Airspace Command and Control in the Contemporary Operating Environment

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Airspace command and control in the combat zone is becoming more complex due to the proliferation of unmanned aircraft, and the introduction of host nation and civilian aircraft. The ability to deconflict and integrate multiple airspace users continues to challenge commanders operating in a system that was designed during the Cold War and optimized for traditional warfare fought on a linear battlefield. The current airspace command and control system struggles to adapt to the nonlinear environments in Iraq and Afghanistan where near real-time coordination and constant surveillance is required to detect and defeat an asymmetric enemy.

The purpose of this paper is to determine if the current airspace command and control system is optimized for the contemporary operating environment. The research examines airspace command and control organizations and structures, airspace control procedures and methods, and relevant equipment limiting air and ground operations. The problems highlighted in these areas will prove the research hypothesis that the current airspace command and control system is not optimized for the contemporary operating environment.

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Abstract

AIRSPACE COMMAND AND CONTROL IN THE CONTEMPORARY OPERATING ENVIRONMENT by MAJOR Christopher J. Russell, USAF, 45 pages.

Airspace command and control in the combat zone is becoming more complex due to the proliferation of unmanned aircraft, and the introduction of host nation and civilian aircraft. The ability to deconflict and integrate multiple airspace users continues to challenge commanders operating in a system that was designed during the Cold War and optimized for traditional warfare fought on a linear battlefield. The current airspace command and control system struggles to adapt to the nonlinear environments in Iraq and Afghanistan where near real-time coordination and constant surveillance is required to detect and defeat an asymmetric enemy.

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Table of Contents

Introduction

Numerous joint and service after action reports highlight airspace command and control as a problem area in Iraq and Afghanistan.[1] Commanders face challenges that can no longer be solved by simple pre-planned routes, fixed altitudes, and stagnant airspace coordination measures. Deconflicting fires while integrating multiple airspace users in the same area of operations in near real-time is exceeding the limits of the current airspace command and control (AC2) system. The problem is exacerbated with the proliferation of unmanned aircraft, aging equipment, doctrinal shortfalls, and the introduction of host nation and civilian aircraft. The inability for commanders to integrate and synchronize all airspace users limits combat effectiveness and efficiency.

The operational art of coordinating and sequencing multiple airspace users to achieve theater campaign objectives is nothing new in the military. However, doctrine, training, organizational structures, and equipment were designed and perfected during the Cold War to operate in a linear battlefield against an enemy's fielded forces. Airspace control procedures were tested in Iraq in 1991, Bosnia in 1995, and Kosovo in 1999 and each of these operations highlighted deficiencies in airspace command and control, but many of the lessons went unheeded. Although many would consider these operations successful, these campaigns built a false sense of efficacy in airspace management and control due to minimal integration between air and ground forces, both in combat and in training.

Today, the battlefield is a nonlinear environment where the current AC2 system struggles to adapt to the contemporary operating environment. Integrating military airspace users continues to challenge Airmen and Soldiers; however, the military is not the only organization competing

[1] Air Force and Marine Tiger Team CENTCOM Trip Report, January 2008. Marine Corps Center for Lessons Learned. Marine Air Command and Control System (MACCS): *Operations in Iraq*; Lessons and Observations from MACG-28, January 2007 to January 2008 Deployment; Center for Army Lessons Learned (CALL) and Air Force Office of Lessons Learned (HQ USAF/A9L). *OIF-OEF Airspace Command and Control Collection and Analysis Team Initial Impressions Report 07-14*; Center for Army Lessons Learned. *Joint Lessons Learned Report.* May 24, 2006.

for the same airspace. Host nation and civil aviation desire a return to normalcy, presenting challenges to commanders conducting military operations in adjacent airspace. Additionally, the enemy is not easily identifiable on the open battlefield and now blends in with the population requiring constant surveillance and near real-time coordination to find, fix, and target the enemy. The current AC2 system is limited in providing near real-time capabilities due to incompatible equipment and the inability to provide a common operating picture of all airspace users. To counter the shortfalls in the current AC2 system, commanders are forced to create ad hoc organizations, generate unit-level alternatives to circumvent the limitations of the current system, and block off large volumes of airspace inhibiting other missions. Although these short-term fixes show flexibility and adaptability of operational commanders, having to flex and adapt too much may indicate the system is not adequate. Additionally, the innovative fixes do not answer the question *why. Why*, after nearly nine years of combat in Afghanistan, and seven years of combat in Iraq, are commanders still highlighting airspace command and control as a problem?

The problem of airspace control is rooted in a system that is optimized for major combat operations on a linear battlefield, not for stability operations where multiple users are competing for similar airspace in a nonlinear environment. The problems of airspace control will not get easier as ground commanders inherit more unmanned aircraft, long loiter weapons are fielded requiring large volumes of maneuver airspace, and the enemy begins launching unmanned aircraft with little warning above the division commanders Area of Operation (AO). Given the steady increase in airspace complexity in the combat zone, this paper seeks to answer the question, is the current airspace command and control system optimized for the contemporary operating environment? The analysis will reveal that the airspace command and control system <u>is not</u> optimized for the contemporary operating environment.

To support the research hypothesis, the paper will examine three areas in the current AC2 structure. First, the paper will examine AC2 organizations and structures and reveal that the AC2 system and doctrine were designed for linear combat operations and was not optimized for

nonlinear environments. Historical examples will illustrate how AC2 evolved, how different services view unity of command, determine if current doctrine is adequate in fighting in a nonlinear environment, and extract AC2 lessons learned from both Iraq and Afghanistan. Second, the analysis will explain why linear airspace command and control procedures of integrating multiple airspace users are pushing the limits of the current AC2 system. The second problem area will provide historical evidence as to why the AC2 system was optimized for a linear battlefield, review current doctrine on airspace control, and finally discuss how the airspace in the contemporary environment is becoming more complex with the proliferation of multiple airspace users. Integrating the vast number of airspace users is causing airspace congestion and deconfliction problems, especially in high-density areas. Third, the paper will explain why limitations in equipment are restricting the ability for commanders to coordinate and synchronize airspace users in near real-time. Ground commanders often establish unit specific procedures to control aircraft in their area of operations to circumvent the limitations of the Theater Air Ground System (TAGS). The stove-piped technology developed during the Cold War combined with bandwidth problems continues to slow down coordination and integration. Additionally, a common operating picture showing all air assets does not exist, forcing many controllers to create ad hoc processes such as coordinating multiple airspace users via internet chat rooms. These three problem areas will prove the research hypothesis that the current AC2 system is not optimized for the contemporary operating environment.

After identifying three problem areas with the current AC2 system, the research paper will offer recommendations for improving these areas. The first recommendation seeks to clarify joint airspace command and control relationships and clearly articulate that the Joint Force Commander (JFC) be the supported commander throughout a military operation. Second, joint training needs to exercise all elements of TAGS in a traditional and irregular warfare environment. Third, to be effective in irregular warfare, air and ground operations needs to be tightly integrated and synchronized. The joint services need to continue development of the Joint

Air Ground Integration Cell (JAGIC) to properly integrate and coordinate fires and air operations. Finally, a common operating picture needs to be fielded to all airspace controllers to reduce confusion and maximize combat effectiveness. These recommendations will help the joint force best prepare for uncertainty in future operating environments.

Literature Review

The nonlinear operating environment in Iraq and Afghanistan is generating much needed literature in the realm of air and ground integration. Private industry "think-tanks," professional military journals, War College papers, and joint lessons learned centers are also contributing to the topic of airspace command and control. The United States (U.S.) Army contracted RAND Corporation to examine the Army airspace management problem. An August 2009 paper published by RAND titled, "Army Considerations in Airspace Management," provides military leaders a conceptual model of AC2 that anticipates future demands and gaps in the current system.[2] With multiple actors competing for the same airspace, tensions are increasing among airspace users that must be managed. The RAND Corporation monograph recommends implementing measures of performance and measures of effectiveness to help better manage airspace. The RAND monograph highlights that effectively using airspace is in the best interest of all users and the JFC. Military journals such as *Air & Space Power Journal* and *Military Review* provide a useful forum to gain an understanding of the problems facing airspace command and control.

Retired Air Force Lieutenant Colonel Alexander Wathen, a military defense analyst at Air University, Maxwell Air Force Base, Alabama, has written a series of articles in *Air & Space Power Journal* relating to airspace command and control. In one article titled, "The Miracle of Operation Iraqi Freedom Airspace Management," Wathen details the herculean effort airspace

[2] RAND Corporation Arroyo Center, "Army Considerations for Airspace Management," prepared for the United States Army, August 2009, xv.

managers' accomplished to safely execute daily combat operations. Wathen attributes the successes in Iraq to four areas including prior airspace management experience gained in Afghanistan, an inordinate amount of time to prepare for combat operations in Iraq, the vast airspace available, and the abundant and readily available fuel resources.[3] Although there were many successes in airspace management, Wathen is not shy to point out these feats were done with an archaic and technologically deficient command and control system. Wathen challenges the military services to develop an airspace deconfliction system that can incorporate current technologies with future systems, standardize information throughout the AC2 architecture, and provide controllers' the ability to predict airspace conflicts. [4] The Army, Air Force, Marines, and Navy War Colleges continue to produce research papers relating to airspace command and control; however, a majority of the theses focus on integrating unmanned aircraft into the battlespace, rather than addressing the issues with the AC2 system.

Colonel David Hume, an Air War College graduate, wrote a thesis on command and control and integration of unmanned aircraft into the battlespace. Hume argues that the TAGS is not optimized to support the integration of unmanned aircraft operations. The thesis concludes with recommendations on how best to integrate and employ unmanned aircraft in future operating environments. Many students attending the War Colleges have followed suit with similar topics on how best to integrate unmanned aircraft given the recent demand and growth. In addition to research being conducted at military professional institutions, service and joint lessons learned centers are addressing the airspace congestion problems in the contemporary operating environment.

