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COMMAND, CONTROL AND COORDINATION OF THE THIRD DIMENSION: THE EVOLUTION OF ARMY AIRSPACE AFTER THE COLD WAR

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ABSTRACT

Airspace coordination is inherently one of the most joint endeavours in today's military. Coordination and integration of air and ground assets can be the key to successful operations in the asymmetric battlefield. Command control and coordination at the operational level can set the stage for success or failure. Advances in technology, changes in warfare and transformation of Army organization have led to rapid change in the world of command control and coordination of the army airspace. Doctrine publications at all levels struggle to keep pace with changes. With this problem in mind, the primary question is whether current doctrine and tactics, technique and procedures have evolved sufficiently to ensure effective airspace command, control and coordination at the operational level in the current asymmetric operational environment.

This paper starts with a historical review of airspace coordination in the context of conventional warfare. It then compares current Joint, Air Force, Army and Allied publications to understand how airspace coordination has evolved. Finally, professional papers and lessons learned articles for the Iraq and Afghanistan theatres are reviewed to identify disconnects with the current doctrine that might suggest there is a additional requirement for the new doctrine to further developed and evolve.

This thesis confirms that the asymmetric battlefield has dramatically changed the way airspace coordination must be conducted. It also proposes concrete steps to achieve substantial improvements in this critical area of joint and combined combat operations. Finally, and most importantly this thesis demonstrates that there remain significant areas for future research and analysis as technological advances continue to redefine the complexity of airspace management in peace and war.

C^3 OF THE THIRD DIMENSION IN ASYMMETRIC OPERATIONS: THE EVOLUTION OF ARMY AIRSPACE AFTER THE COLD WAR

Late on the night of 17/18 April 2002, a section from "A" Company, 3rd Battalion, Princess Patricia's Canadian Light Infantry BG (3 PPCLI BG) were conducting a live-fire exercise in the vicinity of Kandahar, Afghanistan, when they were mistakenly engaged by two American F-16 fighter aircraft. . . ..

It is the opinion of the Board that current procedures between Coalition Ground Forces and Coalition Air Forces require review. . . .. The Board believes that if the procedures had been more stringently enforced, the chain of events that led to the incident at Tarnak Farm on 17 April 2002 could possibly have been avoided.[1] - Tarnak Farm Board of Inquiry

CHAPTER 1

AIRSPACE WHY WE NEED TO TALK ABOUT IT

1.1 – INTRODUCTION

The modern battlefield must be considered in three dimensions: width, depth, and airspace. Width and depth have traditionally been considered during operations and emphasized by land and sea commanders. The prevalence of asymmetric operations on the modern battlefield coupled with the rise and the ascendancy of UAVs, has indicated that the battlespace be equally viewed in terms of the third dimension - airspace. For the Canadian Forces this point was driven home when as noted in the quote above, Canada lost its first four soldiers in Afghanistan, not to enemy fire, but to a friendly fire incident. This combined with the fact Canada was about to deploy her first UAV, drove the Canadian Forces (CF) to deploy its first ever Army based Airspace Coordination Centre (ASCC) in recent history.[2]

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[1] Canada. Department of National Defence, *Board of Inquiry - Tarnack Farm 2002* (Ottawa: DND, [2002]), http://www.vcds.forces.gc.ca/boi-cde/tf-ft/fr-rf-22-eng.asp (accessed 6 February 2010).

This chapter will introduce in broad terms why the low-level airspace has changed and what are some of the problems with coordinating the plethora of users in the army airspace. The aim of the thesis will then be addressed accompanied by some of the goals the paper proposes to achieve. Although introduced in the opening quote of the paper, discussion will be presented on why this issue is critical to the joint[3] airspace environment in asymmetric operations now being executed in places like Iraq and Afghanistan. Finally, the outline of how this paper will achieve its aim and goals will be reviewed in order to provide a roadmap as to how this complex topic will be addressed.

1.2 - GOALS OF THE DISSERTATION

Airspace command, control and coordination has become an increasingly complex challenge for airspace coordinators that can no longer be addressed on the modern battlefield with simple pre-planned routes, static control measures and fixed altitudes. The conventional plan centric and overly cumbersome method of coordinating the airspace use does not allow commanders to conduct real time integration of airspace operations. The operational airspace environment has become increasingly complex with the proliferation of UAVs and the introduction of non-governmental agencies and civil aviation within the battlespace of a host nation. This presents commanders with new and unique airspace coordination challenges never seen before on the modern battlefield. In order to operate successfully in a complex airspace environment, commanders at all

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[2] Brigadier-General Devlin Peter, "Canadian Soldiers Deploy to the Kabul Multi-National Brigade - July 2003," *The Bulletin* 10, no. 2 (2004), 3.Ibid.

[3] Joint defines when the different environments (Army, Air Force and Navy) of the same country come together.

levels must understand and be capable of synchronizing airspace users and war fighting functions in the third dimension in near real time.

Unfortunately, there is a lack of cohesive doctrine on the third dimensional battlespace in asymmetrical warfare. Given that modern operations maybe conducted in a non-linear, non-contiguous battlespace, with operational and strategic level assets pushed to the lowest tactical level, the antiquated cold war concepts such as low-level transit routes or air corridors no longer apply.

There is no common terminology or definitions and there is a lack of cohesive doctrine because NATO only uses "one nation's" doctrine, belonging to the US, and all must adapt to it.[4] Even in Canada, there is no agreement between the land, air and maritime components of the Canadian Forces on the doctrine needed for coordination of the third dimensional battle space. Part of the problem is that this doctrine has been slow to evolve from the cold war doctrinal mentality to the non-linear, non-contiguous modern battlefield. This doctrinal void is currently hampering joint work in NATO and it is causing problems with coordination and standardization.

This thesis will analyze current army airspace command and control doctrine, and lack of it, across NATO. It will analyze and identify gaps and inconsistencies between the doctrines from the different allied countries, and propose potential solutions. It will then, using current doctrine and writings on operations in non-linear and non- contiguous battlefields to propose updated doctrine that accommodates the current reality of the airspace environment.

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[4] LCol Gauvin, Barton, Defining the Battlespace, 07 October 2009.

This thesis aims to achieve two goals. The first goal would be that the recommendations and proposals from this thesis would be suitable for recommendation to the NATO Joint Doctrine Board. The second goal would be to propose joint doctrine challenges for further study for the third dimensional battlespace in the asymmetric modern battlespace

1.3 – WHY IS THE COORDINATION OF THE ARMY AIRSPACE IMPORTANT?

The end of the cold war has seen the emergence of a different world. Many argue this different world is less safe, now that the concept of Mutual Assured Destruction has become less of a threat. Regional wars often religious or ideology based are the threat of today. There are often no uniforms to identify the enemy, wars today are fought by soldiers, civilians, terrorists, insurgents and religious fanatics not just in cities but also in remote areas, such as Sudan, and places where they establish their training and support facilities. Gone are the concepts of rear area or front lines. There are no battle lines; there is no defined enemy territory and friendly territory. There are strong points and green zones.[5] Terms such a three-block war and fourth generation warfare have been coined in an attempt to codify the new battlefield.

Similarly, the old structure of the airspace, where all air traffic traveled toward the Forward Edge of the Battlefield Area (FEBA) no longer exists. The old days, when

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[5] {{189 Pike, Paul 2007/s1;}} The green zone Paul Pike, "Green Zone," Globalsecurity.org, http://www.globalsecurity.org/military/world/iraq/baghdad-green-zone.htm (accessed 12 January 2010). It is a term coined to refer to the secure zone originally designated the International Zone of Iraq in Baghdad, Iraq. The term green zone remains the most commonly used term. It has come to signify a secure zone in a hostile region.

aircraft were restricted to corridors and transit routes over friendly territory only to be set free beyond the FEBA to do what was require to hit their target and stay alive, no longer exist. The second a pilot leave his airfield he is in a mix of enemy and friendly territory. Pilots are no longer free to do what is required to hit their target, as the target is not easily distinguishable between hostile forces, civilians or friendly forces. The friendly fire incident at Tarnak Farms in Afghanistan is a stark example of how pilots have a much more difficult task in identifying hostiles on the ground. Coordination measures designed to protect ground troops such as No Fire Lines (NFL) or Forward Line of Own Troops (FLOT) no longer exist on the asymmetric battlefield to help guide pilots. The new reality is pilots can no longer assume that any observed fire is hostile.

A new dynamic was created when technological advances allowed us to use airspace for UAVs, helicopters, aircraft and long-range weapons. The airspace has become crowded, particularly at the low level. The proliferation of airspace users, particularly UAVs and the absence of traditional boundaries has made the airspace environment infinitely more complex. This is still a relatively new concept in warfare and militaries have yet to adapt in order to use the airspace to its full potential in modern military operations.

Five Canadians have lost their lives to friendly fire incidents in Afghanistan due to allied aircraft.[6] Many more allied soldiers have been killed or wounded. Improved and effective airspace coordination can limit these casualties. As well, UAVs have become a force multiplier for allied militaries. It allows for increased intelligence on enemy forces and it allows allied forces to go places once too dangerous for manned

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[6] Canada. Department of National Defence, "Fallen Canadians," http://www.forces.gc.ca/site/news-nouvelles/fallen-disparus/index-eng.asp (accessed 15 February 2010).

aircraft or ground troops.[7] They allow a military presence over an extended area permitting Commanders to exert influence on areas with no troops. Effective and flexible coordination of these assets will enable allied forces to successfully complete their mission. With proper and effective command, control and coordination of the army airspace lives will be saved.

1.4 – THESIS OUTLINE

The evolution of the army airspace is a very technical and specialized field of study. This paper although ambitious will limit its scope to an analysis of a few of the doctrinal areas that affect the major users of the airspace. Chapter 2 will briefly discuss key concepts and definitions of airspace coordination in the combat zone. Explanation of theses concepts will be helpful to put the issues discussed in this paper into context. Chapter 2 will continue with a review of the work militaries have done to date. Finally, a review of the old doctrinal approach toward coordination will be presented. Chapter 3 will discuss the methodology of this paper and the framework that will be used to analyze the various coordination issues presented. Chapter 4 will present some of the real world issues facing airspace coordination personnel. Through the use of anecdotes from operational theatres, the aim of the Chapter is to help further an understanding of the complexity and interrelationship of the army airspace users in a manner more easily understood than a doctrinal study. With a basic understanding of some of the complexities and terms, Chapter 5 will focus on an analysis of old and new doctrine for

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[7] Oliver Sutton, "Mission Dull, Dirty or Dangerous? Call Up a UAV," *Interavia Business & Technology* 58, no. 672 (Jul, 2003), 2,http://search.ebscohost.com/login.aspx?direct=true&db=mth&AN=10955031&site=ehost-live.

issues facing each of the nine major airspace users. Conventional doctrine will be reviewed and the new doctrine discussed in comparison. If there is a deviance from new doctrine to what is being practiced in the field, these new methods will be studied to determine their validity. The major findings of the paper will be reviewed in Chapter 6, in Chapter 7 the findings will be summarize, and areas for future work on airspace coordination will be proposed.

1.5 - SUMMARY

Canada has deployed into a theatre unlike any that has come before, it is an asymmetric operating environment without clear delineation between friend, or foe, and takes place among the civilian and commercial population. Allies have recently purchased and operated several tactical level UAVs in a theatre of operations, significantly affecting the army airspace. As well, the findings from the Board of Inquiry into the friendly fire incident that killed four soldiers had several recommendations relating to airspace coordination. These two issues alone suggest that the Canadian Force's understanding of the command control and coordination of the third dimension must improve.

CHAPTER 2

BACKGROUND

2.1 – INTRODUCTION

As indicated in Chapter 1, there are an increasing number of users of the airspace. Airspace control (ASC) provides the principles for de-conflicting the airspace.

> The objective of ASC is to maximize the effectiveness of military operations by promoting the ability of air, land, maritime and special operations forces to operate in an efficient, integrated and flexible manner with minimum mutual interference and without undue restraint and risk to friendly forces and non-combatant airspace users. ASC provides a commander with the operational flexibility to effectively employ forces according to mission priorities.[8]

There are two methods of control: procedural and positive. The airspace control means are the actual procedural measures used to coordinate the airspace.[9] These measures themselves are simple enough to understand and apply, however it is the actual practise of de-conflicting joint airspace users, which is extremely complex. If the airspace is not properly coordinated it could have a significant impact on joint operations. That is when positive control is exercised. Military forces today can expect to be involved in a wide variety of operations covering the entire spectrum of conflict, from peace support and conflict prevention, through to warfighting, including all post conflict missions. Every operation requires airspace coordination and each mission's airspace will be unique.

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[8] NATO, *AJP 3.3.5(A) Doctrine for Joint Airspace Control* (Brussels: NATO, 2006), 1-1.

[9] NATO, *ATP-40 (C) Doctrine for Airspace Control in Times of Crisis and War*, 2004), 2-2. "Airspace Control Means (ACM). Procedural measures that when established, reserve airspace for specific airspace users, restrict the action of airspace users, control the actions of specific airspace users, and/or require airspace users to accomplish specific actions. ACM can also be used to identify friendly or neutral users, to avoid the risk of being engaged by friendly AD weapons."

Airspace can no longer be the domain of any single service. Each component Army, Navy, Marines and Air Force now have multiple users of the airspace. Furthermore, actions in the airspace can have significant effect on the operations of each component. The joint nature of the airspace today suggests that the command, control and coordination of the airspace must be conducted on a joint basis. Although airspace primacy within an operation, or part of it, may be given to a single commander, that decision must be taken at the joint force level of command, based on recommendations from joint and component staffs, including airspace control specialists. In any joint environment, there will be pressures as each component operates in a slightly different manner.

> For example, for the Joint Force Air Component Commander (JFACC), the reach and pace of air operations require adherence to the fundamental principle of "Centralised Control and Decentralised Execution"; furthermore, his assets must be able to utilise, to the maximum extent, the available airspace throughout the JOA. In contrast, for the Joint Force Land Component Commander (JFLCC), the inherent friction of the land environment requires decentralised command and individual commanders' initiative ('mission command'); nevertheless, many land assets need rapid access to large volumes of airspace. In addition, maritime operations will be conducted both in deep water and in the littoral. Littoral operations will involve maritime units, using their specialised Anti-Air Warfare procedures, operating in an integrated manner within the JOA. Indeed, the Joint Force Maritime Component Commander (JFMCC) may be the Supported Commander for certain parts of the coalition operation.[10]

The coordination of the airspace affects all components. The differing approaches each component has towards warfighting must be fused into a common set of rules and procedures. This fusion reflects the true nature of the jointness of the airspace. The

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[10] ABCA and ASCC, *Quadripartite Advisory Publication - Coalition Airspace Control Manual*, 1st ed., Vol. 287, Primary Standardisation Office, Director, ABCA Armies, 2001), 4.

airspace in military operations is no longer the sole domain of military forces. Airspace is sovereign to a nation or in the case of the airspace around airports the airspace falls under the International Civil Aviation Organisation's (ICAO) regulations. There are now political, legal and commercial interests involved. This must be factored into any planning.

This chapter will address some of the key concepts and definitions involved in airspace coordination. This will assist in the understanding of some of the broader concepts of how the airspace is coordinated and some of the issues associated with airspace coordination.

2.2 - KEY CONCEPTS AND DEFINITIONS

Prior to discussing the challenges that are now present with airspace coordination, it is important to understand the old process for airspace C^3. Airspace coordination and the structure of the airspace for an operational theatre are defined by the following key documents:

a. The Airspace Control Plan (ACP). The ACP is a document that provides planning guidance and procedures for the airspace C3 within the area of operation. It lays out the structure and identifies responsibilities. The ACP is generally published prior to the commencement of operations and remains extant throughout the operational period.
b. The Air Tasking Order (ATO). The ATO lists the missions subordinate units are to execute during the given period. It represents the planned tasks of all air assets. The ATO is normally produced on a 24-hr cycle.

c. The Airspace Control Order (ACO). The ACO expands upon and implements the ACP. It provides the details of approved Airspace Control Measures (ACMs) listing the location, use and duration of volumes of airspace. The ACO normally follows the same 24-hr cycle as the ATO.[11]

Historically, during conventional military operations, missions were planned 72 hours ahead of schedule.[12] The missions were coordinated with the Air Operations Center (AOC) and included in the ATO. The ATO is published and disseminated 12 hours prior to implementation. The ACO is published to support the ATO and it details the ACMs in effect that the aircraft will use during their missions. By coordinating the ACMs with the identified air tasks, airspace coordinators provide procedural controls, which help to mitigate the risks of an air-incident or fratricide. The ACO accommodates and de-conflicts all airspaces users by allocating blocks of airspace, times and altitudes for use.

During Operation Iraqi Freedom, daily ACOs on average contained "over 1200 ACMs and was amended 12 times a day."[13] Air C3 is a complex activity, which must be effectively planned, coordinated, disseminated and executed in a timely manner. This very structured system has been slow to evolve and keep up with the flexibility and speed in which asymmetric operations take place. While the ACP as a document outlining the

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[11] *Ibid*, 7.

[12] Short notice missions, such as Combat Search and Rescue or strikes against time-sensitive targets can be planned, disseminated and executed within hours or minutes as exceptions.

[13] Moseley, Lt Gen Michael T., *Operation Iraqi Freedom - by the Numbers*, (Shaw Air Force Base: USCENTAF, 2003), http://www.globalsecurity.org/military/library/report/2003/uscentaf_oif_report_30apr2003.pdf (accessed 15 March 2010).

structure of the airspace remains sound the ATO and ACO process needs to me more nimble and flexible to respond to the new operating environment.

The process of airspace coordination is complex and must be adaptable to the new dynamic nature of asymmetric warfare. Airspace coordination has become increasingly complicated with the proliferation of guided munitions and airborne assets. Airspace coordination remains a largely manual process. Even after an ACO has been produced, the information must be disseminated in a timely manner to a wide array of organizations and coalition partners involved in or impacted by air operations. In almost all circumstances, interoperability between these organizations and coalition partners is extremely limited. The asymmetric battlefield poses a number of challenges for airspace coordinators that need to be addressed. The risk to both equipment and personnel, in the air and on the ground, may be adversely affected and the risk of fratricide is significant unless the coordination of the airspace is sufficiently evolved to address the new realities of the modern battlefield. One of the key measures to coordinate between the ground and air forces is the coordination level.

Defining the Third Dimensional Battlespace

When defining the battlespace there generally are six dimensions to be considered. These are Land, Sea, Air and Space, Electro Magnetic Spectrum (EMS), Computer Generated Space (cyberspace) and Time.[14] No one dimension should be considered in isolation and there must be a clear delineation of who is the controlling authority for each, to ensure effective coordination.

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[14] United Kingdom. Ministry of Defence, "Battlespace Management," in *Army Field Manual - Combined Arms Operations*, Vol. 1 (London: Ministry of Defence, 2007), 1-1.

Traditional dimensions include Air and Space, Land, Sea, and EMS; however, the intertwining of civilian and military operations along with recent theories such as Effects Based Operations (EBO) has fuelled a growing belief that local populations, the human dimension, also comprises part of the battlespace. Missions such as an air power show of force are specifically designed to influence populations; therefore, low flying aircraft can have significant impact. Local traditions and religions can also influence how the airspace is managed. "There is everything to be said in favour of doing what we can to understand the people whose minds comprise the battlespace in irregular warfare."[15]

Finally, altitude, an element of the third dimension, and time are considered dimensions. It should be noted that all of these factors could also be used as tools to help manage all other airspace dimensions. Airspace coordinators must consider all eight dimensions of the battlespace when controlling and coordinating the airspace.

Positive and Procedural Control Methods

As mentioned previously there are two primary methods of exerting control over the airspace: positive control and procedural control. Positive control is defined as "a method of airspace control that relies on positive identification, tracking, and direction of aircraft within airspace, conducted with electronic means by an agency having the authority and responsibility therein."[16] At the operational level, this can be achieved using Airborne Warning and Control System (AWACS) aircraft and ground-based radars. Procedural control is defined as "a method of airspace control which relies on a

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[15] Colin S. Gray, "Irregular Warfare: One Nature, Many Characters," *Strategic Studies Quarterly* 1, no. 2 (Winter 2007), 52.

[16] NATO, *AJP 3.3.5(A) Doctrine for Joint Airspace Control*, 3-2.

combination of previously agreed and promulgated orders and procedures."[17] The airspace control authority, through the ACP sets forth Airspace Control Measures (ACM), which define the procedural control measures. Table 2.1 outlines examples of positive and procedural of control.

