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AN ASSESSMENT OF THE IMPACT ON THE ARMY'S FORCE XXI PROCESS IN DIGITIZING AVIATION BRIGADE UNITS

by

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September 1999

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This thesis examines the issues encountered by the United States Army Aviation during the implementation period of the Army's Force XXI process. The research focuses on the digitization impact on the brigade and its subordinate units as Aviation prepares to proceed into the 21st Century. The dynamics and complexity of digitization require utilization of the Army's warfighting requirements framework. This framework consists of the following domains: doctrine, training, leader development, organization, materiel, and soldier (DTLOMS). These domains or DTLOMS provide the mechanism to record the implications of Force XXI and identify lessons learned in the process. Force XXI is the concept that the Army will use to manage and exploit anticipated revolutionary changes in technology. This information-based concept will transform the entire Army's requirements determination process, materiel acquisition approach, and garrison and wartime operations. The case analysis identifies significant warfighting requirements issues in the DTLOMS framework impacting Aviation. Conclusions drawn from the analysis revealed that the Force XXI effort to digitize Aviation brigade units is progressing on the right path to the next century accompanied with training, integration, and acquisition challenges. Implementing the recommendations to combat these challenges should harness the digitization effort and manage the risks associated with the paradigm shift, so Aviation can effectively prepare its forces for the future.

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ABSTRACT

This thesis examines the issues encountered by the United States Army Aviation during the implementation period of the Army's Force XXI process. The research focuses on the digitization impact on the brigade and its subordinate units as Aviation prepares to proceed into the 21st Century. The dynamics and complexity of digitization require utilization of the Army's warfighting requirements framework. This framework consists of the following domains: doctrine, training, leader development, organization, materiel, and soldier (DTLOMS). These domains or DTLOMS provide the mechanism to record the implications of Force XXI and identify lessons learned in the process. Force XXI is the concept that the Army will use to manage and exploit anticipated revolutionary changes in technology. This information-based concept will transform the entire Army's requirements determination process, materiel acquisition approach, and garrison and wartime operations. The case analysis identifies significant warfighting requirements issues in the DTLOMS framework impacting Aviation. Conclusions drawn from the analysis revealed that the Force XXI effort to digitize Aviation brigade units is progressing on the right path to the next century accompanied with training, integration, and acquisition challenges. Implementing the recommendations to combat these challenges should harness the digitization effort and manage the risks associated with the paradigm shift, so Aviation can effectively prepare its forces for the future.

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I. INTRODUCTION

A. OBJECTIVE

Since 1993, the United States Army has embraced the digitization concept to prepare its forces for the 21st Century. Consequently, this evolution has impacted the Army's imperatives or domains of warfighting: doctrine, training, leader development, organization, materiel, and soldier (DTLOMS). These domains or warfighting requirements define the role, missions, and operations of the U.S. Army to support our national strategy and interest. This digitization process known as Force XXI presented challenges to modernizing the Army. The following briefly characterizes a few of the impacts of the Force XXI digitization:

- New tactics, techniques, and procedures for warfighting were developed to keep pace with the dynamics of the digitized battlefield.
- Digital military facilities were built to train system developers and soldiers to master the skills to operate evolving technology.
- Reclassification of the soldier's military occupational skill (MOS) or job required the attrition of other MOSs to meet the digitization battleforce.
- Battlefield commanders were relearning the decision-making process of the digitized applications.
- A smaller force structure was redesigned to a modular and versatile configuration that can fight in any wartime environment.

As a result of these challenges, the readiness of Army units is placed in a compromising situation during this transitional period to digitize the force. If a part of the digitization process is prolonged, units will deploy with a mixture of analog and digital equipment and unable to fight as a cohesive combat arms team. Also, any unscheduled system integration dampens a combat unit's readiness. Unless there is standardization in the

technical architecture, several digitized platforms may not be compliant or compatible thus impairing the integrity of the digitized battlefield.

In March 1997, the Army witnessed similar consequences during the first digitized Advanced Warfighting Experiment (AWE) for a Brigade Combat Team (BCT) called Task Force XXI (TF XXI). This experiment was the first of a series of experiments to test the hypothesis of digitizing the land component force. A unit from 4th Infantry Division in Fort Hood, Texas was selected for the TF XXI AWE. Within this TF, an Aviation battalion-size TF was organized with internal elements and additional non-organic elements consisting of attack, reconnaissance, utility and medium-lift helicopter assets. Prior to the AWE, the TF was consummated in the transformation of the digitization process. During the train-up or ramp-up phase of the experiment, weapons system and equipment were non-mission capable because of the system integration and retrofitting. Soldiers were involuntarily extended past their rotation date to a next assignment due to their critical participation in the experiment. During the experiment, several systems were not fully integrated and became strap-on systems that conflicted with the intent of the exercise.

Since that time, the Army has enhanced the Force XXI digitization process, but new and recurring challenges continue to plaque the effort. Therefore, this thesis will research the Army's methodology to digitizing brigade units in Army Aviation and analyze how these efforts impacted warfighting in the third dimension—air operations. Aviation operations contribute to the combined arms team within the battlespace by delivering ordnance and timely dissemination of critical information to the warfighters. Chapter II will further describe the entire process and its elements, specifically the Army XXI objective. Furthermore, this thesis will examine the rationale exhibited in the warfighting requirements

and system integration process. It will provide lessons learned based on my analysis developed and data accumulated. As a preface, only conventional aviation units and combat arms (CA) forces in the Army's heavy division will be addressed in this thesis. Other elements, such as special operation forces (SOFs), combat support (CS), and combat service support (CSS) will not be covered in detail. Another concept known as the Army After Next (AAN) is a follow-on objective for the 21st Century Army. Its evolution and ties to Army XXI will be examined briefly.

The digitization effort is inevitable, and the Army must adapt. For Army Aviation, it has and will, through the acquisition process, transition from analog systems to a fully integrated, digitized warfighting entity on the battlefield. In a 1997 Army Aviation Association of America (AAAA) article, former Secretary of the Army, Honorable Togo D. West Jr., said "Make no mistake. Army Aviation is a vital technology and a vital component of the battlefield of the future". He commented on recent successes that aviation achieved during several Advanced Warfighting Experiments (AWEs) and progressed to gaining insights in developing future TTPs for many of the its initiatives. He pointed out that culture shock and digital challenges come with the transition into the information age. This modernization effort has affected the warfighting skills, strength, command and control (C2), and system capabilities as they relate to the doctrine, training, leadership, organization, materiel, and soldier (DTLOMS) domains of warfighting requirements. In addition, the Aviation Restructure Initiative (ARI) has felt the impacts in the fielding process. Retrofitting of earlier fielded or prototype models and mixing systems (analog with digitized equipment) in a forward-deployed combat organization are some of the shortcomings. This

research will focus on these challenges and other impacts within Army Aviation which will be elaborated later in Chapter IV applying the DTLOMS format.

B. RESEARCH QUESTIONS

1. Primary Research Question

How are Army Aviation brigade units integrated into the digitized Army XXI?

2. Secondary Research Questions

a. What is the Army XXI objectives and architecture?

b. What are the potential enablers and inhibitors in digitizing Aviation within the Army XXI architecture?

c. How is the current Army development process support the development of digitization systems?

d. What problems and strategies did the acquisition community pursue to digitize Aviation?

C. SCOPE

The intended audience for this thesis involves combat developers, program management offices, Service components, and Department of Army policy makers. This case study will mainly focus on the impacts of digitizing Army Aviation units at brigade and below. A deductive approach from the Force XXI conceptual template to identifying digitized systems in Aviation units will be used. Specifically, Task Force XXI (TF XXI) AWE requirements, developments, and challenges as they pertain to Aviation will be addressed. Several Division AWEs (DAWEs) data peculiar to Army Aviation will be presented and analyzed.

D. METHODOLOGY

This study will include the traditional case study approach and incorporate requirements and system development analysis on methodology, advantages and disadvantages, enablers and inhibitors, and lessons-learned on Army Aviation's digitizing efforts. Data will be collected using two primary methods: literature review and interviews. A broad review of literature on Army digitization, information technology, and system development and acquisition will be conducted. Literature will be obtained from the Dudley Knox Library, the Defense Logistics Studies Information Exchange (DLSIE), respective service agencies, and the Internet. Literature will include current publication, periodicals, articles, reports, federal documents, and related previous theses. The literature review will be conducted to gain a comprehensive understanding of the Army's Force XXI effort, to identify the requirements and system development pathologies, and to determine the impacts of digitization.

Interviews with subject matter experts (SMEs) from warfighting centers and program management offices will be conducted. This interaction will enable data to be gathered on individual perspectives regarding the focus of this study. Ultimately, the interviews and literature reviews will establish the basis for concluding on developed lessons learned.

E. ORGANIZATION

Chapter II will provide the background. It will address the historical conception and development of the 21st Century Army elements: AAN and Army XXI. It will elaborate on Army Aviation's operational framework or architecture and outline Aviation's warfighting digitization requirements. It will identify the key players and their responsibilities from the

requirements agencies, program offices, and system developers. The chapter will explain the DTLOMS elements and their restructure. Finally, the chapter will review the objectives and execution of the Army's AWEs for TF XXI and DAWE.

Chapter III will present the on-going efforts in digitizing Army Aviation brigades and subordinate units. It will identify Aviation's interface and architecture with other C2 systems of the combined arms team on the battlefield. The chapter will conclude by describing Aviation's critical digitized programs and their acquisition status.

Chapter IV presents the analysis of the issues and lessons learned associated with digitizing Army Aviation. This analysis will focus on the warfighting requirements within the DTLOMS domains to include project management and integration issues. The lessons learned will emerge from the analysis on the impact of digitization on DTLOMS.

Chapter V provides the conclusion and the recommendations addressing the issues identified and analyzed in Chapter IV. It will provide summarized answers to the research questions and suggest areas for further research.

II. BACKGROUND

A. INTRODUCTION

In America, computers are moving into our daily lives at an accelerating rate. About 35 percent of American families and 50 percent of American teenagers have a personal computer at home; an estimated 30 million people, and climbing, have access to the internet; and over 65 percent of new computers are sold to homeowners. (Negroponte, 1995) These computers have large storage capacity from 750-megabyte re-writable compact discs to ten-gigabyte internal hard drives. The information highway is cluttered with data for anyone to access and process in minimal time, worldwide.

The military is exploiting this commercial advancement and deploying them as commercial-of-the-shelf (COTS) equipment into hotspots around the world and on battlefields. The Army has known this technology over the past 22 years and made significant advancement in its effort. (Hartzog, 1995) The Army is developing information technology-based operational concepts to employ, protect, and sustain forces in the Information Age through a process called Force XXI. These concepts leverage the space-based capabilities, information processing, and emerging communications technologies. (DA DCSOPS, 1995) Force XXI is intended to develop operational and support concepts, design forces, and determine modernization requirements to conduct war and operations other than war in the Information Age.

This chapter will provide the background for emergence of the Force XXI concept. The chapter is divided into four sections. The first section briefly explains the Army After Next (AAN) vision as a target for Force XXI's evolution. The second section describes the Force XXI process and its associated elements, specifically Army XXI. The third section

focuses on Army Aviation operational framework on the digitized battlefield. Finally, the fourth section discusses the Army's AWE approach including past exercises.

B. ARMY AFTER NEXT

The Army's long-term vision beyond Army XXI is called the Army After Next (AAN), which explores the uncertain world of the future beyond 2010. It uses a systematic approach to forecast future Army requirements integrated with other services, as well as those of the Joint Staff and the Office of the Secretary of Defense. The AAN project is currently focused toward national security strategy, growth of major competition, deterrence and conflict prevention, warfighting, and conflict termination.

The compression of time is an important influential physical parameter for the AAN. For the Army, this means taking advantage of future advancements in information technologies while concurrently increasing speed on the battlefield. Also, it includes reducing the time required to strategically deploy, tactically maneuver, traverse the kill zone, deliver ordinance on targets, and provide timely logistics support to the battleforce. To this end, information technologies will allow forces to position outside the combat zone, except for those forces necessary to close with the enemy.

AAN sets a compelling concept for the Army's role in land warfare. This process carefully incorporates a comprehensive foundation that will determine the essential science and technology investments enabling the Army to achieve such vision. Figure 1 depicts the entire path to arrive at AAN.

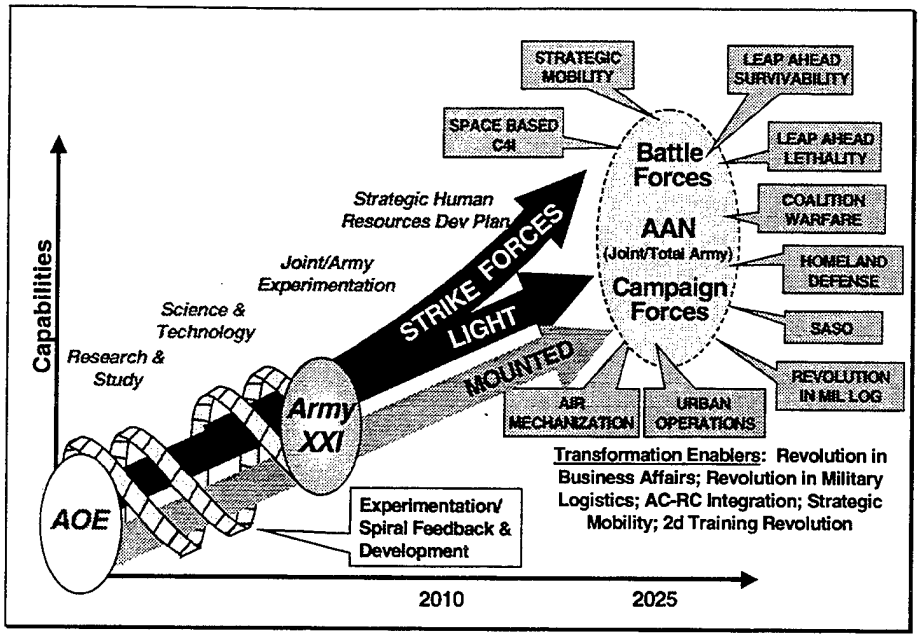

Figure 1. Path to Army After Next (AAN)
From Ref. (USAAVNC AMBL, 1999)

The figure illustrates the different axes from Army of Excellence (AOE) through Army XXI to AAN. These axes compose of the three combat forces projected to meet AAN capabilities: Mounted or Mechanized Contingency Forces, Light Forces, and Strike Forces. The Strike Force emerges from the other two at the Army XXI milestone. As part of the AAN concept, the Army Experimentation Campaign Plan (AECP) schedules milestones along these axes identifying major tests and Army and Joint experiments leading to AAN. The Mechanized Force axis establishes critical events to achieve optimization in shaping and winning the close fight on U.S. terms. In order to perform this task, the unit must maneuver, engage, and attack with precision. The Light Force axis creates a premier forced entry capability to operate in urban/complex terrain for decisive operations. The evolved Strike Force is a tailored, rapidly deployable, lethal, survivable and highly mobile force. (TRADOC, 1999)

The Army Enterprise Strategy is the single, unified vision for the Army Command, Control, Communications, Computers, and Intelligence (C4I) community. The strategy focuses on the information needs of the entire Army. It addresses the following Army requirements: (OSA DISC4, 1993)

- Organize, train and equip the force.
- Operate as a joint and combined force.
- Sustain the force from a tactical and enterprise perspective.

Integrated with the Army Modernization Plan (AMP), it is the enabler for the Land Force Dominance objective and the evolution of information systems. The Strategy is composed of two documents or phases: The Vision and The Implementation. The first document defines the ten principles to achieving information superiority over any adversary, and the second publication outlines the steps to fulfill the Vision. The Strategy has the following purposes: (OSA DISC4, 1993)

- Unify the C4I community toward a common goal.
- Establish a structure to guide the system development process.
- Develop economic, functional, and technical guidelines and criteria to aid resource managers in making C4I System assessments.
- Provide a broad systems perspective across Department of Defense (DoD).

Both phases will support the Army Warfighters in the 21st Century.

Army Vision 2010 (AV 2010) supports the AECP, Army Enterprise Strategy and AAN concepts. This vision is the blueprint for the Army's contributions to the operational concepts identified in Joint Vision 2010 (JV 2010). It is the conceptual template for how the United States Army will channel the vitality and innovation of its soldiers and civilians and

leverage technological opportunities to achieve new levels of effectiveness as the land component member of the joint warfighting team. (DA CoS, 1997) AV 2010 emphasizes the Army's ability to conduct prompt and sustained land operations throughout the entire spectrum of crisis. It recognizes the necessary initiatives and enablers to successfully attain full spectrum dominance--the end-state of JV 2010. AV 2010 links together Force XXI, the Army's on-going efforts to advance into the 21st Century, and AAN. Figure 2 illustrates the combining efforts or objectives of AV 2010 and JV 2010 to achieve full spectrum dominance.

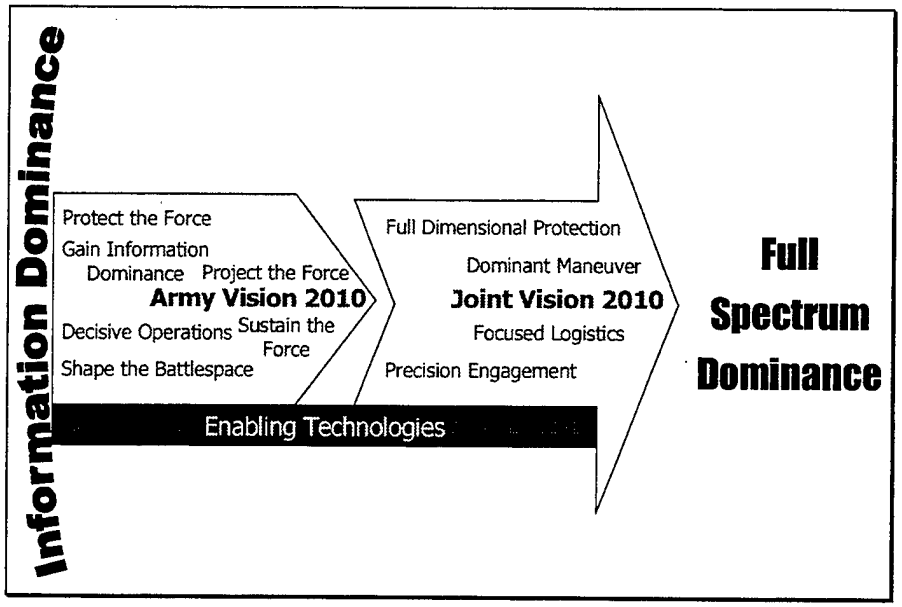

Figure 2. Army Vision 2010 and Joint Vision 2010 Integration
After Ref. (TRADOC, 1999)

C. FORCE XXI CONCEPT

The Army has experienced tremendous changes during the last 10 years as it reorganized to operate in the Post-Cold War Information Age. The streamlining and redesigning are expressed succinctly in the *Army Focus 1994*: (DA CoS, 1994)

> Over the past five years, the Army has undertaken an enormous transformation. While remaining trained and ready, it has built a strong and enduring bridge to the future. The Army has shifted its intellectual and physical focus away from the Cold War and beyond the industrial age. This focus on the future is captured in the "Force XXI—America's Army for the 21st Century." The Army's vision of Force XXI reflects its historical spirit and values; its serves as a guide to aid the Army in achieving its goals.

In March 1994, the Army committed itself to redesigning the operational forces to field a total Army force that is capable of meeting the nation's 21st Century challenges. This mission involved change in how the tactical Army is organized and how it fights; changes in the institutional Army on how it trains and supports this new force; and the creation of the Army's Digitization Office (ADO) to integrate information age systems into the force. These changes would be the foundation of the Force XXI Campaign Plan. Training and Doctrine Command (TRADOC) was tasked by the Army's Chief of Staff to develop a campaign plan to redesign the operational forces. In 1995, TRADOC published the Joint Venture Campaign Plan in response to this task. With TRADOC as the lead, the redesign efforts also included the Department of the Army headquarters staff and all the Army major commands. The Joint Venture partnership would manage this change and make important decisions as a body through the Experimental Force (EXFOR) Working Group.

Force XXI is the Army's vision to future warfighting on the battlefield. (Hyde, 1998) The Army visualized that digitizing systems from communication to weapon platforms at the soldier level to Echelon Above Corps (EAC) units will provide its forces with the winning edge against any threat in a conflict, and Force XXI is that enabler. Force XXI is the blueprint for all Army elements, including the Army Aviation segment of the architecture. Force XXI is characterized by increased dependence on information to move forces rapidly, employ those forces effectively, guide precision weapons to their targets, and

support widely dispersed forces from remote locations. With real-time access to information, military forces will deploy rapidly and operate at a tempo never imagined possible. Air and land forces will attack enemy forces simultaneously throughout the battlefield. Distinction between the deep and close battle coincide due the availability of accurate and timely information increases the range and speed with which forces can move and weapons employ. (DA DCSOPS, 1995) The United States must win the information war.

Former Army Chief of Staff, General Gordon R. Sullivan, said, "Force XXI is a journey, not a destination." The Army's Force XXI initiative seeks to experiment with, demonstrate, analyze, develop and field the requisite modern technology, doctrine, tactics, techniques and procedures for a well-equipped, well-trained and well-led Army of the 21st Century that is organized to master information technology and swiftly defeat any threat anywhere with few casualties. The initiative's fundamental hypothesis postulates: If we know the performance of a baseline organization, then we can apply information age technology to that organization, conduct experiments and gain insights into improved battlefield performance, which will cause us to redesign operational concepts and units to optimize military capabilities. (Singley III, 1995)

1. Force XXI Campaign Plan

Force XXI is the process that drives the Army to Army XXI. The initiative facilitates the process by:

- Redesigning the Tactical Army
- Integrating Information Age technologies
- Redesigning the Institutional Army

During General Sullivan's tenure as Army Chief of Staff, the Army crafted the Force XXI Campaign Plan identifying three axes to Army XXI. The campaign plan is the concept that the Army will use to manage and exploit anticipated revolutionary changes in technology. A balanced, stable force structure offers flexibility and focus during modernization efforts throughout the transition period and provides a stable launching platform for transition to Army XXI. The plan relies on doctrine, experimentation, virtual simulations, and experiences for the intellectual transition for each axis to Army XXI. These factors facilitate and orient their movement and effort. The first two axes are pertinent to the intent of this research. Figure 3 lays out the plan in its entirety.

