NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

THE EXPEDITIONARY AEROSPACE FORCE AND DISTRIBUTED OPERATIONS FOR COMMAND AND CONTROL

by

Sean P. Robinson

June 1999

Principal Advisor:	Michael Mullady
Associate Advisor:	William G. Kemple

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REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	June 1999	Master's Thesis

4. TITLE AND SUBTITLE : THE EXPEDITIONARY AEROSPACE FORCE AND DISTRIBUTED OPERATIONS FOR COMMAND AND CONTROL

5. FUNDING NUMBERS

6. AUTHOR(S) Robinson, Sean P.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Postgraduate School
Monterey, CA 93943-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
N/A

10. SPONSORING /MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(maximum 200 words)*

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The Air Force's transition to an expeditionary aerospace force and corresponding reliance on "distributed operations" poses new challenges to command and control. This thesis examines the changes the Air Force is undertaking to meet the challenges associated with implementing the EAF concept. These changes fit into the three pillars of command and control – personnel, processes, and technology.

14. SUBJECT TERMS Expeditionary Aerospace Force, Command and Control, Distributed Operations

15. NUMBER OF PAGES 100

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

Approved for public release; distribution is unlimited

THE EXPEDITIONARY AEROSPACE FORCE AND DISTRIBUTED OPERATIONS FOR COMMAND AND CONTROL

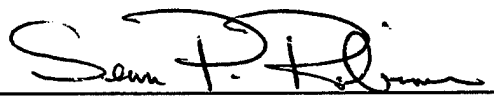
Sean P. Robinson
Captain, United States Air Force
B.S., West Virginia State College, 1990

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN SYSTEMS TECHNOLOGY (COMMAND, CONTROL, AND COMMUNICATIONS)

from the

NAVAL POSTGRADUATE SCHOOL
June 1999

Author: 
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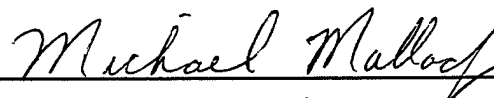
Approved by: 
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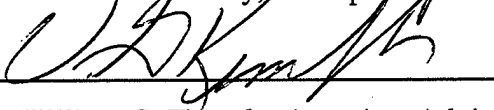
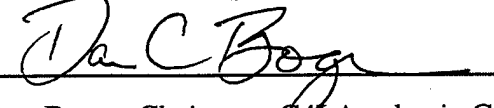

William G. Kemple, Associate Advisor


Dan Boger, Chairman, C4I Academic Group

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In the latter part of 1998, the United States Air Force began to institutionalize its post-Cold War expeditionary nature by ushering in its "Expeditionary Aerospace Force" (EAF) concept. A critical component of this concept is a "lean" force which calls for a reduction of the Air Force's forward-deployed footprint of both personnel and equipment. This reduction is supported by and relies on advances in information and communications technologies. These technological advances allow the Air Force to conduct operations from multiple, independent nodes in a teaming manner. This approach, also known as "distributed operations", is becoming standard throughout the U.S. Armed Forces. It allows many personnel to remain geographically separated from the forward-deployed forces which "reach back" to rear locations for required support.

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Force Experiment 1998. Finally, the thesis covers the technology pillar, which includes facilities, equipment, and communications by providing an overview of various command and control nodes used in aerospace operations, including the Rear Operations Support Center utilized during EFX '98, the Theater Deployable Communications and Theater Battle Management Core Systems programs, and the Collaborative Virtual Workspace software.

The thesis begins, though, with an overview of the EAF concept as well as a review of several broad initiatives underway to aid the Air Force in transitioning to an expeditionary aerospace force.

I. INTRODUCTION

A. SCOPE

In the latter part of 1998, the United States Air Force began to institutionalize its post-Cold War expeditionary nature by ushering in its "Expeditionary Aerospace Force" (EAF) concept. A critical component of this concept is a "lean" force which calls for a reduction of the Air Force's forward-deployed footprint of both personnel and equipment. This reduction is supported by and relies on advances in information and communications technologies. These technological advances allow the Air Force to conduct operations from multiple, independent nodes in a teaming manner. This approach, also known as "distributed operations", is becoming standard throughout the U.S. Armed Forces. It allows many personnel to remain geographically separated from the forward-deployed forces which "reach back" to rear locations for required support.

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The thesis begins, though, with an overview of the EAF concept as well as a review of several broad initiatives underway to aid the Air Force in transitioning to an expeditionary aerospace force.

B. THE ROAD TO EAF

In August 1998, the United States Air Force (USAF) Chief of Staff, General Michael Ryan, and F. Whitten Peters, Acting Secretary of the Air Force, unveiled a major restructuring initiative for employing Air Force forces in preparation for the 21st Century. The new concept, termed "Expeditionary Aerospace Force" (EAF), will require a cultural change on the part of USAF personnel to an "expeditionary mindset."

In a nutshell, the Air Force is intent on fashioning leaner, more mobile, yet still very capable deploying forces that can quickly and decisively support regional commanders overseas in the varied peacetime contingency operations that have become the norm. At the same time, the Service wants to reduce the high personnel tempo burden

that its units have experienced in recent years as a result of those frequent contingencies. [Ref. 1]

Why the change? Although the EAF concept will hopefully alleviate problems plaguing the Air Force today (i.e., PersTempo, retention rates, etc.), the main reason for restructuring stems from the end of the Cold War. General Ryan noted, "Our Cold War transitioning to our two regional war scenario has ill-prepared us for the expeditionary demands of ... lesser regional contingencies." [Ref. 1]

During the Cold War, the Air Force was a garrison force focused on containment and operating as wings primarily out of fixed bases in the United States, Europe and the Pacific. With the end of the Cold War, the Air Force closed many of those fixed bases, and operations increasingly focused on contingency operations in which selected squadrons deployed from the United States, the Pacific or Europe to forward bases for the duration of the mission. Over the past decade, the Air Force decreased its permanent overseas bases from 50 to 17, leading to more deployments from US bases. The Service had to create eight expeditionary bases overseas to facilitate ongoing operations in the Middle East and in Bosnia, and found itself gutting the support structure of its permanent home bases in order to man those deployment bases. Service officials say they need to consolidate forces on fewer permanent bases. [Ref. 1]

In emphasizing this point, General Ryan stated:

> We have been stuck in a Cold War-basing paradigm that had, as its basis, that if we need to fight a theater war, we would deploy the forces and support [personnel], win the conflict, and return victorious. Meanwhile, the bases we stripped of support for our deployed forces would just have to make do. But the security demands of the world we

> live in are not cooperating with the paradigm and will not in the foreseeable future. [Ref. 1]

Ryan amplified those comments at the 1998 Royal Australian Air Force Airpower Conference:

> The US Air Force is no longer a Cold War garrison force focused on containment. We no longer have the massive preplanned beddown bases [overseas] with the fixed infrastructure of the past. The paradigm has shifted to a world that requires rapid and tailored engagement in many regions and many situations. [Ref. 1]

C. AIR EXPEDITIONARY FORCE

A key component of the EAF will be the Air Expeditionary Force or AEF. Beginning in 1995 the Air Force began experimenting with moving a large integrated force, termed AEF, of fighter and bomber aircraft into a foreign theater as a unit with integrated command and control. The AEF is an aerial task force structured to respond swiftly to overseas contingencies, with ample air-to-air and air-to-surface firepower. The integrated AEF gives an area Commander-in-Chief (CINC) the ability to put large, sustained firepower onto targets within 72 hours of an execute order.

For example, the first AEF deployed to Bahrain in late 1995 with F-16Cs and F-16HTSs for air-to-air combat, air-to-surface strikes, and suppression of enemy air defenses. More recently, an AEF deployed to the Persian Gulf in November 1998 when President Clinton authorized a new buildup in the region. This AEF comprised of B-1Bs, B-52s, F-16CJs, F-15C/Ds, F-16Cs, and F-117s.

The Air Force's experience with AEFs has convinced its leaders that such forces are a far superior way to respond to crises and that the Air Force should move forward from ad hoc forces and command and control structures used in the past. What Mr. Peters and General Ryan announced in August was the next logical step in institutionalizing the AEF concept.

The Air Force plans to refine the AEF concept over the next two years as it organizes standing AEFs, each with similar capabilities, made up of different mixes of different aircraft from different home bases that will train together on a regular basis. Chapter II provides a detailed look at some of the key features of the EAF concept and the AEF structure.

D. IMPROVED C2/C4 FOR A "LIGHT, LEAN, LETHAL" FORCE

General Ryan described the Expeditionary Aerospace Force as being a "light, lean, and lethal" force:

> Light–so it can move rapidly and efficiently to where we are required. Lean–so that we can move with fewer airlift resources. It means operating out of any location with a smaller footprint that requires less support and fewer lives in danger. Lethal–to accomplish the mission, whatever it is, effectively, with minimum resources. [Ref. 1]

The key to successfully implementing this "light, lean, lethal" force will be improving the command and control (C2) processes and the command, control, communications, and computers (C4) systems that will be used to support these C2 processes. One of the major initiatives toward achieving "leanness" is a reduction of the Air Force's forward-deployed footprint of both personnel and equipment. This reduction

is supported by and relies on advances in information and communications technologies. These advances, in turn, allow a higher reliance on distributed operations.

E. DISTRIBUTED OPERATIONS

Distributed operations refer to conducting operations from multiple, independent nodes in a teaming manner. In distributed operations the relationships between nodes may vary according to the nature of the operation, while enabling a more survivable endeavor through distribution of tasks and databases in a redundant network. In some instances, a superior/subordinate relationship exists between distributed nodes, while in other instances, distributed nodes have a horizontal relationship [Ref. 2]

Similarly, the term "split operations" describes those operations conducted by a single C2 entity that is split between two or more geographic locations. However, unlike distributed operations, the elements involved in a split operation belong to the same commander. [Ref. 2]

Distributed operations are not new to the military. In fact, military operations have used distributed technologies in the area of command and control for many years. The method of communication and the network for working issues has changed, but military leaders have always distributed their operations between multiple echelons. What has changed is that technology enables more participants to create complex networks. With the advent of a global grid, concepts such as global awareness and information superiority will further enhance the U.S. Armed Forces' ability to conduct operations in a networked, distributive/collaborative manner.

Distributed operations powered by advances in technology will reduce the deployment footprint of air forces by allowing many personnel to remain in a rear area. For example, during Operation Desert Storm, it took 10 to 15 days and 25 C-17 air lifters to create a support system for nearly 2,000 people [Ref. 3]. However, during the Air Force's 1998 Expeditionary Force Experiment, the forward operations center was deployed in just two C-17s to support approximately 115 personnel. Although the required manning for forward operations will vary with each type of mission, the Air Force's goal is still to dramatically reduce its forward-deployed footprint by harnessing advances in technology, as well as improvements in processes and organization.

Utilizing the advantages of distributed operations is not unique to the Air Force; it is quickly becoming standard operating procedure for the U.S. Armed Forces. In fact, a 26 April 1999 *Federal Computer Week* article [Ref. 4] highlighted how the U.S. Central Command (CENTCOM) is rethinking some of the fundamental concepts that make up military command, control, communications and intelligence (C3I) doctrine. Spearheading this shift is the notion of distributed/split operations - using more information and fewer people in fighting battles. The management of both would be handled from stationary locations away from the fighting. Nowhere is this concept being put to a greater test than throughout CENTCOM's vast area of responsibility, including the Persian Gulf and Central and Southwest Asia. [Ref. 4]

"All of the Services have gone through a change in the way they go about providing C3I support," said Marine Col. Timothy J. Himes, division chief for CENTCOM's J-6 Plans and Operations Division. "During Desert Storm, we virtually

disconnected from everything in the U.S.," Himes said. "Now we are talking about having our core processes in the rear and leaving them in the rear." [Ref. 4]

F. DEFINING COMMAND AND CONTROL

Department of Defense (DOD) *Joint Pub 1-02: DoD Dictionary of Military and Associated Terms* [Ref. 5] defines command and control as follows:

> The exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures which are employed by a commander in planning, directing, coordinating and controlling forces and operations in the accomplishment of the mission. [Ref. 5]

Air Force Doctrine Document 2-8: Command and Control Doctrine [Ref. 6] groups this "arrangement" into logical categories:

> The first category is personnel, which covers the human aspects of command and control. The definition next mentions equipment, communications, and facilities, which are technology elements needed to overcome the warfighting problems of integrating actions across space and time. This second category has a tendency to dominate command and control because high technology warfare characterizes American warfare. A third category called process encompasses "procedures." [Ref. 6]

These three areas – personnel (which encompasses organization), technology, and processes – are the "pillars" of command and control. Improving these pillars is crucial to ensuring the success of the Expeditionary Aerospace Force. In a paper produced by the Air Force's Aerospace Command and Control Agency in August 1998 [Ref. 7], command and control is referred to as a weapons system. Like any other weapon system in the aerospace force, the paper stresses, the C2 weapon system provides the Air Force the

capability to achieve the EAF objective. "Along with fighters, bombers, air lifters, and Intelligence, Surveillance, and Reconnaissance, C2 is an integral part of creating an AEF. However, command and control is the link that ties it together and is rapidly becoming the single most important key to the success of our future AEFs and the EAF concept as a whole." [Ref. 7]

G. THESIS ORGANIZATION

Chapter II provides an overview of the Expeditionary Aerospace Force concept. Chapter III highlights several of the initiatives the Air Force has taken to make the transition into an Expeditionary Aerospace Force. Chapter IV examines the organization and employment of aerospace power as presented in a recently released Air Force doctrine document. Chapter V reviews the air tasking cycle as detailed in *Joint Pub 3-56.1: Command and Control for Joint Air Operations*. Chapter VI analyzes some of the technologies the Air Force will rely on to reduce their forward-deployed footprint. Finally, Chapter VII concludes this paper.

