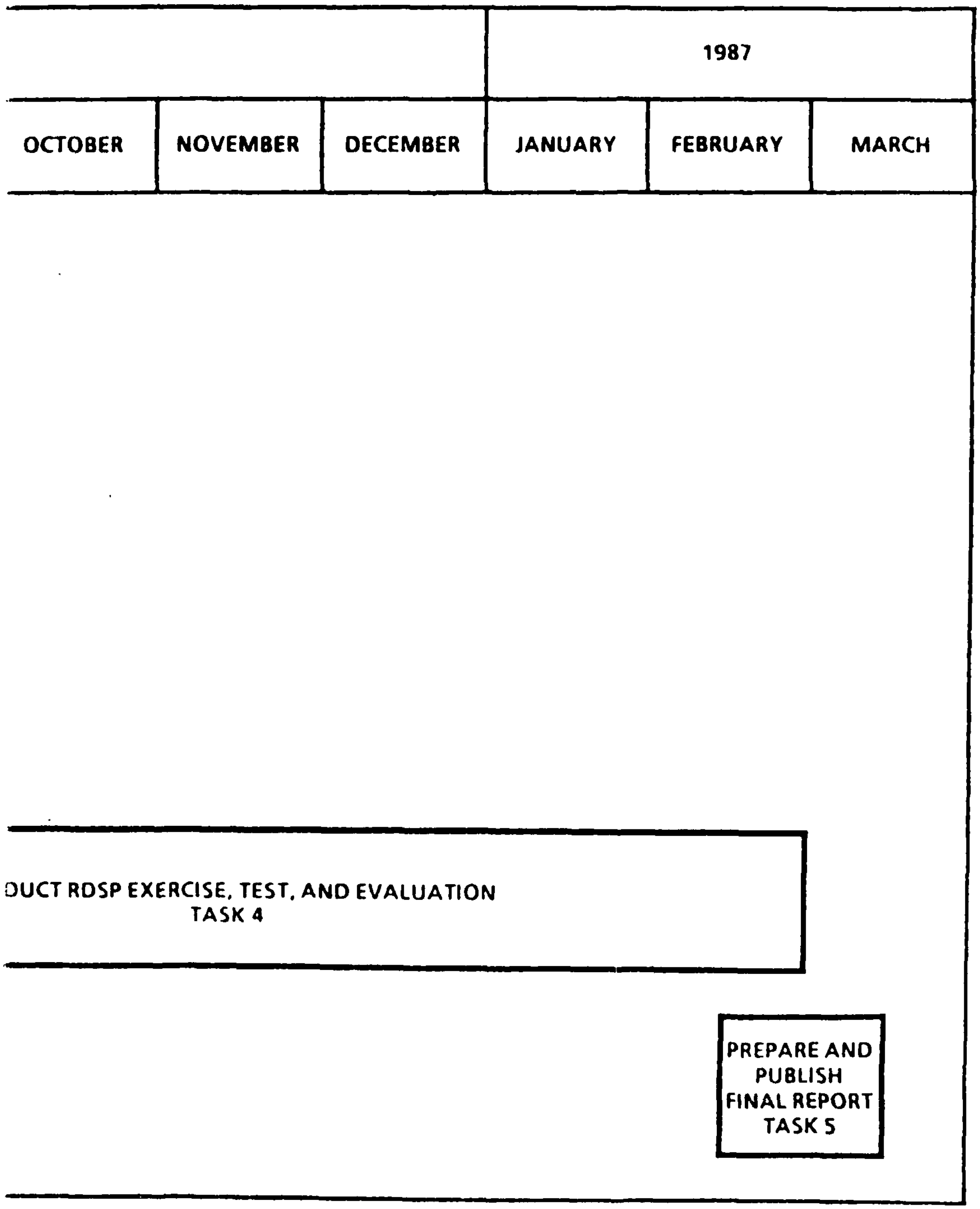


FIGURE 7.2 THE RDSP TASK SCHEDULE

2. Task 1--Development of RDSP Requirements and Objectives. Activities to take place during Task 1 include:

a. PMO Activities

(1) Review lessons learned from DNA, Army, and Marine Corps exercises with SPADS and DCCS (MCS 2.0) systems employment.

(2) Develop functional requirements.

(3) Develop evaluation objectives.

(4) Develop evaluation scheme and finalize test bed equipment configuration.

(5) Develop RDSP evaluation plan.

b. Contractor Activities

(1) Provide procurement services for the intended suite of test bed equipment (hardware and software).

(2) Begin equipment configuration.

(3) Investigate communications integration requirements.

(4) Provide technical assistance in the development of functional requirements, evaluation objectives, and the evaluation plan.

3. Task 2--Modify, Integrate and Test Equipment Configuration. Task 2 activities include:

a. PMO Activities

(1) Provide equipment and support necessary to support equipment integration.

(2) Refine and publish the RDSP evaluation plan.

b. Contractor Activities

(1) Complete equipment configuration (hardware and software).

(2) Deliver and test integrated equipment.

(3) Refine equipment integration.

4. Task 3--Develop Documentation and Conduct Training. Activities to take place during this period include:

a. PMO Activities

(1) Develop, coordinate, and publish policy and guidelines for test bed system use.

(2) Identify material resources required for training.

(3) Identify personnel to receive initial system training.

b. Contractor Activities

(1) Assist in development of policy/ guidelines for system use.

(2) Prepare and deliver training materials.

(3) Prepare and deliver a training schedule.

(4) Conduct initial training.

5. Task 4--Conduct RDSP Exercise, Test, and Evaluation. Task 4 activities include the following:

a. PMO Activities

(1) Schedule exercises.

(2) Conduct exercises and evaluations.

(3) Review evaluation results.

(4) Refine RDSP evaluation plan.

(5) Develop and publish evaluation repcrts.

b. Contractor Activities

(1) Provide technical assistance in planning, setup, conduct, and reporting of evaluation exercises.

(2) Assist evaluation efforts.

(3) Provide system hardware maintenance and modification.

(4) Provide software maintenance and modification.

6. Task 5--Prepare and Publish the RDSP Final Report. Activities concluding the study period include:

a. PMO Activities

(1) Prepare the RDSP final evaluation report to include:

(a) Conduct of the evaluation:

--Schedule.

--Problem areas.

(b) Lessons learned.

(c) Identified requirements of the core increment.

(2) Publish the Final Report.

b. Contractor Activities

(1) Assist in preparation of the RDSP final evaluation report.

(2) Prepare and deliver the contractor's perspective of the following:

(a) Conduct of the evaluation.

(b) Lessons learned.

(c) Identified requirements of core increment.

Concurrent Actions

Planning is a continuous activity in EA, and planning of the core increment and future increments must be concurrent with the conduct of the RDSP. The RDSP will mark the beginning of the transition from the existing architecture to a target force level architecture.

Architecture Study

Contracting of technical expertise in the development of information systems architectures is a preferred approach for the Air Force and should be procured as soon as possible after the establishment of the PMO. Frequent change of contractors providing architectural development could seriously impede and disrupt an EA approach.

Maintaining competition. The preferred solution to providing for competition and maintaining a smoothly evolving system would be to adopt one of these approaches:

1. Different parts of the system (e.g., TACC, WCC, ABCCC) could be contracted to different contractors, under the management of the architectural/systems integration contractor or the PMO.

2. Designate the architecture/system integration contractor as primary contractor and solicit competitive bids for

system development/engineering of <u>every other</u> increment.

3. Designate the architecture/system integration contractor as the primary contractor and require that various subsystems be recompeted (e.g., WOC).

Maintaining continuity of architectural/ system integration is essential. ADEA has successfully managed three contractors, each supporting a different aspect of the test bed, with minimal disruption. One contractor manages the development of the Upper-Echelon MCS 2.0 (R&D Associates), another the Lower-Echelon MCS 2.0 and systems integration (the BDM Corporation), and the third manages the packet switched network--this is <u>not</u> TRI-TAC--(SRI International). The only drawback to this method has been the failure to designate one contractor as the primary contractor. All contractors have expressed dissatisfaction with this peer-peer-peer relationship, but cooperation is nevertheless high.

Software Configuration Management

This too is a dynamic, continuous process, and should of course remain a function under the

PM's direction. The AFCEA study provided this insight into software support:

> Using contractor support for systems using current commercial technology (including software) could be more practical (in terms of cost, timeliness, and effectiveness) than attempting early development of in-service support resources. This is particularly pertinent to facilitating timely deployment of the "core" capability.[2]

In-house SSF personnel must remain, at least in part, allocated to supporting CAFMS until it is replaced. Contractor support in software development and maintenance is a viable and preferred option. Several senior information systems officers interviewed felt that, from their experiences, strong military management of contracted software support has yielded positive results. ADEA's "quick reaction" software support will likely be contractor based and is intended to speed up the already 18-month Army in-house development time for MCS software.