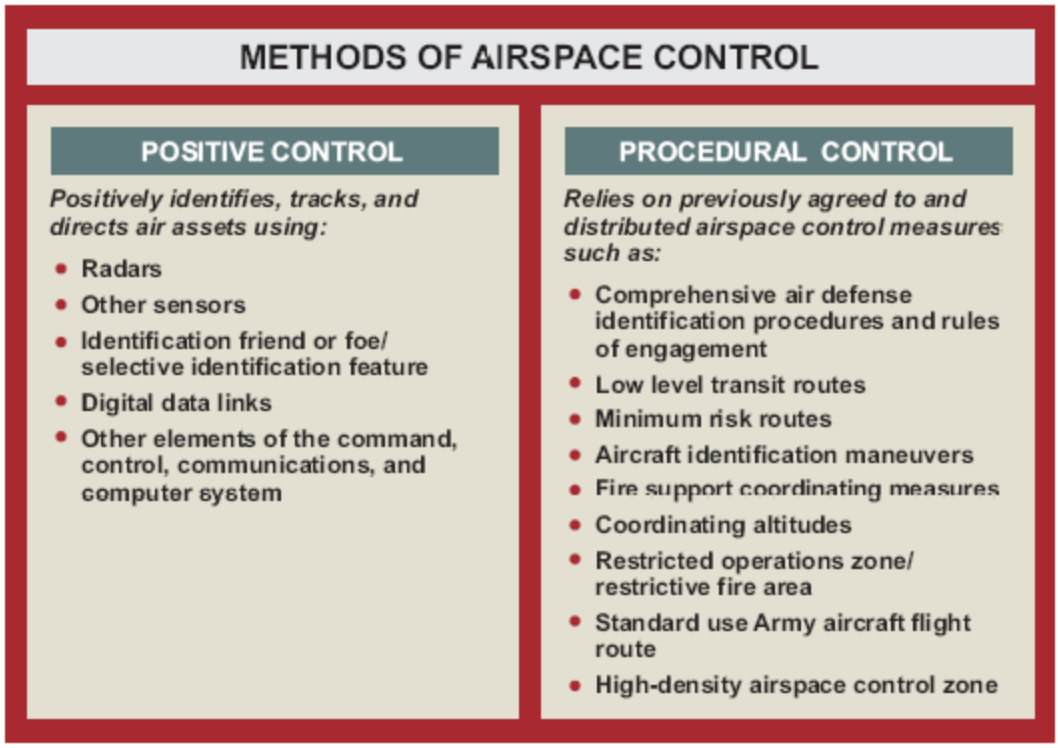

Table 2.1: Methods of Airspace Control.
Source: Office of the Secretary of Defense, Joint Publication 3-52, *Joint Doctrine for Airspace Control in the Combat Zone*, III-4.

Coordination Level

The coordination level is defined as "an advisory measure established to increase the aircrew awareness of conflicts between slow and fast moving air

[17] *Ibid*., 3-2

traffic at low level."[18] Above the coordination level is where most fixed winged assets can be found and the method of control is predominantly positive control. Below the coordination level is where many of the army airspace users reside. The method of control in this area is predominantly procedural.[19] For example in Afghanistan and Iraq, the coordination level is 3500 feet above ground level.[20]

The Air Force traditionally had the expertise in airspace management, but in general, it was only concerned with aircraft flying above 10,000 feet. The Army decided it needed to develop its own skills in airspace coordination because its aircraft typically flew at much lower altitudes and they usually interacted with troops engaged in combat. In fact, the introduction of Army UAVs has brought the discussion of the coordination level into focus. In response to a US Air Force position that all high and medium level UAVs should be under Air Force control for coordination reasons, US Army Aviation Director Brigadier-General Mundt stated, "The Army would give up some of its capability and platforms, depending on UAV use, above 3,500 feet. But no line in the sky determines a particular service competency."[21]

Doctrine is careful not to call the area below the coordination level, army airspace because the airspace environment is supposed to be a fluid flexible environment used to

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[18] *Ibid*., A-2

[19] United States of America. Joint Staff, *JP 3-52 Joint Doctrine for Airspace Control in the Combat Zone* (Washington: Joint Staff, 2004), III-4.

[20] Captain Lang Scott, "2 RCR BG ASCC February Report" (Report, Kandahar, 2007).

[21] Michael Fabey, "AF Leaders Push for Better UAV Coordination," *Aviation Week* (2007), https://aviationnow.com/aw/generic/story_generic.jsp?channel=aerospacedaily&id=news/uav032707.xml&headline=AF%20Leaders%20Push%20For%20Better%20UAV%20Coordination (accessed 6 February 2010).

effectively employ air assets. The argument above suggests that although the airspace may be seamless, the army's influence and desire to be the masters of the airspace below the coordination level is significant.

The airspace coordination system is made up of several parts. A basic understanding of the process, what defines the air battlespace, the control measures and their relation to the coordination level are all important to aid in the understanding of the larger issue of airspace coordination.

2.3 – REVIEW OF AIRSPACE DOCTRINE

Upon reviewing the current doctrine on airspace coordination, it was found that only three countries that have evolved their doctrine in any significant manner. The United States, the United Kingdom and to a lesser extent Canada have all issued updated documents on the subject. These changes have also been reflected in varying degrees in the organizations that the three countries are members of, namely NATO and ABCA.[22] It should be noted that all three countries have been major contributors to the wars in Afghanistan and Iraq and their lessons learned are starting to be reflected in their respective doctrines. Within each country however, there is a wide divergence on how each of their force components have updated their doctrine. In many cases, there has been an evolution in the doctrine to accommodate the significant changes to accommodate asymmetric operations. However, there remains a delta between what is published in the new manuals and what is currently occurring in the Afghanistan and Iraq theatres of operations. There is an abundance of professional papers and lessons learned

[22] ABCA stands for the American British, Canadian, Australian and New Zealand Program. Its aim is to ensure the interoperability of their military forces.

articles on the subject coming out of the respected theatres of operations. A quick review of the work completed by each of the countries will be discussed as well as the organizations listed. The review will not look into detail of some of the changes, as this will be addressed in the analysis in Chapter 5. Instead, the review will look at how pervasive the changes have been in each country.

NORTH ATLANTIC TREATY ORGANIZATION (NATO)

NATO's capstone document on airspace coordination is Allied Joint Publication 3.3.5(A), *Doctrine for Joint Airspace Control*. This publication updated in 2006 supersedes ATP 40(C), the previous tactical publication that was considered the bible of airspace coordination. This publication has gone a long way to capture the realities of airspace coordination in asymmetric operations. Some of the old terminology and airspace measures remain with no revision on what to do in an asymmetric battlefield. One such example is the Identification Friend or Foe switching line. This measure states:

> IFF Switch OFF and IFF Switch ON Lines are to be established and will be published in the ACO. All aircraft en-route to targets beyond the IFF Switch ON Line should stop squawk as they cross the IFF Switch OFF Line. Aircraft conducting operations between the IFF Switch On/Switch OFF Lines, or those returning to friendly territory after crossing the Switch ON Line, should squawk at all times.[23]

This measure is still required in case that conventional warfare is still fought. The policy however does not account for IFF in the case where defined enemy territory does not exist. Is IFF to remain on at all times? Are pilots only to turn off their IFF transponder just before attacking? There are several sections in AJP 3.3.5(A) that comes directly

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[23] NATO, *AJP 3.3.5(A) Doctrine for Joint Airspace Control*, A-3.

from the old doctrine (ATP 40 (C)) with no update to address the complexity of the asymmetric battlefield.

Other sections have been added to directly address the asymmetric battlefield. There is an entire new chapter addressing the integration of civilian air traffic services into the airspace control system. Although the chapter is only two pages in length, it is a good start to introduce the issue. For the first time in any publication, there is mention, albeit as a passing example, that planned artillery and mortar fire should have an airspace control means request made to reserve the airspace. There is no addition under the airspace control means chapter on what type of airspace should be requested for artillery or mortar fire. It should be noted that all fires currently executed in both Afghanistan and Iraq require airspace clearance before an engagement is authorized, even in troops in contact scenarios an airspace warning is delivered.

Other publications such as AJP 3.3.2 *Air Interdiction and Close Air Support*, issued in 2004, although incrementally better than previous versions have not been updated to the level of currency as AJP 3.3.5.

AMERICA, BRITISH, CANADIAN, AUSTRALIAN AND NEW ZEALAND ARMIES PROGRAM (ABCA)

ABCA has produced two key documents that address airspace coordination. The *Coalition Airspace Control Manual*, published in 2000 and *the Coalition Operation Handbook, Edition 4*, produced in 2008. The Manual was produced prior to the lessons learned from Iraq and Afghanistan; however, there are large sections in the manual dedicated to military operations other than war (MOOTW). This was the term coined

back in the 90's to peace support operations to include peacekeeping, peacemaking, peace enforcement and peace building.[24] Although not as up to date as the NATO AJP 3.3.5, this manual provides a better framework in some areas. For example, the section on IFF adds the following:

> An IFF regime will be required that is responsive to the various users' needs, particularly AD and de-conflicts IFF/SIF parameters with civil ATC. Platform IFF/SIF capabilities must be checked to ensure the ACP encompasses individual needs. Consideration should be given to establishing more than one procedure in theatre, separated by area, if this would allow more capable units greater freedom.[25]

Clearly, this expanded explanation on the implementation of an IFF procedure is more responsive to an asymmetric battlefield.

The Coalition Operation Handbook is written to cover all aspects of operations in very generic terms. The specific section in the handbook that deals with airspace coordination has been updated and now reflects the doctrine and procedures outlined in NATO's AJP 3.3.5.

CANADA

The coordination of the army airspace is conducted by the airspace coordination centres (ASCCs) in Canada. These organizations are manned by the Air Defence Artillery trade. In Canada, this trade is very small and specialized. Due to the small nature of the trade the issues of airspace coordination is not well understood in the Canadian Forces. The only doctrine manual that covers airspace coordination is B-GL-

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[24] Hugh Segal, *Geopolitical Integrity* (Montreal: Institute for research on Public Policy, 2005), 275.

[25] ABCA and ASCC, *Quadripartite Advisory Publication - Coalition Airspace Control Manual*, 32.

372-001/FP-001 *Air Defence Artillery Doctrine,* which was published in 1999. One chapter of twelve pages covers airspace coordination. In fact, the chapter cites NATO's ATP 40 (B) a NATO publication that was superseded by ATP 40 (C) that in turn was superseded by AJP 3.3.5.

The Canadian capstone document B-GJ-005-300/FP-000, *Canadian Forces Operations,* was updated in late 2005. It has one chapter dedicated to airspace coordination. The chapter reflects nearly word for word the first three chapters of NATO's AJP 3.3.5. These chapters cover the broad introduction of the airspace control system, broad concepts of airspace coordination and the general operation of the airspace control system. What Canadian doctrine is lacking is a document covering the details of how to execute the airspace control system and the integration with the civilian airspace with the airspace control plan.

THE UNITED KINGDOM (UK)

UK doctrine on airspace coordination in centred on three documents all published in 2007-2008. Joint Doctrine publication 3-70, *Battlespace Management,* is a strategic level document that discusses airspace coordination as a part of the over all battlespace. This document focuses on the entire battlespace, all components and all environments. The second document Joint Force operating Procedure 2-06, *Joint Battlespace Management,* is an operational level document that discusses airspace coordination as a key part of the different components battlespace. This document discusses host nation integration into the battlespace and specifically addresses the operational issues of

integrating the airspace of the different components through the implementation of an airspace control plan.

The third document the Army Field Manual, Volume 1, *Combined Arms Operations Battlespace Management* is a tactical level document that details the specific coordination of army airspace. This document has included many of the new procedures and concepts that have been trialed or are in place in theatres like Afghanistan and Iraq. The British have been very efficient at updating their doctrine and other publications from lessons learned on their operations. Concepts such as the kill box for coordinating artillery and fixed wing aircraft are detailed in these manuals. Innovative concepts such as the addition of a third control method "dynamic procedural" are worthy of attention.[26]

The British have drafted a complete set of documents encompassing all element of battlespace management. These documents cover the larger integration of the whole battlespace and not just the airspace. The publications are topical and they have introduced many of the concepts being tried in their current theatres of operation. However, by moving so quickly to include new policies and procedures developed in Afghanistan and Iraq, some parts of their publications are potentially flawed as operators have found that some of their tactics and techniques they have put in place were flawed and have been discarded.

UNITED STATES

The US has embarked on a revision of all of their doctrine and TTP manuals. "To renew its capability at counterinsurgency, the military is assessing 21st century

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[26] United Kingdom. Ministry of Defence, *Battlespace Management,* 2-7.

insurgency, particularly in Iraq and Afghanistan, and revising its strategy, operational concepts, organization, and doctrine."[27] Six main publications discuss airspace coordination in the United States. The key document, JP 3-52, *Joint Doctrine for Airspace Control in the Combat Zone*, published in 2004, is a tactical/operational level document outlining the detailed mechanics of airspace coordination. The publication is slightly dated, as it does not include any of the information contained in the NATO AJP 3.3.5. The document is not forward thinking like the UK's tactical publication, as it remains relatively focused on cold war conventional doctrine and tactics. There has been some discussion on the integration of UAVs as well there is very general direction on integration the airspace in operations other than war. There has been little integration of lessons learned from either Afghanistan or Iraq.

JP 3-0, *Joint Operations*, published in 2008, gives an updated view of airspace coordination from the joint operational perspective. Although not all encompassing as the UK's publication, this document does cover the operational level considerations for airspace coordination and is generally up-to-date for the time it was published. The second joint document from the United States is JP 3-09.3, *Joint Tactics, Techniques, and Procedures for Close Air Support*, published on 2003. This publication specifically discusses the use of CAS and its integration into the airspace. This tactical level document explains in detail the coordination of CAS with other arms of the Army. It remains focused on conventional warfare with little mention of new procedures or the asymmetric battlefield. Although still useful as the specific coordination of an attack will

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[27] Steven Metz Dr and Raymond Millen, *Insurgency and Counterinsurgency in the 21st Century: Reconceptualising Threat and Response* (Carlisle: Strategic Studies Institute, 2004), 2, http://www.strategicstudiesinstitute.army.mil/pubs/display.cfm?pubID=586 (accessed 4 April 2010).

remain relatively similar when coordinated by a Forward Air Controller (FAC), this document provides little on how to integrate CAS on the asymmetric battlefield.

The fourth document is the Marine Corps, MCDP 1-0, *Marine Corp Operations,* this is a tactical level publication issues in 2000. Although this document is somewhat dated in its airspace coordination chapter, it has the most complete directives on how to conduct airspace coordination in littoral operations. The section on naval gunfire coordination requires significant updates to bring it in line with current policies on fires coordination in the airspace. The final two documents on airspace coordination come from the US Air Force. AFDD 2-1.3, *Counterland Operations,* was published in 2006 and AFDD 2-1.7, *Airspace Control in the Combat Zone,* which was issued in 2005. AFDD 2-1.7 is simply an updated air force centric version of JP 3-52, *Joint Doctrine for Airspace Control in the Combat Zone*. *Counterland Operations,* although an operational level air force document, specific for air interdiction and CAS operations, it provides an updated version of airspace coordination to include concepts for contingency operations. Lessons learned and tactics and techniques from Afghanistan and Iraq have been incorporated.

It should come as no surprise that the three countries that have evolved their doctrine in any significant manner are all currently involved in asymmetric theatres of operation. There is a wide divergence on how each has updated their doctrine. In many cases, there has been an evolution in the doctrine to accommodate the significant changes presented by the asymmetric battlefield. However as stated, there remains a delta between what is published in the new manuals and what is currently occurring in the

Afghanistan and Iraq theatres of operations. Therefore, evolution of airspace doctrine needs to continue.

2.4 – AIRSPACE DOCTRINE DURING CONVENTIONAL OPERATIONS

Historically conventional warfare could be defined as a 180-degree, bi-directional fight within a linear battlefield, a forward line of own troops, and with defined rear, close, and deep battlefield areas. Aircraft and weapon systems "generally flew or fired from the rear to the front with little lateral movement or firing required."[28] All airframes were flown by trained pilots. UAVs were rare, generally high level and were operated by specifically trained pilots. These pilots were trained in airspace coordination issues and the potential impact their actions could have on other airspace users. Outside of the army, very few organizations used army airspace, simplifying coordination by allowing the airspace user to communicate with those directly on the ground. The coordinating altitude in general separated the army airspace users from those of the air force. In essence, they were separated by altitude and there was rarely a reason to enter the airspace of another component. Fixed wing aircraft were rarely required to fly below the coordination level while rotary wing aircraft generally rarely flew above. Very short-range and short-ranged air defence systems used visual engagement rules or air defended areas, that when coupled with static airspace coordinating measures and identification, friend or foe (IFF), mitigated the risk of fratricide. Enemy use of the airspace was generally higher altitude fast movers or deliberate aviation incursions. Theatre-level air

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[28] United States of America. Department of the Army, *TRADOC 525-7-3 the US Army Concept Capability Plan for Airspace Command and Control for the Future Modular Force 2015-2024* (Fort Monroe, Virginia: Director Army Capabilities, 2009), 15.

defence systems would detect and identify enemy threats at extended ranges. Once identified, this would negate coordination issues with low altitude airspace users as they would be tracked and engaged. Generally, from the onset of military actions, only military aircraft flew in the battlespace. Civilian aircraft would simply avoid or be restricted from operating in the combat area. Artillery and mortars generally fired in the same direction as the flow of air traffic providing for lateral separation with aircraft. Simply put the flow of air traffic was towards the FEBA.

The airspace structure had evolved over many years during the cold war conventional battlefield. High-level airspace above the coordination altitude was coordinated by the air force. Radars and dependable communications allowed the air force to retain positive control over the airspace. Below the coordination level, the airspace was much harder to coordinate. Radar pictures were dependant on ground clutter and communication was less robust. This airspace was under positive control where possible but generally, it was under procedural control. Helicopters were the predominant user of this airspace, slow movers as described by the air force, and visual flight rules dominated the airspace coordination protocols. In the rear area of the battlefield, routes and corridors were established in the airspace for administrative movement of aircraft. As aircraft flew towards the front lines of the battlefield aircraft tended to travel in the direction of the front line and the enemy. Lateral movement across the front of the battlefield generally did not happen. When there were complex operations with multiple airspace users in a small area, specific coordination measures were put into effect. Once aircraft passed into enemy territory, there were limited airspace coordination measures and restrictions of aircraft movement. The rationale was

the pilot needed to fly where required to hit their target and avoid enemy fire. Only in rare circumstances were aircraft allowed to release munitions over friendly area. When this was done, it was planned in detail and under the positive control of an air controller. There was no risk to troops training in the rear nor was there risk of fratricide. Civilian traffic was generally restricted from operating in war zones. On the friendly side of the battlefield, the airspace was well structured. Positive control and detailed planning was exercised when aircraft fired in close proximity to friendly troops near the front lines and aircraft were generally free to fly and fire over enemy territory. Missions on the enemy side were less structured and there were minimum restrictions on weapon release in enemy territory once targeting was determined. Simply put, coordination was relatively easy on the conventional battlefield. Figure 2.1 is a simplistic diagram depicting the linear nature of the conventional battlefield.

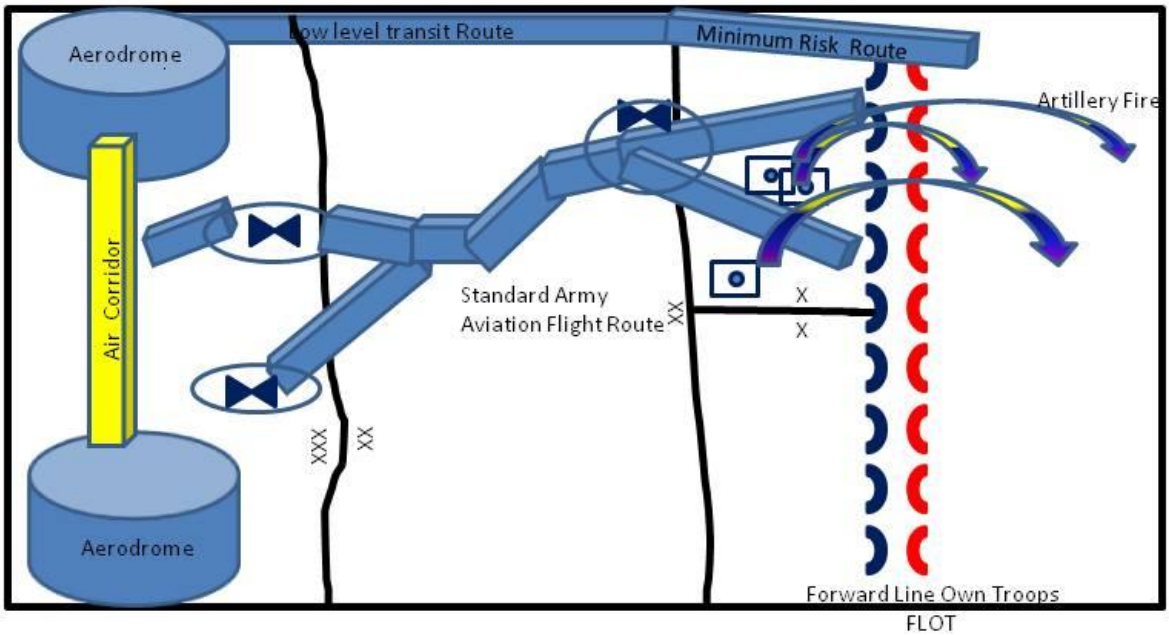

Figure 2.1: Airspace Control Measures – Cold War.

2.5 - SUMMARY

Airspace control doctrine has developed incrementally since the inception of aircraft during the First World War. The evolution of aircraft and artillery during that period only necessitated incremental changes in airspace doctrine. The nature of warfare with enemy lines and friendly lines drove the airspace system to be well structured, civilian like in the rear and single direction focused as they approached the front lines. The doctrine was thoroughly analysed and detailed to suit that method of warfare. However, the nature of warfare has changed. Enemy and friendly territory has been replaced by a mixed enemy/friendly quasi-civilian environment. UAVs have proliferated across the battlefield and trusted methods for pilots such as see and avoid became less dependable. Airspace coordination has changed and become more complicated. It needs to be reassessed in the context of an asymmetric battlefield.

CHAPTER 3

METHODOLOGY

3.1 – INTRODUCTION

The transition to an asymmetric battlefield with no defined enemy or friendly territory has had significant impact on the C^3 of the airspace. Incidences such as Tarnak Farms highlighted early that the airspace control environment had significantly changed and a new way forward needed to be developed. Doctrine and tactics, techniques and procedures have been slow to evolve. The reality is with deployments in Iraq and Afghanistan Western forces are learning and developing the way forward in real life. The battlefield has become the environment where new policies are being trialed and lessons learned out of necessity, are being developed.