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II. EXPEDITIONARY AEROSPACE FORCE OVERVIEW

A. INTRODUCTION

According to General Ryan in an article he wrote in December 1998 [Ref. 8], the EAF concept was eight years in the making. Since the end of the Cold War, the Air Force has been wrestling with various ways to respond to an increasing number of contingencies. This challenge took a high toll on Air Force personnel, both on those deployed to remote locations around the world, as well as those who remained at home station whose workload expanded to make up for their absent teammates. To meet the demands of this challenge and others, the Air Force conducted a six-month study during 1998 to devise a new framework. [Ref. 8]

This new framework was to meet three straightforward requirements:

- Provide U.S. military Commanders in Chief the right force at the right place at the right time, regardless of mission. [Ref. 8]
- Reduce deployment tempo by building more stability and predictability into the way the Air Force scheduled its personnel to respond to contingencies. [Ref. 8]
- Take full advantage of the vital contribution of the total force -- active duty, civilians, Reservists, and Air National Guardsmen. [Ref. 8]

The resulting plan -- the EAF concept and the Air Expeditionary Forces -- will allow the Air Force to provide aerospace power rapidly and decisively, anywhere and anytime. The goal is to have the capability in place by 1 January 2000. However, an *Air*

Force Times article dated 10 May 1999 stated that the demands placed on the Air Force by Operation Allied Force may cause the date to slip [Ref. 9].

In August 1998 Acting Secretary of the Air Force Peters and General Ryan highlighted the key features of the EAF concept:

- Each Air Expeditionary Force will be on call to handle contingencies for about 90 days roughly every 15 months; on average, two AEFs out of about 10 will be on call at any time [Ref. 10]. (See section F of this chapter for details on the 15-month cycle.)
- Units assigned to AEFs will train as they will fight. During certain periods, active duty, Guard and Reserve units will train together using integrated command and control provided by a lead wing plus command elements from constituent units. [Ref. 10]
- Deploying forces from each AEF will be specifically tailored to a contingency in support of warfighting CINCs, making the air forces lighter, leaner, and more lethal than before [Ref. 10].
- Personnel will have more predictability and stability to their lives as units deploy forward or remain on call for operations during a known 90-day window [Ref. 10].
- All operational units will have a schedule of deployments -- for training and exercises, as well as known contingency deployments -- up to a year or more in advance. This will provide Guardsmen, Reservists and their employers

much better notice of deployments, allowing better use of those forces. [Ref. 10]

- About 5,000 positions will be created to support deployed forces and home bases by switching authorizations from specialties less likely to deploy. The new positions will be spread across Air Force installations, using a small manpower boost to ease the tempo for highly stressed support forces. [Ref. 10]

Each AEF team will consist of approximately 175 aircraft. This includes F-15C air-to-air fighters; F-15E ground-attack jets; F-16CJ jets to suppress enemy antiaircraft missiles; A-10s for armor attack missions; as well as other surveillance, refueling and transport aircraft. The team will also have F-117 Stealth fighters, B-52, B-1, and B-2 bombers on call, but those will remain at military bases until needed. [Ref. 11]

A recent *Air Force Times* article [Ref. 12] highlighted additional details about the expeditionary plan. The details, released by the Air Force during a 4 March 1999 announcement, included four main segments:

- Ten AEFs, as originally announced
- Two rapid-response wings, called aerospace expeditionary wings, or AEWs
- Five forces geared toward airlift and refueling, called mobility aerospace expeditionary forces
- Groups of noncombat forces, called enablers

Each of these groups has lead units (see Table 1). For example, there are 10 lead AEF wings. As of this writing, the Air Force has not announced which Air Force units

will be assigned to work with these lead units. Units within the four segments will begin training together during the summer of 1999, with the first units deploying in October 1999 for three months. The goal is to complete the entire expeditionary structure by the end of 1999. [Ref. 12]

Aerospace Expeditionary Forces	
388th Fighter Wing	Hill AFB, Utah
7th Bomb Wing	Dyess AFB, Texas
3rd Wing	Elmendorf AFB, Alaska
48th Fighter Wing	RAF Lakenheath, England
355th Wing	Davis-Monthan AFB, Arizona
20th Fighter Wing	Shaw AFB, South Carolina
2nd Bomb Wing	Barksdale AFB, Louisiana
28th Bomb Wing	Ellsworth AFB, South Dakota
27th Fighter Wing	Cannon AFB, New Mexico
1st Fighter Wing	Langley AFB, Virginia
Aerospace Expeditionary Wings	
366th Wing	Mountain Home AFB, Idaho
4th Fighter Wing	Seymour Johnson AFB, North Carolina
Mobility Aerospace Expeditionary Forces	
43rd Airlift Wing	Pope AFB, North Carolina
60th Air Mobility Wing	Travis AFB, California
22nd Air Refueling Wing	McConnell AFB, Kansas
319th Air Refueling Wing	Grand Forks AFB, North Dakota
92nd Air Refueling Wing	Fairchild AFB, Washington

Table 1 Lead AEF Units From Ref. [12]

B. AIR EXPEDITIONARY FORCES

The 10 aerospace expeditionary forces listed above are the main building blocks of the structure. The lead wings were chosen because each had "deep pockets of people and leadership," said Colonel Mark Jefferson, deputy director of expeditionary force

development at the Pentagon. The lead wings also have sufficient infrastructure to handle deployments as well as their stay-at-home responsibilities. [Ref. 12]

Ideally, the forces will have similar combat and noncombat capabilities and similar numbers of geographically separated squadrons. Although some personnel slots and aircraft will be shuffled among bases, those numbers are quite small. An entire expeditionary force, though, would rarely deploy, leaving units behind that could be tapped by the other expeditionary segments if necessary. [Ref. 12]

"If any expeditionary force deploys to an area where there is not an established command and control structure, the lead wing commander will deploy his command structure and serve as commander of that deployment," Jefferson said. [Ref. 12] However, during most deployments, the expeditionary units will plug into established command structures, similar to the way units plug into the joint task force in Southwest Asia. [Ref. 12]

C. AIR EXPEDITIONARY WINGS

According to the Air Force's 4 March 1999 announcement, the two rapid-response wings are primarily designed to handle "pop-up" events that would require combat forces to deploy quickly. [Ref. 12]

The 366th Wing at Mountain Home Air Force Base, Idaho, and the 4th Fighter Wing at Seymour Johnson Air Force Base, North Carolina, will form the core of the wings. Each wing will operate as a mini-expeditionary force. Each will be on call for 90-day periods about twice a year. Neither wing will get additional permanent aircraft for

deployment purposes, but each will have other geographically separated aircraft units "attached" to them for training and deployment purposes. Eventually, Air Force officials hope to meld the wings into the 10 expeditionary forces, but currently, the wings have squadrons that do not have enough personnel or equipment to operate independently. [Ref. 12]

D. MOBILITY AIR EXPEDITIONARY FORCES

The five mobility forces are the newest segment of the expeditionary plan. The mobility forces were added to the mix after October's Hurricane Mitch, which devastated Central America. During the 4 March 1999 announcement, Acting Secretary Peters said, "We realized when we did Hurricane Mitch that we needed a core leadership element to do all these humanitarian operations, primarily coming from the transport and global mobility communities." Compared with the other segments, the mobility forces are more of a leadership element. They have few of their own forces, so they will draw manpower from the 10 expeditionary forces that are on call at the same time as the mobility forces are. [Ref. 12]

E. ENABLERS

Enablers are forces not assigned to specific expeditionary forces because they are in short supply, their job is too specialized, or they support other military services. For example, long-range airlift would be an enabler, as would other aircraft in short supply, such as U-2 spy planes and E-3 Sentry AWACS planes. At the same time, special

operations troops, satellite operators and civil engineering RED HORSE teams have jobs that are too specialized to assign them to an expeditionary force. [Ref. 12]

F. SUMMARY

As stated in the *Air Force Posture Statement 1999*:

> The Expeditionary Aerospace Force (EAF) concept represents an evolutionary transition from a threat-based, Cold-War garrison force, oriented on containing the Soviet Union, to a capabilities-based force focused on responsiveness and engagement. AEFs will provide US combatant commanders more capable, highly trained forces. Training as a team during their spin-up cycle, AEFs will form fully integrated aerospace units that combine the capabilities of the Service's weapons systems to create a powerful composite force. [Ref. 13]

However, a point to keep in mind, as noted by F. Whitten Peters during the February 1999 Air Force Association Air Warfare Symposium, is that "...as good as the EAF plan is ... it is a journey and a vision, not an end state we will complete on January 1, 2000." [Ref. 14]

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III. EAF INITIATIVES

This chapter provides a broad overview of the various U.S. Air Force initiatives for transitioning to an Expeditionary Aerospace Force culture. The following is not an all-inclusive list but provides insight into some of the methods the Air Force is using.

A. DOCTRINE

In September 1998, the Air Force released *Air Force Doctrine Document 2 (AFDD 2): Organization and Employment of Aerospace Power. AFDD 2* serves as the Air Force's capstone document of its operational doctrine series. *AFDD 2* is the companion document to *AFDD 1: Air Force Basic Doctrine*, which presents the fundamentals of aerospace power. Although *AFDD 2* is less than a year old from the time of this writing, changes to the document are already underway. The Spring 1999 revision, which is in draft status as of this writing, reflects mostly cosmetic changes. As *AFDD 1: Air Force Basic Doctrine* highlights, "Doctrine is constantly changing as new experiences and advances in technology point the way to the force of the future." [Ref. 15] Chapter IV of this thesis covers *AFDD 2* in more detail.

B. TRAINING

The Air Force has also initiated modifications in training of its personnel to complement the changes in doctrine.

In July 1998 the Air Force launched a new level of professional military education – the Aerospace Basic Course (ABC). ABC is now the first level of professional military education (PME) instruction for commissioned officers. ABC was created to strengthen

the culture of the Air Force. In his opening ceremony address for ABC, General Lloyd W. "Fig" Newton, Commander, Air Force Air Education and Training Command, remarked that ABC was designed to provide Air Force officers with a common frame of reference for understanding and employing aerospace forces [Ref. 16]. The course will help officers move from Air Force specialists to warfighting strategists [Ref. 16]. The pinnacle of the 4-week course is a 3-day wargame in field conditions. During the wargame students are thrust into decision-making positions in a Wing Operations Center and Joint Air Operations Center. This capstone exercise demonstrates to the student the teamwork required to successfully plan a joint aerospace campaign.

Building on the basics taught at ABC, the Air Force has developed the Aerospace Power Course (APC). APC is intended to better prepare Air Force Officers for joint duty by providing them knowledge of aerospace power theory, doctrine, and employment. The student is exposed to many of the aerospace power doctrinal tools necessary to perform joint staff duties by progressing through the following: air power history, lessons learned from past applications of air power, and discussions on how aerospace power contributes to attaining national security and theater objectives. The Aerospace Power Course better prepares Air Force officers to articulate and advocate aerospace power principles and beliefs in the joint arena. The course is a self-paced, interactive course that uses a variety of distance learning media and consists of 11 separate blocks of instruction. [Ref. 17]

C. WARGAMING

The Air Force conducts two major wargames each year that focus on force employment concepts and long-range planning. The first, the Global Engagement series, investigates operational issues eight years into the future. The second, the Aerospace Future Capabilities series, focuses on capability issues 20 years into the future. [Ref. 13]

Global Engagement wargames improve the understanding of the contributions aerospace power makes to the joint force. A key aspect of Global Engagement '98 was the rapid deployment and sustainment of multiple Aerospace Expeditionary Forces that included Air Reserve Component elements. The game demonstrated the use of aerospace power as a potent maneuver force for the joint force commander. [Ref. 13]

The Aerospace Future Capabilities Wargames evaluate strengths and weaknesses of capabilities contemplated by the Air Force's Vision and Strategic Plan. They also test alternative force structures in future warfighting environments. During the 1998 game, the Air Force gained valuable insights into the opportunities provided by—and challenges associated with—standoff warfare in an anti-access environment. [Ref. 13]

D. EXPEDITIONARY FORCE EXPERIMENT

In a 1996 study [Ref. 18], the U.S. Air Force Scientific Advisory Board (SAB) recommended developing a migration strategy and process improvements to rapidly develop and field modern command and control capabilities for the Air Force. The SAB noted, "The Air Force needs to institutionalize a process to ensure it can rapidly exploit technology advances as it continues to modernize its C2 systems." The SAB also

recommended the Air Force devise and employ a "spiral" development process to continually assess modernization opportunities. This "spiral" development process allows operational feedback during all phases of system development and takes advantage of rapidly evolving new technology from the commercial world. The end result is rapid fielding of operationally viable capabilities that exploit the latest advances in technology.

