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Joint Engagement Zone (JEZ): Air Defense At The Operational Level Of War

A Monograph
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The study first reviews air defense fundamentals by looking at theory and employment concepts that have developed since the introduction of aircraft on the battlefield brought the need for air defenses. Two campaigns are then analyzed to validate criteria for evaluating air defense effectiveness. A look at service and joint doctrine completes the review of fundamentals. The study concludes with a discussion and analysis of the likely effectiveness of the joint engagement zone concept for US operations.

The study concludes that the JEZ concept can be effective at the operational level of war and future US forces should be prepared to use joint engagement zones when planning and conducting campaigns in a theater of operations.

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ABSTRACT

JOINT ENGAGEMENT ZONE (JEZ): AIR DEFENSE AT THE OPERATIONAL LEVEL OF WAR by Major Robert C. Grosvenor, United States Air Force, 52 pages.

Control of the air and air defense will be major priorities at the operational level in most joint or combined operations. Advanced weapons allow air defense systems to engage airborne threats at longer ranges, thus increasing the possibility of accidently engaging friendly aircraft or simultaneously engaging a threat with more than one system.

Several recent Green Flag exercises (GF 88-3 and 89-4) have demonstrated that employing ground based air defense systems in the same airspace with friendly fighters can increase both fratricide and ground systems' missile expenditures. As one alternative in joint air defense operations (JADO), the JEZ concept could use emerging identification technologies based on non-cooperative target recognition (NCTR) to increase air defense effectiveness while decreasing the possibility of friendly aircraft fratricide.

This study analyzes the joint engagement zone concept to determine the impact on operational level air defense. The JEZ concept provides an increased degree of flexibility by reducing procedural control and maximizing positive control via positive hostile identification (PHID) rules of engagement.

The study first reviews air defense fundamentals by looking at theory and employment concepts that have developed since the introduction of aircraft on the battlefield brought the need for air defenses. Two campaigns are then analyzed to validate criteria for evaluating air defense effectiveness. A look at service and joint doctrine completes the review of fundamentals. The study concludes with a discussion and analysis of the likely effectiveness of the joint engagement zone concept for US operations.

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

LIST OF FIGURES

LIST OF TABLES

SECTION I INTRODUCTION

Time: *0225Z 15 Aug 1996*
Place: *With deployed contingency forces*

Lieutenant General Thomas, the joint force air component commander (JFACC), looked approvingly around the air defense command center. All appeared ready. Both the airborne warning and control system (AWACS) aircraft and the few available ground based early warning radars were providing superb aerial coverage.

The Army air defenses consisting of two Patriot battalions a single Hawk battalion, and two short-range air defense (SHORAD) battalions equipped with the new laser systems, had all batteries fully operational. General Thomas wanted another Hawk battalion, but they were not scheduled to arrive for at least another week. He felt lucky to even have two Patriot battalions.

General Thomas checked the status of the fighter combat air patrols (CAPs) . Like the AWACS, they had been on increased alert since the enemy deployed into his forward airfields two days ago. Also since that time, an AWACS and four fighters had been airborne around the clock. Two Air Force F-15s and two Marine F/A-18s were currently in the forward CAP orbits. The four fighters had been positively identified to all air defense systems by call signs and missions . Other fighters were on 15 minute alert, but once again General Thomas wished there were more fighters available. He had sent numerous requests through the Commander-in-Chief (CINC) to the Joint Chiefs of Staff (JCS), but due to other possible contingencies throughout the world, he would have to make do with his current 72 fighters -- 24 of them older aircraft belonging to the allied country they were operating from.

General Thomas had one nagging doubt. He had ordered a joint engagement zone (JEZ) established because of his limited air defense assets. Although the JEZ had worked well in numerous training exercises, there had never been an actual combat situation were men's lives depended on the success of the concept. Faced with the overwhelming enemy forces and restricted from launching a preemptive attack to gain air superiority, the JEZ was the best option. He pushed away the doubts just as the alert warning klaxon sounded.

Long range radar and higher level intelligence sources confirmed launch of an enemy air attack with

150 - 200 aircraft. General Thomas picked up the hotline to the CINC. After the 30 second conference he turned to the on-duty controller and gave the authorization to engage the enemy aircraft with established JEZ rules of engagement (ROE). The operations center quickly swung into action. Orders went out to Army firing units at the same time ground alert fighters were preparing for takeoff. General Thomas rechecked the actual enemy positions and their approximate numbers. It appeared to be three strikes with 50 to 60 aircraft in each. That was almost half of the enemy's available aircraft!

General Thomas surveyed the situation board that dominated the operations center. Suddenly, numerous smaller blips appeared just across the border, 50 miles ahead of the rest of the aircraft. They must be low-altitude cruise missiles attempting to destroy the allied air defenses prior to the aircraft ingress. Immediately, the air defenses responded. Advanced systems positively identified the cruise missiles as hostile, allowing the air defenses to engage without identifying the targets.

Airborne fighters close enough to intercept began to track and engage the low-flying missiles. The SHORAD units equipped with the new laser systems were alerted and cleared to engage. Quickly, the remaining missiles were destroyed and the defenses refocused on the main enemy aircraft attacks.

Patriot missiles engaged the first aircraft crossing the border in all three strike packages. Simultaneously, allied fighters engaged the groups of enemy attackers. The general showed his concern lest his own ground based missiles or even his own fighters shoot down friendly aircraft in the heat of battle. He knew every missile was important, especially for his Patriot and Hawk batteries.

In the first 15 minutes of the air battle the enemy lost 77 aircraft while the allies lost only 3 aircraft to the escorting enemy fighters. The surviving enemy aircraft broke off the attacks, jettisoned their bomb loads, and fled back across the border. Patriots had expended 40 missiles with 31 confirmed kills, while Hawk units shot 24 missiles with 20 confirmed kills. Allied fighter aircraft had destroyed the remaining 26 aircraft. Additionally, fourteen cruise missiles were destroyed by fighters and SHORAD units. General Thomas smiled to himself. The

joint engagement zone had been highly effective in defending the theater forces and had insured no friendly aircraft were lost due to fratricide.