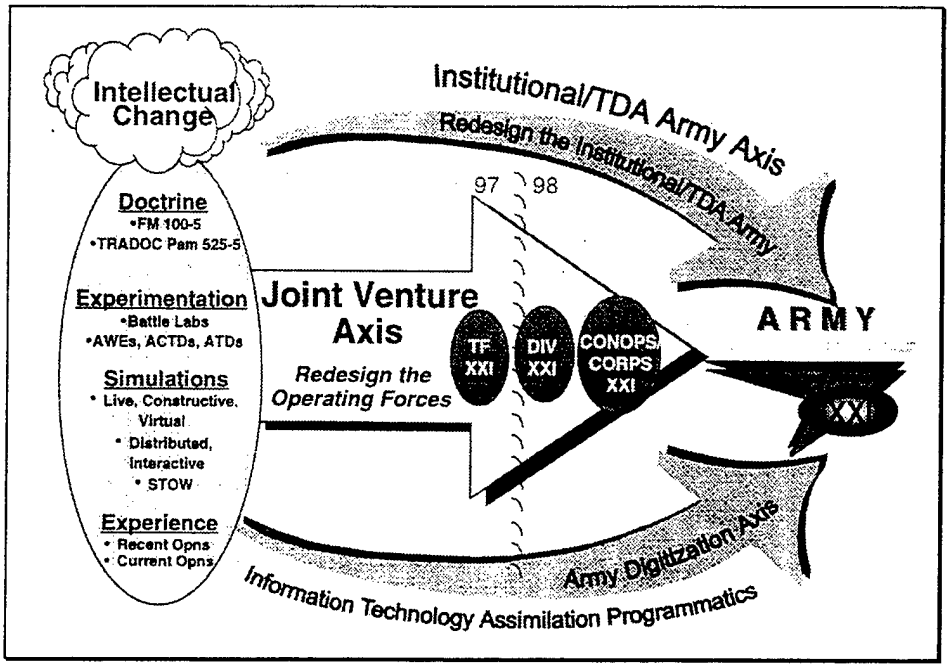

Figure 3. Force XXI Campaign Plan
After Ref. (DA DCSOPS, 1998)

a. Joint Venture Axis

The main axis of the campaign plan is Joint Venture. One of TRADOC's missions to plan, develop and execute and Army-wide efforts to achieve Force XXI fielding

decisions for the operational force by the end of the century. TRADOC, and its partners across the Army and in industry, are participants in a joint venture to build the Army of the future. The experimental axis is an interactive series of events like AWEs, Advanced Technology Demonstrations (ATDs), and Advanced Concept Technology Demonstrations (ACTDs) to explore and verify the future Army's force structure. The experiments will establish the focus for creating future organizations, equipment, training, and doctrine. The primary goal of the experimentation axis is to prompt interim and final force design decisions. (DA DCSOPS, 1998)

b. Army Digitization Axis

The Army Digitization Office (ADO) has the responsibility for this path. The Army Digitization Plan requires four thrusts: acquisition, Tactical Internet, battlefield operating systems (BOS), and battlefield information transmission system (BITS). The top thrust is the acquisition of maturing or strap-on systems like Applique, a situational awareness terminal, with associated hardware and software for digitized experiments and early fielding of such systems. This short-term acquisition runs concurrent with the long-term BITS thrust. The second thrust establishes a Tactical Internet that links tactical communications hardware systems. Mobile Subscriber Equipment (MSE), Single Channel Ground and Airborne Radio System (SINCGARS), and Enhanced Position Location Reporting System (EPLRS) are some of these tactical communication programs. The third thrust is integration of various software programs associated with each BOS. For example, the fire support software for the Advanced Field Artillery Tactical Data System (AFATDS) must interface with the intelligence software program of the All Source Analysis System (ASAS). These software programs are part of the Army Battle Command System (ABCS)

which will be addressed later in this chapter. Currently, software modifications are required for interoperability outside the BOS. The bottom or last thrust is BITS. BITS is a long-term plan to identify solutions to digital communications for future digital radios capable of handling long-term digital communications requirements. All four thrusts will focus on efforts to develop common operational, technical information, and architecture for future systems that are interoperable with the joint community's evolving Global Command and Control System (GCCS).

The ADO developed the Army Digitization Master Plan (ADMP) as a guide to proceed on its path to Army XXI. The plan is a living document that is updated annually. The 1999 ADMP is currently under revision, so the 1996 ADMP version is referenced. As digitization efforts mature, the plan will be refined and adjusted based on results from the extensive modeling, simulation, and experimentation built into the program.

The ADO has made significant progress toward the digitization effort since its initial 1995 ADMP. The plan accomplished following:

- Received the Joint Requirements Oversight Council's (JROC) approval for the Horizontal Integration of Battle Command (HIBC) Mission Need Statement (MNS).
- Developed and received approval for the Army Technical Architecture (ATA).
- Developed the digitized Applique C2 and situational awareness systems for Task Force XXI AWE and the involvement of the Digital Integrated Laboratory (DIL) for follow-on AWEs.
- Led the first acquisition-streamlining model that subsequently became the standard for future digital systems.
- Established the Common Operating Environment (COE) consisting of a set of integrated services (software development environment, architecture

principles, and methodology) supporting mission application software requirements across the service wide.

- Extended U.S. digitization effort to several allied and potential coalition countries.

- Conducted a broad-based information and education campaign about Army digitization and its future role on the battlefield.

Additionally, the second release, 1996 ADMP, expanded or added the following:

- Defined the migration of DoD specific systems to the COE.

- Conformed the technical, system, and operational architectures to DoD guidelines.

- Migrated specific Army Battle Command Systems (ABCS) to the COE.

- Cross-walked AWEs digitization expectations and their results.

- Provided an in-depth view at interoperability at the joint and multinational levels.

- Defined the following digitization functions:

  o Security.

  o Risk management.

  o Spectrum management.

  o Digitization training.

The ADO has the following key requirements documents that guides the Army's digitization effort: (DA ADO, 1996)

- Horizontal Integration Battle Command Mission Needs Statement (HIBC MNS) - establishes the baseline operational requirements for digitization of the battlespace and future command systems.

- Army Battle Command System: Common Operating Environment/Common Applications (ABCS: COE/CA) Operational Requirements Document (ORD) - refines the operating capability needs defined in the HIBC MNS.

This document requires the migration of current Army command and control component systems into one integrated system.

- Force XXI Battle Command, Brigade-and-Below (FBCB2) ORD - defines the needed command and control capabilities down to the lowest echelons.

c. Institutional/Table of Distribution and Allowances (TDA) Axis

This axis involves the reengineer and redesign of the Institutional Army by 2000. The Army's Vice Chief of Staff is charged with this mission. The axis employs three phases.

- Phase I: Establish a TDA organization baseline.
- Phase II: Interim transition from the baseline to a revised organization to better posture for Army XXI.
- Phase III: Begins with the objective Institutional/TDA organizational design completed by 2000.

2. Army XXI

The end-state for Force XXI is Army XXI, which is a stepping stone or transition to AAN. Army XXI is moving from a threat-based to capabilities-based Army. (DA DCSOPS, 1998) From the National Military Strategy (NMS) to Army Modernization Plan, Army XXI is postured to close the gap for the 21st Century Army and beyond. The force will be more lethal, mobile, and survivable. Army XXI will improve the Army's battlefield awareness through C4I integration. These enhancements will influence the doctrine and design of the future force. The force will be characterized as information dominant, modular, and tailorable, enabling a rapid response to multiple contingencies around the world.

In today's era of DoD downsizing, the 21st Century Army must adapt to limited budgets and force structure reorganization. The future Army must provide superior land

forces in support of joint operations. It must exploit and explore current and emerging technologies that will boost operational capabilities tremendously for land forces. These advancements will provide the future Army the combat power and force structure to defeat any opposition to our nation's values.

To remain within the scope of this research, the Army's Division XXI for Mechanized Force or Heavy Division and its compliment of Aviation Brigade units will be further addressed.

a. Division XXI

The end of the Cold War, a reordering of the international community, a surge of information age technologies, and the military draw down pressured the Army to re-evaluate the division as an organizational structure. During a five-year period, TRADOC, who was responsible for the Joint Venture Axis, conducted numerous analyses and executed a series of AWEs aimed at restructuring the future Army. Because of its effort, the restructured heavy division, the Army Division XXI, became the vision and implementation. The new division is unique due to its smaller size of about 15,000 soldiers. It has fewer combat elements consisting of 45 enhanced combat platforms of M1A2 Abrams Tanks or M2A3 Bradley Fighting Vehicles (BFVs) in maneuver battalions. The infrastructure relies on digital technology and computers. By being smaller, the future division is rapidly deployable. The division will have the ability to interface technology horizontally and vertically across the battlefield thus allowing combat units to sustain a rapid tempo of planning, preparing, and executing operations. In addition, it will provide the flexibility to sustain and recover from operations. The modular structure gives the organization the versatility to conduct specific missions. The design offers the integration of

the Total Force between active and reserve components. The design increases the warfighters' survivability through the information agility of the technology-based structure. The Army XXI heavy division structure aims to make armored and mechanized formations more deployable and agile while increasing combat power through modernization that relies on information dominance, advanced targeting systems, and command and control systems. Figure 4 depicts the task organization of the Army Division XXI (Heavy).

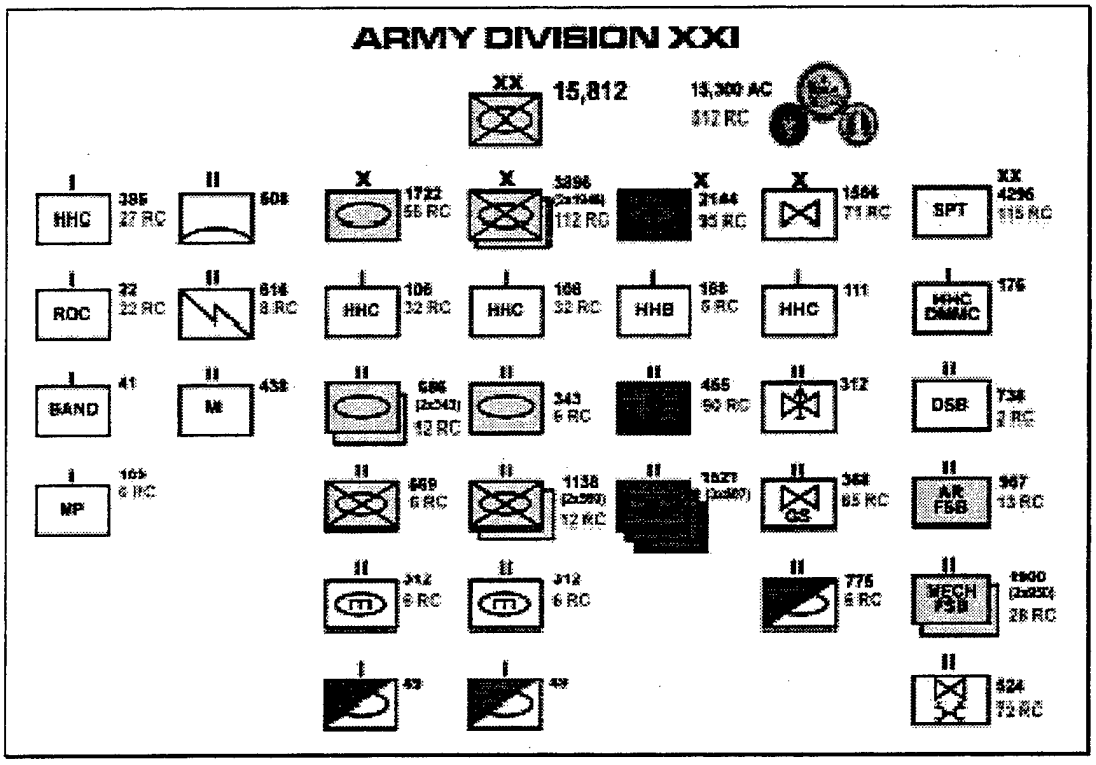

Figure 4. Army Division XXI (Heavy)
From Ref. (TRADOC, 1999)

The outward appearance of the Army XXI heavy division appears similar to today's division. It has three maneuver brigades (one armor and two mechanized infantry), a division artillery and a division support command. Each armor brigade will have two armor battalions and one mechanized infantry battalion, and each mechanized infantry brigade will have two mechanized infantry battalions and one armor battalion. The line battalions,

however, will have only three companies, one less than the traditional four-company structure, consisting of a total of 45 "enhanced combat platforms" in each battalion. This feature differs from the 58 armored vehicles, M1A1s or M2A2s, in each of today's battalions. Platoons will continue to have four combat vehicles, and mechanized infantry platoons will be structured with three, nine-soldier squads. The division reorganization significantly affects the division support command. The restructure will provide forward support battalion/forward support company in direct support of line units and use the most modern capabilities to change from a supply-based system to a delivery-based system.

The Army XXI division will field additional reconnaissance assets, such as a new brigade reconnaissance troop; more fire support, including three multiple-launch rocket system batteries; and enhanced aviation assets within its organic structure. The heavy division is projected to have the capabilities to cover a battlespace of 120 kilometers front by 200 kilometers deep because its elements can be more dispersed through the use of the advanced command and control systems. In addition, its intelligence systems will see farther, and its fire support will reach farther. As systems are anticipated to be delivered by 2005, the Army XXI division's battlespace is expected to expand. This future heavy division is expected to fight four to five battle plans simultaneously as well as recover from and continue or reenter the fight immediately.

The characteristics of the Force XXI Division operational environment are: (TRADOC, 1999)

- Multidimensional. The division will operate in an extended battlespace. The battlespace goes beyond the traditional physical dimensions of width, depth, and height. It includes portions of the electromagnetic spectrum. It extends beyond the physical boundaries of the division through its communications and digital connectivity to other Army, joint, and coalition elements, and even reaches back to the Continental United States (CONUS).

- Precise. Precision operations go beyond precision strike to include every aspect of military operations from deployment through combat and redeployment or transition to other operations. Precision in decisive operations is enabled by three emerging capabilities. First, digitization provides soldiers and leaders at each echelon the information required for making decisions. Second, a full suite of strategic, operational, and tactical sensors linked to analytical teams fuses combat information into situational awareness across the battlespace. Lastly, simulations enable Army elements to be tailored and operations planned, wargamed, and rehearsed yielding precision execution.

- Nonlinear. Nonlinear operations do not seek a battlespace grid of close, deep, and rear operations. Instead, the battlespace is fluid, changing as mission, enemy, troops, terrain, and time available (METT-T) change through the duration of mission preparation and execution. Another dimension of this characteristic is the synchronization of near-simultaneous operation to achieve nonlinear effects across the battlespace.

- Distributed. Division operations are distributed or executed where and when required to achieve decisive effects concentrated at a decisive point. Dispersion empowers subordinates to operate independently within the commander's intent, leading to synergistic effects that exceed the effects of a centralized headquarters.

- Simultaneous. The concept of decentralized operations that are multidimensional, precise, distributed, and nonlinear yields the capability to conduct simultaneous operations across the battlespace. Simultaneous operations seize the initiative and present the enemy leadership with multiple crises and no effective response. Rather than a single, concentrated attack, the division executes a series of attacks (lethal and non-lethal) as simultaneously as possible.

- Integrated. Division operations are fully integrated with joint, multinational, and non-governmental partners. Integrated operations enable the Army to leverage the full suite of capabilities the Services bring to the battlespace.

The following seven Battlefield Operating Systems (BOSs) have improved in the development of Division XXI: (Hartzog, 1998)

- Battle Command. The C2 systems provide a common picture of the battlefield that is shared throughout the division. This common picture will answer the important issues: Where am I? Where are the friendlies? Where is the enemy? A common understanding of the battlefield, the enemy

situation, and the friendly situation facilitate commanders to rapidly assess, decide, disseminate, and execute plans.

- Intelligence. The cavalry squadron will field a combined ground and air reconnaissance capability built around the M1A2 Abrams tanks, the Future Scout Combat System (FSCS), and the Comanche helicopter. Maneuver brigades will have a ground reconnaissance capability in a troop of FSCSs. The MI battalion will employ tactical unmanned aerial vehicles, ground radar, links to higher echelon intelligence sources, and ground-based common sensors.

- Maneuver. The ground maneuver battalions are limited to 45 systems as a result of eliminating a company from the previous task organization. The M2A3 Bradley Infantry Fighting Vehicle (BIFV) and the M1A2 System Enhancement Program Abrams tank coupled with improved situational awareness increase the effectiveness on the new smaller maneuver battalion. The division's aviation assets have changed as will be discussed later.

- Fire Support. The division artillery possesses a new generation of cannon artillery, Crusader, and a general support rocket artillery, Multiple Launch Rocket System (MLRS). The Fire Support Team-Vehicle (FIST-V) and Combat Observer Lasing Team have improved and will replace forward observers below company level.

- Mobility/Counter Mobility/Survivability. The engineer structure of the division has been redesigned so that an engineer battalion is organic to each maneuver brigade. The engineer planning and coordination effort will reside in the division's engineer planning cell. The key enablers in the redesign of the engineer battalions are the Grizzly and the Wolverine. These systems along with the situational awareness capability increased efficiency and reduced the structure of the Mine Clearing Line Charges and assault/obstacle platoons. Chemical detection remains with the division, and chemical decontamination and smoke generation tasks have been delegated to corps.

- Air Defense. The air defense battalion will receive the new Linebackers that are Bradleys with mounted Stinger pods and will lose its Man Portable Air Defense (MANPAD) Stinger missile platoons. The new Sentinel, a low-level air defense radar system, platoon will significantly add automated C2 to the integrated air defense system across the division area.

- Logistics. The division will be able to centralize logistics nodes at the Division Support Command. Completely transparent equipment status with digitized communications will enable logistic to be focused and efficiently distributed "just in time" rather than stockpiled for "just in case." Logistic elements can be in direct support to infantry, armor, and engineer commanders. Forward support battalions will field multifunctional forward

support companies that provide all types of organizational and direct support to maneuver battalions.

The final structure of the division is subject to change because of latest major technological breakthroughs in propulsion, lightweight armor, power supplies, information distribution, and other advanced hardware. The battlefield constantly changes based on location, terrain, and the uncertain threat. Army Division XXI is a learning and developmental process that will establish the foundation for the divisions in AAN.

b. Aviation in Force XXI

Aviation forces in support of Army XXI or Force XXI efforts will face the demanding challenge to be a highly mobile and responsive force, capable of leveraging information technologies for effective and synchronized operations. As a combat multiplier of Army XXI, Army Aviation possesses a variety of capabilities that fosters battlefield dynamics and full dimensional operations. Given Aviation's inherent mobility, lethality, and versatility coupled with technological advancements, Aviation's digitization efforts ensure continuity as the Army redesigns to meet the evolving threat and mission requirements of Army XXI and AAN.

Army Aviation advances into 21st Century meeting AV 2010's objectives:

- Project the Force. Aviation's nature to rapidly self-deploy and conduct aviation operations immediately will permit force projection. As Army XXI moves to a capabilities-based force, employing aviation early will meet the needs of any contingency. Having self-diagnostic capability during force projection will diminish the transportation requirements.

- Protect the Force. Armed Reconnaissance, security, air-to-air combat, suppression of enemy air defense (SEAD), attack and medical evacuation (MEDEVAC) provide active and passive protection. Speed and agility are key advantages that ensure survivability of the battleforce. Extending communication ranges and covering long distances in a short time establish a lethal presence detrimental to the opposition.

- Gain Information Dominance. The diversified missions of aviation enable the force to gain greater information, maneuver, firepower and protection for the force. The RAH-66 Comanche is the premier digitized platform in the 21st Century battlespace. With its latest information age technology, commanders at all echelons have the ability to integrate joint and national reconnaissance systems. It also gives commanders the winning edge and reserve capability.

- Shape the Battlespace. Aviation shapes the battle with simultaneous attacks throughout in order to set the conditions for a decisive victory. Aviation's combat missions also manipulate the battlespace for friendly commanders to control the events.

- Conduct Decisive Operations. Aviation's long-range platforms facilitate commanders to succeed in decisive operations. Its rapid response time assists commanders in risk management and decision-making.

- Sustain the Force. Aviation's rapid deployment, air movement of wartime supplies and equipment, and re-supply to forward deployed forces play a significant role in force sustainment. Additional missions like aerial recovery/evacuation ensure that critical supplies get to the right place and time avoiding system downtime. The Improved Cargo Helicopter (ICH) will play an important role in the deployment of future forces.

Aviation provides combat, combat support, combat service support, and special operations across the spectrum of full-dimensional operations. Figure 5 provides Aviation's ability to achieve full spectrum dominance.

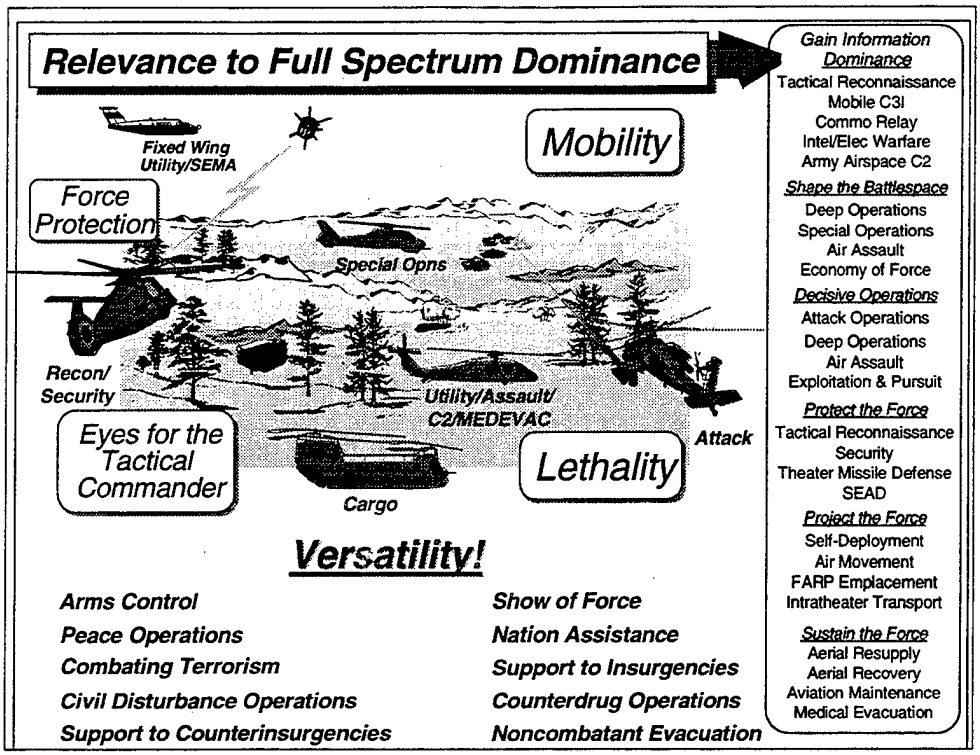

Figure 5. Aviation Full Spectrum Dominance
From Ref. (USAAVNC DCD, 1999)

The largest warfighting element of Army Aviation is a brigade or regiment. The C2 headquarters at brigade and battalion must have the capability to communicate via voice, data, and imagery with Air Defense, Air Traffic Services (ATS), Field Artillery, Air Force, Navy, and other friendly forces over all types of terrain. The Aviation Brigade for Division XXI is equipped to conduct these missions for future forces. By 2010, the division attack aviation and support aviation battalions are scheduled to receive 30 AH-64D Longbow Apache aircraft, 42 RAH-66 Comanche aircraft, 32 UH-60 Black Hawk aircraft, and four EH-60 aircraft. Brigade strength will consist of 118 officers, 138 warrant officers, and 1,232 enlisted soldiers totaling to 1,488 personnel. This quantity increased by 41 personnel from the Army of Excellence version. Figure 6 illustrates the Heavy Division Aviation Brigade.