In step with the SAB study, the CSAF directed the newly implemented Air and Space Command and Control Agency to develop and manage a series of experiments, called Expeditionary Force Experiments (EFXs). The purpose of the EFX was to explore emerging technologies, procedures, and requirements to strengthen Air Force capabilities into the next millenium. EFX combines people in new organizational structures, and offers them technologies with new capabilities to perform processes in which they are the current experts. EFX provides warfighters the opportunity to explore new and different ways of doing what they do. [Ref. 19]

EFX integrates both C2 concepts and technologies and air and space weapons systems. The spiral development process facilitates integration. Experts from acquisition and industry join developers, testers, and warfighters—the users—to work together to accelerate the improvement and acquisition of C2 systems. EFX underpins the Air Force EAF efforts by improving joint warfighting capabilities, allowing operational experimentation without the fear of failure inherent with a military exercise, and integrating people, processes, concepts, organizations and technologies faster and more efficiently. [Ref. 19]

EFX combines live-fly exercises, simulations, and technology insertion into a seamless warfighting environment for experimentation. Experimentation will help field new and updated C2 processes, equipment, and software tools to the warfighter as soon as the technology becomes available. Experienced operators and staff personnel assess the concepts and technologies, or "initiatives," in an operational arena, the Joint Air Operations Center (JAOC). Warfighters determine value added of new concepts and technologies in the context of how they support JAOC processes within new or existing structures. [Ref. 19]

The overarching hypothesis for the EFX Program is: *Advanced Air and Space warfighting concepts enhance the nation's ability to rapidly halt an invading force anywhere in the world, even with limited warning.* EFX results will be achieved through incremental, annual experimentation. The Air Force will use emerging paradigms for distributed C2 to employ unique capabilities of the nation's Air and Space forces in response to contingencies. [Ref. 19]

The general methodology for experimentation is to identify an overall *Joint Vision 2010* focus for each year and the Desired Operational Capabilities (DOCs) that define the new operational concept. The concepts and defining DOCs are provided periodically to the public and private sectors, and initiatives (technologies, applications, etc.) are generated. Assessment of the initiatives during each EFX helps validate or refine the Air Force's understanding of the desired capabilities and also identifies implications for changing doctrine, organizations, training, materiel, future leaders, and people. [Ref. 20]

The initial Expeditionary Force Experiment, EFX '98, took place 10–24 September 1998. EFX '98 focused on Command and Control, specifically, how to manage a short-notice air operation without breaks in command, while reducing the number of people and amount of equipment to be deployed. The experiment was designed to evaluate how the U.S. could use advanced C2 for planning and control of forces while operating in a distributed (split) Joint Air Operations Center (JAOC) configuration. EFX '98 featured more than 200 individual technology demonstrations and tests. [Ref. 20]

The EFX '98 scenario posed an emerging crisis far from the United States as its problem. In response, CONUS-based forces assumed an alert posture and the Joint Force Air Component Commander (JFACC) assembled his staff at a Joint Air Operations Center-Rear (JAOC-R) in the United States. At the onset of hostilities, long-range aircraft launched from the United States, attacking high-payoff targets within 24 hours of notification. Forces from the Army's 82nd Airborne Division secured an airfield shortly thereafter, paving the way for the arrival of a tailored Air Expeditionary Force. Once facilities were relatively secure, the JFACC and key staff moved to the theater and occupied the JAOC-F. The JFACC exercised continuous command from a specially-equipped aircraft while enroute. Once on the ground, command functions were transferred forward. The JAOC-Rear conducted intelligence and combat support operations, provided an alternate command center, and generally supported forward functions. [Ref. 19]

E. ORGANIZATIONS

The Air Force established several new organizations to advance the Air Force into the new millenium. These include a temporary Air Staff directorate at the Pentagon to oversee the Air Force's transition into an EAF, the Aerospace Command and Control, Intelligence, Surveillance, and Reconnaissance Center AC2ISRC, the Command and Control Training and Innovation Center (C2TIC), as well as six Battlelabs.

As a result of the April 1997 Air Force C2 Summit, the Chief of Staff of the Air Force directed the Commander, Air Combat Command (COMACC), to establish the Air and Space Command and Control Agency (ASC2A). ASC2A has since undergone a name change to the Aerospace Command and Control, Intelligence, Surveillance, and Reconnaissance Center (AC2ISRC). AC2ISRC was created to be the lead agency to pull command and control together across the Air Force. AC2ISRC works for all of the major commands and Commanders in Chief. AC2ISRC, in turn, created the Command and Control Training and Innovation Center, located at Hurlburt Field, Florida. The Center's mission is to integrate C2 processes across the Air Force. The Center will evaluate and test every piece of equipment used in command centers in an operational environment and standardize them throughout the Air Force. In addition, the center will also train C2 professionals.

In 1997, the Air Force established six Battlelabs to identify and validate innovative ideas that improve execution of the Air Force mission. The six Battlelabs are the Aerospace Expeditionary Force Battlelab, Command and Control Battlelab, Force Protection Battlelab, Information Warfare Battlelab, Air Force Space Battlelab, and

Unmanned Aerial Vehicle Battlelab. These battlelabs identify potential ways to advance the Air Force's defined core competencies of air and space superiority, global attack, precision engagement, information superiority, rapid global mobility, and agile combat support.

F. C2 BASELINE FORUM

The Air Force Command and Control Training and Innovation Center hosted the first EAF C2 baseline forum in January 1999. The forum brought together over 360 C2 warfighters from worldwide locations to discuss a wide range of issues related to EAF command and control. Additionally, a series of working groups, including an O-6 senior officer forum, addressed specific EAF C2 structure topics. A follow-on EAF C2 baseline forum is scheduled for June 1999.

Overall, the forum produced acknowledgement that a professionalized and re-engineered Air Force C2 capability, extending from the combined or joint task force level down to the tactical level, is one of a few key enablers for the future expeditionary air force to reach its full potential. The forum produced general consensus on a proposal to delink deployable aerospace operations centers (AOCs) from Air Force numbered air forces (NAFs), instead creating three standing and deployable AOC units ready to plan and execute an aerospace campaign in support of NAF commanders/JFACCs and their key staff members. These units could reside at USAFE, PACAF, ACC headquarters or selected NAFs, and contain the appropriate mix of forward and rear capability.

IV. ORGANIZATION OF AEROSPACE POWER

A. INTRODUCTION

As stated in Chapter III, the Air Force released the capstone document of its operational doctrine series, *Air Force Doctrine Document 2 (AFDD 2): Organization and Employment of Aerospace Power*, in September 1998. The Spring 1999 revision of *AFDD 2* reflects mostly cosmetic changes. Although the revision has not been finalized yet, this chapter incorporates the changes within the draft.

AFDD 2 provides a broad overview of how the Air Force transitions to contingency operations, organizes itself afield, and assesses, plans, and executes its assigned missions. It introduces new concepts for Air Force operations, including the role of the Commander, Air Force Forces (COMAFFOR), the methodology for setting up aerospace expeditionary task forces (ASETFs), and the use of air operations centers (AOCs) as the "nerve centers" behind all aerospace operations. [Ref. 21]

AFDD 2 consists of six chapters as follows:

- Chapter One: Aerospace Operations
- Chapter Two: The Transition from Peace to Conflict
- Chapter Three: Organizing Air Force Forces
- Chapter Four: Leading Expeditionary Aerospace Forces
- Chapter Five: The Aerospace Operations Center
- Chapter Six: The Joint Air Operations Plan

The following sections concentrate on Chapters Three through Five of *AFDD2* in order to familiarize the reader with how Air Force Forces will organize under the EAF plan as well as the importance of the Joint Air Operations Center (JAOC).

B. ORGANIZING AIR FORCE FORCES

Chapter Three discusses how US Air Force forces are organized for expeditionary operations and explains the mechanics for setting up Aerospace Expeditionary Task Forces. US overseas-based forces have drawn down considerably in recent years since the Cold War. The US Air Force now has the challenge of deploying smartly and quickly from the continental United States (CONUS) to areas in which there is little or no in-place presence; therefore, it needs organizational models to support these deployments. The US Air Force should organize to provide clear lines of authority and should present the JFC with a single face to execute the US Air Force element within a joint force. [Ref. 21]

Chapter Three begins by emphasizing the importance of two central ideas to the way the Air Force organizes – unity of command and centralized control/decentralized execution. These two principles, in turn, require an organizational structure that can support joint and combined operations throughout the entire spectrum of conflict. As such, two entities - the COMAFFOR and the ASETF - emerge to present the Joint Forces Commander (JFC) with a task-organized, integrated package with the proper balance of force, sustainment, and force protection elements. The COMAFFOR is designated from the US Air Force and serves as the commander of US Air Force forces assigned and

attached to the US Air Force component. Air Force elements deployed in an expeditionary role are designated as an ASETF. [Ref. 21]

The Air Force is comprised of nine Major Commands (MAJCOMs) and the military heads of these MAJCOMs report to the Air Force Chief of Staff. There are two types of commands: Operational and Support; most units in the Air Force are assigned to one of these major commands. Commands may also be divided into Numbered Air Forces (NAFs). The NAF is considered to be the senior war-fighting echelon of the Air Force. The Wing is the fundamental working unit of the Air Force and each Air Force Base is built around a wing which reports to one of the major commands. Each Commander in Chief's (CINC's) COMAFFOR is the associated Air Force MAJCOM commander. However, MAJCOM commanders may delegate COMAFFOR authorities to numbered Air Force (NAF) commanders. For example, Commander, Air Combat Command (ACC) has delegated some authorities to Commander, Ninth Air Force (9 AF), who acts as COMAFFOR to Commander in Chief, US Central Command (USCINCCENT). [Ref. 21]

When a CINC forms a joint task force (JTF) that includes Air Force forces, the associated MAJCOM will form an ASETF or task an in-place NAF to provide the command framework for all assigned/attached Air Force forces. The ASETF provides the Joint Forces Air Component Commander (JFACC) with a single point of contact for aerospace force capabilities. The ASETF can be sized depending on the level of conflict and the desired political and military objectives. The ASETF commander or NAF

commander will act as the COMAFFOR and normally will not also function as an operating force commander (i.e., wing commander or group commander). [Ref. 21]

The command element for aerospace expeditionary forces has three main components: the commander, an appropriately sized staff, and adequate command and control (C2) facilities to direct and support the operating forces and interact with the JFC. The C2 mechanism has two faces: the operational and the functional. [Ref. 21]

The Aerospace Operations Center (AOC) is the operational C2 center for Air Force forces. The AOC will be the senior operations center and focal point for the command and control of aerospace forces in Air Force-only operations. When the COMAFFOR also serves as the JFACC, the AOC is called the joint air operations center (JAOC). There should only be one AOC within an area of operations. [Ref. 21]

The Air-staff (A-staff) manages the functional, Service authority issues. This activity, functionally separate from the war-fighting activities performed by the AOC, is responsible for a range of support activities such as (but not limited to) logistics, personnel, medical, and security. [Ref. 21]

The parent MAJCOM of the engaged NAF, or the NAF rear, will function as the Air Force component rear. When a MAJCOM directly provides forces, as the Air Force component of a supported CINC, it will act as the component rear. If authorized by the supported CINC, the Air Force component rear will coordinate with the supporting CINCs and other Air Force MAJCOMs or agencies on behalf of the COMAFFOR. [Ref. 21]

Aerospace Expeditionary Forces (AEFs) are deployable wings, groups, or squadrons which deploy within the framework of an ASETF. Such wings, groups, and squadrons are designated "expeditionary" from the time they are attached until no longer attached. [Ref. 21]

An Air Expeditionary Wing (AEW) is a deployed wing or a wing slice attached to an ASETF or in-place NAF by G-series orders. An AEW normally is composed of the wing command element and several groups. Where possible, the AEW is formed from units of a single wing. The AEW commander, normally a brigadier general, will report to the ASETF/in-place NAF commander. Figure 1 depicts a notional AEW. [Ref. 21]

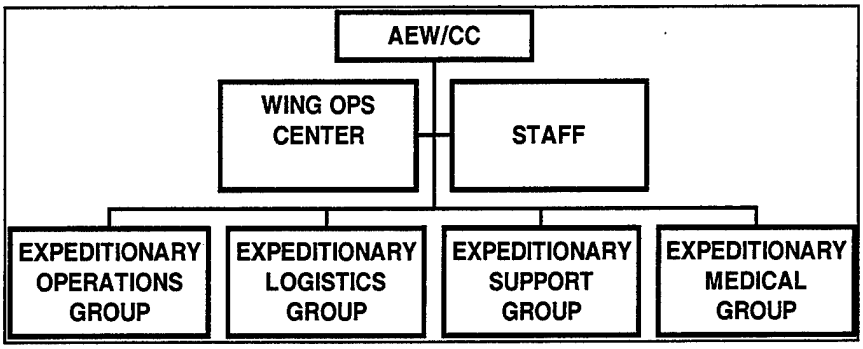

Figure 1 Notional AEW Command Structure From Ref. [21]

An Air Expeditionary Group (AEG) is a deployed independent group attached to an ASETF or in-place NAF by G-series orders and is the lowest command echelon of AEFs reporting directly to the COMAFFOR. An AEG is composed of a slice of the wing command element and some squadrons. Since Air Force groups are organized without significant staff support, a wing slice is needed to provide the command and control for AEFs smaller than the normal wing. Where possible, the AEG is formed from units of a

single wing. The AEG commander, normally a colonel, will report to the ASETF/in-place NAF commander. Figure 2 depicts a notional AEG. [Ref. 21]

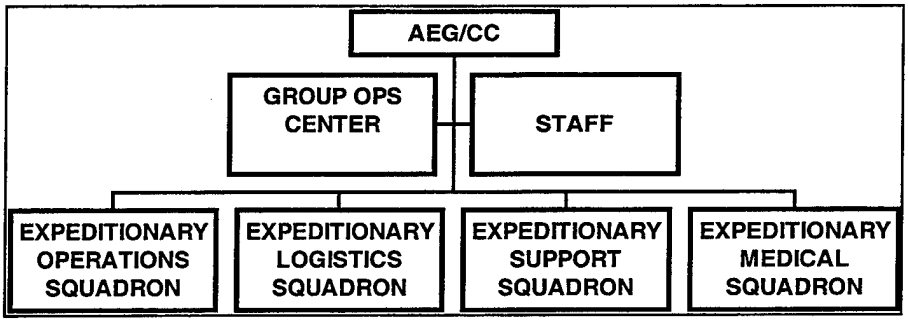

Figure 2 Notional AEG Command Structure From Ref. [21]

The squadron is the basic fighting unit of the US Air Force. Squadrons are configured to deploy and employ in support of crisis action requirements. They are not designed to conduct independent operations but rather to interact with other units to provide the synergy needed to conduct sustained and effective operations. As such, an individual squadron should not deploy by itself; it should deploy along with the appropriate support and command elements (a "group slice"). Afield, it would look more like a group. [Ref. 21]

C. LEADING EXPEDITIONARY AEROSPACE FORCES

Chapter 4 of *AFDD 2* examines the responsibilities, relationships, and nominal staff organizations of the three key leadership positions within the JTF construct that affect the employment of aerospace power: the JFC, the COMAFFOR, and the JFACC.