In order to facilitate discussion and analysis on the subject of command, control and coordination of the army airspace this paper will focus on those elements that have emerged as the primary users of the army. Traditionally these army airspace users were fixed winged aircraft, rotary winged aircraft, field artillery, and the users of the electromagnetic spectrum. Since the Cold War, there has also emerged a group of users that, although may have used the airspace in the past, were not considered major users of the airspace. These new primary users of the airspace include UAVs, civilian aircraft and explosive ordnance disposal teams (EOD). Finally, recent experience has shown that friendly bases and ranges and civilian airspace have an impact on the contemporary operational environment and must be considered to fully appreciate and understand their influence on the command, control and coordination of the army airspace after the cold war. In essence, the army airspace has gone from four major users of the airspace in

conventional operations to nine primary users of the airspace in the asymmetric battlefield. This Chapter consider each of these nine users.

3.2 – INTRODUCTION OF THE RESEARCH METHODOLOGY

Each of these nine users will be analysed individually. Specific analysis will be conducted on a coordination issue for each of the users, which is representative of the major problems emerging within the field of airspace coordination for the user. The methodology of this paper will be a comparative analysis of the old and new doctrine for each of the identified nine users. Shortfall for both old and new doctrine will be discussed and lessons learned or emerging practical theories will be presented and analysed to determine if they address current doctrinal shortfalls. Finally, recommendations on future work or the future direction of the doctrine will be proposed.

3.3 – HOW THE METHODOLOGY WILL BE APPLIED

By employing a comparative doctrinal framework for the analysis of the old doctrine in relation to the asymmetric battlefield, shortfalls, such as the airspace coordination of artillery fire, can be identified. Analysing the identified shortfalls against new doctrine and TTPs will give insight if the new doctrine has effectively addressed the problems posed to airspace coordination within the asymmetric battlespace. Iraq and Afghanistan have provided an outstanding opportunity to test the new doctrine and TTPs. Studying the lessons learned and emerging theories from these theatres of operations will allow for an objective analysis of the status of the new doctrine and TTPs.

3.4 - SUMMARY

The following chapter will explore some of the unique problems the asymmetric battlefield has caused in recent years for each of the identified nine airspace users. The aim of the chapter is to help identify the problem domain. The problems posed by the asymmetric battlefield are complex and not always evident. Using examples taken from real life experiences on exercise or operations some of the new problems posed by the asymmetric battlespace will be described in practical terms. By describing some of the complexities of the airspace, it will help to provide insight into the complexities that will be analysed in this paper.

CHAPTER 4

DEFINING THE PROBLEM:

PRACTICAL PROBLEMS FROM OPERATIONS

4.1 – INTRODUCTION

This chapter is designed to give the reader an appreciation of some of the common, unforeseen difficulties asymmetric operations can cause to the coordination of the army airspace. In order to better comprehend the complexity and interrelationship of the different users of the army airspace, a practical discussion is needed with specific examples in order to help recognize some of the unique issues posed by the command, control and coordination of the various assets. As outlined earlier in this paper the discussion will focus on each of the nine major airspace users.

These examples will help clarify in practical terms some of the many issues and problems with the command, control and coordination of the army airspace post cold war. These examples taken from current missions will help to identify and highlight shortfalls of the old doctrine. Although no solutions will be offered, the goal of this chapter is to illustrate the problem domain in terms that are easily understood. It will then lead into the discussion in follow on chapter that will dissect the doctrine, analyse new doctrine adopted and lessons learned that have been adopted in the field. These examples have been taken from operational reports, lessons learned articles, interviews and personal experience while deployed in the Kabul Multinational Brigade Airspace Coordination Centre. Many have been sanitised for operational security reasons.

4.2 – DETAILED DESCRIPTION OF THE PROBLEMS

Fixed Wing Aircraft

Many believe fixed winged assets only affect the army airspace when they physically enter the low-level airspace. Many forget however, that aircraft even at high levels can have an effect on the ground forces and the low-level airspace. Even at altitudes above the coordination altitude, the coordination of fixed winged aircraft must be considered.

During the Loya Jirga of 2003, where the Afghans were deciding on the future constitution of their country there was an incident that highlighted the requirement for coordination of fixed winged aircraft.[29] Although the aircraft did not penetrate the army airspace, their actions had a direct effect on the operations of the ground forces. In asymmetric operations, it is possible and likely to have several missions and forces working in the same battlespace. In this example Operation Enduring Freedom, Afghanistan (OEF-A) was still executing the war on terror in southern Afghanistan in the Kandahar region. At the same time, the International Security Assistance Force (ISAF) under NATO was conducting peace enforcement operations in the city of Kabul. ISAF was in the midst of a large security operation to protect the Afghan Loya Jirga.[30] The security consisted of an inner and outer ground cordon as well as a no fly zone over the site of the Loya Jirga. NATO was responsible for the security of the meeting and President Karzai. OEF-A was responsible for executing the war on terror in the rest of Afghanistan.

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[29] NATO, "Constitutional Loya Jirga begins in Afghanistan," NATO, http://www.nato.int/docu/update/2003/12-december/e1217a.htm (accessed 10 March 2010).

[30] *Ibid*.

The city of Kabul was a volatile city and the NATO forces were frequently attacked by remotely launched rockets and IEDs during this period. NATO forces were on high alert during the conduct of the Loya Jirga. On the first evening of the Loya Jirga the ground forces thought the city had come under attack from several rockets as streak of light were seen in the skies above Kabul. Special Forces were put on high alert to move President Karzai to safety and forces were waiting for reports of impacts across the city. The situation was tense and the ground troops were preparing to mobilize. However, it was identified by the airspace coordinators that it was aircraft flares and not rockets over the city. Evidently, the Commander of OEF-A ordered a show of force over the city. All transiting OEF-A aircraft were to deploy flares over the city as a show of force by the US air force. Once this was discovered, the ISAF ground troop stood down. Although this show of force display became very successful during later parts of the mission in Afghanistan, the first time it was implemented it had a significant negative impact on friendly ground troops. [31]

Since the cold war, terms like the three-block war have been used to describe a situation where a military force "may be required to conduct full scale military action, peacekeeping operations and humanitarian aid within the space of three contiguous city blocks."[32] These types of differing operations all within the same geographical area can cause significant coordination issues not only between the three blocks but in the third dimension as well. This example highlights the reality that the coordination of fixed

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[31] Joseph A. Katz, "Afghanistan: The Role of "show-of-Presence" Aircraft in the First Democratic Elections," *FA Journal* (Jan/Feb, 2005), 1, http://proquest.umi.com/pqdweb?did=1301197581&Fmt=7&clientId=1711&RQT=309&VName=PQD.

[32] Gen Krulak Charles C., "The Strategic Corporal: Leadership in the Three Block War," *Marines Magazine*, no. January (1999), http://www.au.af.mil/au/awc/awcgate/usmc/strategic_corporal.htm (accessed 12 February 2010).

wing aircraft is more complex than just ensuring aircraft are under positive control when they operates below the coordinating altitude.

Rotary Wing Aircraft

Helicopters have always worked in the army airspace. In many militaries, helicopter assets belong to the army so it would be expected that their integration would be well coordinated with other army assets. Historically, helicopter movement in the rear was administrative and nature and did not conflict with combat operations. As helicopters moved toward the combat zone, they were more closely coordinated. On the asymmetric battlefield, all aviation traffic must be closely coordinated. The minute helicopters leave their base they are potentially in enemy territory and a combat zone. If helicopters use the same routes all the time and are predictable, they are susceptible to enemy fire. This is why helicopter pilots prefer to have a great deal of latitude in their flight planning both in altitude and laterally.

In 2007, there were several instances where helicopters crossed different areas of operation (AO) without coordination. The Canadians had established and maintained voice communications with the majority of air assets operating in their AO. The intelligence, surveillance and target acquisition coordination centre (ISTAR CC) had communications with all the UAVs. The Fire Support Coordination Centre (FSCC) had communications with the artillery, and the Tactical Air Control Party (TACP) had communications with all the fixed winged air assets. The airspace coordination centre (ASCC) had direct communications with all the other coordination centres. The aviation assets remained the one airspace user without reliable communications. There was an

aviation officer working in the headquarters, but his sole purpose was to coordinate aviation airlift for the battle group. Occasionally they would have real-time contact with aviation assets through a chat window over the internet but this was not reliable. This lack of communications with the aviation assets impeded their efficient coordination. However, a lack of communication with mobile low flying assets is still a reality even with today's technology.

During one incident in particular, a medevac helicopter was dispatched to the South of the Canadian AO. It was escorted by two Blackhawk helicopters. As per standard procedures, the pilots checked in prior to departure with the ASCC to clear a route to the site. The mission was cleared and the helicopters departed on schedule. Around the same time, further North in the Canadian AO, Canadian soldiers came under attack from insurgents. UAV support (SPERWER) was immediately redirected to cover the area and provide real time situational awareness to the troops under fire. The attack was relatively minor and the troops were in the midst of destroying the enemy. The UAV pilot, who was in the main camp, was concentrating on the video feed he was receiving from the UAV. The Commander in the headquarters was also receiving the real time feed from the UAV. Suddenly, the UAV screen was filled with rotor blades as one of the Blackhawks made an unannounced and unexpected foray in to our Airspace to see if they could be of assistance. People immediately began to panic as they thought a mid air collision between the UAV and Blackhawk was imminent. Luckily there was at least a few hundred feet of separation between the two aircraft, however people were stunned to see the Helicopter so close to the UAV. If it were not for the fact that the UAV was

above its usual flight altitude due to weather, a mid air collision might well have happened.[33]

In asymmetric operations, every flight must be treated as if it could have potential life and death impact on operations. This example highlights that there is no such thing as simply diverting a flight without coordination. The requirements for coordination and pilot awareness are critical in the complex environment.

UAVs

UAVs have been a huge combat multiplier to friendly forces in recent years. They give our forces a technical advantage over our enemies. They give us a level of situational awareness that is unprecedented. A company commander can launch a mini UAV in an instant to see over the next hill or over a wall to see what is in the next compound. At the tactical level, UAVs can provide observation in areas that are unsafe for ground troops and one tactical UAV can cover the area that would have taken a brigade worth of assets in the old days. As these assets proliferate, ground troops have become dependant on the instant information these UAVs can give them. [34] Troops want the instant information UAVs can give them and this necessitates the launching of numerous unplanned or emergency UAV missions. These types of missions cause significant challenges when trying to coordinate their integration into a busy airspace and represent one of the greatest challenges facing airspace coordination.

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[33] Captain Lang Scott, The Blackhawk Helicopter Airspace Incident, 6 April 2010.

[34] ABCA and ASCC, *Quadripartite Advisory Publication - Coalition Airspace Control Manual*, 6.

The proliferation of UAVs in recent years, specifically within tactical level units and sub-units, has caused a dramatic increase in the risk to air operations. In Afghanistan, “an Airbus 300 airliner with 100 personnel on board came within 170 feet of a German EMT Luna tactical UAV”,[35] while in Iraq “reports have indicated that helicopters have been struck by UAVs”.[36] Though UAVs are unmanned, their coordination is one of the easiest in theatre because of the use of Liaison Officers, and direct voice communications with the pilots. Many feel, incorrectly, that UAVs are a huge burden to airspace coordination.

UAVs provide our forces significant advantage. The real time nature of the information they provide push commanders at all levels to demand immediate and unplanned missions. These missions present significant challenges to airspace coordination as the system is dependant on detailed planning and procedural control measures particularly in the army airspace. These examples highlight that with the proliferation of UAVs are significantly straining the airspace coordination system as it tries to evolve to accommodate this new technology and employment tactics. The integration of UAVs particularly at the low level represents one of the greatest safety concerns facing the use of the airspace.[37]

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[35] Peter La Franchi, "Animation: Near Misses between UAVs and Airliners Prompt NATO Low-Level Rules Review," *Flight International*, no. March (2006), http://www.flightglobal.com/articles/2006/03/14/205379/animation-near-misses-between-uavs-and-airliners-prompt-nato-low-level-rules.html (accessed 25 March 2010).

[36] Sandra I. Erwin, "Controlling Iraq's Crowded Airspace no Easy Task," *National Defense* 90, no. 625 (Dec, 2005), 20, http://proquest.umi.com/pqdweb?did=969142231&Fmt=7&clientId=1711&RQT=309&VName=PQD.

[37] Captain Linda Shrum, "Lessons Not Learned - Tactical Airspace Operations in Afghanistan," *The Bulletin* 11, no. 8 (2005), 6.

Field Artillery

One of the difficulties for artillery in asymmetric operations is to decide which direction the guns should face for their centre of arc. Historically the enemy was in one general direction. The guns would face toward the enemy and with a small correction for azimuth and elevation; the gun could be fired quickly. To reposition the gun to face another direction can be time consuming and delay the firing of the guns. Generally, the guns have been positioned daily based on intelligence reports on enemy most likely positions. However, in asymmetric ops this may only be a best guess. The issue of the direction of the guns is also key consideration for helicopters. To ensure the safety of the helicopter, airspace coordination would have the helicopter routed to the rear of the gun position avoiding the flight path of the rounds. The nature of asymmetric operations may cause the guns to significantly change their direction of fire.

A practical example of this occurred one evening in Kabul. One of the military units was doing administrative flights from their camp to the main airfield. Their flight path took them past the east side of the Canadian camp. They were aware that there were two Canadian howitzers recently deployed on the camp; however, they believed they were deployed facing North West. The guns had been brought to the camp to conduct counter battery operations in response to earlier rocket attacks. At the same time as these flights were, flying near the camp a call for fire came in for the guns to support troops in contact. The contact was southeast of the camp. The troops had called for an immediate illumination mission. Unfortunately, as the guns were about to fire they heard the sound of helicopters in front of their position. Due to the dark, they could not positively identify the location of the helicopters and there was no means to contact the helicopters

from the gun position. The guns were not allowed to fire if they could not positively identify the location of a potential aircraft forward of their firing position. The guns fire was delayed for a few minutes and fortunately, for the mission it was not critical. However, the delay of guns firing in support of operations could have had a critical impact on the lives of our soldiers.

This incident highlights the fact that the airspace must remain flexible for emergency operations. The ability to reroute flight paths or calculate firing data to ensure flight paths are avoided is critical. It also highlights the difficulties of airspace coordination in and around gun positions.

EXPLOSIVE ORDINANCE DISPOSAL (EOD)

EOD historically was not something that airspace coordinators considered an airspace user, "but when a plum of phosphorus reaches to 1000ft, it becomes a real issue to low fliers."[38] EOD either happened on friendly rangers in the rear or in enemy territory. When the engineers would crater a road in friendly territory, it would be considered a deliberate operation and a review of old doctrine makes no mention of ever reserving airspace specifically for EOD operations. In asymmetric operations, engineers are continually working on de-mining tasks or destroying enemy weapons caches. Much of this work is done in place due to the risk of booby traps.

The coordination of EOD, particularly when they are destroying improvised explosive devices (IEDs) or weapons caches is rarely planned. They are last minute missions that require the airspace to be flexible and reactive to their needs.

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[38] Major Notaro Michael, "Airspace Coordination in Afghanistan," *The Bulletin* 10, no. 6 (2004), 7.

Unfortunately, it is not always possible for the engineers to move their target to a safe site or EOD range. An example of the type of issue that can occur in asymmetric operations occurred in early October 2003. The Canadian battle group had been doing operations in a mountainous region southwest of Kabul. The battle group uncovered a very large weapons cache in a cave complex. The cache was so large the EOD teams were called in to destroy the cache on site. The only problem was the site was directly underneath standard-use army aircraft flight route (SAAFR). The Americans were doing a large operation that day to the south of Kabul and the SAAFR was in use. The Americans were allocated the airspace for the SAAFR from surface to 300feet and they were unwilling to allow the EOD permission to blow the enemy weapons cache. The Americans did not have real time situational awareness and did not know the exact location of their helicopters in the SAAFR. There was a danger to the Canadian troops as they were susceptible to an enemy attack as they had just found and were about to destroy a major enemy weapons cache. After 30 minutes of trying to get approval for the use of the airspace and the EOD team seeing no American helicopters in the SAAFR, the Canadian airspace coordination cell (ASCC) ordered the EOD to destroy the weapons cache. They were ordered to put out air observation posts (OPs) to ensure no helicopters were near the EOD site and the American were simply given a warning the EOD was going to destroy the cache at a specific time. The EOD explosion occurred without incident.

This example highlights the fact that the airspace coordination measures must be flexible and able to accommodate unplanned events. It also highlighted that in spite of a

detailed procedural system in place, common sense and simple solutions such as posting air observation posts, in the end, can provide the best solution.

Civilian Aircraft

When airspace becomes too dangerous for civilian aviation, the International Civilian Aviation Organization (ICAO) will close the airspace to civilian traffic. Such was the case for Afghanistan in 2001. However, once the heavy fighting ended and the transitional government of President Karzai was installed, the airspace was reopened. It was a practical and commercial decision, over flight fees are an important and lucrative revenue stream for the government.[39] The existence of civilian airspace over the ISAF mission complicated the airspace.

Civilian airliners transiting Afghanistan travel differing flight levels. The map at Figure 4.1 shows the flight levels around Kabul to be FL140 to FL 290, approximately 14000 to 29000 feet above sea level. It should be noted that the city of Kabul is already at roughly 6000ft above seal level.[40] This means that transiting civilian airlines could be travelling between 8000 and 23000 above ground level.

Due to the fact the artillery may be firing into areas that potentially may have civilians in them, gunners must ensure the fall of shot of their rounds are completely safe. One way to minimize the risk is to fire round at high angle. When this is done the impact of the round, and its ricochet (the footprint), tends to be much smaller than if they fire

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[39] International Civil Aviation Organization, *ICAO and Afghanistan Sign Agreement for Rebuilding of Kabul Airport* (Montreal: International Civil Aviation Organization,[2002]), http://www.icao.int/icao/en/nr/2002/pio200207_e.pdf (accessed 2 April 2010).

[40] World Atlas, "Afghanistan Facts and Figures," http://www.worldatlas.com/webimage/countrys/asia/af.htm#facts (accessed 2 February 2010).

rounds at lower angles. At lower angles, the "footprint" of the impact tends to be larger and oblong. This desire to ensure safety on the ground means that rounds are fired much higher in the air. The max ordinance of the M777, the artillery pieces the Canadians use, can reach altitudes between 35000 and 65000 feet above ground level.[41] This means the rounds easily reach the altitude that civilian aircraft are travelling.

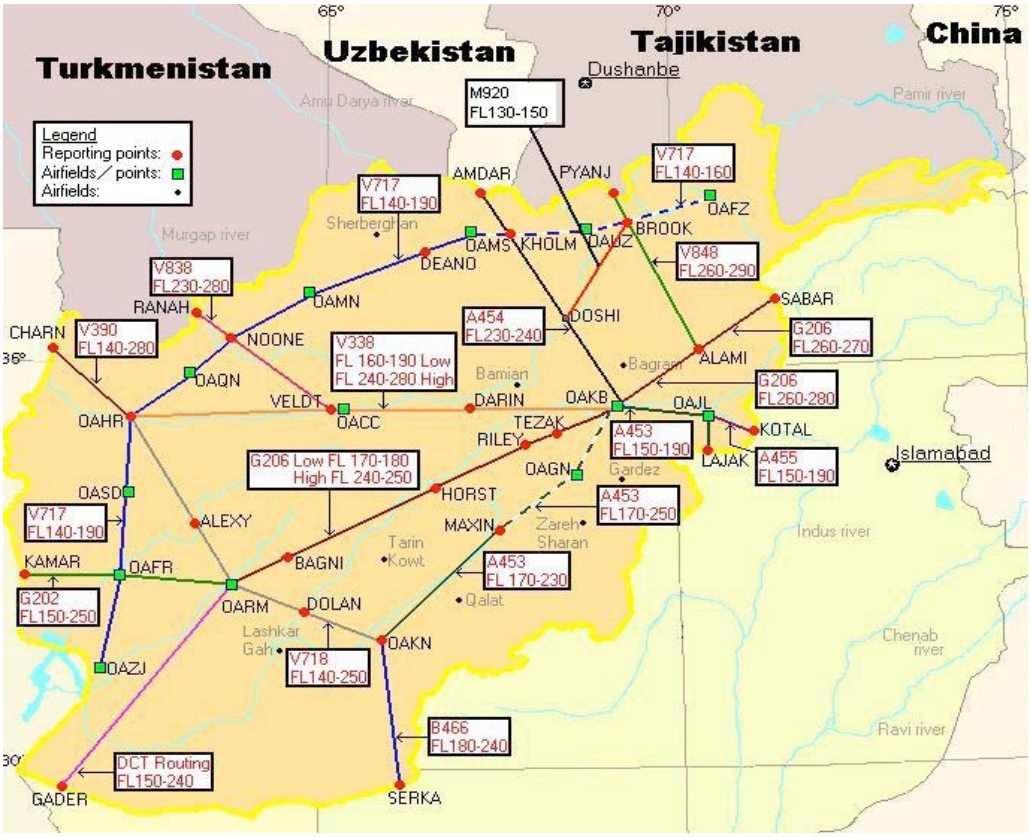

Figure 4.1: Afghanistan Low-level en Route Chart.
Source: Republic of Afghanistan, *Aeronautical Information Publication (AIP)*, 72.[42]

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[41] Canada. Department of National Defence, *C-71-777-000/56-001 Abridged M777 Firing Tables* (Kingston: DND Canada, 2008), 63.