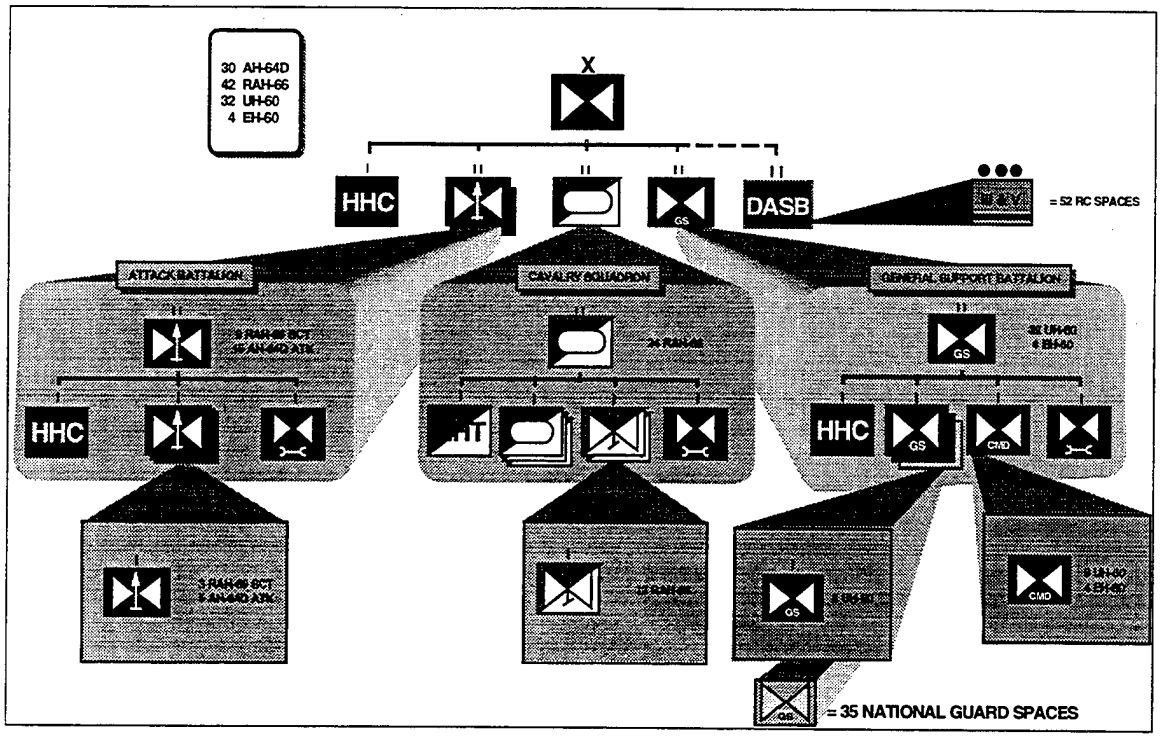

Figure 6. Division XXI (Heavy) Aviation Brigade
After Ref. (USAAVNC DCD Aviation Force Structure, 1997)

D. AVIATION DIGITIZATION ARCHITECTURE AND REQUIREMENTS

1. Digitization Architecture

The Army's C4I Architecture provides the network for the digitized force from the individual soldier to a joint environment. Figure 7 depicts a simplified layout of this complex architecture. The architecture reflects the various C2 systems within the COE for the Army. Remaining within the scope of this thesis, brigade and subordinate units will be discussed.

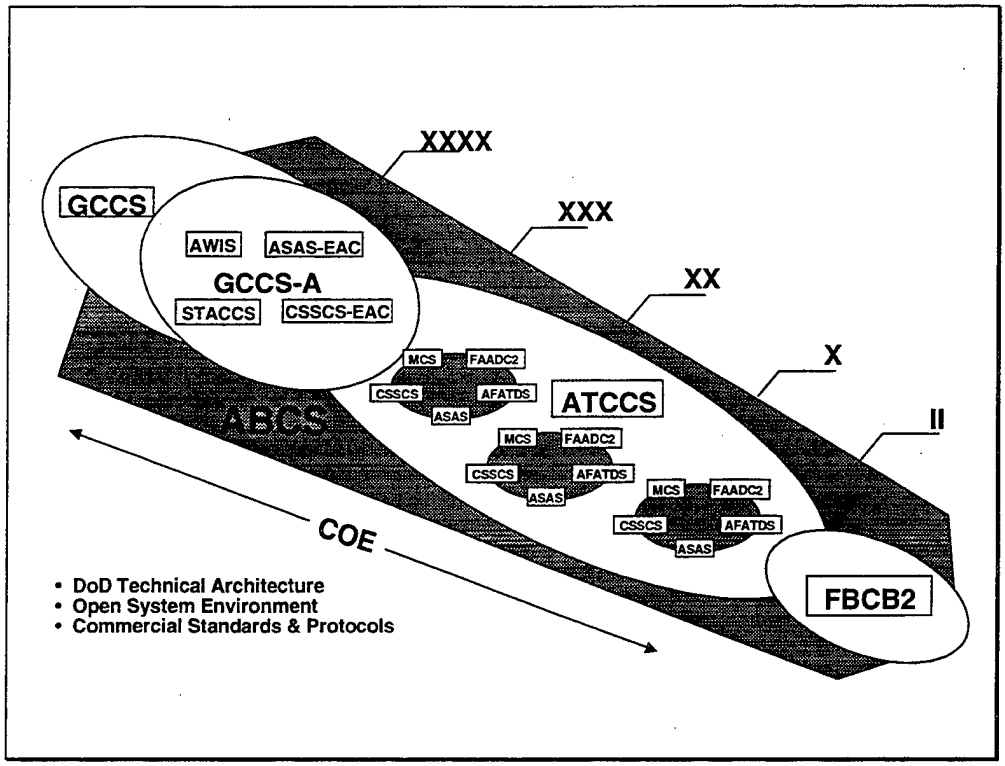

Figure 7. Army C4I Architecture
After Ref. (USAAVNC DCD, 1997)

a. Army Battle Command System (ABCS)

The ABCS is an integrated combination of automated C2 systems with horizontal and vertical digital interoperability/connectivity from echelons above corps to the individual platform/soldier level. Its three major components are the Global Command and Control System-Army (GCCS-A), Army Tactical Command and Control System (ATCCS), and Force XXI Battle Command Brigade and Below (FBCB2). The latter two will be further discussed.

(1) ATCCS.

An integral part of the ABCS network is the Army Tactical Command and Control Systems (ATCCS). This is a tactically deployable, computer-assisted processing, analysis reporting, and technical control system at corps, division, brigade, and

battalion operations centers and command posts. Its five component systems are the Maneuver Control System (MCS) for operations, All Source Analysis System (ASAS) for intelligence, Advanced Field Artillery Tactical Data System (AFATDS, Forward Area Air Defense Command and Control (FAADC2), and Combat Service Support Control System (CSSCS) for administrative and logistics. The Tactical Airspace Integration System (TAIS) is Army Aviation system and a part of ATCCS, but it is located at division and above units. ATCCS automates many of the tasks required to operate the modern Army. Friendly forces can develop and execute a highly integrated battle plan at a tempo that overwhelms opposing forces. It provides automatic data distribution for timely coordination, and both horizontal and vertical coordination through exchange of messages, maps, and graphics overlays. The ATCCS is the management information capability for the warfighting maneuver elements – division and subordinate units. This information age enabler allows warfighting units operate on the digitized battlefield.

- Maneuver Control System (MCS): This primary battle command (BC) source provides the common picture, decision aids, and overlay capabilities to support the tactical commander. The system is deployed at the Corps level to maneuver battalions.

- All Source Analysis System (ASAS): This intelligence and electronic warfare (IEW) component provides a mobile, tactically deployable, computer-assisted intelligence and electronic warfare processing, analysis, reporting and technical control system. The system is deployed at Echelon Above Corps (EAC) to battalions.

- Forward Area Air Defense Command and Control (FAADC2) System: This system integrates air defense fire units, sensors, and C2 centers into a coherent system capable of defeating/denying low altitude aerial threat. It provides rapid collection, storage, processing, display, and dissemination of critical, time-sensitive situational awareness (air and ground) and battle command information throughout the FAADC2 battalions and between other air defense units in joint or combined structure.

- Advanced Field Artillery Tactical Data System (AFTADS): This system automates decision support for the fire support (FS) functional subsystem, to include joint and combined fires (i.e. naval gunfire, close air support). AFATDS provides a fully integrated FS C2 system. This system is deployed at EAC to the firing batteries.

- Combat Service Support Control System (CSSCS): This logistics system provides information of all classes of supply, field services, maintenance, medical, personnel, and movements to CSS, maneuver and theater commanders and their logistic and special staffs. It is deployed at EAC to battalions.

Figure 8 diagrams the communications architecture for ATCCS and associated components.

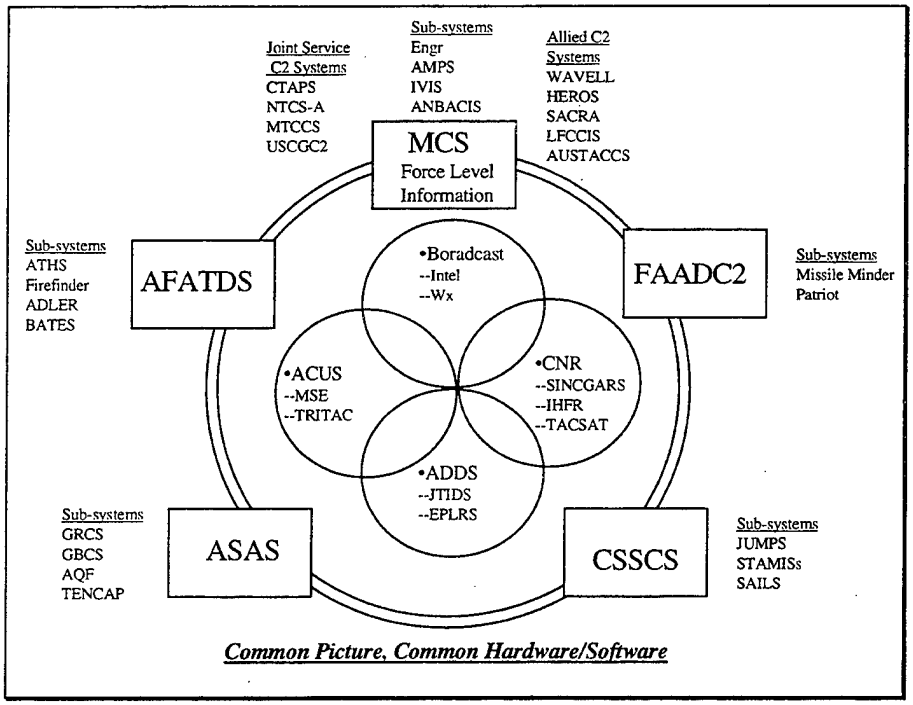

Figure 8. Army Tactical Command and Control System (ATCCS)
Communications Architecture
After Ref. (USAAVNC DCD, 1995)

(2) Force XXI Battle Command Brigade and Below (FBCB2).

The FBCB2 is a C2 system that provides real-time situational awareness over the Tactical Internet (TI) and assists with timely dissemination of orders,

overlays, and logistics messages. Figure 9 shows a prototype of the earlier version known as Applique. It provides a seamless battle command capability to leaders and soldiers at brigade and below. FBCB2 provides horizontal and vertical integration of the information generating and processing capabilities of individual weapons, sensors, and platforms. Embedded Battle Command (EBC) is the software program that allows exchange of Joint Variable Message Format (JVMF) messages between ATCCS and FBCB2. EBC also allows JVMF message exchange between the Improved Data Modem Plus [IDM (+)] equipped aircraft and FBCB2/ATCCS. The TI is the primary means of communication connectivity for FBCB2, which is dependent on SINCGARS-System Improvement Program (SIP) and EPLRS data transfer, with expansion planned for High Frequency (HF) radios and the Joint Tactical Radio System (JTRS). FBCB2 major capabilities include:

- Real-time situational awareness of friendly platform locations.
- Display of reported enemy and unidentified unit locations.
- Display of neutral/non-combatant locations.
- Display of geo-referenced spot reports, calls for fire, and Nuclear, Biological, and Chemical (NBC) 1 reports.
- Sends and receives over 100 JVMF messages to include spot reports, NBC reports, medical evacuation requests, and free text.
- Orders and overlays creation and dissemination.
- Development of logistics and personnel reports.
- Display of unit readiness status.

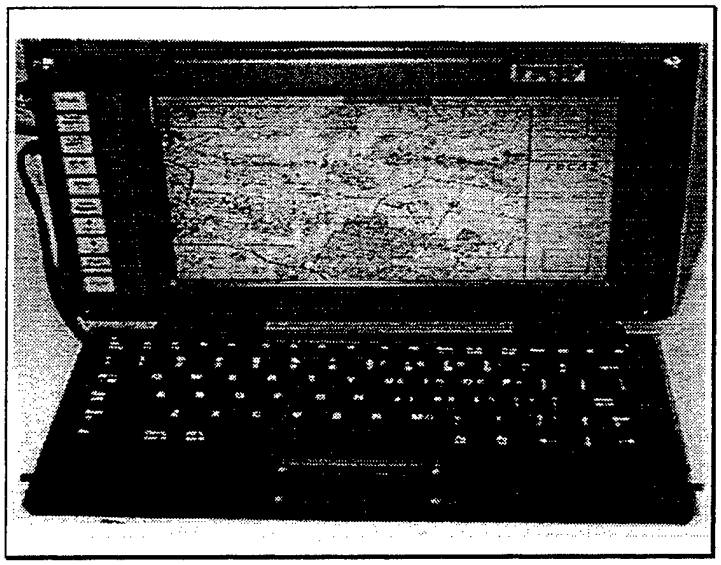

Figure 9. Force XXI Battle Command Brigade and Below (FBCB2) Prototype
From Ref. (DA DCSOPS, 1998)

(3) Tactical Internet (TI)

The information highway on the digitized battlefield is the TI that provides the communications backbone for the digital effort. The TI is a network of communications systems employing interoperable hardware and software for the exchange of digital communications. It is networked with radios, routers, and gateways that provide a communications infrastructure for messages to pass seamlessly from a sender to a designated addressee or group of addressees. The TI is integrated with the ABCS but focused at providing the necessary information exchange for battle command at brigade and below. FBCB2 devices of the TI are integrated into Tactical Operations Center (TOC) Local Area Networks (LANs) at battalion and brigade, thus enabling information flow from the soldier/platform level to the division and throughout ABCS. The EPLRS also links the TI to the ABCS at the brigade and battalion TOCs. The EPLRS network provides the primary data and imagery communications transmission at these echelons. Figure 10 elaborates on the TI features.

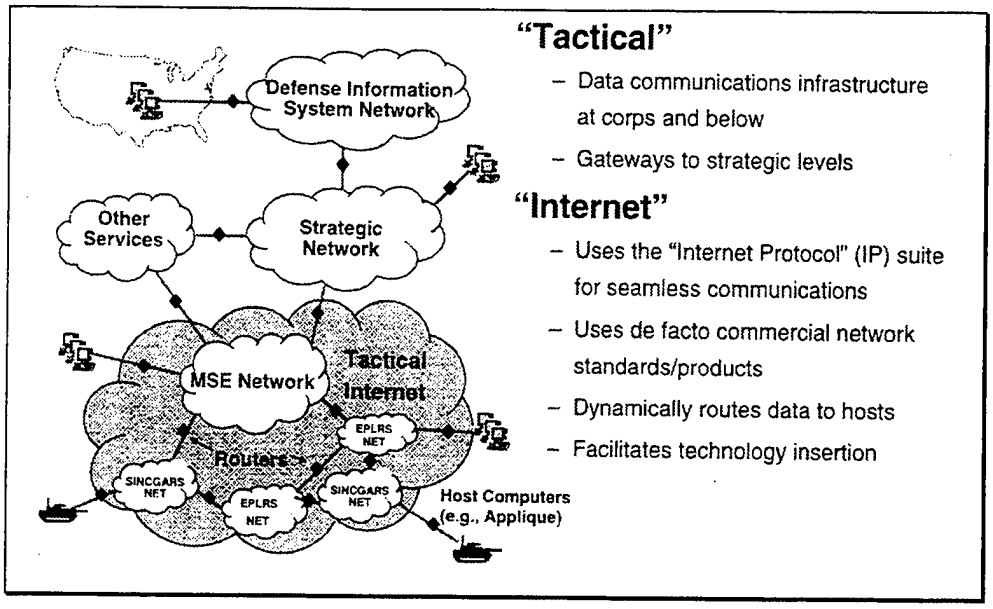

Figure 10. Tactical Internet
After Ref. (DA DCSOPS, 1998)

b. Architecture Concept

The digitized architecture integrates the Aviation brigade into the Tactical Internet, situational awareness picture, and information warfare scheme. As part of the digitized division, Army Aviation conducts missions in areas of operations (AOs) of considerable breadth and depth (as much as 120 km x 200 km). Operations are characterized by precision made possible by three emerging capabilities. The first is digitization, which provides soldiers and leaders at each echelon with the highly accurate information required for making the best decision in each situation. The second is a full suite of strategic, operational, and tactical sensors, linked to analytical systems that can provide situational awareness across the battlespace with greater clarity and precision than previously possible. Finally, simulation provides tools that enable tailoring of Army elements for an emerging situation/crisis, planning operations based on METT-T, wargaming, and rehearsing operations to yield execution precision.

The timeliness and accuracy of information provided by digitized systems and sensors enable the greater lethality, survivability, and operational tempo (OPTEMPO) that differentiate digitized from contemporary operations. Aviation's operational information architecture is composed of four critical battle nodes: the Aviation TOC (AVTOC), Digital Tactical Center (TAC), Army Airborne Command and Control System (A2C2S), and the collective fleet of modernized aircraft. The AVTOC serves as the planning and primary synchronization point for the entire aviation operation. The Digital TAC is a mobile ground-based digital command post (CP) that focuses on execution of current operations. The A2C2S is the airborne TAC. It also focuses on the execution of current operations. It permits Command and Control On-The-Move (C2OTM) allowing the commander to influence operations throughout the battlespace. Modernized reconnaissance and attack aircraft use data and imagery to conduct target acquisition and direct precision fires. Their sensors also collect battlefield information that is shared with commanders, intelligence analysts, and other weapons systems. The digitized aviation force provides the commander:

- Increased situational awareness.
- Enhancements to the mission planning process, orders preparation and distribution, intelligence flow, and battle tracking.
- Digital aids that enhance the timeliness of the Military Decision-Making Process (MDMP).
- Synchronized fire support.
- Real-time threat targeting and target cueing information to ground maneuver weapons platforms.

Figure 11 portrays a top-level architecture view for Army Aviation indicating the network links in the battlespace.

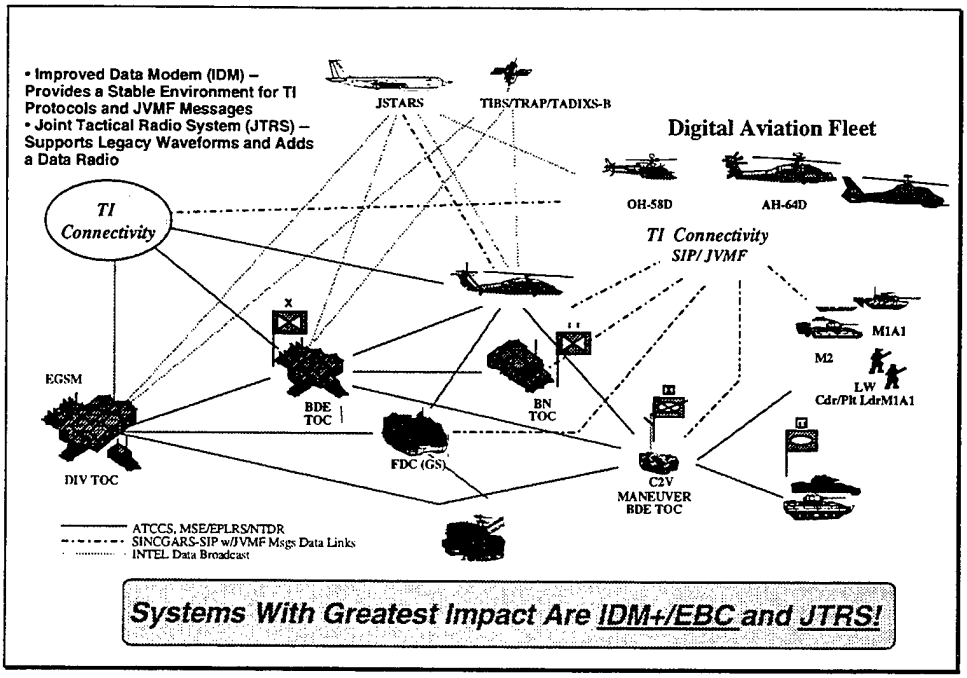

Figure 11. Army Aviation Architecture Concept
After Ref. (USAAVNC DCD, 1990)

2. Digitization Requirements

a. Requirements Determination

The Army Chief of Staff charged the TRADOC Commander the responsibility to pave the road to Force XXI or to be the Army's requirements "gatekeeper." He approves all Army warfighting requirements prior to submission to Department of the Army (DA). DA will review and evaluate the requirements based on issues raised by other services, the Joint Staff, and the Office of the Secretary of Defense (OSD). DA will then recommend changes to the TRADOC Commander. The TRADOC Commander is responsible to (1) produce future warfighting vision, (2) approve warfighting concepts, and (3) approve requirements. The warfighting vision is a holistic description of desired Army capabilities as seen during a commander's recon from a "mountaintop" in the distant future.

The 21st Century Army and beyond require certain warfighting capabilities, user needs, which are expressed in a Mission Needs Statement (MNS) and Operational Requirements Document (ORD). Additionally, modifications to the domain of DTLOMS signify a required need. In the past and even today, the Army constantly upgrades and changes the way it fights in order to maintain battlefield superiority over all potential adversaries and to achieve complementary capabilities with other services and nations. The new process, implemented in 1996, identifies requirements more holistically based on desired Joint and Army capabilities versus known deficiencies. Figure 12 emphasizes this process.

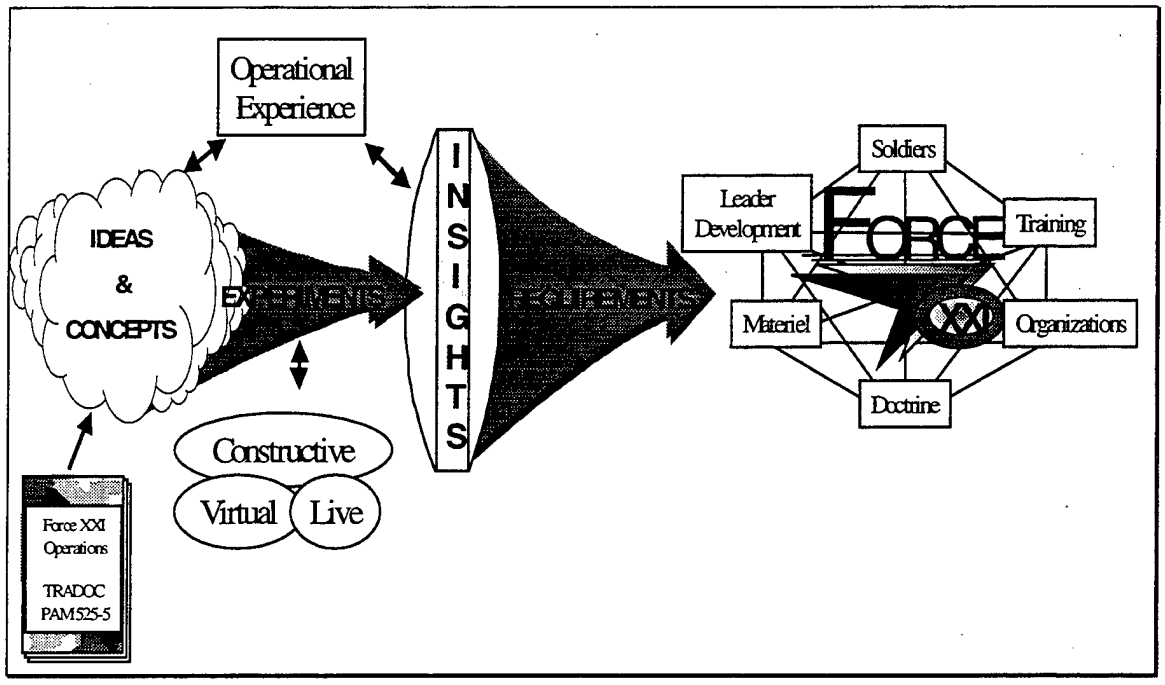

Figure 12. Training and Doctrine Command (TRADOC) Requirements Determination Process
After Ref. (USAAVNC DCD, 1998)

The process begins with TRADOC's vision written into its Pamphlet 525-5, Force XXI Operations, and disseminated throughout the Army. Major commands (MACOMs), combat developers, and warfighters develop hypotheses and test these

concepts. Experiments are conducted through either live, simulated, or through both events (constructive) on the concept. Based on the outcome of the experiment, the valuable insights drive the need as a Force XXI requirement in any of the domains. On the other hand, if the idea was demonstrated as a mission need in any exercise or contingency conflict, the lessons learned provide insights to developing the requirements for the Force XXI domains. Other influences throughout the process include science and technology (S&T) applications, national military strategy, and future warfighting scenarios. The end result is defining the full spectrum of Army operations and functions by combining the warfighting DTLOMS requirements for the total force.