The preceding scenario could conceivably happen anytime in the near future. Reduced force structure throughout the United States Department of Defense will require all services to work closely together in theaters of operation where our enemies possibly both outnumber us and possess weapon systems as equally sophisticated as our own. New concepts that optimize weapons employment are necessary to insure we maintain an edge throughout the spectrum of conflict. Control of the air and air defense will be major priorities at the operational level in most joint or combined operations.

Air Defense at the Operational (Theater) Level of War

The theater air defense (AD) mission is to defend shared airspace.

> The objective of counter air operations is to gain control of the air environment. Counter air operations protect friendly forces, ensure our freedom to use the aerospace environment to perform other air missions and tasks, and deny the use of that environment to the enemy. The ultimate goal of counter air is air supremacy.[1]

Counterair operations at the operational level or theater of operations are joint efforts to support the

conduct of campaigns or major operations designed to attain strategic goals within a theater of operations. At the operational level, the joint force air component commander (JFACC) plans, controls, and executes counterair operations to support the objectives and priorities of the joint force commander (JFC) and works closely with the land component commander (LCC) in the development of an overall campaign plan. Synchronization of combat power to nullify enemy air operations is essential.[2]

To support the campaign plan, air defenses must engage hostile aircraft entering the airspace while trying to not engage friendly aircraft. At the same time, air defenses must conserve munitions by insuring hostile aircraft are engaged by only one system at a time. The key to the successful execution of theater air defense is accurate aircraft identification, both hostile and friendly. Current air defense operations rely almost exclusively on identification friend or foe (IFF) and selective identification feature (SIF) systems for friendly aircraft identification. Non-cooperative target recognition (NCTR) systems based on advanced technologies may possibly provide additional capabilities to identify both friendly and hostile

aircraft for all air defense systems.

Several recent Green Flag exercises (part of the USAF's "flag" series of training exercises sponsored by the Tactical Air Command), GF 88-3 and 89-4, have demonstrated that employing ground based air defense systems in the same airspace with friendly fighters increases both fratricide and ground systems' missile expenditures[3]. As one alternative in joint air defense operations (JADO), the JEZ concept could use emerging identification technologies based on NCTR to increase air defense effectiveness while decreasing the possibility of friendly aircraft fratricide.

The JEZ concept was initially proposed by both United States Air Forces Europe (USAFE) and Army Air Defense Command (AADCOM) as a possible concept to use in conjunction with the deployment of Patriot ground based missile systems. Due to the increased range and effectiveness of the Patriot, friendly fighter aircraft could be constantly flying in and out of Patriot or Hawk missile engagement zones (MEZ) during combat missions (see Figure 1[4]). With the increased ground based systems capabilities and the problems of sorting friendly and enemy aircraft while airborne, the Office of the Secretary of Defense (OSD) chartered a joint

AIRSPACE SCHEMATIC

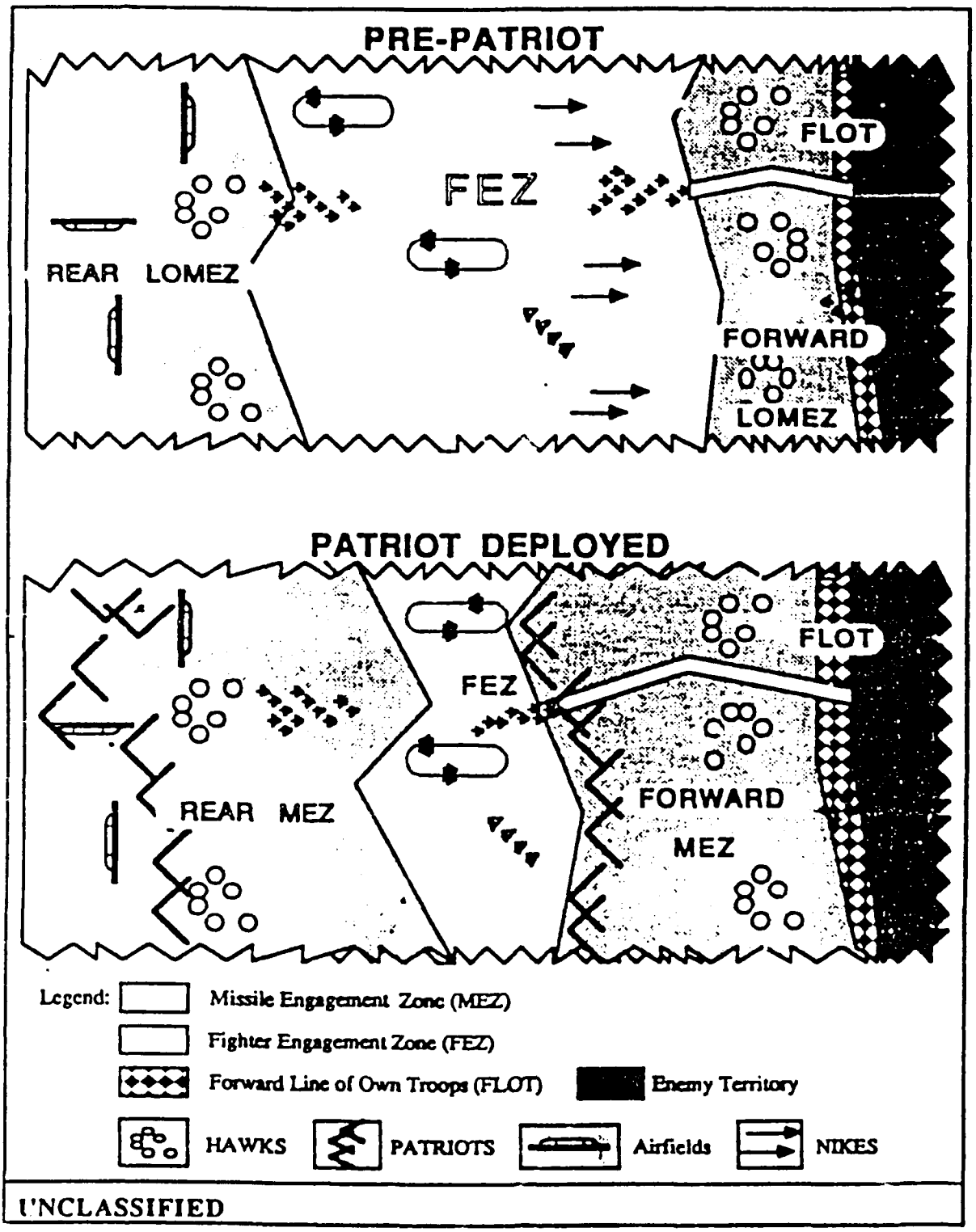

FIGURE 14

test and evaluation (JT&E) of JADO to evaluate the JEZ concept. The JT&E is ongoing, with completion expected in FY 1994. The JEZ concept potentially could have a major impact on operational level air defenses.