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[3] Alexander M. Wathen, "The Miracle of Operation Iraqi Freedom Airspace Management," *Air & Space Power Chronicles – Chronicles Online Journal*, October 4, 2005.

[4] Ibid.

The Center for Army Lessons Learned (CALL), the Air Force Office of Lessons Learned Directorate, and the Marine Corps Center for Lessons Learned are working together to address airspace congestion and integration problems. As military units redeploy home, these lessons learned centers capture best practices, identify what worked effectively, what did not work effectively, and offer recommendations for follow-on units deploying to the combat zone. These reports, journal articles, War College papers, combined with the analysis done in this paper, will add to a growing body of knowledge that will continue to improve airspace integration problems occurring in the contemporary operating environment.

Airspace C2 Organizations and Structures

Commanders in both Iraq and Afghanistan continue to highlight airspace command and control as a problem area. This section will review current airspace command and control relationships, organizations, and structure while fusing historical context and after action reports from both Iraq and Afghanistan to assist in explaining why the current AC2 construct is struggling to adapt in the contemporary operating environment. A review of how different services view unity of command will shed light on confusion over C2 relationships in the Central Command (CENTCOM) Area of Responsibility (AOR). This is directly affecting air and ground integration and creating friction between the services. This section will also break down the critical elements of the TAGS and highlight deficiencies with a system built for major combat operations. This section begins with a discussion on unity of command and its relation to airspace control. Joint Publication (JP) 3-30, *Command and Control of Joint Air Operations*, provides the fundamental principles of C2 for joint air operations in order to ensure unity of effort.[5] This concept is supported by a key principle in joint air operations, centralized control.

[5] Joint Publication 3-30, *Command and Control for Joint Air Operations*, June 5, 2003, I-1.

Centralized control allows a single commander to be responsible for planning, directing, and coordinating military operations. Centralized control also provides coherence, guidance, and organization to the air effort and assures the effective and efficient use of air assets in achieving the JFC objectives.[6] The actual employment of joint air operations are conducted using decentralized execution. Decentralized execution delegates authority to subordinate commanders allowing for flexible and responsive actions during combat operations. This reads well in doctrine, but history shows that the Air Force, Marines, and Navy have different views on unity of command with respect to air operations, causing inter-service friction. Several lessons learned in airspace control emerged following the Vietnam War including the importance of unity of command and having a "single air manager."

During the early stages of the Vietnam conflict, Air Force and Navy planners divided North Vietnam into seven geographic areas called "route packages." The Navy controlled four areas adjacent to the coastline, and the Air Force controlled the remaining three, most notably, the area encompassing the heavily defended capital city Hanoi. This fragmented approach went against the basic belief by airpower theorists, including Brigadier General William "Billy" Mitchell, that one commander be in control of all air assets.[7] Not wanting to repeat the failures in Vietnam, General Chuck Horner, Combined Forces Air Component Commander (CFACC) for Desert Storm, developed an air campaign that avoided assigning targets and geographical areas to particular services. General Horner strongly believed that air power must be unified and integrated, with all players "singing from the same sheet of music."[8] The air campaign planned

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[6] Ibid.

[7] Benjamin S. Lambeth, *The Transformation of American Air Power*, Chapter 2, "The Legacy of Vietnam," Winter 2000, reprinted with permission in *Expeditionary Air and Space Power*, Air University, Maxwell Air Force Base, AL, 72.

[8] Richard P. Hallion, "Storm over Iraq: Air Power and the Gulf War," (Washington D.C.: Smithsonian Institution Press, 1992), 144. The use of CFACC will be used interchangeably with Joint Forces Air Component Commander (JFACC). For the purposes of this paper, they are referring to the same position.

and controlled by a "single air manager" proved successful in Desert Storm, but were all of the services in agreement in who should command their air forces?

According to the authors of *Joint Air Operations: Pursuit of Unity of Command and Control, 1942-1991*, the Air Force historically believes that all air forces should be under a single commander. This single commander should report directly to the theater commander and not be placed under another subordinate commander.[9] This aligns with unity of command defined in JP 3-30 and the philosophy employed by General Horner. The Navy also believes in unity of command, but all air assets supporting fleet operations should fall under the authority of the fleet commander, not a theater commander. The unique requirements to protect fleet operations means the priority goes to the sea control mission before being released to another commander.[10] Marine Corps air has a different view on unity of command. Marines have a long history of "organic" air assets supporting the Marine ground component. Placing Marine air under the command of another service component is undesirable without unacceptable decreases in Marine combat capability.[11] This paper does not seek to determine which service philosophy is better, but simply highlight the different philosophies in unity of command as it pertains to air operations. These different philosophies create undesirable tensions between services and are impacting operational cohesion in the contemporary operating environment. These tensions are evident based on recent after action reports from Iraq and Afghanistan.

A six person Air Force and Marine Corps Tiger Team traveled through the CENTCOM AOR from 8 to 20 January 2008 to investigate areas of tension between the services, one of them being airspace command and control. They visited all of the major C2 nodes for air operations in Iraq, Afghanistan, and Qatar. One of their major findings noted confusion over joint C2

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[9] James A. Winnefeld and Dana J. Johnson, *Joint Air Operations: Pursuit of Unity in Command and Control, 1942-1991*, (Annapolis: Naval Institute Press, 1993), 8.

[10] Ibid., 9.

[11] Ibid., 11.

relationships and the position of the JFC. The Tiger Team asked each commander at the C2 nodes who they believed the JFC and the supported commanders were. Nearly every commander had a different answer.[12] Not clearly understanding who the JFC and supported commanders are can affect unity of effort, impact operational cohesion, and degrade combat effectiveness. This confusion is understandable given the multiple subordinate Combined Joint Task Force (CJTF) commanders established in the AOR. For example in Iraq, the CENTCOM commander established Multi-National Force-Iraq (MNF-I), Multi-National Corps-Iraq (MNC-I) and Multi-National Security Transition Command-Iraq as CJTFs. The MNF-I is actually the JFC for Iraq, which many of the C2 node commanders did not clearly understand. Multiple JTFs can create friction as the commanders compete for air support within their respective AORs. This leads to the next tension existing throughout the CENTCOM AOR, the command relationship of the CFACC and the JFC.

JP 3-30 states that the JFC will normally designate a CFACC to exploit the capabilities of joint air operations.[13] This has been the case for every major military operation following the Cold War. However, the JFCs in Iraq and Afghanistan do not have a CFACC or Air Force component commander within their CJTFs. Currently, the CFACC located at Al Udeid Air Base, Qatar, reports directly to the CENTCOM commander, who synchronizes theater-wide air operations in the Horn of Africa, Iraq, and Afghanistan. Although the CFACC works for the CENTCOM commander, the CFACC supports multiple JTFs in various AORs. Supporting multiple JTFs with a single CFACC is described in Air Force doctrine, but not explained in joint

[12] Air Force and Marine Tiger Team CENTCOM Trip Report, 9. At the time the trip report was written, MNF-I was the JFC in Iraq. At the time of publication of this monograph, the MNF-I changed designation to United States Force-Iraq (USF-I). This paper will use MNF-I vice USF-I as this was the designation at the time of the after action reports gathered for this research paper.

[13] JP 3-30, I-2.

doctrine.[14] Given the unique organizational structure in the CENTCOM AOR, are the C2 relationships between the CFACC and the JFC in Iraq or Afghanistan aligned with joint doctrine? The simple answer is yes and a brief explanation follows.

JP 1-02 defines a JFC as "a general term applied to a combatant commander, subunified commander, or joint task force commander authorized to exercise combatant command (command authority) or operational control over a joint force."[15] Therefore, a JFC exists for the entire CENTCOM AOR, this being the CENTCOM commander. Also, a JFC exists within Iraq, the MNC-I commander, and a JFC exists in Afghanistan with the International Security Assistance Forces (ISAF) Commander. So according to joint doctrine, the CFACC is supporting a JFC, the JFC in this case happens to be the CENTCOM commander. This unusual relationship helps explain why there may be confusion when the C2 commanders were asked who is the JFC, and who are the supported and supporting commanders. This current implementation of doctrine, although correct, frustrates some of the senior commanders of MNF-I and MNC-I.[16] This addresses the centralized control aspect of airspace control, but another area that requires examination is the structure that facilitates airspace command and control, the Theater Air-Ground System.

Although not a complete and formal system, the TAGS provides the C2 framework that allows each services' airspace management system to exist in a joint environment.[17] The TAGS incorporates the Air Force Theater Air Control System (TACS), the Army Air Ground System (AAGS), the Navy Tactical Air Control System (NTACS), and the Marine Air Command and

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[14] Air Force Doctrine Document (AFDD) 2-1.7, *Airspace Control in the Combat Zone*, Department of the United States Air Force, July 13, 2005, 8.

[15] JP 1-02, Department of Defense Dictionary of Military and Associated Terms, April 12, 2001, 223.

[16] Air Force and Marine Tiger Team CENTCOM Trip Report, 9.

[17] Field Manual (FM) 3-52: *Army Airspace Command and Control in the Combat Zone*, Headquarters, Department of the Army, August 2002, 1-7.

Control System (MACCS).[18] Termed the Air Ground Operations System (AGOS) during the Cold War, the TAGS was designed for major combat operations against a peer threat, mainly in the defense of Western Europe. The system was designed as a means to initiate, receive, process, and execute requests for air support.[19] Following the Cold War, Operation Desert Storm in 1991 validated the TAGS construct, and the services took great pride in their success. Yet the Department of Defense budget drawdown following Desert Storm forced the armed services to retreat to a "service-centered" focus as they fought for their piece of the defense budget, negatively impacting joint air operation development and training.[20] This impacted how the services enhanced, or failed to enhance their portion of TAGS. The following discussion will introduce the services airspace management systems in TAGS and discuss relevant limitations.