Summary

An RDSP is essential in defining a core system, which is needed in the near term. An RRDC is the basis from which the core system will be specified and will evolve.

A PMO should be formed as soon as possible and formalized later. TAC, as implementing command, should run the RDSP and overall system acquisition effort through the PM. The PMO should be a "combined program office." Roles and responsibilities among users, testers, and developers could be settled in memoranda of agreement. These need to be ironed out at the program's inception.

The RDSP would mark the beginning of serious architectural development. This must also be started ASAP. This is consistent with AFISA policy and guidance. As the force level C^2 system evolves so would HQ TAC's ability to define the architecture for the future TACS. Joint architectural development could be furthered through multiservice exercise, test, and evaluation of test bed systems.

This chapter identified both PMO and contractor support elements required for the RDSP. A timeline was established to fulfill RDSP requirements in a one year test bed effort. It has been assumed that, given the priority of this initiative, "color of money" matters could be worked out for the near term.

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[2]Armed Forces Communication and Electronics Association (AFCEA), Command and Control (C^2) Systems Acquisition Study Final Report (Falls Church, VA, 1 September 1982), p. IV-31.

CHAPTER VIII

SUMMARY AND DISCUSSION

> It was striking to me that whenever veterans of the defense business--the ones with "dissident" tendencies, the kind in any organization who stop to look carefully at things everyone else takes for granted--reached the point, after hours of talk, where they wanted to move beyond the details to explain what *really* troubled them about defense, it was always *this* theme they emphasized: the corruption of military purpose by procurement.
>
> --James Fallows, *National Defense*

The EA Approach toward Requirements Definition

The Need

Paper studies and laboratory experiments will no longer substitute for a "hands-on," adaptive, iterative requirements definition process in acquiring tactical C^2 systems.

The frustrated operational commanders (users) who have had to live with greaseboards, acetate, and obsolete systems in their tactical command centers are seeing that affordable, flexible, adaptive, and supportive systems *can* be rapidly acquired to meet today's operational needs. Experience within the DNA, Army, and Marine Corps strongly indicates that EA strategies are paying off; they have gained steady support among users despite attempts from the formal "acquisition communities" to disparage their successes.

EA is a viable acquisition strategy. An evolutionary approach is warranted in the development and acquisition of a force level C^2 capability and in the definition of architectures within which the Air Force's tactical C^2 must evolve.

1. Information systems technology is changing at a staggering rate.
2. Command and control systems are unique.
3. Today's and tomorrow's C^2 systems must fully interface with a myriad of other systems supporting the commander (one only has to read the TAF C^2 Improvements Developers' Guide).
4. Air Force and joint tactical C^3 architectures are not well-defined.
5. The "conflict bandwidth" has greatly expanded, and operational commanders must have flexible systems that support their shifting operational needs--now.
6. Modern information systems must do more with less manpower, and remain affordable.

The Flexibility to Implement EA

EA is generally supported by senior military leaders who have had experience in C^2 system acquisition. The emerging command and control managers, the senior officers who, in their younger days, personally experienced acquisition horror stories like TACC AUTO, are beginning to seek answers to today's C^2 problems with today's technology.

DoD guidance provides the Services the direction they need to establish EA policy and guidelines. AFISA directs EA as a "preferred strategy." Direction on EA from the Joint Logistics Commanders is expected in early 1986.

The Strategy

The first recommendation in this report is that the TAC adopt EA as a deliberate strategy in the development and acquisition of a future force level C^2 system. It is anticipated that the spate of insurmountable problems foreseen by the "business as usual" community in adopting such a strategy will quickly disappear when General Russ, Commander of Tactical Air Command, directs this initiative.

"Spoofing the system" (Chapter II) is a lie to the Air Force, DoD, Congress, and the taxpayer. Establishing firm, specific requirements for the

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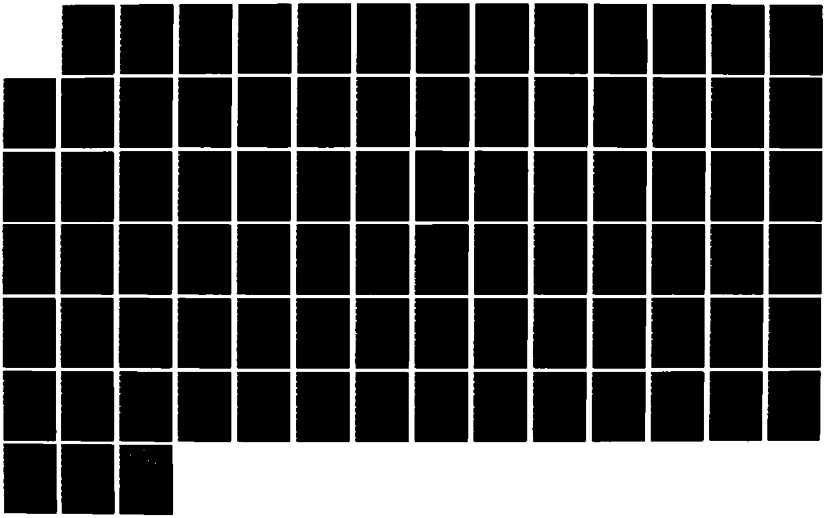

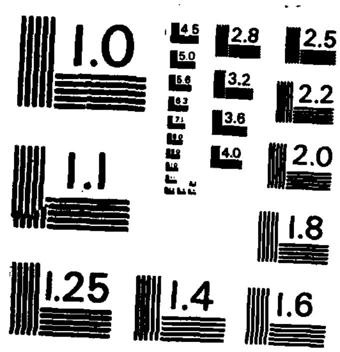

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

entire life of a C^2 system is a way of (1) receiving funding, and (2) ensuring that funding is retained when the system is stacked against other systems for funding. It is planned deception, an attempt to squeeze an evolutionary approach into a system that, as Mr. O'Donohue has stated, knows only one way of doing things: the traditional, serial, formal way.[1] TAC has the flexibility to adopt EA, and should exercise this flexibility in meeting its near term and future operational needs.

The basic strategy should be to:

1. Establish a management structure to champion an EA strategy.
2. Establish liaison with ADEA, the TCO Development Office, 17th AF, the JTC^3A, and supporting/participating organizations.
3. Redefine the relationships among users, developers and testers.
4. Describe in general functional terms the overall system requirement; use a "software first" perspective.
5. Conduct a "hands-on" test bed based Requirements Definition Study Period (RDSP).

6. Begin design of the architecture that allows system growth and incremental fielding.
7. Define in detail, fund, develop, user-test, and field, and user-test an operational core system.
8. "Build a little, field a little, test a lot."
9. **Above all, start small.**

A test bed system (an RRDC) must be established quickly and affordably, and the exploitation of the evolving test bed systems already in use is the key to this.

The Marine Corps estimated that the cost to develop software functionally equivalent to that of SPADS and DCCS would be over $6 million (in 1984). Development would require several years.[2]

Readiness and Sustainability

Readiness

JCS Pub 6, Volume II is the document that governs the combat readiness status reporting from the operational units to the Joint Chiefs of Staff. This document, and command level regulations, specify the way wartime readiness is quantified.

The pivotal readiness rating of a UNITREP (Unit Status and Identity Report) reportable unit is its C-Rating, or combat readiness rating. The overall C-Rating of a unit is derived from the individual ratings of constituent areas (e.g., designated equipment readiness, contingency spares status, training status), plus a commander's overall (and pre-eminent) rating. The Designed Operational Capability (DOC) statement is the basic list of systems against which a unit's combat-ready status is rated. Items on the 507th Tactical Air Control Wing's DOC might include, for example, OV-10 Bronco forward air controller aircraft or AN/TRC-97A tactical microwave radios.

CAFMS has never achieved Initial Operational Capability (IOC), so it is not included on the DOC. As the AFFOR commander's force level C^2 system, CAFMS' present status could be said to have seriously degraded combat readiness of both 9th AF and 12th AF tactical forces. If CAFMS were on the DOC, but it's not, this fact would translate to a conspicuous statistic. Readiness and sustainability are issues (surfaced in part by events such as the Iran rescue mission in 1980) that have received not only bad press but the SECDEF's and the JCS's unambiguous concern.

As bad as CAFMS is, TACS personnel have gotten used to it over several years of exercises. CAFMS does provide an automated assist in ATO preparation, and this has shaved several hours off of the manual process and has indisputably improved accuracy. Returning to a purely manual system would result in even worse chaos, especially in a non-exercise scenario.