The JFC organizes a joint staff to carry out assigned duties and responsibilities. The tasked NAF or parent MAJCOM normally will augment a JTF staff with Air Force personnel specifically designated and trained as JTF augmentees. Augmentation

requirements that cannot be filled by the engaged NAF or parent MAJCOM will be provided from throughout the US Air Force using normal personnel channels. In addition, the COMAFFOR/JFACC should provide a liaison team to the JFC to serve as the direct representative of the COMAFFOR/JFACC and to maintain close contact with the JFC staff to ensure information cross-flow between JFC and COMAFFOR/JFACC staffs. [Ref. 21]

In most cases, the COMAFFOR will deploy to a location in the theater, preferably close to the JFC. In mature theaters like Korea, the COMAFFOR staff and the AOC may operate effectively from permanent, in-garrison facilities. In either case, the tasked NAF or the parent MAJCOM functions as the Air Force component rear for 24-hour support of the operation. Also, the tasked NAF is responsible for providing the COMAFFOR and the core of the headquarters A-staff. [Ref. 21]

The JFC normally will designate a JFACC to exploit the capabilities of joint aerospace operations through a cohesive Joint Air Operations Plan (JAOP) and a responsive and integrated control system. The JFACC recommends the proper employment of aerospace forces from multiple components. The JFACC also plans, coordinates, allocates, tasks, executes, and assesses aerospace operations to accomplish assigned operational missions. [Ref. 21]

The JFACC should be the component commander with the preponderance of aerospace assets and the capability to plan, task, and control joint aerospace operations. The JFC gives the JFACC the authority necessary to accomplish assigned missions and tasks. When the COMAFFOR is designated the JFACC, the Air Force component staff

structure normally forms the basis for the JFACC staff. In cases where the COMAFFOR commands an ASETF, the principal component staff directorates (A–1 through A–6) normally assume parallel JFACC staff functions. Augmentation within each directorate from relevant Service components ensures adequate joint representation on the JFACC staff. At the discretion of the JFACC, officers from other Services may fill key deputy and principal staff JFACC positions. In this arrangement Air Force component and joint air component functions and responsibilities remain distinct; both are essential to successful joint aerospace operations. When the Air Force component staff assumes JFACC staff functions, the JFACC must provide clear definition of responsibilities and adequate resources to ensure both Air Force component and JFACC staff functions operate effectively. [Ref. 21]

If another Service provides the JFACC, the COMAFFOR will relinquish tactical control (TACON) of assigned forces to the JFACC as directed by the JFC. In addition, the COMAFFOR will coordinate with the JFACC through a liaison officer (LNO) team and fill designated billets within the JFACC staff and JAOC. However, the COMAFFOR will maintain an A-staff and a command and control function to perform Service specific functions. [Ref. 21]

If working with allies in a coalition or alliance operation, the JFACC may be designated the air component commander (ACC). For very large and complex operations, as might be encountered with large coalitions, the COMAFFOR function might be separate from the JFACC (or ACC) function. When a separate COMAFFOR is established, a separately manned Air Force component staff is normally appropriate. This

provides Air Force elements more focused Air Force leadership, and permits the JFACC to focus on joint and multinational issues. [Ref. 21]

By definition, the JFACC must control and execute aerospace assets of other Services, in whole or in part, depending on the situation. However, the other Services have developed their air arms with differing doctrinal and operating constructs in mind. They have other mission priorities (primarily support of surface forces) that constrain their availability to exploit the full scope of aerospace operations at the strategic and operational levels of war. Similar concerns also apply to the aviation arms of our allies. The JFACC must consider these differing philosophies when developing the joint aerospace scheme of maneuver. [Ref. 21]

1. COMAFFOR Headquarters Organization

The COMAFFOR headquarters should usually be comprised of normal staff directorates, A–1 through A–6, as well as a special staff. The A-staff structure is used instead of the more "traditional" Air Force staff designations (DO, LG, SC, etc.) to more readily identify the Air Force component staff equivalents of the corresponding J-staff functions. Figure 3 depicts the organization of a COMAFFOR headquarters. In some cases, senior component liaison elements may not be needed. Some of the required support may be obtained through reachback. Finally, for very small or limited operations, a "full" A-staff may not be required. [Ref. 21]

The organization for a COMAFFOR who is dual-hatted as the JFACC is the largest, most robust capability required and will include a full A-staff with an ASC, a JAOC, a JAOC Director, and a Director of Mobility Forces (DIRMOBFOR). The

COMAFFOR staff normally forms the basis for the JFACC staff; however, the COMAFFOR staff still retains its function as the primary provider for the Air Force component.

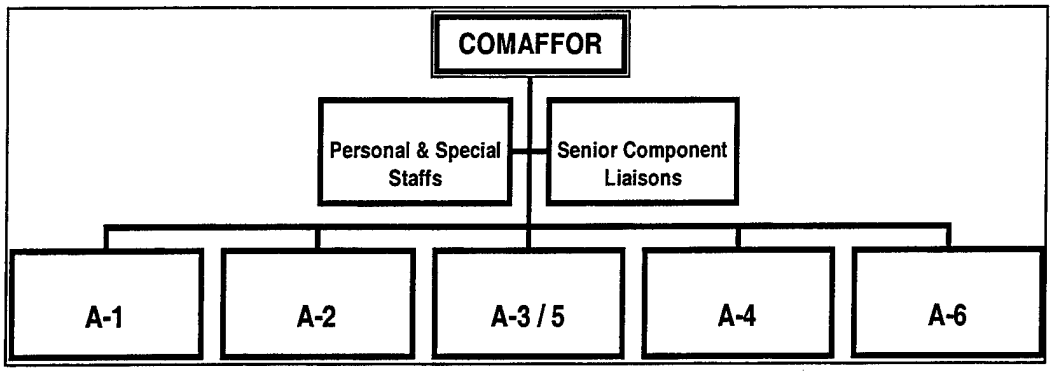

Figure 3 Notional Component Headquarters Organization (A-Staff) From Ref. [21]

The principal Air Force component staff directorates (A–1 through A–6) normally assume parallel JFACC staff duties. Augmentation from relevant Service components ensures adequate joint representation. At the discretion of the JFACC, officers from other Services may fill key deputy and principal staff positions. This dual-hatted organization is functionally depicted in Figure 4. (This is also the Air Force organization when the JFC is operating solely through Service components and has not designated a JFACC). The JAOC will be tailored to the mission of the COMAFFOR/JFACC, and the position of JAOC Director may be filled by the A–3. [Ref. 21]

The DIRMOBFOR is the COMAFFOR's or JFACC's designated coordinating authority for air mobility with all commands and agencies both internal and external to the JTF. The DIRMOBFOR provides direction to the Air Mobility Division in the AOC and normally will be a senior Air Force officer familiar with the AOR. [Ref. 21]

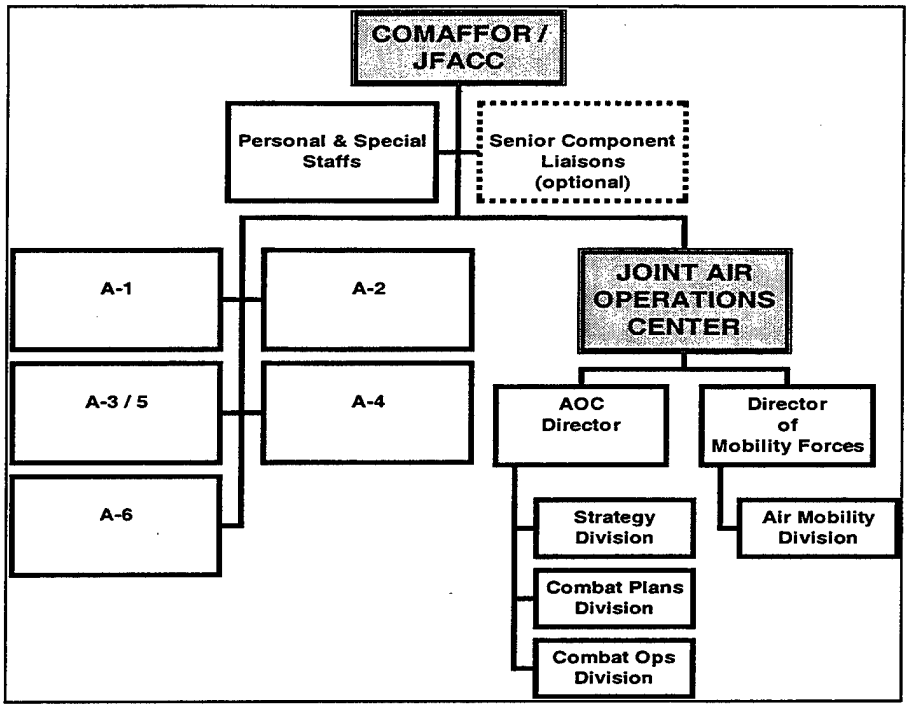

Figure 4 Notional Headquarters with COMAFFOR as JFACC From Ref. [21]

D. THE JOINT AIR OPERATIONS CENTER

Chapter Five of *AFDD 2* broadly describes the JAOC's key functions and notional organization, as well as the fundamental aerospace assessment, planning, and execution process that drives the JAOC. The JAOC is the aerospace operations planning and execution focal point for the JTF and is where centralized planning, direction, control, and coordination of aerospace operations occurs for which the COMAFFOR/JFACC has OPCON/TACON. JAOC personnel are responsible for planning, executing, and assessing aerospace operations and directing changes as the situation dictates. [Ref. 21]

1. Primary JAOC Functions

The primary functions of the JAOC are to [Ref. 21]:

- Develop aerospace operations strategy and planning documents that integrate air, space, and information operations to meet JFACC objectives and guidance.
- Task and execute day-to-day air operations; provide rapid reaction, positive control, and coordinate and deconflict weapons employment, as well as integrate the total aerospace effort.
- Receive, assemble, analyze, filter, and disseminate all-source intelligence and weather information to support aerospace operations planning, execution, and assessment.
- Issue airspace control procedures and coordinate airspace control activities for the Airspace Control Authority (ACA) when the JFACC is designated the ACA.
- Provide overall direction of air defense, including theater missile defense (TMD), for the Area Air Defense Coordinator (AADC) when the JFACC is designated the AADC.
- Plan, task, and execute the theater intelligence, surveillance, and reconnaissance (ISR) mission.
- Conduct operational-level assessment to determine mission and over-all aerospace operations effectiveness as required by the JFC to support the theater combat assessment effort.
- Produce and disseminate an air tasking order (ATO) and changes.
- Provide for the integration and support of all air mobility missions.

A point that *AFDD 2* emphasizes is the need for the JFACC to also serve as the AADC, ACA, and the ISR coordinator. These functions demand integration to ensure unity of command and effort. This is central to the Air Force's tenet of centralized control. [Ref. 21]

2. Notional JAOC Organization

A full JAOC normally is led by a JAOC director and may have up to four divisions with ten core teams, and numerous specialty and support teams. The A-staff directors, the A–1 through A–6, support the JAOC director (in planning and executing the COMAFFOR/JFACC's operational tasks) and fulfill their responsibilities by supervising their personnel on the JAOC teams. Specialty and support team members move into the core teams as required.

The following discussion describes a notional JAOC organization that describes a full range of potential tasks. Actual JAOC organizations afield may reflect the results of conscious decisions based on assigned missions and the scope of the operation.

JAOC Director: The JAOC Director is charged with the effectiveness of joint aerospace operations and focuses on planning, coordinating, allocating, tasking, executing, and assessing aerospace operations in the area of responsibility/joint operations area (AOR/JOA) based on JFACC guidance and DIRMOBFOR coordination. It is the director's responsibility to ensure JAOC functions necessary to complete the aerospace assessment, planning, and execution process are executed in a timely, efficient manner. [Ref. 21]

Core Teams: The workload in each division is usually parceled out among core teams, which drive the planning and execution process. These teams have functional experts under the direction of a single team leader and operate with a common purpose to achieve unity of effort. The core teams are composed of permanent, principal, and temporary members. Permanent members have no other responsibilities in the JAOC, are experienced in their positions, and usually have specific training. Principal members are experts within their functional area, are required for the core team's mission, and stay with the team but have other JAOC responsibilities. Temporary members contribute special expertise as the need arises. [Ref. 21]

The number of teams and their size vary according to the scope of the operation a given JAOC is supporting. For a large operation, a JAOC may organize its core teams in its divisions as follows [Ref. 21]:

- **Strategy Division**: Strategy plans team and operational assessment team (some variations also have a target integration team).
- **Combat Plans Division**: MAAP team and ATO/ACO production team.
- **Combat Operations Division**: Offensive operations team and defensive operations team.
- **Air Mobility Division**: Air mobility control team (AMCT), airlift control team (ALCT), aerial refueling control team (ARCT), and air mobility element (AME).

Specialty Teams: The specialty teams provide a JAOC with diverse capabilities to help orchestrate theater aerospace power. Many of these capabilities are provided to

the JAOC from agencies external to the JAOC organization. The following are examples of specialty teams [Ref. 21]:

- Component liaisons
- ISR
- Area air defense (AAD)
- Information warfare
- Space
- Airspace management
- Rescue coordination
- Medical
- Weather
- Logistics and sustainment
- Legal

Support Teams: Support teams provide direct support to the JAOC and to operational echelons above and below the JAOC (higher headquarters [HHQ] and tactical units). Support teams are led by team chiefs who report to the appropriate level within the JAOC. They perform their tasks allowing the core and specialty teams to focus on the aerospace assessment, planning, and execution process. Examples of support teams are [Ref. 21]:

- Intelligence unit support
- Systems administration
- Combat reports

- Information management
- Communications center
- Supply
- Request for information

Figure 5 illustrates a large notional JAOC with all four major divisions and several support and specialty teams. The mission will determine the actual mix of divisions and teams in the JAOC; not all divisions and teams may be needed.