The Air Force TACS is the C2 mechanism for the commander, Air Forces (COMAFFOR). Typically dual-hatted as the CFACC, the COMAFFOR uses TACS as a means to execute the Air Control Plan (ACP) and Air Control Order (ACO). The ACP and ACO explain how the airspace will be used to support the JFC objectives. The Air Operations Center (AOC) is the senior element of TACS where centralized planning, direction, control, and coordination occur to facilitate decentralized execution.[21] The AOC consists of five divisions: strategy; combat plans; combat operations; intelligence, surveillance, and reconnaissance (ISR); and the Air Mobility Division. Service components provide liaisons to the AOC to articulate service requirements and provide a conduit for information flow back and forth between the units and assist in developing the ACP and ACO. A majority of military operations in the 1990s were dominated by air power. Consequently, those portions of the TACS that integrate with ground

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[18] Ibid.

[19] Thomas A. Cardwell III, *Airland Combat: An Organization for Joint Warfare*, (Montgomery: Air University Press, 1992), 116.

[20] Winnefeld and Johnson, 169.

[21] AFDD 2-1.7, 30. This paper will use AOC and Combined Air Operations Center (CAOC) interchangeably, both implying the element of the TACS.

forces including the Control and Reporting Centers (CRCs), Air Support Operations Centers (ASOCs), and Tactical Air Control Parties (TACP), received only minor attention and few upgrades.[22]

According to JP 3-09.3, *Close Air Support,* CRCs are deployable but fixed "ground-based airspace control/air defense, battle management centers that provide the COMAFFOR with a decentralized C2 execution capability."[23] The CRC is a communication hub that connects the joint C2 nodes to the AOC. CRCs also provide safe passage, radar control, and surveillance for all airspace users transiting the joint operating area.[24] Airspace control responsibilities may be delegated to the CRC in response to immediate requests from airspace users such as Brigade Combat Teams (BCTs) or divisions.[25] The requests for air support flows through the Joint Air Request Network (JARN). The JARN is a process that helps TACPs communicate and manage ground commander requests for air support (See Figure 1). TACPs send requests for air support to the ASOC located at corps headquarters, which passes the request to the Battlefield Coordination Detachment (BCD) located in the AOC. The BCD deconflicts the request within the CAOC, then approves, disapproves, or works modifications with the ASOC.

The ASOC is the C2 node for integrating airpower into the land component commander's scheme of maneuver and is typically collocated with the senior Army tactical echelon. In Iraq, the ASOC is collocated at the corps level. Primary functions of the ASOC include managing Close Air Support (CAS) assets within the supported commander's AO, processing CAS requests, deconflicting Airspace Coordinating Measures (ACMs) and Fire Support Coordination Measures (FSCMs), assigning and directing attack aircraft to joint terminal attack controllers (JTACS), and

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[22] Air Force and Marine Corps Tiger Team CENTCOM Trip Report, 10.

[23] JP 3-09.3, *Close Air Support,* July 19 2009, II-6.

[24] Ibid.

[25] Multi-service Tactics, Techniques, and Procedures and Airspace Control (MTTP), FM 3-52.1/AFTTP 3-2.78, 10.

managing requests within the JARN.[26] The ASOC also coordinates and deconflicts airspace with the Army's fires cell airspace C2 element, TACPs, G-3 air, Army Airspace Command and Control (A2C2), and the AOC.[27]

The AAGS is the AC2 system that provides the synchronization, coordination, and integration of air operations in support of the Land Component Commander's (LCC) scheme of maneuver. The Air Force provides liaisons to the AAGS to aid in planning, deconflicting, and integrating the air assets with the ground elements. These elements include Air Liaison Officers (ALOs), TACPs, and the ASOC.[28] See Figure 1 for key components of TACS and AAGS.

The division AC2 element is responsible for managing the airspace over the entire division AO; however, the JFACC remains the airspace control authority. When the division divides the AO, AC2 can be delegated to a BCT; however, doing this may require additional AC2 personnel to support the BCT. All multifunctional brigades except sustainment have an organic air defense airspace management (ADAM)/brigade aviation element (BAE).[29] ADAM/BAE responsibilities include authority over all Army airspace users in their AO, authority of all CAS aircraft in support of BCT operations, coordination with all Army airspace users transiting the BCT AO, and with the division AC2 element when special airspace requests impact the division AO.[30] The Marine Corps also has an airspace command and control element of TAGS and contributes significantly to joint air operations.

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[26] Ibid., 11.

[27] Ibid. The Army recently changed AC2C to Army Air Command and Control (AC2) cell. These two terms will be used interchangeably throughout this paper.

[28] FM 3-52, 1-14.

[29] MTTP, FM 3-52.1/AFTTP 3-2.78, 12.

[30] Ibid, 13.

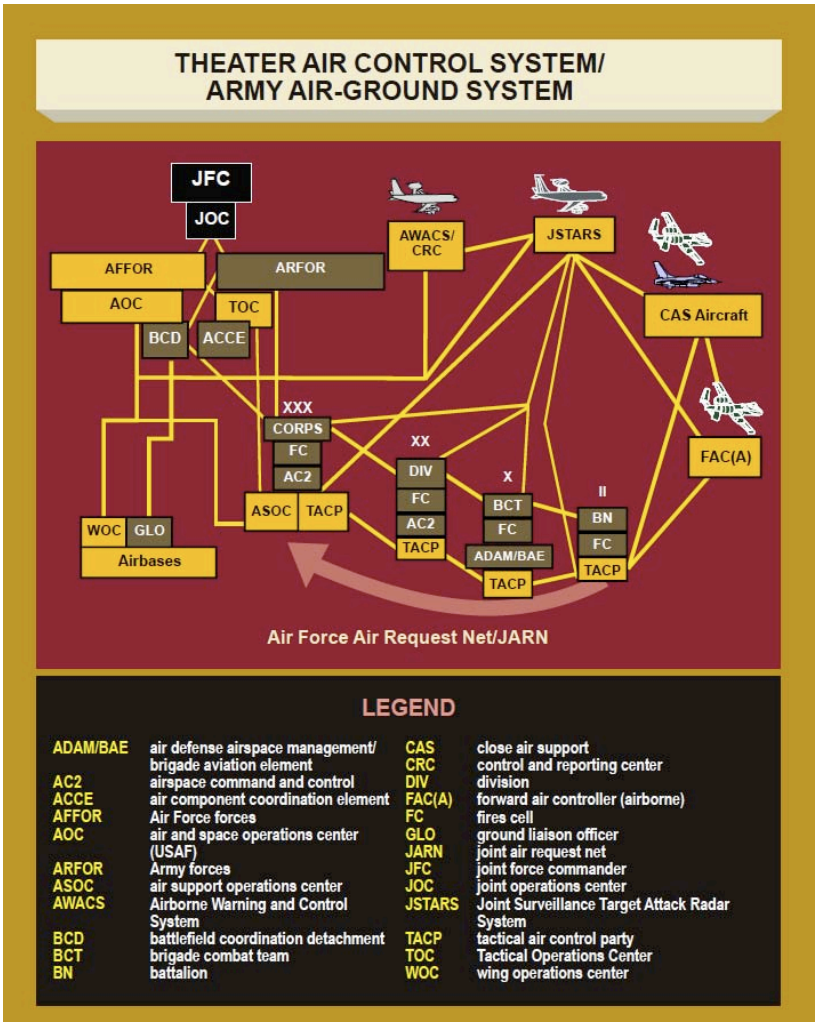

Figure 1: Key components of the TACS-AAGS[31]

The MACCS is the Marine Corps AC2 element. Traditionally it facilitates amphibious air operations, but in Iraq, the MACCS controls the western air sector of Iraq.[32] The main elements of the MACCS include the Tactical Air Command Center, the Tactical Air Operations Center, the Marine Air Traffic Control Detachment, and the Direct Air Support Center (DASC). The DASC provides procedural control services to fixed and rotary wing aircraft and provides

[31] JP 3-09.3, II-5.

[32] Lessons and Observations from MACG-28, 2.

decentralized execution of close air support and assault missions.[33] These systems exist to provide a safe and efficient airspace and permit greater flexibility to the JFC.[34] As the paper will discuss later, inter-service tensions in Iraq are raising concerns on the proper use of airspace control during stability operations. Never before in combat has the TACS, AAGS, and MACCS been tested like it has in the contemporary operating environment. The protracted wars in Iraq and Afghanistan highlight several problem areas for AC2 and TAGS.

An Army and Air Force investigative team traveled to Iraq and Afghanistan in 2006 focusing on AC2, with emphasis on high-density/low altitude operations. An observation made by the team indicated the current AC2 system was not prepared for the transition from major combat operations to stability operations.[35] Part of the problem is rooted in doctrine and how the TACS and AAGS are optimized for major combat operations. Referencing Figure 1, notice the CRC and ASOC are separated. This makes sense during major combat operations where the primary role of a ground-based CRC is air defense and typically does not mobilize until the land component secures the AO. The E-3 Airborne Warning and Control System (AWACS) provides air battle management and airspace control to airspace users during major combat operations. Once air supremacy is achieved, the CRC mobilizes and the AWACS returns to their U.S. bases. As operations became more complex during stability operations in both Iraq and Afghanistan, the separation of the CRC and ASOC added coordination time and prevented rapid and effective support to the land component.[36] Another important issued raised throughout both AOs is that AC2 training at home did not reflect combat reality.

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[33] FM 3-52, 1-13.

[34] Ibid.

[35] CALL and HQ USAF/A9L, *OIF-OEF AC2 Initial Impressions Report 07-14*, 26.

[36] Ibid., 27.

The investigative team interviewed five elements of the TACS; many admitted their pre-deployment training did not address the complexity of stability operations. The training lacks equipment, personnel, and necessary agencies to conduct proper training.[37] The air battle managers within the CRCs do not have the necessary training and certification courses needed to accomplish airspace deconfliction while integrating tactical and civilian aircraft during stability operations. The Army has similar issues as several soldiers were quoted in saying that they would have benefited from more hands-on, scenario-oriented training.[38]

Army personnel working within AAGS remarked that pre-deployment training provided a tremendous amount of information, but there was no opportunity to integrate all of the systems within AAGS. As the investigative team traveled throughout the AOR, pre-deployment training and daily operations in garrison did not adequately prepare the Army personnel for the contemporary environment. Additional trends were noted including a lack of joint airspace doctrine training, scenario-based training did not reflect real world operations, courses did not teach ADAM/BAE operators how to use the digital systems of AAGS, and the courses did not cover the Air Tasking Order (ATO) and ACO processes.[39] Airspace managers did not have a full understanding of the complexities of the operating environment when they arrived in the AOR and were quickly overwhelmed. The Army and Air Force were not the only services experiencing troubles operating in the current environment; the Marines Corps faced similar challenges and made similar remarks during interviews.