Research Question

This study will examine air defense at the operational level and investigate the JEZ concept to answer the question "How will a joint engagement zone concept impact on the modern air defense system for the theater of operations?" Three criteria will be used to answer the question. First, operational air defense should provide adequate defensive coverage for a majority of the vital elements in the theater of operations. Second, operational air defense must be flexible enough to respond to various attacks: diverse types of weapons systems; large-scale attacks: and attacks from multiple or unexpected axes. Third, operational air defense needs to ensure unity of effort, thus maximizing all air defense assets.

Before looking closely at the JEZ concept, a discussion of some air defense fundamentals is necessary. A brief look at air defense theory and employment concepts will establish the basis for operational air defense. Next, historical analyses of

two campaigns in which air power significantly influenced the conflict will review operational air defense elements and illustrate the results gained from executing particular air defense doctrines. To conclude the air defense fundamentals, a review of existing doctrine will show how air defense systems are currently employed.

After discussing air defense fundamentals, the study will describe the JEZ concept and show, based on previously established criteria, the impact a JEZ will have on the US theater air defense system. Finally, the study will offer some conclusions and implications for future US campaigns. The entire study will remain at the operational level of war and not attempt to get into detailed discussion of tactical execution.

Constraints and Assumptions

Two constraints are imposed on this study. First, the study will remain unclassified to allow the widest dissemination possible. Consequently, specific results relating to systems capabilities will not be addressed. The actual reports are available and listed in the bibliography for further review. Second, although passive air defense is extremely important, only active defensive counter air (DCA) operations are considered

in this study.

I have assumed from the JEZ concept JT&E that emerging technologies can be applied to air defense operations allowing increased ability to identify aircraft.[5] Implicit in this is the assumption that defensive systems will not make any revolutionary advances that would negate the emerging identification systems. The study begins first with the discussion of air defense theory and employment concepts.

SECTION II AIR DEFENSE THEORY & EMPLOYMENT CONCEPTS

Beginning in the early twentieth century, the airplane brought a revolutionary new capability to the art of war by incorporating the third dimension over the battlefield. With this new capability there emerged the need to defend territory and forces from air attack. World War I air attacks became the stimulus for many air defense theories.

Theory

One of the first and most influential individual proponents of air power, Air Vice Marshall Guilio Douhet, wrote extensively based on his experiences from WWI. In his major work, The Command of the Air, Douhet

wrote regarding defense against attacking aircraft:

> Aerial offensives were instinctively and empirically met by anti-aerial defense alone, whether operating in the air or from the ground. Thus were born antiaircraft guns and reconnaissance and pursuit planes. But subsequent experience demonstrated that all these means of defense were inadequate....[6]

Douhet further stated that antiaircraft guns were foolish and a waste of resources since "... there is no practical way to prevent the enemy from attacking us with his air force except to destroy his air power before he has a chance to strike at us."[7] With these ideas he initiated the concepts of command of the air and offensive counter air, which today are called air superiority. Douhet's theories led many to believe that a force of heavy bombers were the ultimate weapon and could not be defeated.

A second influential air power theorist was America's own General William "Billy" Mitchell. Mitchell also believed that bombers would be the decisive force in future battles because of their ability to strike the vital centers of the enemy. Unlike Douhet, Mitchell had more confidence in air defense.[8] He advocated a balanced air arm with bombers, pursuit, observation, and attack aircraft to perform specific missions. He believed that a limited

defense against attacking bombers or dirigibles was possible using pursuit aircraft to attack them before they reached the vital targets.

Western air force leaders were greatly influenced by Douhet and to a lesser extent by Mitchell. American and British official interest between the wars was toward strategic bombers with very little development dedicated for pursuit (fighter) aircraft or ground based defensive measures. Fortunately, some research efforts were still directed toward air defense. These efforts brought forth the US P-47 Thunderbolt and P-51 Mustang, the British Hurricane and Spitfire (all fighter aircraft), several larger caliber anti-aircraft artillery (AAA) weapons, advances in fuzes for AAA projectiles, and better searchlights and sound detectors for locating aircraft at night. Air defense theories were applied and new concepts evolved through military operations from World War II (WWII) to the present day.

Employment Concepts

Western air defense employment concepts after 1940 were based primarily on lessons gained from WWII, the Korean war, the Vietnam war, and more recent conflicts in the Mideast. In the beginning, air defense was

provided primarily by fighter aircraft but ground based systems generally have proven more effective in the majority of the campaigns.

Early in WWII radar became critical to operational level air defense because it allowed timely reaction by AAA weapons and also allowed fighters to launch later and mass forces at critical points during the battle. Radar was able to give essential information about target locations, speeds, altitudes, and formations which increased the probability of engaging the targets. Bombers attempted to use chaff (strips of radar reflecting foil) and electronic jammers to deceive enemy radars.

One of the major concepts gained from WWII concerned aircraft identification. The British introduced IFF (codes displayed on radar screens when aircraft electronically respond to ground radar stations) to aid in friendly aircraft identification. Trained observers also assisted in identifying and tracking aircraft throughout each theater. However, correctly identifying aircraft still was very difficult and in every theater of operations there were instances of accidently attacking friendly aircraft.

Several other important concepts gained from WWII pertained to flak (the allies' name for enemy AAA). Flak was the most lethal form of air defense -- destroying more allied aircraft than any other enemy weapon. The increase in flak's effectiveness was partly due to rapidly evolving technologies such as target radars located with the guns and proximity fuzes for the shells. Flak made low-level aircraft operations very costly. Even when not actually destroying aircraft, flak remained highly effective by decreasing medium altitude bombing accuracy, distracting the aircrews, and assisting friendly fighters in visually locating target aircraft.[9] All of the lessons and concepts from WWII resulted in overturning the widely held theory of invincible bombers that Douhet, Mitchell, and other air power proponents had fostered before the war.