Tactical air forces must, in 1985, be prepared to fight and win operations that CAFMS could not begin to support. Lieutenant General Cunningham, Commander, Twelfth Air Force stated in August 1985:

> Third World contingencies have and will continue to arise where Air Force forces have been committed without the benefit of an established information infrastructure or the lead time needed to introduce a full Tactical Air Control System and its complete command and control elements, i.e., the TACCS (Operations) and TIS (Intelligence) squadrons, and a supporting communications squadron.[3]

Sustainability

What happens if, next week, a short-notice contingency operation necessitates the deployment of CENTAF or USAFSO forces and a viable command and control center operation? They will undoubtedly do the very best with the resources they have available, as professionals do. If the situation involves the 12th AF, there is practically nothing with which to work. The 9th AF would probably deploy its CROMEMCOs and other CENTAF/personally acquired hardware and software, unsustainable as it might be. One staff officer expressed that if Lieutenant General Kirk, COMUSCENTAF, had to assign a dedicated plane to fly ATOs to his subordinate wings, he would.

It would seem that if the efficient, accurate, and timely generation and distribution of the commander's ATO prevented one pilot and weapon systems officer, and their F-4E, from being "hosed" by anti-aircraft fire or from missing a refueling rendezvous, then the command and control system would quickly pay for itself.

Interoperability through Joint Architecture

> The bottom line in interoperability decisions is to determine how much interoperability is required and what resources should be used to obtain that degree of reliability.

The above statement was made by Lt Gen C. E. McKnight, USA, the Director for Command, Control, and Communications, Organization of the Joint Chiefs of Staff.[4] The agency tasked with ensuring interoperability, the JTC^3A, has begun the study of present architectures in the hope of establishing a baseline generic tactical architecture. The emphasis at this point is to identify joint interface points and the interoperability requirements at each of these points.[5] At present JTC^3A is working from documents such as the TAFIIS Master Plan (see Chapter IV).

Through the experience gained with SPADS at the corps level, and DCCS at the division level, the Army has guided the evolution of its tactical C^2 requirements and its force level control architectures from the company through the corps level. The Marine Corps will be able to better define its MAGTF C^2 requirements through the TCO Test Bed. The basic logic:

1. To adopt an evolutionary approach toward C^2 requirements definition.
2. To define C^2 system architecture from user requirements.

TAC can field a C^2 system that can meet near term user needs and at the same time begin defining its TACS architecture by following the above (admittedly incomplete) logic.

If CINC (i.e., Unified and Specified Command) architecture is considered to most influence the JTC^3A's joint architecture development efforts, and if evolutionary approaches are being taken in the design of service component architectures, then it would stand to reason that the evolutionary development of a Unified commander's C^2 requirements would shed a great deal of light on solving the interoperability problem. In Chapter VI it was recommended that compatibility and interoperability be aggressively exercised, tested, and evaluated through "hands-on" experiments, exploiting the proven capabilities of SPADS and DCCS based C^2 systems. As mentioned in Chapter I, the JTC^3A could benefit from such an approach as well as the users. There should be no problem getting enthusiastic planners from JTC^3A to study and assist such a user-driven initiative. This initiative would be a first (and, therefore,encounter resistance), but results would surely be shown quickly.

A Few Variables

There are few precedences for EA within the Air Force; there is no precedent for a deliberate EA strategy toward the fielding of TACS C^2 systems. A few variables:

1. A very recent change in TAF senior leadership.

2. A force level automated assist that does not adequately meet present or projected requirements and has degraded present readiness.

3. Establishment of Air Force information systems doctrine and long-range planning.

4. The flexibility to adopt EA for C^2 systems.

5. The opportunity to actually plan, user-test, and evaluate compatibility and interoperability in the near term.

6. The opportunity to be innovative and realize the results of such innovation in both warfighting capability and taxpayer savings.

The 1984 Air Force merger of ADP and communications into information systems has blurred the distinction between the two previously very separate activities. This merger set the groundwork for information systems architectural policy.

No events will shape the future of tactical C^2 systems more than the marriage of EA into developing architectures and the leadership driving it.

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APPENDIX A

LIST OF ACRONYMS

LIST OF ACRONYMS

AADCOM	Army Air Defense Command
AAFCE	Allied Air Forces Central Europe
ABCCC	Airborne Battlefield Command Control Center
ACCS	Airborne Command and Control Squadron
ADEA	Army Development and Employment Agency
AF	Air Force
AFAA	Air Force Audit Agency
AFCC	Air Force Communications Command
AFCEA	Armed Forces Communications and Electronics Association
AFFOR	Air Force Forces
AFISA	Air Force Information Systems Architecture
AFLC	Air Force Logistics Command
AFMAG	Air Force Management Analysis Group
AFOTEC	Air Force Operational Test and Evaluation Center
AFSC	Air Force Systems Command
AFSC	Air Force Specialty Code
AGOS	Air-Ground Operations School
AI	Artificial Intelligence
AJ	Anti-Jam
ASAS	All Source Analysis System

LIST OF ACRONYMS
(continued)

ATAF	Allied Tactical Air Force
ASOC	Air Support Operations Center
ATO	Air Tasking Order
ATOC	Allied Tactical Operations Center
ATTB	Advanced Technology Test Bed
AUTODIN	Automatic Digital Network
AWACS	Airborne Warning and Control System
BCE	Battlefield Coordination Element
BPI	Bits per Inch
BPS	Bits per Second
C^2	Command and Control
C^3	Command and Control and Communications
C^3I	Command, Control, Communications, and Intelligence
C^4IS	Command, Control, Communications, Computer and Intelligence Systems
CAFMS	Computer Assisted Force Management System
CAI	Computer Assisted Instruction
CAM-G	Computer-Assisted Message Generator
CENTAG	Central Army Group
CG	Commanding General
CGS	Communications Gateway Station
CINC	Commander in Chief

LIST OF ACRONYMS
(continued)

CIU	Communications Interface Unit
CLiP	Communications Link Processor
COMUSCENTAF	Commander United States Central Command Air Forces
CPU	Central Processing Unit
CPX	Command Post Exercise
CRC	Control and Reporting Center
CTOC	Corps Tactical Operations Center
DAC	Defense Acquisition Circular
DARPA	Defense Advanced Research Projects Agency
DAViD	Data Automated Video Display System
DCCS	Distributed Command and Control System
DCIU	DCCS Communications Interface Unit
DC/SR	Display and Control/Storage and Retrieval system
DNA	Defense Nuclear Agency
DOC	Designed Operational Capability
DoD	Department of Defense
DoDD	Department of Defense Directive
DOS	Disk Operating System
DPO	Development Project Officer
DSB	Defense Science Board
DSMC	Defense Systems Management College
DSU	Direct Support Unit
EA	Evolutionary Acquisition
EIFEL	European Command and Control System

LIST OF ACRONYMS
(continued)

ELINT	Electronics Intelligence
ENSCE	Enemy Situation and Correlation Element
EPROM	Erasable Programmable Read Only Memory
ESC	Electronic Security Command
FM	Frequency Modulation
FP	Force Planning
FRG	Federal Republic of Germany
FSSG	Force Service Support Group
FY	Fiscal Year
GPE	Government Furnished Equipment
GPIB	General Purpose Interface Bus
HF	High Frequency
HMMWV	High Mobility, Multi-Purpose Wheeled Vehicle
HQ	Headquarters
HTLD	High Technology Light Division
HUMINT	Human Intelligence
ICP	Integrated Command Post
ID	Infantry Division
IEW	Intelligence and Electronic Warfare
IP	Internet Protocol
IR	Infrared

LIST OF ACRONYMS
(continued)

ISB	Independent Sideband
ISSG	Information Systems Support Group
JAMPS	JINTACCS Automated Message Preparation System
JANAP	Joint Army, Navy, Air Force Publication
JCS	Joint Chiefs of Staff
JINTACCS	Joint Interoperability of Tactical Command and Control Systems
JTC^3A	Joint Tactical Command, Control, and Communications Agency
KBPS	Kilobits per Second
KTACS	Korean Tactical Air Control System
LANTCOM	Atlantic Command
LAN	Local Area Network
LENSCE	Limited Enemy Situation and Correlation Element
LPM	Lines per Minute
LSD	Large Screen Display
MAC	Military Airlift Command
MAF	Marine Amphibious Force
MAGTF	Marine Air-Ground Task Force
MB	Megabyte
MCDEC	Marine Corps Development and Education Command

LIST OF ACRONYMS
(continued)

MCE	Modular Control Equipment
MCS	Maneuver Control System
MIFASS	Marine Integrated Fire and Air Support System
MIJI	Meaconing, Intrusion, Jamming, and Interference
MILSPEC	Military Specification
MISCAP	Mission Capability Statement
MPC	Message Processing Center
MSS	Mass Storage Station
NATO	North Atlantic Treaty Organization
NAVELEX	Naval Electronic Systems Command
NCP	Network Control Processor
NDI	Nondevelopmental Item
NOFORN	Not Releasable to Foreign Nationals
NORAD	North American Aerospace Defense Command
O&M	Operations and Maintenance
OS	Operating System
P^3I	Pre-planned Product Improvement
PACAF	Pacific Air Forces
PC	Personal Computer
PDP	Program Decision Package
PE	Perkin-Elmer
PM	Program Manager