Following their deployment from January 2007 to January 2008, the Marine Air Command Group-28, with the help of the Marine Corps Center for Lessons Learned, published a lessons and observations document on air operations in western Iraq. The TAGS, along with

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[37] Ibid., 42.

[38] Ibid., 37.

[39] Ibid., 38-42.

doctrine and training were designed primarily for major combat operations. Several Marine commanders voiced the same concerns as the Army and Air Force personnel. In describing the airspace challenges in western Iraq, one Marine squadron commander quoted during an interview:

> *"We are constantly trying to bring civil and operational aircraft into these airfields while at the same time conducting tactical close air support missions. So we've combined it all right on top of each other and so there's a lot more things happening directly above the airfields and directly in a very small, congested area that requires a lot more interface with air command and control agencies then you'd ever see before."*[40]

Another quote by a squadron commander highlights how training did not reflect reality:

> *"When you have these type of operations going on that close, to include within five miles of the airfield, where you have indirect fires that are both, at times outgoing and incoming, you have to clear airspace with the outgoing as much as you do for any other airplane that is in the area. It takes education because our controllers in the air traffic route are not exposed to this training in the states."*[41]

The Marine commanders also said these comments with caution. The feeling among the Marines is that the airspace controllers and elements within MACCS adapted well to combat operations in Iraq; however, multiple deployments to Iraq are slowly eroding the traditional skills of an expeditionary Marine force. While not having a significant impact to operations in Iraq, Marine commanders interviewed during collection for the unit trip report voiced concern that basic fighting principles and skills unique to Marines are fading.[42] Another area of concern by Marine commanders was the lack of joint force LNOs in the MACCS.

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[40] Lessons and Observations from MACG-28, 7. This quote captured during an interview on January 12, 2008 with LtCol Ward Quinn, commanding officer of MASS-1.

[41] Ibid., This quote captured on January 13, 2008 during an interview with LtCol Von Pigg

[42] Ibid., 7.

Marines interviewed during the Tiger Team visit highlighted tensions between the Air Force and Marines due to a lack of trust between the airspace controlling agencies. The Marines send LNOs to the CAOC, yet the CAOC does not send LNOs to the Marine MACCS. One interviewee stated that the CFACC and many air assets do not venture into western Iraq due to not understanding Marine airspace capabilities.[43] Providing LNOs to the Marine MACCS would alleviate the misunderstanding and lack of trust existing between the services. These after action reports all highlight the challenges in AC2 relationships, the challenges of current doctrine, how training at home does not reflect reality, and the service tensions existing in the contemporary operating environment.

Linear Airspace Control in a Nonlinear Environment

The ability to integrate multiple airspace users, deconflict fires, and synchronize tactical missions is nothing new to the U.S. military. However, in high-density areas such as the airspace above Baghdad, commanders can no longer rely on simple pre-planned routes, fixed altitudes, and stagnant airspace coordination measures to solve the airspace congestion problem. In addition to military airspace users, the proliferation of unmanned aircraft, the introduction of host nation, nongovernmental and civilian aircraft challenges a system that was optimized for a linear battlefield. Orchestrating these assets in a nonlinear environment presents significant challenges never before encountered by the JFC. To circumvent the limitations of the current system, commanders are relying on ad hoc organizations and processes to solve the airspace problems, but these fixes do not address the reason why challenges continue to emerge. To answer that question, this section will provide historical evidence as to why the airspace control system was optimized for a linear battlefield, review current doctrine on airspace control, and finally discuss airspace complexity in the current operating environment.

[43] Ibid., 9.

Airspace coordination measures in the combat zone are a product of the Cold War. During the Cold War and the decade following, the integration of air and land forces primarily occurred on a linear battlefield where warfare was thought of in terms of a 180° fight. The Army divided its linear battlefield defined by deep, close, and rear areas. Land component weapon systems generally flew and fired from the rear area to the front with little lateral movement.[44] All Army airspace user requirements had to be identified, planned, and deconflicted. The requests to reserve and restrict airspace were sent through the A2C2 cell. The airspace requests were reviewed, deconflicted and forwarded to the Army aviation liaison in the CAOC. The ACA, typically the JFACC, would integrate and deconflict the land components requests into the air attack plan. Any changes were sent through the TAGS and distributed to all airspace users.[45] To deconflict airspace users including artillery and mortar fire, pre-planned routes with timing and specific altitudes were developed to ensure deconfliction and no friendly fire incidents.

The Air Force and Navy developed strike missions against known enemy targets that were generated from a joint targeting list. Similar to the Army, pre-planned routes were developed and integrated into the air attack plan. The air attack plan would describe the type of mission the strike aircraft would fly to meet the JFC objectives. Strategic attack sorties were planned to fly deep into hostile territory to strike the enemy's centers of gravity. Air interdiction sorties would be flown along deconflicted routes to destroy, neutralize, or delay the enemy's capabilities before it could be brought to bear against friendly forces. These interdiction sorties would be conducted at distances from friendly forces that detailed integration was not required.[46] A typical mission would launch aircraft from air bases located in friendly territory, ingress along a pre-planned route, penetrate enemy air defenses, release ordnance on the target, then fight their

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[44] TRADOC Pamphlet 525-7-3, "Airspace Command and Control for the Future Modular Force, 2015-2024," Department of the United States Army, April 20, 2009, 15.

[45] Ibid., 14.

[46] AFDD 2-1.3, *Counterland Operations*, December 14, 2006, 96.

way out against surface and air threats, and return to the friendly air base. In addition to interdiction sorties, close air support sorties were scheduled in advance in support of ground units. Airspace coordinating measures were developed in a linear manner to move airspace users throughout the joint operating area while executing an array of mission profiles.

Following the Cold War, three military operations refined airspace control procedures, but little air-ground integration occurred during these conflicts and lessons learned went largely unheeded. Desert Storm in 1991 was the first major campaign following the Cold War and was dominated by a 43-day air campaign followed by a swift and decisive 100 hour ground offensive.[47] Following a successful two week bombing campaign against Serbian forces in 1995, Operation Deliberate Force ended with a peace settlement with no ground force involvement.[48] Operation Allied Force in 1999 concluded after a 78-day bombing campaign with no air-ground integration. The conflicts during the 1990s did little to push the limits of airspace control doctrine and mostly operated in a linear environment. The opening phases of OIF occurred in a linear fashion, but soon after coalition forces occupied the battlefield and major combat operations transitioned to stability operations, the current airspace control structure quickly became saturated and several after action reports highlighted significant deficiencies with operating in a nonlinear environment. So why were the existing airspace control procedures in doctrine adequate for a linear environment, but not adequate for the nonlinear environment experienced in OIF and OEF?

First, airspace users in past conflicts primarily consisted of military aircraft and military weapon systems. Civilian aircraft and commercial air carriers avoided the combat zone. Second, fixed-wing and rotary wing aircraft were easily separated vertically be a coordination altitude. During the Cold War, the coordinating altitude over Europe was only 200 feet above ground

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[47] Richard P. Hallion, *Storm Over Iraq: Air Power and the Gulf War*, (Washington DC: Smithsonian Institution Press, 1992), 236.

[48] Robert C. Owen, "The Balkans Air Campaign Study," *Airpower Journal*, Fall 1997, (Montgomery: Air University Press, 2000), 19.

level. The coordination altitude was used to separate rotary-wing aircraft from fixed-wing aircraft. Today in Iraq, that altitude is 3,000 feet with many ground commanders pushing that altitude to 10,000 feet as the mission dictates.[49] Additionally, fixed-wing aircraft are flying below the coordination altitude for shows of force and during gun strafing attacks to achieve desired weapons effects. Third, Army airspace users were limited to specific organizations allowing controlling agencies to communicate directly with the owning headquarters.[50] With the proliferation of unmanned aircraft, more organizations require coordination with controlling agencies. Fourth, all aircraft were flown by rated pilots, including unmanned aircraft. Today, smaller sized Unmanned Aircraft System (UAS) operators do not require Federal Aviation Agency certification and are unit trained.[51] Fifth, targets on a linear battlefield against a state actor are easier to identify and often stationary. Typical targets for the air component are military facilities, C2 nodes, leadership headquarters, war production facilities, and fielded forces. The enemy today is not easily identifiable. The enemy is very decentralized, has no fielded forces or large military facilities, and blends into the urban environment. As a result, targeting the enemy requires real-time targeting capabilities that are sometimes delayed by the current AC2 system. Many of these factors were adequate in past conflicts on linear battlefields, but are they adequate for the nonlinear environments in Iraq and Afghanistan? The following section will review current airspace control doctrine and reveal how the doctrine developed largely during the Cold War challenged commanders operating in Iraq and Afghanistan.

The primary document outlining the principles, relationships, and guidelines for airspace control in combat is JP 3-52, *Joint Doctrine for Airspace Control in the Combat Zone*. The JFC is primarily responsible for airspace control in the combat zone, and designates the JFACC as the

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[49] Rebecca Grant, "The Clash of the UAV Tribes," *Air Force Magazine*, September 2005, 50.

[50] TRADOC Pamplet 525-7-3, 15.

[51] Ibid., 18.

Airspace Control Authority (ACA). As the ACA, the JFACC's responsibilities include planning, coordinating, and monitoring joint air operations based on the JFC's concept of operations and air apportionment decision. Once the ACA develops the air control plan, the JFC approves and distributes it throughout the joint operating area and to all supporting airspace users. [52] After the air control plan and air control order are distributed, a daily planning process begins to safely integrate all the airspace users.