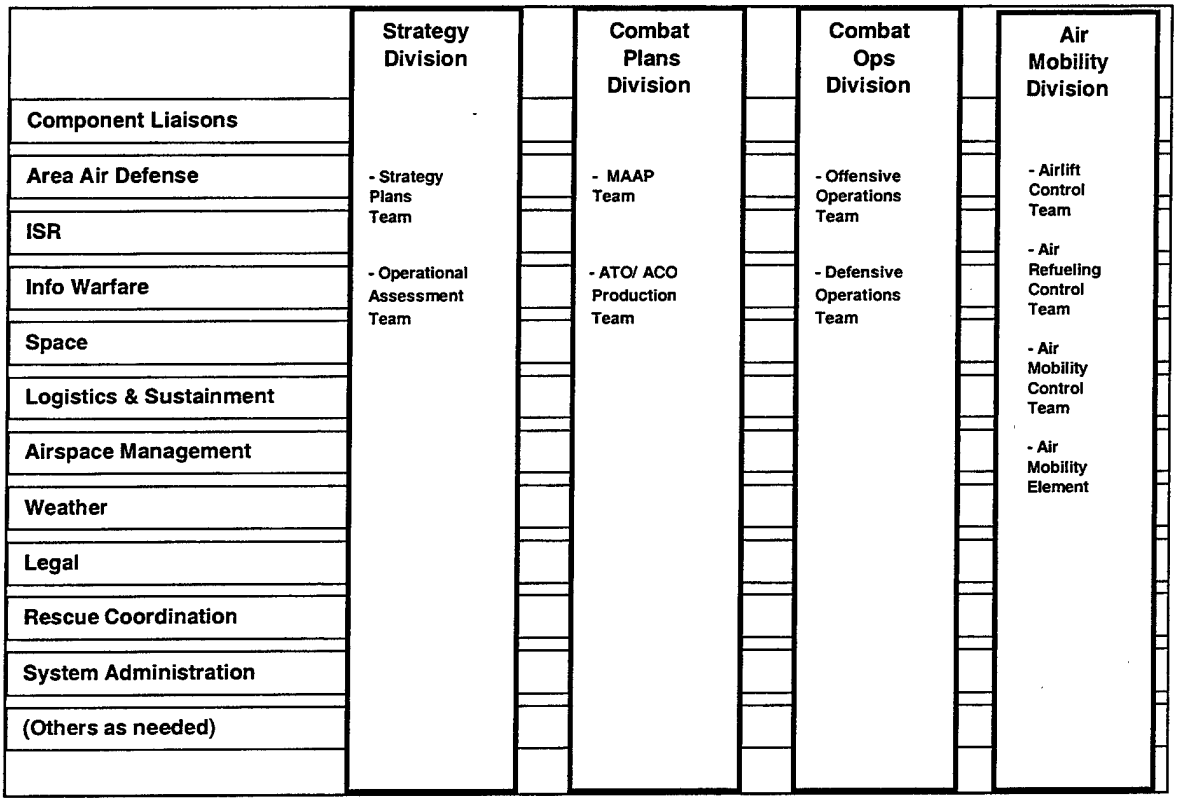

Figure 5 Notional JAOC with Representative Teams From Ref. [21]

V. PROCESS: THE AIR TASKING CYCLE

A. INTRODUCTION

Joint air operations constitute an integral part of the JFC's operation or campaign plan. The JFACC is normally assigned responsibility for joint air operations planning and develops a joint air operations plan (JAOP) for employing that portion of the air effort made available to the JFACC to accomplish the objectives assigned by the JFC. The joint air operation plan documents the JFACC's plan for integrating and coordinating joint air operations. The JAOP and supporting plans state how the air component commander conducts theater aerospace operations. This is the heart of what is colloquially called "the air campaign." [Ref. 22]

Once the JAOP and its guidance have been developed, the operational art of aerospace planning prior to execution of operations is essentially finished. When operations begin, an air tasking cycle is normally established to develop daily tactical tasking (the ATO) based on the operational guidance provided by the JAOP and other inputs. [Ref. 23]

This chapter provides the reader with an overview of the air tasking cycle as outlined in *Joint Pub 3-56.1: Command and Control for Joint Air Operations* [Ref. 22]. The air tasking cycle is used to provide for the efficient and effective employment of the joint air capabilities/forces made available [Ref. 22]. Understanding this cycle and its various processes and products is critical to deciding how to split functions between a forward and rear JAOC. Following the overview of the air tasking cycle and the joint

ATO phases, section E discusses a notional method of dividing the air tasking cycle between a forward and rear air operations center as attempted during Expeditionary Force Experiment '98.

B. THE AIR TASKING CYCLE

The air tasking cycle (Figure 6) provides a repetitive process for the planning, coordination, allocation, and tasking of joint air missions/sorties, within the guidance of the JFC. The cycle accommodates changing tactical situations or JFC guidance, as well as requests for support from other component commanders. The air tasking cycle is an analytical, systematic approach that focuses targeting efforts on supporting operational requirements. Much of the day-to-day air tasking cycle is conducted through an interrelated series of information exchanges (through designated component liaison officers and/or messages), which provide a means of requesting and scheduling joint air missions. Note: A timely joint ATO is critical--other joint force components conduct their planning and operations based on a prompt, executable joint ATO, and are dependent on its information. [Ref. 22]

There are usually three joint ATOs at any time: (1) the joint ATO in execution (today's plan), (2) the joint ATO in production (tomorrow's plan), and (3) the joint ATO in planning (the following day's plan). The air tasking cycle begins with the JFC's air apportionment process and culminates with the combat assessment of previous missions/sorties. Figure 7 is a notional joint air tasking timeline, which may be modified to fit the particular situation. [Ref. 22]

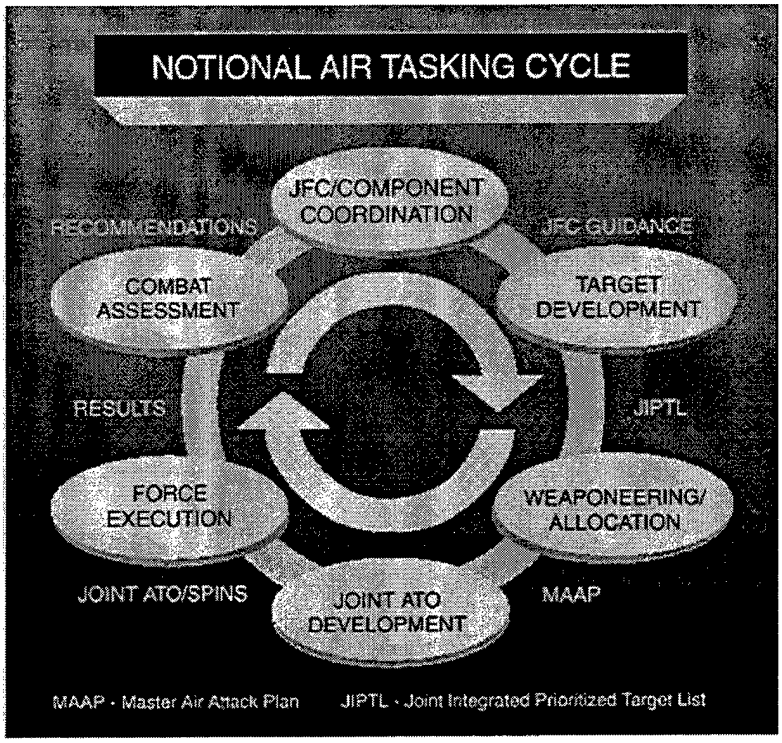

Figure 6 Notional Air Tasking Cycle From Ref. [22]

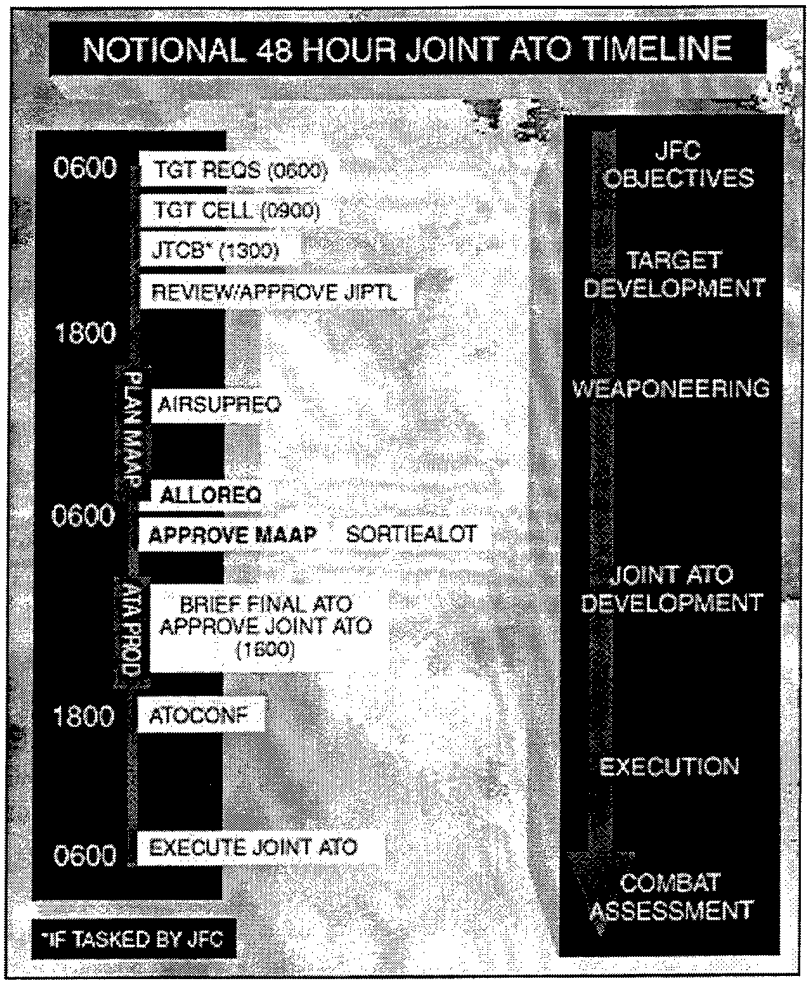

Figure 7 Notional 48 Hour Joint ATO Timeline From Ref. [22]

The full joint ATO cycle from JFC guidance to the start of joint ATO execution is dependent on the JFC's procedures. Notionally, this spans a 30-72 hour period. Each actual joint ATO period usually covers a 24-hour period (0600-0600 for illustrative purposes in this document). The precise timeframes for the air tasking cycle must be specified in the JFC's operation plans or the JFACC's joint air operations plan. [Ref. 22]

The execution phase of the air tasking cycle will notionally consist of 24-hour periods with start and end times as specified by joint air operations plans. The joint ATO

embodies JFC objectives and intent in a joint air tasking directive. The joint ATO matches specific targets compiled by the JFACC/JFC staff with the capabilities/forces made available to the JFACC for the given joint ATO day. [Ref. 22]

C. JOINT ATO PHASES

The joint ATO phases depicted (Figure 6) are related to the targeting cycle. The approach is the same, a systematic process that matches available capabilities/forces with targets to achieve operational objectives. The number of ATO phases may vary based on theater and contingency requirements. Prior to the JFC and component commander's meeting, the JFACC meets with senior component liaisons and the JFACC staff to develop recommendations on joint air strategy and apportionment for future operations. (The use of the term "meeting" is notional; other methods of information exchange could also be used.) This meeting may review JFC objectives and guidance; analyze results of joint force operations and consider changes to planned or ongoing joint air operations; review adversary capabilities and courses of action, centers of gravity, decisive points, critical areas, and key targets; develop and recommend updates to the joint target list (JTL); and assess joint air capabilities for future operations to meet JFC objectives. The JFACC provides objectives and guidance to the staff for joint air operations to support the JFC's intent, recommends broad target categories that support the JFC's objectives, reviews joint force air capabilities/forces to achieve assigned tasks, refines requirements for capabilities/forces from other components, and after consulting with the other component commanders or their representatives, formulates an air apportionment

recommendation for presentation to the JFC. Examples of air apportionment categories include, but are not limited to, strategic attack, interdiction, counterair, maritime support, and close air support. [Ref. 22]

1. Phase 1 : JFC/Component Coordination

The JFC consults often with his component commanders to assess the results of the warfighting effort and to discuss the strategic direction and future operation plans. This provides component commanders an opportunity to introduce recommendations, support requirements, and state their ability to support other components. The JFC provides broad guidance and objectives and his vision of what constitutes military success. The JFC also defines the intent of the operation or campaign and sets priorities. The JFC's guidance and objectives will identify targeting priorities, JTL/ JIPTL planning guidance, procedures, appropriate maneuver and movement control, joint fire support coordinating measures, ROE, and what defines component direct support sorties. This guidance will also include the JFC's air apportionment decision. [Ref. 22]

Air apportionment is the determination and assignment of the total expected effort by percentage and/or priority that should be devoted to the various air operations and/or geographic areas for a given period of time. Air apportionment allows the JFC to ensure the weight of the joint air effort is consistent with campaign phases and objectives. Given the many functions that the joint air effort can perform, its AOR/JOA-wide application, and its ability to rapidly shift from one function to another, JFCs pay particular attention to its apportionment. JFCs normally apportion the air effort by priority or percentage of effort into geographic areas, against mission-type orders, and/or by categories significant

for the campaign. These categories can include, but are not limited to, strategic attack, interdiction, counter air, maritime support, and close air support. After consulting with other component commanders, the JFACC/JFC staff makes the air apportionment recommendation to the JFC. [Ref. 22]

2. Phase 2: Target Development

The specific objectives received during Phase 1 are used to focus target development. Targets are nominated to support the targeting objectives and priorities provided by the JFC. All potential targets are processed through the JAOC (Combat Plans), which will identify, prioritize, and select specific targets that meet the JFC's objectives and guidance. Targets are selected from joint target lists, component requests, intelligence recommendations, electronic warfare inputs, and current intelligence assessments, as the situation dictates. In accordance with the JFC's objectives and component targeting requirements, the JFACC/JFC staff will develop the joint air operation plans to employ available capabilities/forces. The end product of the target development phase is a prioritized list of targets--the JIPTL that supports the objectives and conforms to guidance. [Ref. 22]

