Reachback Operations for Air Campaign Planning and Execution

Scott M. Britten, Colonel, USAF

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Colonel Scott M. Britten, USAF, is a member of the Air Force's acquisition corps, having held acquisition management and flight test positions for 18 of his 20 years of service. Prior to entering the Air War College, he was the Program Director for Special Projects at the Electronic Systems Center, Hanscom AFB MA. In this position, Colonel Britten managed the development, test, and deployment of classified electronic weapon systems. Other assignments included a tour on the staff of the Assistant Secretary of the Air Force for Acquisition; Chief of Maintenance and Engineering for the U-2 aircraft fleet, sensors, and ground stations; Joint Test Force Director for a classified aircraft; manager of all armament testing for the Air Force Flight Test Center; Deputy for Engineering for the Antisatellite Combined Test Force; and manager of a data processing system development for a surveillance satellite. Colonel Britten is a distinguished graduate of the Air Force Academy, USAF Test Pilot School, Squadron Officer School, and Air Command and Staff College. He was also a National Science Foundation Fellow at the Massachusetts Institute of Technology, where he earned a Master of Science degree in Aeronautical and Astronautical Engineering in 1977. A 1997 graduate of the Air War College, Colonel Britten conducted this research under the auspices of the Center. His current assignment is the Director of the F-15 System Program Office at Robins Air Force Base in Georgia.

Preface

The inspiration for this research occurred long before I entered the Air War College. I became enamored with the possibility of applying reachback operations to air campaign planning and execution after learning how General Charles Horner and his staff overcame tremendous challenges during Desert Shield and Desert Storm to orchestrate an air war unique in human experience. General Horner's difficulties convinced me of the absolute necessity of avoiding the problems of survivability, deployability, and supportability for future Joint Air Operations Centers (JAOC) through advanced communications and computational technologies. My conviction is certainly not unique, or even original; many talented operators and computer system developers have worked for years to implement geographically distributed data processing for the JAOC. This paper will make two contributions: first, to analyze reachback operations for the JAOC, and second, based on this analysis, to argue for implementing such a system in the near-term using today's technologies and upgrading as appropriate when advanced research and development allows.

I was truly amazed at the unstinting assistance I received from many extremely busy people. Foremost in providing help was Lt Gen (Ret) Stephen B. Croker, an experienced Joint Force Air Component Commander whose mentoring during my research put me back on course whenever I strayed. I am also indebted to Dr. Bert Fowler, past chairman of the Defense Science Board, for his thoughtful review and extremely helpful suggestions. Lt Col Tom Gorman, the Air Force's maestro of the Contingency Theater Automated Planning System, contributed his enormous knowledge and insight. Other experts in various fields also lent me invaluable assistance. Chief among them were: Col Bill Hoge, Col Carl Steiling, Col Larry Carter, Col Chuck Fox, Cdr Donald McSwain, Lt Col Fred Norman, Maj Bruce DeBlois, Mr. Ron Thompson, Mr. Carl DeFranco, and Mr. Jerry Friedman. Of course, my Air War College faculty advisors, Dr. William Martel and Col (Ret) Theodore Hailes, deserve special thanks for their encouragement, insight, and editorial assistance. Finally, I am indebted to my wife Eileen for proofreading above and beyond the call of duty. That being said, I am responsible for any inadequacies remaining in this paper.

Abstract

Air campaign planning and execution are two extremely complex tasks in modern warfare. Each day during a major regional contingency, thousands of sorties from dozens of bases must be choreographed for maximum effect against the enemy to carry out the Joint Force Commander's intent, in concert with other friendly military activities. Today, the Contingency Theater Automated Planning System (CTAPS) assists this task, using a large assortment of modern computer tools. Although CTAPS is an enormous improvement over previous planning and execution methods using paper charts and grease pencils, there remain deficiencies in the survivability, deployability, and supportability of the way the Joint Air Operations Center (JAOC) implements CTAPS, otherwise known as the CTAPS architecture. However, emerging communications capabilities, coupled with existing or emerging distributed data processing technologies, promise to improve these three deficiencies through reachback operations using data-linked, but geographically separated computer workstations. This will allow most of the JAOC's personnel and equipment to remain in a secure location, rather than being deployed forward in the theater. This paper describes CTAPS and its architecture deficiencies; as well as a conceptual reachback system, along with its advantages and drawbacks. Finally, the paper recommends that the DOD, through the services, develop a reachback system for the JAOC.

I. INTRODUCTION

War is perhaps one of the oldest human endeavors and in modern times is certainly one of the most complex. Desert Storm's air campaign illustrated this complexity, for 2,400 coalition aircraft flew day and night with precise synchronization from over 20 airfields and 6 Navy carriers[1]. For most of these sorties, air campaign planners specified the missions, types of ordnance or cargo, targets, flight paths, refueling tracks and off-loads, and many other parameters essential for success. Planners had to choose on a daily basis among hundreds of targets to maximize progress toward the Coalition's objectives, while minimizing the risk to the aircrews and ground forces, as well as the risk to enemy civilians, religious and historically significant buildings, and other proscribed sites. Few peacetime undertakings could match the Herculean task of planning and executing the Coalition's air campaign.

What tools did the planners have for this daunting task? Despite over 3,000 computers in the war zone data-linked to computers in the United States[2], much of this excruciating work was "conducted as it had been for decades: with paper charts and grease pencils."[3] Lt Gen Charles A. Horner, the Desert Storm Joint Force Air Component Commander (JFACC), overcame the shortcomings of these methods by canvassing the Air Force for Fighter Weapons School graduates to form the nucleus of his planning staff, which was aptly named the "Black Hole." These experts, as well as the entire JFACC staff, did what was necessary with available computer tools, such as the Computer Aided Force Management System.[4] As this paper explores, today's advanced data processing and communications technologies promise to transform air campaign planning and execution far beyond the rudimentary tools available to General Horner and his staff.

Since the late 1980s, the Air Force has been developing an integrated set of computer hardware and software tools to lessen the air planner's burden. These computer tools are collectively known as the Contingency Theater Automated Planning System (CTAPS). To better understand CTAPS, Section II first describes the Joint Air Tasking Cycle, which is the set of activities that CTAPS supports. The section then explains how CTAPS works, providing an overall understanding of the tasks involved, as well as defining the vocabulary unique to air campaign planning and execution. The way the Joint Air Operations Center (JAOC) implements CTAPS, which also is referred to as the CTAPS architecture, requires a large number of people and extensive amount of equipment in the theater. Unfortunately, the CTAPS architecture's large size and in-theater location may lead to poor survivability, deployability, and supportability. In addition to explaining CTAPS, Section II also explores these deficiencies and other less serious shortcomings of the current CTAPS architecture.

Section III introduces a possible solution to these CTAPS architecture deficiencies. This improvement relies on advanced communications and distributed data processing to break up a complex computational task into subtasks performed by data-linked, but geographically separated computers, often simultaneously and synergistically. Businesses and the Department of Defense (DOD) do this all the time. In fact, the Air Force's Tactical Air Command headquarters at Langley Air Force Base (AFB), Virginia used a similar reachback concept extensively during Desert Storm to assist General Horner in his administrative duties as commander of all Air Force personnel in the theater.[5] Since Desert Storm, new data communications technologies offer the JFACC the option of leaving most CTAPS computer systems and operators in either a continental United States (CONUS) garrison or in another rear area. Only the JFACC, along with a much smaller supporting staff and much less equipment, need be put at risk in the theater. The capability to use data-linked, but geographically separated, segments of an air campaign planning and execution system to enhance survivability, deployability, and supportability is often called reachback operations. This paper uses the term reachback system to refer to a conceptual air campaign planning and execution system embodying a reachback operations capability.[6] Section III further explores the hardware and personnel that should deploy to the theater for a major regional contingency, as well as the equipment and personnel which should remain in a secure garrison. This section then points out the factors for deciding where the garrisoned segment should reside, and discusses the rapidly evolving US communications capabilities that make reachback operations possible.

Based on the conceptual system introduced, Section IV examines the advantages of reachback operations. To be clear, a reachback system using advanced communications to implement geographically distributed data processing will not, by itself, improve CTAPS' functionality. If in an ideal world there were no constraints on threats or logistics, the most effective CTAPS architecture would involve co-locating all the equipment and operators in a large room in the theater. This would have the effect of maximizing the synergy among the CTAPS components and keep the air planners close to the war. However, a reachback system's improved survivability, deployability, and supportability would make it far preferable to the current, centralized CTAPS architecture. Overall, because of these three advantages, reachback operations would directly support the new DOD vision of expeditionary warfare that rests on information superiority.[7] Other ancillary advantages also derive from using reachback operations. Databases of intelligence information, terrain, current forces, and many other critical factors could be standardized for all services employing air assets. A reachback system could also alleviate a number of problems faced by a JFACC operating aboard ship, and should make the transition between a JFACC afloat and a JFACC ashore less complex than is the case today. Another benefit of a stable garrison location may include the opportunity for its personnel to gain more proficiency than is currently possible, because larger numbers of civilian operators and system administrators could be employed alongside the military staff. Finally, depending on the number of garrisoned locations, the reachback system's infrastructure could feature less duplication in equipment in comparison with today's multiple JAOC force structure. Improved survivability, deployability, and supportability, as well as the five ancillary benefits, suggest that investing in reachback systems is compelling indeed.

Of course, reachback operations have their own drawbacks. Both human proclivities and the systems geographically distributed architecture present impediments. Section V explores these disadvantages and, where possible, suggests avenues for mitigating the adverse consequences of reachback operations. In particular, the following concerns could impede successful operation of a reachback system: concerns of senior officers, communications dependencies, lower operational efficiencies requiring additional personnel and equipment, leadership challenges for garrisoned personnel, and difficulties in incorporating theater-produced intelligence into the garrison's databases. Although none of these drawbacks should be taken lightly, there are ways to mitigate virtually all of these concerns. Even more important, no insurmountable obstacles exist for implementing a reachback system. Finally, Section VI concludes by summarizing the case for reachback operations as the mainstay of air campaign planning and execution, and recommends specific actions that are required to implement a reachback system.

II. THE CONTINGENCY THEATER AUTOMATED PLANNING SYSTEM

The need for flexible planning in war has been evident for millennia, and the planning and execution of air campaigns illustrate this maxim. Airmen must choreograph numerous, disparate air assets to achieve the Joint Force Commander's (JFC) objectives. Therefore, centralized control has been the Air Force's doctrinal foundation ever since the costly lessons from Tunisia during World War II, when disjointed air power failed to mass against the enemy wherever most needed throughout the theater.[8] A less renowned, but equally important lesson from Tunisia was the need for synergistic cooperation among the air and ground combatants.[9] The Navy had already learned the need for maritime air and surface force coordination as it developed carrier air doctrine in the 1930s. Thus, planning and executing modern air campaigns involves not only large numbers of aircraft, but also rapidly changing circumstances and objectives given operations on the ground and at sea.

Even before Desert Storm, the Air Force recognized the need for a new generation of automated tools to help planners become more responsive. In the late 1980s, the Air Force started the CTAPS program, which eventually became an evolutionary development based on extensive work with prototype tools at Langley AFB, Virginia.[10] CTAPS is still evolving as new technologies open up possibilities to better support the JAOC staff. To illustrate how the number of iterations the design has undergone, version 5.2 is slated for release to the field soon.[11] The Air Force plans to incorporate CTAPS into the Theater Battle Management Core Systems, and eventually to provide the CTAPS capability within the Global Command and Control System environment.[12]

This paper first focuses on CTAPS. Even though the CTAPS components could readily accommodate worldwide distributed processing, the current CTAPS architecture does not use the long-distance communications that a reachback system would involve. On the other hand, CTAPS is the product of years of evolutionary growth in automated tools for air campaigns. Further, the DOD has embraced CTAPS' successors for joint procurement and operations. Thus, the CTAPS core capabilities discussed in this section will undoubtedly be followed by many follow-on systems, including reachback systems. Sections III and IV build upon the material in this section regarding how air campaigns are conducted today. To better understand CTAPS, a brief review of the Joint Air Tasking Cycle, based upon Joint Publication 3-56.1, Command and Control for Joint Air Operations, is presented.

The Joint Air Tasking Cycle

Modern air campaigns operate rhythmically to accomplish all required activities in a logical order. Although the Air Tasking Order (ATO) is a key, and perhaps best known, product of this cycle, all major activities produce important data products. According to Joint Publication 3-56.1,

> The [Joint Air Tasking] cycle . . .provides a repetitive process for the planning, coordination, allocation, and tasking of joint air missions/sorties, within the guidance of the JFC . . .
>
> 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).[13]

Figure 1 diagrams the principal steps in the Joint Air Tasking Cycle.

The JFC's procedures dictate how long this cycle requires for each of the three ATOs that are in progress at any one time. The time to complete this cycle must be shorter than the enemy's decision cycle, because if it is not, then the enemy will control the tempo of the war. A short description of each major step in the Joint Air Tasking Cycle follows.[14] For clarity, this discussion focuses on the top-level actions and thus leaves out many details.

Step 1: Coordination between the Joint Force Commander and the Components. The JFC considers the implications from the most recently completed combat assessment, and with the advice of the component commanders for air, land, and maritime forces, issues guidance and objectives for the next cycle. As an example, if air superiority has been achieved, then the JFC might decide to place greater emphasis on air interdiction objectives.

Step 2: Target Development. With the JFC's guidance and objectives understood, the component commanders then nominate to the JFACC targets that they cannot attack with their own assets. Targets may also come from previously defined joint target lists, intelligence reports, and electronic warfare inputs. The JFACC recommends how best to rank the priority of targets to the JFC to support the campaign. The Joint Integrated Prioritized Target List (JIPTL) documents the JFACC's recommendations to the JFC for the detailed planning to follow.