The planning and integration process has also evolved during the last ten years in both Iraq and Afghanistan, specifically with the ATO cycle. A typical ATO cycle, as outlined in JP 3-30 is 72 hours. This cycle starts from JFC guidance and ends after a 24-hour execution period.[53] In the counterinsurgency fight occurring in both AORs, targets may not be accessible in 72 hours due to the rapid changing environment. As an example, airspace requests generated from the lowest tactical level needs to be approved by the ACA. Each echelon reviews, deconflicts, and forwards the request up the chain until it reaches the Army liaison in the CAOC. The air request is then integrated into the air control order and sent to all TAGS C2 nodes, which is then distributed back to the original unit making the request. This process is time consuming and often the airspace request is no longer needed by the time the approval reaches the tactical unit.[54] In Iraq, this 72 hour ATO cycle has been truncated to 44 hours.[55] Once the ATO is generated and published, airspace coordination measures are required to safely deconflict and move airspace users through the battlespace.

The methods of airspace control vary throughout the range of military operations to provide safe, efficient, and flexible use of airspace with minimal restrictions placed upon airspace

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[52] JP 3-52, *Joint Doctrine for Airspace Control in the Combat Zone,* August 30, 2004, II-2.

[53] JP 3-30, III-20.

[54] TRADOC Pamphlet 525-7-3, 14.

[55] Ibid., 12.

users. The primary methods of airspace control are *positive* control and *procedural* control, or a combination of both. *Positive* control relies on radars, identification, friend or foe (IFF) interrogators and receivers, digital data links, beacons, computers, and communication equipment to identify, track, and direct air assets.[56] Continuous communication with airspace users is required for positive control and necessitates a robust command and control network. The Air Force prefers positive control and is best suited for dynamic operating environments. *Procedural* control uses airspace coordination measures such as coordinating altitudes, low-level transit routes, minimum-risk routes, aircraft identification maneuvers, FSCMs, Restricted Operating Zones (ROZs), and high-density airspace control zones to control and deconflict aircraft and fire systems.[57] The Marines in western Iraq prefer procedural control because their operating environment is less dynamic than Baghdad. The *coordinating altitude* is a procedural control method typically used to separate fixed-wing from rotary-wing aircraft. Current operations in Iraq and Afghanistan use the term "coordinating altitude" as the vertical limit between airspace controlling agencies [i.e. the top of Army controlled airspace and the bottom of the CRC controlled airspace.][58] This definition differs slightly from the doctrinal definition. As operations matured in OIF and OEF, the JFACC agreed to raise the coordinating altitude.[59]

During stability operations in OIF and OEF, the CRC uses both positive and procedural control to task and deconflict aircraft above the coordinating altitude.[60] The CRC will control aircraft below the coordinating altitude when the JFC has a higher priority mission operating above the division commander's airspace. According to Army airspace control doctrine, airspace controllers have no control authority over aircraft operating below the coordinating altitude unless

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[56] JP 3-52, III-4.

[57] Ibid.

[58] MTTP, FM 3-52.1/AFTTP 3-2.78. *Airspace Control*, May 2009, 2.

[59] CALL and HQ USAF/A9L, *OIF-OEF AC2 Initial Impressions Report 07-14*, 5.

[60] Ibid.

it is dealing with its own unit assigned aircraft. One of the major findings in the OIF and OEF after action reports is the need to update Army doctrine to add control authority. Because of this limitation, the Army relies heavily on procedural control to move aircraft through the AO. To expedite operations, the ACA allows the Army division AC2 cell to manage aircraft below the coordinating altitude. The key word being 'manage,' so deconfliction is still by advisory only.[61] To manage and deconflict aircraft in a nonlinear environment where pre-planned routes are not realistic given the complex environment, grid reference systems are added in doctrine to deconflict airspace users.

Having a common reference system reduces the coordination required to support JFC requirements with maximum flexibility while preventing fratricide.[62] Additionally, a common reference system provides a two-dimensional (2-D) framework from which 3-D coordination measures can be created. Common reference systems are not new, they were used during the siege of Khe Sanh in 1968 to establish restricted and free fire zones.[63] During Desert Storm, "kill boxes" were used both short and beyond the Fire Support Coordination Line (FSCL) to allow for rapid targeting with minimal risk to friendly forces.[64] OIF began by using the Common Geographic Reference System (CGRS) as a common reference system and there is a push in the joint community to transition to Global Area Reference System (GARS). Joint Publication 2-03, *Geospatial Intelligence Support to Joint Operations*, directs the use of GARS unless the Combatant Commander determines that the use of another reference system is mission critical.[65]

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[61] Ibid.

[62] AFDD 2-1.7, 41.

[63] Trest, Warren A. Khe Sanh (Operation Niagara) 22 January – 31 March. *Project CHECO Report*. Headquarters, Pacific Air Forces, CHECO Division, 79.

[64] AFDD 2-1.7, 41.

[65] JP 2-03, *Geospatial Intelligence Support to Joint Operations*, March 22, 2007, H-2.

GARS is a 2-D reference system primarily used as an operational-level administration measure to coordinate geographic areas rapidly and provide a common frame of reference for the joint force. GARS can be digitally displayed in command centers to enhance situational awareness and allow for efficient air-to-ground coordination, deconfliction, and integration. It is important to understand what GARS is not. GARS is neither a FSCM nor an ACM, nor should it be used to describe exact geographic locations or to describe precise positions for guided weapons delivery. GARS divides the entire surface of the Earth into a grid system, as opposed to CGRS, which only divided a particular AO into a grid system. GARS uses the WGS-84 geodetic latitude and longitude reference system to divide the Earth into 30 minute by 30 minute areas. These 30x30 minute areas are subdivided by quadrant into 15x15 minutes areas, then further subdivided by a keypad division into 5x5 minute areas (see Figure 2).[66] The 5x5 minute keypads are roughly 5 nautical miles (nm) by 5nm depending on how far the keypad is from the equator. Controllers can quickly control aircraft and efficiently manage airspace using GARS. Using the 5x5 minute keypads in Figure 2 as a reference, an airspace controller can hold an unmanned aircraft in keypads 1 and 2 while a fighter aircraft conducts an attack in keypads 4 through 6. Once the attack is complete and the fighters exit the keypads, then the airspace user can open other keypads to the unmanned aircraft as required for mission execution. One word of caution as the joint force transitions from CGRS to GARS is CGRS keypads are 10x10 minutes, while the GARS keypads are 5x5. This subtle difference may lead to confusion and possibly a dangerous situation for the airspace users. The problem existing in Iraq is that one common reference system is not being used, which is leading to confusion among airspace users.

[66] Ibid., H-3.

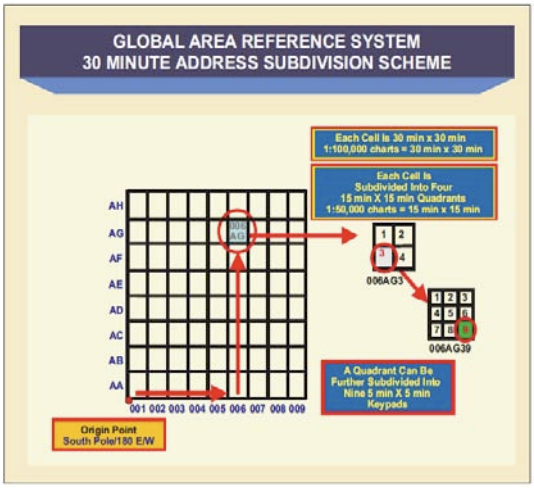

Figure 2: Global Area Reference System (GARS)

In 2007, two different reference systems were being used over Baghdad, CGRS used by Air Force controlling agencies and the Zone diagram used by Army controllers. The use of two reference systems led to confusion among aircrew and controllers. Ground units operating in Baghdad divided the airspace in relation to security zones on the ground. Religious, tribal, population density, and other demographic factors divided the security zones.[67] The CRC and air traffic controllers use CGRS to manage and deconflict aircraft throughout the AOR. Although this is doctrinally correct, ground commanders argue that this does not adequately integrate airspace users in an urban environment.[68] Additionally, fixed-wing aircraft only have CGRS loaded on computer maps in the cockpit and do not always have updated zone information. Additional airspace users such as non-governmental and civilian aircraft flying in the Baghdad airspace have neither reference systems. The use of two different reference systems leads to confusion and increases the chance that information will not get to the right users at the right

[67] CALL and HQ USAF/A9L, *OIF-OEF AC2 Initial Impressions Report 07-14*, 55.

[68] Ibid.

time. Although the use of GARS has been approved, after action reports indicate that is has not been fully integrated.[69] The following section will review how the increase in airspace complexity in Iraq and Afghanistan tested the limits of the current AC2 system. This will help answer the research question if AC2 is optimized for the contemporary operating environment.

The transition from major combat operations to stability operations in Iraq and Afghanistan highlighted several challenges to an airspace control structure optimized for traditional battlefields. Just four months after hostilities began in OEF, commercial air carriers resumed overflight of Afghanistan and a drastic increase in airlift began flying in personnel, equipment, and much needed supplies. Soon traffic would increase with the addition of ISAF, international organizations, nongovernmental organizations, and other civil operators operating in the region supported by the Regional Air Movement Control Center.[70] Unfortunately, there was no airway system in place in Afghanistan and inadequate communication equipment to provide terminal control.

According to joint doctrine, establishing an airspace control system is the responsibility of the ACA. The responsibilities also include assisting the host nation in establishing a civil structure where none exists.[71] Unfortunately, the Afghanistan government had no capability to lead the effort in establishing an airspace control system. Therefore the ACA, Lieutenant General T. Michael Moseley, had to operate outside doctrine and assume the lead in order to fill the void of the host nation. These challenges of converting a battlespace into a national airspace structure capable of safely integrating civilian aircraft while conducting military operations challenges the role of the ACA that is not typically found in linear environments. Similar issues would challenge commanders in Iraq a few years later.