[42] Republic of Afghanistan, "Republic of Afghanistan Aeronautical Information Publication (AIP)," Ministry of Transportation, http://ramcc.dtic.mil/afghan_AIP_12May05.pdf (accessed 2 April 2010).

Although not always obvious, ground operation can have an impact on not only the low-level airspace but higher-level airspace as well. The theory of a little bullet in the big sky, implying minimal risk, is insufficient when dealing with civilian aircraft. This incident exemplifies the issues that can arise when civilian airspace is inserted into a zone where military operations are occurring.

Civilian Airspace

For military operations, particularly asymmetric battlefields like those in Afghanistan the airfield is the vital aerial port of debarkation (APOD), and acts as an ever expanding base of operations. The airfield is a key Centre of Gravity for coalition forces, while at the same time, these airfields remain important transport nodes for the host nation country and the option to close the airfield down for strictly military use is not always viable. For an airfield to be able to operate and accept civilian airliners, it must follow the rules of the ICAO. These rules and regulations lay out common standards for civilian flight. For example, if UAVs were operating within the Class D airspace of the Kabul Afghanistan International Airport (KAIA) a Notice to Airmen was required.[43]

When ISAF wanted to fly their LUNA UAVs in the vicinity of the airfield, they needed to plan the mission 48 hours before the mission. They needed to submit an Airspace Control Measure Request on the military side and a NOTAM on the civilian

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[43]International Civil Aviation Organization, *ECCAIRS 4.2.6 Data Definition Standard* (Montreal: International Civil Aviation Organization, 2006), http://www.icao.int/anb/aig/Taxonomy/R4LDAttributesvaluesbyattributeid.pdf (accessed 2 April 2010). ICAO defines Class D airspace where operations may be conducted under instrument flight rules, visual flight rules, or special visual flight rules. Flights are subject to air traffic control clearance. Aircraft flying using IFR and SVFR are kept separated from one another, and are given traffic information on VFR flights. Flights flying using VFR are given traffic information on all other flights. It is for smaller airports with a control tower. A NOTAM is filed with an aviation authority to alert pilots of any hazards en route or at a specific location.

side. Although operational security on the time and location of the UAV flight could be assured on the military side, it was not the case on the civilian side. All NOTAMs need to be filed 48 hours in advanced to the ICAO regional office in Singapore. Once approved the NOTAM with the exact location and time for the UAV flight would be posted on the World Wide Web for all to see. The enemy could virtually look on the ICAO web site to determine when and where the UAV would fly. Unplanned missions were not allowed near the airfield since a NOTAM could not be issued in short notice.

The rules and regulations limited the use and effectiveness of ISAF's UAV when operating near the airfield, an airfield whose airspace covered 80% of ISAF's area of operations. Unplanned missions were not approved by the ATCs and all approved mission were posted on the World Wide Web for all to see. The integration of civilian airspace with military airspace can pose some unique problems for a military force on the modern battlefield.

ELECTRO-MAGNETIC SPECTRUM (EMS)

When discussing the electromagnetic spectrum it is usually assumed that the signals trade is responsible for the management of frequencies. This is true for the most part but in asymmetric operations with no enemy territory defined, friendly forces will always be conducting jamming missions in and amongst friendly forces. If left uncoordinated this could have serious impacts on friendly operations. A practical example of this occurred in Afghanistan.

Communication had been lost two nights in a row between the Canadian camp, Camp Julien, in the south west of Kabul and the Kabul Multinational Brigade (KMNB)

Headquarters (HQ) in downtown Kabul. The Signals community assumed it was due to electromagnetic interference potentially caused by construction in the city or environmental conditions. The airspace coordination centre believed it might have been caused by American aircraft working in the area. The ASCC was aware that an American Prowler EA-6B, an electronic warfare aircraft, had been engaged in operations over Kabul for the previous two evenings. When contacted the EA-6B squadron commander confirmed that they had been engaged in operations over Kabul and that they were indeed working on the same frequencies the Canadians were using for their radio communications. The Americans agreed to remove the Canadian frequencies from the range of frequencies they were working with.

Although the signals community had requested and been given the frequencies the Canadian radio net was using, these frequencies were not transmitted to the US air forces. It was identified that this type of information would need to be inserted into the airspace control order (ACO). This example again highlights that when operations are intermingled between friendly and enemy elements a greater degree of coordination is required. It also highlights that airspace coordination encompasses such varied users including users of the EMS.

Friendly Ranges and Bases

The friendly fire incident at the Tarnack farms range is an example of the difficulties that arise when friendly ranges or bases are part of the battlespace in which operations are occurring. Historically friendly bases and ranges were located behind the forward limit of own troops (FLOT). There was no need to specifically identify them, as

friendly aircraft were not allowed to drop ordinance in friendly territory unless expressly ordered.

In the asymmetric battlefield, air forces are conducting operations in and around friendly installations. In the case of Tarnack Farms, the pilots believed they were under attack from ground troops as they misidentified ground fire at night at hostile. The pilots believing the fire was hostile turned in and attacked the target in self-defence.[44] The Board of Inquiry identified several problems relating to airspace coordination in the asymmetric environment including the failure to properly identify ranges in the ACO and the lack of visibility the airspace coordination system had on ground operations.[45]

Realistically, however the issue of ranges and bases pose a significant problem to pilots and airspace coordinators. To populate a map with multiple friendly installations, may bureaucratically sounds simple, however it is a far more difficult problem for the pilot. A pilot travelling at mach speed over large distances would pass many of these installations in a matter of seconds. When travelling at approximately a kilometre every four seconds the pilot would require either a very large map or a significant improvement in technology his heads up display to provide real time data. As well to simply restrict aircraft from engaging under any circumstances may overly restrict a significant amount of firepower at the commander's disposal. Therefore procedural controls alone for fast movers like fixed wing aircraft are only a small part of the solution. For example, in 2007, a Tactical Air Control Party (TACP), a team of air force tactical air command and control specialists, was added to the battle group HQ. The TACP had direct voice

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[44] Canada. Department of National Defence, *Board of Inquiry - Tarnak Farm 2002*, Air Events.

[45] *Ibid*.

communications with the aircraft working within the area of operations (AO). Aircraft would check-in with the TACP upon entering the AO, the TACP would then brief the pilots on the standing airspace control measures in the area before handing the pilot over to the FAC, the controller at the tactical end.[46]

This example illustrates that the requirement for the integration of friendly installations into the airspace causes several problems for pilots and airspace coordinators. Seemingly, simplistic doctrinal solutions may not be entirely realistic.

4.3 - WHY IS THIS SUCH A DIFFICULT PROBLEM?

As shown, the airspace in asymmetric operations offers unique challenges that did not need to be considered during Cold War era operations. The asymmetric operating environment has no friendly or enemy boundaries; the area of operations is a fluid mix of both. The flow of air users is not linear and other airspace users such as artillery can fire in any direction on short notice. Strategic and operational assets, weapons, and sensors can be pushed the lowest tactical level adding layers of complexity to the airspace, particularly UAV use has proliferated adding a new dimension to coordination. Military operations are in many cases overlaid on top of existing civilian airspace structure and the assumption of a battlespace void of civilian traffic is no longer valid. Figure 4.2 depicts a simplistic diagram highlighting the non-linear nature of the asymmetric battlefield. The airspace has significantly changed and the subtleties of these changes have not yet been fully understood by the military community.

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[46] Lang, *The Blackhawk Helicopter Airspace Incident*.

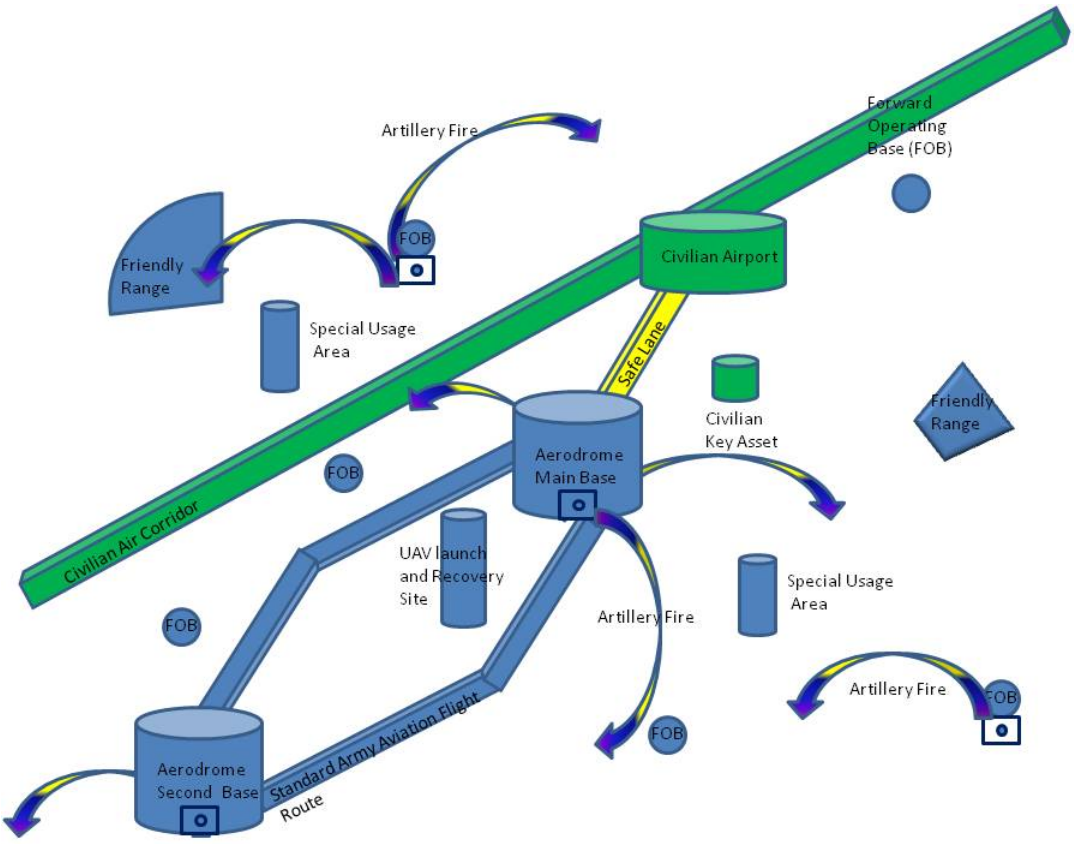

Figure 4.2: Airspace Control Measures - Asymmetric airspace

4.4 – SUMMARY

The aim of this chapter was to give the reader an idea of some of the issues, in practical terms that have been experienced in the field on operations. The examples were purposely selected to demonstrate the breadth and depth of the problems for airspace coordination in asymmetric operations. In each case proper tactics, techniques and procedures (TTPs) in accordance with policy at the time were applied however, shortfalls in the TTPs and doctrine become abundantly clear by the outcome of each example. These examples set the stage for a detailed discussion and analysis in Chapter 5 of airspace coordination doctrine. A basic understanding of the types of problems faced by

airspace coordinators will facilitate in the understanding of the issues that have arisen as airspace doctrine has evolved. A practical understanding of some of the issues will help to explain why personnel on operations are further evolving the doctrine and TTPs.

CHAPTER 5

AIRSPACE PROBLEM ANALYSIS

> *The objective of airspace control is to maximize the effectiveness of military operations by promoting the ability of air, land, maritime and special operations forces to operate in an efficient, integrated and flexible manner with minimum mutual interference and without undue restraint and risk to friendly forces and non-combatant airspace users.*
>
> -AJP-3.3.5(A)

5.1 – INTRODUCTION

The previous chapters have provided a comprehensive analysis of what airspace coordination used to be like on the conventional battlefield. It has also explained how the asymmetric battlefield has challenged current ideologies and affected the airspace. Through the specific examples previously discussed, a sense of some of the issues still facing the command, control and coordination of the battlespace have also been made explicit. After reviewing the Canadian doctrine on airspace it was determined that, it is significantly out of date and the portions that have been updated come directly from NATO or US publications. For this reason Canadian doctrine was not factored into the analysis as it was determined that it would provide no added value. This chapter will focus on an analysis of old and new doctrine for specific issues facing each of the nine major airspace users. Conventional doctrine will be reviewed and the new doctrine discussed in comparison. The new doctrine will then be critically assessed. If there is a deviance from new doctrine to what is being practiced in the field, these new methods will be studied to determine their validity. Conclusions will then be drawn to determine if the new doctrine has effectively addressed the problems posed by airspace coordination within the asymmetric battlespace.

5.2 – ANALYSIS

Fixed Wing Aircraft

Low-level airspace coordination with fixed winged aircraft should be an easy thing. As long as they stay above the coordination level, there is no chance of conflict. When aircraft do fly below the coordination level, they are usually being terminally guided by a Forward Air Controller (FAC), and again there should be no issue for coordination as they are being positively guided by the FAC. The majority of coordination issues with the fixed winged community are when they fire their rockets or drop their bombs.

Rules of engagement and coordination measures alone cannot be relied upon as sufficient measures to properly coordinate the effects of aircraft weapons delivery. Ground forces measure distance in metres and kilometres. A fighter aircraft, flying at 250 meters per second, measures distance in hundreds of kilometres not metres. This difference causes many of the coordination problems between the fixed winged aircraft and the ground forces.

The airspace measures used to coordinate fixed wing aircraft have not changed significantly. What has changed is the coordination that is required for aircraft to drop and fire their rockets and bombs. Simply, in a conventional war, once the aircraft passed into enemy territory, they could drop there bombs knowing there was little chance they would strike or have an impact on friendly ground troops. As warfare evolved, air forces became more selective about which targets they hit in enemy territory, and they used munitions, which were more precise to reduce collateral damage. Again there was little impact on friendly forces, as the targets were often deep in enemy territory and friendly

forces were simply were not near the targets. Targeting became more formalized but coordination with ground forces remained the same. When aircraft dropped bomb in close proximity to troops in contact, then the missions were coordinated and under the positive control of a FAC.

This all changed in asymmetric operations. With friendly forces, facilities and civilians intermixed with enemy forces the dropping of munitions became much more complicated. The airspace control measures for coordinating aircraft remain virtually unchanged. What has changed is that unless specifically tasked with higher-level targets that have been approved by targeting boards, aircraft must now be under the positive control of a FAC who is trained to guide the aircraft onto the intended target. As well, strict requirements must be met to authorize the release of weapons, according to the Rules of Engagement, and collateral damage assessments.

The Common Grid Reference System (CGRS), traditionally used as a high level coordination method for fast movers has now been used to evolve some airspace coordination measures relating to fixed winged aircraft; particularly in the area of coordinating fires, it is for this reason, this section will critically look at this system.

Common Geographic Reference System (CGRS)

During Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF), operators successfully employed the use of a gridded area reference system.[47] CGRS is a system of grid squares that uses an arbitrary origin point in the lower-left hand corner of

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[47] Francis DiLego A. and et al, *Joint Airspace Management and Deconfliction (JASMAD)* (Rome: Air Force Research Laboratory,[2009]), http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA493585 (accessed 22 March 2010).

the matrix. Each cell is identified with an increasing number on the Y-axis (latitude) and a letter on the X-axis (longitude) at 30-minute intervals. Each square is broken down into a 10-minute keypad and then each keypad is further broken down into 5-minute quadrants. Figure 5.1 below illustrates graphically how the system works.

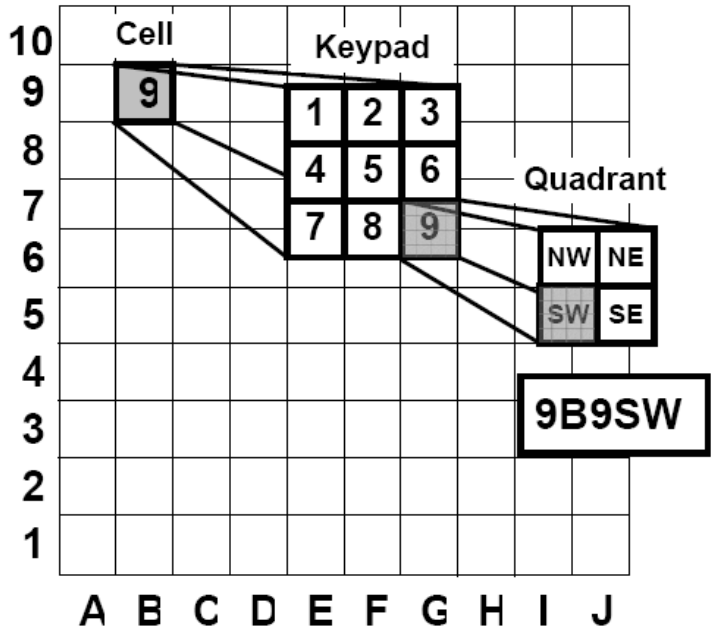

Figure 5.1: Common Geographic Reference System (CGRS)
Source: United Kingdom, *Battlespace Management*, 4-3.

Once the grid matrix is established, a coordinator can identify a cell, keypad, or quadrant to implement an airspace coordination measure. This method is specifically designed for fast moving fixed winged aircraft that travel large distances and may need a general area of airspace coordinated in a relatively short time. CGRS "is primarily an operational-level administrative measure used to coordinate geographical areas rapidly for battlespace de-confliction and synchronization . . .."[48]

[48] United States of America. Department of the Army, *FM 3-60.1 TST Multi-Service Tactics, Techniques, and Procedures for Targeting Time-Sensitive Targets* (Washington: Secretary of the Army, 2004), G-3.

The map at figure 5.2 represents how the CGRS would be applied to a geographical region. The map depicts how the system is better suited for large-scale de-confliction and coordination. As described above a 5 min x 5 min box represents a 25km x 25 km box on the ground. A box this size is perfectly suited to fixed wing aircraft travelling several hundred kilometres. In terms of the ground commander, this area is large and not easily avoided or circumvented. To place airspace limitations in even the smallest cell could represent an entire area of operations for a battle group.

Work has been done by soldiers in the field to try to adapt this system to the command, control and coordination of army airspace and it has been trialed in Afghanistan and Iraq. It has been used to coordinate close air support mission as well as joint fires with artillery. The utility of this control measure in joint fires with artillery will be fully analysed in the artillery section of this paper.

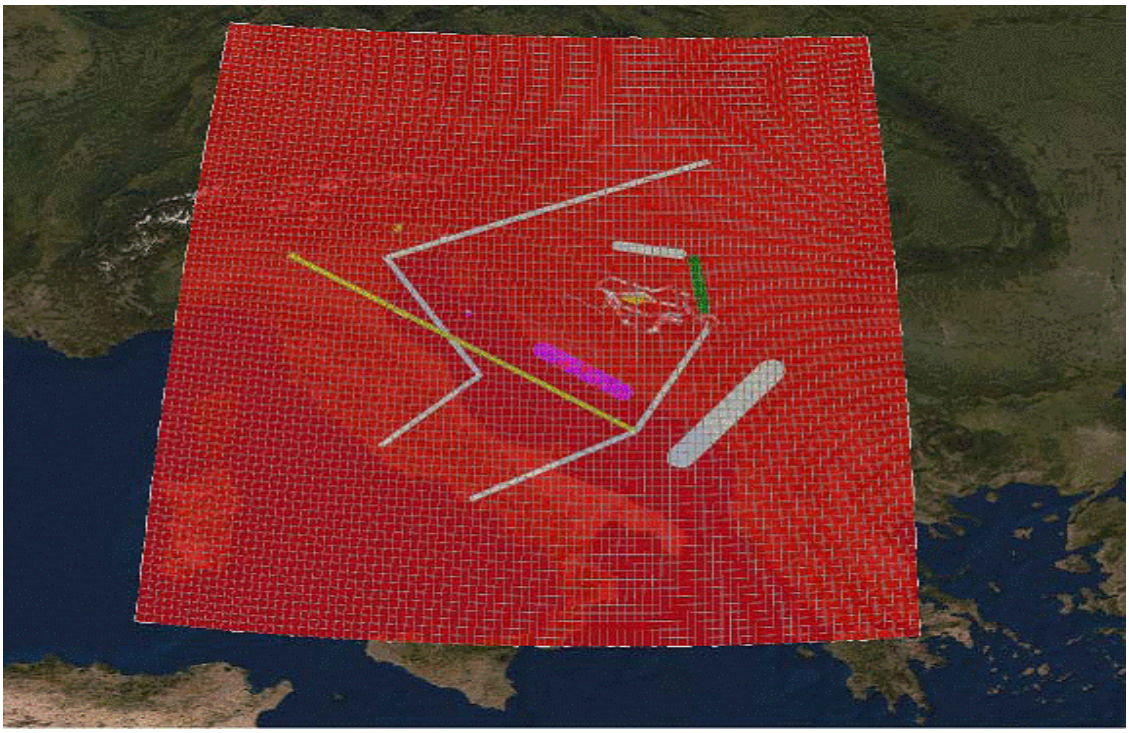

Figure 5.2: CGRS Large Scale Display
Source**:** DiLego et al, *Joint Airspace Management and De-confliction*, 8.

The airspace coordination of fixed winged aircraft in the army airspace has been complicated by the increased numbers of users of the airspace and the corresponding limitations on large areas of airspace that can be dedicated to fixed winged assets. The commander can allocate this airspace if fixed winged aircraft become his airspace priority. In essence, there has been no change. However, the limitation, in most cases, of munitions being dropped under the positive control of a FAC has caused some issues due to the lack of qualified FACs on the battlefield. Ground forces have found it difficult on occasion to have a FAC on the ground when the aircraft was available and the firepower was required.[49] The current airspace coordination measures are still valid for the integration of fixed winged aircraft into the army airspace. Greater limitation have been put on aircraft releasing munitions, however these limitation were always in place when friendly troops were in close proximity. The assessment of the CGRS system will follow in the artillery section.