The new requirements determination process was designed to (1) discipline the system, (2) identify requirements faster, (3) improve products, and (4) shorten acquisition time. The process has multiple entry and exit opportunities that are easily tailored to support different types and levels of requirement determination such as tactics, techniques, and procedures (TTPs), software, and architecture. Integrated concept teams (ICTs) representing their organization facilitate the process to define the DTLOMS requirements quickly. The ICT approach, through the dynamics of the members, enables the Army leadership to make sound and timely decisions.

Receiving warfighting needs or shortcomings from the Army community, TRADOC schools process and translate the needs into the DTLOMS requirements. Determining requirements is just the first of many steps or activities leading to the desired future warfighting capabilities. Of the DTLOMS domains, TRADOC submits the organization, materiel, and soldier requirements to DA for final action. If the materiel requirement needs further action, the acquisition process is implemented. Figure 13 depicts

the current acquisition cycle for material requirements. TRADOC resources and develops solutions for the doctrine, training, and leader development requirements.

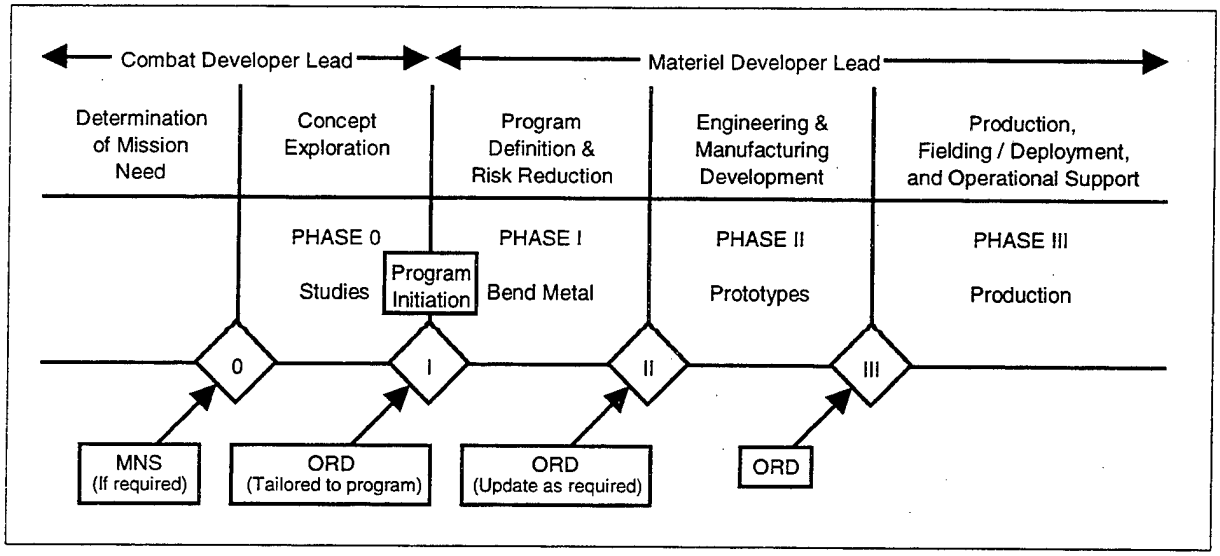

Figure 13. Acquisition Process
From Ref. (TRADOC Pamphlet 71-9, 1998)

b. DTLOMS Domains

Since this research centers on the impacts on the warfighting requirements, DTLOMS, the following generally describes the domain's affects. (TRADOC Pamphlet 71-9, 1998) All these requirements are interdependent and not determined separately.

- **Doctrine:** The requirements are changes or additions to any of the Army's fundamental principles that guide operational forces. These principles range from TTP to Field Manual 100-5, Operations. School training and doctrine directorates are responsible for preparing training requirements and forwarding them to Headquarters (HQS), TRADOC for approval.

- **Training and Leader Development:** The requirements are changes or additions to any of the Army's training or professional development programs. These range form institutional training conducted at TRADOC schools to individual self-development and unit training programs conducted in the field. School training and doctrine directorates are also responsible for preparing training requirements and forwarding them to HQS, TRADOC for approval.

- **Organization:** The requirements are changes or additions to any of the Army's tables of organization and equipment (TOE). These range from modifying the numbers or types of equipment in a current organization to documenting entirely new organizations. School combat development directorates and other similar development organizations are responsible for preparing organization requirements and then forwarding them to HQS, TRADOC for approval.

- **Materiel:** The requirements are changes or additions to any of the Army's families of weapons, support systems or training aids, devices, simulators, and simulations (TADSS). They range from: modernizing exiting materiel through parts replacement; major product improvements of existing materiel; one for one replacement of old materiel with new materiel designed to do the same job; to completely new families of materiel designed to do something that has not been done before. School combat development directorates, training and doctrine directorates or development organizations are responsible for preparing the materiel requirements, ORDs, and then forwarding them to HQS TRADOC for approval.

- **Soldier:** The requirements are changes or additions to the Army's military occupational specialty (MOS) structure. These changes range from changes in the numbers of soldiers needed in a MOS to creation of an entirely new MOS and identifying the skills desired of these soldiers. Branch proponent offices are responsible for preparing soldiers requirements and forwarding them to the Deputy Chief of Staff for Training (DCST), TRADOC. The DCST then forwards the requirements to the Army Deputy Chief of Staff for Personnel (DCSPERS), who adds them to the Military Occupation Classification and Structure Plan and resources the requirement based on overall Army Force Package needs.

c. Aviation Digitization Campaign Plan

The Army Chief of Staff's vision for Force XXI is more than a redesign of TOE forces. It is creating the right force for the future, getting it into the fight and sustaining it across a wide range of missions. It is developing versatile doctrine, tactics, techniques, and procedures to exploit the integration of information technology. The center path of Force XXI, Joint Venture, is the redesign of the warfighting force for the information age. The TRADOC Commander has the lead in partnership with the Major

Command (MACOM) commanders. This effort is focused along the DTLOMS dimensions and will be defined through the experiment process.

The Aviation Digitization Campaign Plan (ADCP) is the initiative to define what aviation capabilities are required to achieve Force XXI goals. It is an extension of the current aviation modernization plan that incorporates an organizational re-design and integrates information age technology to create a more agile, versatile, and deadly force. The plan focuses on information-age technology in order to achieve electronic linking of air and ground forces allowing the commander to synchronize combat power with devastating effects. This technology integration is formalized in the seven major aviation programs: Global Positioning System (GPS), HAVEQUICK II (HQ II), High Frequency Nap-of-the-Earth Communications (HF NOE COMM) Radio, Improved Data Modem (IDM), Aviation Mission Planning System (AMPS), Army Airborne Command and Control System (A2C2S), and Aviation Tactical Operations Center (AVTOC). The latter four initiatives will be further discussed in the next chapter.

The goal of the plan is to determine the increased warfighting capability of a digital aviation force and the impact on DTLOMS. The following are objectives in pursuit of this goal:

- Facilitate battle command.
- Seamless aviation connectivity [scout, attack, and Battle Command Vehicle (BCV)].
    - o Digital communications.
    - o Common graphics.
- Increase situational awareness.

- Intelligence connectivity and synchronization [Joint Surveillance and Target Attack Radar System (JSTARS), ASAS, Ground Station Module (GSM), AH-64D Longbow Apache, National Assets].
- Precision targeting/increased lethality.
- Force protection.

- Enhance battlefield synchronization.
  - Fast, precision aviation mission planning (AMPS)
  - Increase tempo
  - Optimize CS and CSS functions
- Demonstrate how Aviation enhances warfighting capabilities.
- Evaluate prototypes.
  - AVTOC
  - A2C2S
  - AMPS
  - HF NOE COMM
  - HQ II
  - GPS

Aviation learned valuable lessons from Advanced Technology Demonstrations (ATDs) and Advanced Warfighting Experiments (AWEs). While field experience proved insightful, the continued reduction in resources dictates an increased emphasis on simulation. To that end, aviation recognizes the need to expand its current simulation capability to more accurately portray the field environment. Therefore, aviation simulation may begin to enhance field exercises for training, testing, and experimentation.

Army Aviation is moving down the pathway to Force XXI with its modernization plan. The Aviation Restructure Initiative (ARI) continues to serve as the baseline force design in all warfighting experiments. In conjunction with experiments and demonstrations, this campaign plan orients technology to meet Force XXI goals.

d. Aviation Modernization Requirements

According to the Army Modernization Plan, ongoing aviation efforts have five primary objectives: solving Army aviation's most critical battlefield deficiency of tactical reconnaissance and security; maintaining attack helicopter overmatch; enhancing command, control, communications and intelligence (C3I) and joint and combined interoperability through battlefield digitization; recapitalizing aging utility, cargo and fixed-wing fleet assets until replacement is possible; and developing the technological underpinnings for JV 2010 and AAN requirements.

As examples of the initial two objectives, the RAH-66 Comanche program is addressing reconnaissance and security shortfalls while the AH-64D Longbow Apache and Hellfire missile activities are helping to ensure attack overmatch. In addition to upgrading remaining fleet assets, aviation planners are devoting significant attention to developing the technology necessary to guarantee the continued relevance of Army aviation as the Service reshapes itself to meet evolving threats and mission requirements of the Force XXI and AAN time frame.

In meeting Force XXI and ADMP objectives, Army Aviation has established modernization and digitization of it aerial platform and C4I infrastructure. Required capabilities and milestones have been identified to reach into the 21st Century and beyond. Figure 14 outlines the projected rotary wing fleet into AAN.

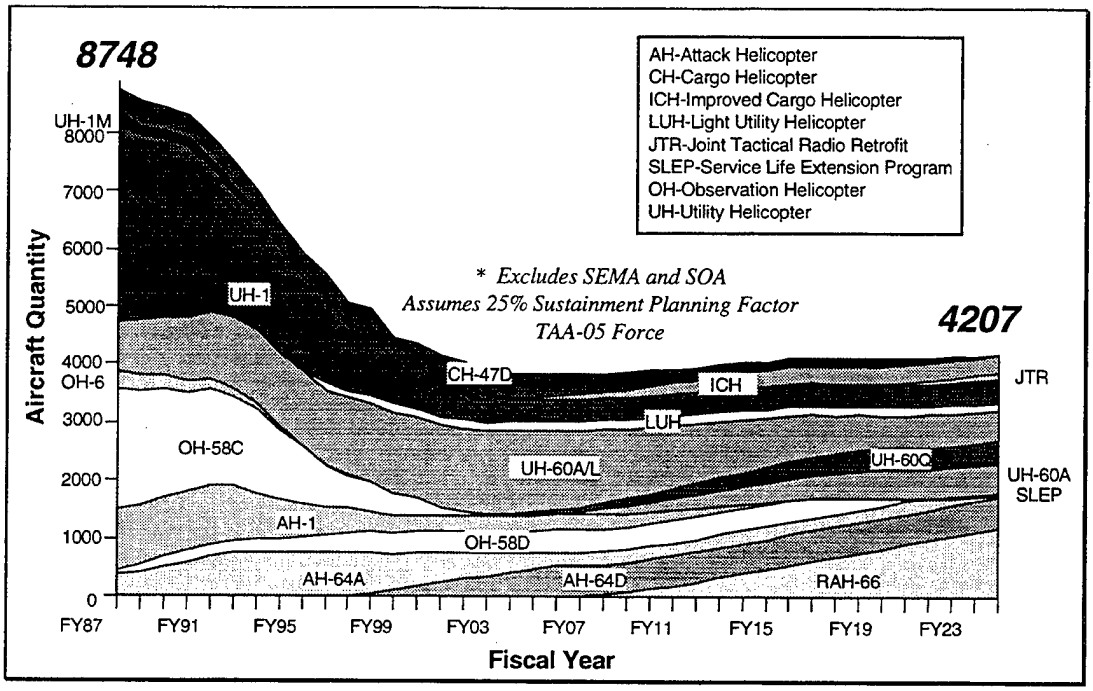

Figure 14. Aviation Modernization Strategy
From Ref. (USAAVNC DCD, 1999)

Aviation platforms have the following requirements:

- Joint/Army digital interoperability.
- Improved OPTEMPO/lethality/survivability.
- Secure information dominance.
  - o Fix recon/security.
  - o Insert digital technology.
- Maintain attack overmatch.
- Recapitalize on aging systems.

C4I requirements identified the following shortcomings:

- C2 OTM for Maneuver Commander/Division Commander.
- Aviation platforms must have same digital capabilities as ground platforms.

- Aviation is outflying current communications/ needs NLOS gateway to Tactical Internet.
- Aviation requires long legs to meet the Commander's battlespace.
- Increasing requirement for Aviation self-deployment.
- Aviation is filling the Commander's information void (reconnaissance).
- Battlefield Situational Awareness (SA).

The above objectives or requirements forced modifications to Army Aviation's DTLOMS domains.

E. ADVANCED WARFIGHTING EXPERIMENTS (AWES)

AWEs are the heart of the Army's warfighting requirements determination process. Army Battle Labs under directions of TRADOC plan and execute the experiments. Throughout the process, progressive and iterative mixes of high fidelity constructive, virtual and live simulations using real soldiers and units in relevant, tactically competitive scenarios provide Army leaders with future operational capability insights. This aspect of the new requirements process is often overlooked or misrepresented. The experiments are not another test and evaluation approach. Although testing may occur during the experiment, the main intent is to better understand future capabilities and the potential requirements that satisfy them. At the end, the experiment proponent decides if the idea or concept tested in the AWE is discarded, allowed to continue with further experiment, or documented as a warfighting requirement. The decision is based on the analyses of the collected experimental data.

The Air Maneuver Battle Lab (AMBL) located at the Aviation Warfighting Center is Army Aviation's facilitator to demonstrate and experiment with new conceptual systems for

Force XXI. AMBL is responsible to integrate air operations into the AWEs. The organization's mission is:

> To fully integrate air maneuver into Force XXI combined arms operations through the planning, execution and analysis of warfighting experiments and technology demonstrations in order to examine advanced concepts and technology which enhance the commander's capability to project the force, protect the force, gain information dominance, shape the battlespace, conduct decisive operations, and sustain the force.

Another facility that contributes to the Force XXI effort is the Central Technical Support Facility (CTSF). The CTSF is an enabler for rapid integration of dissimilar software and hardware systems through real time interaction with soldiers, contractors, testers, program managers, and the requirements community. Located in Fort Hood, Texas, the CTSF's primary functions are to evaluate software releases for interoperability and perform software problem replication and resolution; to maintain configuration management for the exercise; provide on-site training, and perform digital TTPs and battle drills deployment with soldiers. This facility brings industry and the Army's program offices to the warfighters.

There is a variety of warfighting experiments. All begin with formal hypotheses derived from contemporary operational issues, warfighting concepts or S&T research. The hypotheses may relate to any of the DTLOMS domains. New or changed doctrine, organizations, and materiel generate the majority of experiment hypotheses. However, training, leader development and soldier issues may also drive independent experiments. Regardless of what initiates an experiment, it becomes a training and leader development experience for the entire Army as it experiences some aspect of future warfighting.

1. Task Force XXI Advanced Warfighting Experiment (TF XXI AWE)

The purpose of the TF AWE at the National Training Center (NTC), Fort Irwin, California in March 1997 was to experiment with concepts, ideas, and materiel in order to test hypotheses regarding the capabilities of a specific echelon of command under evaluation. The experiment was accomplished in eleven months what might have taken years. Key factors contributing to the TF AWE's success were the cooperation and participation of materiel developers, combat developers, soldiers (users), data collectors, and independent assessment teams. The experiment facilitated the identification of the potential of digitization. Improvements were required for a complex and still continuously evolving digital capability. The TF AWE significantly refined the definition of requirements as well as providing an opportunity for early identification of other potential high payoff capabilities.

The hypothesis for TF AWE was, "If information age battle command capabilities and connectivity exists across all battlefield operating system functions, then increases in lethality, survivability, and tempo will be achieved." The Army investigated this hypothesis using primarily live experimentation with prototype digital technologies, all of which varied in technical maturity.

The objectives were:

- Provide information to support investment decisions on the most promising of the 72 initiatives considered in the experiment.
- Refine digitized tactics, techniques, and procedures (TTPs) for brigade operations.
- Experiment with advanced technologies and concepts that leverage capabilities of information technologies.
- Assess digital brigade combat service support concept.

- Assess Force XXI Battle Command Brigade and Below (FBCB2) Applique and Tactical Internet capabilities all with our Experimental Force (EXFOR) – the 4th Infantry Division's 1st Brigade.

The TF AWE was a highly successful experiment that exceeded the expectations of planners and participants alike. Not only did it reveal a clear vision of the dynamic potential in the digital land force, but also validated the Army's whole approach to experimentation. In accordance with the Joint Venture strategy for building the future Army, the exercise incorporated large scale, multi-echelon, field experimentation as a vital component to the overall testing and experimentation process. The results have vindicated the expense.

AWEs serve not only to put concepts to the most rigorous test possible, short of actual combat, but they also serve as "forcing functions," to synchronize and bring to fruition of all the complex pieces of the digital force in one place at one time. The NTC is a tactically competitive environment where the Army could demonstrate, stress soldiers and systems, and assess digitization and situational awareness. The facility is able to synchronize non-linear and distributed operations in an expanded battlespace that cannot be replicated in testing.

Consequently, the Army saw remarkable progress. Technical obstacles that were initially declared to be insurmountable "can't get there from here" problems were solved in a matter of weeks and sometimes days. These accomplishments would have taken years in the old requirements determination model. Throughout our experimentation process, the Army has taken steps to keep the imperatives of DTLOMS in balance as the Army prepares to field Army XXI organizations.

2. Division XXI Advanced Warfighting Experiment (DAWE)

The DAWE culminated in November 1997 at Fort Hood, Texas in a Battle Command Training Program (BCTP) approach in a constructive exercise with digitized a Division and Brigade TOCs in the field. It was the vehicle to validate Force XXI. The exercise is designed to enable commanders and staffs to experiment with information from a digitized battlefield and tactically employ the division under the interim Force XXI division design (IDD), to include the new centralized combat, combat support (CS), and combat service support (CSS) concept. The experiment was intended to validate the Force XXI Division Design, the Force XXI CSS concept, information age TTPs, and enhanced Battle Command capabilities. Additionally, it will provide insights on echelon above division (EAD)/Joint digitized operations.

Prairie Warrior (PW), a ramp-up exercise to DAWE, took place in May 97 at Fort Leavenworth, Kansas with students from the Army Command and General Staff College (CGSC). This was a capstone exercise for the course. PW focused on Battle Command issues and initiatives for the proposed heavy division redesign organizations. It started the data collection build for the DAWE and afforded the evaluation team the opportunity to train, refine, and utilize the Center for Army Lessons Learned Collection Plan and Observation Management System (CALLCOMS).

The DAWE hypothesis was "If information age battle command capabilities/connectivity exist across all BOS/functions within a division then enhancements in lethality, survivability, and TEMPO will be achieved." The experiment's additional objectives include the validation of the following:

- Force XXI Division Operational Concept.

- Force XXI Battle Command and Information.
- ATCCS Integration Plan.
- Seamless integration between Tactical Internet and ATCCS.
- Revised Force XXI Information Age Doctrine/TTP/Training.
- EAD/Joint requirement across DTLOMS.
- Training program framework transitioning Army from AOE to Force XXI.

3. Division Capstone Exercise (DCX)

The DCX is tentatively scheduled for 4th Infantry Division, Experimental Force (EXFOR) in the year 2001 at Fort Hood, Texas and NTC, California. The exercise will involve two phases: Phase 1in April 2001 and Phase 2 in October 2001. The purpose of the DCX is listed:

- Assess the division's warfighting capability using current Operations and Organizations (O&O) in a realistic Force Projection scenario.
- Assess current levels of development for Doctrine, Soldiers, and Leader Development.
- Train the division in live, constructive, and virtual environments.
- C4I integration at all levels over doctrinal distances.
- Evaluate the Logistics C2 concept in the domains that can be evaluated.
- Provide extensive evaluation and feedback on the New Division Design with available enablers.

The DCX has the following conditions to successfully meet its purpose.

- Strategic Situation.
    - o On-going Joint Contingency Force committed September 2001.
    - o Deteriorating situation, insurgency and threat to friendly nation.

- Friendly nation requests U.S. assistance.
- National Command Authority (NCA) directs deployment of ground forces. Constrained to a Division plus.

- Operational/Tactical Situation.
  - Force Projection.
  - Rapid deployment into immature theater.
  - Must fight on arrival.

Table 1 lists the timeline to DCX.

EVENT	DATE
Task Force XXI AWE	March 1997
Division AWE	November 1997
2d Brigade National Training Center (NTC) Exercise	February 1998
MCS Initial Operational Test and Evaluation (IOTE)	June 1998
FBCB2 Limited User Test (LUT)	August 1998
4th Brigade Tactical Center Exercise	August 1998
3rd Brigade NTC Exercise	September 1998
Division Warfighting Exercise (WFX)	December 1998
1st Brigade Combat Team (BCT) Exercise	February 1999
FBCB2 IOTE	October 1999
4th Brigade NTC Exercise	August 2000
First Digitized Division (FDD)	September 2000
Division Capstone Exercise (DCX) Phase 1	April 2001
Division Capstone Exercise (DCX) Phase 2	October 2001

Table 1. Timeline to First Digitized Division (FDD) and Division Capstone Exercise (DCX) After Ref. (TRADOC DCSOPS, 1998)

F. SUMMARY

Force XXI digitization is a complex process. The Army's implementation directed and established objectives and milestones for its organization. The Force XXI Campaign Plan and the C4I architecture outlined a structured approach to digitizing the force. These requirements cascaded throughout the Army that initiated the implications to come. Based on these digitized requirements or vision, Aviation devised the Aviation Digitization Campaign Plan to compliment the Army's plan. Chapter III will address the results of Aviation's effort by describing its critical components to digitization.

III. DIGITIZING ARMY AVIATION BRIGADE AND BELOW

So it is said that if you know others and know yourself, you will not be imperiled in a hundred battles; if you do not know others, but do know yourself, you win one and lose one; if you do not know others and do not know yourself, you will be imperiled in every single battle.

Sun Tzu, The Art of War

A. INTRODUCTION

From the Civil War to the latest Kosovo crisis, Army Aviation has evolved in terms of its information architecture, specifically at the warfighter's level. From a tethered balloon, Professor Thaddeus Lowe observed the Battle of Bull Run and passed time-consuming accounts of the events to commanders who needed the battlefield information. He would yell the information to a relay person on the ground who would then pass this information to the user. This was the first aerial scout employed in battle. (Jones, 1999) Unfortunately, the information distributed was not timely and useless in making sound decisions by field commanders. The information was old and did not portray a real-time account at the time of delivery. Now, with the fielding of the AH-64D Longbow Apache and the developmental, prototype RAH-66 Comanche, disseminating timely and critical real-time or near real-time intelligence and information is imminent. These weapon platforms and other digital systems will change and thrust Army Aviation warfighting into the 21st century.

Digitizing the battlefield is the application of information technologies to acquire, exchange and employ timely digital information throughout the battlespace. The information must be tailored to meet the needs of each decision-maker (commander),

shooter, and supporter. The information must also foster a clear and accurate vision of our forces' battlespace necessary to support planning and execution.