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[69] Ibid., 56.

[70] Regional Air Movement Control Center, http://ramcc.dtic.mil/history.html (accessed on January 7, 2010).

[71] JP 3-52, II-2.

Prior to OIF, the JFACC used air assets to patrol the skies in order to contain Saddam Hussein's military. The skies over Iraq were virtually empty with the exception of a few Iraqi Air Force training missions and occasional domestic civilian air traffic. As major combat operations began in March 2003, AWACS, Joint Surveillance and Targeting Attack Radar System (JSTARS), and other air assets provided the air picture. After air superiority was quickly achieved and the ground forces occupied most of the AO, CRCs' combined with A2C2 elements provided airspace control as stability operations began. The competition for airspace became more intense as ground commanders fought for control over the airspace above their AO. With the proliferation of unmanned aircraft, an increase in civilian traffic, and ongoing military operations, the airspace quickly became saturated.

An explosive growth in unmanned aircraft occurred during the conflicts in Iraq and Afghanistan. From 2007 to 2009, the Air Force's primary unmanned aircraft, the Predator, logged more than 250,000 flying hours. The Air Force started with one Predator orbit patrolling the skies in Afghanistan in 2001; in 2009 that number jumped to 37 orbits in Iraq and Afghanistan. The Chief of Staff of the Air Force, General Norton Schwartz, stated the number of orbits is expected to jump to 50 by the end of 2011.[72] The addition of unmanned aircraft adds to the airspace complexity problem in the contemporary operating environment. The proliferation of unmanned aircraft and the increase in number of orbits in the last decade has caused airspace integration challenges. In a 2005 *Air Force Magazine* article, roughly 800 unmanned aircraft ranging from miniature size to high-altitude Global Hawk were operating in Iraq and Afghanistan.[73] The Army, Navy, and Marine Corps have also expanded their unmanned aircraft inventory.

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[72] Norton Schwartz, "The Future of Unmanned Systems," Chief of Staff of the US Air Force speech given to the UAS "Beta Test" Graduation, September 25, 2009, 3.

[73] Grant, 46.

The services quickly realized that persistent coverage over the battlefield provided by the higher altitude unmanned aircraft was invaluable to gaining an advantage over the enemy. The Army quickly procured several small backpack sized RQ-11 Ravens, flying at an altitude of 500 feet, and the RQ-7 Shadow 200, operating at altitudes up to 8,000 feet. The MQ-5B Hunter operates up to 15,000 feet providing organic ISR to division commanders.[74] Although providing enhanced over watch and targeting capability, the increase number of unmanned aircraft is creating congestion and deconfliction problems for airspace users. One challenge of integrating unmanned aircraft in the contemporary operating environment is how to command and control them.

Most unmanned aircraft are positively controlled; however, many are too small to carry transponder equipment, such as the half-pound Black Widow. With no transponder, air traffic controllers cannot identify an unmanned aircraft on the radarscope and provide safe deconfliction from manned aircraft. Joint doctrine cautions integration of unmanned aircraft, "UAVs may be difficult to visually acquire and do not always provide a clear radar or electronic signature, presenting a hazard to other aircraft."[75]An ad hoc solution to ensure safe deconfliction is to block off a volume of airspace, typically a ROZ, and ensure manned aircraft remain clear. Another option is to allow manned aircraft to penetrate the ROZ under "see-and avoid" principles. The difficulty in "see-and-avoid" is that small unmanned aircraft are too small to visually acquire and avoid, causing an inherent risk to manned aircraft. Additionally, unmanned aircraft lack "see-and-avoid" capability. The camera onboard the UAS provides a very narrow field of view picture primarily used to identify targets, not scan the airspace for other aircraft. Another method of deconfliction is creating a blanket altitude. Reserving a blanket altitude exclusively for unmanned

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[74] Army-technology.com, "Hunter RQ-5A/MQ-5B/C Tactical Unmanned Aerial Vehicle, USA/Israel," http://www.army-technology.com/projects/hunter/.

[75] JP 3-52, IV-6.

aircraft is a safe alternative, but can restrict freedom of movement for other airspace users. Equipment limitations are also creating challenges to airspace control in the nonlinear environment and will be addressed in the next section.

Equipment Limitations

Arguably the biggest problems in providing adequate airspace command and control in Iraq and Afghanistan are equipment limitations. Due to the speed, diversity, and distribution of operations in the current environment, commanders require technologies and capabilities to integrate multiple airspace users in near real-time. Unfortunately, the stove-piped technology developed during the Cold War is being pushed to the limits in both AORs creating significant challenges to commanders. Currently, equipment shortfalls include the inability to share digital data between services in order to provide a common operating picture of the battlespace. Additionally, the inability for the current system to provide real-time coordination and deconfliction forced airspace managers to use internet chat relay programs to integrate air and ground operations. Although internet chat programs have proven successful in increasing overall situational awareness, it is not without disadvantages. Finally, the increase in airspace users and the need for continuous streams of data is creating a significant strain on the finite bandwidth available in the combat zone. The equipment designed during the Cold War supported centralized control of CFACC missions; however, the current AC2 system is not equipped to support the highly decentralized operations in the current nonlinear environment. The first equipment limitation to address is the inability to provide a common operating picture throughout the AOR.

The CAOC, located at Al Udeid Air Base, Qatar, serves as the senior air and space command and control entity throughout the CENTCOM AOR. The CAOC relies on a series of radar feeds to provide an overall air picture of the battlefield. In Iraq, the CRC's TPS-75 radar, along with two other radar sites, digitizes the radar feed and sends the information to a local Air Defense System Integrator (ADSI), which then sends the signal via satellite to the ADSI at the

CAOC, which is then displayed on a large screen in the CAOC. This display is often referred to as a common operating picture. The video display in the CAOC is the same air picture displayed in the CRC located in Iraq. The video provides the CFACC and personnel in the CAOC situational awareness of the battlefield. This radar system is optimized for providing the air picture above the coordinating altitude, but situational awareness provided for the low altitude environment can be limited given the coverage and placement of radar sites.[76]

The farther away an aircraft is from the radar, the more difficult it is to provide a radar signature. Helicopters and unmanned aircraft flying at low altitudes and at distances far away from the radar site make it difficult for CRC controllers to provide adequate deconfliction. In these cases, procedural control becomes the primary means of deconfliction. The 4th Infantry Division (4 ID) in Iraq implemented workarounds given the limitations in radar equipment. The 4 ID's A2C2 element used air defense radars to establish a real-time low altitude air picture of airspace users operating below the coordinating altitude.[77] To bridge the gap between the low air picture and the high air picture, controllers relied on Mardam-Bey Internet Relay Chat (MIRC) rooms, voice over internet protocol, telephones, e-mail, and radio communications to positively and procedurally control airspace. Monitoring several systems to provide adequate airspace control can overburden an air traffic controller. In some instances, controllers are monitoring ten internet chat rooms at a time trying to keep up with deconflicting airspace users.[78] Because the AC2 system was designed for major combat operations, the airspace command and control infrastructure forced commanders to create ad hoc process to circumvent the limitations of the current system. Additionally interoperability problems exist between service equipment

[76] CALL and HQ USAF/A9L, *OIF-OEF AC2 Initial Impressions Report 07-14,* 28.

[77] Ibid., 29.

[78] Ibid., 32.

preventing a common operating picture. The following is an example of how the lack of interface between Army and Air Force equipment negatively affected a mission.

The CRC controllers are not seeing the same air picture as the Army AC2 element. The AC2 develops a composite air picture using the data link provided by the CRC and combines that feed with the live data from the air defense Sentinel radars. The data is synthesized and displayed on a Tactical Airspace Integration System (TAIS).[79] This method works well for integrating division air assets, but the CRC does not have the same displays. The inability to coordinate on identical digital displays between the CRC and the Army AC2 cell caused an unnecessary change in mission. Two 4ID BCTs and a non-4ID unit were conducting separate operations within a 15-kilometer area. The non-4 ID unit was conducting a raid, one 4 ID unit was provided unmanned aircraft support to an area of interest, and the other 4 ID BCT was attempting to shoot illumination rounds. The non-4 ID unit requested a ROZ to secure the airspace above the raid, but this ROZ overlapped three keypads and the CRC closed all three keypads forcing the unmanned aircraft to leave the area and delay the illumination mission.[80] Later investigation revealed that unmanned aircraft surveying the area of interest was six kilometers away from the ROZ, and the illumination unmanned aircraft was operating seven kilometers away from the ROZ and firing rounds away from the three keypads.[81] Had the CRC had the same displays as the 4 ID AC2 cell, the two agencies could have coordinated the missions without interrupting operations. The challenge of developing a common operating picture exists between the services, but also challenges intra-service systems.

Even within the Army, a common operating picture of the low altitude environment does not fully exist. As previously stated, the Army uses air defense radars, namely the Sentinel air

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[79] 4 Infantry Division Observation Report. "Digital Airspace Command and Control systems interoperability," Observation ID: M1, 2006.

[80] Ibid.

[81] Ibid.

defense radar, to increase situational awareness in the low altitude environment. The Army merges the radar data provided by the Sentinel radar with data streaming from Blue Force Tracker (BFT). The overlay leads to a confusing air picture due to the slower refresh rates of the BFT. To alleviate confusion, the operator has to correlate both feeds by cross-referencing the ATO to identify IFF information, and then manually match the data.[82] This works only if an aircraft transmits an IFF beacon or BFT code. Several unmanned aircraft variants do not carry IFF transponders because the equipment is too heavy and can only transmit a BFT signal. The slow refresh rates of BFT presents an inaccurate air picture that can decrease overall situational awareness. Adding to airspace complexity, the Army must integrate artillery and mortars with other airspace users to ensure a safe operating environment; however, interoperability between TAGS equipment challenges operators.