Rotary Wing

Aviation is an integral part of many armies in the world. For that very reason, they are some of the best-coordinated users of the army airspace. The daily interaction with the ground environment has enabled the helicopter community to establish well-defined procedures for airspace coordination. However, aviators have had to make a significant adjustment not only to the asymmetric battlespace but also to the proliferation of UAVs in the airspace. This section will specifically look at how the main airspace

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[49] United States of America. Special Operations Command, "Joint Terminal Attack Controller (JTAC) Shortage," USSOCOM, http://www.nscc.bices.org/GetFile/?File_ID=94 (accessed April 5, 2010).

control means for the helicopter, the standard use army aircraft flight route (SAAFR) has been affected.

A SAAFR is a "route established below the coordination level to facilitate movement of army aviation assets in the forward area in direct support of ground operations."[50] This definition for a SAAFR has not changed in some time despite revisions of Airspace Doctrine. As noted in Chapter 4 these routes would define a corridor of airspace in the forward area that enable aviation assets to conduct combat service support missions or to move them to the forward edge of the battlefield. If the helicopter crossed into enemy territory, they were free to fly wherever they needed to ensure their survival and achieve their mission. SAAFRs were normally temporary in nature following a series of predefined airspace control points, or communication check points, and the ingress and egress routes were often different.[51]

Army aviation doctrine manuals are all dated in the 1990s and have not been updated. Current airspace coordination documents contain the same unchanged definitions for airspace control measures, relating to helicopters, as are written in the older documents. In essence, the airspace coordination tactics, techniques and procedures have remained the same despite the fact that the environment in which army aviation work has significantly changed. Once helicopters leave the security of their base they are potentially at risk to enemy fire, which is significantly different from the conventional battlefield. The flexibility they had when in enemy territory and at risk no longer exists. Pilots must remain in their SAAFR on the asymmetric battlefield.

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[50] NATO, *AJP 3.3.5(A) Doctrine for Joint Airspace Control*, A-14.

[51] United States of America. Department of the Army, *FM 100-103 Army Airspace Command and Control in a Combat Zone*, 2-14.

Most of the problems experienced by aviation assets have been in how other airspace users interact with them. In particular, UAVs have posed a problem. Many of these issues relate to the other airspace users not remaining in their designated airspace.

> There has already been one reported midair collision between a Raven SUAV [small UAV] and an OH-58D [Kiowa helicopter] and several reported near misses. Because Raven SUAV and Army helicopters frequently operate in the same airspace and at the same altitudes (0-500 feet above ground level), potential collisions between Raven SUAV and helicopters are serious concerns.[52]

The doctrine for the coordination of army aviation seems to have stood the test of time. A review of the internet and other reference did not produce any commentary on shortfalls with aviation doctrine. Anecdotal evidence suggests that airspace coordinators have increase the width of the SAAFRs to allow helicopters more latitude when flying but this is not contained in any doctrine or tactics manuals and since manuals do not dictate the size of a SAAFR this seems to be in line with giving pilots increased flexibility while flying in a potentially hostile environment. Doctrine relating to rotary winged aircraft seems to be sufficient. The key outstanding issue with aviation is their ability to communicate with ground elements

Unmanned Aerial Vehicles (UAVs)

The greatest change to the airspace environment has been the introduction and proliferation of UAVs. From their early stages as Remotely Piloted Vehicles (RPVs) that flew pre-programmed flights, UAVs have evolved into miniature aircraft that are piloted

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[52] John Wagner C., "The Raven SUAV: Working with Army Aviation," *Infantry Magazine*, no. May-June (2005), 2, http://findarticles.com/p/articles/mi_m0IAV/is_3_94/ai_n27864867/?tag=content;col1 (accessed 22 February 2010).

and controlled in real time and deliver both weapon and sensor effects to the battlefield. At the tactical level, these UAVs can be launched by hand to see over an obstruction, or they can be launched from designated launch sites to loiter in the airspace looking for enemy activity. They are used to coordinate artillery fire and to track individual enemy combatants. They have entered into every aspect of warfare as they have the capability to find, fix or strike or in recent years, conduct all three missions simultaneously, giving allied forces a technology advantage over the enemy.[53]

A review of the older airspace doctrine revealed small sections on how to coordinate the RPV. These early UAVs had limited capability and generally flew pre-programmed flight routes. Correspondingly, the doctrine was also limited in nature. ATP 40(C) mentions in passing that UAV or Drone flights will require an airspace control means request (ACMREQ) to request airspace for the flight.[54] There is no other mention of UAVs, drones or RPVs in the document. The US doctrine discusses the coordination of RPV flight under a chapter called special airspace users. The doctrine calls for launch and recover restricted operations zones (ROZ) as well as special corridors for transiting RPVs. It suggests positive control can be established 'to a limited degree' because the UAV is controlled by a ground control station. The doctrine and policy also states that air forces may wish to accept risk when transiting a RVP ROZ by 'using the principle of see-and-avoid."[55] Both of these concepts have been dismissed by modern

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[53] Captain Yadali S., "Unmanned Aerial Vehicles - Benefits to the Warfighter" (Masters, Command and Staff College, Marine Corps University), 16, http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA504319&Location=U2&doc=GetTRDoc.pdf (accessed 4 April 2010).

[54] NATO, *ATP-40 (C) Doctrine for Airspace Control in Times of Crisis and War*, 5-4.

[55] United States of America. Department of the Army, *FM 100-103 Army Airspace Command and Control in a Combat Zone*, 2-24.

day airspace controllers. UAVs are too small to see and the ground controller can only see the target he is focused on, not the airspace users around the UAV. The development of these procedures and doctrine was conducted when the use of RPV/UAVs was rare. The proliferation of UAVs however has caused current doctrine to expand significantly.

Prior to reviewing the current doctrine on UAVs, a quick explanation of the different types of UAVs will be helpful as different categories of UAVs are coordinated in significantly different manners. Figure 5.3 graphically illustrates the three classes of UAVs, Mini/Micro, Tactical level and Strategic level along with the main subclasses.[56] The key concept to understand is that the higher the level the UAV the larger the UAV is and the more capable it becomes and the more it can carry. Larger UAVs can carry GPS and collision avoidance transponders as well as munitions.

[56] Maria De Fatima Bento, "Unmanned Aerial Vehicles: An Overview," *Inside Global Navigation Satellite Community*, no. January/February (2008), 55, http://www.insidegnss.com/auto/janfeb08-wp.pdf (accessed 21 December 2009).

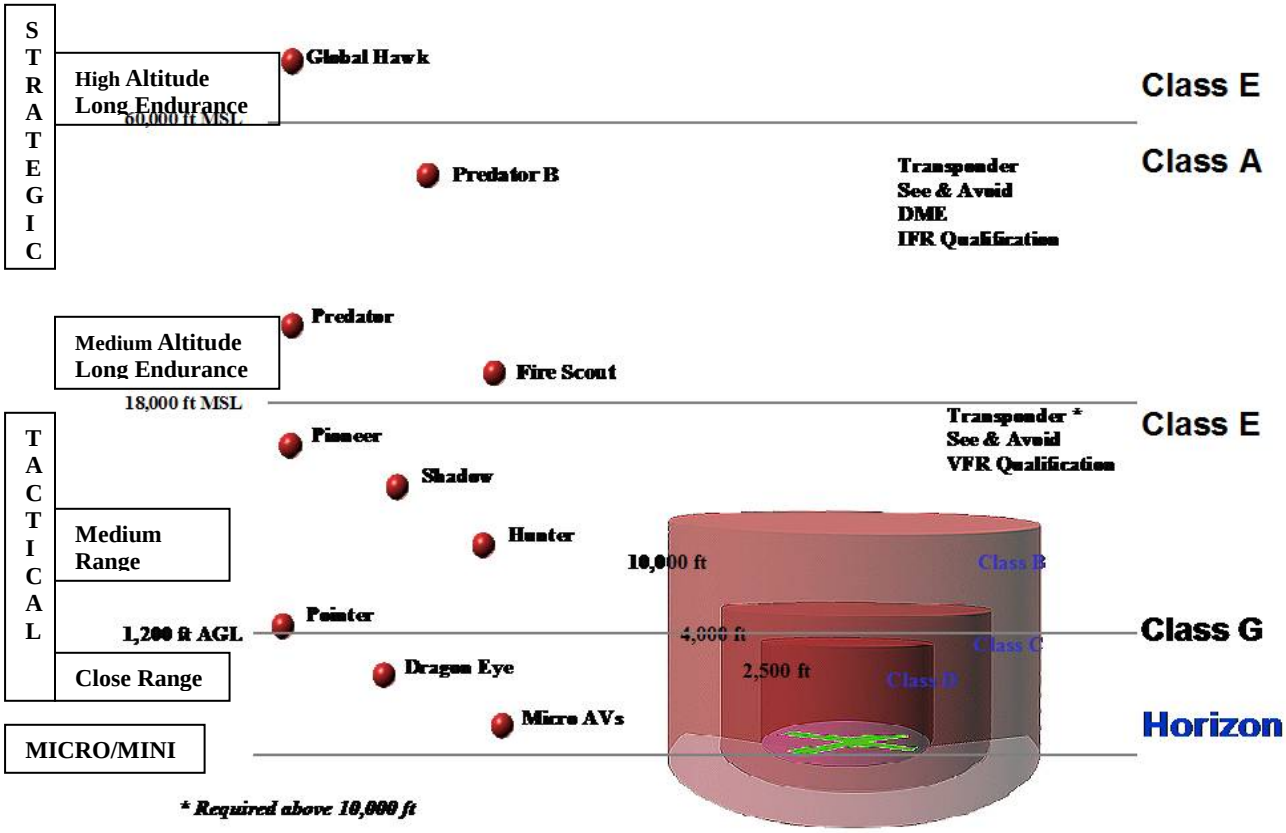

Figure 5.3: UAV Airspace Classes and Typical Sub Classes.
Source: United States, Department of Defense, *Airspace Integration Plan for Unmanned Aviation*, 6. [57]

The other key concept to understand is that UAVs that fly below the coordination level, generally 3500 feet, as with all flyers in the area, are expected to fly using see-and-avoid procedures. Current optics packages on these smaller UAV look downward to acquire targets, they are not looking for other aircraft. These UAV are too small to carry larger optical suites. In addition, if UAVs fly in areas requiring visual flight rules, pilots

[57] United States of America. Department of Defense, *Airspace Integration Plan for Unmanned Aviation* (Washington: Secretary of Defense, 2004), 5. "Classes B, C, and D relate to airspace surrounding airports where increased mid-air collision potential exists; Classes A, E, and G primarily relate to altitude, and the nature of flight operations that commonly occur at those altitudes. ATC provides separation services to all flights in Classes A, B, and C. They provide it to some flights in Class E, and do not provide service in Class G. Regardless of the class of airspace, or whether ATC provides separation services, pilots are required to "see and avoid other aircraft" whenever weather permits."

of manned aircraft would be expected to detect them as well. Many mini and micro UAVs are too small for pilots to see. Even if detected it is difficult for a pilot to judge the distance to the UAV.[58] The problem of seeing and avoiding other aircraft is a difficult challenge with UAVs in the low-level airspace. UAVs must have a see and avoid capability in order to operate safely in the low-level airspace. This capability will require the addition of sensors that can effectively detect aircraft.[59] Collision avoidance is the primary airspace coordination and safety concern for UAVs. Unfortunately, technology has not kept up with the proliferation of theses smaller UAVs. Current avoidance solutions are too large and too heavy for the smaller classes of UAVs.[60] As discussed, larger UAV have identification systems that are designed to augment their radar returns. These systems allow the tactical air control system to acquire the UAV and populate data link networks with the UAV position. The operation of larger UAVs is handled in much the same way as aircraft. The missions are reflected in the ATO and the UAVs have transponders to track their locations in real time. The integration of the mini/micro level up to tactical level is much different. Airspace coordinators have a limited ability to control UAV operations at the mini/micro level where hand-launched mini UAVs are often launched to provide local reconnaissance at a moments notice. These smaller UAVs do not have the payload capability to carry transponders for identification and are far too small to be identified by radars. However, these mini/micro UAV are operated by ground controllers that require line of sight to fly their UAV. They

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[58] Mathew DeGarmo T., *Issues Concerning Integration of Unmanned Aerial Vehicles in Civilian Airspace* (Virginia: Mitre Corp, Center for Advanced Aviation Systems Development,[2004]), http://www.mitre.org/work/tech_papers/tech_papers_04/04_1232/04_1232.pdf (accessed 15 January 2010).

[59] *Ibid*.

[60] *Ibid*.

could easily implement a see-and-avoid policy even if the helicopter could not do the same. However, the see-and-avoid system is predicated on both pilots taking action. Some have suggested that the airspace system treat these small UAVs in the same manner as birds and a collision would be considered in the same light as a bird strike, potentially damaging to the aircraft but a part of life.[61] As the use of UAVs continues to proliferate, their impact on airspace coordination will increase exponentially. For example, tactics such as UAV 'swarms' in a surveillance, intelligence, or reconnaissance role will significantly increase the potential for air-to-air collisions due to the concentration of tactical UAVs in a small volume of airspace.[62]

To further complicate the airspace, the advent of standoff and loitering munitions add yet another new complexity to low-level coordination. Weapons such as the Joint Air-to-Surface Standoff Missile (JASSM) and the Low-Cost Autonomous Attack System (LOCAAS) are difficult to incorporate into the airspace structure. Current airspace coordination measures are inadequate to deal with these types of weapons that loiter for long times looking for a target. The limitations in coordinating the use of standoff and loitering munitions represents a significant risk of an air-to-air collision.

Current manuals have formally integrated UAVs in to the doctrine, tactics and procedures for airspace coordination. UAVs must now be included into all aspects of airspace planning as well as all the key airspace documents such as the ACO and ATO.

> The established principles of airspace management used in manned flight operations will normally apply to UAV operations. However, UAVs may be difficult to visually acquire and do not always provide a clear radar or

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[61] Roland Weibel E. and R. John Hansman, *Safety Considerations of Operation of Different Classes of UAV in the NAS* (Cambridge: MIT Press, 2004), 11.

[62] Erwin, *Controlling Iraq's Crowded Airspace No Easy Task*, 20.

> electronic signature, presenting a potential hazard to other aircraft. Therefore, UAV operations require some special considerations in terms of airspace control and usage. Specific volumes of airspace need to be included in the ACO. Additionally, the ACO should provide times of activation of airspace for UAV operations (where a standing ACO is used, UAV operations are addressed in the ATO/SPINS).[63]

All manuals now include a specific airspace control means for UAV operations. The newly created UAV Area is "airspace created specifically for unmanned aerial vehicle operations."[64] The doctrine from the UK goes into detail on the planning and consideration factors for UAV operations in relation to each of the environments and major airspace users, and this doctrine notes the specific interaction and coordination requirements with sea assets, electromagnetic users and air forces while defining the impact UAV operations could have on higher level operations.[65]

Figure 5.4 depicts current direction on low level UAV coordination. Procedures have been updated to have UAVs follow airspace control points in the same manner as army aviation for flight planning.

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[63] United States of America. Joint Staff, *JP 3-52 Joint Doctrine for Airspace Control in the Combat Zone*, III-6.

[64] NATO, *AJP 3.3.5(A) Doctrine for Joint Airspace Control*, A-14.

[65] United Kingdom. Ministry of Defence, *Battlespace Management*, 4-E-1.

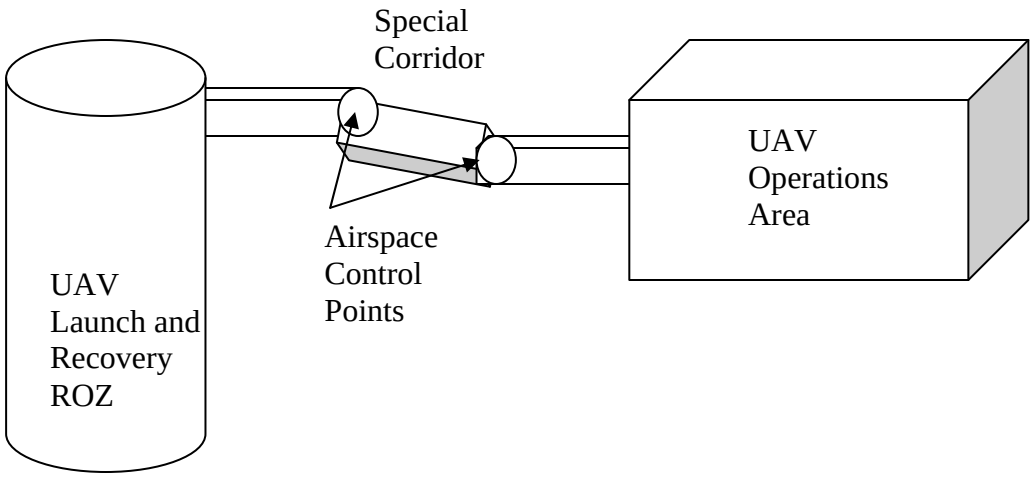

Figure 5.4: UAV Coordination Airspace Control Means.

UAV coordination in practice has been one of the most written about subjects. Pilots are concerned about the inability of UAVs to "see-and-avoid", army personnel continually express concern over the UAVs being responsive to their needs.[66] The inability for smaller UAVs to transmit their exact location to other aircraft remains an issue. A review of many of the writings and lessons learned from current operational theatres, suggest that many of the issues surrounding UAV airspace coordination is that the operators of UAVs, aircraft pilots or air traffic coordinators are not following the procedural control measures established. One of the most highly publicised near misses was when the civilian airliner nearly missed a UAV in Afghanistan. An investigation determined that, "due to the failure of the air traffic control tower to follow standard procedures, the two aircraft nearly occupied the same airspace at the same time."[67] Recent airspace coordination issues in Iraq have seen UAV planners try to make UAV

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[66] Kris Osborn and Michael Hoffman, "Finally, Ground Rules for Air Ops - US Army, USAF Near UAV Pact," *Defense News*, sec. 1, 15 September 2008.

[67] La Franchi, *Animation: Near Misses between UAVs and Airliners Prompt NATO Low-Level Rules Review*.

search area over half the size of the country.[68] The rationale was to account for possible contingencies or mission changes. This is just a poor application of airspace control means and violates the objective of airspace coordination; one user should not overly restrict other airspace users.

Advancements in technology are restricting the further integration of UAVs into the battlespace. In the low-level airspace, there is a greater reliance on procedural control over positive control. Land features continually cause communications problems and there will never be enough radars to see the entire low-level airspace. Positive control, to the disappointment of pilots, will not be easily achieved in the army airspace. However, the procedural measures currently outlined in the doctrine combined with direct communications to the pilots, seem to provide a basis for effective airspace coordination. In many cases the communications network with the UAV pilot allows for an increased level of positive control. Work is still required in the area of loitering UAVs. Question need to be address such as the feasibility of blocking out large areas of airspace to allow these systems to operate. Finally as mini and micro hand launched UAVs proliferate policy will need to be developed on how to more effectively integrate them into the battlespace treating collisions like a bird strike is not a viable option.

Field Artillery

Three important areas must be considered when analyzing the impact of filed artillery on the airspace; the explosion of the round, either impact or airburst, is the area

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[68] United States of America. Department of the Army, *FM 3-04.15 Army Aerial Vehicle System Operation* (Washington: Secretary of the Army, 2005), D-13.

where the greatest attention is paid however, the trajectory of the rounds thru the airspace and the gun position are equally important. The old theory of "big space, little bullet" is nothing more than coordination by hope and no longer viable when coordination affects civilian users of the airspace. This section will specifically look at how doctrine has addressed the coordination of indirect fire from the gun position, through the trajectory of the round to the impact area.

The coordination of field artillery during the cold war centered on the threat posed to low flying aircraft in the direct vicinity of gun batteries.[69] In this era, gun batteries were positioned with their centre of arc facing the enemy. In effect, most gun batteries on the battlefield were generally pointing in the same direction. As long as aircraft flew behind the gun batteries, they were safe. Coordination also focused on deep attacks, but not from the perspective of de-conflicting the airspace with friendly airspace users. The policy of the period was more concerned with the fact that if artillery prosecuted deep targets without coordination, it could cause enemy air defence units to reposition without the knowledge of our friendly air forces or intelligence organizations.[70] There is no mention in any old doctrine about coordinating the flight path of artillery rounds or airspace coordination at the target site. The artillery focus during that time was to ensure safety of ground forces forward. They used a series of fire support control measures to ensure limits of fire and safety of ground troops. For complex missions where artillery, fixed winged aircraft and helicopters were being used such as an opposed air insertion, special planning teams would come together to

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[69] United States of America. Department of the Army, *FM 100-103 Army Airspace Command and Control in a Combat Zone*, 1-6.

[70] *Ibid*., 1-6

coordinate the convergence of the three assets with ground force movement. These teams are known as a joint air attack team.[71] These planning teams convened only for complex joint operations that required detailed coordination.

Airspace coordination for artillery under the old doctrine was relatively simple. Do not allow aircraft to fly immediately in front of battery positions and only coordinate the impact of complex missions. Due to the linear reality of the battlefield, the flight path of the rounds was rarely considered unless it was a joint and coordinated attack. The terminal trajectory of the rounds and point of impact was generally only coordinated from the perspective of ensuring there were no ground troops in the vicinity. This was only considered by the Forward Observation Officer (FOO), during the calculation of the firing data, not as a coordination issue. Little consideration was given to the surrounding airspace of the impact area; after all, it all occurred in enemy territory. This level of coordination is no longer acceptable in asymmetric operations.