LIST OF ACRONYMS
(continued)

PMD	Program Management Directive
PMO	Program Management Office
PRO	Program Review Organization
RAM	Random Access Memory
RDJTF	Rapid Deployment Joint Task Force
RDSP	Requirements Definition Study Period
ROC	Required Operational Capability
ROKAF	Republic of Korea Air Force
ROM	Read Only Memory
RRDC	Rapid Requirements Definition Capability
SATCOM	Satellite Communications
SCI	Single Channel Interface
SCO	Science Technology Objective
SDS	Staff Duty Station
SHF	Super High Frequency
SIGINT	Signals Intelligence
SIU	Serial Interface Unit
SOC	Sector Operations Center
SON	Statement of Need
SOS	Shared Output Station
SPADS	Staff Planning and Decision Support System
SSF	Software Support Facility
SWA	Southwest Asia

LIST OF ACRONYMS
(continued)

TAC	Tactical Air Command
TACC	Tactical Air Control Center
TACCS	Tactical Air Control Center Squadron
TACTICS	Tactical Information Control System
TACS	Tactical Air Control System
TADIL	Tactical Digital Information Link
TAF	Tactical Air Forces
TAFIG	Tactical Air Forces Interoperability Group
TAFIIS	Tactical Air Forces Integrated Information System
TASS	Tactical Switched System
TC^2 - 21	21st Century Tactical Command and Control Architecture Working Group
TCO	Tactical Combat Operations
TCP	Transmission Control Protocol
TCP	Tactical Computer Processor
TCS(T)	Tactical Control Squadron (Test)
TEP	Tactical ELINT Processor
TIS	Tactical Intelligence Squadron
TOC	Tactical Operations Center
TRI-TAC	Joint Tactical Communications Program
UDDAS	USAREUR Distributed Decision Aid System
UPS	Uninterruptable Power Supply

LIST OF ACRONYMS
(continued)

USA	United States Army
USAF	United States Air Force
USAFE	United States Air Forces in Europe
USAFSO	United States Air Forces Southern Command
USAFTAWC	United States Air Force Tactical Air Warfare Center
USAREUR	United States Army Europe
USMARCENT	United States Marine Corps Central Command
USCENTCOM	United States Central Command
USMC	Untied States Marine Corps
USN	United States Navy
UTC	Unit Type Code
VP	Video Package
WOC	Wing Operations Center
WINTEL	With Intelligence Information
WS	Workstation
WSO	Weapon Systems Officer

APPENDIX B

GLOSSARY

GLOSSARY

Air Force Information System Architecture. A conceptual framework for all Air Force information system elements and interrelationships; the hierarchy of technical, functional and command information system architectures within the Air Force. (AFISA)

Airborne Battlefield Command and Control Center (ABCCC). The ABCCC is an airborne command and control element of the TACS that provides management of tactical forces operating beyond the normal communication coverage of ground TACS elements. The mobility and communications advantages inherent in this platform enable it to stay abreast of the current ground and air situation within its assigned area of responsibility. This assures continuity of operation in the event elements of the TACS are disabled or not yet deployed. The ABCCC system, with its trained battle staff, is able to perform limited roles for: Crisis Management, Special/Contingency Operations, TACC Combat Operations, and ASOC (see TACR 55-130). (TACR 55-45)

Architecture. The architecture of a system relates to its design, and the way in which the component parts interrelate. It refers to the logical structure of a system, rather than the specification details of the individual components used to construct the system.

Architecture as used in the Air Force Information Systems Architecture is not in the traditional Air Force sense. It is not simply a programmatic document. An architecture describes the current situation (point A) and the target environment architecture (point B). It then describes the approach required to get from point A to point B in terms of technologies and capabilities which need to be exploited by all programs. (AFISA Vol. II draft)

Area of Responsibility. A defined area of land in which responsibility is specifically assigned to a commander of the area for the development and maintenance of installations, control of movement, and conduct of tactical operations involving troops under his control along with parallel authority to exercise these functions. (JCS Pub 1)

Army-Air Force Center for Low Intensity Conflict. Planned in 1985 as an Air Force-only initiative, the center will be established as a joint Army-Air Force center in early 1986. Headquartered at Langley AFB, VA, the organization will be manned by 30 specialists who will study low-intensity conflict and identify resources needed to improve low-intensity conflict capabilities. The Navy is expected to join the center in 1987. The first commander of the center will be Col Frederick C. Bosse, who will move from his position of director of operations of the 507th TAIRCW (9th AF), Shaw AFB, SC.

Combined. Between two or more forces or agencies of two or more allies. (When all allies or Services are not involved, the participating nations and Services shall be identified, e.g., combined Navies.) See also joint. (JCS Pub 1)

Command and Control. The exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of the mission.

Command and Control Systems. 1. Those systems that augment the decision-making and decision-executing processes of operational commanders and their staffs. The central, essential ingredient in any command and control system is the commander or decision maker himself. (AFCEA/This Report) 2. Those facilities, equipment, communications, procedures, and personnel essential to a commander for planning, directing, and controlling operations of assigned forces pursuant to the missions assigned. (JCS Pub 1)

Command Architecture. A framework or formulation of mission-oriented information system elements, both functional and technical, which interrelate to support a command's war-fighting capability and other, command unique missions; these apply the system design guidance of technical architectures and the information flow guidance of functional architectures (logistics, command and control, etc.) to the command mission requirements. Major Commands, Separate Operating Agencies and Direct Reporting Units create Command architectures and use them in program and project evaluations. (AFISA)

Command Center. A facility from which a commander and his representatives direct operations and control forces. It is organized to gather, process, analyze, display, and disseminate planning and operational data and perform other related tasks. (JCS Pub 1)

Command Post Exercise (CPX). An exercise in which the forces are simulated, involving the commander, his staff, and communications within and between headquarters. (JCS Pub 1)

Compatibility. Systems for tactical command and control, and communications are compatible with one another when necessary information can be exchanged at appropriate levels of command directly and in usable form. Equipments are compatible with one another if signals can be exchanged between them and if the equipments or systems being interconnected possess comparable performance characteristics including suppression of undesired radiation. (TC^2-21)

Connectivity. That linkage of (tele) communication paths which organizes an assembly of resources and procedures, united and regulated by interaction or interdependence, to accomplish a set of specific functions. (TC^2-21)

CONSTANT WATCH. The PACAF CONSTANT WATCH program is a multiphased effort to provide selected upgrades to the Korean Tactical Air Control System (KTACS), supporting combined Republic of Korea Air Force (ROKAF)/USAF operations. (TAF C^2 Improvements Developers' Guide)

Defense Science Board (DSB). The DSB is the senior independent advisory body of the Department of Defense. It was established in 1956 and undertakes tasks of high personal interest to the Secretary of Defense, the Deputy Secretary of Defense, the Under Secretary of Defense for Research and Engineering or the Chairman of the Joint Chiefs of Staff. (Charles A. Fowler, Chairman of the DSB)

EIFEL (European Command and Control System). EIFEL, developed by the Federal Republic of Germany and acquired by unilateral agreement, provides a similar capability to CAFMS to the principally U.S. manned and equipped Allied Tactical Air Operations Center at Sembach Air Base, Germany. The functions performed by EIFEL are similar to those performed by CAFMS, but they are implemented in a slightly different way. EIFEL is already operational at the German Allied Tactical Operations Centers at Kalkar, Messtetten, and the U.S. manned and equipped ATOC at Sembach, Germany. (TAC C^2 Improvements Developers' Guide)

Evolutionary Acquisition. A system acquisition strategy in which a basic capability is fielded quickly to satisfy a general statement of the requirement. Subsequent increments are acquired based on end-user feedback from acceptance testing and operational use of each increment fielded. (AFISA)

Functional Architecture. A framework or description of support functions (for example, services, capabilities, and interfaces to them) which interrelate to satisfy particular needs for information, where and when needed. Major functional areas (Plans and Operations, Logistics, Comptroller) create these architectures using technical guidance supplied by the Air Force Information Systems Architecture. (AFISA)

Ground Attack Control Center (GACC). The GACC is a software capability that decentralizes the attack of time-sensitive ground targets. GACC is modeled on the existing air defense Control and Reporting Center (CRC) structure. GACC will receive ground target information on mobile targets (moving and stationary) using existing/programmed systems. Weapons will be matched to targets at the GACC according to established guidance and priorities. The GACC will provide the latest target data, threat warning, and other mission essential information to attack aircraft. Each operations module of the MCE is planned to be able to perform CRC or GACC functions. (TAFIG Smart Book)