One weapon that began limited use during WWII was flak rockets--the precursor to surface-to-air missiles (SAMs). SAMs were an important technological advance in air defense and would have a great influence on air defense employment concepts and operations. The next major changes in air defense concepts occurred during the Vietnam War.

The large-scale use of SAMs in Vietnam had a marked effect on air operations as the US endured extensive SAM engagements over North Vietnam. While US tactics and methods evolved to counter the SAM threat, more US aircraft became susceptible to the other portions of what evolved as an integrated air defense system (IADS). This system incorporated AAA, SAMs, and fighter aircraft to make a multiple layer air defense. AAA was the most effective weapon during the Vietnam war, accounting for over 70% of USAF fixed wing loses (see Figure 2[10]).

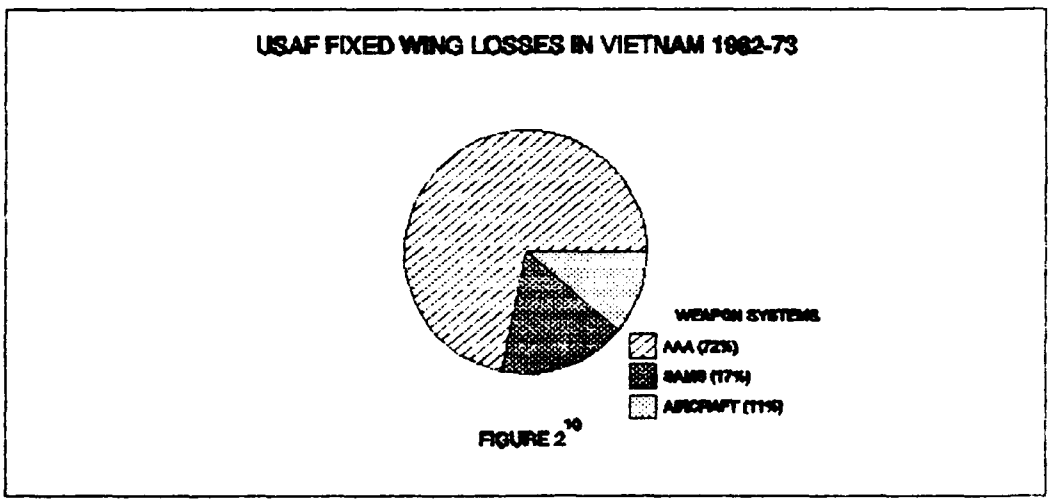

FIGURE 2[10]

The IADS concept remains one of the basic elements in modern air defense theory. Modern day air defense concepts uphold the importance of an integrated system.

Most concepts are derived from recent conflicts in the Middle East--the Arab/Israeli conflicts, the USSR war with Afghanistan, the Iran/Iraq war, and the most recent Operation Desert Storm. The British war in the Falklands provides valuable insights, especially for a maritime perspective. Each one of these conflicts has influenced current air defense employment concepts.

The basic premise for air defense concepts is that air defenses must protect critical assets from different types of threats. The increased speed of aircraft and reduced radar ("stealth") technology have increased the problems for air defenses. Air defense systems must detect hostile air attacks early enough to identify the threat while still allowing enough time to engage the threats.

Modern air defense weapons systems need to provide a high probability of negating initial attacks while retaining sufficient defenses in depth to insure vital assets remain functional. The detection and identification of threats is accomplished by a combination of intelligence and early warning (radar or observers). The depth of defenses should include several different types of systems so that if an enemy attempts to exploit a weakness of one system, another

system can successfully engage the target.

To provide overall control of the air defense system a centralized command and control system is necessary to insure unity of effort. With a variety of systems and centralized control, the electromagnetic spectrum is vital to air defense operations.

The electromagnetic spectrum has become critically important because it is required for target detection, weapons aiming and guidance, and for some identification systems. In order to deny hostile forces the use of the electromagnetic spectrum, additional systems have been developed (electronic counter measures [ECM] and electronic counter-counter measures [ECCM]). Electronics is an area that needs to be exploited. "The future seems to belong to those who can best use...modern, high-cost, high technology in combat."[11] Electronics is an important element of air defense operations and has significantly impacted air defense employment from its beginnings in the early twentieth century.

Air defense theory was derived from early air power theorists with employment concepts refined in most larger campaigns during the twentieth century. Modern day operational level air defenses must be

flexible and redundant to protect critical assets throughout the theater. The air defense system should also have a unified command and control (C^2) system to optimally integrate various weapons systems. With these concepts firmly in mind we conclude the discussion of air defense theory and employment concepts. Next, the study turns to the historical analyses of two campaigns in which air power played a significant role.

SECTION III HISTORICAL ANALYSES

The two historical campaigns, the Battle of Britain and the 1973 Arab-Israeli conflict, were selected because of the significant influence of air power and the impact air defenses had on the campaigns. These two campaigns will show both successful and unsuccessful air defense operations. The analyses will examine operational issues in each theater in order to validate the proposed criteria for determining the impact of the JEZ concept on the theater air defenses.

The Battle of Britain

The German high command realized that before beginning the invasion of the British islands they

needed to have air superiority over both the English Channel and the landing beaches for a successful initial assault[12]. The Luftwaffe primarily relied on its bomber forces during Blitzkrieg's rapid conquest of the European continent. Now the fighter arm of the Luftwaffe would become more important as the British organized an air defense system relying principally on fighter aircraft.