Digitization of the battlefield involves the integration into the force of information technologies that are widely used today in the commercial world, and future technology coming from industry and government research. These information technologies will permit horizontal and vertical information sharing though the battlespace and will provide total situation awareness, allowing the commander to know the enemy, friendly, and environmental situations, in other words, a common picture of the battlespace. Figure 15 reflects the process of getting the picture to battlefield echelons. The digitized battlefield extends from the highest echelon command post forward to the attack helicopter at trigger pull, to launch an anti-tank missile on a confirmed enemy target. It affects how forward command posts function internally and how they work in concert with other command posts. Similarly, it affects the way weapons systems function and the way they interoperate with other weapons systems.

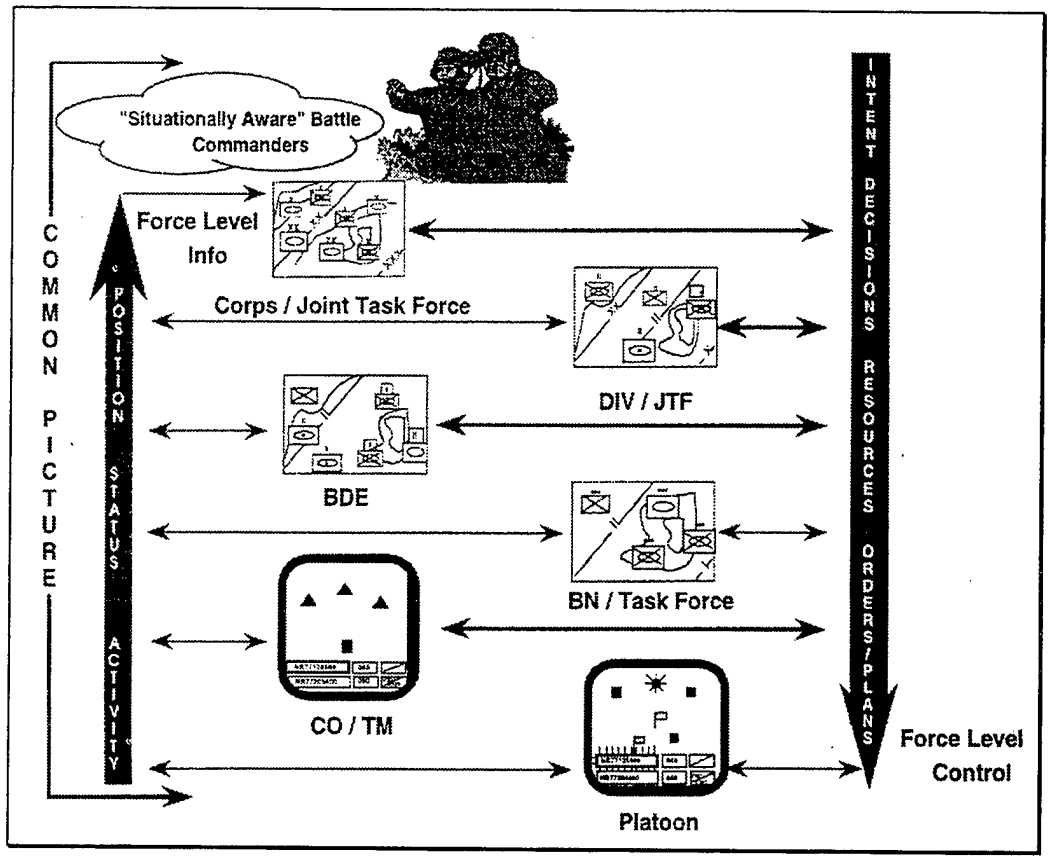

Figure 15. Common Picture Process
After Ref. (DA DCSOPS, 1998)

Digitization is a complicated process because of the many intricate parts or systems involved. It requires disciplined and rigorous standards for data, communication suites, and a comprehensive, seamless architecture. For example, Figure 16 outlines the connectivity between ground systems and airborne systems using the "gateway" applications. These applications include the Embedded Battle Command, Force XXI Battle Command Brigade and Below, Joint Variable Message Format, and the Tactical Internet.

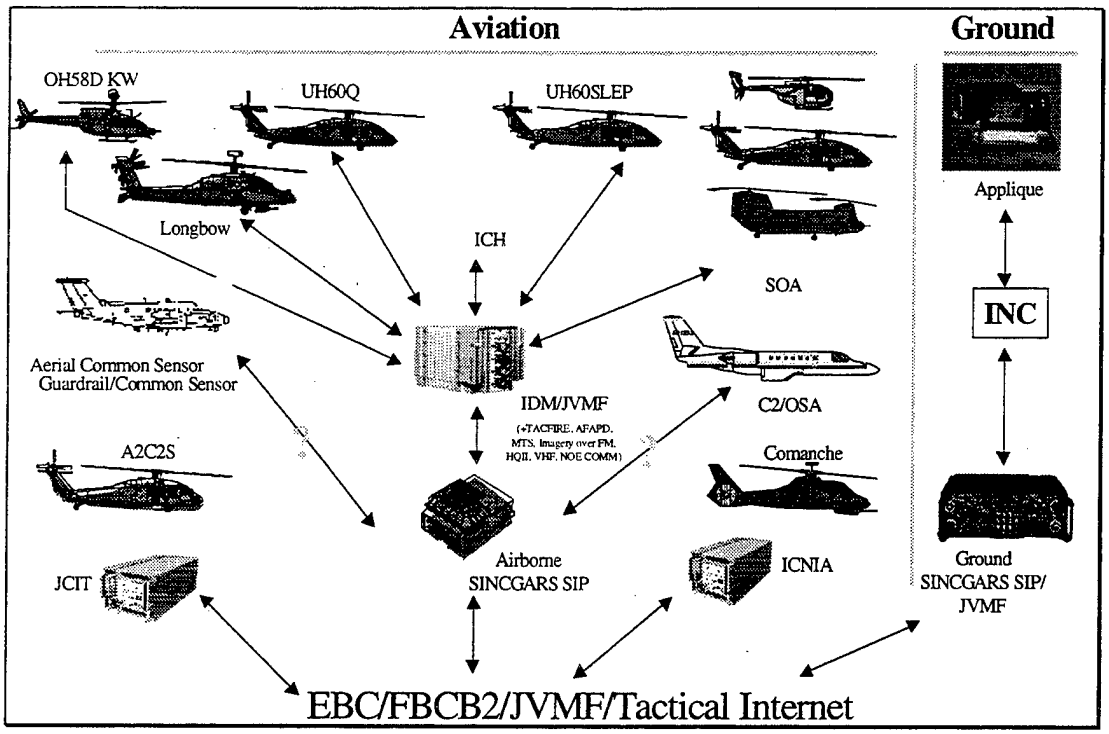

Figure 16. Aviation-Ground Connectivity
After Ref. (USAAVNC DCD/PEO AVN, 1997)

If the process is successful, the Army and other warfighters will benefit from these advantages:

- Joint interoperability.
- A common picture of the battlespace.
- Situational awareness.
- Improved compatibility across the BOS.
- The opportunity for sharing system components.

The Force XXI concept identified nine critical linkages for Aviation to establish as part of the digitization process. The following critical linkages set the basis for Aviation's digitization strategy:

- Critical Linkage #1: ASAS/Ground Station Module (GSM)/Common Ground Station (CGS) to Army Airborne Command and Control System (A2C2S) and Aviation Tactical Operations Center (AVTOC).
- Critical Linkage #2: Aviation Sensors to GSM/CGS.
- Critical Linkage #3: Broadcast Intelligence to A2C2S and AVTOC.
- Critical Linkage #4: Joint Surveillance Target Attack Radar System (JSTARS) to A2C2S and Inflight Aircraft.
- Critical Linkage #5: Coordinated Unmanned Aerial Vehicle (UAV)/ Aviation/Air Defense Artillery (ADA) Operations.
- Critical Linkage #6: ADA Sensors to AVTOC and A2C2S.
- Critical Linkage #7: AVTOC/A2C2S to FAADC2.
- Critical Linkage #8: A2C2S to Ground Maneuver TOC.
- Critical Linkage #9: Aviation to Aegis Platform.

B. AVIATION DIGITIZATION STRATEGY

Aviation is a major player in the Army's digitization effort for Force XXI. Communications is the transport mechanism in the digitization process. Aviation communications require the following: (USAAVNC DCD, 1998)

- Tactical Internet Operations for voice, data, and imagery.
- Interface with Joint assets, internal Aviation, and Air Traffic Services (ATS) through voice and data.
- Beyond Line of Sight (BLOS) using voice, data, and imagery.
- Mission planning system to interface with MCS.

As mentioned in the previous chapter, the Tactical Internet is the backbone of the digitized battlefield. Aviation enhancement requirements for the TI will permit integration

of its digitized platforms. These enhancements consist of the following features: (USAAVNC DCD/PEO AVN, 1997)

- Net Join: A mobile Internet addressing techniques to allow systems to join other network groups with the same situational awareness and C2 message services.

- Internet Relay: SINCGARS-SIP feature in selected radios that will store and forward C2 messages from the sender to the intended receiver who may be BLOS of the sender.

- Team Icon: Situational awareness icon, different in color or configuration, which represents aircraft/vehicles operating in close proximity. One system transmits situational awareness for the group.

- Longbow Fire Control Radar (FCR): Broadcast distribution of the FCR message to a defined set of recipients in the same manner as the situational awareness broadcast.

Several Aviation developmental and fielded systems and aircraft platforms have met the challenge of the paradigm shift to digitization. However, Aviation struggles with the concept of technology insertion. Technology insertion imposes on a system to adjust to the inserted design, whereas technology migration fosters an efficient integrated effort. Aviation digitization strategy exhibits more of a technology migration approach in its digitized systems. The challenge is to tailor the inserted technology to the migration process for the digitized systems. Although the Combat and Training Developers, from the Aviation Warfighting Center, in coordination with the Materiel Developers, from Program Executive Office for Aviation, have several program initiatives on-going, this section will address those critical components of the Aviation's digitization strategy categorized as aircraft platforms, C2 systems, and Avionics. (USAAVNC DCD, 1990) These components with their characteristics and progress will be discussed in their respective appendices.

1. Aircraft Platforms

a. RAH-66 Comanche

The Comanche is the U.S. Army's new reconnaissance-attack helicopter under development to replace the aging fleet of OH-58A/C/D aircraft and AH-1 attack helicopters. (USAAVNC DCD Program Summary, 1999) Appendix A provides a description of the characteristics of the RAH-66 Comanche.

b. AH-64D Longbow Apache

The Longbow Apache has evolved from the U.S. Army's planned Multi-Stage Improvement Program (MSIP) for the AH-64A Apache. (USAAVNC DCD Program Summary, 1999) Improvements include the Integration of the Longbow Fire Control Radar (FCR) and the Longbow Hellfire Modular Missile System (LBHMMS) providing a choice of laser and radar guided missiles. Appendix B describes the characteristics and status of the AH-64D Longbow Apache.

c. CH-47F Improved Cargo Helicopter (ICH)

The ICH is a program is like the Longbow Apache program in terms of improving from an existing earlier model. (USAAVNC DCD Program Summary, 1999) The program will extend the life of the CH-47 helicopter variant until the 2025 timeframe. Appendix C explains the characteristics of the CH-47F ICH.

d. OH-58D Kiowa Warrior (KW)

The Kiowa Warrior is the U.S. Army's fielded, armed reconnaissance aircraft. Appendix D describes the characteristics of the OH-58D Kiowa Warrior.

2. Command and Control (C2) Systems

a. Army Airborne Command and Control System (A2C2S)

The A2C2S enables commanders, from attack helicopter battalion through corps, to receive and communicate critical voice and data information while airborne or on the ground as a tactical command post (TACCP). (USAAVNC DCD Program Summary, 1999) As a mission kit mounted in a UH-60 helicopter, it affords the warfighter a common digitized picture of the battlefield that enhances C2 of assigned and attached elements and coordination with adjacent, supported, and supporting forces. The A2C2S provides modernized capabilities including reconfigurable radios, near real-time digital situational awareness, and direct access to Army data distribution. The on-board system provides battlefield information processing and connectivity equivalent to ground TACCP and Battle Command Vehicle (BCV). The system is a C2 "on-the-move" platform capable of rapidly traversing across the battlefield. This capability affords the commander the flexibility to lead and transition from a ground based tactical operations center (TOC) to an airborne TACCP and vice versa. The mission kit is also equipped with five reconfigurable battlestaff workstations capable of hosting MCS, ASAS, AFATDS, FBCB2, and Aviation Mission Planning System (AMPS) software. The commander and his battlestaff can view their individual screens or two large common display screens. The system will have connectivity with Special Operations C2, embassy, law enforcement, maritime, joint and/or other humanitarian network communications.

In 1997, the A2C2S was nominated, and the only Aviation system selected as a candidate for the Warfighting Rapid Acquisition Program (WRAP). The A2C2S program received an additional $3.7 million in Fiscal Year (FY) 1997 for Research,

Development, Test, and Evaluation (RDTE) and $11.1 million in FY 98 to accelerate system development. The additional funding warranted early fielding by 21 months.

Figure 17 displays the A2C2S configuration. The fielding/BOI is:

- Corps and Division Aviation 6
- 101st Air Assault Division 12
- Regimental Aviation Squadron 2
- Special Operations-Aviation 5
- U.S. Army-South (USARSO) 2
- U.S. Army-Pacific (USARPAC) 2

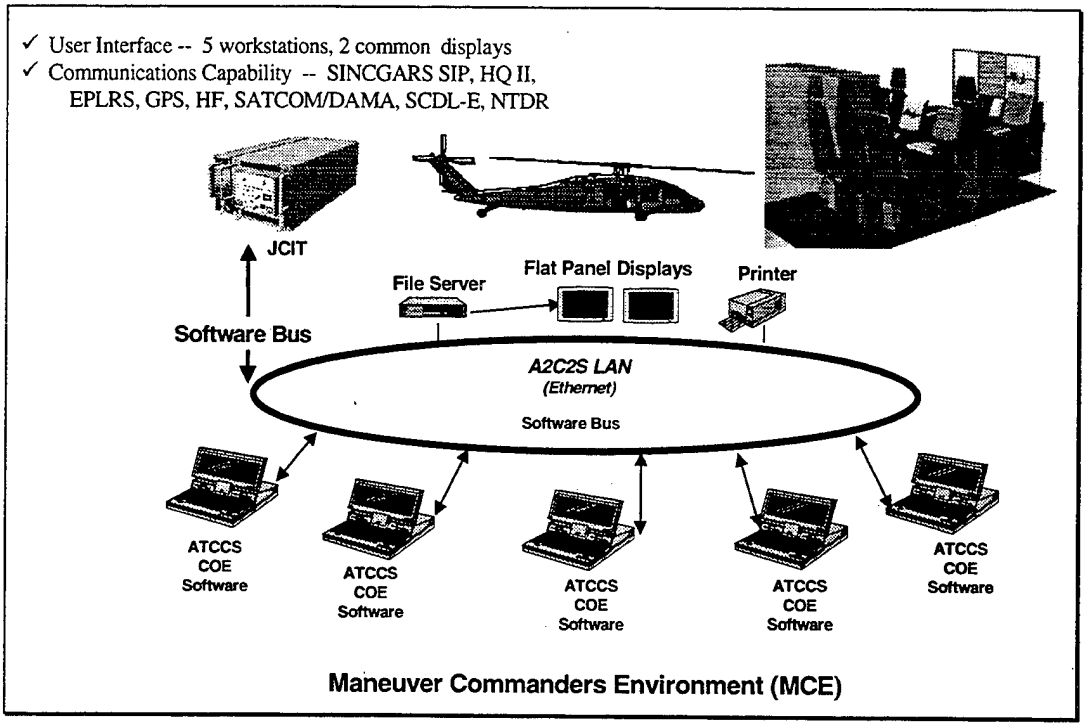

Figure 17. Army Airborne Command and Control System (A2C2S)
After Ref. (USAAVNC DCD, 1999)

b. Aviation Tactical Operations Center (AVTOC)

The AVTOC complements the Standard Integrated Command Post Shelter (SICPS) and the Command and Control Vehicle (C2V) programs. (USAAVNC DCD Program Summary, 1999) It incorporates the capabilities of these systems and includes aviation-unique hardware and software to support the commander. The AVTOC is a system of systems. It is a mobile, deployable, tactical wheeled vehicle with mounted shelter and stowable tent extension for the aviation brigade, battalion, and separate company commanders to use for planning, controlling, and reporting aviation operations. The system is part of the Army TOC program under the Project Manager for TOC (PM TOC). Aviation requirements are addressed in Integrated Product Teams (IPTs) by the Aviation Combat Developer. Three assemblages will be fielded at Aviation brigade/group and battalion/squadron headquarters. The assemblages are designated for the (1) Operations and Plans Officer and staff, (2) Intelligence Officer and staff, and (3) Personnel and Logistics Officers with their staff. The attachment of other liaison teams (Air Defense, Fire Support, etc.) will have their respective assemblages to connect with the Aviation system. Figure 18 depicts the configuration of the AVTOC.

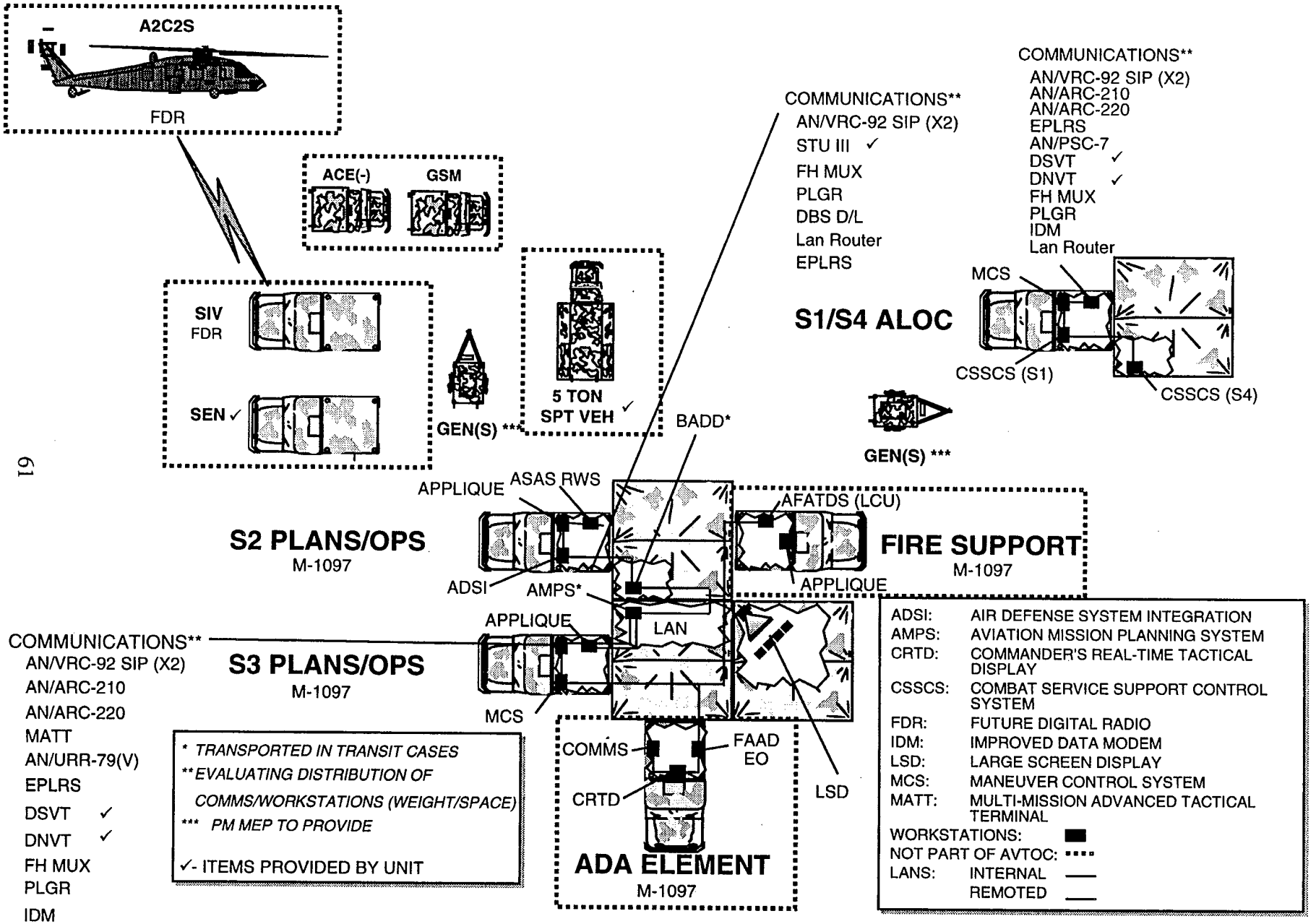

Figure 18. Aviation Tactical Operations Center (AVTOC)
After Ref. (USAAVNC, 1999)

c. *Aviation Mission Planning System (AMPS)*

The AMPS is a subordinate system of the MCS. (USAAVNC DCD Program Summary, 1999) AMPS software is hosted on a portable ruggedized workstation, Lightweight Computer Unit (LCU), under the Army Common Hardware/Software (CHS) contract. The system consists of peripheral devices such as the data transfer system (DTS), printer, magnetic optical (MO) drive, and compact disc read only memory (CD-ROM) drive. The AMPS automates brigade and below aviation mission planning and distribution of mission files between units. The system improves battlefield synchronization/intelligence in the tactical C2 arena, and interfaces with the ATCCS allowing aviation mission planners to download both friendly and enemy situational information needed to plan missions. The AMPS can generate three-dimensional computer images of the terrain using Digital Terrain Elevation Data (DTED) and the digital map, and pilots can use these images to facilitate mission rehearsals by "stepping through" the mission at 200-meter intervals. An essential feature of the AMPS is its ability to graphically display "threat domes" base on the reported locations of threat weapon systems. This feature increases aircrew survivability. Future software versions will allow pilots to fly simulated missions in real-time. The system also initializes and provides mission data loading into the aircraft for navigation, communications, weapons, and post mission information. Figure 19 depicts the components of the AMPS. Appendix E outlines the capabilities and fielding requirements for the AMPS.

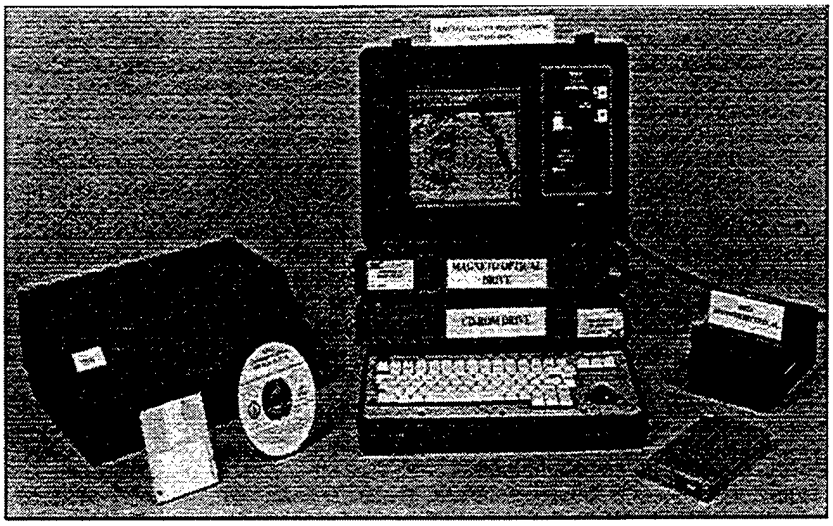

Figure 19. Aviation Mission Planning System (AMPS)
From Ref. (USAAVNC DCD, 1999)

3. Avionics

a. Joint Tactical Radio System (JTRS)

The evolving JTRS Program will meet the Army's emerging requirements for DoD's next generation of a secure digital radio. (USAAVNC DCD Program Summary, 1999) Appendix F describes the characteristics of the JTRS.

b. Improved Data Modem (IDM)

The IDM is a multi-service, interference-resistant, digital data transfer system that will allow both air and ground forces to exchange complex battlefield information in short coded bursts. (USAAVNC DCD Program Summary, 1999) This modem permits digital communication of information from tactical radios, onboard sensors, and processors. Appendix G provides a description of the characteristics of the IDM.