Implementing Command. 1. The command responsible for exercising overall management of an approved program for engineering, installing, and testing the facilities or equipment necessary to fulfill a requirement. (AFR 700-3) 2. The command or agency designated by Headquarters, United States Air Force to manage an acquisition program. (AFR 800-2)

Information System. The totality of resources devoted to handling information needed by a specified end-user community. (AFISA)

Interoperability. 1. The ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces and to use the services so exchanged to enable them to operate effectively together. 2. The condition achieved among communications-electronics systems or items of communications-electronics equipment when information or services can be exchanged directly and satisfactorily between them and/or their users. The degree of interoperability should be defined when referring to specific cases. (JCS Pub 1)

Joint. Connotes activities, operations, organizations, etc., in which elements of more than one Service of the same nation participate. When all Services are not involved, the participating Services shall be identified; e.g., joint Army-Navy. See also combined. (JCS Pub 1)

Military Capability. The ability to achieve a specified wartime objective (win a war or battle, destroy a target set). It includes four major components: force structure, modernization, readiness, and sustainability. (JCS Pub 1)

Mobility. A quality or capability of military forces that permits them to move from place to place while retaining the ability to fulfill their primary mission. (JCS Pub 1)

Modular Control Equipment (MCE). The MCE program consists of two key efforts to improve the ground Tactical Air Control System (TACS). First, MCE will replace obsolete CRC command and control operations centers. Since each module has an inherent message processing capability, MCE will replace the MPC. Second, the MCE program will provide a hardware baseline for the GACC, an additional operational function that will permit display at the CRC level of time-sensitive ground targets (i.e., tank/troop concentrations, threat emitters, high-value point targets, etc.) in the enemy second echelon. GACC will receive and display ground targets based on sensor data from the Joint Surveillance and Target Attack Radar System (Joint STARS), Precision Location Strike System (PLSS), and Advanced Synthetic Aperture Radar System (ASARS). GACC controllers will use this information to provide in-flight target/threat updates to attack aircrews. Presently, GACC is planned as a software change to the basic MCE module to provide a display capability for ground track data. (TAF C^2 Improvements Developers' Guide)

Operational Suitability. The degree to which a system can be satisfactorily placed in field use, with consideration being given to availability, compatibility, transportability, interoperability, reliability, wartime usage rates, maintainability, safety, human factors, manpower supportability, logistic supportability, and training requirements. (DoD Directive 5000.1)

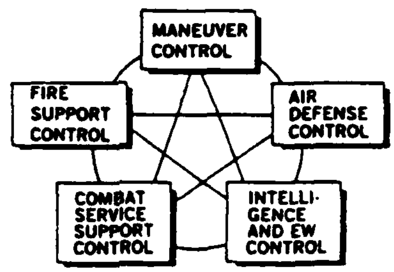
Participating Command. Program Management Directive (PMD) designated command or agency that provides support and takes part in carrying out tasks the PMD and Program Management Plan. (AFR 57-1)

Program Management Directive (PMD). The official Headquarters United States Air Force (HQ USAF) management directive used to provide direction to the implementing and participating commands and to satisfy documentation requirements. It is used throughout the acquisition cycle to state requirements and request studies and to initiate, approve, change, transition, modify, or terminate programs. The content of the PMD, including the required HQ USAF review and approval actions, is tailored to the needs of each individual program. (AFR 800-2)

Readiness. The ability of forces, units, weapon systems, or equipment to deliver the outputs for which they were designed (includes the ability to deploy and employ without unacceptable delays). (JCS Pub 1)

Reliability. The ability of an item to perform a required function under stated conditions for a specified period of time. (JCS Pub 1)

SIGMA STAR. A graphical representation of an integrated structure of five "functional areas": maneuver control, fire support, air defense artillery, intelligence/electronic warfare, and combat service support.



The SIGMA STAR

The overall commander of each echelon (e.g., brigade, division) is able to utilize information from each of the functional areas, from any part of the battlefield, for force level control.

Supportability. The ability of a system to be logistically supportable. Requirements must be satisfied within established time frames required for mission effectiveness. Supportability is closely related to reliability and maintainability.

Survivability. The ability of a system to continue to perform essential functions in the absence of some of its components. Factors to be considered include hardness, protectability, mobility, reconstitutability and redundancy. (TC^2-21)

Sustainability. The ability to maintain the necessary level and duration of combat activity to achieve national objectives. Sustainability is a function of providing and maintaining those levels of force, materiel, and consumables necessary to support a military effort. (JCS Pub 1)

TAF (Tactical Air Forces). The TAF is comprised of Tactical Air Command (TAC), the United States Air Forces in Europe (USAFE), and the Pacific Air Forces (PACAF).

Technical (or Subsystem) Architecture. A framework of concepts and guidance which band a subject area, or of physical components (e.g., hardware, software, transmission media) which interrelate to perform a bounded subset of information handling, both processing and transfer. (AFISA)

TEMPEST. TEMPEST is a short name referring to investigations and studies of compromising emanations. TEMPEST is often used synonymously for the term "compromising emanations," as in TEMPEST tests, TEMPEST inspections, and TEMPEST certification.

Test Bed (General Definition). A facility or composite of resources used to obtain, verify or provide qualitative and/or quantitative data for evaluation of progress toward completing development objectives, system performance or operational capability and utility. (Brig Gen Brown)

The test bed system in this report is additionally referred to as a prototype and a Rapid Requirements Definition Capability (see Chapter IV), the main purpose of which is to enable TAC to quickly, intelligently, and accurately specify requirements for a "core" force level C^2 system; develop a TACC system concept; begin definition of TACS architecture; and exercise, test, and evaluate interoperability in "hands-on" experiments.

Transportability. The capability of material to be moved by towing, self-propulsion, or carrier via any means, such as railways, highways, waterways, pipelines, oceans, or airways. (JCS Pub 1)

TRI-TAC (Joint Tactical Communications) Program. TRI-TAC is a joint service tactical communications equipment program designed to replace old analog equipment. TRI-TAC deals with the design, development, and acquisition of the equipment. It is a family of tactical communications systems, which includes the following: message and telephone switches; communications control facilities; transmission equipment (tropospheric scatter radio); user terminals (teletype, telephones, and facsimile); and communications security equipment (crypto devices). TRI-TAC will be utilized throughout the TAF. USAFE has priority within the Air Force for receipt of the first TRI-TAC equipment. (TAFIG Smart Book)

Unified Command. A command with a broad continuing mission under a single commander and composed of significant components of two or more Services, and which is established and so designated by the President, through the Secretary of Defense with the advice and assistance of the Joint Chiefs of Staff (JCS); when so authorized by the JCS, by a commander of an existing unified command established by the President. (JCS Pub 1)

U.S. Central Command Air Forces (USCENTAF). USCENTAF is the Air Force component of U.S. Central Command (USCENTCOM), the unified command. The Commander, USCENTAF is "dual hatted" as the Commander, Ninth Air Force (9th AF) within Tactical Air Command. USCENTAF and 9th AF headquarters are located at Shaw Air Force Base, South Carolina.

User (End-User). The individual or organization having a need for information in order to perform command, control, or management of Air Force resources. (AFISA)

Vulnerability. The characteristics of a system cause it to suffer a definite degradation of mission performance as a result of having been subjected to a hostile environment. (TC^2-21)

Weapon System. A delivery vehicle and weapon combination including all related equipment, materials, services and personnel required so that the system becomes self-sufficient in its intended operational environment. (JCS Pub 1)

APPENDIX C

EVOLUTIONARY ACQUISITION COMPARED WITH PRE-PLANNED PRODUCT IMPROVEMENT

d. Evolutionary Acquisition Compared with P^3I

The Study Team found much confusion in various policy and field groups visited about the difference between "Evolutionary Acquisition" (EA) and "Pre-Planned Product Improvement" (P^3I). Most either considered them to be quite similar, if not identical, or EA merely to be a sub-set of P^3I. The Study Team found a number of similarities and differences between the two approaches. The similarities are as follows:

(1) Both are incremental approaches, where it is planned to implement regular upgrades from the beginning of a program.

(2) In both cases, initial and subsequent design efforts are deliberately approached in such a way that the planned upgradings can be accomplished more easily, i.e., design is focused initially as much on changeability as on system optimization. In the case of C^2 systems, this might be done by providing extra through-put capacity and/or memory and taking a modular approach to system design.

(3) Both ordinarily involve initially striving for something less than either the system

or technological states-of-the-art would permit, particularly something less than the most far-reaching states, or "revolutionary" leaps, would permit.