The operational level of British air defense was Royal Air Force (RAF) Fighter Command, commanded by Air Marshal Sir Hugh Dowding (also Commander in Chief of Air Defense of Great Britain). RAF Fighter Command consisted of four Fighter Groups, the Observer Corps, Radar Group, Balloon Command, and also had operational control over Anti-Aircraft (AA) Command which contained seven divisions with AAA and searchlights.[13] The primary resources available for air defense at the beginning of the battle were 988 fighter aircraft[14], 1,279 heavy guns[15], 3,000 light guns, 20 early warning radars, and 2,204 balloons. The Luftwaffe had 1,576 bombers (all types) plus 1,089 fighter aircraft.[16] The actual outcome of the battle depended mainly on the match between the 700 Hurricanes and Spitfires and the 1,100 German fighters.[17] While AAA played a secondary

role it still accounted for 357 of the 1,733 German aircraft the British claimed to have destroyed from 10 July 1940 to the end of the war.[18]

During the Battle of Britain the air defense system successfully defended Great Britain, never allowing the Luftwaffe to gain even limited or local air superiority. However, the air defenses were not entirely adequate because Luftwaffe bombers were continually able to attack critical assets throughout the theater. Luftwaffe bombers caused massive damage in London (a British strategic decisive point). By attacking RAF bases and support facilities (British operational center of gravity was the RAF; bases and EW radars were operational decisive points) the Luftwaffe caused extensive damage and had they continued these attacks, might have gained air superiority.

One of the major successes for the British was Fighter Command's flexibility in responding to changes in Luftwaffe tactics and weapons. Night bomber attacks using radio beacons were initially very successful as were attacks later by V-1[19] "buzz bombs". However, Fighter Command responded by increasing available night fighters and improving intercepts of the V-1s. The V-1 effectiveness was decreased by repositioning AAA

batteries to the seacoast and by adding additional barrage balloons. The air defenses were successful in destroying almost 53% of all the V-1s launched at Great Britain (see Table 1).

Results of German V-1 Attacks Against Great Britain

Total V-1s fired against Great Britain:	10,492	
Crashed shortly after takeoff (approx):	2,000	
Defenders observed:	7,488	
Total shot down:	3,957	(52.8%)
Credit		
Fighters:	1,847	
AAA:	1,878	
Balloons:	232	

Table 1[20]

Unity of effort was another key to success because Fighter Command maintained overall control of EW radars, observers, fighters, AAA, and balloons. Fighter Command overcame insufficient resources by exercising effective command over the available resources and by having enough flexibility to respond to unanticipated operational requirements.

The British were successful because their operational level air defense allowed them to accomplish the strategic goal of preventing the Germans

from invading the country. The second historical analysis discusses the 1973 Arab-Israeli conflict, focusing on the failure of Arab operational air defense.

1973 Arab-Israeli Conflict

Following the unsuccessful 1967 Six Day War against Israel, both Egypt and Syria rebuilt their air defense systems. The Arabs made a decision to counter the Israeli Air Force with ground based air defenses. With large quantities of Soviet systems, especially modern SA-6s, the Arabs were planning to gain air neutrality[21] over the battlefield so that their superior numbers of ground forces could defeat the ground Israeli Defense Force (IDF) They planned to gain air neutrality by deploying an extensive mobile air defense umbrella (initially Arab operational center of gravity, then became an operational decisive point) to prevent the Israeli Air Force (IAF)(Israeli operational decisive point) from significantly influencing the ground battle. Egypt and Syria prepared similar air defense systems.

Egypt formed a large separate air defense service in 1968, comprising almost one-fourth of its total armed forces. This force included all Egyptian Air

Force (EAF) aircraft (including approximately 430 Soviet fighters) and 150 SAM batteries (46 of them were new Russian SA-6s, the remainder were SA-2s and SA-3s). Additionally, they had 128 platoons equipped with 15-20,000 SA-7 missiles. AAA pieces ranged from 12.7mm to 100 mm guns and numbered approximately 3,000.[22]

Syria's air defenses were numerically smaller, but they were actually denser than the Egyptians because of the reduced front they were operating on. The Syrians had 47 SAM batteries (32 SA-6s and the rest SA-2s and SA-3s). They also had 64 platoons with approximately 10.000 SA-7 missiles. Almost 2,000 AAA guns were deployed, ranging from 12.7mm to 130mm.[23] Both Arab countries had other Soviet air defense equipment including a small number of highly effective ZSU 23-4 four barrel 23mm AAA.

Initially the Arabs were very successful because they exploited the element of surprise and their ground based air defenses took a large toll of Israeli aircraft. They staked the success of their air defenses on forward units maintaining the air defense umbrella and not allowing Israeli aircraft to penetrate into the rear areas where the defenses were not as prepared. The Arabs did not use their own air forces

very much because their aircraft could not match the Israeli aircraft qualitatively nor could their pilots match combat skills when confronting the Israelis. As the war proceeded, the Israelis were able to suppress the Arab ground based air defenses by using a combination of anti-radiation missiles (ARM--air-launched missiles designed to home in on radar transmitters) and by using artillery to destroy the mobile SA-6s.[24] Toward the latter part of the campaign, Israeli ground forces crossed the Suez canal and directly attacked Egyptian SAM batteries. With the SAMs neutralized, the IAF was able to attack the rear areas containing C^2 systems (operational decisive point) and then destroyed the EAF on the ground and in air-to-air combat.

During this war the Arab air defenses were successful for the first week, but eventually failed in all critical elements at the operational level. The deployment of mobile ground based air defenses, especially modern SA-6 batteries and the multitude of man portable SA-7s, surprised the IAF. However, the failure of the air defenses centered on the lack of fighter aircraft (primary operational decisive point) adequately prepared with trained pilots to compliment

the ground based systems. Once the Israelis had penetrated to the rear area the EAF was not capable of protecting critical assets, including its own airfields. Additionally, they lacked a plan to reinforce the air defense umbrella once the Israelis were able to negate air defense coverage in selected areas. The Arabs lacked unity of effort at the operational level because they did not organize the two fronts into a coordinated effort. Furthermore, the Egyptians did not integrate the SAMs with the fighters which resulted in the Egyptians destroying approximately 35 of their own aircraft.[25] Finally, the Arabs lacked flexibility to respond effectively when they were confronted with a changing situation and did not have branch plans to cope with the new situation. At the operational level, the air defenses were unable to successfully protect the Arab ground maneuver forces during the campaign and further allowed the IAF to attack critical rear area assets. Thus, operational level air defense failures reduced the Arabs' ability to achieve strategic goals.

The analysis of the two campaigns has provided a means to further examine critical operational level air defense elements and validate these elements as

criteria for determining the impact a joint engagement zone will have on present day operational air defenses. Next, the study will review present air defense doctrine for a fuller understanding of current operational issues.