Step 3: Weaponeering / Allocation. Based on the JFC-approved JIPTL, targeting personnel match the types and numbers of aircraft and weapons best suited to attack these targets, as well as target aim points and other critical mission planning factors. This information is compiled into the Master Air Attack Plan (MAAP). The JFACC, and perhaps even the JFC, will review the MAAP, which forms the foundation for the ATO, to ensure that it addresses the JFC's guidance and objectives.

Step 4: Joint Air Tasking Order Development. JAOC planning continues to turn the high-level MAAP into the detailed ATO by generating directions that are sufficient for the assigned forces to plan and execute their missions. Some tasks, such as determining the types and settings of weapon fuses, are normally accomplished by the wing planning cells, rather than the JAOC.[15] 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.[16] Joint ATO Development also generates Special Instructions (SPINS) and the Airspace Control Order (ACO) to assist aircrews in completing their missions safely without interfering with other military operations.

Step 5: Force Execution. As its name implies, this step in the Joint Air Tasking Cycle involves carrying out the missions assigned by the ATO. An important aspect of this activity is the real-time redirection of previously planned sorties in order to be able to react to time sensitive tasks. A classic example of real-time redirection occurred on the night of 30 January 1991. Based on real-time warning from a Joint STARS aircraft,[17] General Horner's staff retasked over 140 tactical aircraft sorties to interdict an Iraqi attack on Khafji, Saudi Arabia. These sorties were decisive, for "the Iraqis had received such devastating blows from the air around Khafji that they had no intention of moving again; nor did they for the rest of the air war."[18] While the Joint Air Tasking Cycle may appear ponderous, the force execution step gives the JFACC the ability to react immediately to an evolving operational situation.

Step 6: Combat Assessment. Although Figure 1 presents combat assessment as the final step in the Joint Air Tasking Cycle, this activity is a continuous process and is the most critical activity in the cycle. Combat assessment determines what happened during force execution, and evaluates not only the results of friendly sorties, but also enemy actions and other changes in the JFC's area of responsibility. Based on experience, this is the most problematic activity in the Joint Air Tasking Cycle.[19] Combat assessment used to be called "bomb damage assessment," but as the current name implies, all combat activity should be analyzed, not just bombing results. The products of this step are reports and recommendations for the JFC to consider when the next cycle begins.

Contingency Theater Automated Planning System Tools

CTAPS is an integrated set of tools that partially automates the activities of the Joint Air Tasking Cycle.[20] Figure 2 indicates which step(s) of the Joint Air Tasking Cycle each primary CTAPS tool assists, and uses standard acronyms for each tool.[21] Subsequent paragraphs will briefly describe these tools. With the sole exception of the JFACC Planning Tool, all of these computer programs freely interchange data and products, so that any operator can call up any information available throughout CTAPS. Actually, CTAPS contains over 150 tools. For clarity, Figure 2 shows only the primary CTAPS tools, leaving out other tools such as message handlers. Any CTAPS workstation can access any tool for appropriately designated operators,[22]

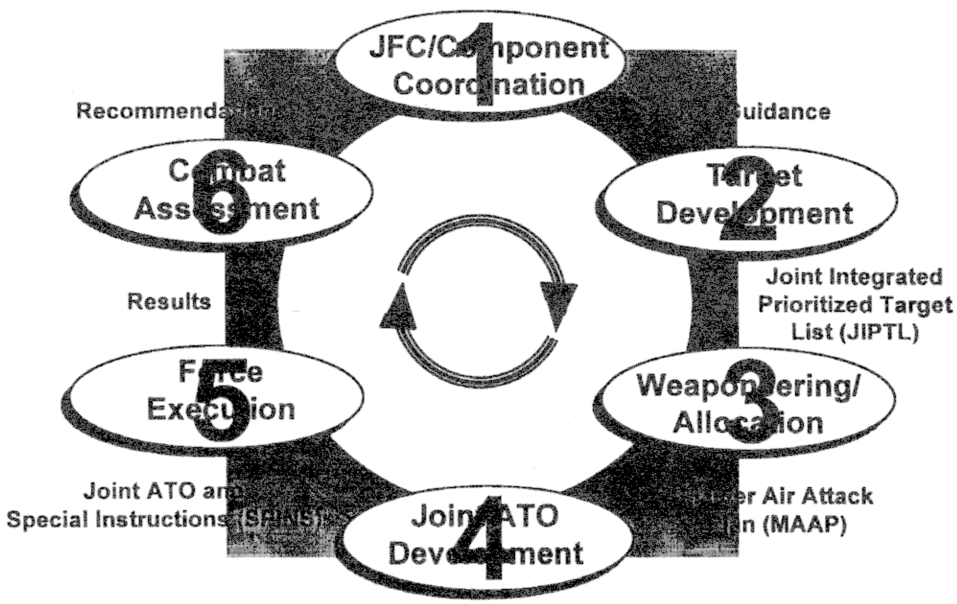

Figure 1. Joint Air Tasking Cycle

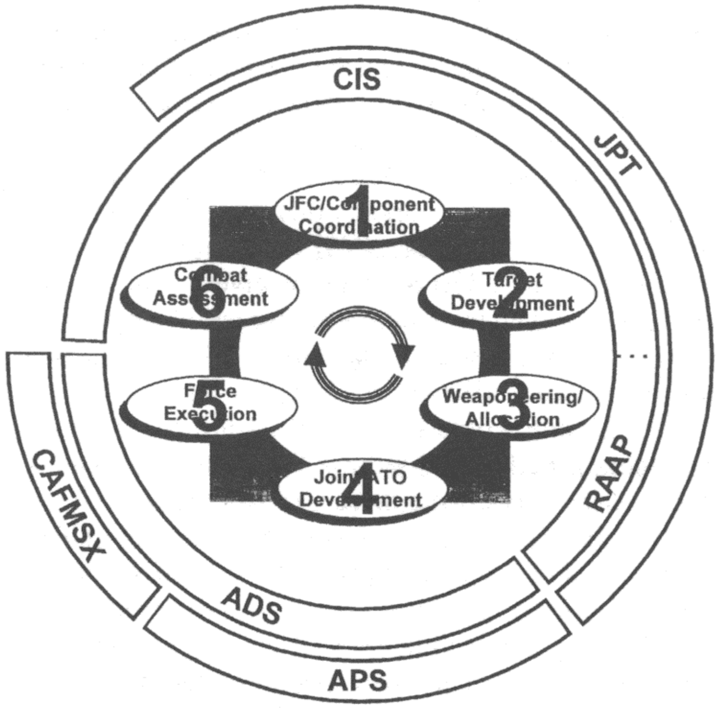

Figure 2. CTAPS Tools for the Joint Air Tasking Cycle

although most operators specialize in using one of the primary tools described below.

One of CTAPS' attributes is its ability to size the number of workstations in a flexible fashion to fit the nature of the contingency. The following paragraphs relate the number of workstations each tool might require for a major regional contingency, such as Desert Storm. A smaller operation would generally use fewer workstations than the numbers quoted below.

Advanced Planning System (APS). The APS tool assists planners in developing the ATO. The APS database contains theater data, including aircraft types, radar locations, and digital maps; scenario data, such as the JFC's guidance, logistics status, and nominated targets; and the Air Battle Plan, which is an electronic version of the ATO. The APS not only maintains all this data, but it also assists the planners in generating new data for upcoming ATOs.[23] The DOD has designated the APS as the standard joint planning tool. For a large contingency, APS might use 36 workstations, with a minimum of one workstation for each aircraft type.[24]

Airspace Deconfliction System (ADS). The ADS tool helps generate the Airspace Control Order (ACO) to deconflict the allocated airspace blocks for military forces in the theater for aircraft as well as surface-to-air missiles and cruise missiles.[25] Up to eight workstations can manipulate the ADS database, although most of the other CTAPS workstations would also typically access ADS products.[26] Due to the size of the ADS database these machines manipulate, all eight workstations should be located together.[27]

Combat Intelligence System (CIS). Accurate, timely intelligence information is critical to CTAPS. CIS receives, analyzes, displays, and distributes intelligence data from multiple sources, and can extract data from the Defense Intelligence Agency's database. CIS also maintains its own theater database, and allows access by wing-level intelligence workstations.[28] As one would expect CIS is a large system. In a major regional contingency, perhaps 50 workstations may be devoted to this task, but it is not necessary to collocate these CIS workstations.[29]

Computer Aided Force Management System - X (CAFMSX). The CAFMSX tool monitors and displays both offensive and defensive air operations status. With it, the JAOC keeps track of mission status for each sortie.[30] CAFMSX not only links the JAOC to geographically separated wings equipped with their own CAFMSX workstations, but can distribute ATOs to the wings in seconds rather than the many hours experienced in the early days of Desert Shield.[31] Like CIS, CAFMSX has a large allocation of workstations within the JAOC. While a major regional contingency would use 40 workstations, there is no reason to collocate CAFMSX workstations.[32]

JFACC Planning Tool (JPT). The JPT helps the JFACC keep track of national strategic objectives, the JFC's theater objectives, air campaign objectives, air tasks, and targets, and thereby relates each target and air task to national objectives. The JPT assesses threats, develops and evaluates alternatives, and estimates the size and composition of the air assets necessary to reach these objectives. The JPT can export its target list to the RAAP (discussed below), and create a draft MAAP as well,[33] although the JPT is not yet integrated into the suite of CTAPS tools.[34] Currently, the JPT handles various missions, including offensive counter air, strategic attack, air interdiction, and close air support. In the future, the JPT will include force enhancement and force support missions, and will be integrated with the other CTAPS tools. For now, the JPT requires two displays, one processor, and many disk drives for data storage.[35]

Rapid Application of Air Power (RAAP). While the RAAP tool is a part of the CIS, the function of the RAAP is so important that it is highlighted as a separate tool. RAAP not only helps planners define targets and choose appropriate weapons, but RAAP also stores the history of each target, including when the target was attacked, the results of the attack, the state of repairs since the attack, and so forth.[36] RAAP requires a more modest number of workstations than either CIS or CAFMSX. Typically, ten workstations connected to a server run the RAAP.[37]

Shortcomings of the CTAPS Architecture

Despite its obvious technology leap over "paper charts and grease pencils," the CTAPS architecture still requires a large amount of manpower and equipment deployed in the theater, making it vulnerable to attack and difficult to deploy and support.[38] The following paragraphs discuss the shortcomings stemming from CTAPS' size and in-theater location.

Survivability. If an asset takes up a lot of space, requires many people, or has an easily detectable signature, it is said to have a large footprint. Even in the theater's rear area, the CTAPS-equipped JAOC has very large electronic and physical footprints, making it a relatively vulnerable target to air raids, missile attacks, guerrilla actions, or sabotage. These threats could either damage the JAOC directly, or indirectly cripple the infrastructure that supports the JAOC (for example, electrical power or communications links). According to an experienced former JFACC, the loss of highly trained personnel or the loss of the JAOC's critical air combat planning capabilities represents extremely serious concerns for a JFACC.[39]

As General Horner observed, “The American people have demonstrated unbelievable tolerance at the losses of sons and daughters in battle when they believe in the cause, but no President or general can overestimate the speed at which that patience will disappear if they are perceived to be spending lives foolishly. Public sensitivity to casualties can dominate our political and military decision-making in a crisis.”[40] For a variety of reasons, the United States is averse to wartime casualties, which suggests that placing many hundreds of people in harm’s way must be avoided if at all possible.

From a strategic perspective, losing the JAOC’s capabilities during wartime would constitute a greater blow than sustaining a large number of casualties among the JAOC staff. Incapacitating the JAOC would be tantamount to putting the coordinated air war on hold until a new JAOC could be constituted. In the interim, the types of sorties flown would be restricted to what could be controlled by the ground or maritime component commanders, which is reminiscent of the nearly disastrous operations in Tunisia during World War II. The resulting drastic loss of effectiveness would not only impede the war effort, but would also result in additional friendly casualties beyond those that would be suffered if the JAOC were attacked. Indeed, an adversary would be well advised to consider the JAOC a preeminent center of gravity when planning to attack US forces.[41]

Deployability. A JAOC equipped with CTAPS is extremely difficult to deploy. Today, fully deploying a JAOC for a large campaign like Desert Storm requires 41 loads on C-141 aircraft to carry the equipment, in addition to 3 widebody airliners required to deploy the 900 people needed to operate the JAOC.[42] During a major regional contingency, such as Desert Storm, airlift is always in short supply,[43] so the burden of quickly transporting a JAOC with its CTAPS is truly onerous.

Given the massive lift required, deployment timelines suffer. Deployment schedules are also lengthened due to the need to augment JAOC personnel augmentation. Without augmentation, the numbered air forces could not mobilize beyond a small, quick reaction package.[44] As with airlift and skilled personnel, there is never enough time to react during a crisis. Recalling the frantic activity of Desert Shield, General Horner observed:

> We were surprised at Pearl Harbor, in Korea, and again in the Gulf. Iraq’s invasion of Kuwait took us completely by surprise . . . I will never forget those long dark nights in August 1990 when we struggled desperately to build up our forces . . .. Fortunately, Saddam stayed put in Kuwait, and the rest, as they say, is history. But he and other potential aggressors learned a valuable lesson: Don’t give America six months. (Emphasis added)[45]

Because the United States is the sole superpower with global commitments, it is likely that America’s next major military confrontation will require forces ready to fight far sooner than the JAOC deployment lead time can support[46]. In such a scenario, the JFACC may have no choice but to depend on either a ship-based or a CONUS-based CTAPS until the JAOC is operational ashore in the theater.