The modern battlefield tends to combine linear and non-linear. The reality is there is no longer friendly and enemy territory. This has caused airspace coordinators to consider the flight path of rounds and the airspace surrounding the impact area of the rounds. To address the issue of airspace at the impact area and the trend towards non-linear operations, the military developed the kill box concept. In much the same way the Fire Support Coordination Line (FSCL) is a linear Fire Support Coordination Measure (FSCM) that defines the limits of coordination and control required, the kill box is a permissive FSCM that defines these limits both for linear and non-linear operations to

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[71] United States of America. Department of the Army, *FM 6-20-40 Tactics, Techniques, and Procedures for Fire Support for Brigade Operations (Heavy)* (Fort Sill, Oklahoma: Field Artillery School, 1990), A-6-1.

ensure the safety of the airspace surrounding the impact area.[72] According to joint doctrine, the kill box combines elements of FSCMs and airspace control measures to facilitate expeditious air-to-surface operations in support of the joint force commander's objectives while also allowing surface-to-surface targeting by ground forces.[73]

The kill box has been standardized using the Common Grid Reference System (CGRS) box system discussed earlier. A 5x5 minute sector would represent a typical kill box and each kill box would be identified in this manner. The next two figures give a better conceptualization of how components operate within the kill box for both independent and joint fires. Figure 5.5 is a notional 'blue' kill box. This kill box "permits air-to surface fire effects in the kill box without further coordination with the establishing headquarters."[74] In this example, the aircraft operating in the blue kill box is permitted to fly at any altitude below 24,000 feet. Both the aircraft and ordinance must physically remain inside the boundaries of the box. Coordination with the ground commander would ensure that no enemy forces inside the kill box would be attacked using artillery or other surface-to-surface fires. Similarly, no air or ground assets are permitted to penetrate the vertical or lateral boundaries of the kill box without prior coordination with the airspace coordinators. De-confliction is achieved and maintained throughout the lateral and vertical dimensions of the kill box between fixed winged air assets and artillery but do not preclude surface-to-surface fires that exceed the vertical

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[72] Karl E. Wingenbach, "KILL BOX: The Newest FSCM," *FA Journal* 10, no. 4 (Jul/Aug, 2005), 13, http://proquest.umi.com/pqdweb?did=913854081&Fmt=7&clientId=1711&RQT=309&VName=PQD.

[73] United States of America. Secretary of the Air Force, *AFDD 2-1.3 Counterland Operations* (Washington: Secretary of the Air Force, 2006), 74.

[74] *Ibid*.

limit of the kill box. Surface-to-surface fires could be launched as long as the trajectory passed over or outside of the kill box.

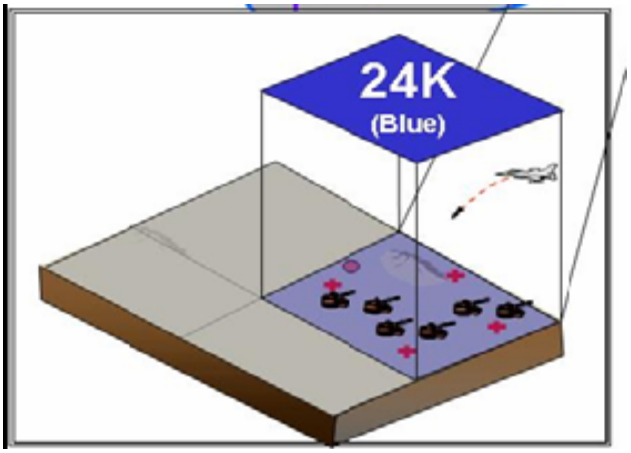

Figure 5.5: Blue Kill Box.
Source: United States of America, Secretary of the Air Force, AFDD 2-1.3 Counterland Operations. 76.

Figure 5.6 illustrates a notional 'purple' kill box. This kill box "permits the integration of surface-to-surface fires with air-to-surface fires into the purple kill box without further coordination."[75] In this example, enemy forces are targeted by both air and artillery assets in the same geographical area. The difference between the blue kill box and the purple kill box is the establishment of an intermediate altitude. The maximum ceiling is identical to the previous example; however, the intermediate altitude is used to separate aircraft from the ground munitions. The aircraft remains above the established intermediate altitude. This allows the artillery rounds to pass through the side of the kill box below the intermediate altitude ensuring de-confliction. No rounds, artillery, or any other munitions, such as ship launched cruise missiles or air launched standoff weapons are permitted to penetrate the kill box between the intermediate and

[75] *Ibid*., 74.

maximum altitudes established within the confines of the box. These boundaries and limits for the kill box ensure the positive safety of airborne assets, eliminating the potential for fratricide, while expediting the prosecution of targets in a specific geographic area.

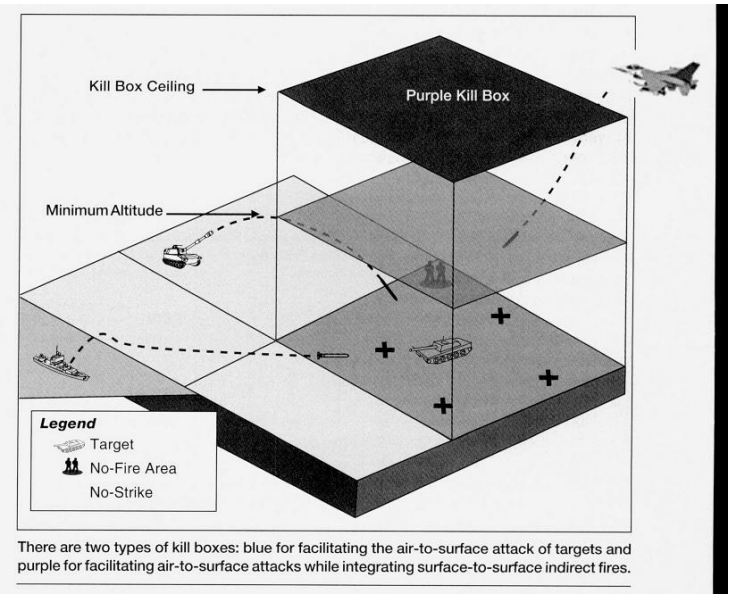

Figure 5.6: Purple Kill Box.
Source: Wingenbach, Kill Box the Newest FSCM, 13.

The battlefield is evolving and procedures must be in place that allow for the expedient and safe prosecution of enemy targets. Doctrine has begun to evolve in order to addresses the changes brought by the asymmetric battlespace, which is becoming more prevalent in today's conflicts.

> "A combination of kill box and traditional FSCMs is possible, such as when a single large advance is made from a classic linear battlefield (such as operations during OIF). Here the standard FSCL could be used for the slower moving ground forces, and a localized JFLCC [Joint Force Land Component Commander's] kill box system could be created in front of, or behind, a rapid advance. This allows for more efficient air attack on non-engaged enemy land forces, the greatest freedom of land and aerial

> maneuver, and enhanced combat effectiveness— especially during non-linear operations."[76]

The kill box conceptually has been lauded as a step forward in coordination of fires. However, there are major critics outside of the artillery and fixed winged aircraft communities. The main concern seems to be the size of the kill box in relation to the ground. The CGRS is designed for high performance aircraft travelling at great distances. It allowed for easy de-confliction in the higher-level airspace. FM 3-60.1 *MTTP for Targeting Time-Sensitive Targets*, Appendix G, "Common Geographic Reference System," notes that the, "CGRS is primarily an operational-level administrative measure used to coordinate geographical areas rapidly for battlespace de-confliction and synchronization." The adaptation of the CGRS to a fires support coordination measure and an airspace control measure in the low-level airspace has caused a great deal of concern. The concept is proven however, the size of the box is not. The kill box should be de-linked from the area reference system (CGRS).

> The two clearly can be related but are not synonymous. OEF and OIF proved the usefulness of the area reference system beyond facilitating rapid air-to-ground attack of targets.[77]

The CGRS system is an ideal big hand small map coordination system/protocol for fixed winged aircraft; however, it is not a tactical level coordination tool. The kill box can be a useful coordination measure at the operational level, however to reserve a 5x5 minute box on the ground would equate to roughly a 25 square km area. To a fixed winged pilot this is a relatively small area easily bypassed. To a ground commander this

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[76] *Ibid*., 77.

[77] Wingenbach, *KILL BOX: The Newest FSCM*, 15.

area represents a very large area making it virtually infeasible in the context of land operations. "We had helicopters that were forced to fly around these boxes. The distances were too great and we almost had helicopters making hard landings because they were running out of fuel."[78] This has caused army operators to develop new but similar techniques to solve the issue. Recent professional writings have seen the development of firing and terminal effects restricted operating zones (ROZ). American experience has show that in asymmetric environments like Iraq and Afghanistan, artillery batteries remain static for long periods.[79] This stability in the gun positions has lead to de-confliction of the firing platform by using a ROZ. The coordinating altitude for the theatre and the average range and highest charge expected to be fired from the firing platform are then determined. This data is used, along with the firing tables for the weapon, to determine the distance from the gun at which a projectile fired at low angle will climb above coordinating altitude on its trajectory toward the target. An additional safety buffer is added to this distance to determine the radius of the circular ROZ around the firing unit.[80] This ROZ below the coordination level is closed to all aviation and UAV operations. The CGRS box remains the same above the coordination level. This type of ACM is depicted graphically at Figure 5.7. With the ROZ permanently erected over the firing position the airspace coordinator simply makes a calculation at the target site to determine the size of the ROZ at the target end. This calculation at the target end is rarely made because a large proportion if not all indirect fires in asymmetric operations

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[78] Lang, *The Blackhawk Helicopter Airspace Incident*.

[79] Daniel A. Pinnell, Victor S. Hamilton and Michael T. Oeschger, "Deconflicting Army Aircraft and Indirect Fires: Brigade-Level A^sup 2^C^sup 2^," *FA Journal* 9, no. 2 (Mar-Jun, 2004), 47, http://proquest.umi.com/pqdweb?did=913854361&Fmt=7&clientId=1711&RQT=309&VName=PQD.

[80] Ibid., 48.

are observed by a forward observation officer (FOO). When the FOO is present, he would make a simple visual observation or radio confirmation to determine there are no other airspace users in the area. The fact that the Fire Support Coordination Centre and the Airspace Coordination Centre are generally co-located allows for relatively quick and simple building of a trajectory ROZ and confirmation of the airspace.

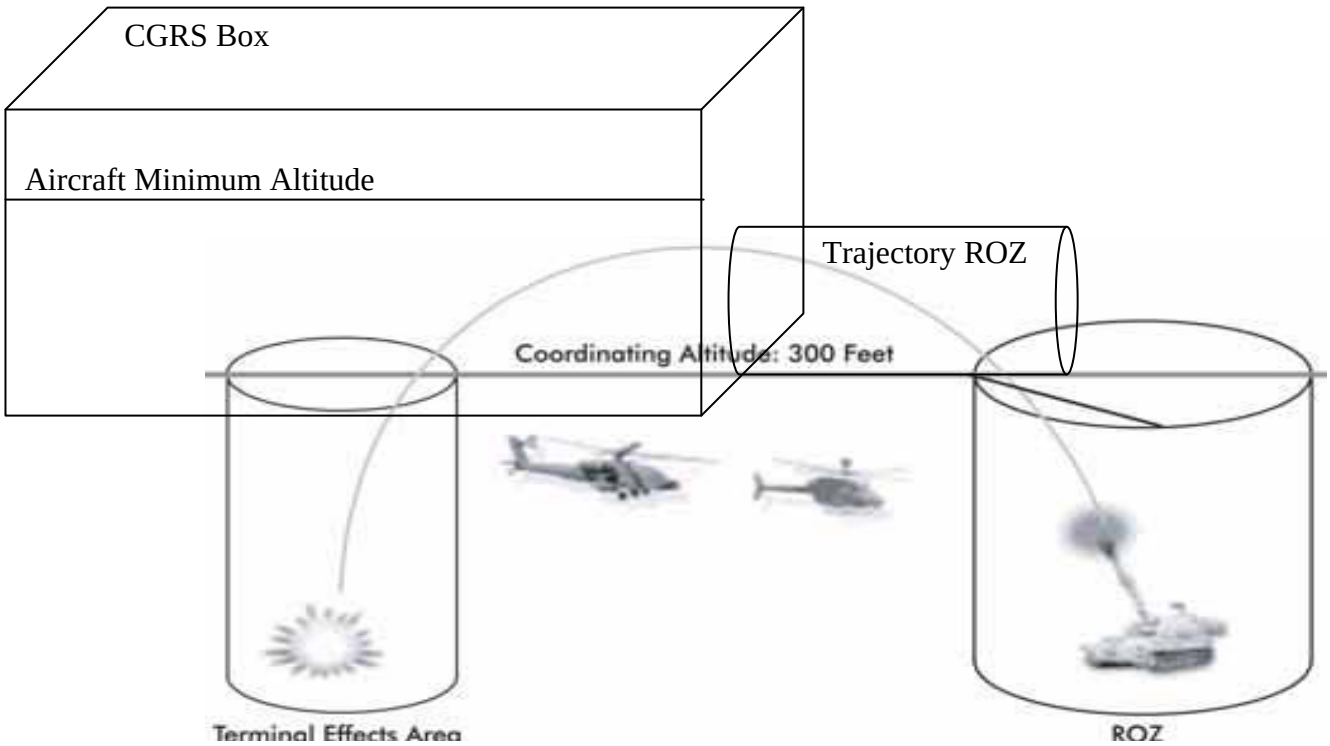

Figure 5.7: Example of a Firing and Terminal Effects Area ROZ with CGRS. Source: Pinnell, Hamilton and Oeschger, *De-conflicting Army Aircraft and Indirect Fires: Brigade-level A2C2*, 61.

The coordination High Mobility Artillery Rocket Systems (HIMARS), and the Multiple Launch Rocket System (MLRS) has also moved away from the large kill box. "Goalposts" have been created, relatively small Restricted Operations Zones (ROZ), and are established over the target area, and one around the weapons platform. Then a 2km wide rectangle is built connecting the two. This allows operations to continue unabated

under the trajectory of the projectile in the space between the goal posts.[81] The unacceptably large size of the kill box has driven coordinators in the field to adapt the procedure to something that is more manageable in the low-level airspace.

The adoption of the CGRS system as the basis for a kill box has been written into doctrine, however practitioners in the field have modified this procedure to reduce the size of the airspace below the coordination level. This evolution in the doctrine allows for greater flexibility of all airspace users, and reducing the mutual interference between airspace users which is in line with the objectives of effective airspace coordination.

Canadian scientists at Defence Research and Development Canada (DRDC) have done some analysis that supports a more limited structure of airspace control measures as outlined by Pinnell and in line with what soldiers are doing in the field.[82] Further analysis and research should be conducted in the area to determine the optimal size of airspace that needs to be reserved to conduct joint fires and the adoption of the CGRS in the army airspace needs to be reviewed.

Explosive Ordinance Disposal (EOD)

Western armies are increasingly conducting operations in countries that are heavily mined. De-mining of countries becomes one of the tasks during operations for military and other non-governmental agencies. Complex battlefields now have de-mining and large EOD operations going on the same time as fighting. EOD operations

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[81] Lang, *The Blackhawk Helicopter Airspace Incident*.

[82] Sylvia Lam and Shiva Poursina, "As-is Architecture Document for Joint Fire Support Capability TDP" (Report, DRDC Ottawa, 2006), http://www.cfd-cdf.forces.gc.ca/websites/Resources/cfec/Joint%20Fires/Documents/JFS_AS-IS_OP_ARCH_V_005b.pdf (accessed 5 April 2010).

and their potential use of army airspace require coordination. "Most do not think of the EOD organizations as airspace users but when a plum of phosphorus reaches to 1000ft, it becomes a real issue to low fliers."[83] This section will investigate how EOD has been integrated into the airspace.

Simply put, there is no reference to airspace coordination with EOD, de-mining or any other engineer activity in any doctrine manual old or new. There is no mention in either airspace or engineering doctrine. Airspace coordination of EOD activities has not been a consideration in doctrine or procedures. However, the example in Chapter 4 would seem to illustrate a requirement for de-confliction.

A review of lessons learned and literature emanating from operational theatres around the world do mention the requirement to de-conflict EOD and de-mining operations. The requirement to de-conflict EOD operations with the airspace in Bosnia-Herzegovina, Iraq and Afghanistan has been identified.

In as early as 2000 the airspace controllers for the Stabilization Force in Bosnia Herzegovina (SFOR) noted the requirement to issue a Notice to Airmen, the civilian equivalent to an Airspace Control Order. "The NOTAMs from Maj. Lopis's office are usually about air space restrictions, and must be issued when certain activities take place. This includes de-mining, . . . and range activation."[84]

In Afghanistan, a policy was developed to institute a temporary ROZ over the de-mining site.

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[83] Notaro, *Airspace Coordination in Afghanistan*, 7.

[84] Javier Donesteve 1Lt, "Airspace Control: SFOR Creates a Reference Website," SFOR, http://www.nato.int/sfor/indexinf/104/s104p04a/t0101104a.htm (accessed April 2, 2010).

> The general policy was that all these organizations were to recover the ordnance to one of two sanctioned EOD ranges. If they could not move the round then the ESCC [Engineer support Coordination Centre] would request a temporary ROZ on their behalf.[85]

The American airspace coordinators in Iraq ensured that they provided, "staff and aircrews situational awareness of known flight hazards, such as explosive ordnance disposal."[86]

The most specific direction to date was issued by the United Nations Mine Action Office in their document entitled "*National Technical Standards and Guidelines for De-mining in Suda*n". This document contains an entire chapter detailed direction for coordination between EOD operations and the airspace.

> When the use of an explosion in an emergency situation is necessary, such as for the destruction of UXO [unexploded ordinance] in a dangerous location or emergency situation, the details required for NOTAM are to be passed on to the UNRMAO [United Nations Regional Mine Action Office]. An Emergency NOTAM will be dealt with on a case-by-case basis. These should be the exception rather than the rule. In all such cases, the means of initiation is to be electrical and the time of detonation is to be carefully controlled to ensure that the airspace is clear of aircraft. Normal safety precautions are to be taken whenever the explosive destruction of any item of ordnance is carried out. These safety precautions are to include visual and aural inspection of the airspace above and around the demolition area to encompass the implemented safety distance.[87]

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[85] Notaro, *Airspace Coordination in Afghanistan*, 7.

[86] Wagner, *The Raven SUAV: Working with Army Aviation*, 19.James M. Waring, Carl L. Giles and John A. Robinson, "The 19th BCD in Counterinsurgency Operations," *FA Journal* 10, no. 4 (Jul/Aug, 2005), 16, http://proquest.umi.com/pqdweb?did=913854241&Fmt=7&clientId=1711&RQT=309&VName=PQD.

[87] United Nations Mine Action Office, "National Technical Standards and Guidelines Sudan Part 1 Demining" (Technical Guide, Sudan, 2008), http://www.mineactionstandards.org/nmas/files/sudan/Sudan_NTSG%20SINGLE%20DOCUMENT.pdf (accessed 4 April 2010).

There will be de-mining or EOD operations occurring in today's asymmetric battlefield. These large explosions must be coordinated to ensure the safety of airspace users. These EOD missions often take place within the very area of operations that combat operations continue within, this means UAV, and Aviation activity will remain high in these areas. The soldiers on the ground in both NATO and UN missions have noted this requirement. Doctrine must be written and enforced in this area to define how hazards from de-mining will be captured, and what airspace control means will be used to reserve the airspace for these types of operations.

Civilian Aircraft

Another significant change to the airspace in modern times is that operations during a military conflict will need to be conducted in airspace used simultaneously by civilian aircraft. Current tactics, techniques and procedures only provide rudimentary guidance for integrating International Civil Aviation Organization (ICAO) airspace. Coordination with civil aircraft is essential to ensure their safety as they continue to operate in war zone. As countries such as Canada continue with concepts such as the whole of government approach to conflicts, humanitarian assistance as well as work by non-governmental agencies will continue. This section will review how new doctrine has tried to integrate civilian aircraft into the operational theatre.

A review of old doctrine resulted in little or no mention of interoperability with civilian aircraft. The expectation under the old doctrine was that there would be little to no civilian aircraft activity in the airspace. In ATP-40 (C), the only reference to civilian aircraft is mention with respect to military operations other than war (MOOTW).

> Especially during a crisis or in MOOTW, the requirement to operate civilian aircraft in the airspace control area or parts thereof must be considered and maximum safety consideration consistent with peacetime operations allowed without disrupting operation effectiveness.[88]

New doctrine manuals expand on the concept of civilian aircraft working in a combat zone. All acknowledge that the introduction of civilian aircraft complicate and demands, "airspace control planning becomes much more intensive, often requiring the establishment of detailed airspace control procedures."[89] There is also explicit acknowledgement that civilians will be working in the military airspace and that the airspace control system needs to integrate these aircraft into the system.

> Civilian agencies will operate in many theatres, even when the risks are significant. Such agencies include OGD [other governmental departments], UN, NGOs [non-governmental agencies], HN [host nation] and private military companies. Agencies working wholly within a formation's AOR should, if possible, be integrated into the battlespace to minimise their risk.[90]

NATO doctrine requires that military forces may need to protect the right of civilian passage taking the integration of civilian aircraft beyond mere coordination.[91] All of the current doctrine notes that the integration of civilian aircraft should never jeopardize the operational security of the mission and that civilian operators should be given all of the unclassified information from the airspace control orders and the air tasking orders. There is a difference between the doctrine of the UK and NATO when it

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[88] NATO, *ATP-40 (C) Doctrine for Airspace Control in Times of Crisis and War*, 3-1.