SECTION IV COUNTER AIR DOCTRINE

This study is directed toward the defensive counter air (DCA) subcomponent which is defined by JCS Pub 26 (3-01.2) as "The protection of assets from air attack through both direct defense and destruction of enemy's air attack capacity in the air."[26] The discussion will continue to concentrate on air defense at the operational level of war. Each service's doctrine must integrate into joint doctrine to ensure effective operational level air defense.

US Army

Airland Battle doctrine emphasizes the importance of the air dimension:

> *Air Dimension.* The airspace of a theater is as important a dimension of the ground operations as the terrain itself. ... **The control and use of the air will always affect operations; the effectiveness of air operations in fact can decide the outcome of campaigns and battles.** ... They [commanders] must **protect** their own forces

> from observation, attack, and interdiction by the enemy and expect the enemy to contest the use of airspace.[27]

Control of the airspace is critical at the operational level of war since air operations can decide the outcome of the battle. "All counter air systems must be integrated to preclude the attack of friendly aircraft and to engage hostile aircraft."[28] Protecting the forces of the theater commander is the job of theater counter air operations. FM 44-100 further emphasizes the operational level impact of integrating all Army air defense artillery (ADA):

> Army air defense supports joint counterair objectives and is an essential player at the theater level. ... The Army's primary active DCA force is ADA, which provides dedicated low-, medium-, and high-altitude air defense systems.[29]

Army ADA is integrated into the overall air defense system through the use of weapons control statuses such as "weapons free", "weapons tight", or "weapons hold".

TRADOC Pamphlet 11-9, Army Programs: Blueprint of the Battlefield, places air defense (DCA) under the Operational Protection OOS (operational operating system) stating:

> "Operational air defense is always joint and can be a combined activity. Army operational air defense is under the theater air defense command (ADCOM),...the ADCOM will be under the operational

> control of the air component commander for joint theater counterair operations."[30]

In Appendix C, section 3.1, the primary air defense activities are listed as: process operational air defense targets: provide airspace control; and attack enemy air defense targets. Theater air defense integrates joint and combined operational air defense forces by providing airspace control through the use of positive and procedural control measures[31]. Air defense command and control (C^2) establishes readily identifiable electronic, visual, or other means of identification crucial to survival of friendly aircraft in the event positive control measures fail. Close cooperation between US Army and Air Force is essential for successful air operations throughout the theater.

US Air Force

One of the fundamental principles of US Air Force doctrine is to establish one authority for air defense and airspace control. AFM 1-1 addresses the reasons for central authority:

> Through central authority, an air commander gives **unity and coherency** to the defensive effort and to controlling the aerospace environment. The planned and coordinated use of airspace gives **flexibility** to the self-defense of surface forces and helps prevent inadvertent attacks on friendly forces.[32]

The central authority is usually the air component commander who, as the JFACC, has the main responsibility for determining positive and procedural control measures throughout the theater of operations. The JFACC works closely with the LCC to insure critical assets are given priority protection while maximizing the employment of all air defense systems.

US NAVY

The US Navy (USN) term for counter air operations is anti-air warfare (AAW). Naval Warfare Publication 32 (Rev K) (Confidential), specifically chapter 7, establishes the USN doctrine and concept for coordinating AAW engagement tactics during maritime operations. Naval AAW operations are different from land based counter air due to the much larger distances involved, difficulties in communications between forces spread over a larger area, and the multi-dimensional threat. Specific areas are established around the naval task force to provide air defense (refer to Figure 3[33]).

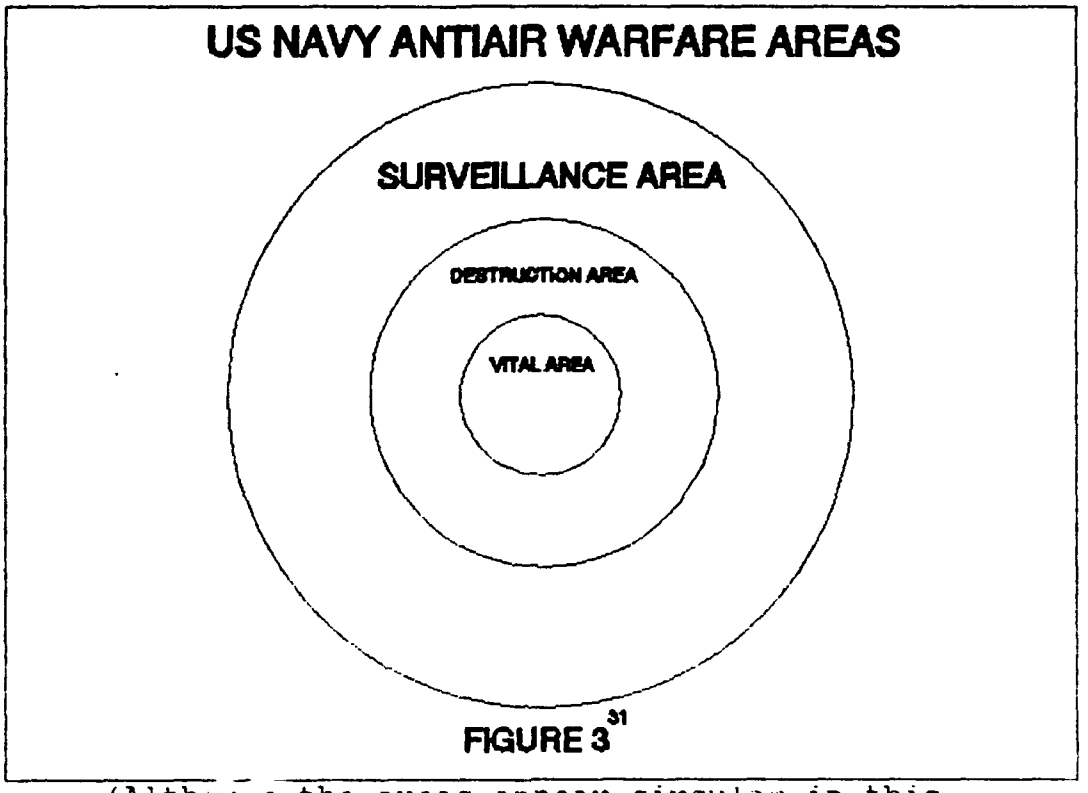

FIGURE 3[31]

(Although the areas appear circular in this example, the size and shape can be altered based upon the intelligence estimate of the threat capabilities and the specific task force deployment.)