In view of these similarities, one might ask what differences there are between the "evolutionary approach" and P^3I. In answer, several possible differences might be noted where C^2 systems are concerned:

(1) The evolutionary approach usually is adopted as a strategy because it has to be, i.e., because: (a) it is so difficult to state requirements adequately at the beginning of a true C^2 program, (b) such requirements are expected to change frequently over the life of the program, or (c) users cannot specify acceptability criteria adequately in advance due to the subjective nature of these criteria. This leads to a "design- and-tryout" approach having to be taken both to defining the need and to the approach to satisfying the need. In contrast, the P^3I strategy may be adopted for any one of a number of reasons, even when it doesn't have to be--even, for

example, when a requirement can be stated adequately and its achievement can be measured objectively.

(2) An overall program to which the evolutionary approach is being taken may involve little to no advanced development (6.2/6.3A) of any type: for example, when the user upgrades his C^2 capability through using existing commercial or military material to build a "prototype" of some type. In fact, this is the mode preferred by policy (Section 13 of DoDI 5000.2 of March 1980; Appendix D hereto). In contrast, a P^3I program ordinarily does involve advanced forms of development--significant amounts of such development, in fact. Indeed, P^3I is a strategy that has come to the fore in recent times as a means of dealing with just such uncertain advances, because, among other principal reasons, the development period involved in taking a very large or "revolutionary" jump towards the limits of art, each time a new program starts, has been taking so long and been so risky, that U.S. readiness is being threatened.

(3) While it is highly desirable that users be constantly knowledgeable about P^3I programs--indeed, play a continuous, if reactive role in the acquisition of any DoD system--the P^3I approach per se does not require that the user accept any significant responsibility at any stage of the acquisition cycle. In contrast, strong real user/lead user participation in and influence over the acquisition is a major aspect of the EA of C^2 systems, as previously indicated. EA requires a larger role and heavier continuing involvement in the user in terms of:

- Planning and design initiative (e.g., CAFMS).
- Relative responsibility for program results.
- Management control of the program as it progresses (e.g., determination of operational utility).

In fact, the fundamental need for continuing, close interaction among all the participants in the C^2 system acquisition process--especially the provider, user and independent tester--is basic to EA, whereas it is not basic under P^3I.

(4) Finally, EA differs from P^3I in several other respects:

-EA demands an accelerated and abbreviated "requirements process" and "procurement process" leading to contractor selection. This is necessary to enable rapid fielding of a "core" and subsequent increments so that evolution can occur based on feedback from test in the user's environment.

-Different PPBS/budgeting approach arising from less initial detail on the ultimate total program.

-Differences in Program Office staffing. A traditional acquisition is "front-end heavy" in specialists in producibility, testing and ILS. Under EA, there is essentially a continuous need for all these skills but in a more "level-of-effort" fashion.

In sum, while the two approaches are incremental and have a number of similarities in form, they differ significantly in front-end specification and implementation. They are distinctly different concepts.

APPENDIX D

EXTRACTS FROM DEFENSE ACQUISITION CIRCULAR 76-43

6. Acquisition Strategy

a. An initial program acquisition strategy will be developed by the DoD Component concerned for each major system acquisition when a new start is proposed. The acquisition strategy should be tailored to the unique circumstances of the program. Proposed exceptions to applicable DoD Directive and Instructions will be identified in the acquisition strategy as it evolves. Advice and assistance should be sought from business and technical advisors and experienced managers of other major system programs.

b. The acquisition strategy is the conceptual basis of the overall plan that a program manager follows in program execution. It reflects the management concepts that will be used in directing and controlling all elements of the acquisition to achieve specific goals and objectives of the program and to ensure that the new system satisfies the approved mission need. The acquisition strategy encompasses the entire acquisition process of the basic system, preplanned product improvement (P^3I), and post-production support. The strategy must be developed in sufficient detail, at the time of issuing solicitations for the concept exploration phase, to permit competitive exploration of alternative system design concepts. Sufficient planning must be accomplished for succeeding program phases, that involve design, competition, provisioning and support economies, and production source availability.

c. The acquisition strategy must evolve through an iterative process and become increasingly definitive in describing the interrelationship of the management, technical, business, resource, force structure, support testing, equipment standardization, and other aspects of the program. Normally, the baselining and definition of a program will progress from establishment of operational requirements (JMSNS) to functional characteristics (Milestone I) to an allocated functional baseline (Milestone II) to a production baseline (Milestone III).

d. Acquisition programs will be executed with innovation and common sense. The flexibility inherent in DoDD 5000.1 and DoDI 5000.2 will be used to tailor an acquisition strategy to accommodate the unique aspects of a particular program, as long as the strategy remains consistent with the basic logic for system acquisition problem solving and good business and management principles.

27. Command and Control C^2 Systems.

a. The types of systems that augment the decision-making and decision executing functions of operational commanders and their staffs in the performance of C^2 require a tailored acquisition strategy. The principal characteristics of such systems are: (1) acquisition cost normally is software dominated; (2) the system is highly interactive with the actual mission users and is highly dependent on the specific doctrine, procedures, threat, geographic constraints, and mission scenarios of these users; and (3) these systems are characterized by complex and frequently changing internal and external interfaces at multiple organizational levels, some of which may be inter-Service and multinational.

b. The use of pre-planned product improvement (P^3I) is a procedure highly appropriate to such systems and should be considered when appropriate. C^2 systems generally require an evolutionary acquisition approach. This is an adaptive, incremental approach where a relatively quickly fieldable "core" (an essential increment in operational capability) is acquired initially. This approach also includes with the definition of the "core capability"; (1) a description of the overall capability desired; (2) an architectural framework where evolution can occur with minimum subsequent redesign; and (3) a plan for evolution that leads towards the desired capability.

c. Programming, budget approval, and acquisition management must be tailored to encourage and enable early implementation and field evaluation of a "core" system. Subsequent increments must be based on continuing feedback from operational use, testing in the operational environment, evaluation and (in some cases) application of new technology. Operational and interface requirements and operational utility criteria should be evolved with the participation of actual mission users (or lead user and appropriate surrogate for multi-user systems). There must be regular and continual interaction with developers, independent testers, and logisticians.

d. The user will support the independent T&E agency in determining readiness for operational use of the "core" system and work closely with the development activity and independent tester in evaluating subsequent increments of new technology. A centralized facility will be used to accomplish post deployment software support of fielded increments under centralized configuration management. Consideration must be given to the use of existing commercial equipment, related system software and firmware, and contractor maintenance (with warranties) whenever logistic, interoperability, readiness considerations, and field conditions permit it.

e. Those elements of C^2 systems that must survive and endure in strategic or theater nuclear warfare will be at least as survivable as the weapon system they directly or indirectly support. A proper mix of survivability techniques must be applied. Existing military and commercial hardware, software, and procedures should be used only if it can be demonstrated that they can be protected against and made resistant to wide-area threats such as jamming, spoofing and electromagnetic pulse, and that they can provide reasonable functional/system/path redundancy against direct attack and sabotage. Interoperability and battlefield sustainability will be key considerations.

f. The procedures described above are equally applicable to similar non-major C^2 systems as well as counter - C^3, electromagnetic countermeasures, and electronic warfare systems.

APPENDIX E

ELEMENTS REPRESENTED IN FIGURE 3.1

ELEMENTS REPRESENTED IN FIGURE 3.1

The Tactical Air Control Center (TACC)

The TACC is the senior air operations element of the TACS and functions at the component level. As the Commander's operation center/command post, the TACC provides the facility and personnel necessary to accomplish the planning, directing and coordinating of tactical air operations.

Two functions form the core of the TACC. They are housed in two AN/TSQ-92 multi-cell inflatable shelters. Approximately 40 people are required to assemble and wire these facilities in a 24-hour period. An additional 24 hours is normally required to achieve operational status.

The TACC requires approximately 350 people for sustained performance of all functions: plans, operations, communications, intelligence, maintenance, and liaison.

Combat Plans

Combat plans compiles and manipulates data on aircraft, aircrews, electronic combat and tanker support and munitions availability; targets, threats; enemy and friendly battle orders; weather; and many other factors. This information is used to build an ATO which satisfies the commander's daily objectives for the air war. The normal planning cycle takes 36 hours and the majority of the work is done manually.

Combat Plans is supported by the Army Battlefield Combination Element (BCE) and Combat Intelligence Division (CID) providing Army targeting priorities; intelligence on enemy and friendly ground situations, targets, threats; and order of battle information. ATO information is manually entered into the CAFMS which compiles, sorts, and collates the data into standard and JINTACCS formats. When the ATO is complete, access is granted to CAFMS user terminals. Also, a paper punch tape is cut for hard copy ATO transmission to tasked units not possessing CAFMS terminals. This is transmitted by low-speed teletype.