To deconflict field artillery from other airspace users, the Army uses the Advanced Field Artillery Tactical Data System (AFATDS) and TAIS. The AFATDS is an automated digital coordination system that processes all fire support requests.[83] The trajectory of the round is checked against ACMs and alerts the user if a violation occurs. However, AFATDS will not check the trajectory of a mortar round, this is done through a handheld, lightweight, Mortar Ballistic Computer (MBC).[84] The TAIS, the second coordination system, takes inputs from several sources and combines to form a single picture of the air and ground battlespace. TAIS can also deconflict near real-time airspace requests and generate alerts when aircraft enter a unit's airspace. [85] TAIS is enhancing situational awareness in the CENTCOM AOR, but interoperability with other systems of the TAGS is a problem currently frustrating airspace operators.

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[82] Ibid., 31.

[83] FM 3-52, 5-6.

[84] MTTP, FM 3-52.1/AFTTP 3-2.78, 25

[85] FM 3-52, 5-11.

To deconflict and synchronize air assets, the Air Force uses three coordinating entities including the TACPs, the Theater Battle Management Core System (TBMCS), and MIRC chat. The role of the TACPs was discussed in a previous section under the elements of TAGS. Planners at the CAOC use TBMCS to build, distribute, and execute the ATO and ACO. TBMCS interfaces with AFATDS and TAIS to support ACM requests, run deconfliction validity checks, and digitally aid in the production of the ATO and ACO.[86] Once the ATO is loaded into TBMCS, a validity check is conducted on all airspace users to determine potential conflicts. The deconfliction analysis uses take-off times, routes, altitudes, target location, and estimated arrival times to determine conflicts in the ATO and generates alerts when there is a conflict.[87] The problem with TBMCS is not all events that occur in a given ATO cycle are predictable. For example, many fighter aircraft are executing a mission called "airborne on-call CAS." Meaning the fighter aircraft take-off with no preplanned target and no detailed pre-planned route flown from take-off to landing. The route consists of flying to a 30 square mile "box" in the sky and waiting for a tasking, making it difficult for the TBMCS to deconflict when a prediction of the tasking in nearly impossible. Also, the ground commander can chose to launch a number of systems including the Army Tactical Missile System when the situation warrants and may not always be entered into the ATO. Another problem identified by operators in the Qatar AOC is the deconfliction software in TBMCS produces so many deconfliction alerts that it is nearly impossible to deconflict every alert with the current system.[88] Because the war will not stop and wait for the next ATO to deconflict airspace problems, real-time coordination is needed. Ad hoc processes were developed to circumvent the limitations of the current AC2. One of the most

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[86] Ibid., 5-3.

[87] Alexander Wathen, "Joint Airspace Management and Deconfliction: A Chance to Trade in a Stovepipe for Network-Centric Warfare," *Air and Space Power Journal*, Fall 2006, 3.

[88] Ibid.

talked about coordination systems in both AORs is the use of MIRC, a real-time internet chat room.

MIRC was an ad hoc internet chat relay program developed to overcome shortfalls in the current AC2 system to provide a real-time coordination capability. The use of radio, voice communications, and Cold War processes to deconflict airspace users is at times cumbersome, frustrating, and time consuming. MIRC allows the user to open multiple chat rooms and pass information throughout the elements of TAGS. Many operators within TAGS monitor and coordinate request in real-time to solve airspace command and control issues and expedite operations. Overall, MIRC has received positive feedback in both Iraq and Afghanistan as a system that increases overall situational awareness and reduces coordination time within the TAGS architecture. However, the use of MIRC as an ad hoc process to circumvent the limitations of the current AC2 system is not without its disadvantages.

Keeping up with ongoing operations requires constant heads-down time to process and the information being exchanged in multiple chat rooms. Because of the advantages of MIRC, the growth rate and usage of MIRC is sometimes overwhelming to airspace controllers. For example, airspace controllers in the CRC are controlling and directing aircraft that require constant attention to the radarscope. Monitoring nine to twelve internet chat rooms can be difficult for the airspace controllers. There is also no joint force standardization on the use of MIRC. Abbreviations, short phrases and terminology are not standardized and require experience to understand the information being conveyed. As with radio discipline and brevity, those using MIRC need to exercise discipline and not abuse the capability. Additionally, when a significant event occurs, the system has been known to crash as the increase in users “log-on” to follow the internet chatter. The increase in the use of MIRC combined with the proliferation of unmanned aircraft and existing technology is putting significant strains on bandwidth. The equipment limitations and stove-piped technology of TAGS frustrates commanders and airspace controllers.

Given the problems of the current AC2 system, the following section provides recommendations for improvement to facilitate more effective air and ground integration.

Recommendations

This paper highlighted several problem areas with airspace command and control in the combat zone. To transform the current system to a system that is optimized for current and future operating environments, this paper recommends improvements to doctrine, the AC2 structure, improvements in training, and equipment. The first recommendation addresses a need to change doctrine, specifically command and control relationships. The six person Tiger Team traveling throughout the CENTCOM AOR in 2008 investigated areas of tension between services regarding airspace command and control. The team noted confusion among the C2 node commanders as to who was the JFC and who were the supporting and supported commanders. Confusion on who are the supporting and supported commanders can affect unity of effort and limit operational cohesion. According to JP 3-0, "more than one supported command may be designated simultaneously."[89] For the land and maritime domain, JP 3-0 states, "the land and maritime force commanders are the supported commanders within the AOs designated by the JFC."[90] For the air domain, JP 3-0 states that the JFACC will be the supported commander for the JFC overall air interdiction and counterair.[91] Multiple supported commanders under the JFC can lead to inter-service friction and cause confusion, as was the case in Iraq and Afghanistan. To alleviate confusion, joint doctrine should change to reflect that the supported commander should always be the JFC. Allowing the JFC to be the supported commander throughout the operation where the JFC sets the priority in resources and support would ensure unity of effort and

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[89] JP 3-0, *Joint Operations*, September 17, 2006, Incorporating Change 1, February 13, 2008, III-5.

[90] Ibid., III-7.

[91] Ibid., III-8.

eliminate C2 confusion. Unity of effort will allow for better cohesion when integrating land and air operations in support of the JFC objectives. With unity of effort assured, the next recommendation to doctrine is to add "control" to Army doctrine.

Although the word "control" is in the title Army Airspace Command and Control, Army doctrine still does not recognize the Army AC2 element as capable of controlling airspace. Joint doctrine still states that the ACA is responsible for control of all airspace users. If the joint force requires more decentralized control to adapt to the rapidly changing environment, then Army doctrine must first gain the authority through doctrine to control airspace. The second step is the ACA would have to agree to release authority to the division AC2 cell to assume control of all air assets users including manned and unmanned aircraft. The Army will also need to train and educate its operators on how to control the myriad of airspace users, especially in high-density areas. A recent exercise conducted in 2009 tested several air-ground integration concepts. One of them being the Army's AC2 cell ability to command and control multiple airspace users including coordinating fires and air operations over and within a division commander's AO. A major finding was that the Army's AC2 cell is not organized, trained, or equipped to handle the centralized control in high-density airspace zones.[92] Additionally, a host of lessons learned were captured including a possible 240 recommended changes to doctrinal manuals.[93] The Army and Air Force must continue to develop the necessary tools for effective air and ground airspace integration, especially in a nonlinear environment. The next recommendation deals with optimizing the current AC2 structure for the contemporary operating environment.

The nature of conflict in the last decade shifted from traditional to irregular warfare. As operations in both Iraq and Afghanistan matured to an irregular fight, the need to better integrate

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[92] Michael A. Vane, (LTG). "Earth, Wind, and Fire 2009: Emerging Insights Brief," Director, ARCIC, November 2009, slide 13.

[93] Ibid., slide 4.

air and ground operations quickly became apparent. To be effective in irregular warfare, air and ground operations must be tightly integrated and synchronized. Several structural and personnel improvements within TAGS will help address problems highlighted by AC2 commanders. The first deals with establishing a cell that brings together critical elements of the TACS and AAGS. This cell should be comprised of the ASOC, TACP, Fires cell, Intelligence, the Army AC2 cell, Air Defense, and other agencies as the mission dictates. Currently, these agencies are not combined into one cell, making real-time coordination more difficult. Integrating these TACS and AAGS elements in the same coordination cell places them in close proximity with each other creating a more effective air and ground cell.

As stated in the previous paragraph, other agencies can be added to the coordination cell as mission dictates. An example would be the CRC. The CRC can be collocated with the air-ground coordination cell as major combat operations transitions to stability operations. However, caution should be made on when this move should occur. The CRC typically will not be mobilized until the ground campaign is complete and friendly forces are in control of the AOR. This move must be planned prior to combat operations beginning. The Army and Air Force are reviewing the concept of combining elements of TAGS and the new cell is tentatively called the Joint Air Ground Integration Cell (JAGIC). The services are currently conducting simulation exercises to determine if the concept is valid, and are identifying personnel and equipment requirements for implementation. The second recommendation within TAGS deals with the proper allocation and location of LNOs.

The highly decentralized nature of irregular warfare requires more air and ground integration to effectively move airspace users through the operating environment. The Marines send LNOs to the CAOC, but the Air Force does not send LNOs out to the Marine MACCS. Following interviews with airspace operators in western Iraq, many Marines stated that a better

relationship and understanding between Air Force and the Marines is required to be effective in the current operating environment.[94] Many Marines felt that the joint force would benefit if Army and Air Force personnel were collocated within the MACCS. If the Marines control airspace for the JFACC in future operations, LNOs from the services should be integrated into the MACCS to gain a better understanding of the Marine airspace control capabilities and to better synchronize air and ground operations. With recommendations to changes in doctrine and the current AC2 structure complete, the next focus area for recommendations deals with adequately training airspace operators for the challenges of a nonlinear environment.