During the Cold War, the United States depended on forward basing and pre-positioned forces to prepare for war in vital theaters, such as the Persian Gulf. However, the end of the Cold War precipitated a reduction of US military bases on foreign soil and a withdrawal of most American forces to the CONUS.[47] In effect, US military forces are returning to their pre-World War II heritage, albeit with more expeditionary capability than they had in the past.[48] Although the United States still maintains pre-positioned war materiel, sophisticated and expensive systems such as CTAPS are typically kept at home, both for physical security and for daily use during training and exercises. If the United States must fight, it may not have the luxury of a prepared theater with a CTAPS-equipped JAOC already in place.

Supportability. Even if JAOC deployment problems could be overcome, supportability remains a challenge. Providing facilities and supplies for 900 people in an operational theater is not trivial. However, 41 C-141 loads of high-technology CTAPS and other JAOC equipment pose an even larger supportability challenge. Even though CTAPS was not operational during Desert Storm, deploying similar equipment during that conflict illustrated the magnitude of the supportability challenge. When Computers, generators, and other sophisticated equipment broke regularly due to the harsh climatic conditions, spare parts or replacement equipment were on the other side of the world.[49] It is unfortunate that in terms of reliability, cost and availability will continue to dictate commercial standards for most of the equipment in the JAOC. Rugged handling during deployment sometimes overwhelms commercial quality equipment. After the equipment is installed, dust, grit, and humidity are often problems even in an environmentally controlled facility, not to mention the far less hospitable environment deployed equipment usually sees. In a war zone, service on-site is usually not feasible, and flying in replacement units merely adds to the airlift burden.

Other Ancillary CTAPS Architecture Deficiencies

In addition to the three serious shortcomings described above, there are several other deficiencies with CTAPS. While these five deficiencies do not represent sufficient reason to invest in a reachback system, if a reachback system were procured, the developers should pay attention to improving the following areas.

Database Standardization. By any standard, CTAPS databases are enormous. They contain data on topics that are crucial to modern air warfare. This includes the JFC's guidance and direction, friendly and enemy force dispositions and status, target vulnerabilities, aircraft capabilities, weapons effects, terrain data, political boundaries, surface and foliage composition, current and predicted weather, supply status, combat assessments, air-to-air refueling orbits, and other vital knowledge.[50] Similar databases are equally important to the other military services as they conduct their own operations, yet Air Force databases are often not compatible with those of other services.[51]

Database incompatibilities can be disastrous. For example, during a recent Roving Sands theater missile defense exercise, Air Force and Marine Corps missile-warning grid coordinate systems were different, even though the two services coordinated the grids in advance of the exercise. Thus, Air Force warnings to Marine units of incoming missile attacks confused all units until they received the correct grids. This situation illustrated the opportunities for confusion even in a well planned military operation, given that before the Roving Sands exercise Air Force and Marine staffs worked closely together prior to the exercise to avoid this problem.[52] Although the DOD has designated the APS as a joint service standard, the Air Force, Navy, and Marines had different systems for directing air campaigns. At times, the database incompatibilities among these systems, as well as among databases within each service, pose truly significant problems.

Support for the JFACC Afloat. Joint Publication 3-56.1 specifies that the JFACC may be stationed on a ship if the situation in the theater makes this location advantageous.[53] If so, the JFACC would normally be placed on an aircraft carrier or on a command and control ship. More planning staff, computer tools, and communications are available to the JFACC on a command and control ship than on an aircraft carrier. Furthermore, a command and control ship's communications capabilities and deck space limits the JFACC staff to about 280 personnel and place similar restrictions on the number of automated tools.[54] These space limitations are unlikely to ease in the future, since a new class of ships would have to be built to provide significantly more room and facilities. Even though CTAPS has been adapted for these command and control ships, a JFACC afloat is currently limited to planning and executing about 800 sorties per day,[55] which is roughly one quarter of the sorties that may be required in a major regional contingency.

Transition between JFACCs Afloat and Ashore. Any JAOC staff member will attest to the enormous difficulties in making the transition in planning and execution authority from a JFACC afloat to a JFACC ashore. These transitions are one of the toughest tasks these staffs will ever perform.[56] Not only are the databases different, but the supporting automation differs between ship and shore. Thus, JAOC staffs have learned to expect a lot of hard work, and more than a little pandemonium whenever the authority of the JFACC makes the transition. The result may be one or more days during the transition when a new ATO cannot be issued, which represents a potentially serious situation during combat.[57]

Operator Proficiency. As noted above, the numbered air forces cannot deploy and operate a JAOC for a major regional contingency without increasing the permanent staff with personnel from other JAOCs and from subordinate units. Although augmented personnel may receive some training, in most cases their proficiency must come from on-the-job experience, which is hardly desirable in the middle of combat operations. The fact that "permanent" military members of the designated battle staffs rotate to other assignments every two to four years means that roughly one-third of the staff is new at any given time. In many other occupational specialties, the Air Force relies on civil servants to provide continuity, but operating CTAPS in a war zone potentially limits the number of civilians that can staff the JAOC. As a result, the first time the JAOC staff must prepare a real-time ATO, it is less than affectionately called "the ATO from hell."[58] Eventually, the JAOC staff will gain proficiency, but the staff will never be able to relive the early days of the war, which is the moment when the adverse consequences of inexperience may have the greatest costs for the United States and its allies.

Configuration Control. At least 28 US military organizations have the potential to operate a JAOC.[59] Even though some of these units have limited capabilities and equipment, this number of organizations still represents a sizable investment in personnel and hardware. CTAPS configuration control is a thorny problem not only given the dispersion of equipment, but also in view of the fact that some of these 28 units cannot afford to change their hardware configuration often enough to keep up with the innovation in the electronics industry. Consequently, some organizations use state-of-the-art CTAPS equipment, while other organizations use computer equipment that lags behind by one or two generations.

This turbulence means that configuration control for data-processing systems is a huge undertaking. What is state-of-the-art today may not even be supportable tomorrow. As a consequence, when the DOD buys commercial data processing systems, it also makes an implicit (although sometimes unrecognized) decision to replace those systems every two to three years to keep them maintainable and compatible with other systems. The configuration control challenge becomes nearly impossible when equipment is dispersed throughout the world, responsibility for upgrading it is scattered to each unit owning the equipment, and unit budgets are squeezed to the point that new equipment is unaffordable.

Configuration control is also a difficult task in view of CTAPS' development history. CTAPS was developed incrementally, and is still evolving. Recognizing both the importance and difficulty of controlling the CTAPS configuration, the J-6 Directorate of the Joint Chiefs of Staff chairs a configuration control board that oversees how the CTAPS will become part of the Theater Battle Management Core Systems and ultimately reside within the Global Command and Control System. While such configuration changes offer the benefit of continually expanding capabilities, it is a challenge to keep all users operating the most recent CTAPS configuration.

Clearly, CTAPS is a more powerful capability than computer tools that are not integrated, not to mention paper charts and grease pencils. However, the CTAPS architecture suffers from three serious drawbacks in the areas of survivability, deployability, and supportability. In addition, there are deficiencies in the current CTAPS configuration in the areas of database standardization support for the JFACC that is afloat, transition between JFACCs afloat and ashore, operator proficiency, and configuration control. Thus, it is worthwhile to consider how to better plan and execute air campaigns. The next section describes a conceptual reachback system to address some of the deficiencies of the CTAPS architecture.

III. A CONCEPTUAL REACHBACK SYSTEM

For the purposes of this paper, *reachback operations* describe using data-linked, but geographically separated, segments of an air campaign planning and execution system to enhance the survivability, deployability, and supportability of that system. A *reachback system* is a conceptual collection of the communications equipment, computer hardware, and software that are necessary to conduct reachback operations. *The deployed* segment of a reachback system consists of the equipment located in the theater, specifically in the JAOC, while the *garrisoned segment* (also referred to as the *garrison*) contains the reachback system's equipment that does not need to be deployed. The garrisoned segment would be located away from the immediate dangers of the theater.

Except where otherwise noted, the concept that is envisioned in this paper is to locate the garrisoned segment in the CONUS. Although the JAOC is located in the theater, the staffs of both the deployed and garrisoned segments are collectively referred to as the JAOC *staff* because they function as one team. The CTAPS components discussed in Section II could comprise a reachback system in this near term with the appropriate data linkages between the deployed and garrisoned segments. However, this paper does not limit the definition of a reachback system to only new CTAPS architectures because other implementations are possible using communications, computer hardware, and software still in development.

The first order of business when conceptualizing a system is to decide on the design goals. Broadly speaking, a reachback system must provide the same ability to prosecute an air campaign, while minimizing the number of personnel and the amount of equipment in the theater. A reachback system concept should also address all three of the CTAPS architecture deficiencies noted in Section II, improving upon each of these deficiencies to the extent possible with current or imminent technology. Finally, a reachback system must use high capacity, reliable, secure, and survivable communication links to tie its deployed and garrisoned segments together into a "virtual JAOC."

The reachback system concept is central to accomplishing the above design goals. As the US Central Command's JAOC Director recently observed, "If an operator spends the whole day at a computer terminal in the JAOC, what does it matter where the room containing the terminal is? Why not keep that room back in the CONUS?"[60] Conceptually, a reachback system design is no more complicated than deciding which functions should be retained in a garrison that is located in CONUS or another rear area. But to make the system work, sophisticated and powerful distributed data processing and communication technologies are absolutely essential.

A reachback system raises three fundamental questions. The first is the appropriate separation of personnel and functions between the garrisoned and deployed segments, the second is the location of the garrison, and the third is the communication between the geographically separated components. The remainder of this section addresses these three questions in the context of a major regional contingency, such as Operation Desert Storm. If a contingency is significantly different than Desert Storm, such as the recent intervention in Haiti,[61] then the JFC's concept of operations may require changes to the way the JFACC operates, and hence, changes to the JAOC configuration as well.

Separation of Personnel and Functions

A reachback system must support both the JFACC and the JAOC staff. Thus, decisions on the CTAPS architecture should begin with an understanding the JAOC organization and proceed to make recommendations about the location of the JFACC, JAOC staff, and any coalition officers. Finally, the workstations associated with the JAOC staff can be distributed between the garrison and the theater.

Joint Air Operation Center Organization. Figure 3 illustrates a notional JAOC organization that for manning purposes can be divided into four groups. The first is the command section and the JFACC's staff which is assigned to perform administrative duties. The second group is combat plans, which looks ahead to anticipate the future needs of the JFC. In addition to supporting the ATOs in work, combat planners also generate sequels, or plans for the upcoming phase(s) of the JFC's campaign. Based on the most recent combat assessment and the JFC's guidance, combat plans develops the MAAP, and ultimately the ATO. The third group, combat operations, is responsible for overseeing ATO execution. In the words of General Croker, "Combat ops gives us the quick reaction capability we need to fight a war flexibly."[62] The fourth group consists of the liaison officers from land, maritime, space, and special operations component commanders.[63] While liaison officers do not actually work for the JFACC, they represent their commanders' interests and campaign goals to the JFACC and keep their commanders informed about air operations.

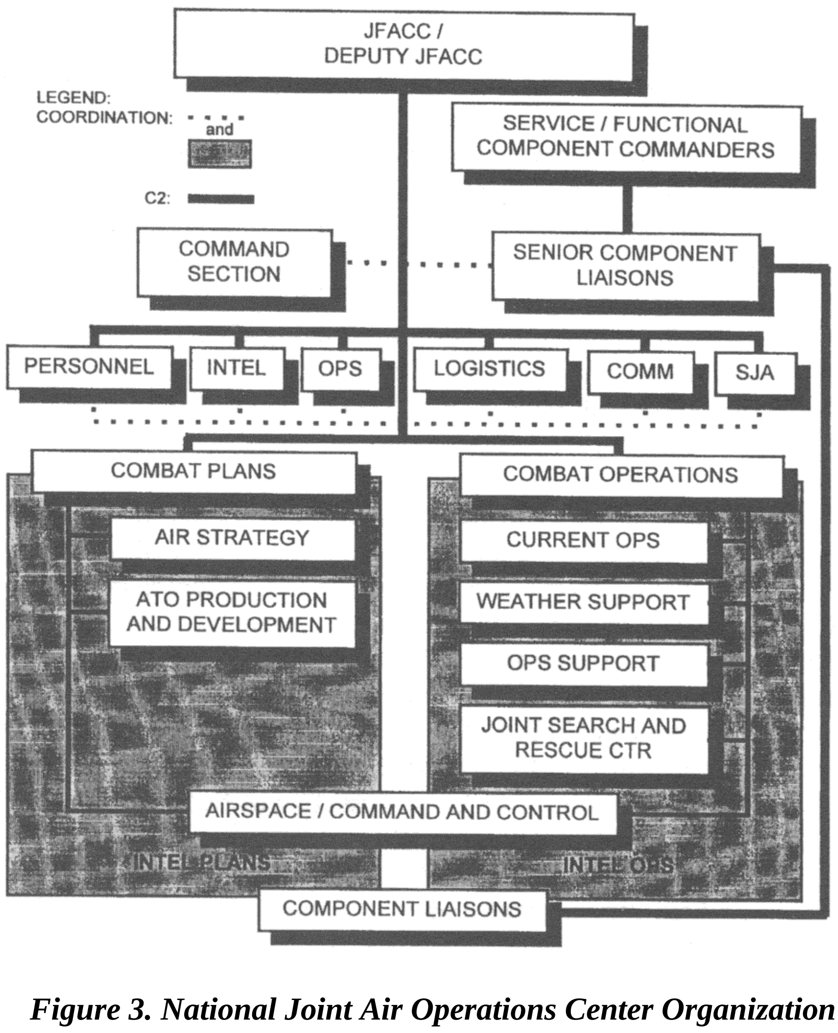

Figure 3. National Joint Air Operations Center Organization

JFACC Location: Arguments for JFACC in CONUS. When considering where each member of the JAOC should be located, the most important question must be "Where is the JFACC?" One school of thought (not shared by this author) argues for locating the JFACC in the CONUS.[64] There are three reasons. First, the JFACC will have better information in the CONUS and thus can do a better job there. Second, forward-deployed headquarters are vulnerable, difficult to deploy, slow to set up, and have poor connectivity. And third, because many flying units under the JFACC's control will not be based in the theater, there is little benefit to exposing the JFACC to enemy action. In reality, these arguments have serious flaws for most contingency situations.