C. SUMMARY

Digitizing Aviation enhanced the operational employment to conducting air operations. The aircraft weapons system increased its lethality and survivability over similar

platforms. The command and control infrastructure projects the commanders influence throughout the battlespace. The avionics and communication networks extend the process and exchange of information beyond line-of-sight capability. Aviation's critical digitization initiatives brought changes to the way it conducts operations and prepares its warfighters for the 21st Century. Chapter IV will analyzed these changes on Aviation warfighting by addressing the issues and impacts of digitizing Aviation within the Army's digitization process.

IV. ANALYSIS AND LESSONS LEARNED

A. INTRODUCTION

The DTLOMS framework provides the mechanism to capture the impacts of the Force XXI's futuristic concept. With the unpredictable, rapidly changing world environment, the DTLOMS approach permits the flexibility to address the impact of digitization. (TRADOC Pamphlet 525-5, 1994) General Gordon R. Sullivan said, "Rather than a single, focused threat, America's 21st century Army faces a broad range of challenges." TRADOC emphasizes the DTLOMS structure to doctrine developer, training developer, leader developer, and combat developer to access the impact and challenges of digitization. In addition, the interviews conducted for this research solicited statements and perceptions based on the DTLOMS domains.

The implications of digitization on Aviation are considered similar across the Army. Since digitization is the application of information technologies to acquire, exchange, and employ digital information throughout the battlespace, several digitized systems in Aviation are common in other branches of the Army. Therefore, some analysis may be based on generalized implications rather than specific to Aviation.

B. DOCTRINE ISSUES

1. Field Manual (FM) and TTP Revamp

Before 1995, the Directorate of Training, Doctrine, and Simulation (DOTDS) at USAAVNC began an assertive effort to revamp Aviation publications to reflect the future paradigm shift. Since that time, over five FMs and several TTPs were revised and staffed for review and comments. A significant part of the change is an addition of a digitization appendix. The appendix incorporates sections addressing information technology, doctrine

and organization, digital systems and equipment, digital battle command, digital planning and reporting, employment, and combat service support. All the sections emphasize the digital transformation process. At the time of this research, a majority of the publications were still in their second draft versions. In a July 1999 interview, Major Lance Atkins, Chief for Doctrine Division of DOTDS, stated that constant changes in the digitization requirements for Aviation systems disrupted the revamp of the publications. This revamp process differs significantly with the traditional sequence. It would take a year from the submission of the first draft to the approved draft including local and worldwide staffing. Granted that some of the systems are not fielded, the purpose of the FM is to provide warfighters an inclination of the changes in doctrine and TTPs forthcoming. This advanced knowledge would increase the retention and familiarization of the employment and operations of digitized systems before the units receive the systems. Additionally, the learning curve or apprehension is decreased by having prior information on digitization. The FM is a means of communicating the new doctrine to fight on the digitized battlefield to the warfighters.

2. Aviation's Versatility

Even before digitization came into fruition, Army Aviation provided battlefield commanders maneuver flexibility, enemy intelligence and mass firepower. With the advent of digitization, Aviation is further enhanced with tactical agility and the ability to expand the battlespace for commanders. Aviation brings a degree of versatility not replicated by other members of the combined arms team and a range of unique capabilities associated with agility, speed, lethality, and flexibility that complement those of other combat arms. Aviation is the branch that provides combat, combat support, and combat service support

capabilities across the spectrum of full dimensional operations. Aviation's digitized versatility and warfighting effectiveness in all dimensions of the battlespace make it a relevant force for the 21st century.

Aviation will operate on the Force XXI's fluid, high OPTEMPO, and nonlinear battlespace. This is a change from the tradition battlefield framework: rear, close, and deep areas. The Force XXI battlespace framework portrays two types: close and extended operations. For example, Aviation Task Force Tiger's stability operations in Bosnia-Herzegovina did not delineate the battlespace. (Phipps, 1998) The battlespace had no distinct boundaries that clearly defined the opposition's area of operations. The forward, deployed Aviation task force remained vigilant in force protection operations against warring factions. Similar conditions existed in an earlier crisis in Somalia. Aviation must be prepared to conduct seamless, simultaneous operations in all directions.

The Amy's transition from threat-based doctrine to capability-based doctrine influenced Aviation to orient on that approach. Aviation's digitized units will be modular and deployable with the ability to provide joint force commanders with a lethal and flexible force to rapidly deploy from continental United States (CONUS), or abroad; to any theater by strategic air or sea lift, self-deployment, with a maritime force aboard aircraft carriers, or by any combination of these means. No other force can match Army Aviation's ability to rapidly project the force and build combat power in an immature theater. Once on the ground, Aviation becomes the Army's principal means to protect the force as the other ground forces continue to deploy and flow into theater of operations. This is best exemplified by the initial days and weeks of DESERT SHIELD as Aviation units quickly

deployed to Saudi Arabia and became the principal combat power for the initial covering force.

Throughout the future fight, Army Aviation will be at the forefront of gaining information dominance. The Comanche and Longbow Apache, coupled with unmanned aerial vehicles (UAVs) and the A2C2S, form a team that becomes, in effect, the Command, Control, Communications and Intelligence (C3I) quarterback for the Force XXI battlefield. These Aviation digitized platforms afford the commanders the ability to eliminate the enemy's reconnaissance and destroy the enemy's command and control and intelligence gathering assets. Concurrently, these missions also contribute to Army Aviation's key role in shaping the battlespace. During TF XXI AWE, the two early models of the Longbow Apache proved effective against the opposing force in a desert environment. The two platforms destroyed over 45 tanks and several targets throughout the exercise. This alarming ratio exemplifies Aviation's armor defeating capability on the battlefield. By conducting armed reconnaissance and security missions with real-time sensor-to-shooter linkages, Army Aviation can rapidly confirm the enemy's intentions, disrupt its tempo, deny its freedom of action, and act within its decision cycle. Shaping the battlespace precludes the need to conduct decisive operations. Aviation can sustain the tempo of the fight, attacking with depth and simultaneity throughout the battlespace. Aviation, at its own choosing, can initiate the decisive operation in conjunction with other maneuver ground forces to complete the destruction or defeat of enemy forces. The A2C2S, during TF XXI AWE, was instrumental in the tactical commanders decision loop. This platform placed commanders close to the fight and extended their presence on the battlefield by digital links. Finally, Aviation can sustain the force and transition to future operations with combat

support (CS) and combat service support (CSS) provided. Digitization of CS and CSS systems provide updated logistical data for Aviation to move and prepare for follow-on operations.

Aviation assets will be capable of executing rapid movement and offensive activity across the breadth and depth of the divisions battle area, effectively increasing the division's battlespace. This rapid reaction capability will increase the tactical mobility of the division and improve the flexibility of the division commander's response to evolving battlefield conditions. The communication suite on weapons systems and C2 platforms facilitates the speed of battlefield data exchange while enroute to a target or objective. Aviation will be organized and equipped to conduct deep operations, allowing the division to simultaneously attack the enemy throughout the depth and breadth the tactical area, disrupting all command and support echelons to achieve maximum synergy and destructive effect.

The digitization of Aviation and its impact on doctrine offers many insightful contributions. However, it tends to leave one to wonder if digitization is a liability rather than an asset. At this point, it is too early to really make an educated assessment because of the missing systems that complete the Aviation digitization plan and the on-going experimentation of the Force XXI process. One premature speculation is the doctrinal synergy employment of digitized platforms into battle and maintaining the OPTEMPO. The known limitation on digitization is the human interface. The warfighter's human nature may not be able to perform or keep pace with the digitized platforms employment and OPTEMPO capability. Several occurrences at TF XXI AWE indicate that this could impact on the doctrine warfighting requirement. For example, the assembly and operations of the AVTOC challenged the soldiers. With the mixture of integrated and stand-alone systems,

the construction of the TOC took longer than required. This forced limited C2 operations during ongoing missions. The combat developer and materiel developer have, and are still addressing the issue.

C. TRAINING ISSUES

1. Individual Training

Across the Army, Force XXI is changing the individual training structure and affecting all branches alike. With a smaller force comes fewer individual specialties for both officers and enlisted soldiers. Soldiers will continue to attend initial entry training at their respectively installations but with more emphasis on Force XXI applications. Individual training will be more specific to each soldier. Interactive student training devices will be necessary for academic training. Institution and installations will be connected through the Internet to facilitate long distance learning for soldiers. Individual skill training refreshers and sustainment will be available to each soldier. Databases will be available to the soldier routinely to address lessons learned from previous operations, worldwide political and demographic information, or expert individual specialty training requirements. Several digitized systems, such as AMPS and MCS, will have embedded training within the platform. Basically, it is a classroom without walls.

A significant challenge to Aviation is administering new equipment training to soldiers on digitized systems. In a July interview with Chief Warrant Officer Four (CWO4) Steve Woods, Aviation Electronic Combat Team Leader for DOTDS, he stated that digitized systems or applications, both Aviation and non-Aviation, pose training challenges for his team. His team is responsible for training Aviation soldiers at USAAVNC and in units on the digitized systems. The ATCCS applications present a problem of determining

the level of exposure training. He has to identify students who will be trained as operators, maintainers, and leaders in the application of the ATCCS workstations. The functions or tasks of the applications do not distinct the levels of usability. At the operators level, the application does not clearly state whether the operator is a specific MOS soldier or non-related operator. For the ASAS workstation, the issue addresses whether the operator should be an intelligence MOS soldier or Aviation assigned soldier. In addition to usability training, the trainer prerequisite and hardware/software status lack clarity in qualifications and availability. The other ATCCS applications from the Army's different branches require subject matter experts (SMEs) or qualified trainers to instruct soldiers. His team faces the difficulty of structuring training based on the available resources, specifically funding. Since this situation is common Army-wide, TRADOC is addressing the impact.

Another potential impact is assessing the soldier's capability level. In the early 1980's, a Soldier Job Book was carried and maintained by the soldier. First line supervisors were responsible to check, test, and annotate the soldier's skill level on specific MOS tasks. These tasks were simple and easy to evaluate. This document was phased out for obsolescence and never replaced. With digitization, soldiers' jobs will consist of more complex tasks on a wider array of systems for them to master. An assessment plan for the soldier is required detailing the critical skills and skill advancement criteria on digitized systems.

2. Unit Training

The Army is redesigning its collective training concept into a seamless training system. This effort involves networking and virtual live and constructive simulations across the full range of military operations. Aviation is participating in this redesign to meet Force

XXI. USAAVNC is networking capable team trainers for both initial and sustainment training. Distributed interactive simulations will tie geographically dispersed units together for training and actual mission rehearsal. This capability requires the scenario to be joint and often combined. Units will conduct continuous field environment training at combat training centers (CTCs), particularly for battalion and below units where teamwork skills are rapidly perishable.

Digitization emphasizes training as a team. The effectiveness of the information age technology is dependent not only on how well information is collected, but, more importantly, how well information is exchanged. This was evident in the Longbow Apache's early stage of operational testing which demonstrated the exchange and interpretation of the data between battlecrews within the team.

Unit training traditionally has been inefficient due to lack of planning and innovation, limited resources, and distracters. (ARI, 1998) Aviation is part of this trend. In the cited Army Research Institute (ARI) report, units are not prepared for the added training load of digitization. This finding is based on the inherent weaknesses that all units demonstrated, ranging from personnel turnover and shortages to nonstandard and competing missions. The Army is still wrestling with the issue.

3. Training Simulators

Simulation is the next best training approach short of actual execution. Digitization has opened new training concepts and systems for Aviation. Besides requiring digitized systems to have embedded training capability, simulators or trainers have emerged for Aviation to train its force. The Longbow Crew Trainer (LCT) and the Comanche Portable Cockpit (CPC) devices have incorporated the latest technology in aircraft simulation.

The LCT is a high fidelity crew simulator for the AH-64-D Longbow Apache helicopter. It supports aircraft qualification and sustainment training for the pilot, co-pilot/gunner, Instructor Pilot, and Maintenance Test Pilot skills. This device allows training of simulated combat operations under various meteorological conditions, visual and instrumentation, day, night, obscured battlefield, or nuclear, biological, and chemical (NBC) flight conditions. The cockpits are separated so that a high-definition visual system can be integrated and placed at a design eye-point for each of the two-crew members. The electrical control loaders provide force-feel stimuli to the flight control in the pilot and co-pilot/gunner (CPG) stations. The system is housed in a trailer to provide mobile training at different locations. The trainer increases the proficiency of the users by duplicating the actual cockpit functions of the real aircraft. The trainer is installed at Longbow Apache locations and affords the units an alternative to training. This capability is important especially in during these times of DoD budget constraints.

The CPC is the training device that is part of the Comanche's man-in-the-loop development of simulators. The CPC is a fixed-base device that is mounted in two modules on the back of a semi tractor-trailer. It has the capability to run on its own power supply and self-cooling system. In a few hours, the CPC can be set up and operational. It permits units to rehearse missions and perform information dominance capabilities prior to actual execution of missions. It can interface with other Aviation simulation platforms and the ATCCS workstations. This full-dimensional virtual simulation provides the warfighters the capability to observe battle command, conduct staff planning, and track the battle.

D. LEADER DEVELOPMENT ISSUES

1. Situational Awareness

The digitization impact or change for developing Aviation leaders is to understand situational awareness. This statement probably holds true in other branch of the Army. Aviation, as well as the Army as a whole, is challenged on how to train leaders in a digital environment. Improving situational awareness does not necessarily lead to better situational understanding. The end-state of digital capability is not situational awareness, but it should be a vastly improved ability to command in battle. The Force XXI effort demands commanders and leaders to make sound decisions based on the data from sensors and other intelligence gathering sources. This improved ability provides potential for more pertinent information available for mission analysis, better management of tactical forces, and greater focus on the enemy. Leaders must be cognizant of the potential for information overload. During the TF XXI AWE, leaders in the AVTOC were overwhelmed by the data being pushed into the digital systems. Applique and ASAS workstations presented friendly and enemy locations respectively. Other real-time systems displayed video images of the actual target locations. C2 systems were blinking with inquiry messages awaiting response on the commander's decision to execute an attack. Leaders often did not know what they wanted to do until they saw it during the battle. The instantaneous exchange of data among the digitized systems and a situational awareness picture projected on a large screen display can belittle the commanders ability to manage and orchestrate information flow.

2. Commander and Battlestaff Drills

The transition to digitization brought more battlestaff drills because of the complexity of the concept. In preparation for TF XXI AWE and DAWE, the Aviation unit

conducted more train-up events than for a traditional field training exercise. The train-up was a digital training exercise (DTX) aimed at training the commander and his battlestaff on the management and operations of the digitized systems. This effort proved effective at the actual experiment. The battlestaff, through the systems, successfully prepared, briefed, and executed the critical tasks at every mission. At the battle or shift changeover, TOC personnel used the monitors and automated data to brief their counterparts. The drills strengthen the leaders' confidence in the digitized systems.

E. ORGANIZATION ISSUES

1. Equipment

The digitization's transition period impacts equipment readiness of Aviation units. New digitized systems will be fielded as a one-for-one replacement. This procedure involves certain strict requirements. The Army cascades displaced older systems, reissuing them to the reserve components. Therefore, when the regular Army units turn-in older equipment, it must comply with usability standards. This turn-in procedure can take months or years as part of the unit's force modernization process. There are high costs and personnel requirements associated with this process, which impacts the units' combat readiness.

Fielding of the digitized systems may not go as scheduled which impacts readiness. This significant impact compromises the integrity of the unit to operate as a cohesive team. Having a mixture of equipment and systems deploy to battle can have operational ramifications. The fielding of digitized systems, thus far, has not been standardized in a logical sequence. At the time of this research, Aviation indicated that delivery of the Aviation EBC capability for the IDM will be delayed. The EBC gives the Longbow Apache

and Kiowa Warrior the ability to interface through the IDM with the ground forces. This significant delay degrades these Aviation platforms to meet full integration for the First Digitized Corps (FDC) in latter part of year 2004 – a critical milestone for Army XXI. Aviation's senior leadership is addressing the issue with DA.

2. Personnel

Digitization has increased personnel strength within Aviation. The Longbow Apache battalions have increased the TOE enlisted strength by 28 soldiers, which compromised of MOS 68R Longbow Apache Helicopter Repairer and MOS 68X, which will change to 68Y Armament/Avionics/Electronics Repairer. The communication sections at each battalion and brigade level increased by three and eight soldiers, respectively. These additional soldiers resulted from the many different digitized systems applied throughout the brigade. The additional battalion and brigade enlisted soldiers possess the MOS 74B, Local Area Network (LAN) Technician. They are primarily maintainers or trouble-shooters. At the brigade level, the additional warrant officer with the specialty skill as a 251A, Information System Technician, and a commissioned officer with the specialty skill as a 53A, Information Management Officer, function as the brigade's System Administrators on all the digitized systems. Ironically, the objective of digitization is to simplify the workload or tasks for the warfighters that should not increase the number of maintainers. Final changes to personnel strength are still in progress and not available for analysis.

Personnel manning shortages and instability during the transition will impact the digitization process. Aviation recognizes that the fielding of digitized systems and personnel will never reach 100 percent. The challenge for the Army is to identify the excess

personnel from the old Army of Excellence (AOE) structure to backfill the new Force XXI structure.

F. MATERIEL ISSUES

Chapter III presented the implications of Aviation's critical digitization components divided into three platforms: aircraft, C2, and avionics. The following issues focus on the acquisition process.

1. Spiral Development

The Force XXI process introduced the new Spiral Development concept as an alternative to the traditional linear acquisition approach. Several of Aviation's digitized programs, like the A2C2S, have experienced the drawbacks associated with this new approach. Figure 20 depicts the Spiral Development approach with its essential players.

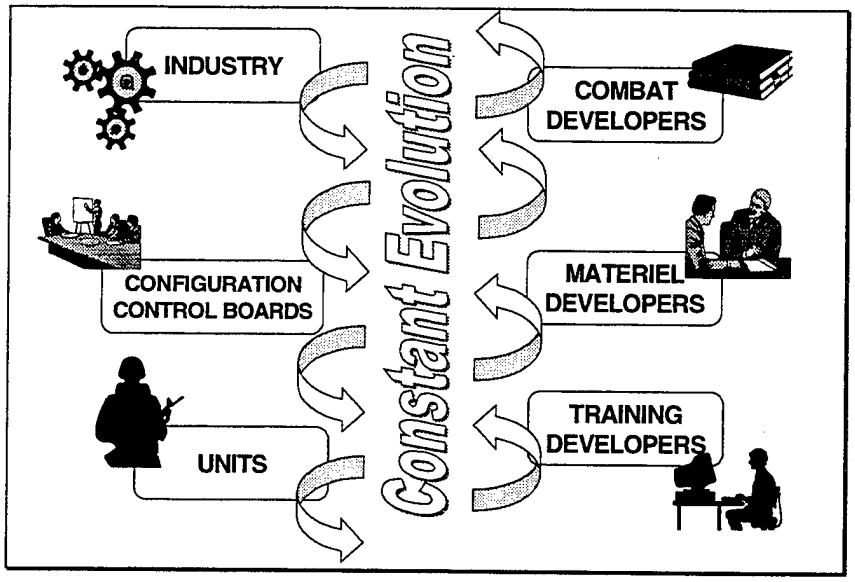

Figure 20. Spiral Development Process
From Ref. (DFCC, 1999)

The concept is a materiel management philosophy where the materiel developer, combat developer, tester, and the user communities work together using an iterative development, fielding, and sustainment process to provide the latest materiel capabilities to

the warfighters in minimal time on a continuous basis. With spiral development, the requirements are adjusted to a package of capabilities, each being a more advanced version of the system. This process provides the soldiers from the EXFOR, 4th Infantry Division, the systems very early in the development cycle, and they provide feedback to their TRADOC System Managers (TSMs) and program managers. This interaction fosters early insights to honing a battle-field-ready system. The bottom line for the spiral development is that the soldier receives the combat ready systems much faster than in previous years. The traditional system's development cycle averaged between seven and ten years where the spiral development targets a two-year cycle.

Aviation's digitized systems that rely on other digitized systems for integration have a difficult time with the new approach. The EBC problem presented in the organization's equipment issue relates to this matter. Since the spiral development applies the capabilities-packaged versions, Aviation requirements were not fully considered. This analysis is based on several interviews that will be addressed in the next section.

2. Requirements Creep

Throughout the Force XXI acquisition process, new requirements or functionality for Aviation systems emerged frequently and in large numbers. It is common to see a system's core requirements altered to accommodate new functions. The AMPS source lines of code (SLOC) has been through many changes because of internal Aviation requirements and external requirements. These new requirements are not recommended, but directed or forced on the system in order to be compliant with other systems. This creeping effect jeopardizes the program's cost, schedule, and performance factors.

Another impact of the requirements creep problem is the competing requirements dilemma. In a July interview with Major Greg Kokoskie, Assistant Product Manager for Longbow Apache Preplanned Product Improvements (P3I), and Mr. Doug Madigan, contractor staff support to the Comanche Program Management Office (PMO), both gentlemen agreed that competing requirements dampened the progress in their programs. Peculiar to these aircraft is the Air Worthiness Release (AWR) requirement that is needed when any hardware or software change is performed. If the new requirement change has a slight possibility of interfering with the aircraft flight performance, an AWR is conducted. This safety requirement consumes resources and slips the schedule back if it was an unanticipated requirement.

G. SOLDIER ISSUE

The other domains, training and organization, addressed the digitization impact on Aviation pertaining to this soldier requirement. On a macro-level, digitization will capitalize on the inherent capabilities of soldiers who will use it while not exceeding their limitations. Digitization requires quality soldiers who will face a variety of challenges in preparing for and executing missions in full-dimensional operations. The digitization concept will empower and develop quality soldiers to understand and manipulate data. This significant change is evident outside the Army. In February of this year, the U.S. Marines conducted a digital experiment in the local area of the Monterey Bay called Operation URBAN WARRIOR. This experiment focused on the digitization impact on the Marines' urban operations. Each Marine was equipped with digital systems that enabled him to see the entire battlespace. The Marine had the power of information at his fingertips that can influence the operations. This information control gave him the nickname "High Tech

Corporal". Colonel Stephen Ferrell, Commander for 4th Brigade in the 4th Infantry Division, summed it by saying, "The best computer on the battlefield is still a soldier."

H. LESSONS LEARNED

As a result of the analysis on the impact of digitization on Aviation units, the following lessons have been identified:

- The effect of digitization expands the battlespace by dominating across the full-spectrum of military operations. Aviation's role and responsibility have increased which burden units to keep pace with demand of a high OPTEMPO battlefield.

- The potential to conduct operations in a noncontiguous vice linear manner is inevitable. Fortunately, digitization facilitates operations in a variety of environments.

- Digital training at all pillars or levels needs to be seamless to prevent any disruption in the momentum of the learning rate of individuals, units, and institutions.

- Situational awareness is valuable to a leader to increase the lethality, survivability, and operational tempo of a force. The value is in the leader's ability to understand and leverage off situational awareness to command the battle.

- The complexity of digitization requires additional personnel strength to maintain and oversee the digitized network and applications.

- The acquisition approach for Force XXI, Spiral Development, doesn't recognize the system of systems development requirements. These requirements compete with each other, which results in critical functions being dropped or placed in P3I.

- The soldier is the heart of the digital force. Keeping the soldier in the loop throughout the digitization process will ensure that the warfighters get the right systems at the right time at the right place.