3. Phase 3: Weaponeering/Allocation

During the weaponeering/allocation phase, targeting personnel quantify the expected results of lethal and nonlethal weapons employment against prioritized targets. The JIPTL, the prioritized listing of potential targets, constructed during the target development phase, provides the basis for weaponeering assessment activities. All approved targets are weaponeered on target worksheets, which detail recommended aim

points, recommended number/type of aircraft and weapons, fuzing, target identification and description, target attack objectives, target area threats, and probability of destruction. The final prioritized targets are then included into the Master Air Attack Plan (MAAP). The resulting MAAP is the plan of employment that forms the foundation of the joint ATO. The MAAP is a key element of the concept of joint air operations. The development of the MAAP includes the review of JFC and JFACC guidance; component direct air support plans and support requests from components; updates to target requests; availability of capabilities/ forces; target selection from the JIPTL; and aircraft allocation. [Ref. 22]

Following the JFC air apportionment decision, the JFACC/JFC staff translates that decision into total number of sorties by aircraft or weapon type available for each operation/task they support. [Ref. 22]

4. Phase 4: Joint ATO Development

After the MAAP is approved by the JFACC (JFC under the JFC staff option), detailed preparations continue by the Combat Plans section on the joint ATO, Special Instruction (SPINS), and the Airspace Control Order (ACO). JFC and JFACC guidance, target worksheets, the MAAP, and component requirements are used to finalize the ATO/SPINS/ACO. Components may submit critical changes to target requests and asset availability during this final phase of joint ATO development. [Ref. 22]

The JAOC reviews each air capable component's allocation decision/allocation request (ALLOREQ) message and may prepare a sortie allotment (SORTIEALOT) message back to the components as required, in accordance with established operations

plans guideline. If SORTIEALOT messages are not used, the JAOC can pass the information normally contained in the SORTIEALOT by other means (e.g., contingency theater automated planning system (CTAPS), through component liaisons). The SORTIEALOT message confirms (and where necessary modifies) the ALLOREQ and provides general guidance for planning joint air operations. [Ref. 22]

Once approved for release, the ATO will be transmitted to appropriate units by the most expeditious means available. ATO transmission will occur in this order of precedence: (a) Contingency Theater Automated Planning System (CTAPS)/Theater Battle Management Core Systems (TBMCS) via the Secure Internet Protocol Router Network (SIPRNET), (b) CTAPS host-to-remote via dedicated circuits, (c) Global Command and Control System (GCCS), (d) theater-unique C2 systems, (e) PC-PC file transfer (via STU-III), (f) courier/hand carry, and (g) AUTODIN (only as last resort). [Ref. 24]

If only a small number of units are involved, the ATO would be a relatively short message to the tasked units, but in the case of large operations that require precise coordination among many units, ATOs must be commensurately more lengthy. For example, ATOs during Desert Storm were typically 600 pages long, containing mission data for 3,000 sorties. [Ref. 25]

5. Phase 5: Force Execution.

The JFACC/JFC staff directs the execution and/or deconflicts all capabilities/forces made available for a given joint ATO. The JFC may give the JFACC the authority to redirect joint air operations. The affected component commander must

approve all requests for redirection of direct support air assets. Aircraft or other capabilities/forces not apportioned for tasking, but included in the ATO for coordination purposes, will be redirected only with the approval of the respective component commander or designated senior JAOC liaison officer. Components execute the joint ATO as tasked and recommend changes to the JAOC as appropriate, given emerging JFC and component requirements. [Ref. 22]

The JAOC must be responsive to required changes during the execution of the joint ATO. In-flight reports and initial battle damage assessment (BDA) may cause a redirecting of joint air capabilities/ forces before launch or a redirection once airborne. [Ref. 22]

Ground or airborne command and control platform mission commanders may be delegated the authority from the JFACC to redirect sorties/ missions made available to higher priority targets as necessary. It is essential, however, that the JAOC (Combat Operations Section) be notified of all redirected missions. [Ref. 22]

6. Phase 6: Combat Assessment (CA).

Combat assessment is done at all levels of the joint force. The JFC should establish a dynamic system to support CA for all components. Normally, the joint force J-3 will be responsible for coordinating CA, assisted by the joint force J-2. CA evaluates combat operations effectiveness to achieve command objectives. Effective campaign planning and execution require a continuing evaluation of the impact of joint force combat operations on the overall campaign. The JFACC/JFC staff continuously evaluates the results of joint air operations and provides these to the JFC for

consolidation and overall evaluation of the current campaign. The CA concept of operations should include BDA, munitions effects assessment (MEA), and reattack recommendations. It must take into consideration the capabilities/forces employed, munitions, and attack timing in assessing the specific mission and joint air operations success and effects against the specific targets attacked, target systems, and remaining enemy warfighting capabilities, relative to the objectives and strategy. Future enemy courses of action and remaining enemy combat capabilities should be weighed against established JFC and JFACC targeting priorities to determine future targeting objectives and reattack recommendations. The JFACC/JFC staff assessment should be forwarded to the JFC to determine overall campaign success and recommend changes in courses of action. Although CA marks the end of the targeting process, it also provides the inputs for process re-initiation and subsequent target development, weaponeering/allocation, joint ATO development, force execution, and combat assessment. [Ref. 22]

D. DISTRIBUTING THE AIR TASKING CYCLE

1. EFX '98 Plan

For EFX '98, a vision of the split functions and sub-functions between the JAOC-Forward at Duke Field, Florida and the JAOC-Rear in the Rear Operations Support Center at Langley AFB, Virginia was formulated [Ref. 26]. The rear element was designed to be the larger element, encompassing the majority of the support functions and planning capabilities [Ref. 19]. The forward portion was envisioned to contain the bulk of the execution personnel [Ref. 19]. The following is taken from the experiment vision

and describes a notional air tasking cycle, associated functions and sub-functions, and action locations.

Command and guidance reside with the JFACC. Starting in the rear, moving with him enroute, and finally forward as he establishes himself at the JAOC-F. [Ref. 26]

Strategy functions are in the JAOC-F. When the JFACC is rear or enroute, the strategy receives guidance via the Chief of Strategy, who will stay with the JFACC. Product will be the JFACC's aerospace guidance. [Ref. 26]

Target development resides in the JAOC-F. They receive inputs from strategy forward and the Intel targets experts rear. Product is the Candidate Target List (CTL). [Ref. 26]

The Guidance, Apportionment, and Targeting (GAT) team is in the JAOC-F. They receive the CTL from the forward targets team and coordinate with the Joint Targeting Coordination Board (JTCB) to produce the Joint Integrated Prioritized Targets List (JIPTL). While the JFACC is rear or enroute, the Master Air Attack Plan (MAAP) team in the rear accomplishes this function. [Ref. 26]

The MAAP team resides in the rear with the rest of the Plans division. After they receive the JIPTL from the JOAC-F, they add weaponeering and force allocation. The product is an ATO shell passed to ATO production. [Ref. 26]

The ATO production team also resides in the JAOC-R. Their function is to produce the ATO, add the ACO and SPINS, then send it to Combat Operations for execution. [Ref. 26]

ATO execution is the function of Combat Operations JAOC-F, supported heavily by the JAOC-R. [Ref. 26]

Time Critical Targeting (TCT) is performed from the JAOC-F. Before the JFACC establishes himself forward, TCT functions are accomplished in the rear. Additionally, after the JFACC is forward, the JAOC-R will be able to perform TCT functions if the forward is unable. [Ref. 26]

Primary battle damage assessment and air operations assessment take place in the JAOC-R. This assessment is given to the JFACC forward for recommendations in further ATOs, thus completing one ATO cycle. [Ref. 26]

Figure 8 provides the locations for the various air tasking cycle processes based on the above plan.

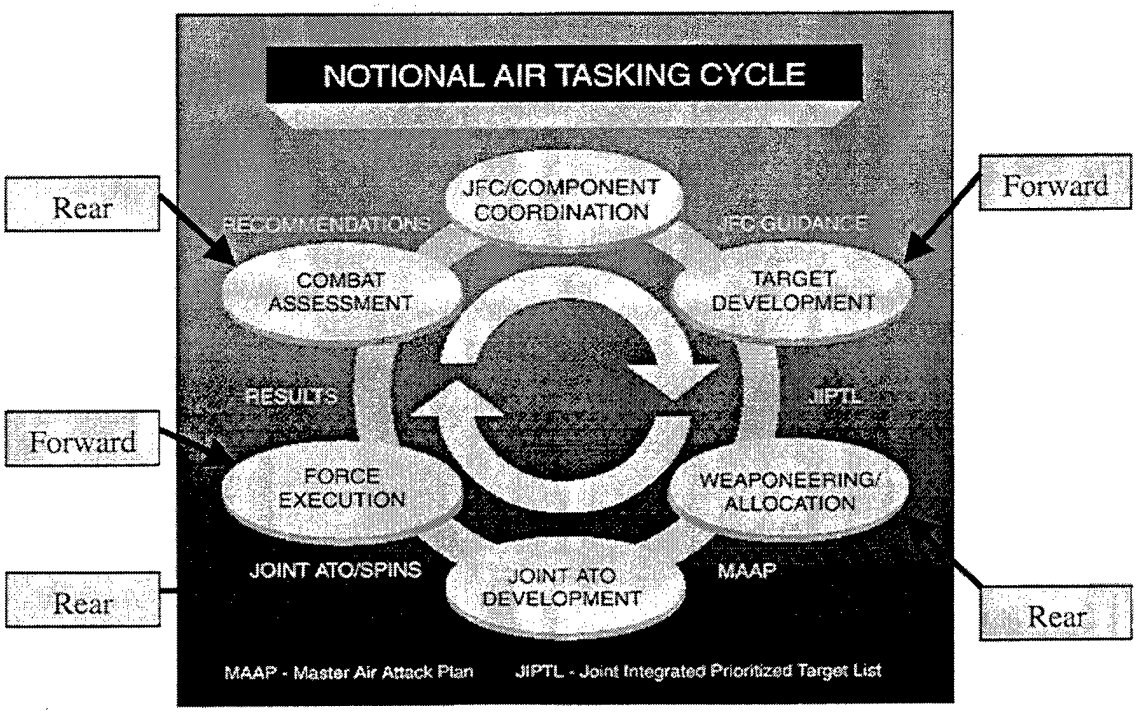

Figure 8 Notional Locations for Air Tasking Cycle Processes After Ref. [22]

Although the above distribution seems logical, ultimately, the commander who is tasked with mission accomplishment will determine where processes are accomplished. Overall campaign objectives, communications capability, timing, and Joint or Coalition influences, etc. will affect the commander's decision. [Ref. 2]

2. Distributed Operations Results

Unfortunately, technical difficulties between the JAOC-F and the JAOC-R during EFX '98 prevented a proper assessment of distributed/split operations. Furthermore, poor planning for actual operations in a distributed environment exacerbated the situation. Despite these setbacks, EFX '98 assessed a variety of technologies. Chapter VI reviews some of these technologies. In addition, personnel were able to develop usable procedural baselines and processes to support distributed operations. Refinement of these procedures and processes will occur in subsequent experiments. [Ref. 19]

Even though EFX '98 did not provide a thorough assessment of distributed operations, it did provide insight into the problem. General Charles A. Horner, USAF (Retired), who served as the JFACC during the Gulf War, summed up the issues by addressing concerns with split operations:

> ...nor does it appear that humans are ready to accommodate fully to virtual environments. This became apparent in the Gulf War where the rear operations were deeply appreciated in their support efforts to the forward, but not entrusted with planning or execution functions of the air campaign. Likewise in this experiment ... it became apparent that there was a different appreciation of the situation, hence a different operating tempo and focus depending on an individual's distance from the JFACC. Whether or not human responses to computer generated environments can be altered to create synchronous tempos, equal loyalties, and sense of oneness between two distant headquarters remains to be seen. [Ref. 19]

General Horner also commented on "virtual versus real environments":

> Successful commanders depend on their capacity to read the unspoken messages of briefers sent by eye and facial expressions as well as gestures and posture. Virtual environments for the present afford graphics and voices. We mistake exchange of data for human interaction and the latter is vital to team activities and frequently is not present in a virtual environment. Computer screens are immensely valuable for creating a common data environment but they have severe drawbacks for achieving understandings by interpreting non-oral communications humans have been trained to appreciate. [Ref. 19]

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VI. TECHNOLOGY–FACILITIES, EQUIPMENT, COMMUNICATIONS

A. INTRODUCTION

As stated in Chapter I, a critical component of the EAF concept is a "lean" force which calls for a reduction of the Air Force's forward-deployed footprint of both personnel and equipment. This reduction is supported by and relies on advances in information and communications technologies. These advances allow a larger reliance on distributed operations. The Air Force put many of these technologies, as well as distributed operations concepts to the test during Expeditionary Force Experiment '98.

This chapter reviews some of the technologies (facilities, equipment, and communications systems) being utilized and developed to allow large-scale distributed operations within the Air Force. The first section presents various C2 facilities for distributed operations as envisioned in a draft concept of operations (CONOPS) developed by the Air Force Command and Control Training and Innovation Center (AFC2TIC) EAF C2 Baseline Team. Following this is a separate section that details the Rear Operations Support Center (ROSC) which was utilized heavily during EFX '98. The remaining sections cover the Theater Deployable Communications and the Theater Battle Management Core Systems programs, and the Collaborative Virtual Workspace (CVW) software.

B. FACILITIES FOR DISTRIBUTED COMMAND AND CONTROL

This section is based on a draft CONOPS entitled *Concept of Operations for Expeditionary Aerospace Force Distributed Operations for Command and Control*

[Ref. 2]. The AFC2TIC EAF C2 Baseline Team developed the draft CONOPS in early 1999. While the draft is not final, it serves as a beginning framework for discussion. The following subsections do not cover the CONOPS in its entirety, but should provide the reader with an idea of how various entities will interact in distributed operations under the EAF concept.