JFACC Location: Arguments for JFACC in Theater. To begin with, communication and information technologies will increase the availability of information needed by anyone. In fact, the theater rather than CONUS will be the source of most of the information that is germane to the JFACC (mission status, logistics data, human intelligence, and so forth). In the highly unlikely event that communications between the theater and the CONUS were interrupted for any reason, the JFACC would actually be better off in the theater rather than in the CONUS. This would be true not only because the data originating in the theater would still be available, but also because the JFACC's communications with the in-theater air forces should still be possible through a variety of channels.

The second argument explores the disadvantages of a forward-deployed headquarters. This paper shares those concerns because these were the original motivation for this study. However, a forward-deployed headquarters also has overriding advantages. In the future, the United States will likely fight major regional contingencies as part of multi-national coalitions,[65] so the deployed headquarters is not only where the JFC will be found, but also where the military commanders and staffs of the other coalition nations will be located. Personal interactions with all of these commanders, as well as the other US component commanders in the theater, are absolutely necessary if the JFACC is to support them well.[66]

The third argument for a CONUS-based JFACC is that a significant, and perhaps predominant, portion of US air assets will be based in the United States, or at least far from the theater. While it is true that some aircraft, such as intercontinental bombers, can conduct operations from the United States, for the foreseeable future the vast majority of air combat assets must be based in, or at least close to the theater, as they were during Desert Storm. Otherwise, they will not have realistic combat ranges or short enough missions to allow a useful number of sorties per day. Even if future aircraft designs have enough range, and can fly fast enough so that the crews will still be fit for combat after marathon flights, the bulk of tactical aircraft will probably be the same ones the United States fields today. Advanced technology aircraft, such as the F-22, are too expensive to be procured in numbers greater than a few hundred, and certainly not in the numbers that fought in the Persian Gulf War.[67] In the future most of the JFACC's forces will be based in the theater and if the forces are in the theater, then that is where the JFACC should be.

In addition to planning and executing the air war for the JFC, the JFACC has equally important responsibilities to the airmen (officers as well as enlisted) in the theater. The last "C" in JFACC stands for *commander*, the most duty-bound position in the military, which means that the JFACC must lead people. And to do so, the JFACC must stay in touch with the airmen, eat in their mess tents, shake their hands, and thank them for their sacrifices. No video teleconference can ever accomplish this. And if someday a JFACC is killed while serving in a combat zone, then those are the risks of war. But as long as the last "C" means commander, the theater is where the JFACC belongs.

JAOC Staff Location. If the JFACC is located in the theater, the recommended duty locations of other JAOC members can be managed when there is a reachback capability. Clearly, the JFACC's senior deputies and advisors need to be in the theater to help the JFACC coordinate with other command elements, as well as serve as the JFACC's "brain trust." On the other hand, a large majority of the command section and JFACC's administrative staff can operate in garrison, and hence their jobs can be easily handled through a reachback capability. Combat plans also has a number of personnel who can work effectively in garrison, which includes the vast majority of the targeteers, weaponeers, and ATO production specialists. However, the combat operations staff has a smaller percentage of personnel who can work from a garrison. Often, they act as troubleshooters and expediters, constantly communicating with flying units, liaison officers, and senior JAOC staff. In fact, some JFACCs assign many of these personnel from the operational wings for several weeks, not only to help them better communicate with their counterparts at the air bases, but also help the JFACC and the JAOC staff stay in touch with the war.[68] Like combat operations, the liaison officers need to be in the theater. As the bridges between the JAOC and the supported commanders on the ground or at sea, they must interact extensively with the JFACC and the senior JAOC staff and maintain close communications with the commanders they represent.

The actual number of personnel who can be left in garrison depends on the specific configuration of the reachback system, the JFC's concept of operations, and the JFACC's decision on how to best support the JFC. However, knowledgeable observers, including General Croker and the US Central Command's JAOC Director, estimate that as many as 800 of the 900 total personnel of a typical JAOC could probably operate from the CONUS with the help of a reachback system.[69] The remaining 100 are the JFACC's senior staff, combat operations monitors and expediters, and liaison officers, but this figure represents almost a 90 percent reduction in deployed personnel. Perhaps having 800 fewer people in the theater's headquarters sounds like a trivial reduction compared to the size of an Army corps, but as a following section explores in more depth, there are considerable advantages having these particular 800 people in a CONUS garrison.

Due to the garrison's protected location, it is not necessary for all 800 personnel stationed in the garrison to be military personnel. While the garrison commander should be a military officer who is an experienced senior JAOC staff member that enjoys the JFACC's absolute trust,[70] many workstation operators could be civil servants who have extensive prior military experience in the same or similar JAOC duties.

Coalition Involvement. It is likely that in future conflicts the United States will fight with a coalition of allies and not just US forces. During Desert Storm, members of the coalition relied on US command, control, and intelligence capabilities, since these countries had not made similar investments for their own forces.[71] Although some countries such as France and Australia are now making these investments,[72] for the foreseeable future, coalition air campaigns will probably require US automated capabilities. Lacking their own versions of the JAOC, allied air force officers will probably serve alongside US personnel, as is now the case in the Korean and Bosnian theaters. The reachback concept does not preclude such multinational involvement because allied military officers would add significant value to operations at both the deployed and garrisoned segments of a reachback system. If the JAOC is directing allied air force sorties, liaison officers from the participating countries would be of great value in communicating with their commands and in planning missions for their country's air forces. To prepare for future contingencies, allied air force officers should constitute part of the JAOC staff during multinational exercises, and serve in both the theater and the garrison. They should participate in all JAOC functions, limited only by security constraints on some intelligence data. In the future, these security restrictions will probably decrease because the United States is developing computer operating systems allowing multi-level security, which will allow users with lower security clearances to operate workstations containing data at a higher security level. For example, with multi-level security, an allied officer could operate a reachback system workstation even if some data in the system were restricted to only US personnel. In addition, since Desert Storm, US restrictions have loosened considerably for the release of many types of intelligence information to foreign nations, it will be easier to involve allied officers in virtually all JAOC activities.

Reachback System Hardware Location. A 90 percent reduction in personnel would not necessarily produce a 90 percent reduction in the JAOC's footprint, since not all of the JAOC staff uses the same amount of computer hardware and supporting infrastructure. This section examines equipment placement based on where the various types of manpower are stationed. In effect, the following estimate combines the above discussion on the location of people with the relationship between functions and equipment, as discussed in Section II and shown in Figure 2.

At this point, a caveat is in order. The following hardware placement estimate assumes a reachback system would have the same functions, and is divided into roughly the same types of automated tools, as CTAPS is now. There is no reason this must be so. Although the CTAPS functions described in Section II would still be necessary, the system's components may well change. In other words, a different set of computer tools may do the same job as CTAPS, even if the tasks are divided differently. For example, Rome Laboratory's design for the next generation Distributed Air Operations Center has three primary tools: APS, RAAP, and a new tool called FLEX (Force Level Execution).[73] Another implicit, and probably somewhat unjustified, assumption is that CTAPS efficiency would not be degraded by geographically separating the deployed and garrisoned segments. Section V explores in more depth the inefficiencies that may exist in a reachback version of CTAPS, and discusses the expected equipment and manpower growth to compensate for these inefficiencies. Therefore, the following discussion merely illustrates the possible numbers and types of workstations at the deployed and garrisoned segments, rather than purporting to represent an exact count of the equipment at each location.

Figure 4 illustrates how a reachback system could retain equipment in garrison. In this figure, each rectangle represents a CTAPS tool. The boxes in the left hemisphere represent tools located in a garrison, while the boxes in the right hemisphere denote tools deployed in the theater. The number in each box shows how many computer workstations may be associated with that tool. The dashed lines that connect rectangles represent distributed data processing operations between the garrison and the theater. For clarity, this figure shows neither the local- nor wide- area networks that integrate all of these, but which are necessary. Together, the garrison and theater have 146 workstations in this notional configuration. The total of 39 workstations slated for deployment is reasonably consistent with the deployed manning estimate of about 100 personnel.

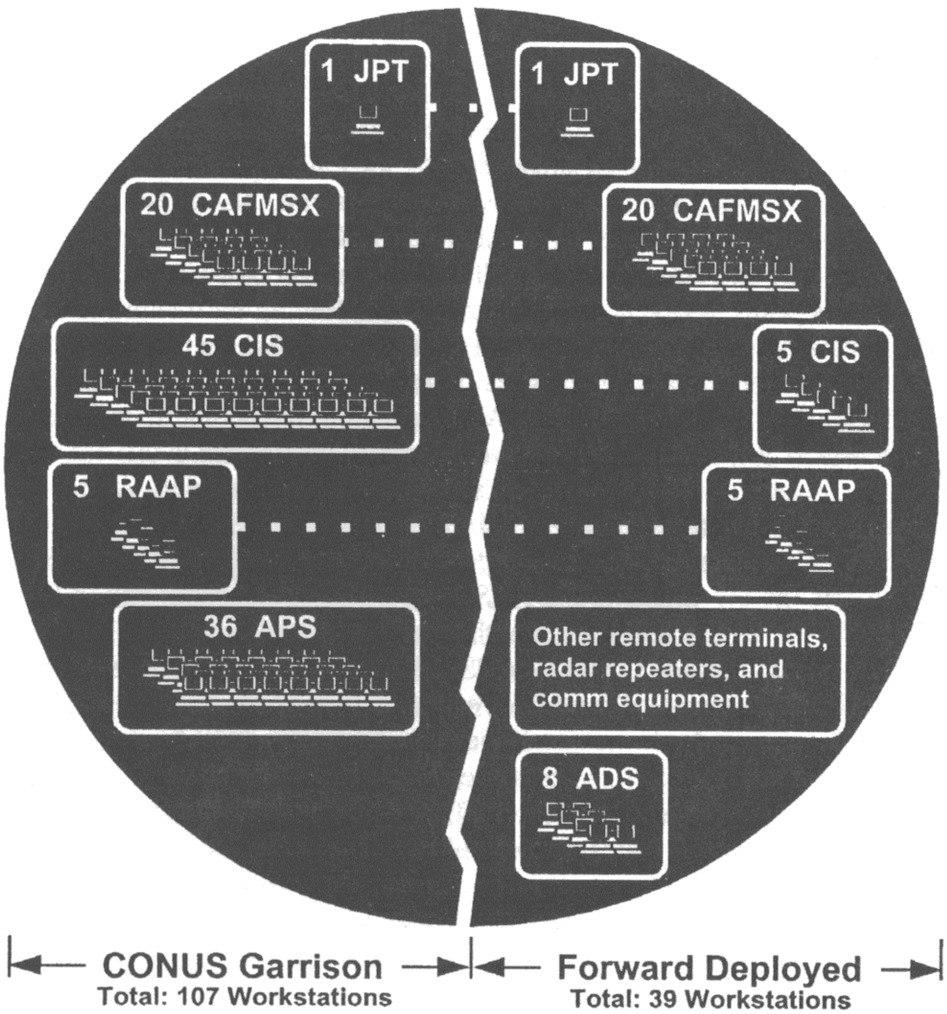

Figure 4. Workstation Distribution for a Conceptual Reachback System

Further explanation is necessary about the block in Figure 4 that is labeled "other remote terminals, radar repeaters, and comm equipment." The types and quantities of these electronic components vary considerably with the nature of the contingency, available facilities, and the range of duties that the JFC delegates to the JFACC. If the JAOC must manage a complex air defense environment and maintain data links with numerous systems (for example, to coordinate with other joint force components or coalition commands), this hardware block may represent a large amount of support equipment, perhaps as much as the equivalent of 80 workstations.[74] While there is no absolute rule about how much additional hardware is necessary, a reachback system could reduce the equipment in the theater by roughly 50 to 70 percent.[75]

Of course, the deployed segment of a reachback system will use other equipment as well. The JAOC will need everything from desks and chairs to stable, filtered electrical power and environmental control. The above estimate does not include any of these additional needs, since the host country's infrastructure should be able to supply the JAOC in all but the most unusual circumstances. And if the host country cannot satisfy the JAOC's additional needs, then airlift requirements will increase.

To summarize, in a major regional contingency reachback operations could reduce in-theater JAOC personnel by about 90 percent and decrease the deployed hardware by 50 to 70 percent, depending on how much additional support equipment the contingency requires.

Garrison Location

The second major question is the location of the garrison. In some ways, choosing the garrison location is peripheral to the thesis of this research because the technology will work wherever the garrison is. However, this is not an insignificant issue, for some of the advantages of reachback operations are a function of the location of the garrison. In addition, the decision to locate a garrison is not transparent in a programmatic sense because some locations may require far less money than others to host a reachback system.

For reasons discussed later, the assumption in this research is that the garrison (or two garrisons, as also discussed later) will be located in the CONUS. Of course, locations other than the CONUS are also conceivable, and in specific circumstances may even be desirable for a prepared theater. For example, warfighters and system developers are considering a garrison in Japan or on Guam to support the Korean theater with a form of reachback operations.[76] Nevertheless, to support a diverse array of contingencies worldwide, particularly in unprepared theaters, a CONUS location is preferable for reasons that are explored in Section IV.