I. SUMMARY

This chapter has provided the identification and the analysis of the significant issues impacting the digitization of Aviation units and the rest of the Army. This analysis has

revealed that the significant digitization issues with regard to Aviation were DTLOMS related. These issues are significant in that failure to address them hinders Aviation efforts to become fully integrated into Force XXI process and a 21st Century combat-ready warfighter. Chapter IV will conclude with insights and infer recommendations based on these findings.

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V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The following are the conclusions drawn from the analysis and lessons learned.

1. Doctrine

Analysis of the doctrine domain revealed two issues: revamp of Aviation publication and versatility. The introduction of digitization requires Aviation doctrine to reflect the employment and operations of its forces on a 21st Century battlefield. The complexity of the concept forced new tactics, techniques and procedures for digitized units to follow. The material change consisted of a comprehensive digitization appendix to Field Manual 1-100 series, applicable to Aviation. In addition to field manuals, unit training and evaluation plans and aircrew training manuals went through the same transformation. Based on the researcher's literature review and interviews, the findings of this study conclude that digitization impacts the documentation aspect of doctrine in regards to unit readiness. While units are receiving digitized platforms, the revamp process on the publications is behind on the staffing process. The reason is the intricate aspect of digitization being a system of systems. Aviation digital avionics rely on other battlefield operating systems to operate in an integrated structure. The concept of digitization is dynamic and unstable, and Aviation doctrine analysts are subjected to these limitations.

This characteristic poses a problem for warfighting units that need the doctrine publications to function as a combined arms team in battle. Without the timely written knowledge and guidelines of warfighting, deployed units, whether on a training exercise or real-world contingency, are susceptible to fail in their mission. The Aviation proponent is concerned and working the issue.

The second analysis captured a larger aspect of doctrine – versatility. To digitize a force requires the application of technology to acquire, exchange, and employ digital information throughout the battlespace. Before the idea of digitization became a reality, Aviation played a major role in combat due to its ability to cover the entire battlefield in short time and deliver massed firepower anywhere. Now, compound that ability with digitization, and the demand on Aviation, at least, doubled. Technology advances at a rate that a person can not keep pace. Computer hardware becomes obsolete within six months of its introduction into the market, and people have yet to comprehend its full potential. The Aviation soldier faces the same situation but in a more volatile environment. For the most part, the digitization effort follows a compressed schedule to meet its near-term objective, Army XXI in the year 2010. Currently, about 45 percent of the digitized systems in the Force XXI effort are developmental with subsequent versions forthcoming. As an illustration, the full configuration for FDD in September 2000 is not the same configurations exercised in recent AWEs. The contributing factor is the insertion of prototypes until the real system is fully developed as scheduled. In the meantime, the soldiers are training, operating and maintaining interim systems.

The result of Aviation digitization is versatility, but the process to achieve the result challenges the warfighters ability to maintain the momentum. During this transitional period, these challenges may discourage warfighters to operate the systems. Another drawback may be the warfighters' lack of confidence in the developmental systems. It has been the researcher's experience to observe such occurrence. If the digitization process continues without considerations on the warfighters' limitations, the effort is futile.

2. Training

The basis of the following conclusions focuses on the analysis of individual training and unit training. TRADOC has overall responsibility for the Army to provide the resources and personnel to conduct training in support of the digitization effort. This responsibility is further delegated to the branch or schools. The Aviation Warfighting Center is the proponent for Aviation institutional training which encompasses initial-entry individual training and collective training for its forces. Sustainment training and unit training are conducted at field unit locations. Training directives and circulars are disseminated throughout all echelons in the Army specifying training requirements. Digitization contains these training requirements.

The analysis revealed that indoctrination training or new equipment training is hindered by lack of specificity on who needs training and how much training is required. The research found that there is no standardized training for soldiers Army-wide other than what proponents developed internally. This deficiency poses a problem for similar systems that are found in other branch schools. This training diversity degrades the proficiency of digital soldiers by presenting different individual operating tasks of a particular system.

Another conclusion related to this issue addresses the shortage of institutional training systems. Field units have priority of issue over training institution on digitized systems. Thus, individual soldiers do not get the full appreciation of hands-on training before arriving to their units. The purpose of the individual initial-entry training at branch schools is to provide the soldier with the fundamental applications of the digitized system. This is not the case for Aviation soldiers. The interview conducted on this research confirms this conclusion.

Soldier and unit assessment training were not fully addressed in the digitized effort. Digitization involves automated procedures and tasks, and a soldier's proficiency, culminating at unit collective training, should be measured and recorded on these related functions. As the Aviation moves away from manual procedures to automation, the soldier's and unit's performances become increasingly important because of the increased demand on technical tasks and missions. The ARI report cited earlier supports this finding.

3. Leader Development

The analysis on this domain indicated the correlation between the commander understanding situational awareness and the frequency of commander and battlestaff drills. As battlestaff drills increase, the commander's understanding of the common picture also increases. Digitization floods the commander with intelligence, maneuver, fire support, and logistics data to assist in the decision-making process. Too much information is a liability to the commander, if not filtered accordingly. The battlestaff fuses the data into a picture that the commander can interpret to make a sound decision for his next move. If the battlestaff fails to portray an accurate account of the battle, the commander will make a grave error in his decision that could impact the lives and equipment of his force. Battlefield data processed into useful information is only valuable in the eye of the beholder. Frequent drills honed the commander's situational awareness skills.

4. Organization

The analysis on the organization issue found that the delay fielding of digitized systems and the instability of personnel manning impact the unit's integration efforts. Inter-related to issues on training and materiel, Aviation uses other digitized systems to integrate with its own systems. When an Aviation integrated system is delayed, a negative ripple

effect occurs in the acquisition timeline for the Aviation system. Testing and system deliverables are postponed and rescheduled normally incurring increased costs. The greatest impact is not delivering the system to warfighters on time when they need it most.

Personnel shortages and manning instability disrupt the digitization process. The transition is a critical period to have sufficient soldiers in place to receive and operate the systems. An understrength unit runs the risk of not employing the systems to full capacity. Any personnel turnover degrades the continuity and institutional knowledge of the digitized systems. TF XXI AWE is a testimony to this impact. In the early stage of digitizing the TF, personnel influx contributed to a decline in unit readiness to advance forward to the next phase of the digitization process.

5. Materiel

The analysis pointed out that the Spiral Development process and requirements creep issues impact digitization when not applied properly. The Spiral Development process is a unique acquisition approach for the Force XXI concept. Although the process works effectively for some digitized systems, it is detrimental to others. The process is not conducive to systems that host other integrated systems. This is evidenced in the case of the A2C2S program where the platform hosts ATCCS software on reconfigurable workstations and communications suite. The problem lies in the development changes in the communication hardware and software interface. This change required a reprogramming request for an undisclosed amount and a schedule slip for testing.

Additionally, requirements creep produces similar impact on the implementation of digitized systems. Any deviation from the base or core requirements requires an extensive change to implement the new requirements. The materiel developer is normally confronted

with the requirements change and conducts a trade-off analysis to present to the users. The trade-off analysis requires the user to prioritize the core requirements against the new requirements. This process is confined to cost and time constraints, which comprises the total system. Requirements creep will continue to occur, and the solution is in how we manage it.

6. Soldier

The analysis of this domain recognized that Aviation and the Army, as a whole, need quality soldiers. The training and organization domains addressed soldier implications as well. These soldiers will operate technological advanced systems that influence the battlespace. They will have access to information that provide updated enemy intelligence, near real-time friendly locations, and real-time video images of the targets. These soldiers will need the ability to process and fuse the data for the commander's assessment. In the past, they have performed these tasks manually. With the aid of automation, the soldier will process data twice as fast. It is imperative that the soldier is managed and trained for digital Army.

B. RECOMMENDATIONS

Based on the analysis in Chapter IV of this thesis, and the conclusion of the previous paragraphs, the following recommendations are provided. These recommendations seek to eliminate or minimize the impact of the Force XXI digitization process on Aviation.

- **Doctrine**
  - o Training Developer should research other TRADOC school's methodology in updating warfighting manuals with digitization requirements.
  - o Training Developer, Combat Developer, and Materiel Developer should structure Aviation digitization doctrine to coincide with digitized systems.

The application of the systems should be supported with the pertinent "how to" doctrine.

- o TRADOC should conduct a study that analyzes the correlation of increased digitization tasks and the decreased ability for soldiers or trainers to keep pace.

- **Training**

  - o Training Developer should develop a soldier's Smart Book that contains the description, immediate step operations, and basic skills to operate the digitized systems deployed in Aviation. The book should have a section that measures the performance of the soldier's capability.

  - o Training Developer, in coordination with TRADOC, should define the institution's responsibility on digitized training. The issue should focus on what and how should institutions teach digitization.

  - o Combat Developer and Training Developer should form a Systems Training IPT to address system requirements coinciding with training requirements.

- **Leader Development**

  - o Training Developer, Combat Developer, and Materiel Developer should identify the common perishable leader's skills and ensure that the system will require those skills. Backup skills for conventional operations (when systems are operating in degraded mode) should be maintained.

- **Organization**

  - o Combat Developer, Materiel Developer, and DCSOPS Aviation should anticipate and respond during the fielding of digitized systems that unit readiness will decrease. The fielding schedule must not be delayed.

  - o The Army Personnel Command should develop and disseminate a personnel stabilization plan that will not deteriorate the digitization process and at the same time, maintain morale and esprit de corps within the ranks. This action should minimize personnel manning shortages in digitized units.

- **Materiel**

  - o Materiel Developer, Combat Developer, and Training Developer should address the applicability of the new Spiral Development process on Aviation's digitized systems. The concept should be examined and

revised to accommodate systems that depend on other systems for advancement and integration. Other development processes should be identified as options.

- o Combat Developer and the warfighter -end user- should provide the Materiel Developer a prioritized list of warfighting requirements. In return, the Materiel Developer should present his assessment on the tradeoff impacts along with applicability criteria for the desired requirement to be considered for integration.

- **Soldier**

  - o All developers should keep the soldier in the loop in determining requirements for operational, training, and materiel.

C. ANSWERS TO RESEARCH QUESTIONS

This section just provides summarized answers to the questions, which guided this research.

1. The Joint Venture Axis of the Force XXI Campaign plan is the process that integrates Aviation brigade units into Army XXI.

Through the requirements determination process outlined by TRADOC Pamphlet 71-9, *Force Development, Requirements Determination*, Aviation ideas and concepts are analyzed and evaluated against the criteria described in TRADOC Pamphlet 525-5, *Force XXI Operations*. The concept is associated with an existing system either in a developmental or fully matured form. Integrated Concept Teams (ICTs) are organized to follow the concept through the determination process and capture the operational value for Aviation. Other analytical tools to determine such value are experimentation through virtual, live, constructive, and operational experience.

AMBL is instrumental in experimenting to discover early, accurate solutions to shortfalls in the desired Aviation warfighting capability. In a July interview with Doctor Joseph Van Loo, Operations and Research Analyst for AMBL, he pointed out the

significance of the Army Experimental Campaign Plan (AECP) to identify major tests and Army and Joint experiments for the Army's future forces. These experimentation are warfighter driven and not technology driven.

The Army Chief of Staff charged TRADOC with the responsibility to plan and implement the Joint Venture Axis of the Force XXI Campaign Plan in redesigning the tactical Army. This venture is still a part of the requirements determination process. If the Aviation idea or concept proves valuable in the experimental analysis by meeting the desired warfighters capability by either making slight modifications or in its existing configuration, then requirements are updated in the ORD to reflect the impact on the DTLOMS domains of warfighting. This process runs concurrent with the early stages of the acquisition process from the pre-Milestone 0 to Milestone I. Figure 13 in Chapter II illustrates the concurrency.

The reader must realize the timeframe when the Force XXI concept was introduced. Digital systems that are in their advanced stage of acquisition life cycle migrated into the Force XXI process. The Longbow Apache's Initial Operational Test and Evaluation (IOTE) occurred before the Force XXI effort was implemented. In a July interview with Lieutenant Colonel Clay Carter, Deputy TRADOC System Manager (TSM) for Longbow Apache, he pointed out that the inherent digitized features of the Longbow Apache filled the void of the Army's integrated Force XXI puzzle. The weapons platform proved effective and lethal in the AWEs. The Longbow Apache program is currently in Phase III, the Production, Fielding/Deployment, and Operational Support phase of the acquisition process., and successfully moving along the path to Army XXI.

2. The Army has defined the objective and developed an architecture for Army XXI.

The Army XXI objective is a force design of information dominant, modular, and tailorable for rapid response to multiple contingencies around the world. The architecture supports the objective by establishing a common operating environment (COE) for all digitized systems, both Joint and Combined. Figure 7 in Chapter II depicts the Army C4I Architecture for Army XXI.

Long-term planning has facilitated the Army to be compliant within the Joint Technical Architecture (JTA) for DoD. The Army produced a document called the JTA-Army. The documented architecture applies to C4I systems and any systems that produce, use, or exchange information electronically. The Army continues to posture for jointness in its Force XXI objective and architecture design.

3. The enablers that permit Aviation to be fully digitized within the Army XXI architecture are the same inhibitors that impact Aviation's ability to demonstrate its full integrated potential.

The mandated requirement for all digitized systems to utilize the Tactical Internet posed development shortcomings for several of Aviation's critical digitized components, specifically the aircraft platforms. Aviation aerial platforms rely on the Embedded Battle Command software to have digital links through the Improved Data Modem (IDM) to its own and friendly ground forces. The IDM will host the EBC software that permits the exchange of Joint Variable Message Format (JVMF) text and data between aircraft and ground elements.

The development contractor for FBCB2 is also the software developer for the EBC. The EBC contractor is faced with competing requirements from all branches of the Army to be a user of the Tactical Internet by the FDC in the year 2004. This significant achievement advances the Army along the axis to Army XXI. Unfortunately, due to limited budget and resources, the EBC contractor has to prioritize Force XXI's systems in order to receive the EBC software. Somewhere in this process, the Longbow Apache and Kiowa EBC requirements did not make the cut list, which meant that these combat multipliers will not demonstrate the its full capacity at a major milestone for Army XXI. The EBC contractor has formed Integrated Product Teams (IPTs) to review the problem and find solutions that will meet Army's requirements.

4. The development of digitized systems requires a new way of doing business through the Spiral Development process and the Central Technical Support Facility (CTSF).

The spiral development process contributed to the success of the AWE efforts. The process permits rapid engineering and prototyping of Force XXI systems in preparation for TF XXI AWE and DAWE. The Aviation systems that used the spiral development have made great strides in getting the right systems to the warfighters on time. Chapter IV explained the concept of this digitized development process.

The CTSF was instrumental in examining issues related to the incorporation of new technologies, both developmental and commercial-off-the-shelf, and brings these latest innovations to the user's locations. The CTSF bridges the gap between the acquisition organizations and the warfighters through daily interactions. The facility is structured to design and build the system close to warfighters location. This practice produces immediate

feedback from the warfighters. The traditional acquisition cycle doesn't possess this feature. The CTSF is the conduit that keeps the warfighters in the development loop.

5. The Warfighting Rapid Acquisition Program (WRAP) Army Systems Acquisition Review Council (ASARC) was an alternate process to digitizing Aviation systems.

The WRAP ASARC is another means for a program to receive additional money for digitized systems. The process is designed to link TRADOC experimentation and systems acquisition. WRAP provides TRADOC the mechanism to accelerate the acquisition of selected candidates from successful warfighting experiments.

Currently, the A2C2S WRAP candidacy is questionable. The program is experiencing the impact of digitization requirements, technical challenges, and other developmental integration efforts. The TRADOC and Program Executive Office (PEO) for Aviation will meet to address the candidacy.

D. AREAS FOR FURTHER RESEARCH

1. Comparative study of the Spiral Development Process versus the traditional Acquisition Lifecycle Process.

This thesis has examined briefly the dominant Spiral Development process in the digitization effort. A follow-on study should capture the similarities and differences with detail focus on impacts and applicability to Aviation.

2. Case study on the impact of digitization on other branches of the Army.

This thesis provides a template for other Army officers to follow. These studies can validate any common occurrence and include cost data of digitization.

3. Modernization: Brigade Set Fielding

This thesis addressed organization impacts. The Army has develop a package fielding called Brigade Set Fielding as an approach to the digitization process. This concept is a system of system fielding. Three groups of interrelated systems are concurrent fielded to a Brigade Combat Team (BCT) or brigade.

4. Comparative study between technology migration and technology insertion on Army digitized systems.

During the course of this thesis research, several individuals expressed concerns over the acquisition approach on digitization. This thesis identified certain systems with technology insertion and their challenges. A follow-on study should research technology migration aspects including cost and compare with technology insertion in detail.

5. The need for an Army Integrator for all digitized systems.

Each PM develops a system to solve a specific deficiency (e.g. a tank, an artillery tube, a helicopter), but determine who is the Army's integrator at each level to ensure all digitized systems are compatible and interoperable. The study should find a configuration management solution for the Army's digitization effort.

E. FINAL THOUGHTS

Army Aviation's participation in the Force XXI digitization process experienced failures and tribulations along the path to the 21st Century. The digitization transformation posed developmental and integration challenges to all that were involved. The Army continues to explore pliable and innovative approaches to prepare its forces for Army XXI and the Army After Next. With a collaborative partnership with industry and other DoD agencies, the impact and struggle towards Army Vision 2010 are minimized.

The digitization concept affected Aviation's warfighting domains in the process. This research identified these setbacks. The transition to a digitized force changed the way Aviation employs, trains, leads, organizes, and equips its force. Despite digitization intent to enhance Aviation's warfighting capabilities, the implementation impacted the transformed unit's readiness and wartime mission as analyzed in this study. There is no single solution or method that will address all of the issues involved in the complexity of digitization. The leadership in Aviation and throughout the Army must remain vigilant and persistent to control and manage risks in the digitization process.

The Army's holistic approach to battlefield digitization has concurrent activities taking place in TRADOC. Its various schools and centers are using experience gained from AWEs to revise the requirements' documents and further refine the warfighting requirements - DTLOMS. In the meantime, Aviation has a critical role and is capable of meeting the Force XXI challenge. It is an integral part of the total military capability like the other combat arms team. Aviation has played an important role in the military's success during this century, and that role will continue to increase in the 21st Century.

Table 2 summarizes the operational gains of digitization based on modeling and simulation results. The asterisk indicates that the results were from the TF XXI AWE Integrated Report. The loss exchange ratio (LER) is the number of Red losses divided by the number of Blue losses. A higher LER is better.

Task	Before	After	Force Effectiveness Consequences
Plan Development (Division Level)	72 Hours to Complete	12 Hours to Complete	Increased OPTEMPO (6-fold)
Call for Fire	3 Minutes to Complete	½ Minute to Complete	Greater Lethality (10-fold)
Deliberate Company Attack	40 Minutes to Initiate	20 minutes to Initiate	Increased OPTEMP, Lethality, and Survivability (2-fold)
* Hasty Company Attack	Red Loss-39 Blue Loss-82 LER=.49	Red Loss-112 Blue Loss-92 LER=1.24	Increased OPTEMPO, Greater Lethality (2.5-fold)
* Defense in Sector	Red forces penetrate Blue defense LER=1.01	Blue stops Red penetration LER=2.45	Increased Lethality and Survivability (2.5-fold)
* Movement to Contact	Red Loss-91 Blue Loss-80 LER=1.10	Red Loss-128 Blue Loss-72 LER=1.65	Increased Lethality and Survivability (1.5-fold)

Table 2. Operational Gains of Digitization
From Ref. (ADO, 1998)

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APPENDIX A. RAH-66 COMANCHE

The RAH-66 Comanche is a twin engine (T-801), single rotor helicopter with an all-composite fuselage. The aircraft is designed for low observability from radar and infrared sensors, and has enhancements to reduce its audible and visual signature. Both cockpits are identical, allowing all pilotage and mission equipment tasks to be conducted from either seat. All weapons systems are retractable, as is the three-wheeled landing gear. Supportability is based on two-level maintenance concept, Aviation Unit Level Maintenance (AVUM) and Depot Maintenance. Its armament includes the radar frequency (RF) version of the Hellfire missile. Designed for armed reconnaissance and incorporating the latest in stealth, sensors, weapons, and advanced flight capabilities, this combat multiplier is electronically integrated with other components of the digitized battlefield. Figure 21 depicts the capabilities of the Comanche. The fielding/basis of issue (BOI) is:

- Air Cavalry Troop (ACT) 12
- Heavy Attack Battalion 9
- Attack Battalion 24

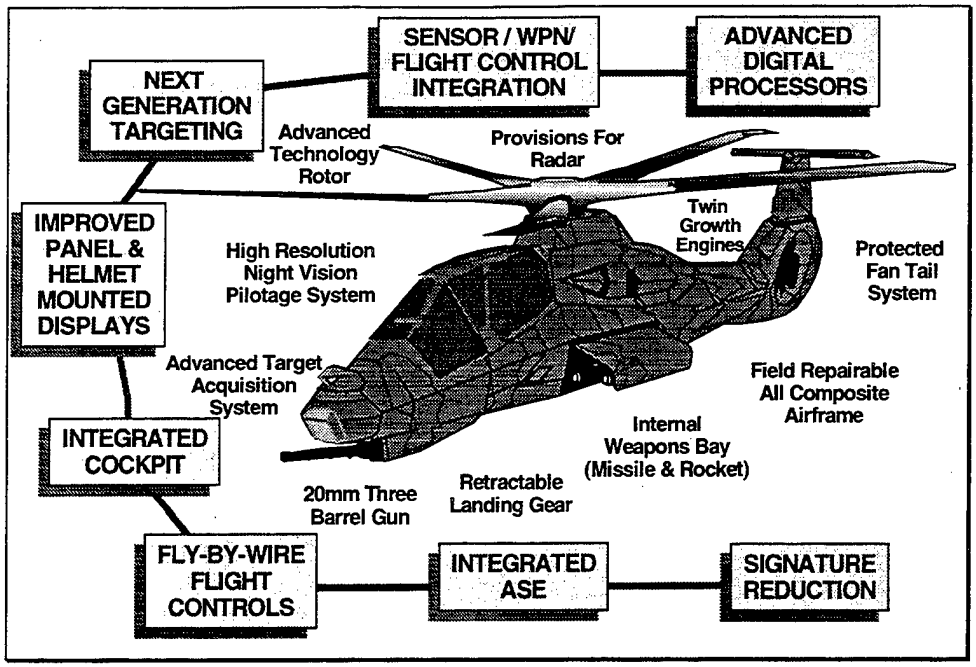

Figure 21. RAH-66 Comanche
From Ref. (USAAVNC DCD, 1999)

APPENDIX B. AH-64D LONGBOW APACHE

The AH-64D Longbow Apache is a twin engine, four bladed, tandem seats, and aerial weapons platform. The mission is to conduct distributed operation; precision strike against relocatable targets; and provide armed reconnaissance and security when required in day, night, obscured battlefield, and adverse weather conditions. The weapon systems include the 30mm automatic cannon, 70-millimeter (mm) aerial rockets, and the Hellfire modular missile systems. The aircraft's target acquisition system can automatically detect, classify, and prioritize ground and air targets. The target acquisition system uses a millimeter-wave radar to provide target data to a radar frequency (RF), fire-and-forget version of the Hellfire missile. The aircraft will retain the Semi-Active Laser (SAL) Hellfire missile and other existing weapon systems. The battle crew is digitally connected to ground forces. Figure 22 depicts the Longbow Apache's capabilities. The fielding/BOI is:

- Interim Attack Battalion — 24 (19 FCR equipped)
- Armored Cavalry Regiment (ACR) — 16 (FCR equipped)

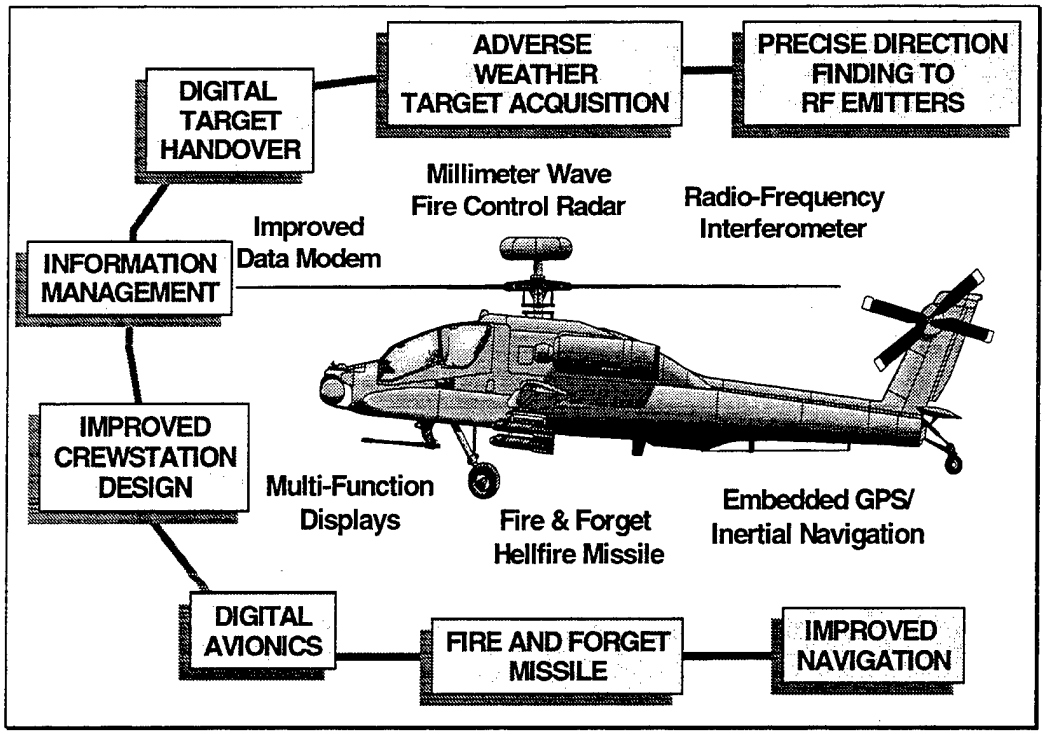

Figure 22. AH-64D Longbow Apache
From Ref. (USAAVNC DCD, 1999)

APPENDIX C. CH-47F IMPROVED CARGO HELICOPTER (ICH)

The improvements on the CH-47F Improved Cargo Helicopter (ICH) include new communications and electronic (data bus) architectures, powertrain upgrades, and airframe modifications. The program requires remanufacturing the CH-47 aircraft to reduce the aircraft's vibration resulting in lower Operations and Support (O&S) costs and allowing the aircraft to operate on the Army XXI digital battlefield. The aircraft will have a 1553 data bus and upgraded avionics that provides situational awareness display. The ICH will also acquire the capability to carry 16,000 pounds of external/internal cargo for a 50 nautical mile (NM) radius at 4000 feet pressure altitude (PA) and 95 degree Fahrenheit ambient with a 30 minute fuel reserve. These conditions characterize the operational combat scenario. The fielding/BOI is a one for one replacement of 300 CH-47D aircraft. Figure 23 depicts the capabilities of the ICH.