Combat Operations

Combat Operations (Combat Ops) monitors and coordintes execution of the ATO and incorporates both defensive and offensive air operations functions. Defensive operations monitors the air situation and controls defensive air assets by manual greaseboard plotting and by displaying air/ground radar presentations on scopes via data link from air/ground/sea radar sites. Offensive Operations tracks mission progress, coordinates mission support and retargeting using plexiglas status boards, wall maps and CAFMS.

Combat operations is supported by the BCE and Enemy Situation Correlation Element (ENSCE) providing ground situation, threat and target priority updates; airspace coordination; and joint operations coordination. ENSCE supplies the most current intelligence available for adjusting air operations to meet changing battlefield requirements within the confines of the commander's objectives.

Direct Support Unit (DSU)

The DSU is a unit from the Air Force Electronic Security Command. It provides the TACS with Communications Security, surveillance support, support to electronic communications, and other security assistance.

Control and Reporting Center (CRC)

The CRC is directly subordinate to the TACC and is the primary element concerned with decentralized execution of air defense and airspace control functions. Within its area of responsibility, the CRC directs the region or sector air defense and provides aircraft control and monitoring for both offensive and defensive missions. It relays, as directed, mission changes to airborne aircraft and coordinates control of missions with subordinate TACS elements and other agencies, as necessary. Inherent in these functions are the requirements to supervise subordinate radar elements, provide threat warning for friendly aircraft, implement procedures to ensure that air defense assets of all services are employed in mutually supporting roles, establish coordination procedures based on friendly artillery fire plans, establish the means for air traffic regulation identification, and support air rescue operations.

Message Processing Center (MPC)

The MPC is responsible for assuring the automatic transfer of tactical data over digital MPC data links between elements of the TACS; in figure 3.1, between the MCP, CRCs and the AWACS.

Airborne Warning and Control System (AWACS)

The AWACS is an airborne radar control element of the TACS. It has the ability to provide detection and control of aircraft below or beyond the coverage of ground-based radar, or when ground-based radar elements are not available. The AWACS radar and radio coverage permits air defense warnings, aircraft control, navigational assistance, coordination of air rescue efforts and changes to tactical missions.

Air Support Operations Center (ASOC)

The ASOC plans, coordinates and directs immediate tactical air support of ground forces. It is subordinate to the TACC and provides fast reaction to immediate requests for close air support, battlefield air interdiction, tactical air reconnaissance and, in some situations tactical airlift. The ASOC is normally collocated with a Corps Tactical Operations Center (CTOC) but may also be deployed to support echelons above or below corps. An ASOC is primarily concerned with the exchange of combat data between air and ground forces concerning the planning, coordination and execution of immediate tactical air support of ground operations. Provisions are made within the

ASOC for G-2 (intelligence) and G-3 (operations) Army air representation and for other appropriate liaison personnel, as required, for joint/combined operations.

Wing Operations Center (WOC)

A WOC is a Wing Commander's headquarters facility which includes a command post, command section, battle staff and other planning and support elements as required. Through the WOC, the Wing Commander manages and controls all assigned/attached resources, directs operations and receives orders and combat taskings from the TACC. A WOC is subordinate to the TACC and functions as the operations center for all units assigned/attached to the wing for operations.

Corps Tactical Operations Center (CTOC)

The CTOC is the Army Corp's main command post. The ASOC is collocated with the CTOC to provide direct coordination for planning and control of tactical air support.

Computer Assisted Force Management System (CAFMS)

CAFMS is described in Chapter III.

Display and Control/Storage and Retrieval (DC/SR) System

The DC/SR provides automated assistance for intelligence collection management, target intelligence, and intelligence data base management. The system is housed in six 8' x 8' x 20' vans with associated environmental control and power equipment. DC/SR terminals are located within the AN/TSQ-92 facility. Deployment of a fully functional DC/SR facility requires six C-141B sorties.

Limited Enemy Situation and Correlation Element (LENSCE)

LENSCE is a prototype system, operated by the 9th AF, that provides automated assistance for intelligence collection management, target intelligence, and other tactical fusion functions. It is housed in two 8' x 8' x 20' vans with associated support equipment.

Tactical ELINT Processor (TEP)

The TEP processes, correlates, and reports electronic intelligence (ELINT). The system is housed in an 8' x 8' x 30' trailer. Associated terminals are located within the AN/TSQ-92.

APPENDIX F

MCS 2.0 INTEGRATED APPLICATIONS SOFTWARE SUITE

MCS 2.0

INTEGRATED APPLICATIONS SOFTWARE SUITE

GRiDManager

GRiDManager provides a variety of functions to allow the user to manage system files, sign-on and sign-off with the GRiD Server, duplicate, erase, move, and exchange files, display all commands with a summary of their functions, and display or print a listing of files.

GRiDWrite

GRiDWrite allows the user to edit (full screen) and format text. Popular uses include letters, memos, and other document generation.

GRiDFile

GRiDFile is a relational database management system. It allows the user to store, retrieve, sort, display, and print information from its two-dimensional table. Data is automatically saved as it is entered, and a special utility helps the user to recover data lost in the database due to human error.

GRiDPlan

GRiDPlan is an electronic spreadsheet similar to other popular commercial spreadsheets. Basic features allow the user to perform the following functions:

1. Type numbers or text into a table.
2. Modify the table without complicated reformatting.
3. Define formulas to calculate values.
4. Perform "what if" analysis.

GRiDPlot

GRiDPlot displays numerical data graphically. From data contained in other files the user can choose a graph format (i.e., clustered bar, segmented bar, line graph, or pie chart) to present information for review and analysis. The user may also create a graph from data entered into a table.

GRiDPaint

GRiDPaint is an application for drawing images and typing text on an "electronic canvas" on the computer screen. GRiDPaint allows the user to:

1. Create images.

2. Modify files created with GRiDPlot or GRiDPaint's Screenwatch utility program.

3. Type text using typefaces of various sizes and styles.

The Computer-Assisted Message Generator (CAM-G)

CAM-G is a custom software application that allows the user to create and subsequently fill in a pre-formatted message template that may contain pre-set optional entries for each blank in the template. With CAM-G the user can write scheduled data in a message to an existing database, or use data in a message to update data in an existing database.

The Automated Report Generator (ARGEN)

ARGEN allows the user to design and create a unique display of selected data from existing files.

The Electronic Mail System (E-Mail)

E-Mail is the most important of all applications, as it allows the user to send information automatically to another user. The sender identifies the computer addressee unit (and recipient), the particular communications means (e.g., single-channel radio, telephone, etc.), mail precedence, and other information, and sends the file. The sender receives acknowledgment when the file reaches its destination. E-Mail automatically notifies the recipient of the incoming "mail" and its precedence. Mail of user specified precedence may be automatically printed upon receipt. The recipient updates the database with the received information, as necessary.

The Data Automated Video Display (DAViD) System

DAViD allows the user to overlay information from a database on map backgrounds stored on a videodisc platter. Information is represented on the map in the form of predefined symbols or other graphic types, such as lines, circles, polygons. DAViD allows the user to point to a specific graphic symbol to "call up" more detailed information about that graphic from the database.

The database containing the user's information may have any format, though at least one field must be defined to contain coordinates in order to link specified information to map location.

Various displays can be created by placing conditions on the displayed data or by turning on or off specific data to display. These overlay pictures can then be saved for later retrieval.

APPENDIX G

LETTER FROM MAJOR GENERAL BRECKNER

TO GENERAL DONNELLY

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SEVENTEENTH AIR FORCE (USAFE)
APO NEW YORK 09130

30 May 1985

General Charles L. Donnelly
CINCUSAFE

Dear General Donnelly

As you may recall from your recent visit to ATOC Sembach during WINTEX-CIMEX 85, we have been investigating a number of approaches to enhancing joint air-ground operations and providing a means for better coordination between the air and ground commanders. During your visit, you saw some of the capabilities of DNA and USAREUR developed software on CORVUS computers. This prototype system, called the USAREUR Distributed Decision Aid System (UDDAS), appears to hold great promise for near term improvement to our operations.

The UDDAS system is being fielded throughout USAREUR (V and VII (US) Corps) and CENTAG. Gen Otis and his staff have been very cooperative in helping us understand the attributes and capabilities of the system. In a recent development, a joint US State Department approved technology agreement was signed between the US BDM Corporation (which developed the software) and the German Diehl Corporation to put the software on their computers. This should open the way for even greater proliferation of UDDAS capabilities among allied nations.

We think that the UDDAS system can enhance our ability to conduct the air battle. We are proposing to adopt the UDDAS system at the ATOC to provide us automated connectivity and data transfer capability to bridge the air to ground coordination gap. A talking paper on this proposed plan is attached (Atch 1). The end goal must naturally be bridging the gap at all levels of command where physical co-location as realized by 4ATAF/CENTAG is not possible. It is with this thought that I enjoin you to give us your support both from a US national position as well as from COMAAFCE to bring in AAFCE and the ATAFs as part of the whole scheme.