The "vital area" contains primary units of the task force. Unidentified targets entering this airspace will be engaged immediately either by short-range SAMs or by AAA. The "destruction area" is the zone next closest to the task force. This zone is where enemy airborne threats are planned to be destroyed. Unidentified threats entering this zone are subject to engagement from either missile or aircraft

systems. The outer "surveillance area" is the first zone an airborne threat enters. Friendly interceptor aircraft are normally airborne and available to identify and possibly engage targets entering this zone.

Integrating the various weapons systems is one of the most difficult tasks facing the AAW coordinator. He must maintain a clear and accurate picture of the entire area. The most critical aspect is timely and accurate information exchange regarding airborne aircraft identification. The AAW commander can employ his air defenses by using area coordination, zonal coordination or a combination of the two. The combination of the two types provides the most capability for air defense, but also risks higher probability of engaging friendly aircraft.

US Joint (JCS)

Joint counterair operations are essential to gain control of the air and to protect US forces. JCS Pub 26 (3-1.02) defines counterair operations as:

> Those operations conducted to attain and maintain a desired degree of air superiority by the destruction or neutralization of enemy forces. Counterair operations include such measures as the use of interceptors, bombers, antiaircraft guns, SAMs, and ECM, to destroy the air or missile threat both before and after it is launched....

> Both offensive and defensive actions are involved. The former range throughout enemy territory and are generally conducted at the initiative of the friendly forces. The latter are normally conducted near or over friendly forces and are generally reactive to the initiative of the enemy air forces.[34]

Joint doctrine for air defense attempts to coordinate and integrate air defense systems under a single commander. Normally the Air Force component commander will be the area air defense commander. Other service components will provide representatives and liaison officers to the AD headquarters. The best theater air defense is obtained through complete system integration based on compatible doctrine.

Joint doctrine incorporates air defense doctrine and concepts from all services to make the most effective operational level air defense system possible for the theater of operations. The underlying concepts of US doctrine are to detect, identify, engage, and destroy hostile enemy air forces. The key elements throughout all of the doctrines are accurate identification, centralized control, and multiple integrated systems to insure adequate protection of critical assets. Currently, most air defenses engage targets that are **not confirmed friendly**. Aircraft identification is based on using both positive and

procedural control methods. These two methods offer the best compromise between successfully engaging the enemy and in protecting friendly airborne aircraft. With better identification systems the single air defense authority could more effectively employ an operational air defense system.

The study now looks at the joint engagement zone to determine how the concept will impact operational level air defense.

SECTION V JOINT ENGAGEMENT ZONE CONCEPT

> "CENTCOM has a special interest in the JADO/JEZ JT&E." It offers "significant improvements in both joint and combined air defense operations."
>
> USCINCCENT (Gen Schwarzkopf), 131701Z Jun 90 Msg[35]

Joint air defense operations (JADO) are critical at the operational level of war. The goal is to maximize the effectiveness of each weapon system while eliminating problems and vulnerabilities. Integrating the weapons requires making tradeoff decisions between air mission flexibility, possible fratricide of friendly aircraft and air defense effectiveness. New technologies may make the joint engagement zone concept the most effective operational level air defense.

Joint Engagement Zone Description

The joint engagement zone concept is based on emerging technology that will enable positive hostile identification (PHID). Rather than looking for friendly aircraft electronic codes, all aircraft are identified by one or more systems. Those aircraft positively identified as hostile are engaged. Likewise, aircraft identified as friendly are continuously tracked to preclude accidently engaging them later. Currently, a number of devices capable of positive hostile identification are in use throughout the air defense and intelligence communities. Each device analyzes different aircraft characteristics and provides data to a central facility that collects and verifies the information. Once a specified number of devices correlate a hostile identification, that aircraft is entered into the air defense system as a positive hostile and it is subsequently engaged.[36]

Under the JEZ concept, a volume of airspace in the theater is identified with specific dimensions (latitude/longitude or by grid coordinates along with minimum/maximum altitudes). Within this airspace, multiple air defense weapons systems of one or more services are simultaneously employed (see Figure 4).

The joint engagement zone concept allows several weapons systems to operate in the same airspace volume against airborne threats. With multiple systems covering the same zone of airspace the air defenses can ensure that each of the critical assets in the theater are protected by a layered integrated air defense system. As the history analyses showed, an air defense system that does not have adequate and varied weapons can be penetrated. However, a layered integrated air defense system provides adequate defenses that will make the enemy air forces pay a high price for attacking critical targets that are heavily defended.

The demonstration test that took place during Green Flag 89-4 involved a composite Patriot and Hawk battalion with up to 43 friendly aircraft (35 aircraft across the FLOT and 6-8 support aircraft) and up to 10 adversary aircraft. The adversaries attacked the friendly forces ingressing the target vicinity and egressing the area. Additionally, the adversaries simulated a limited number of attacks against friendly SAMs. The test concentrated on evaluating emerging technologies for identifying aircraft and on determining what procedures are necessary for operating a joint engagement zone effectively. Despite some