U-2 Reachback Example. A historical analogy will illuminate the importance of the location issue. In the 1980s, the U-2 aircraft program developed a reachback capability for remote ground station processing of data collected in-flight. However, rather than using this reachback capability, the U-2 would downlink data to an in-theater ground station for processing, analysis, and dissemination. This was the way U-2s conducted operations in Europe until the end of the Cold War, during Desert Storm, and still do so in South Korea. The theater commanders-in-chief (CINCs) felt strongly that a ground station represented a more reliable approach because they could depend on their assets in the theaters, and thus because assets outside the theaters are outside their control and hence less reliable. However, when U-2 support for Bosnia became necessary, the last available ground station was at Beale AFB, California. Because moving the ground station to Europe would have made it unavailable for training and for other contingencies, the Air Force established a datalink between the U-2s supporting Bosnia and the ground station in California where the data are processed. Then, the results are sent back to the Combined Air Operations Center in Italy, which adds only a few seconds to the data processing timeline. This arrangement works well, the European Theater is supported adequately, and the ground station can still conduct training in California and support worldwide U-2 operations.[77] The eventual acceptance of the U-2 reachback capability may be a good model for JAOC reachback systems.

Possible Basing. For perhaps the same reason that the theater CINCs did not want to lose control over their U-2 ground stations, senior Air Force officials are reluctant to endorse reachback operations for the JAOC.[78] One way to mitigate this concern is to locate reachback garrisons at the home bases of all the numbered air forces and the rest of the 28 DOD units potentially involved in conducting air campaigns. The commanders could more easily oversee JAOC training, orchestrate exercises, refine their concepts of operations, and achieve greater overall familiarity with reachback operations. Of course, this course of action would mean a significant duplication of equipment.

Recommended Basing. In the long run, a phased approach to locating the garrisons may be more advantageous. During the first phase, a single reachback garrison would be established temporarily at a numbered air force headquarters. Initial training and operations would work through the inevitable difficulties in the concept of operations, equipment design, and interoperability with other systems, and thus give the numbered air force commander time to develop confidence in reachback operations.

After satisfying these objectives, the program would enter the second phase. A permanent location (not necessarily at the first phase's base) would host a facility containing the equivalent of several reachback garrison sites. Each potential JFACC would command a reachback operator detachment stationed at this facility.[79] These detachments would be responsible for providing the reachback capability necessary to support their respective JFACCs during exercises and contingencies. The garrison facility would be sized to support the highest realistic number of concurrent contingencies, exercises, and training sessions. Even if the facility is sized to handle a worst-case workload, there will be occasions when resources requested by from different JFACCs will conflict. In such cases, a priority rating determined by the Joint Chiefs of Staff J-3 could be used to settle any conflicts. During a major regional contingency, the JFACC's operator detachment could be easily supplemented with trained, experienced personnel from other detachments, and additional workstations could be made available.

Finally, the third phase would construct a second garrison at a different location, and then electronically link the two permanent garrisons to ensure survivability, as discussed below. Overall, this three-phased approach provides a robust, expandable, and survivable reachback capability, and minimizes the expense of duplicating hardware at various bases.

Selecting Garrison Location. Three factors influence the decision about the location of the reachback garrisons. First, the garrisons' physical security must be assured. As prime wartime targets, the locations should provide security against terrorist or guerrilla attacks, as well as against conventional cruise missile or ballistic missile attacks. (Of course, nuclear weapons may also threaten the garrisons, but if nuclear weapons detonate on American soil, the JFACC's responsibilities may switch to the US Strategic Command.) These survivability considerations argue for military bases with hardened, possibly underground, facilities. Preferably, the two bases would be somewhere in America's heartland, as these are the most difficult locations for cruise or ballistic missiles to attack successfully.

It is necessary to say more about the rationale for the dual garrison concept. As the residents of Oklahoma City can attest, the middle of America's heartland does not guarantee physical security. Thus, survivability considerations make an alternate, geographically separated, but electronically linked garrison highly desirable, if not mandatory. Thus, even if a garrison were destroyed or otherwise rendered ineffective, the JFACC could continue fighting the war from the alternate garrison. While constructing and operating two garrisons would cost roughly twice as much as a single garrison,[80] such increases in cost must be weighed against the need to protect America's ability to conduct devastatingly effective air campaigns. As an added benefit, during peacetime one garrison could be used primarily in conjunction with Blue Flag exercises at Hurlburt Field, Florida, and the other could routinely support Red Flag exercises at Nellis AFB, Nevada. Because the garrisons would be centers of gravity for US air combat capabilities, extraordinary efforts must be made to assure survivability.

The second factor that affects the location decision is access to communication links. Even though adequate links could be installed virtually anywhere in the United States, overall installation costs would be reduced if worldwide connectivity already exists at the garrisons' locations. Finally, a host of facility and personnel support questions need to be examined for each candidate location, including the existence of suitable structures and resources to support several thousand additional families.

Locations to Avoid. Conducting site surveys to find the best garrison locations is beyond the scope of this study. Based on the above factors, Offutt AFB, Nebraska and Falcon AFB, Colorado, come to mind as possibilities, but there undoubtedly are many good choices. However, one location that would cause much consternation for operational commanders would be the Pentagon or any location in the Washington area. For the reachback concept to succeed, the JFACC must command the garrisoned detachment, and the unfortunate reality is a garrison near Washington would undermine confidence in the JFACC's command authority.

Overall, the precise locations for the garrisons are not as important as instilling confidence that the facilities and personnel will be there when the JFACC needs them. The three-phased approach discussed above will add to the JFACC's confidence in reachback operations.

Communications

A third question about reachback operations concerns the connectivity between the theater and the CONUS garrisons. Obviously, a high capacity, reliable, secure, and survivable global communications are essential to effective reachback operations. Unless connectivity is assured, the JFACC will not be able to use the garrisoned segment of the reachback system.

Fortunately, the requisite communications technology already exists. As Lt Gen John S. Fairchild, Air Force deputy chief of staff for command, control, communications and computer systems, observed in January 1996:

> . . The Air Force recently demonstrated a major advance in sending massive amounts of information to dispersed warfighters. Using commercial satellite broadcast capabilities, the Air Force transmitted audio, video, imagery and data at speeds approaching 23 million bits per second. This impressive capability, named the Global Broadcast Service, is part of the Air Force's thrust to use state-of-the-art commercially available digital systems to improve command and control of air, land, and sea forces. The Air Force is dedicated toward enhancing joint and coalition warfare by rapidly distributing information to deployed warfighters throughout the theater of operations at dramatic cost reductions.
>
> Critical information such as the air tasking order, imagery, weather and command and control updates can be transmitted to literally thousands of warfighters, using antennas as small as 18 inches in diameter, in a matter of seconds.[81]

The Global Broadcast Service is not yet operational, but according to the vice chief of staff of the Air Force, it will be available to support combat operations "around the turn of the century."[82] And the Global Broadcast Service is not the only communications network. Depending on the required communications speed, other commercial and military communications systems could handle a portion of the data flow. Due to rapid advances in communication technologies, the best communication system architecture to support reachback operations will be a matter of choice among a number of possibilities rather than a matter of capability. [83]

To summarize, roughly 90 percent of the personnel, and between 50 and 70 percent of JAOC equipment, can remain in a CONUS garrison for a major regional contingency scenario. For survivability reasons, two garrison locations are needed. Where these garrisons should be located is an open question as long as the garrisons are not located near Washington. Wherever the garrisons are located, adequate communications technologies will be operational by about the year 2000. Given this system concept, the next section discusses the relative advantages of a reachback system compared to the current CTAPS architecture.

IV. ADVANTAGES OF REACHBACK OPERATIONS

The preceding section hinted at several advantages of a reachback system compared to the current CTAPS architecture. This discussion in this section parallels the analysis of drawbacks in the CTAPS architecture.

Primary Advantages

Section II portrayed three principal deficiencies of the current CTAPS architecture: survivability, deployability, and supportability. By contrast, a reachback system has several attributes that in the aggregate provide a powerful rationale for developing a reachback system.

Survivability. The large physical and electronic signature of a modern JAOC raises several significant concerns. But reducing personnel in the theater by 90 percent and the amount of deployed equipment by 50 percent to 70 percent would decrease the JAOC's footprint, and contribute to increased security for the JAOC.

Another aspect of survivability is the functional continuity of a JAOC, by which it is meant the ability to ensure that a CONUS-based garrison would not have its operations interrupted by in-theater threats. Garrison operations could continue even if deployed operations were interrupted by enemy attack, personnel and equipment decontamination, JAOC relocation, and so forth. While there are threats in the United States, two geographically separated, electronically linked, inland garrison locations would reduce the risks posed by these threats. Ultimately, increased JAOC survivability directly contributes to increased air combat effectiveness.

Deployability. The trend in the United States toward expeditionary military forces implies that rapid deployability during a crisis is an important factor in the ability to project power overseas.[84] If only 100 of the original 900 JAOC staff members must deploy, the personnel transportation requirements shrink from three widebody airliners to a fraction of one. More significantly, the real savings in airlift come from deploying less equipment rather than fewer people. Assuming the amount of airlift required for equipment varies approximately with the number of workstations, retaining 107 workstations in garrison would save over 19 C-141 sorties.[85] The airlift sorties freed from deploying JAOC equipment would be available to transport other vital supplies to the theater.

Another measure of deployability is the time it takes for a deployed unit to become fully operational. Not only would a reachback system arrive in theater using less lift, but it would be ready to start planning and executing the air campaign sooner, because the majority of the system and its operators would not have to relocate. In many potential contingencies, the JFACC may not have to depart for the theater until the JAOC is operational, which means that the JFACC and the garrison staff could produce JIPTLs, MAAPs, and even ATOs while the deployed segment is on its way to the theater. In extreme cases that require the conduct of air combat immediately, the JFACC could start fighting the air war while still in the CONUS. Of course, with today's CTAPS architecture, the JFACC could also direct the air campaign from the CONUS if so ordered by the JFC (as was the case during the recent military intervention in Haiti).[86] However, a subsequent JAOC relocation to the theater would either require a significant break in operations while CTAPS is reassembled, or force JFACC responsibilities to be transferred to a backup JFACC, followed by another disruptive responsibility transfer back to the primary JFACC. The ability of a reachback system to deploy more quickly and provide better reaction in contingencies better fulfills the DOD's vision of expeditionary warfare.

Supportability. Like deployability, the two aspects of supportability are people and equipment. Although supporting an additional 800 people in the theater is not trivial, the resulting problems are usually manageable given that far more than 800 people deploy to fight a major regional contingency. In contrast, supporting the JAOC equipment is a difficult undertaking.

Many regions of the world pose significant challenges to electronic equipment, particularly equipment built to commercial standards rather than more rugged military specifications. Although a reachback system would use the same commercial quality electronics as CTAPS, supportability would be better because the roughly 107 workstations that remain in a CONUS garrison provide an immediate source of spares, additional capacity, and on-site maintenance contracts. While maintaining the reachback system's deployed segment still faces the challenges of a harsh environment, the fact that far less equipment is deployed decreases the supportability burden commensurately.

Ancillary Advantages

Reachback systems have several ancillary advantages, which, while important, are not sufficiently important reasons for investing in a reachback system, even though they will add value to this approach.

Database Standardization. Databases are vital to modern warfare, particularly air warfare. They contain virtually every fact needed for planning and executing air campaigns. Ideally, various military databases should agree because all databases representing the world should be congruent.[87] Although this currently is not the case, particularly between Air Force and Navy intelligence-oriented databases,[88] a reachback system offers hope for the future.

A master database maintained by the CONUS garrisons could solve the two common database problems of different facts and different data structures. If two CONUS garrison locations exist, as recommended in Section III, these two sites must be linked electronically to ensure that their databases are identical. (Of course, electronically linking the two sites also enables either garrison to back up the other to increase survivability.) The master database could become a single interface to the myriad of intelligence sources, focusing both data receipt and retransmission for intelligence germane to the air war. In the past, limitations in database capacity forced specialization, which meant that each military services kept track of its own information in different ways. With technological advances data storage and manipulation are no longer meaningful constraints, so having a single "world picture" is entirely feasible and certainly desirable. This worldwide database need not be contingency specific, since the need for partitioning data by theater of operations is disappearing as database capacity increases. Further, a single master database would solve the frustrating problem that exists when the Air Force and Navy are unable to exchange intelligence data because their databases are different.

The emergence of "object-oriented databases" should make it easier to design, implement, use, and extend a master database as new requirements evolve. An object-oriented database would allow new data structures, such as multi-media digital video, audio, text, and maps to be used and stored in the reachback system.[89] Much work remains to formulate the standards and structure for such an ambitious undertaking, but a single, overarching JAOC database would represent a significant improvement in air campaign information management.[90]

Support for the JFACC Afloat. The Navy has significantly expanded command and control facilities for JFACCs afloat. Although limited in capabilities, the USS *LaSalle* pioneered in providing JFACC support facilities at sea. The Navy's next step was to build two command and control ships, the USS *Mount Whitney* and the USS *Blue Ridge*.[91] These ships can direct far more extensive air campaigns than aircraft carriers. An augmented JFACC staff on an aircraft carrier can control two aircraft carrier wings, an Air Force wing, and an Amphibious Ready Group,[92] for a total of roughly 400 sorties per day.[93] In contrast, a command and control ship can control up to three aircraft carrier wings, two Air Force wings, and two Amphibious Ready Groups,[94] for a total of more than 800 sorties per day.[95]

The Navy's command and control ships can be critically important resources when the JFACC cannot be ashore. Facilities aboard these ships can support a 280 person staff for the JFACC.[96] As a further improvement, the Navy is modifying the USS Coronado to become a "Joint Command and Control" ship, which is capable of accommodating a 200+ person JFC staff as well as a 240-plus person JFACC staff.[97] Even though a larger staff cannot reside aboard ship, reachback operations can supplement the JFACC afloat with a "virtual JAOC staff" as large as the air campaign requires.