During Exercise CENTRAL ENTERPRISE we will be concluding our initial investigation of the system in the ATOC. I am inviting V Corps Commander, Lt Gen Wetzell, and MGen Todd and his staff to visit the ATOC and discuss these initiatives. During this period we also intend to conduct limited battle management of SOC III operations from within the ATOC. I propose to show them the UDDAS operation and discuss this and other initiatives to improve our joint battle capabilities. Your approval and support in these efforts is essential to accomplishing our goals. We stand ready to provide any additional information or support you may require.

Very respectfully

WILLIAM J. BRECKNER, JR., Maj Gen, USAF
Commander

1 Atch
Talking Paper on Near Term Air-Ground Command and Control System Plan

TALKING PAPER

ON

A NEAR TERM

AIR-GROUND COMMAND AND CONTROL SYSTEM

PLAN

PROBLEM

-There is currently no automated communications/data system that crosses the air to ground boundaries and ties in the essential elements of land-air battle coordination.

BACKGROUND

-Recent studies highlight serious deficiencies which will still exist within the NATO air-ground C^2 environment even when the current infrastructure is completed. Some of these deficiencies include limited ability to coordinate detection, targeting and attack of mobile time-sensitive targets and non-existent or severely limited automated C^2 systems between air and ground battle commanders.

-USAREUR has initiated a program to provide an automated C^2 system throughout the ground battle elements. The USAREUR Distributed Decision Aid System (UDDAS) was initially deployed in Exercise WINTEX-CIMEX 84. During Exercise WINTEX-CIMEX 85, the system was expanded to CENTAG/4ATAF elements to establish connectivity between CENTAG and its four Corps. The system was also deployed with ATOC Sembach (ATOC(S)) as a first step in providing air-ground C^2 connectivity and coordination. With this currently fielded system, the potential exists to extend automated C^2 connectivity to NATO and national systems in the very near future.

DISCUSSION

-The UDDAS system was designed as a command and control network based on the concept of a dispersed command post. The system employs an automated distributed processing scheme which allows key elements to be "electronically co-located" with other key elements to form a total command and control function. Information can be displayed in data formats as well as color graphic formats, reducing the time necessary to interpret volumes of data. All data bases are replicated at each node so if a given node is lost, other nodes are not affected. Each node has a stand-alone capability and the software to perform all functions. The system can interface with multiple other systems and provide for expansion into the networks of these systems.

-The UDDAS systems offers the following essential improvements to ATOC/SOC current operations

--Automated displays replacing grease boards

--Information and battle data exchange between 4ATAF/CENTAG and supported corps ("single sheet of music")

--Redundancy to EIFEL

--Easing of message center traffic jam

--Automated communications over multiple comm means

--Interface with other automated systems

-The approach to fielding such an operational C^2 system is proposed to capitalize on the USAREUR initiative and provide a companion effort among the air elements of AAFCE using an evolutionary development approach. The proposal should be implemented in phases to derive maximum benefits and planning.

—Phase I. Conduct limited experiments during planned exercises to demonstrate capabilities and attributes. This was essentially accomplished in WINTEX-CIMEX 85 and should be concluded in CENTRAL ENTERPRISE 85. (Timing - now)

—Phase II. Field an operational prototype using existing equipment connected with real-time communication links to 4ATAF/CENTAG, ATOC/SOC, and V and VII (US) Corps. (Timing - next 6 mos.)

—Phase III. Let a contract to enhance system software as required, provide interface with EIFEL, and field additional nodes to include mobile TACS, and 32 AADCOM. (Timing - ASAP upon completion of Phase II.)

—Phase IV. Upgrade hardware and finalize network deployment to provide an operational system. Initiate formal definition for capabilities/attributes of a follow-on system. (Timing - within 12 mos.)

CONCLUSION

-An effective air-ground command and control system which provides an integrated common perception of the total battle situation can be established using existing capabilities of the UDDAS System. Through interface of UDDAS with EIFEL and other C^2 systems at hardened facilities such as the ATOC, redundancy and survivability of all systems can be enhanced. The technology and hardware are available now at low cost. An operational system can be completed in the very near term.

RECOMMENDATION

-Seventeenth Air Force should implement this plan for ATOC Sembach and SOC III activities: Additionally, USAFE and AAFCE should be enjoined to complement this initiative with similar actions for HQ AAFCE and 4ATAF. Such actions combined with the USAREUR initiative will provide a fully operational system for the southern sector of the European Central Region. A parallel effort for the northern sector would logically follow suit.

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SEVENTEENTH AIR FORCE (USAFE)
APO NEW YORK 09130

30 May 1985

General Charles L. Donnelly
CINCUSAFE

Dear General Donnelly

As you may recall from your recent visit to ATOC Sembach during WINTEX-CIMEX 85, we have been investigating a number of approaches to enhancing joint air-ground operations and providing a means for better coordination between the air and ground commanders. During your visit, you saw some of the capabilities of DNA and USAREUR developed software on CORVUS computers. This prototype system, called the USAREUR Distributed Decision Aid System (UDDAS), appears to hold great promise for near term improvement to our operations.

The UDDAS system is being fielded throughout USAREUR (V and VII (US) Corps) and CENTAG. Gen Otis and his staff have been very cooperative in helping us understand the attributes and capabilities of the system. In a recent development, a joint US State Department approved technology agreement was signed between the US BDM Corporation (which developed the software) and the German Diehl Corporation to put the software on their computers. This should open the way for even greater proliferation of UDDAS capabilities among allied nations.

We think that the UDDAS system can enhance our ability to conduct the air battle. We are proposing to adopt the UDDAS system at the ATOC to provide us automated connectivity and data transfer capability to bridge the air to ground coordination gap. A talking paper on this proposed plan is attached (Atch 1). The end goal must naturally be bridging the gap at all levels of command where physical co-location as realized by 4ATAF/CENTAG is not possible. It is with this thought that I enjoin you to give us your support both from a US national position as well as from COMAAFCE to bring in AAFCE and the ATAFs as part of the whole scheme.

During Exercise CENTRAL ENTERPRISE we will be concluding our initial investigation of the system in the ATOC. I am inviting V Corps Commander, Lt Gen Wetzell, and MGen Todd and his staff to visit the ATOC and discuss these initiatives. During this period we also intend to conduct limited battle management of SOC III operations from within the ATOC. I propose to show them the UDDAS operation and discuss this and other initiatives to improve our joint battle capabilities. Your approval and support in these efforts is essential to accomplishing our goals. We stand ready to provide any additional information or support you may require.

Very respectfully

WILLIAM J. BRECKNER, JR., Maj Gen, USAF
Commander

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San Antonio, Texas 78217

6 January 1986

Major Raymond C. Harlan
Program Manager, Special Programs Division
Air Force Institute of Technology
Wright-Patterson Air Force Base, Ohio 45433-6583

Enclosed is one unbound copy of my research report. As discussed with Ms. Reed today, I have sent one bound copy to Air University Library. Suggested key words for use by the Defense Technical Information Center are attached.

I would like to express my appreciation to you and Ms. Reed for making my experience in AFIT both enjoyable and relatively headache free. If I can assist you at any time, please do not hesitate to give me a call.

Sincerely,

Charles J. Boensch
Captain, USAF

Enclosure: Suggested Key Words

SUGGESTED KEY WORDS

Acquisition
Command and Control Systems
Evolutionary Acquisition
Tactical Air Control System (TACS)
Tactical Air Control Center (TACC)
Computer Assisted Force Management System (CAFMS)
Tactical Communications
Joint Tactical Communications (TRI-TAC) Program
AirLand Battle
Distributed Command and Control System (DCCS)
21st Century Tactical Air Control System
Information Systems
Communications
Automatic Data Processing (ADP)
Maneuver Control System (MCS)
Architecture
Test Bed
Interoperability
Compatibility
Armed Forces Communications and Electronics Association (AFCEA)
Defense Science Board (DSB)
U.S. Central Command (USCENTCOM)
U.S. Central Command Air Forces (USCENTAF)
Joint Tactical Command, Control, and Communications Agency (JTC^3A)
Tactical Air Command (TAC)
Tactical Air Forces Interoperability Group (TAFIG)
Tactical Air Forces Integrated Information System (TAFIIS) Master Plan
Nondevelopmental Item (NDI)
Air Force Management Analysis Group (AFMAG)
Readiness
Sustainability
Requirements
High Technology Light Division (HTLD)
9th Infantry Division (9ID)
9th Air Force (9AF)
1st Marine Amphibious Force (1MAF)
Joint

END

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