[89] United States of America. Joint Staff, *JP 3-52 Joint Doctrine for Airspace Control in the Combat Zone*, xi.

[90] United Kingdom. Ministry of Defence, *Battlespace Management*, 4-7.

[91] NATO, *AJP 3.3.5(A) Doctrine for Joint Airspace Control*, 4-4.

comes to whether civilian or military aircraft have primacy. NATO doctrine states that civilian aircraft must be given the "maximum safety consideration consistent with peacetime operations allowed without disrupting operational effectiveness."[92] The UK's doctrine notes that, "military operations will often be constrained by civilian airspace control or by unexpected civilian activity in the Joint Operations Area or Airspace Control Area."[93] This is a significant difference in approach to airspace coordination. The key factor affecting airspace coordination during asymmetric operations is de-conflicting military and civilian traffic without overly restricting either one.

Civilian and military aircrews use different documents when flying. Civilians use Aeronautical Information Publications (AIP) defined by the International Civil Aviation Organization and issued by countries for their own airspace. It contains information essential for air navigation, containing details of regulations, procedures and other information pertinent to flying aircraft in the particular country. The Air Tasking Order (ATO) is the source document that tasks aircraft to designate missions and specific directions on flying procedures are contained in the airspace control order (ACO). These documents are planned, produced, and distributed by the military chain of command. Both of these documents are classified and controlled publications and cannot be released to civilians to ensure operational security. This means there are two completely different sources of information for aircraft flying in the same country. Airspace planners must ensure that any changes in one document will not conflict with the other. As well, a balance must be achieved on what information can be release to civilians without

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[92] *Ibid*., 3-5.

[93] United Kingdom. Ministry of Defence, *Battlespace Management,* 1-1.

jeopardizing operational security of the military mission. For example, in Afghanistan, military airlift aircraft fly along routes that are different from civilian airliners. When the civilian and military routes cross, the aircraft are procedurally de-conflicted. The civilian pilots fly as directed in the AIP and the military routes would be classified. Therefore, any change to either the military route or the civilian route would need to be updated in both documents.[94] There would be a duplication of work and an increased potential for error.

To date there have been few articles or lessons learned emanating from the current operational theatres that would suggest that there have been any significant problems with the integration of civilian aircraft into the operational airspace. The likelihood of increased civilian traffic in area of conflict will only increase in the future. Civilian pilots are trained in civilian airspace coordination requirements and thus far have proven capable of integrating into the military airspace. The potential for error exists and the streamlining of the civilian and military documents needs to be resolved. As well, the conflict in doctrine between nations needs to be addressed at the coalition level to determine if and when civilian or military aircraft have primacy of operations. A difficult question when the airspace belongs to the host civilian nation.

Civilian Airspace

The impact of civilian aircraft is not the only civilian consideration for military airspace coordinators. Another significant change to the airspace in modern times is that

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[94] Major Grogan Michael A., "Airspace Control Authority in Stability Operations: The Role of the United States Air Force in Rebuilding Afghanistan's National Airspace System" (Masters, Air Command and Staff College, Air University), 17, http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA476300 (accessed 8 April 2010).

operations during a military conflict will be conducted in close proximity to, or in and around civilian airspace and civilian populations. Current tactics, techniques and procedures only provide rudimentary guidance for military operations in the International Civil Aviation Organization (ICAO) airspace. Particularly in the case of failed states, governments are eager to transition these states back to civilian control as soon as possible. This transition introduces civilian airspace into the operational theatre. Chapter 4 outlined an example in Afghanistan when the Transitional Government was eager to resume civilian transcontinental flight routes over their country. This section will review how new doctrine has tried to integrate civilian airspace into the operational theatre.

A review of old doctrine resulted in little or no mention of interoperability with civilian airspace. In FM 100-103, the only reference to civilian airspace is mentioned in respect to assistance to foreign defence or peacekeeping.

> Airspace control in this environment primarily focuses on providing air traffic services, coordinating military airspace requirements with host nation civil airspace, and integrating and coordinating air operations with fires and the ground activities. Air traffic services may be expanded to provide greater positive control of airspace users.[95]

Current doctrine clearly states that the direction as set out by the host nation will be respected.

> Bilateral and international agreements often establish obligations affecting the use of airspace and the conduct of air traffic control activities by operational and civilian organizations. Any requested changes to or waivers of obligations imposed by these agreements or by Host Nation law, as well as problems that result from restrictions to military operations should be forwarded to the Joint Force Commander and may be referred through diplomatic channels for resolution.[96]

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[95] United States of America. Department of the Army, *FM 100-103 Army Airspace Command and Control in a Combat Zone*, C-1.

Afghanistan provides an excellent example of this. Prior to its invasion almost $23 million a year was being paid to the central government in over flight fees.[97] At the commencement of hostilities, the airspace over Afghanistan was closed to commercial airlines.[98] Once closed, flights were routed around Afghanistan, resulting in longer flight times, and significant additional costs in both fuel and time for flights between South-East Asia and Europe. Immediately after the fall of the Taliban, commercial airlines wanted to resume over flights of Afghanistan and the newly installed government of Afghanistan was eager to collect the over flight fees. The problem facing military forces was how to convert operational airspace into a civilian airspace structure capable of safely integrating military operations with civil aviation.

Once commercial airliners were allowed to fly over Afghanistan, the problem facing the military was balancing the ongoing military requirement for airspace with those of the international civil aviation community. For example, the artillery was required at times to fire high angle missions. The maximum altitude the rounds were reaching, directly conflicted with lower altitudes the airliners were using for civilian over flights. Either artillery missions needed to be limited or over flights restricted, which would have an impact on the revenue that the central government could generate. In the

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[96] United States of America. Joint Staff, *JP 3-52 Joint Doctrine for Airspace Control in the Combat Zone*, IV-3.

[97] Peter J. Peterson, *Case Studies in Sanctions and Terrorism: US and UN Vs Afghanistan (Taliban)* (Washington: Perterson Institute for International Economics,[2000]), http://www.petersoninstitute.org/research/topics/sanctions/afghanistan.cfm (accessed 2 April 2010).

[98] Marian Edmunds, "No Fly Zone: Avoiding Afghan Airspace," frequent flyer, http://frequentflyer.oag.com/backissues/12082001/f120701-3.asp. (accessed 27 December 2009).

end, a ceiling was place on the military airspace and no artillery rounds were allowed to penetrate this altitude unless under positive control and in exceptional circumstances.[99]

Actions in operations suggest the integrity of civilian airspace is a key aspect of coordination, and this is in line with current doctrine. The duplication of work and the increased potential for error between civilian and military documents should be addressed if both systems are to be run concurrently.

Electromagnetic Spectrum (EMS)

Growth in the use of the EMS has increased over the past years. From the use of satellites to UAVs for control of the air vehicle and data transfer, to vehicle mounted radio frequency jammers the use of the EMS has become congested. This increase in use increases the potential for a growing number of conflicts. Some of these conflicts can have potentially devastating effects.

> [During the First Gulf War] it was discovered that certain combinations of airborne jammer frequencies could trigger an involuntary launch of Patriot anti-aircraft missiles, as well as some less catastrophic, but equally unexpected events.[100]

The de-confliction of the EMS has traditionally fallen to the signals trade to solve. This section will focus on the role that airspace coordination can play in assisting in the de-confliction.

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[99] Regional Command South, Airspace Coordination Centre, *Standing Operating Procedures Airspace Coordination Cell* (Kandahar: ISAF RC (S), 2007), A-16.

[100] Strategy Page, "Electronic Fratricide Over Iraq," Strategypage.com, http://www.strategypage.com/htmw/htnavai/20080322.aspx (accessed January 5, 2010).

A review of old doctrine reveals that airspace coordination treated coordination with the EMS as a special case limited requirement. Special electronic mission aircraft (SEMA) and heliborne electronic warfare flights where given restricted operations zones (ROZ) in order to conduct their missions. Both types of missions were generally ordered from the corps level and required detailed preplanning and inclusion into the ATO.[101] US EMS doctrine from 1991 specifically states that the "army representatives [in the airspace cell] helps the corps spectrum manager resolve airspace electromagnetic spectrum problems."[102]

With the increase in use of the EMS, it would be expected the de-confliction of the EMS would be discussed in greater detail. Surprisingly in the NATO AJP-3.3.5, there is very little mention of coordination of the EMS. The section on SEMA and heliborne flights has been removed. The only mention of EMS coordination in the airspace is an airspace control means. It is called an Electronic Combat ACM. It is defined as, "Airspace established specifically for aircraft engaging in electronic combat."[103] Any other mention of EMS refers to the ability of the enemy to degrade allied capabilities through the use of electronic warfare. This lack of doctrine and procedures for airspace de-confliction of the EMS may be due to the fact, that many nations rests that responsibility with the J6 or signals branch.[104] However, even in the

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[101] United States of America. Department of the Army, *FM 100-103 Army Airspace Command and Control in a Combat Zone*, 2-24.

[102] United States of America. Department of the Army, *FMI 6-02.70 (FM24-2) - Army Electromagnetic Spectrum Management Operations* (Washington: Secretary of the Army, 2006), 4-12.

[103] NATO, *AJP 3.3.5(A) Doctrine for Joint Airspace Control*, A-12.

[104] United States of America. Joint Staff, *Joint Operations in the Electromagnetic Battlespace* (Washington: Joint Chiefs of Staff, 2008), D-L-1.

new US EMS joint doctrine that replaced the doctrine form 1991, any reference to coordination with airspace coordinators has been removed. Instead, there is only generic mention of coordination.

> Systems such as UAVs and common user "jammers" all use radio frequency spectrum for operation. It is their widespread use and unique operating characteristics that require special planning and coordination to ensure that frequency fratricide is mitigated. [105]

The exception is the doctrine from the UK. Throughout their doctrine at the strategic, operational and tactical level, there is reference to, and a requirement for, EMS coordination and de-confliction with other airspace users. They have implemented Electronic Warfare Coordination Centres (EWCC), which are to integrate and coordinate with the other coordination centres in the headquarters in particular the Airspace Coordination Centre (ASCC).

> Equally, details of any action which may have a potential, possibly unintended, physical or electronic effect in airspace controlled by another agency must be passed on in order to be coordinated or deconflicted.[106]

> Electronic warfare must be coordinated with [artillery] fires . . . radars, Air Defence and surveillance and UAVs, and there must be the avoidance of electronic fratricide.[107]

As the EMS becomes more complex, it must integrate further into the airspace. The failure of the new doctrine to further integrate the coordination requirement is troublesome. Forces in operational theatres are experiencing a greater number of EMS conflicts within the airspace As noted in the example discussed in Chapter 4, it is only

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[105] United States of America. Department of the Army, *FMI 6-02.70 (FM24-2) - Army Electromagnetic Spectrum Management Operations*, 5-2.

[106] United Kingdom. Ministry of Defence, *Battlespace Management*, 4-5.

[107] *Ibid*., 4-K-1

through interpersonal relationships and the awareness of the organizations involved that the issues are being solved, however there remains many more issues where solutions are not easily found. A CO of a UAV squadron in Afghanistan has noted publicly,

> . . . that the service's Silver Fox drone was "very susceptible" to electromagnetic interference. "In particular with our convoys, with our electronic countermeasure systems going off, they really degrade our range," he said. "And then we have a problem recovering [the UAV]."[108]

The issue of EMS coordination with the airspace requires the coordination between the signals branch and the rest of the army. The management of the EMS rests with the signals branch but the coordination and de-confliction of the myriad of assets using the EMS is a joint function. The UK's doctrine provides a model that should be explored by the rest of NATO.

Friendly Ranges and Bases

When soldiers are on a live fire range they are focused on their drills, and are thinking about what their comrade to the left and right are doing. They are not worried about friendly fire from above.

> Once communications were established between the range and the 3 PPCLI Command Post, the TF [Task Force] Rakkasan Tactical Operations Centre, and the KAF [Kandahar Airfield] Tower Sentry at approximately 16:01Z, permission was granted for the ranges to start live fire. . . . The exercise proceeded without interruption until 20:35Z, when the KAF Control Tower imposed a "Check Fire" through the Control Tower Sentry due to an inbound transport aircraft. The "Check Fire" was cancelled at 20:51Z, after the transport aircraft had landed, and firing resumed. . . . . Between 21:10Z and 21:20Z, a flight of two American helicopters approaching Kandahar Airfield from the east observed weapons at the Tarnak Farm Range, approximately six miles from their flight path. . . .

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[108] Nathan Hodge, "US Struggles with "Electronic Fratricide" in Afghanistan," Wired.com, http://www.wired.com/dangerroom/2009/11/us-struggles-with-electronic-fratricide-in-afghanistan/ (accessed January 4, 2010).

> At approximately 21:21Z, at the same time the transiting F-16s were observing and reporting the ground fire to the AWACS, some members of "A" Company reported hearing jets fly overhead. 3 Section continued to fire, not knowing what was transpiring in the skies above them. . . . The bomb impacted at 21:26:01Z, just as Sergeant Leger was climbing up the west wall of the wadi behind Corporal Dyer and Private Smith . . .[109]

The Board of Inquiry from this incident made several recommendations concerning airspace coordination. The reality was they were making recommendations to fix a problem for a circumstance that the doctrine and procedures to that point had never addressed. This section will look at how asymmetric operations has made the airspace coordination for friendly bases and ranges an issue and how the airspace control system has been adapted to address this issue.

On the conventional battlefield, there was enemy and friendly territory. Friendly aircraft did not drop ordinance in friendly territory unless under strict positive control. Friendly ranges were in the rear with specifically named military operations area (MOA) airspace reserved over them in accordance with civilian guidelines.[110] This was done to keep civilian traffic out. Airspace for key military installations were protected by ground based air defence and had a Base Defence Zone (BDZ) placed over them to coordinate aircraft with the air defence. Any key infrastructure forward may have had a no fire area placed around them, but this was a FSCM to stop weapons and aircraft from firing into them. These were limited and for the most part the airspace in the forward area was not limited by restrictive airspace. There was never reason to restrict airspace on the enemy side. As warfare evolved, there was a growing concern to protect sites of

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[109]Canada. Department of National Defence, *Board of Inquiry - Tarnak Farm 2002*, Findings.

[110] International Civil Aviation Organization, *ECCAIRS 4.2.6 Data Definition Standard*.

significant cultural, political or religious meaning. Detailed targeting procedures were developed to ensure proper target selection and prosecution. The airspace structure never envisioned friendly and enemy forces intermingled with civilians over the entire battlespace.

The new doctrine was slow to evolve. The recommendations from the Tarnak Farms BOI point out that the ranges were not listed in the ACO.

> All future Airspace Coordination Orders (ACO) should contain a detailed list, including but not limited to timings, weapons to be used, altitude restrictions and coordinating agencies, of all the live firing exercises scheduled to take place, on any given day, on any of the existing small arms ranges currently in use by Coalition Forces in the Afghan theatre.[111]

As late as 2003, US forces in Afghanistan did not know the location of friendly ranges or bases in the International Security Assistance Force's (ISAF) AO and none of theses were reflected in the ACO.[112]

In fact, the doctrine books do not mention how friendly locations and airspace are to be integrated in to the airspace. Special Use Airspace (SUA) is mentioned as an Airspace Control Measure to cover these particular instances. The SUA was adopted from civilian airspace terminology and was "a peacetime term contained in Federal Aviation Agency Handbook 7610.4, and was used to define airspace for a specific purpose. It may also designate airspace in which no flight activity is authorized."[113] The SUA has been adopted as the method to identify friendly airspace, however it is a catch all ACM, which covers the following types of areas: Alert Area (ALETA), Airspace

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[111] Canada. Department of National Defence, *Board of Inquiry - Tarnak Farm 2002*.

[112] Notaro, *Airspace Coordination in Afghanistan*, 4.

[113] United States of America. Joint Staff, *JP 3-52 Joint Doctrine for Airspace Control in the Combat Zone*, C-B-22.

Control Area (ASCA), Forward Arming and Refuelling Point (FARP), Forward Operations Base (FOB), Military Operation Area (MOA), No Fire Area (NFA), No Fly Area (NOFLY) and Surface-to-Surface Missile System (SSMS).[114] This is the standard for identifying friendly airspace in asymmetric operations. Brigadier General Devil noted in his mid tour update that the SUA, "no fire areas have been emplaced over all major ISAF installations."[115]

From the onset, there was concern from the fixed wing community and airspace coordinators that placing so many SUAs on the map would only clutter an already busy airspace and overly restrict air forces.[116] Unfortunately, there remains no other way to identify and restrict friendly airspace so that another Tarnak Farms incident does not occur. ISAF had eight friendly bases, one ammo compound, one US SUA and five ranges all within a 30km by 20 km region. A fighter pilot could traverse that area in less than two minutes. The challenge this presents was how could this information be graphically displayed for a pilot traveling at mach speeds that it would make sense and just not be a clutter on his map? The BOI identified this very issue.

> If not already in existence, a control and standardization method needs to be developed to ensure that all aircrew fly with accurate airspace coordination information. More specifically, the information that aircrew will have with them while flying, as well as the format in which the information is presented (maps, diagrams, briefing cards) needs to be clearly defined.[117]

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[114] *Ibid*., C-B-4.

[115] Devlin, *Canadian Soldiers Deploy to the Kabul Multi-National Brigade - July 2003,* 6.

[116] Notaro, *Airspace Coordination in Afghanistan*, 4.

[117] Canada. Department of National Defence, *Board of Inquiry - Tarnak Farm 2002*.

To much small detail would clutter the airspace and significantly affect his ability to conduct missions in such airspace. Figure 5.8 represents a small portion of a 2D map a fighter pilot may require. Each SUA represented on the map may have a different altitude or different restrictions for the aircraft's ability to enter or fire into.

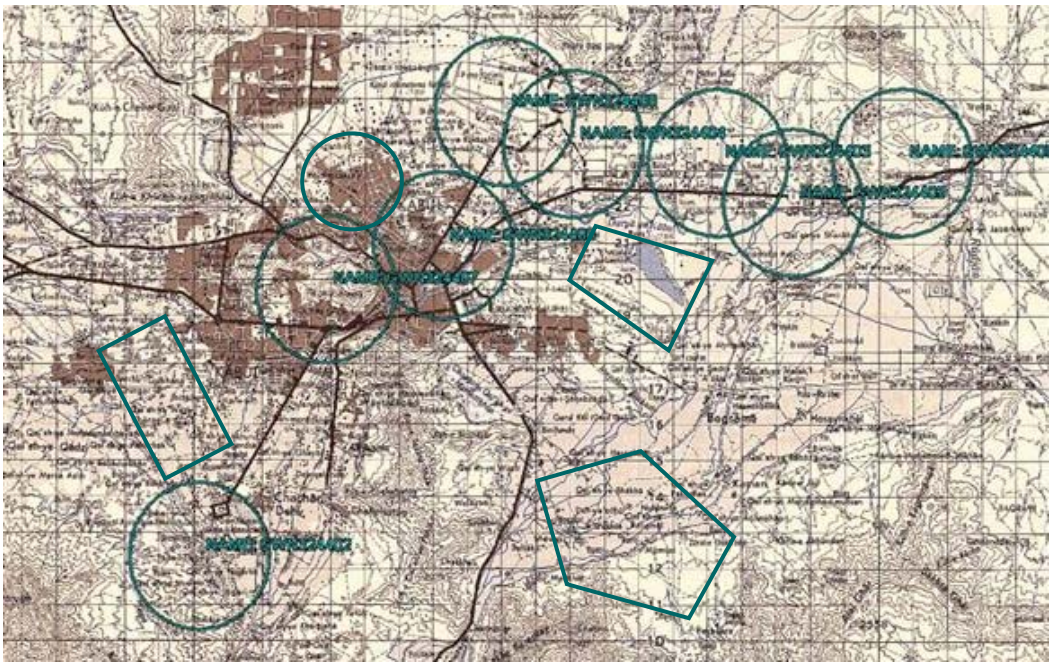

Figure 5.8: 2DGraphical Representation of airspace cluttered with SUA.[118]

Airspace of this nature would be unworkable for a fighter pilot who may have travelled hundreds of kilometres over areas virtually littered with these small areas. "It's very hard for a pilot to know what he can and can't do when there are literally thousands of these [SUA] no-fire areas."[119]

The proliferation of SUAs on the asymmetric battlefield continues to clutter the airspace. Many are put in place merely as no fire areas to restrict aircraft from firing into

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[118] The map is a fictional representation of SUAs on a map of Kabul.

[119] Joe Pappalardo, "Afghanistan Taught US "Hard Lessons" in Close Air Support," *National Defense*, no. August (1 August 2005), http://www.thefreelibrary.com/Afghanistan+taught+U.S.+%22hard+lessons%22+in+Close+Air+support.-a0135117735 (accessed 9 April 2010).

them. One solution may be to populate the battlefield with Forward Air Controllers (FACs) who are trained to control fighter aircraft in Close Air Support (CAS) missions. If this were possible, a force could restrict all aircraft fire to be under the positive control of a FAC. However, the ability of a force to have a FAC at every location on the battlefield where aircraft firepower is required would be near impossible to achieve.

There are other potential options. In areas where there was a large amount of airspace control means or air traffic that required specific coordination a commander, at divisional level or higher, could request and establish an airspace control measure know as a high-density airspace control zone (HIDACZ). A HIDACZ reserves airspace and controls which airspace users have access allowing the commander to restrict other users from the airspace. The HIDACZ would have a specific command, control and coordination organization that would be responsible for all activities in the specified area. This control measure would be used sparingly and only when there was a high level of activity in a defined area.[120] The increased responsibility to control and coordinate the defined airspace would however strain the airspace coordination system.