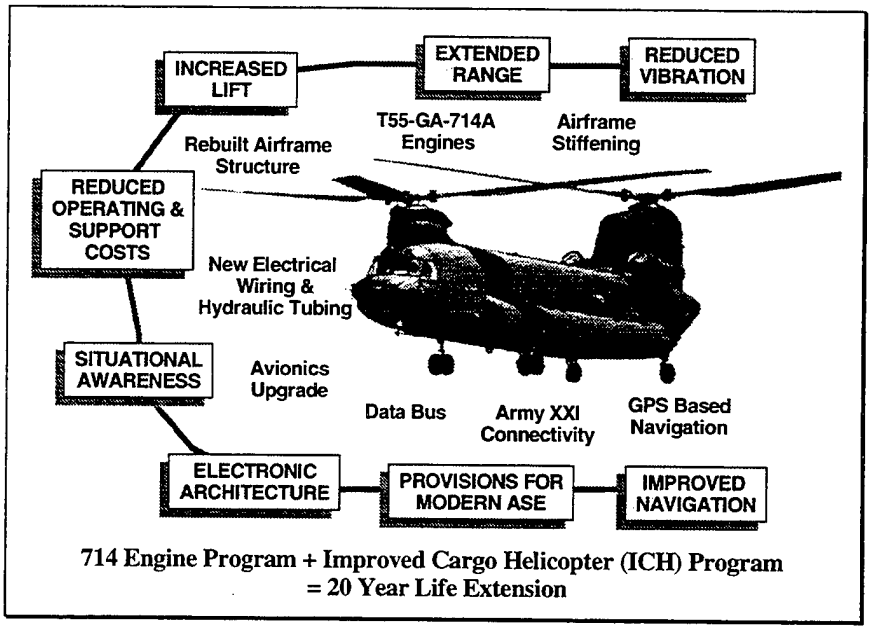

Figure 23. CH-47F Improved Cargo Helicopter (ICH)
From Ref. (USAAVNC DCD, 1999)

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APPENDIX D. OH-58D KIOWA WARRIOR (KW)

The OH-58D Kiowa Warrior enhancements include Embedded Global Positioning System Inertial Navigation Systems (EGI), an Improved Master Controller Processor Unit (IMCPU), Improved Data Modem Plus (IDM[+]), and Video Image Crosslink (VIXL), Improved Mast Mounted Sight Sensor Processor (IMSP), and digital map display. (USAAVNC DCD Program Summary, 1999) The aircraft will transition to a System Safety Enhancement Program (SSEP). The program incorporates the Full Authority Digital Electronic Control (FADEC) R/3 engine, crashworthy seats and cockpit airbags. Figure 24 depicts the enhancements of the KW SSEP. The 310 fielded KWs will be cycled through Bell Helicopter to be retrofitted for enhancements.

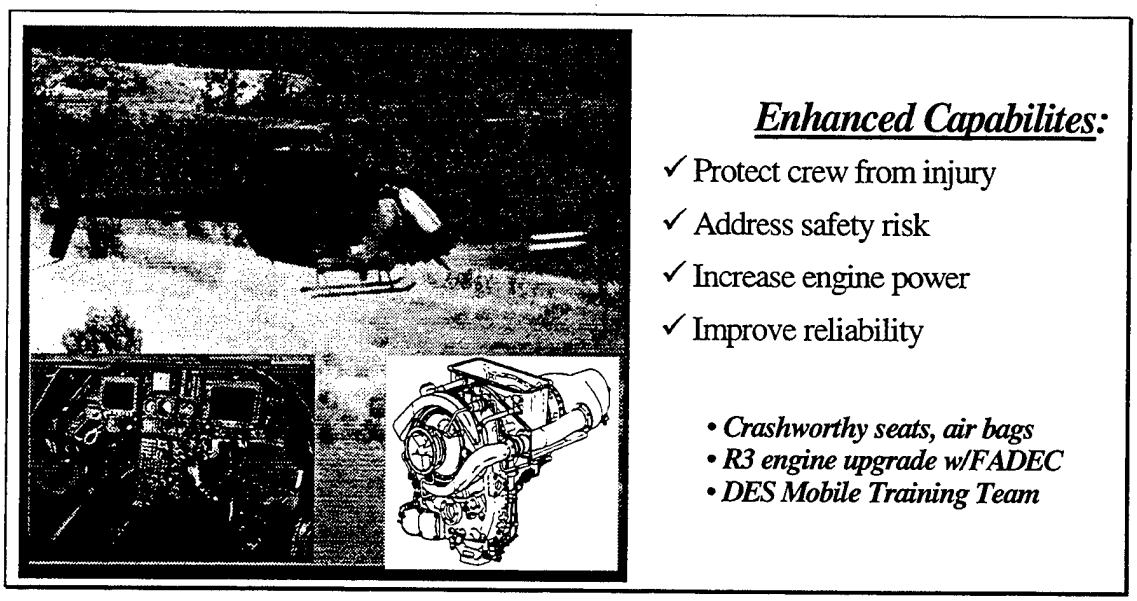

Figure 24. OH-58D Kiowa Warrior System Safety Enhancement Program (KW SSEP) After Ref. (USAAVNC DCD, 1999)

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APPENDIX E. AVIATION MISSION PLANNING SYSTEM (AMPS)

The Aviation Mission Planning System (AMPS) performs the following capabilities:

- Reduces mission-planning time.
- Develops operations order (OPORD).
- Exchanges information with MCS.
- Displays National Imagery and Mapping Agency (NIMA) ARC Digitized Raster Graphics maps.
- Enhances situation awareness using standard military symbology overlays.
- Develops enemy and hazard location overlays.
- Develops route overlays.
- Calculates threat intervisibility using NIMA DTED.
- Prints pilot kneecards.
- Displays 3-D mission preview.
- Initializes aircraft data via upload DTS cartridge.
- Transmits/receives of digital messages or files via Local Area Network (LAN).
- Transmits/receives of digital messages between the AMPS and aircraft via Combat Net Radio (CNR) using the Tactical Communications Interface Module (TCIM).
- Operates on a Pentium processor with Windows Operating System (OS) version 5.0 software.

The AMPS fielding/BOI is:

- Aviation Brigade/Regiment/Group/ Battalion/ Squadron 2 each
- Medium Helicopter Company (MHC) 3 each
- Aviation Company 1 each

- Air Ambulance Company/Detachment 2 each
- Aviation Electronic Warfare (EW) Platoon 1 each
- Aviation Liaison Officer (AV LNO) 1 each

APPENDIX F. JOINT TACTICAL RADIO SYSTEM (JTRS)

The Joint Tactical Radio System (JTRS) is family of secure software-programmable, hardware-configurable, multi-band, multi-mode, digital tactical radio to provide both line-of-sight (LOS) and beyond LOS C4I capabilities and global navigation information. JTRS will be employed on a wide range of weapons platforms and C2 nodes at all echelons for network connectivity across the RF spectrum. The architecture relies on a common communications network. The network will range from low capacity voice or data nets to high capacity video links or Wide Area Networks (WANs). Additionally, JTRS will maintain interoperability with current radios, networks, and legacy waveforms until they phase out of the system. Figure 25 depicts the design and additional capabilities of the JTRS. The fielding/BOI is under review but a tentative fielding date is scheduled for the year 2005.

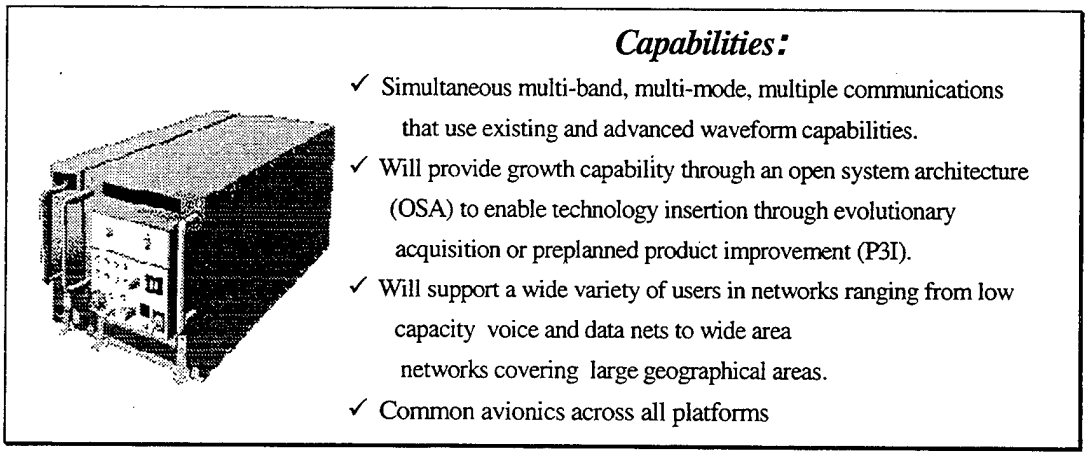

Figure 25. Joint Tactical Radio System (JTRS)
After Ref. (USAAVNC DCD, 1999)

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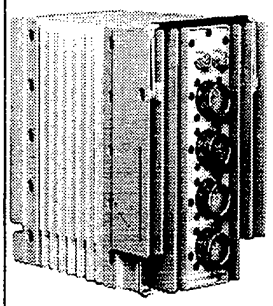
APPENDIX G. IMPROVED DATA MODEM (IDM)

The Improved Data Modem (IDM) is able to simultaneously transmit/receive information using four different radios. It interfaces with the Military Standard (MIL-STD) 1553 data bus and is interoperable with other combined and joint services. The data transmit rate is 16 kilobits per that can process up to 3,500 characters in length. The IDM contains two modems that support the four links and a Generic Interface Processor used for link and message processing. The chassis houses up to seven Standard Electronic Module, Type E (SEM-E). Three module slots are available of potential upgrades like a graphics processor, Asynchronous Transfer Mode (ATM) functionality, a Multi-Band, Multi-Mode transceiver function, or a Joint Tactical Information Distribution System (JTIDS) gateway. The IDM will host the EBC software and other required legacy communication software. The modem supports Tactical Fire (TACFIRE) Direction, Air Force Applications Program Development (AFAPD), JVMF, and Tactical Internet protocols and message sets. It will interface with the Ethernet and EPLRS. Implementing EBC features will permit the user to process situational awareness information. Figure 26 depicts the IDM box and additional capabilities. The fielding/BOI is by aircraft platforms:

- AH-64D Longbow Apache 758
- OH-58D Kiowa Warrior 365
- CH-47F Improved Cargo Helicopter 306
- UH-60X 1423
- UH-60Q 84
- Special Operations for Aviation (SOA) 97



Capabilities:

- ✓ Allows transmission of complex battlefield information in short coded bursts.
- ✓ Permits digital communication of information from tactical radios, on board sensors and processors.
- ✓ Replaces Airborne Target Handover System (ATHS) and is a stand-alone unit, weighing 14 lbs.
- ✓ Can simultaneously transmit/receive info using four different radios, interface with MIL-STD 1553 data bus and transmit data at rates of 16Kb ps.
- ✓Currently being upgraded to be the host for Embedded Battle Command (EBC)

Figure 26. Improved Data Modem (IDM)
After Ref. (USAAVNC DCD, 1999)

APPENDIX H. ACRONYMS LIST

A2C2S	Army Airborne Command and Control System
AAAA	Army Aviation Association of America
AAN	Army After Next
ABCS	Army Battle Command System
ACR	Armored Cavalry Regiment
ACT	Air Cavalry Troop
ACTD	Advanced Concept Technology Demonstration
ADA	Air Defense Artillery
ADCP	Aviation Digitization Campaign Plan
ADMP	Army Digitization Master Plan
ADO	Army Digitization Office
AECP	Army Experimental Campaign Plan
AFAPD	Air Force Applications Program Development
AFATDS	Advanced Field Artillery Tactical Data System
AH	Attack Helicopter
ALOC	Administration/Logistic
AMBL	Air Maneuver Battle Lab
AMP	Army Modernization Plan
AMPS	Aviation Mission Planning System
AO	Area of Operation
AOE	Army of Excellence
ARI	Army Research Institute

ARI	Aviation Restructure Initiative
ASAS	All Source Analysis System
ATA	Army Technical Architecture
ATCCS	Army Tactical Command and Control System
ATD	Advanced Technology Demonstration
ATHS	Airborne Target Handover System
ATS	Air Traffic Services
ATM	Asynchronous Transfer Mode
AV	Army Vision
AV LNO	Aviation Liaison Officer
AVTOC	Aviation Tactical Operations Center
AVUM	Aviation Unit Maintenance
AWC	Aviation Warfighting Center
AWE	Advanced Warfighting Experiment
AWR	Air Worthiness Release
BC	Battle Command
BCV	Battle Command Vehicle
BCT	Brigade Combat Team
BCTP	Battle Command Training Program
BFV	Bradley Fighting Vehicle
BIFV	Bradley Infantry Fighting Vehicle
BITS	Battlefield Information Transmission System
BLOS	Beyond Line-of-Sight

BOI	Basis of Issue
BOS	Battlefield Operating System
C2	Command and Control
C2V	Command and Control Vehicle
C3I	Command, Control, Communications, and Intelligence
C4I	Command, Control, Communications, Computers, and Intelligence
CA	Combat Arms
CALLCOMS	Center for Army Lessons Learned Collection Plan and Observation Management System
CD-ROM	Compact Disc Read Only Memory
CGS	Common Ground Station
CGSC	Command and General Staff College
CH	Cargo Helicopter
CHS	Common Hardware/Software
CNR	Combat Net Radio
COE	Common Operating Environment
CONUS	Continental United States
CoS	Chief of Staff
COTS	Commercial Off-the-Shelf
CP	Command Post
CPC	Comanche Portable Cockpit
CPG	Co-pilot/Gunner
CS	Combat Support
CSS	Combat Service Support

CSSCS	Combat Service Support Control System
CTC	Combat Training Center
CTSF	Central Technical Support Facility
CWO	Chief Warrant Officer
DA	Department of the Army
DAWE	Division Advanced Warfighting Experiment
DCD	Directorate of Combat Developments
DCSOPS	Deputy Chief of Staff Operations
DCSPERS	Deputy Chief of Staff for Personnel
DCST	Deputy Chief of Staff for Training
DCX	Division Capstone Exercise
DIL	Digital Integrated Laboratory
DISC4	Director of Information System for Command, Control, Communications, and Computers
DLSIE	Defense Logistics Studies Information Exchange
DoD	Department of Defense
DOTDS	Directorate of Training, Doctrine, and Simulation
DTED	Digital Terrain Elevation Data
DTLOMS	Doctrine, Training, Leader Development, Organization, Materiel, Soldier
DTS	Data Transfer System
EAC	Echelon of Corps
EAD	Echelon of Division
EBC	Embedded Battle Command
EGI	Embedded Global Positioning System Inertial Navigation System

EH	Electronic Warfare Helicopter
EPLRS	Enhanced Position Location Reporting System
EXFOR	Experimental Force
EW	Electronic Warfare
FAADC2	Forward Area Air Defense Command and Control
FADEC	Full Authority Digital Electronic Control
FBCB2	Force XXI Battle Command Brigade and Below
FCR	Fire Control Radar
FDC	First Digitized Corps
FDD	First Digitized Division
FIST-V	Fire Support Team-Vehicle
FM	Field Manual
FS	Fire Support
FSCS	Future Scout Combat System
FY	Fiscal Year
GCCS-A	Global Command and Control System-Army
GPS	Global Positioning System
GSM	Ground Station Module
HF	High Frequency
HIBC	Horizontal Integration of Battle Command
HQS	Headquarters
HQ	HAVEQUICK
ICH	Improved Cargo Helicopter
ICT	Integrated Concept Team

IDD	Interim Division Design
IDM	Improved Data Modem
IEW	Intelligence and Electronic Warfare
IMCPU	Improved Master Controller Processor Unit
IMSP	Improved Mast Mounted Sight Sensor Processor
IOTE	Initial Operational Test and Evaluation
IPT	Integrated Product Team
JROC	Joint Requirements Oversight Council
JSTARS	Joint Surveillance Target Attack Radar System
JTA-A	Joint Technical Architecture-Army
JTIDS	Joint Tactical Information Distribution System
JTRS	Joint Tactical Radio System
JV	Joint Vision
JVMF	Joint Variable Message Format
KW	Kiowa Warrior
LAN	Local Area Network
LBHMMS	Longbow Hellfire Modular Missile System
LCT	Longbow Crew Trainer
LCU	Lightweight Computer Unit
LOS	Line-of-Sight
LUT	Limited Users Test
MACOM	Major Command
MANPAD	Man Portable Air Defense

MCS	Maneuver Control System
MDMP	Military Decision-Making Process
MEDEVAC	Medical Evacuation
METT-T	Mission, Enemy, Troops, Terrain, and Time
MHC	Medium Helicopter Company
MIL-STD	Military Standard
MLRS	Multiple Launch Rocket System
MM	Millimeter
MNS	Mission Needs Stay
MO	Magnetic Optical
MOS	Military Occupational Skill
MSE	Mobile Subscriber Equipment
MSIP	Multi-Stage Improvement Program
NBC	Nuclear, Biological, Chemical
NCA	National Command Authority
NIMA	National Imagery and Mapping Agency
NM	Nautical Mile
NMS	National Military Strategy
NOE	Nap-of-the-Earth
NTC	National Training Center
OH	Observation Helicopter
OPORD	Operations Order
OPS	Operations

OPTEMPO	Operational Tempo
O&O	Operations and Organizations
ORD	Operational Requirements Document
O&S	Operations and Support
OS	Operating System
OSA	Office of the Secretary of the Army
OSD	Office of the Secretary of the Defense
OTM	On-the-Move
P3I	Preplanned Product Improvement
PA	Pressure Altitude
PEO AVN	Program Executive Office for Aviation
PM	Project Manager
PMO	Program Management Office
PW	Prairie Warrior
RAH	Reconnaissance/Attack Helicopter
RF	Radar Frequency
RDTE	Research, Development, Test, and Evaluation
SA	Situational Awareness
SAL	Semi-Active Laser
SEAD	Suppression of Enemy Air Defense
SEM-E	Standard Electronic Module-Type E
SICPS	Standard Integrated Command Post Shelter
SINCGARS	Single Channel Ground and Airborne Radio Subsystem

SIP	System Improvement Program
SLOC	Source Lines of Code
SME	Subject Matter Expert
SOA	Special Operations for Aviation
SOF	Special Operation Force
SSEP	System Safety Enhancement Program
TAC	Tactical Center
TACCP	Tactical Command Post
TACFIRE	Tactical Fire
TADSS	Training Aids, Devices, Simulators, and Simulations
TAIS	Tactical Airspace Integration System
TCIM	Tactical Communications Interface Module
TDA	Table of Distribution and Allowances
TF	Task Force
TI	Tactical Internet
TOC	Tactical Operations Center
TOE	Table of Organization and Equipment
TRADOC	Training and Doctrine Command
TSM	Training and Doctrine Command System Manager
TTP	Tactics, Techniques, and Procedures
UAV	Unmanned Aerial Vehicle
UH	Utility Helicopter
USAAVNC	United States Army Aviation Center
USARPAC	United States Army-Pacific

USARSO	United States Army-South
VIXL	Video Image Crosslink
WAN	Wide Area Network
WFX	Warfighting Exercise
WRAP ASARC	Warfighting Rapid Acquisition Program Army Systems Acquisition Review Council

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2. Carter, Clay, Lieutenant Colonel, Deputy TRADOC System Manager (TSM) for Longbow Apache, July 1999.

3. Kokoskie, Gregory, Major, Assistant Product Manager (APM) for Apache Longbow Preplanned Product Improvements (P3I), July 1999.

4. Madigan, Doug, Principal Engineer, Applied Technology Group, Veridian Engineering, July 1999.

5. McDonald, Suzie, Instructional Systems Specialist, Directorate of Training, Doctrine, and Simulation (DOTDS, July 1999.

6. Schulz, Robert R., Major, Assistant Product Manager (APM) for Army Airborne Command and Control System (A2C2S), July 1999.

7. Tutin, Lee, Chief Warrant Officer Three, Assistant TRADOC System Manger (TSM) Comanche for Digitization, July 1999.

8. Van Loo, Joseph, Ph.D., Operations and Research Analyst, Air Maneuver Battle Lab (AMBL), July 1999.

9. Woods, Steve, Chief Warrant Officer Four, Aviation Electronic Combat Team Leader, Directorate of Training, Doctrine, and Simulation (DOTDS), July 1999.

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