The document's Executive Summary stresses that the EAF concept requires significant discussion of how to schedule and organize aviation assets to satisfy future force requirements. The C2 centers or nodes used by commanders to exercise their command must evolve a capability to seamlessly exchange information through common databases and interoperable systems. [Ref. 2]

Each C2 entity will have a defined function that contributes to an overall distributed operation whether they provide information from a fixed Continental United States (CONUS) or Overseas CONUS (OCONUS) site, or whether they are deployed forward to a theater. The first step in understanding distributed operations, is to define the C2 infrastructure. The next step is to "baseline" each node in terms of organization, personnel, training, processes, systems, communications connectivity, and backup capability. The next step is to define specific functions and capabilities at each node. [Ref. 2]

Information and communications connectivity are critical to successful distributed operations. Communications networks must be designed with redundancy and robust capability. In addition, Intelligence personnel must be integrated throughout the network

to process the information being sensed and provided via the global grid. Information Operations help to reduce the threat to the distributed network. [Ref. 2]

The CONOPS highlights additional factors that must be considered in a distributed environment, especially in the case of split operations, where the geographically separated elements belong to the same commander of a particular C2 node. These issues include: deciding on where functions reside – forward or rear; how to resolve command relationships between forward and rear centers, and considering the impacts on Joint and Coalition partners when operations are split. [Ref. 2]

The C2 architecture addressed in the CONOPS seeks to rationalize what is available and in place today. From top to bottom, there are strategic, operational, and tactical C2 nodes in the Air Force, which provide the tools by which Air Force leaders exercise command and control. Although there are also horizontal interfaces to Joint and Coalition C2 nodes, the scope of the CONOPS focuses on the Air Force. Furthermore, the CONOPS concentrates mainly on the operational level of C2, with some discussion of tactical C2. However, many C2 nodes transcend the levels of warfare. [Ref. 2]

The EAF C2 architecture will contain fixed, expeditionary, and en route C2 centers. Additionally, various theaters of operation contain fixed command centers. Taken as a whole, these centers, or C2 nodes, form a network. Many of these C2 nodes do not exist on a daily basis, but only during contingency operations. When a contingency occurs, they operate wholly, or in part, to satisfy mission accomplishment. [Ref. 2]

1. Fixed CONUS Centers

CONUS fixed C2 nodes include, but are not limited to, the following centers:

Air Force Operations Support Center: The Air Force Operations Support Center (AFOSC), located at Langley Air Force Base (AFB), Virginia, supports AEF training, spin up, deployment, and employment. Because of its robust communications connectivity between other CONUS centers, the AFOSC provides an excellent source of information for Overseas CONUS (OCONUS) C2 elements. In certain instances, and at the direction of the ASETF commander, the AFOSC may provide a location from which to conduct rear operations for a split AFFOR or AOC staff. This was the case during EFX '98 where the AFOSC served as the Rear Operations Support Center (ROSC). Chapter VI discusses the ROSC in more detail. [Ref. 2]

Tanker Airlift Control Center: The Tanker Airlift Control Center (TACC), located at Scott AFB, Illinois, supports worldwide air mobility operations. Although the mission of the TACC is also tied to support to CINC Transportation Command (CINCTRANSCOM), the TACC remains a critical C2 node for the EAF as a single center for planning and executing worldwide operations. The TACC provides information to the AFOSC through dedicated communication links to enable deployment, sustainment, and redeployment activities. [Ref. 2]

Information Operations Support Center: The Information Operations Support Center (IOSC), located at Kelly AFB, Texas, provides primary support to information operations requirements across the full spectrum of classification levels. Linked to other

CONUS C2 nodes via robust communications, the IOSC can support worldwide warfighters in IO. [Ref. 2]

Space Operations Center: The Space Operations Center (SOC), located at Vandenberg AFB, California, is a focal point for Air Force space operations. Connected to the AFOSC and other CONUS C2 nodes, the SOC provides information key to daily operations as well as contingencies. [Ref. 2]

Command and Control Training and Innovation Center: The Command and Control Training and Innovation Center (C2TIC), located at Hurlburt Field, focuses on testing and training for C2. However, because of its extensive suite of modeling and simulation tools (at Hurlburt Field, as well as at Kirkland AFB, New Mexico, at the subordinate Theater Air Command and Control Simulation Facility [TACCSF]), the C2TIC provides a venue for tactical to operational mission rehearsal. [Ref. 2]

2. Fixed OCONUS Centers

OCONUS fixed C2 centers include, but are not limited to the following nodes:

USAFE Operations Center: The United States Air Forces in Europe (USAFE) Operations Center (UOC) is USAFE's primary operational command center, and provides support to theater operations. In some instances, and when directed by the ASETF, the UOC may perform the functions of a rear AFFOR and/or AOC. [Ref. 2]

PACAF Operations Center: The Pacific Air Forces (PACAF) Operations Center (POC) performs the same C2 role for PACAF as the UOC performs for USAFE. [Ref. 2]

Hardened Theater Air Control Center: The Hardened Theater Air Control Center (HTACC) is unique among EAF C2 nodes, as it exists as a permanent Coalition

command center under a sub-Unified command structure. The HTACC is the primary tool of the 7th Air Force Commander, who also is the Air Component Commander for Combined Forces in Korea. [Ref. 2]

3. Deployable Command Centers

Deployable command centers include, but are not limited to, the following nodes.

Aerospace Operations Center: The Aerospace Operations Center (AOC) is the senior operational C2 node for the ASETF commander. The AOC becomes a JAOC or CAOC through Joint/Coalition augmentation in a Joint or Coalition environment. However, the core EAF AOC is an Air Force capability and enables C2 for the ASETF Commander. The AOC will be connected to the theater operations center or AFOSC for information support. In addition, the AOC, as the senior element of the Theater Air Control System (TACS), will network with all elements of the deployed TACS to form a cohesive C2 operation. In certain instances, the AOC may be split. [Ref. 2]

Air Support Center: The Air Support Center (ASC) is the functional C2 center used by the COMAFFOR's A-staff to monitor and manage assigned forces Service issues. These issues may include, but are not limited to logistics, personnel, medical, and security. [Ref. 2]

Expeditionary Operations Center: The Expeditionary Operations Center (EOC) provides C2 for the AEF commander. An EOC evolves from a lead Wing Operations Center (WOC) staff and is augmented by assigned units. In the case that an AEF deploys forces to multiple geographic locations (Air Expeditionary Wing [AEW] to base X and Air Expeditionary Group [AEG] to base Y), each location will have an EOC. The EOC

enables an AEF commander to accomplish his mission. It is always envisioned that an AEF will report to an ASETF, and that the ASETF will have a command element. The AOC is the primary operational C2 node for the ASETF. Therefore, the EOC will be subordinate to an AOC in theater. [Ref. 2]

Battle Control Center: The Battle Control Center (BCC) provides C2 capability through its ability to execute defensive and offensive operations. Assuming remoted radars and connectivity, the BCC may be collocated with the AOC and EOC in order to reduce infrastructure and support requirements. BCCs are subordinate to the AOC during employment. The Early Warning Center (EWC) is a subordinate element of the BCC. [Ref. 2]

Air Support Operations Center: The Air Support Operations Center (ASOC) provides primary support to a ground commander, and provides the C2 capability to execute airpower in the affected ground commander's sector. As an element of the TACS, the ASOC reports to the AOC. The Tactical Air Control Party (TACP) is a subordinate element of the ASOC. [Ref. 2]

Airborne Enabling Nodes: Several key airborne platforms support the ASETF Commander and his theater C2. Platforms such as the U-2, RC-135, E-3, and E-8 provide data that populates the global grid. In this capacity, these airframes are "enablers" for C2. Moreover, several of these platforms such as the E-3 and E-8, as well as the Airborne Battlefield Command and Control Center (ABCCC) have mission crews which perform C2 roles at the tactical level. These platforms are key to the execution of

the air battle and provide further redundancy to the theater C2 distributed network. [Ref. 2]

Airborne Command Element: The Airborne Command Element (ACE) team is a group of personnel who fly on one of the Air Force's C2 platforms mentioned above, and are an extension of the AOC combat operations division. These individuals operate on a non-interference basis to the aircraft mission crew, but are empowered by the ASETF Commander to oversee execution of the Air Tasking Order. [Ref. 2]

4. En route C2

As commanders travel forward to a theater of operations, they have a requirement to maintain situational awareness by receiving information. Once decisions are made, they must then pass those on to subordinate, lateral, or higher echelons. Consequently, several airborne platforms/configurations are under development to provide EAF commanders the aforementioned capabilities. [Ref. 2]

5. Additional Areas of Interest

The draft CONOPS contains additional areas pertinent to distributed C2. The additional sections not covered here deal with operations, command relationships, intelligence/national agency/space support, communications/computer systems support, joint issues, security, and training.

C. REAR OPERATIONS SUPPORT CENTER

During Operation Desert Storm, it took 10 to 15 days and 25 C-17 air lifters to create a support system for nearly 2,000 personnel in the forward air operations center in

Riyadh, Saudi Arabia [Ref. 3]. With the EAF concept, though, the goal is to dramatically reduce the number of forward-deployed personnel and equipment. In a speech in September 1998 at the Air Force Association National Convention, the CSAF, General Michael E. Ryan said, "We believe we can cut the size of our Air Operations Centers by an order of magnitude...to do with 200 people what we used to do with 2,000." Furthermore, Ryan stated, "A major part of being able to effectively execute the EAF concept is to reduce our forward footprint while connecting our forces to needed information and warfighting capability in rear areas." [Ref. 27]

Reducing the forward footprint and "reaching back" to rear areas for support was the impetus for the construction of the rear operations support center (ROSC). The ROSC, a $1 million facility built at Langley Air Force Base, Virginia, is run by the Air Force's Aerospace Command and Control, Intelligence, Surveillance, and Reconnaissance Center (AC2ISRC). The unique ROSC is a climate-controlled, computer-packed nerve center. It is designed to provide the aerospace forces commanders with a smooth transition from peacetime to war, allowing them to ultimately place fewer troops in harm's way during a conflict. The ROSC began full operation during EFX '98, providing critical command and control capabilities for the forward air operations center at Duke Field, Florida. [Ref. 28]

EFX '98 was the first test of the Air Force's distributed C2 concept, with the ROSC as a major pillar of that concept. Ultimately, though, according to General Richard E. Hawley, commander of the AC2ISRC, the ROSC will allow the Air Force to conduct command and control of its forces "in a lighter, leaner and more lethal way than

we've ever been able to do it before." [Ref. 28] During normal peacetime operations only 20 to 40 people will man the facility, but those numbers could swell to more than 200 during a contingency. If trouble started brewing, an operational commander would come to the ROSC with key staff members to assess the situation, form an initial strategy and develop target lists. When deployed to the hot spot, the group would remain electronically linked to the ROSC even as they flew. They would arrive with the ability to direct the forward-based forces and communicate everywhere. [Ref. 28]

Critical to the success of the ROSC concept are the assumptions of high end computing power, large amounts of bandwidth and perfect connectivity. The ROSC is connected to Langley AFB's fiber-optic, asynchronous transfer mode (ATM) local area network (LAN) with data throughput rates ranging from OC-3 (155 Mbps) to OC-12 (622 Mbps) [Ref.3]. The bandwidth during EFX '98 was a limiting factor in what the Air Force was able to process during the weeklong experiment. "We intentionally didn't use the highest definition imagery, because imagery right now is a major bandwidth hog," said TRW Systems Engineer Toby Logan. "We're only passing 40-50 percent of what we need to fight a shooting war and we're using all the bandwidth we have right now." [Ref. 29]

D. THEATER DEPLOYABLE COMMUNICATIONS

The Theater Deployable Communications (TDC) program began in the early 1990s to improve integration of national, theater, and tactical intelligence and C3 systems. TDC was originally intended to replace and/or augment the Air Force's Wing

Initial Communications Package (WICP), but funding and airlift constraints caused the requirement to migrate toward full replacement of Tri-Service Tactical Communications (TRI-TAC) equipment. However, the TDC program was not originally designed for this replacement. Due to a current gap between TRI-TAC and TDC capabilities some TRI-TAC equipment will need to be retained until suitable replacements are identified, or until TDC can incorporate those capabilities. [Ref. 30]

TDC will replace obsolete proprietary deployed communications equipment (primarily TRI-TAC) with flexible, high-speed commercial equipment. TDC supports the deployed warfighter's need for voice, data, message, and video communications. The TDC system is comprised of commercial off-the-shelf (COTS) and government off-the-shelf (GOTS) technologies that provide the warfighter with flexible, lightweight, secure, modular, and integrated deployable communications. TDC consists of two major components: the Lightweight Multiband Satellite Terminal (LMST) providing long-haul communications and the Integrated Communications Access Package (ICAP) providing a common user communications backbone. Together, these components increase the communications capability of a deployed base, while requiring less than one quarter the airlift of a comparable TRI-TAC configuration. [Ref. 30]

The LMST, developed by the Harris Corporation, is available in either a trailer (AN/TSC-152) or transit case version (AN/USC-59) and utilizes a 2.4-meter satellite dish. Figure 9 shows the LMST trailer version. LMST is capable of operating in C- and Ku-bands at data rates up to T-1 (E-1 in Ku-band in Europe) and X-band at 1152 Kbps over the DSCS satellites (Note: T-1 = 1.544 Mbps and E-1 = 2.048 Mbps). It can operate

up to 8.04 MB/s if a user is patched directly to the terminal's modem. The terminal is INTELSAT and Defense Satellite Communications System (DSCS) certified for operation in the aforementioned bands. [Ref. 31]