The ability to identify and protect ground troops and installations is critical, particularly on an asymmetric battlefield where friendly and enemy elements may be intermixed. Currently this is achieved by placing SUAs of varying size, altitudes and restrictions over friendly assets. This has the potential to clutter the airspace and limit the effectiveness of fighter aircraft. Further study in the area is required to ensure the doctrine, procedure and airspace control means available to the operators allow for the most efficient and safe integration of the airspace.

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[120] United States of America. Department of the Army, *FM 100-103 Army Airspace Command and Control in a Combat Zone*, 2-8.

5.3 – MAJOR FINDINGS

The analysis in this chapter has demonstrated there are significant areas of airspace doctrine, tactics, techniques and procedures that need to be further developed. It had identified contradictions as well as areas of discussion that are completely lacking in direction. In some areas, such as rotary winged aircraft operations, doctrine for the army airspace is sufficient to meet the new challenges posed by the asymmetric battlefield. However, overall doctrine has failed to maintain pace with the dynamic complex operating environment changes. In the case of the common grid reference system (CGRS), it seems that new procedures were introduced, by the Air Force and Field Artillery before a full appreciation of its impacts on other airspace users could have been realized. The lack of concrete and clear doctrine and the varying level of training of Airspace coordinators internationally have led to many cases of trial-by-error adoption of methodologies with no discernable course of action comparison. It is clear airspace doctrine and procedures need to continue to evolve. In particular, five specific areas have been identified above as requiring such evolutionary work.

Areas of Contradiction

The contradiction between UK doctrine and US/NATO doctrine to determine if and when civilian or military aircraft have primacy of operations requires clarification. Although the military answer might be that military operations should be priority, restriction of humanitarian flights or limitations on host nation use of their airspace may not be politically tenable.

Areas Requiring Further Development of Doctrine and Procedures

A review of the doctrine and concepts of how fixed winged aircraft will interact with ground troops must be conducted. If in an asymmetric battlefield, it is concluded that all fire effects delivered by fixed winged aircraft must be under conditions of positive control then the role of the forward air controller need to be reviewed.

Doctrine and procedures for UAVs need to be expanded. Technological advancements may take a while before they can provide a solution for the see-and-avoid problem currently being experienced in coordination below the coordination level. Procedural control measures can be refined to provide a better-structured more manageable airspace environment for UAVs and aviation. Further guidance is required on how to effectively and safely operate an airspace control system when both military and civilian airspace and aircraft are involved. The current operation of parallel systems of airspace control is cumbersome and susceptible to errors. A doctrinal concept of a hybrid system needs to be further developed. Finally, the concept of Special Usage Areas (SUA) requires further development to address the issue of multiple friendly locations requiring controlled airspace, resulting in a cluttered airspace that may be overly restrictive to other airspace users.

New Doctrine Requiring Review

The introduction of the fire box as a means to de-conflict fires for artillery or fixed winged aircraft was premature. The procedures overly burden the airspace below the coordination level and cause unacceptable limitations on airspace use to other users

and in the case of Army Aviation, the potential to run out of fuel is a significant safety concern. A method of procedural and positive control must be developed to coordinate the delivery of both weapon and sensor effects in a congested, localized tactical area.

New Areas for Inclusion in Airspace Coordination Doctrine and Procedures

The inclusion of EOD and de-mining operations need to included into doctrine and other publications. New work must determine how specific types of UAVs will be integrated in to the airspace. Loitering UAVs and other munitions are an emerging class of UAVs that have no defined procedure or method for integration into the airspace. As well, the small, hand launched mini and micro UAVs require inclusion in doctrine. Currently there is no concept on how these will be integrated into the airspace. The EMS is currently only represented in the UK's doctrine. It should be expanded into NATO and other countries doctrine. Airspace coordination can play a key role in assisting the Signals Branch in coordinating the EMS. The inclusion into airspace coordination should be added to doctrine of other western countries and alliances.

Areas Doctrine and Procedures should be Sustained

Procedures for army aviation and fixed winged aircraft remain suitable for the current asymmetric battlefield. They should be continuously reviewed as new procedures are introduced for new airspace users to ensure aviation and fixed wing operations are not overly restricted.

5.4 – SUMMARY

This Chapter has determined there are five areas where doctrine and procedures need to evolved or amended. As with any after action review or lessons learned system it is important to determine, what is working, what is not working, what requires improvement, what is being done well and simply needs to be sustained. In the case where new concepts or assets are being introduced it is also important to determine if current doctrine and procedures provide sufficient guidance for the safe and efficient inclusion of the asset or if new procedures need to be developed.

CHAPTER 6

ANALYSIS & FINDINGS

6.1 – INTRODUCTION

Army airspace command, control and coordination seeks to integrate a dynamic variety of airspace users into a flexible and fluid structure with minimal mutual interference between the various users or their intended effects. It achieves this while applying the commander's priorities to the airspace and ensuring the lowest possible level of risk to friendly troops. It is a diverse field covering almost every branch and element of the modern day military force. This task has been complicated further by the ascension of asymmetrical operations in a post Cold War reality and the proliferation of a new airspace user: the UAV. The analysis in Chapter 5 has detailed five areas where doctrine and procedures need to be revised to take account of these new circumstances.

This chapter will review the evidence and provide some additional analysis as to why the doctrine has evolved in this manner. It will further review which findings may be suitable for recommendation to the NATO Joint Doctrine Board and which findings will require further study in the future.

6.2 – REVIEW OF THE EVIDENCE

Areas of Contradiction

As previously noted, this paper has identified only one major area of conflict in new doctrine. The integration of civilian aircraft and airspace in an operational area needs to have a common standard applied to determine when civilian or military aircraft have primacy of operations. The contradiction between UK doctrine and US/NATO

doctrine is subtle and realistically there will have to be a balance between the safety of civilians and the primacy of the military operation. Doctrine needs to account for the fact that the modern battlefield, particularly in stability operations, is conducted in Host Nations who are the ones who ultimately give the military force the authorization to operate in their airspace. To ignore the civilian requirement for the use of their airspace is not feasible, given the demonstrated commercial and social impacts, yet at times the military force must take priority due to the nature of the threat. What the doctrine needs to address is how the balance between when civilian or military aircraft have primacy of operations will be managed and how the transition between the two systems will be achieved.

Areas Requiring Further Development of Doctrine and Procedures

Doctrine must address what control requirements are required for fixed winged aircraft to operate within an asymmetric environment where enemy, friendly troops and civilians are all intermixed. On the asymmetric battlefield, virtually every mission will be in close proximity to friendly troops or civilians. This has necessitated the requirement for positive control for all missions and the expansion of FAC training to qualify sufficient numbers of ground troops to control these aircraft, and has led to the incorporation of a Tactical Air Control Party (TACP) in the HQ structure at divisional level. As well, the asymmetric battlefield has specific Rules of Engagement (ROE) requirements that lead to a focused targeting procedure for the delivery of weapons effects, particularly important for fixed winged aircraft. Airspace coordination measures can assist in solving this problem by identifying the areas for loitering and operation, as

well as, measures that restrict the release of munitions unless under positive control. The airspace structure needs to be flexible enough to be able to allocate the large amounts of airspace to conduct these types of missions on short notice. Targets in enemy territory did not require this level of coordination and missions that were near friendly troops were conducted under positive control, however these tended to be on the front lines where troops were in contact with enemy forces. The requirement for serious airspace coordination consideration was identified after the unfortunate fratricide events in Afghanistan. Within a asymmetric environment fratricides, as periodically seen in the news can have a significant impact on public perception of a mission's success.

As discussed , there is an existing airspace management methodology for fixed wing aircraft in the CGRS, and this has had mixed success in terms of integration with low-level and ground assets. Future airspace doctrine must provide a comprehensive methodology which supports the complete integration of fixed wing aircraft with low-level assets in an asymmetrical environment.

The introduction and proliferation of UAVs of all types has resulted in a significant increase in airspace control measures in the army airspace. To date procedures and doctrine have only tried to find a solution to allowing UAVs and rotary wing aircraft to co-exist in the same airspace. Since current airspace control means are assumed by most commanders to be sufficient to coordinate the current level of activity, there has been no substantial work done on finding a solution to the fast approaching issue of UAVs consuming larger amounts of airspace and negatively affecting aviation operations. The military must critically look at the expansion of UAVs in the army airspace. In particular UAVs that operate at the same altitude at rotary winged aircraft.

Altitude separation is one manner to de-conflict UAVs from rotary wing aircraft. Military forces should consider reviewing the requirement of having UAV that work in all altitudes. Solutions such as tactical level UAVs being restricted to certain altitudes above the operating altitude of rotary winged aviation could be a solution. Current Advancements in collision avoidance technology have been slow to develop. Research should be conducted to verify the feasibility of optic suites that are more suitable for tactical UAVs flying at an altitude above rotary winged aircraft. Procedural control measures can be strengthened to provide a better-structured more manageable airspace environment for UAVs and aviation, however the proliferation of UAVs operating in the same airspace altitude as rotary winged aircraft will eventually become untenable without the ability to directly communication position data to aviation assets, through and avoidance system or direct voice communication.

The current method of integrating civilian and military airspace is to produce the different airspace documents required for both military operations (ACOs, ATOs) and civilian operations (AIP, NOTAMs). Operators, faced with a lack of doctrine, are simply trying to run both systems in parallel. Missions that require operational security are removed from the civilian airspace document and procedural methods are inserted in the civilian documents to ensure de-confliction. This causes a large duplication of work and necessitates a significant level of double-checking to ensure that every time a military mission requiring operational security changes, the changes are reflected in the procedural control measures that were inserted into the civilian document. This is a cumbersome process fraught with potential for human error. A doctrinal concept of a hybrid system needs to be further developed.

Finally, the protection of ground installations and facilities is critical. Further study in this area is required to ensure the doctrine, procedure and airspace control means available to the operators allow for the protection of these assets while ensuring in the most efficient and safe use of the airspace. The increasing numbers of friendly installations are cluttering up the airspace. Faced with a lack of new doctrine to handle this new reality, airspace controllers are simply adding more and more special usage areas to the airspace control map. Multiple small special usage areas with differing restrictions become meaningless to a fixed winged pilot travelling long distances at high speeds. Current airspace control means such as high-density airspace control zones (HIDACZ) are designed for airspace with multiple aircraft that require a greater level of coordination and are not appropriate for this type of problem. Investigation into new airspace control measures that would identify areas with significant numbers of friendly installation requiring positive control of fires may be an option.

New Doctrine Requiring Review

The adoption of the CGRS system as the basis for a kill box in doctrine and tactics publications requires review. It is overly restrictive in the army airspace below the coordination level and the fact that operators in the field have devised their own reasonable and workable solution should give rise to a review. Further analysis and research should be conducted in this problem to determine the optimal size of airspace that needs to be reserved to conduct joint fires. The introduction of the fire box as a means to de-conflict fires for artillery or fixed winged aircraft was premature. The doctrine review noted the procedure started in Air Force doctrine and migrated to the

Field Artillery doctrine, and was subsequently introduced into the airspace doctrine. This control measure is clearly to the benefit of the fixed winged and artillery users of the airspace. However, the kill box overly burdens the airspace below the coordination level and causes unacceptable limitations on airspace to other users. The area requested below the coordination level is simply too large. Further study of the issue and consideration of the procedures currently adopted on operations is required.

New Areas for Inclusion in Airspace Coordination Doctrine and Procedures

The inclusion of EOD and de-mining operations need to included into doctrine and other publications. This paper has identified a complete lack of doctrine is this area. Operators have also identified this as an area of concern, and have instituted the use of restricted operations zones. This method of de-confliction merits inclusion into current tactics, techniques and procedure manuals. Doctrine publications at all levels also need to identify the inclusion of EOD and de-mining as users of the airspace that require consideration.

New analysis must be conducted to determine how specific classes of UAVs will be integrated into the army airspace. UAVs that loiter, looking for a target, and other munitions are an emerging class of UAVs that have no defined airspace control methods to enable their integration into the airspace. These types of UAV present a difficult problem to coordinators. A UAV of this class would simply fly about the battlefield looking for a specific target, or electronic signal. When it finds its target, it attacks it. These UAV could potentially be autonomous systems pre-programmed with their target specifications. The challenge to coordinate these types of UAVs could be significant.

The smaller class of UAV, the small, hand launched mini and micro UAVs require inclusion in doctrine. This class of UAV presents another unique problem to airspace coordinators. Currently there is no concept on how these will be integrated into he airspace. The simple answer may be to leave the de-confliction up to the mini/micro UAV operator and simply advise other users of the airspace that these types of operation may be conducted in specific areas. However, a solution like that would most likely be resisted by the aviation community as it leaves their safety in the hands of another.

Finally, the doctrine with respect to the EMS is lacking. Serious consideration of the UK's model for integration of EMS and airspace coordination should be given. Airspace coordination can play a key role in assisting the Signals Branch with the management of the EMS.

Areas Doctrine and Procedures should be Sustained

The procedures for army aviation and fixed winged aircraft remain workable for the current asymmetric battlefield. They should be continuously reviewed in relation to new procedures for new airspace users as they are introduced to ensure that aviation and fixed wing operations are not overly restricted.

6.3 – SUMMARY OF RESEARCH OBJECTIVES

This thesis set out to analyze current army airspace command and control doctrine, and lack of it, across NATO. It analyzed and identified gaps and inconsistencies between the doctrines from the selected allied countries, and proposed potential solutions. It was determined that coordination measures for EOD are lacking in

allied doctrine and that countries should consider adopting the measures currently being utilized by coordinators engaging in current operations. Temporary restricted operations zones should be considered as a potential airspace control means.

With respect to the EMS integration into the airspace, this thesis determined that the UK's coordination of the EMS into the airspace is far more developed than the rest of NATO. The procedures proposed by the British, are in accordance with the principles of airspace coordination, and should be considered for adoption by other countries and alliances.

The review of current professional writings and lessons learned articles proved interesting. Operators are being innovative in finding solutions to problems when faced by shortfalls in doctrine and procedures. Of particular note was the reconfiguration of the Common Grid Reference System below the coordination level when used for joint fires or artillery fires.

This thesis provides several concrete findings relate directly to the stated objectives of this paper. The first goal was to develop recommendations and proposals that would be suitable for recommendation to the NATO Joint Doctrine Board. The findings are:

a. A TACP should be incorporated into the HQ structure of NATO forces at divisional level;
b. NATO should adopt the EMS airspace coordination procedures and policies as described in UK publications;
c. NATO should adopt the hybrid system of a ROZ below the coordination level and a CGRS cell above the coordination level for all fires de-confliction;

d. It is recommended that NATO work to further develop the procedures for civilian and military airspace coordination, eliminating the potential conflict with British doctrine; and
e. NATO should set standards for UAVs determining what altitude band they should be allowed to operate, allowing for separation with aviation assets.

The second goal of this thesis was to propose joint doctrine challenges for further study for the third dimensional battlespace in the asymmetric modern battlespace. These proposals are:

a. Airspace control means (ACM) need to be determined for loitering UAVs and munitions;
b. Further study is required to determine the best means of protecting dense areas of friendly facilities. Studies should determine if a cluster of varying Special Usage Areas (SUAs) should be used or another newly defined ACM should be adopted; and
c. If it is determined that fixed winged aircraft can only deliver fires under positive control, a review of how best to employ the Forward Air Controller should be conducted..

6.4 – STRENGTHS & WEAKNESSES OF THE ANALYTICAL APPROACH

In an ever rapidly changing environment such as the airspace, an approach that analyses doctrine and procedure publications, past and present can provide a sound basis of the status of the policies and doctrine. It helps to identify what areas of the doctrine

and procedures have evolved, and which ones have remained static. Combine this analysis with a comparison to lessons learned articles and other professional writings and it becomes clear why some areas have evolved and what areas require further development.

One of the challenges of this approach is that lessons learned and contemporary writings are subject to the risk of writer bias. The proposals for the common grid reference proposed by the Air Force and adopted by the Field Artillery seem to benefit their cause in the airspace. For example, it was noted that there were very few articles written by the Air Defence trade, the branch of the army that is responsible for the Army airspace coordination. By contrast, there was an abundance of articles from Air Force and Field Artillery Officers. As well if doctrine was not updated or simply a copy of another countries document, such as Canada's, then it is difficult to assess if the current trend and direction of doctrine is global in nature or just the viewpoint of a single nation. This thesis tried to mitigate these weaknesses by selecting articles from a cross section from the different components of the selected allied countries.

6.5 – CONCLUSION

Based on the research and findings of this thesis, it can be concluded that it has met its aim and stated goals. It was able to determine that the airspace control doctrine is evolving but there are significant areas that need to be reviewed. The analysis also determined that for the most part, there is a common approach and terminology for airspace coordination. The one area where this differs is between the UK and NATO when determining the primacy of the civilian or military airspace system. Finally, and

most importantly the findings point to the conclusion that there remain significant areas for future study and further analysis.

CHAPTER 7

CONCLUSION

7.1 – INTRODUCTION

While no two military campaigns are the same, it is normal to plan for the future based upon lessons learned from past experiences. Doctrine, and the ability for airspace coordinators to learn from past experiences is limited to what happens on operations. Unfortunately, in Canada, airspace coordination is a function that is often only notionally played during exercises and training, and because of a lack of training opportunities, there have been challenges in the advancement of this doctrine. For an airspace coordinator to be successful, one needs to constantly study how each airspace user employs its aircraft and equipment and how each component views the battlespace. This cannot simply be a study of doctrine or tactics, techniques and procedures, but it must critically look at how they actually think and execute their missions. To be successful, airspace coordinators must have the ability to articulate the requirements to properly manage the airspace and understand the concepts of the full spectrum battlefield. Airspace is an integral part of every aspect of the Joint Force Commander's plan and soldiers on the battlefield need a piece of that airspace to operate, and effectively use their weapons. Therefore, airspace coordinators need to understand the Commander's intent and ensure the airspace is properly structured to support the plan

7.2 – SUMMARY OF FINDINGS

Analysis from this thesis determined the following:

a. A TACP should be incorporated into the HQ structure of NATO forces at divisional level;
b. NATO should adopt the EMS airspace coordination procedures and policies as described in UK publications;
c. NATO should adopt the hybrid system of a ROZ below the coordination level and a CGRS cell above the coordination level for all fires de-confliction;
d. It is recommended that NATO work to further develop the procedures for civilian and military airspace coordination, eliminating the potential conflict with British doctrine;
e. NATO should set standards for UAVs determining what altitude band they should be allowed to operate, allowing for separation with aviation assets;
f. Airspace control means (ACM) need to be determined for loitering UAVs and munitions;
g. Further study is required to determine the best means of protecting dense areas of friendly facilities. Studies should determine if a cluster of varying Special Usage Areas (SUAs) should be used or another newly defined ACM should be adopted; and
h. If it is determined that fixed winged aircraft can only deliver fires under positive control, a review of how best to employ the Forward Air Controller should be conducted.

7.3 – FUTURE WORK

This thesis has clearly outlined five areas requiring further discussion, clarification, and agreement. Of these five areas some, such as the coordination of fires is in the collective consciousness as it relates directly to day-to-day tactical operations in theatre, and thus has generated the most advancement and refinement of doctrine. However, consensus is required on the best methodologies and control measures required to ensure fast, effect fire support that does not negatively affect other assets.

Future doctrine discourse should also be focused in two key areas; the integration of UAVs and the integration of the electromagnetic spectrum into the airspace. UAVs constitute the area of largest growth in the use of the army airspace. Their efficiency and success in two large theatres of operation have pushed them to the forefront of sought after military technologies. The addition of mini and micro UAVs as well as loitering UAVs and munitions to the airspace present some of the greatest future challenges to the airspace. Future work should primarily be focused in this area.

The integration of the EMS users in the airspace is also a growing concern. Example of EMS interference and fratricide are increasing as the use of UAVs and improvised explosive devise countermeasures continues to increase on the battlefield. Airspace coordination can play a significant role in aiding the military's Signals Branch by deconflicting the different EMS airspace users.

Finally, from a Canadian perspective, Canada must update its publications to reflect the advancements in airspace coordination. Canada has had an Airspace Coordination Centre in Afghanistan for over seven years. Unfortunately, the majority of successes and refinement of doctrine have remained in theatre, and genuine discourse has

not happened in Canada. These lessons learned need to be captured better, to allow the updating of Canadian publications, and to allow for the comprehensive training of the next generation of airspace coordinators. Due diligence must be exercised to ensure that the refinement of airspace doctrine incorporates Afghan and Iraqi lessons learned but does not become over biased and the doctrine must be developed with a mindset to support any possible theatre.

7.4 - CONCLUSION

The army airspace the tactical to the strategic level is evolving out of necessity. Military operations in the asymmetric environment are pushing airspace coordinators to devise unique and workable solutions to the practical problems they are being faced within the dynamic airspace environment. This thesis set out to analyse army airspace command and control doctrine and in doing so it has identified areas of conflict in doctrine, areas where doctrine is completely lacking, areas where doctrine needs to continue to evolve, areas where new doctrine need to be revisited and areas where doctrine still remains workable. Airspace command, control and coordination have proven to be an area of significant importance to the Canadian and Allied forces engaged in asymmetric operations such as those being encountered in Afghanistan and Iraq. Incidents such as Tarnak Farms demonstrate the catastrophic consequences if airspace coordination fails to respond to the new demands of the modern battlespace. This thesis confirms that the asymmetric battlefield has dramatically changed the way airspace coordination must be conducted. It also proposes concrete steps to achieve substantial improvements in this critical area of joint and combined combat operations. Finally, and

most importantly this thesis demonstrates that there remain significant areas for future research and analysis as technological advances continue to redefine the complexity of airspace management in peace and war.

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