A JFACC afloat would use the CONUS garrison's capability in much the same fashion as a land-based JFACC. The concept of operations would be identical, except the JFACC afloat would want to tailor the capabilities in garrison to best complement the capabilities already resident aboard the command and control ship. Not only would the JFACC afloat enjoy extended staff support, the JFACC would also gain a powerful communications node given the garrison's connectivity to deployed forces and intelligence sources, as well as many of the other reachback system advantages described in this section. If augmented by a reachback system, the Navy estimates that a command and control ship could direct perhaps as many as 2,000 sorties per day, and surge as high as 3,500 sorties per day on a limited basis,[98] as opposed to today's capability of 800 sorties per day. Thus, a reachback system offers the possibility of increasing a sea-based JFACC's sustained daily sorties by 250 percent. More importantly, with the aid of a reachback capability, a JFACC afloat could begin a potent air war as the prelude to land-based JAOC operations.

Transition between JFACCs Afloat and Ashore. Another advantage of reachback operations is the ability to make a relatively seamless transition between JFACCs afloat and ashore, while ensuring a transparent transition to theater air forces. Rather than transferring enormous and structurally incompatible databases, the entire process would be avoided if both the land and sea-based JFACCs used the same database as the CONUS garrison. In addition, many of the skilled weaponeers, targeteers, and other operators in the garrison could continue to support the war without the need to make a physical transfer. Of course, the JFACC ashore also might want a number of key staff members from a ship-based garrison to join the land-based staff for both continuity and liaison purposes, but a widespread transfer of most staff members would not be necessary. If the situation warranted, a reachback system would simplify the process of transferring from a JFACC ashore to a JFACC afloat, for the same reasons discussed above.

A question remains about the communications capabilities that should exist between the command and control ships and the garrison. While these ships can employ seven types of communications links today,[99] JFACCs still consider restricted communications to be a large problem when at sea.[100] To ensure connectivity between the JFACC afloat and the garrison, the Global Broadcast Service and other advanced communications capabilities must not overlook such an important user as the Navy's command and control ships.

Operator Proficiency. A JAOC staff is a team of skilled professionals using state-of-the-art tools to perform an enormously challenging mission. Senior JAOC officers agree that it is difficult to maintain operator proficiency, not only for targeteers and weaponeers, but also for database managers and computer system administrators. The fact that an experienced military database manager or system administrator can find employment in the civilian sector will contribute to high turnover rates in these career fields.[101]

The reachback concept offers a solution. Simply put, the CONUS garrison is an ideal place for the DOD to locate many of these lucrative jobs by hiring back former active duty personnel with JAOC experience. Instead of relying largely on short-term military personnel, garrison manning could be strengthened considerably by employing permanent, experienced, and relatively high-grade civil servants. Since the garrison would not deploy anywhere, civil service staff would be well suited to stay in these positions for many years, which would contribute to building a tremendous experience base and providing much needed continuity to the JAOC staff.

Configuration Control. The revolution in computer technology means that both processing speed and memory double about every 18 months. While software remains usable longer, in part because most new compilers and operating systems allow backward compatibility for older software versions, software maintenance is a continual process and is hardly free of errors. Even well written code often requires modifications when interfacing with other programs or hardware changes. This turbulence throughout the electronics industry creates configuration control problems for systems as complex as a reachback system.

One solution is to co-locate most of the computer equipment while maintaining configuration control for all equipment and software at the same time. This approach matches nicely with the reachback operations concept. The garrison's configuration could be controlled by a single maintenance contract. In addition, the same contract could maintain and upgrade the workstations slated for deployment. The DOD should name an executive agent (from a roles and missions perspective, probably the Air Force) to manage this contract. One also anticipates that the other military services would contribute their fair share of the maintenance budget for whatever workstations and related equipment they own. This could involve controls on hardware and software configurations and equipment upgrades to ensure that the system can be maintained and remain compatible. Furthermore, the funding for this must be protected at a high level within each service and not be dispersed to subordinate units, where it is often reallocated to meet other pressing demands.

Overall, a reachback system offers compelling advantages. It would improve upon all of the CTAPS deficiencies discussed in Section II, in some cases dramatically, through advanced communications and distributed data processing technologies. Incorporating these technologies would enhance the ability of the US military to plan and execute air campaigns. However, as is virtually inevitable with any good idea, it also has drawbacks.

V. DRAWBACKS OF REACHBACK SYSTEMS

Some drawbacks of reachback systems are a matter of perception, while others are consequences of real world limitations. This section explores the negative aspects of reachback operations, and discusses ways to mitigate these undesirable attributes.

Senior Officer Reservations

Military commanders are a cautious group, and rightly so given the possibly calamitous consequences of poor decisions.[102] Thus, it is not surprising that there would be doubts about the wisdom of splitting the JAOC's resources, physically separating the two segments, then locating one of the segments back in the CONUS. In particular, senior officers might worry that a CONUS garrison would reduce their operational autonomy.

For over two millennia, military commanders have resisted excessive direction from their capitals. In 168 BC, Lucius Aemilius Paulus, the consul in charge of the Macedonia campaign, addressed the citizens of Rome: "In all the clubs and even—God save us! —at dinner tables there are experts who lead armies to Macedonia . . .Such behavior is a great obstacle to the men in the field.. . .Generals should receive advice. . .from those who are on the scene of action, who see the terrain, the enemy, the fitness of the occasion, who are sharers in the danger. . .Be aware that I shall be satisfied with the advice originating in camp."[103]

Today, like Lucius Aemilius Paulus, US commanders in the field believe that direction from Washington is counterproductive. In this respect, Desert Storm was no different than any other war. Following the public relations disaster of killing hundreds of civilians in the Al Firdos bunker, Gen Colin L. Powell's pressure to stop the bombing of Baghdad caused some resentment within the Air Force. At the time, he acted to maintain the support of the US public and the coalition partners, but "to the Air Force, it seemed as if the political fallout from the Al Firdos raid had accomplished what the Iraqi air defenses could not: downtown Baghdad was to be attacked sparingly, if at all."[104]

Perceived Loss of Control. The "principle that Washington should . . . leave the details up to the theater commander" is sacrosanct to CINCs and JFCs.[105] Admittedly, a reachback system with a garrison in CONUS increases the risk that policymakers in Washington will direct the air war. While a detailed discussion of the rationale for avoiding such involvement by Washington would constitute a separate treatise, suffice to say that America has long depended on experienced military commanders to use their initiative to react to unforeseen circumstances and capitalize on fleeting opportunities. Military leaders in the field "see the terrain, the enemy, [and] the fitness of the occasion," as no politician or, for that matter, no military officer can in Washington.

Further, the U-2 ground station basing decision highlighted that theater commanders are unwilling to depend on assets outside the theater, which presumably are not under the commander's control. Indeed, neither the CINCs nor the JFCs will ever receive a guarantee that another crisis will not preempt their access to resources in the CONUS.

Mitigation. Although losing control of the reachback garrison's output is a possibility, it is by no means preordained. For the most part, this concern motivated the recommendation in Section III that a detachment commanded by the JFACC operate the garrison. If required, wartime augmentation could come from detachments belonging to other JFACCs; however, the garrison's core support would come from personnel commanded by the JFACC fighting the air war.

Likewise, in part this issue also influenced the conclusion that neither of the two garrisons should be near Washington. (The other motivation was physical security. Washington's coastal location provides less warning time of cruise or ballistic missile attacks than do other locations in the US heartland.) If the CONUS garrisons reside far from Washington, their locations should lessen the opportunities for unsolicited direction.

Admittedly, actions speak louder than words. CINCs, JFCs, and JFACCs will believe that reachback systems do not encourage unwelcome "help" from home only after they have experienced several exercises, and perhaps conducted a major regional contingency, without coaching from Washington.

Dependence on Communications

The first reaction many warfighters expressed when introduced to the reachback operations concept was "you'd better have good comm links!"[106] Indeed, not only do reachback operations depend on robust, reliable communications, but so also do virtually all facets of modern warfare. Of course, there are no absolute guarantees in the case of communications.

Vulnerability to Communications Outages. Theoretically, communications links have many Achilles' heels. Natural phenomena such as sunspots and lightning can disrupt communications. Enemy action, particularly by a peer competitor, can also degrade or deny US connectivity to the theater. A variety of means exist—from the most selective jamming technique to the most indiscriminate electromagnetic pulse from a nuclear detonation—to deny the ability to communicate. Not only are the links potentially vulnerable, but the ground stations and the data being transmitted are subject to attack. While completely enumerating all electromagnetic communication vulnerabilities is beyond the scope of this paper, an important concept is that "good comm links" cannot be guaranteed with absolute certainty.

A related concern is the available bandwidth, or the range of frequencies comprising the broadcast signal. The larger the bandwidth, the greater the communication channel's maximum data transmission speed. Recent technology developments have vastly increased bandwidth over that available during the Gulf War. As General Fairchild observed in 1996, the Air Force recently demonstrated data transmission speeds approaching 23 million bits per second.[107] Today, the local area network that links all the CTAPS tools together uses a data transmission speed of only 10 million bits per second,[108] so current communications technology should handle a reachback system's data rates. However, if history is a guide, whenever a communications channel has extra capacity, additional data are usually inserted in the broadcast until the channel is saturated.

Mitigation. Just as a complete discussion of communications vulnerabilities is beyond the scope of this discussion, the same reasoning applies to a treatise on all the problems that can arise. Fortunately, the US communications infrastructure can rely on a number of features to reduce communications vulnerabilities. Distributed and redundant links, jam-resistant frequencies, spread-spectrum signal hiding, automated frequency hopping, error-correcting data encoding, encryption, ground station security, and many other techniques can ensure connectivity as far as humanly possible.[109] In addition, new technologies such as the Global Broadcast Service will continue to enhance the robustness of communications between the CONUS and the theater.

But if despite the best engineering efforts connectivity between the CONUS and the theater were lost, the deployed segment would still have impressive computational power available to continue operations, albeit with greater difficulty. Figure 4 illustrates that even with 107 workstations remaining in garrison, 39 workstations for campaign planning, intelligence, deconflicting airspace, and real-time execution monitoring would still reside in the deployed JAOC. During an interruption in communications, some of these computers could run the other software tools as well, since any CTAPS workstation can run any CTAPS tool. This redundant capability would require periodically transmitting at least a subset of the garrison's master database to the theater, but in return the system would have a fallback operating mode to protect against communications failures.

In the near term, current bandwidth capabilities are adequate. Both warfighters and system developers must exercise discipline to keep bandwidth requirements in balance with capabilities, so that "better" is not allowed to conquer "good enough." Over the long term, even though technology advances will undoubtedly increase usable bandwidth, a balance must be maintained. Thus, requirements for bandwidth-intensive signals, such as required for numerous, simultaneous video teleconferences, must remain within the limits of available technology.

Although one cannot absolutely guarantee that there will be uninterrupted connectivity between a CONUS garrison and the JAOC, sufficient safeguards, robustness, and if necessary, fallback capabilities exist to minimize the problems associated with this particular vulnerability.

Decreased Operational Efficiency

Although survivability, deployability, and supportability would be enhanced, geographically separating CTAPS into two segments would not improve its operation. Instead, more effort would be required to maintain the same output that the two segments would have produced if they had remained co-located. This loss of efficiency must be acknowledged as a drawback to reachback operations.

Additional Equipment and Manning. Clearly, implementing a reachback system would require additional communications and interface equipment to electronically link the garrison and the deployed segment. The extent of this equipment depends in large part on the specific system implementation. Nevertheless, one can estimate the types of additional equipment that are necessary. The most demanding new requirements would be for data gateways to link the two groups of workstations into an electronically contiguous net. Another growth area would be for greatly increased video teleconference equipment, not only to connect the JFACC with the garrison, but also to link workstation operators together as a substitute for face-to-face interactions. Additional equipment requirements would also derive from new electronic interfaces among the garrison and various intelligence organizations, as well as the new master database. Finally, extensive electronic interfaces connecting the two garrison locations would add to the new equipment list.

Total JAOC manning would be greater if the JAOC were not divided. Both the deployed and garrisoned segments would need additional liaison officers to coordinate operations between the two locations. Further, the garrison would require more staff than just the operator detachments and system maintainers. The garrison would also require a management staff to ensure the operator detachments receive all the support they need, to manage facility maintenance, and to implement the Joint Chiefs of Staff J-3's priorities to deconflict competing support requests in the event of simultaneous contingencies, or more commonly, simultaneous exercises.[110] In comparison with today's JAOC, total manpower would probably grow by 10 percent to 20 percent or more, depending on the operations concept.[111] However, it is anticipated that the number of manpower positions will grow, and that most of this growth would occur in the garrisoned staff rather than the deployed personnel.

Mitigation. To a large extent, the centralization of facilities may offset the additional equipment requirements. Instead of trying to equip 28 military commands with some version of a JAOC, two garrisons could eliminate unnecessary duplication. In the case of manning, the additional manpower billets would probably not see the same benefits from centralization, at least in the near term. Of course, future technology developments beyond CTAPS may incorporate artificial intelligence or similar software capabilities to decrease manning requirements, but for now the drawback of increased manning has no significant potential for mitigation.

JFACC Leadership for Garrisoned Personnel

Section III argues strongly that the JFACC is a commander, and as such, must interact personally with the airmen. If, as Section III also recommends, the JFACC commands the personnel in the CONUS garrison, it is inevitable that leadership issues for these people will arise.