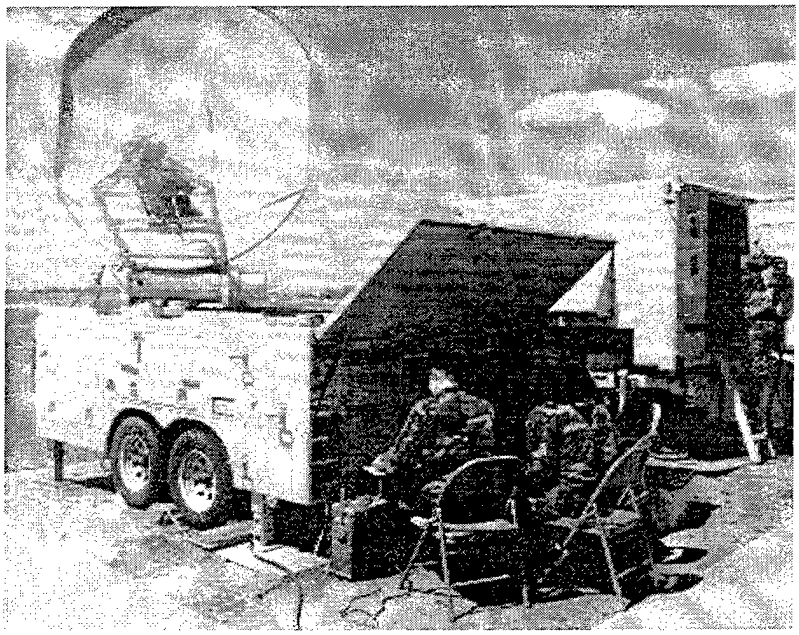

Figure 9 LMST Trailer Version From Ref. [31]

Motorola Corporation serves as the system integrator for the ICAP. ICAP is essentially the communications infrastructure for the deployed base. It includes transit case modules dedicated to secure and non-secure voice, data, messaging, and VTC capabilities, as well as dynamic bandwidth management, and a complete Network Control Center (NCC) capability that mirrors the garrison NCC. Unlike TRITAC systems, which consist of individual large vans providing centralized services to an entire air base, TDC is modeled on the distributed processing model. User communities, such as medical, maintenance, security, or operations, tend to be geographically separated on a deployed base, and have different requirements in terms of their relative demand for voice or data

services. ICAP is designed to put a tailorable voice/data capability at each of these "information transfer nodes" (ITNs) that will provide localized secure and non-secure phone and computer access to the base "backbone." These ITNs will then be centrally overseen and managed at the NCC-Deployed. This model has the advantage not only of increasing robustness by eliminating single points of failure, but also of reducing cable "runs," and thereby dramatically speeding the "stand-up" of a robust base architecture. [Ref. 30]

E. THEATER BATTLE MANAGEMENT CORE SYSTEMS

One major capability examined during EFX '98 was the Theater Battle Management Core Systems (TBMCS). TBMCS is being developed by Lockheed Martin Command and Control Systems and is intended to facilitate improvements in ATO planning, generation, and cycle times. It will facilitate improvements in access and coordination times through improved data residency, sharing, and updating protocols at the system, force and unit levels. TBMCS is the replacement system for the Contingency Theater Automated Planning System (CTAPS) which is the current joint system used for ATO development. [Ref. 19]

The operational mission of the TBMCS program is to develop, integrate, field, and maintain an evolving sequence of increasing capabilities for computer-supported management of theater airborne assets, in peacetime, exercise, and wartime environments at the force and unit levels. In this context, "force level" refers to the headquarters elements of a USAF operating command, numbered air force, unified command, sub-

unified command, joint task force, or combined (multi-national) command, whereas "unit-level" refers to the wings and squadrons which take direction from the force level organization. [Ref. 32]

TBMCS links the various organizational levels of command and control and execution as they relate to air operations. The system will provide connectivity horizontally to other services and allies, and vertically among standard or composite wings, other elements of the theater air control system, and deployed units and higher headquarters. The systems included in TBMCS will be modular to build up or scale down capabilities by adding or deleting information sources, operating units, weapons available, participating services and allies, and dispersal requirements. The TBMCS will provide automated decision support tools to improve the planning, preparation, and execution of joint air combat capabilities. It will also provide support for peacetime operations, i.e., humanitarian, and United Nations peacekeeping. Advanced technology will be transitioned to the field using evolutionary acquisition and rapid prototyping. [Ref. 32]

To meet operational performance criteria, TBMCS will receive, display, and integrate into related applications the current space, air, ground, and maritime situation as provided by US and allied sensors and specified ground processing elements. [Ref. 32]

The TBMCS used in EFX '98 was a version 1.0 prerelease, and, as such, its performance suffered under the EFX environment. In fact the *EFX '98 Assessment Report* [Ref. 19] stressed that TBMCS "could not 'go to war' as it works today. Its applications are too slow to support an ops tempo, it provided inadequate SA [situational

awareness] for distributed ops, and the integration of the various applications/databases was incomplete and/or ineffective." [Ref. 19]

Despite its lackluster performance during EFX '98, results indicated that TBMCS will "provide a great capability for joint service use when the systems are fixed." [Ref. 19]. The *EFX '98 Assessment Report* stressed that "when the system matures, it will provide the best battle management system in the world." [Ref. 19]

One success area highlighted in the *EFX '98 Assessment Report* dealt with the automatic submission and acceptance of the U.S. Army's Critical Target List (CTL). Early in EFX, the Army's Battlefield Coordination Detachment passed the CTL (list of targets submitted by the Army Ground Component to the JFACC for consideration of inclusion in the Target Nomination List (TNL) for each ATO) via the Target Weaponeering Module (TWM) within TBMCS. The CTL was received, read and opened in the TWM, thereby saving valuable time in the TNL and overall ATO process. [Ref. 19]

TWM was one of many applications within TBMCS that were tested during EFX '98. Below are several of those applications with a brief description of their function:

- ATO/ACO Tool (AAT): AAT allows users to view the Air Tasking Order/Airspace Control Order (ACO) United States Message Text Format (USMTF) messages in convenient table form. Users can filter ATO and ACO content and view only those portions that are of specific interest. [Ref. 19]
- Execution Management - Replanning (EMR): EMR is the tool used to replan or modify missions while the ATO is being executed. [Ref. 19]

- Force Level Execution (FLEX): FLEX monitors battlespace/battle plan execution. It tracks the actual mission execution time line and displays the execution flow. [Ref. 19]
- Theater Air Planner (TAP): TAP provides the capability to perform force-level air battle planning and generate an ATO. TAP is a primary program/system and is crucial to the ATO planning process. [Ref. 19]
- Targeting and Weaponeering Module (TWM): The TWM supports target data management. It consists of Rapid Application of Air Power (RAAP) and Joint Munitions Effectiveness Manual (JMEM). TWM generates and updates the Target Nomination List and Joint Integrated Prioritized Target List and maintains the target material database. It is a crucial part of the ATO targeting process. [Ref. 19]

F. COLLABORATIVE VIRTUAL WORKSPACE

A second major system tested during EFX '98 was the Collaborative Virtual Workspace (CVW) developed by Mitre Corporation. CVW is a multi-user object-oriented computing environment in which people interact with documents and one another in a shared virtual space. CVW has audio, video, chat and whiteboard features. [Ref. 33]

CVW provides the illusion of shared physical space in a virtual building that is divided into rooms where people gather to share documents and discuss topics, communicating through audio, video and text. As CVW users move from room to room,

they enter new group sessions to meet with new team members and potential collaborators. [Ref. 33]

During EFX '98, CVW was the main communications tool for internal discussions and between JAOC-F, JAOC-R and other distributed locations. CVW greatly enhanced coordination processes and facilitated better overall situational awareness. It allowed key decision-makers from multiple locations to participate simultaneously, enabling rapid decision-making. CVW provided secure communications and was reasonably reliable. Most operators readily acknowledged distributed operations in a split Joint Air Operations Center would not be possible in the absence of a collaborative environment with capabilities equal to or very similar to CVW. By design, a limited number of phone lines in/out of the EFX distributed sites and restricted operator movement "forced" a relatively high reliance on CVW to perform collaboration activities. Most EFX activities were performed in real-time. CVW services were used extensively during EFX to make up for shortfalls and as workarounds for other C2 applications. [Ref. 19]

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VII. SUMMARY

In his *1999 Annual Report to the President and the Congress*, Secretary of Defense William S. Cohen stated, "America's security relies upon a military that can shape and respond to world events, while at the same time preparing for the uncertain challenges of the future." [Ref. 34] The Expeditionary Aerospace Force (EAF) concept and the development of organized Aerospace Expeditionary Forces (AEFs) are the Air Force's answer to Secretary Cohen's requirement.

Secretary Cohen's report highlights the reduced forward footprint and reliance on "reachback" inherent in the EAF plan:

> A major aspect of effectively executing the EAF concept is the need to reduce the size of the forward logistics and operational footprint, while successfully connecting U.S. forces to requisite information and support capabilities in rear operating areas. New and emerging support concepts, such as information reachback and just in time logistics support to databases and expertise in the rear, are key to tapping this potential. Centers that are geographically separated by significant distances, but electronically connected in a support relationship, constitute reachback operations. Tomorrow's Air Force requires crisis action planning tools that integrate combat and support operations, logistics, force protection, and other functions in a collaborative process supported by shared databases. From an operational and planning perspective, reachback allows the Air Force globally to move information rather than people—a key to effective expeditionary air operations. [Ref. 34]

The AEF concept is predicated on a comprehensive, coherent, and integrated command and control system that pulls together organizations, processes, and technical means [Ref. 34]. *Air Force Doctrine Document 2-8: Command and Control Doctrine* emphasizes this point: "The immense expanse of the global battlespace demands

outstanding people, state of the art technology, and efficient processes for successful operations." [Ref. 6]

Expeditionary aerospace operations will require fast and efficient command and control operations [Ref. 6]. The U.S. Air Force appears to be headed in the right direction in attempting to meet this need. This thesis has presented background on the EAF concept, highlighted initiatives in support of EAF, and offers examples to illustrate how the Air Force is addressing the three pillars of command and control–personnel, processes, and technology.

Chapter I highlighted the reasons why the Air Force has embraced the EAF concept, provided background on the concepts of a "light, lean, lethal" force, as well as distributed operations, and defined the term "command and control." The major driver behind EAF was the end of the Cold War and the increasing expeditionary demands placed on the Air Force since then. Transitioning to an expeditionary culture requires "light, lean, and lethal" forces as described by the Air Force Chief of Staff, General Ryan. A lean force will rely heavily on advances in information and communications technologies to allow for distributed operations, thus reducing the forward-deployed footprint. This environment poses new challenges to command and control operations.

Chapter II provided an overview of the EAF concept and discussed the different types of air expeditionary forces. As General Ryan and Acting Secretary Peters pointed out in August 1998, each of the 10 AEFs will be on-call or deployed for 90 days every 15 months. This schedule will provide more predictability and stability to Air Force personnel. The main segments of the EAF plan include ten AEFs, two rapid response

wings, mobility aerospace expeditionary forces, and enabler forces, such as the U-2 and AWACS.

Chapter III presented various Air Force initiatives aimed at securing a smooth transition to an expeditionary culture. This includes changes in doctrine and training, focusing wargames and the Expeditionary Force Experiment on the EAF concept, establishing new organizations geared towards command and control, as well as coordinating command and control efforts through the C2 Baseline Forum.

Chapter IV focused on the personnel pillar of C2 by introducing the organization of aerospace forces and the Joint Air Operations Center as presented in *Air Force Doctrine Document 2*. Two entities–the commander of Air Force forces (COMAFFOR) and the aerospace expeditionary task force (ASETF)–are designed to present the JFC with a task-organized, integrated package with the proper balance of force, sustainment, and force protection elements. Air Expeditionary Forces are deployable wings, groups, or squadrons which deploy within the framework of an ASETF. A notional JAOC organization consists of a JAOC director, core teams, specialty teams, and support teams.

Chapter V analyzed the major process in conducting aerospace operations–the air tasking cycle. Chapter V outlined the six-step air tasking cycle as presented in *Joint Pub 3-56.1: Command and Control for Joint Air Operations*. In addition Chapter V provided a notional method of distributing the subprocesses of the air tasking cycle. The air tasking cycle provides a repetitive process for the planning, coordination, allocation, and tasking of joint air missions/sorties, within the guidance of the joint forces commander. The six steps of the cycle include JFC/Component Coordination, Target Development,

Weaponeering/Allocation, Joint ATO Development, Force Execution, and Combat Assessment. These six steps were divided between a forward and rear air operations center during EFX '98.

Chapter VI covered the technology pillar of C2 by discussing different facilities, equipment, and communications systems the Air Force is developing in support of expeditionary operations. The chapter began with discussion on various C2 facilities for distributed operations as envisioned in a draft CONOPS by the Air Force Command and Control Training and Innovation Center (AFC2TIC) EAF C2 Baseline Team. Following this, the chapter detailed the Rear Operations Support Center, which was utilized extensively during EFX '98. The remainder of the chapter covered the Theater Deployable Communications (TDC) and Theater Battle Management Core Systems (TBMCS) programs, and the Collaborative Virtual Workspace (CVW) software. The AFC2TIC CONOPS offers a C2 architecture consisting of fixed CONUS and OCONUS centers, deployable command centers, and en route methods of C2. The CONOPS stresses the importance of information and communications connectivity, Intelligence personnel, and information operations for successful distributed operations. The $1 million ROSC facility provides critical command and control support for the forward air operations center. TDC aids in reducing the forward-deployed footprint by replacing older and larger communications equipment with flexible, lightweight, secure, modular and integrated equipment. TBMCS is a system of modules geared towards air campaign planning. Although TBMCS experienced many problems during EFX '98, it promises to

be a highly effective system as it matures. Also utilized heavily during EFX '98 was CVW, which provides computer-based tools for distributive collaborative planning.

As the Air Force continues to transform itself to an expeditionary force, proper arrangement of its personnel, its processes, and technology will be essential to effective command and control. If any of these three pillars becomes too long or too short, command and control, more than likely, will suffer and/or fail. As *AFDD 2-8* highlights: "Untrained people, incompatible equipment, or bureaucratic processes have hurt and even doomed operations in the past." [Ref. 6]

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