For decades the services trained for a linear war. The Air Force's primary pre-deployment training exercise in the Nevada desert, called Red Flag, only exercised a small portion of TACS. The two-week exercise was designed to simulate the first ten combat sorties. It was noted by Air Force leaders following the Vietnam conflict that the first ten sorties in combat statistically lost the most pilots. If a pilot could survive the first ten combat sorties, then statistically, the pilot stood a better chance of surviving his combat tour. Realizing this type of training did not adequately prepare aircrew for the current fight where the U.S. enjoys air supremacy over Iraq and Afghanistan, a third week was added to allow more air-ground integration. However, the additional week only exercises the final link in the kill chain, linking the JTAC with a fighter aircraft to deliver ordnance on a hostile target. Although beneficial to the aircrew and JTAC, this training still does not integrate all elements of TACS and AAGS. In fact, it only integrates the Air Force portion of TAGS. Joint training exercises need to exercise more elements of the TAGS to better prepare the joint force for combat. An exercise that brings together more elements of the TAGS including the CAOC, ASOC, CRC, TACP, Army C2,

[94] Lessons and Observations from MACG-28, 16.

Intelligence, and the Fires Cell, will greatly improve pre-deployment training and combat execution.

The Army also recognizes deficiencies in their garrison training. Pre-deployment training does not simulate or integrate all of the elements of the AAGS. Army AC2 personnel should be trained using all elements of AAGS. Additionally, Army personnel are not adequately educated in joint airspace doctrine prior to deployments.[95] The Army AC2 cell does not have a standardized course for training on joint airspace doctrine. If the Army desires more control of air assets operating in the AO, they must first understand basic airspace control doctrine. Additionally, the Battle Command Detachment personnel working at the CAOC could benefit by attending the BCD operations training held at Hurlburt Air Force Base, Florida.[96] Finally at the battalion level, airspace operators in the ADAM/BAE cells complain that their pre-deployment training is not standardized and did not adequately prepare them for combat operations. The Army must review formal courses to ensure they are standardized and develop scenario-based training that reflects combat reality. The final recommendation area for optimizing AC2 in the contemporary operating environment calls for improvements in fielded equipment.

A major problem area highlighted by AC2 commanders in the CENTCOM AOR is the lack of a common operating picture. The CAOC and CRC are not seeing the same picture as the Army C2 cell. Part of the problem is the inability to share digital data between the services and other interagency, governmental, and civilian organizations. The mix of radar, aircraft friendly identification, blue force tracker, unmanned aircraft limitations, all combine to cause real-time integrations problems with Army and Air Force equipment. Additionally, Army divisions have no organic capability to provide a complete low-level air picture due to a lack of Sentinel radars. To bridge the gap in providing an accurate correlated air picture, all airspace users need to carry self-

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[95] CALL and HQ USAF/A9L, *OIF-OEF AC2 Initial Impressions Report 07-14*, 38.

[96] Ibid., 39.

reporting equipment and this information must be displayed to airspace managers and in aircraft with the ability to display a digital air picture. A common air picture will reduce confusion and coordination time between airspace operators while enhancing a safe operating environment. Another equipment limitation identified in this paper is the deconfliction program within TBMCS.

TBMCS interfaces with several programs to support ACM requests, run deconfliction validity checks, and digitally aid in the production and distribution of the ATO and ACO. The deconfliction program within TBMCS is not adequate for the speed and diversity of airspace users in the contemporary operating environment. This paper recommends implementing a new deconfliction program currently being tested at the Air Force Research Laboratory in Rome, New York. The new deconfliction program called Joint Airspace Management and Deconfliction (JASMAD) is a solution to the deconfliction problems encountered with the current airspace deconfliction program in TBMCS. JASMAD will be able to perform deconfliction analysis during the execution of the ATO by adding a "cursor on target" option. The airspace controller will be able to place a cursor on a target or aircraft and determine deconfliction problems in real-time. This is assuming all information being displayed in accurate. This program is also in close development with coalition partners including the United Kingdom to establish more than just a joint solution, but a multinational solution. The final recommendation to optimize airspace command and control is to improve the MIRC messaging system.

The requirement to deconflict fires and air operations in near real-time challenges an AC2 system built for a linear environment. The complexities of operating in a nonlinear environment forced airspace managers to create an ad hoc process where airspace coordination can be expedited to support the rapidly changing environment. The use of MIRC in both AORs has proven an essential software tool to provide near real-time capability. The disadvantage to MIRC is that it lacks a standardized messaging format and lacks adequate bandwidth to handle surge activity. The joint force needs to develop standardized messaging formats, methods of

passing information, and provide formal training on the use of MIRC. Additionally, if MIRC is considered an adequate command and control tool, then significant attention to bandwidth needs to be addressed. After action reports highlighted that when a significant event occurs in the AOR, for example a rescue mission, many users "log on" to MIRC and cause the system to crash, forcing command and control nodes to use older methods of communication. These recommendations will help transform the current system into a system that is optimized for the current and future operating environments.

Conclusions

After nearly nine years of combat in Afghanistan and seven years of combat in Iraq, commanders continue to highlight airspace command and control as a problem area. These problems are a result of an AC2 system built during the Cold War to operate on a linear battlefield against an enemy's fielded forces. Today, the battlefield is nonlinear and the current AC2 system struggles to adapt to an operating environment where multiple airspace users compete for airspace use and an asymmetric enemy blends in with the local population requiring continuous overhead surveillance. The problem is exacerbated with the proliferation of unmanned aircraft, and the introduction of host nation, nongovernmental agencies and civilian aviation.

Airspace complexity in the contemporary operating environment challenges commanders who can no longer rely on simple pre-planned routes, fixed altitudes, and stagnant airspace coordination measures to solve airspace problems. Given the increase in airspace complexity in the combat zone, this paper sought to answer the question of whether the current airspace command and control system is optimized for the contemporary operating environment. The analysis revealed three problems areas that proves the current AC2 system is not optimized for the contemporary operating environment.

This paper examined three areas of airspace command and control, each revealing problems contributing to a system not optimized for the contemporary operating environment.

The first area reviewed current AC2 organizations and structures and revealed confusion on C2 relationships leading to a lack of unity of effort. This problem area also explained how the TAGS architecture was a product of the Cold War and designed for a linear battlefield, and also determined that pre-deployment training did not adequately prepare airspace managers for the complexities of combat. The second area reviewed how airspace control methods and procedures designed for a linear environment creates challenges to commanders operating in a nonlinear environment. The increase in airspace complexity due to the explosive growth of unmanned aircraft and the introduction of host nation and civilian aircraft pushes the limits of the current AC2 system while highlighting shortfalls in joint and service doctrine. Additional problems emerged as major combat operations transitioned to stability operations forcing commanders to create ad hoc organizations and processes to circumvent the limitations of the current AC2 system. Finally, the third area reviewed how equipment limitations are inhibiting airspace managers' ability to provide real-time coordination and deconfliction of multiple airspace users. The inability to provide a common operating picture throughout the joint operating area, the inability to share digital data between the services, and limitations in bandwidth are limiting combat effectiveness in the current operating environment. The problems highlighted in this paper name only a few challenges commanders are currently facing and recommendations to solve these problems will contribute to improving airspace control in the current and future operating environments.

The recommendations in this paper seek to transform the current system into an effective system providing safe and effective airspace command and control capabilities. Changes in doctrine to include establishing the JFC as the supported commander throughout a military operation will ensure there is a unity of effort and will improve operational cohesion. If the Army desires to control multiple airspace users in high-density areas to include manned and unmanned aircraft, host nation, nongovernmental and civil aviation, then the Army must add "control" to

their doctrine and train and equip their divisions with the ability to provide adequate airspace control.

The transition from major combat operations to stability operations highlighted significant deficiencies in the TAGS architecture and the ability to integrate air and ground operations effectively. In order to be effective in irregular warfare, air and ground operations must be tightly integrated and synchronized. Following the Cold War, military operations during the 1990s saw little air-ground integration. When stability operations matured in both OIF and OEF, close air-ground integration struggled, as elements of TAGS were not closely linked. A recommendation to create a joint air-ground integration cell comprising of the ASOC, TACP, Fires cell, Intelligence, the Army AC2 cell, Air Defense, and other agencies as required will bring air and land components closer together to increase combat effectiveness. Once the land component secures the AO, the Air Force CRCs should mobilize and be collocated with the joint air-ground cell to facilitate air and ground operations. Additionally, LNOs from other services need to be parceled out to the Marine MACCS to better synchronize operations throughout the joint operating area. The next recommendation calls for improvements in AC2 training for nonlinear environments.

Numerous after action reports highlighted pre-deployment training and exercises did not adequately prepare airspace managers for the complexities of deconflicting and integrating multiple airspace users in a nonlinear environment. Training did not exercise all elements of TAGS and did not prepare airspace controllers for dealing with controlling aircraft near military bases while deconflicting from military operations five miles from the airfield. Joint training at home needs to change to exercise all elements of TAGS and provide more realistic scenario-based training. The final recommendations include necessary improvements to TAGS equipment.

The inability to share a common operating picture creates confusion and limits real-time coordination between airspace managers. The services must continue developing software that displays a common operating picture and shares compatible digital data between the elements of

TAGS. Sharing a common operating picture is the first step in solving airspace integration problems. The increase in unmanned aircraft orbits will require an increase in bandwidth. Video data streams required to provide constant surveillance of a division AOs will quickly saturate the current system unless significant attention is given to increase bandwidth in TAGS. Additionally, deconfliction software optimized for traditional battlefields needs to be replaced with JASMAD, a system that provides, among other things, real-time deconfliction alerts. The U.S. military relies heavily on sharing and sending information in a rapid and efficient manner. The ability to provide a common operating picture and provide continuous streams of video and voice data requires an important investment in improving the equipment limitations of the current AC2 system.

This research explained the challenges commanders face in the contemporary operating environment and offered recommendations for improving the airspace command and control structure. Further areas of study should focus on the future operating environment. Although filled with a great deal of uncertainty, the future operating environment will certainly be comprised of adversaries who seek to exploit weaknesses in the AC2 system by using asymmetric approaches. The joint force must be able to maintain complete situational awareness of all airspace users in order to detect and defeat the enemy. Developing a system that is interoperable between AC2 users, provides a common operating picture, and enables near real-time execution of air and ground operations is the way forward in addressing the challenges of airspace command and control in the combat zone.

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