Challenges of Remote Leadership. Clearly, the JFACC would have little, if any, face-to-face interaction with the garrison's staff during hostilities. Both the JFC and the airmen in theater would have a greater need for the JFACC's presence. Furthermore, because the garrison's staff would be far away from personal danger, the extra intensity and clarity of purpose gained from serving in a war zone may be absent.

A related challenge stems from the cultural preference in the US military for combat assignments. Military personnel assigned to a garrison might feel stuck in a backwater job, while their luckier contemporaries are gaining combat experience and enhancing their careers. For this reason, highly qualified operators might shun a garrison assignment. For military staff members ending up in a garrison, low morale may lead to sub-optimal performance.

Mitigation. Fortunately, if senior military officers are specialists in anything, it is leadership. The JFACC and subordinate commanders could avoid, or at least minimize, the problems discussed above through extensive personal contact with the garrisoned detachment before a crisis occurs. During deployment, the JFACC would also have technology, such as video teleconferencing, to communicate clearly with the garrison, and provide at least some of the personal interaction necessary to motivate extraordinary performance from the staff. Historically, CONUS-based personnel have given their maximum efforts to support a war. The administrative assistance the Tactical Air Command at Langley AFB gave to General Horner during Desert Storm is but one recent example of CONUS support.[112] Thus, the garrison's commitment and productivity should not cause problems if the JFACC practices active leadership and establishes clear command relationships.

The JFACC also must address the military perception that the garrison is a backwater assignment, not only by assuring the garrison staff of their critical importance, but also by ensuring personnel performance ratings are not unfairly biased in favor of the deployed staff. In addition, the DOD should view duty in a reachback garrison as an important joint tour for the professional development of operational personnel. By emphasizing that the garrison is a key component of America's military capability, the JFACC and other senior officers could minimize morale and performance problems that derive from the garrison's protected location.

Theater Produced Intelligence

The Gulf War proved that not all intelligence comes from satellites or is heard first in the Pentagon. On the contrary, much useful, even critical, intelligence is produced in the theater, including pilot reports, gun camera film, infrared imagery, and synthetic aperture radar data, as well as the more traditional photography and electronic intercepts from intelligence, surveillance, and reconnaissance platforms. In recent years, intelligence from human sources, including prisoner of war interrogations and reports from agents in the theater has returned to its previous position of importance. This shift reflects a major change from a decade ago, when America relied almost exclusively on technical intelligence systems.[113]

Difficulty of Incorporating Theater-Produced Intelligence. Obviously, this wealth of theater-produced intelligence must somehow be injected into the CONUS garrison, particularly if the garrison is responsible for maintaining the master database. Not only do the garrison's intelligence analysts need this information, but those responsible for targeting and assigning weapons to targets also use these reports on a daily basis. The garrison's physical separation from the theater would make the assimilation of theater-produced intelligence much more difficult because the analysts, interrogators, and other intelligence specialists in the theater would not be physically present to discuss their results with personnel in the CONUS.

Mitigation. Incorporating theater-produced intelligence, like some of the other difficulties facing reachback operations, is primarily a problem of communications. Because data transfer is a two way process, the theater must be suitably equipped to digitize and send data back to the garrison, just as the CONUS garrison must send data forward. As an added benefit, if the garrison receives all the theater's intelligence, the security consequences of damage to or an evacuation of the deployed segment would be lessened. In the event of evacuation, the deployed segment's personnel could erase the electronic data stored in the JAOC with a few emergency software commands, because they would be secure in the knowledge that the garrison retained a complete backup.

Technology could also minimize the problems of physically separating intelligence team members. Video teleconferencing could reduce the barriers to interacting with the analysts and other specialists in the theater who produce intelligence data. While it is true that the theater's day crew may have to interact with the garrison's night crew, productive work can be accomplished with some thoughtful scheduling of shifts. But to maintain situation awareness, theater data must be shipped back to the United States and national-source data ultimately must be shipped forward to the theater. Neither task seems insurmountable, or even particularly difficult, given the capacity, robustness, and security of modern communications capabilities.

In sum, while there are difficulties with the concept of a reachback operations, many of which are the product of human proclivities and physical limitations, there fortunately exist approaches for managing nearly all of these challenges. There are no overwhelming challenges, but successfully implementing a reachback system will require attention to the areas addressed in this section.

VI. CONCLUSIONS AND RECOMMEN-DATIONS

Desert Storm is certainly not the only conflict that offers lessons to be learned, but the lessons are more clear and urgent because it is such a recent event. Many innovations for air campaign planning and execution were demonstrated and first proved during this war. Perhaps the most notable is the fundamental concept that a joint air campaign is not only feasible, but also represents a powerful means for decimating an enemy's military capabilities. However, the complex process of synchronizing a massive, prolonged air effort during Desert Storm also taught another lesson, which is that "paper charts and grease pencils" are no longer the tools of choice. In the future, the JFACC must rely on sophisticated computer tools as well as a highly trained JAOC staff to choreograph an extensive air campaign.

To assist the air campaign, CTAPS provides a number of integrated computer tools to partially automate every phase of the ATO cycle, and it is important to emphasize that CTAPS evolved from the fledging efforts of its designers into the powerful capability that it is today. Moreover, CTAPS continues to evolve as new information technologies offer improvements in performance that were unattainable even a short time ago. Two of these technologies—advanced communications and geographically distributed data processing—make possible a new concept for air campaign planning and execution, which is known as reachback operations.

For many reasons, the JFACC, the senior JAOC staff, and liaison officers must deploy to the theater to fight the air war. However, a reachback system could allow between 50 and 70 percent of the JAOC's equipment and almost 90 percent of its personnel to remain in a garrison, either in the CONUS or in another protected rear area. The revolutionary aspect is that the equipment and personnel could be linked electronically to the JAOC in the theater with no loss of effectiveness. The reachback concept would entail far fewer problems with survivability, deployment, and support. And there would be other benefits that derive from this architecture, including the areas of database standardization, support for the JFACC afloat, transition between JFACCs afloat and ashore, operator proficiency, and configuration control. Table 1 compares today's CTAPS architecture with a conceptual reachback system, highlighting the much smaller in-theater footprint and greater deployability for a reachback system.

Table 1. Comparison between CTAPS Architecture and a Reachback System

Areas of Comparison	Current CTAPS Architecture	Reachback System
Total Personnel	about 900	estimated 1080 (20% more)
Forward Deployed Personnel	about 900	estimated 100
Forward Deployed Workstations	about 146	estimated 39
Additional Support Equipment	about 80 workstation equivalents	estimated 80 workstation equivalents, plus extra communications and nets
Airlift Needed to Deploy Equipment	41 C-141 loads	estimated 22 C-141 loads
Airlift Needed to Deploy the JAOC Staff	3 widebody aircraft	estimated less than 1 widebody aircraft
Number of Installations	1 deployed	1 deployed, plus 2 garrisons in a rear area

Of course, reachback operations suffer some disadvantages as well, particularly in the areas of senior officer reservations, dependence on communications, decreased operational efficiency, JFACC leadership of garrisoned personnel, and theater-produced intelligence. Because none of these represent overwhelming disadvantages, the reachback system concept is the next logical, and compelling, step in the evolution of revolutionary tools for planning and executing air campaigns.

Recommendations

To enhance future JAOCs with reachback capabilities, a number of actions are required. Since this is clearly a multi-service issue, the DOD should:

1. *Direct joint doctrine development groups to sharpen the reachback operations concept and codify it in joint doctrine.* Reachback operations offer a number of opportunities and advantages, of which this paper addresses only the most obvious achievable with a reachback system. A mature reachback operations concept should explore additional possibilities, such as a CONUS garrison that becomes a robust communications node. More importantly, an approved joint doctrine should guide the development of a reachback system.

2. *Approve resources to implement reachback operations for the JAOC.* Unfunded policies are generally ineffective, and therefore, adequate funding that is guided by an approved

joint operations concept, is essential if future JAOCs are to benefit from reachback operations.

3. *Advocate a master database for all operational information needed by the JFACC.* The subject of a master database can be either a dream or a nightmare. Much thought must be given to both current implementation and future expandability. By definition, a master database must contain information that is needed by all services, not just one, and thus joint sponsorship is mandatory if reachback operations are to germinate.

4. *Fund investments in technologies and systems for global connectivity needed to support reachback capabilities.* This recommendation is included primarily for completeness. The DOD is already investing heavily in communications technologies and systems given that such systems offer an enormous force multiplier to warfighters.

5. *Continue to sponsor the DARPA research program "JFACC After Next", until a service begins to fund this program.* Actually, the "JFACC After Next" program goes beyond the near-term reachback capabilities that are examined in this paper. The DARPA effort is also pioneering technologies for real-time ATO generation. Nevertheless, the distributed data processing aspects of "JFACC After Next" contribute directly to this paper's proposed system, and other aspects of the DARPA program fit nicely into the long-term evolution of CTAPS.

As the lead service for developing air power, the Air Force must play a key part in fielding a joint capability for air campaign planning and execution. Specifically, the Air Force should:

1. *Assist the DOD effort to develop joint doctrine for reachback operations.* As noted above, a doctrine for reachback operations requires considerable thinking and analysis. The Air Force has many years of experience relevant to this subject. But developing a reachback system is not enough, because it is equally important to develop doctrine to guide both those who develop the system and those who employ it in war. The Air Force's new Command and Control battlelab at Hurlburt Field, Florida, should play a valuable role in formulating joint doctrine for reachback operations.

2. *To quote the Air Force Scientific Advisory Board, "take active ownership of the DARPA 'JFACC After Next' ACTD [Advanced Concept Technology Demonstration]."*[114] DARPA judges the worth of its programs based on the interest of the services, as expressed by funding commitments. "JFACC after Next"supports an important Air Force mission area. Air Force ownership of this program will assure continued emphasis on improving the planning and execution of air campaigns.

3. *Exercise the reachback concept through early operational demonstrations.* Such demonstrations, perhaps conducted in conjunction with Blue Flag exercises, will give the Air Force early insights into the doctrinal issues that surround reachback operations, and provide valuable information to those charged with developing reachback systems.

4. *Plan, program, budget, and manage a procurement to field the first phase of a reachback capability by the year 2000, then field phases two and three when the concept of operation is mature and interoperability with other systems is proven. The Air Force should incorporate evolutionary improvements from the "JFACC After Next" program*

when available. A reachback capability is so urgently needed that waiting for technologies still under development are not in the national interest. The United States can field a prototype reachback capability by the year 2000, given the development schedule of the Global Broadcast Service. Consistent with the nature of data processing and communication technologies, a near-term procurement should be structured to incorporate evolutionary improvements seamlessly.

5. *Act as the lead service for efforts to create a master database for the JFACC.* Such a complex and controversial undertaking as creating a master database for employing air forces needs the energetic leadership of the Air Force to be successful.

6. *Invest in technologies and systems for global connectivity, particularly by developing interfaces connecting the reachback system to other Air Force operational systems.* The Air Force understands the force multiplier potential of global connectivity. Investments in this area should continue, including investments in systems and interfaces assuring connectivity with reachback garrisons.

As mentioned above, the reachback operations concept is a joint concept. Consequently, other services, particularly the Navy, have important roles to play in fielding this capability. The other military services should:

1. *Assist the DOD effort to develop joint doctrine for reachback operations.* All services, not just the Air Force, can contribute to formulating doctrine for a reachback capability. The resulting doctrine's robustness will reflect the degree of involvement by the military services.

2. *Plan, program, budget, and manage programs required to upgrade service-specific systems (for example, the Navy's command and control ships) to operate with a reachback system.* As this paper briefly explores, a reachback garrison could dramatically increase the JFACC's capabilities aboard ship. In addition, although the issue is not explored in this paper, strategic and tactical roles for Army aviation may also benefit from a reachback capability. However, some investment is necessary to assure interoperability with the reachback garrison.

3. *Assist Air Force efforts to create a master database for the JFACC, and ensure service-specific legacy systems can operate with this database.* Information is a precious resource, but its value will not be realized if warfighters cannot access, use, update, and store the information they need. All services must assist in creating this master database, because otherwise the plethora of today's databases will remain fragmented and service specific, as they are now.

4. *Support investments in technologies and systems for global connectivity, particularly by developing interfaces connecting the reachback system to service-specific systems.* Like the Air Force, the other services must modify their command and control systems to be interoperable with both the reachback system's deployed segment and its garrison. Such investments would allow the services to leverage their own military capabilities by taking advantage of the potential for reachback operations to improve coordination among operational units.

In an era of fiscal constraints, the above tasks will be difficult, but the case for reachback operations is compelling, given the DOD's new vision of depending upon easily deployable and overwhelmingly lethal forces to fight future conflicts. A reachback capability is a concept whose time has come.

Glossary

ACO	Airspace Control Order
ACTD	Advanced Concept Technology Demonstration
ADS	Airspace Deconfliction System
AFB	Air Force Base
AFCEA	Armed Forces Communications and Electronics Association
AGOS	Air Ground Operations School, Hurlburt Field, Florida
AOC	Air Operations Center
APS	Advanced Planning System
ATO	Air Tasking Order
CAFMSX	Computer Aided Force Management System - X
CD-ROM	Compact Disc-Read Only Memory
CENTAF	Air Force Component of the United States Central Command
CIS	Combat Intelligence System
CINC	Commander-in-Chief
COMM	Communications
CONUS	Continental United States
CTAPS	Contingency Theater Automated Planning System
DARPA	Defense Advanced Research Projects Agency
DAOC	Distributed Air Operations Center
DOD	Department of Defense
EHF	Extremely High Frequency
FLEX	Force Level Execution

INMARSAT	International Maritime Satellite
INTEL	Intelligence
JAOC	Joint Air Operations Center
JFACC	Joint Forces Air Component Commander
JFC	Joint Forces Commander
JIPTL	Joint Integrated Prioritized Target List
Joint	STARS Joint Surveillance Target Attack Radar System
JPT	Joint Forces Air Component Commander Planning Tool
JSSC	Joint Air Operations Senior Staff Course, taught at the AGOS
LOS	Line of Sight
MAAP	Master Air Attack Plan
OPS	Operations
RAAP	Rapid Application of Air power
SATCOM	Satellite Communications
SHF	Super High Frequency
SINCGARS	Single Channel Ground and Air Radio System
SPINS	Special Instructions
UHF	Ultra High Frequency
US	United States

USA	United States of America
USAF	United States Air Force
USCENTCOM	United States Central Command
USS	United States Ship

Notes

1. Williamson Murray, Air War in the Persian Gulf, (Baltimore, Md.: The Nautical & Aviation Publishing Company of America, 1995), 12, 41.

2. Alan D. Campen, Information War, (Fairfax, Va.: AFCEA International Press, 1992), 33, quoted in Lt Col David R. Stinson, “Improved Air Campaign Planning Through Cybernetics and Situation Control,” (Mershon Center Program for International Security and Military Affairs Paper, Ohio State University, May 1995), 7.

3. Nick Cook, “USA Plots Mission Support Revolution,” Jane’s Defence Weekly, 19 November 1994, 29, quoted in Stinson.

4. Lt Col Thomas R. Gorman, JFACC Training Program Director, USAF Air Ground Operations School, Hurlburt Field, Fla., to author, electronic message, subject: Review of Reachback Paper, 5 March 1997.

5. Lt Gen (Ret) Stephen B. Croker, interviewed by author 20-21 February 1997.

6. Carl DeFranco of Rome Laboratory, in conjunction with the Defense Advanced Research Projects Agency, is developing a system employing a distributed data processing version of CTAPS. This system is called the Distributed Air Operations Center (DAOC). This paper avoids using Rome Laboratory’s terminology, since the DAOC is a specific hardware and software configuration capable of reachback operations, not a conceptual system as discussed in Sections III-V.

7. Chairman of the Joint Chiefs of Staff, Joint Vision 2010, 1996, 19.

8. Lt Col Stephen J. McNamara, Air Power’s Gordian Knot—Centralized versus Organic Control, (Maxwell AFB, Ala.: Air University Press, August 1994), 7-19.

9. Ibid., 21.

10. Lt Col Thomas R. Gorman, interviewed by author 7-10, 22 January 1997.

11. Ibid.

12. Col Carl H. Steiling, Theater Battle Management Core Systems Program Manager, Electronic Systems Center, Hanscom AFB, Mass., telephone interview with author, 19 November 1996.

13. Joint Publication 3-56.1, Command and Control for Joint Air Operations, 14 November 1994, IV-4, IV-5.

14. Ibid., IV-6 to IV-11.

15. Gorman message.

16. USAF Air Ground Operations School (AGOS), FY97 Multimedia CD-ROM, December 1996.

17. Dr Charles A. Fowler, The Standoff Observation of Enemy Ground Forces From Project Peek to Joint STARS: A Prolusion (pre-publication draft, undated) 17.

18. Murray, 252-3.

19. Lt Gen (Ret) Stephen B. Croker, mentor for Class 97-01, USAF Air Ground Operations School's Joint Air Operations Senior Staff Course, Hurlburt Field, Fla., comments made during class discussions, 7-10 January 1997.

20. In this context, the term tool refers to a software program and its associated hardware, such as the Sun Microsystems(r) SUN SPARC workstations CTAPS typically uses. Col Carl H. Steiling, Theater Battle Management Core Systems Program Manager, to author, electronic message, subject: AWC Research, 24 February 1997.

21. Notes, Class 97-01, Joint Air Operations Senior Staff Course (JSSC), USAF Air Ground Operations School, Hurlburt Field, Fla., 7-10 January 1997.

22. Gorman message.

23. AGOS CD-ROM.

24. Gorman interview.

25. AGOS CD-ROM.

26. Gorman message.

27. Gorman interview.

28. AGOS CD-ROM.

29. Gorman interview.

30. AGOS CD-ROM.

31. Gorman message.

32. Gorman interview.

33. AGOS CD-ROM.

34. JSSC notes.

35. Gorman message.

36. AGOS CD-ROM.

37. Gorman interview.

38. Carl DeFranco, Rome Laboratory, Rome, N.Y., telephone interview with author, 22 October 1996. In addition to the shortcoming stated in the text, another problem is that CTAPS is tied to a lengthy air tasking cycle. The DARPA program "JFACC After Next" is exploring the feasibility of real-time, continuous ATO generation, as well as designing a geographically distributed data processing version of CTAPS in conjunction with Rome Laboratory, Air Combat Command, and other organizations.

39. Croker, class comments.

40. General (Ret) Charles A. Horner, “What We Should Have Learned in Desert Storm, but Didn’t,” Air Force Magazine 79, No. 12 (December 1996): 52-55.

41. Air Force Scientific Advisory Board, Vision of Aerospace Command and Control for the 21st Century, SAB-TR-96-02ES, 26 November 1996, on line, Internet, 23 January 1997, available from http://web.fie.com/htdoc/fed/afr/sab/any/text/any/sabvis.htm, 5.

42. JSSC notes.

43. Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey Summary Report, (Washington, D.C.: Government Printing Office, 1993), 4.

44. Col William Hoge, CENTAF AOC Director, Shaw AFB, N.C., comments made during class discussions at the Joint Air Operations Senior Staff Course, 7-10 January 1997.

45. Horner.

46. Air Force Scientific Advisory Board, 2.

47. Chairman of the Joint Chiefs of Staff, National Military Strategy of the United States of America, 1995, 7.

48. Joint Vision 2010, 4.

49. Maj Gen (Ret) John A. Leide, USCENTCOM J-2, Briefing given to the senior officers at Electronic Systems Center, Hanscom AFB, Mass., 12 June 1996.

50. Defense Advanced Research Projects Agency, JFACC Concept: Jump Start to Future, JFACC After Next Program Review, 14 August 1996, 61.

51. JSSC notes.

52. Croker, class comments.

53. Joint Publication 3-56.1, 8-9.

54. Cdr Donald W. McSwain, Naval Ocean Systems Center, San Diego, Calif., lecture presented at the Joint Air Operations Senior Staff Course, 7-10 January 1997.

55. JSSC notes.

56. Croker, class comments.

57. JSSC class discussion.

58. Ibid.

59. Gorman interview.

60. Col William Hoge, CENTAF AOC Director, Shaw AFB, N.C., interview with author, 9 January 1997.

61. Croker interview.

62. Ibid.

63. Air Force liaison officers would also be appropriate if the JFACC and much of the JAOC staff are naval officers.

64. Jeffrey R. Barnett, Future War: An Assessment of Aerospace Campaigns in 2010, (Maxwell AFB, Ala.: Air University Press, January, 1996), 65.

65. White House, A National Security Strategy of Engagement and Enlargement, (Washington, D.C.: Government Printing Office, February 1996), 14.

66. Croker, class comments.

67. Murray.

68. Class discussion, JSSC.

69. Ibid.

70. Croker interview.

71. Leide.

72. Col Charles T. Fox, Combat Air Forces Chair at the Air War College, Maxwell AFB, Ala., interview with author, 14 March 1997.

73. Carl DeFranco, Distributed Air Operations Center, Rome Laboratory fact sheet, August 1996.

74. Gorman interview.

75. More precisely, the reduction is between 47 percent and 73 percent; however, this paper's notional division of workstations is not accurate enough to quote estimates to the nearest percentage point. The lower bound was calculated by assuming that 80 workstations are equivalent for additional support equipment in the JAOC, while the upper bound was based on the assumption that no additional support equipment would be needed.

76. Steiling message.

77. Ronald L. Thompson, Deputy Director, U-2 System Program Office, Robins AFB, Ga., interview with author, 8 March 1996.

78. Steiling interview.

79.This detachment would not include the JFACC's administrative staff. The support team would remain at its base, where it could better interact with other support agencies for the air component command. A relatively straightforward data and video teleconference link would tie the support personnel to the deployed JAOC.

80. Even though the software must be developed only once, other cost drivers such as facility construction, equipment procurement, and operations and maintenance would realize little or no savings by building and operating two garrisons instead of just one.

81. Lt Gen John S. Fairchild, “HORIZON - A Jointly Focused Vision Charting the Course for the 21st Century Air Force,” Armed Forces Journal International, January 1996, n.p.; on-line, Internet, 24 January 1997, available from http://www.dtic.mil.

82. Gen Thomas S. Moorman, Jr., “The Challenge of Space Beyond 2000,” remarks to the 75th Royal Australian Air Force Anniversary Airpower Conference, Canberra, Australia, 14 June 1996, on-line, Internet, 3 December 1996, available from http:/www.dtic.mil.

83. Air Force Scientific Advisory Board, 5.

84. Air Force Scientific Advisory Board, 2.

85. This result derives from the number of C-141 sorties required to fully deploy CTAPS with its current architecture. Today, 146 workstations, plus the equivalent of 80 workstations worth of additional remote terminals, radar repeaters, and communications equipment, requires 41 C-141 airlift sorties. Thus, assuming the number of sorties varies approximately as the number of workstations and the amount of support equipment, reducing the number of workstations by 107 would save 19.4 C-141 sorties to the theater.

86. Croker interview.

87. Air Force Scientific Advisory Board, 7, 12.

88. JSSC notes.

89. Gerald M. Friedman, Battle Management Portfolio Chief Architect, MITRE Corporation, Bedford, Mass., telephone interview with author, 17 March 1997.

90. Gorman message.

91. Cdr Donald W. McSwain, Naval Ocean Systems Center, USN, to author, electronic message, subject: Air War College Research Paper on Reachback Operations, 5 February 1997. In all, the Navy has four ships with varying capabilities to support a JFACC afloat. The USS Mount Whitney supports the 2nd Fleet in the Atlantic Ocean. USS Blue Ridge is assigned to the 7th Fleet in the Pacific Ocean. The Navy uses the USS LaSalle to support air operations in the Mediterranean Sea, and is modifying the USS Coronado to support the 3rd Fleet in the Pacific and Indian Oceans.

92. AGOS CD-ROM.

93. JSSC notes.

94. AGOS CD-ROM.

95. JSSC notes.

96. McSwain comments.

97. McSwain message.

98. Ibid.

99. AGOS CD-ROM. The seven classes of communications are: SHF SATCOM, EHF SATCOM, SINCGARS, INMARSAT, UHF SATCOM, UHF LOS, and Commercial SATCOM.

100. Croker interview.

101. JSSC class discussion.

102. Richard A. Stubbing with Richard A. Mendel, The Defense Game, (New York: Harper and Row, 1986), 110.

103. Lucius Aemilius Paulus, quoted in Alfred C. Schlesinger, trans., Livy, vol. 13 (Cambridge, Mass.: Harvard University Press, 1951), 161-3. The entire passage is instructive of Paulus' point, and so is reproduced here: "In all the clubs and even—God save us!—at dinner tables there are experts who lead armies to Macedonia, who know where camp should be pitched, what places should be held with garrisons, when or by what pass Macedonia should be invaded, where granaries should be set up, by what routes on land or sea provisions should be supplied, when we must join battle with the enemy and when it is better to remain inactive. Not only do they decide what should be done, but when anything is done contrary to their opinion, they accuse the consul as if he were in the dock. Such behavior is a great obstacle to the men in the field. For not everyone is as unwavering and as steadfast of spirit against hostile gossip as was Quintus Fabius, who preferred to have his independence of command lessened by popular folly rather than to neglect the best interests of the state for the sake of acclaim. I am not, fellow citizens, one who believes that no advice may be given to leaders; nay rather I judge him to be not a sage, but haughty, who conducts everything according to his own opinion alone. What therefore is my conclusion? Generals should receive advice, in the first place from the experts who are both specially skilled in military matters and have learned from experience; secondly, from those who are on the scene of action, who see the terrain, the enemy, the fitness of the occasion, who are sharers in the danger, as it were aboard the same vessel. Thus, if there is anyone who is confident that he can advise me as to the best advantage of the state in this campaign which I am about to conduct, let him not refuse his services to the state, but come with me into Macedonia. I will furnish him with his sea-passage, with a horse, a tent, and even travel-funds. If anyone is reluctant to do this and prefers the leisure of the city to the hardships of campaigning, let him not steer the ship from on shore. The city [Rome] itself provides enough subjects for conversation; let him confine his garrulity to these; and let him be aware that I shall be satisfied with the advice originating in camp."

104. Michael R. Gordon and General (Ret) Bernard E. Trainor, The Generals' War, (Boston, Mass.: Little, Brown and Co., 1995), 326.

105. Ibid.

106. JSSC class discussion.

107. Fairchild.

108. AGOS CD-ROM.

109. Maj Bruce M. DeBlois, instructor at the School of Advanced Airpower Studies, Maxwell AFB, Ala., written comments to the author, 24 February 1997.

110. Presumably, real-world contingencies would automatically take precedence over exercises, so no resource conflicts should arise between contingencies and exercises.

111. Croker interview. Due to the coarseness of these figures, the manning estimates of 800 personnel in the garrison and 100 personnel deployed in the theater have not been adjusted to account for inefficiencies in operations. All such estimates should be viewed as merely illustrating the possible manning levels for a reachback system. A detailed concept of operations must be created before more confident manning estimates are possible.

112. Ibid.

113. Stansfield Turner, Secrecy and Democracy: The CIA in Transition, (New York: Harper and Row, 1985), 91.

114. Air Force Scientific Advisory Board, 13.

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The Center for Strategy and Technology was established at the Air War College in 1996. Its purpose is to engage in long-term strategic thinking about technology and its implications for U.S. national security.

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