JOINT ENGAGEMENT ZONE DEPICTION

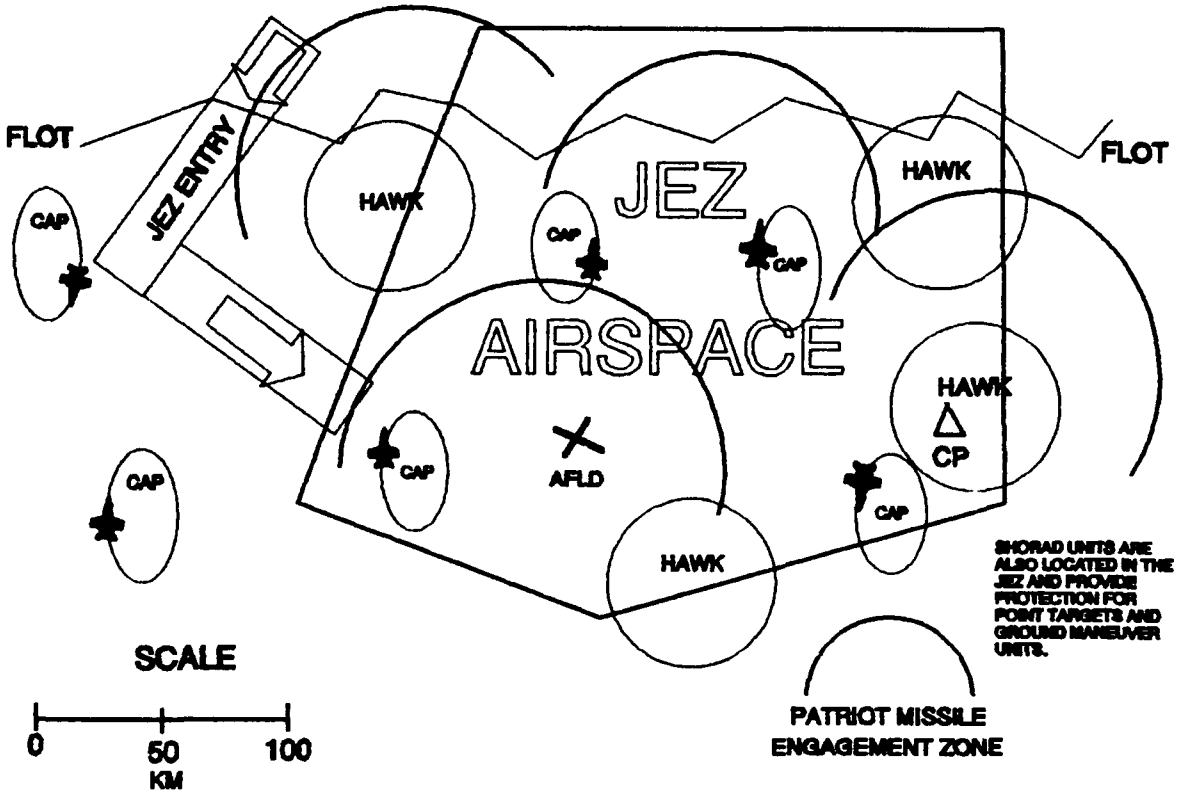

FIGURE 4

limitations the exercise was able to test the JEZ concept enough to encourage further development and continued investigation of the concept.[37]

Impact on Theater Level Operations

With a joint engagement zone delineated in the theater of operations, a dense layer of air defenses would cover the area. The critical assets in the theater could have several ground based air defenses dedicated to their point defense while aircraft operating simultaneously within the same airspace can provide defense against other enemy airborne threats. All weapons systems would be able to engage targets at ranges close to their maximum limits, thus allowing more reaction time and several opportunities to destroy the threat prior to it entering the target area. Most importantly, the JEZ concept enables each weapon system to operate unconstrained which allows a higher likelihood of successfully intercepting enemy airborne threats. A joint engagement zone could more than adequately provided air defense coverage for critical assets throughout the theater of operations.

The joint engagement zone concept allows a high degree of flexibility by reducing procedural control and maximizing positive control via the PHID

identification ROE. Any friendly aircraft airborne can be identified and monitored throughout his mission thereby ensuring he is not accidently engaged by friendly air defenses. The advanced technological identification systems for the joint engagement zone insures friendly aircraft are identified even if they are not equipped with electronic identification systems (such as allied aircraft in different regions of the world) or if the system is not operating properly. With all air defenses centrally controlled and using an integrated system of PHID, each system is more effectively employed with minimal chance of either engaging the same target simultaneously or of accidentally engaging friendly aircraft.

The largest disadvantage in establishing a joint engagement zone would be the necessary procedures to determine aircraft identification if the PHID systems are not fully operational or they are being jammed by the enemy. Prior to flying any mission, pilots would be given JEZ entry procedures to follow in case the identification systems fail or the enemy is able to successfully attack the air defense C^3. If that happens, the unified control system (tactical air control center or equivalent) must tell the pilot to

enter the JEZ airspace at the previously specified altitudes, headings, and airspeeds in order to be identified as a friendly aircraft. Even if unable to enter the JEZ within the specified procedures, the aircraft must still be positively identified as hostile before the air defenses would engage -- unless the aircraft committed a hostile act. The entry requirements at other times would be totally unrestricted as long as the PHID systems were working properly. Thus, even with the restrictive entry procedures, a joint engagement zone would increase air defense effectiveness throughout the theater.

> The JEZ concept of engaging targets positively identified as hostile offers the AD community a high payoff: fratricide and stringent airspace control procedures will be reduced; friendly fighter interceptors will be more flexible (as will ground attack fighters) because they will not be constrained by AD procedural control measures nor engaged by friendly AD; and, rules of engagement by friendly ground based systems will be simplified, significantly reducing the task levels and responsibilities of operators now in control centers. Operators will still be concerned with simultaneous engagements, but problems of identification and monitoring procedural controls will be greatly reduced. Overall, AD and the combat forces they support could have a significantly increased warfighting capability.[38]

The joint engagement zone is designed for operations across the entire spectrum of conflict both in contingency and established theaters of operation. A JEZ could be useful if there is any combination of Navy carrier battle group(s), Marine aviation, USAF fighter aircraft, and ground-based air defense systems protecting theater forces conducting combat operations.

SECTION VI CONCLUSIONS AND IMPLICATIONS FOR US AIR DEFENSE

> JADO/JEZ can "dramatically cut Air Force/Army fratricide ... critical during future combat operations ... allows use of latest means of target identification and allows for the utilization of improved systems in the future ... can be applied across the spectrum of US forces and may be expanded to provide an effective way for our forces to interface with those of host nations."
>
> USCENTAF/CC (LtGen Horner)
> 18 May 90 Ltr[39]

The joint engagement zone concept is an option for joint air defense operations that can provide exceptionally effective operational air defense. Through the use of emerging technologies for the positive hostile identification of airborne threats, a JEZ could offer a truly integrated air defense system

that maximizes each system's capabilities and provides the best air defense protection for the theater of operations.

Simultaneous operation of interceptors and SAMs within the same weapons employment zone can greatly increase the overall air defense effectiveness. The joint engagement zone could assist the joint force commander in executing his campaign plan by protecting the forces at the operational level of war.

The major implication of the JEZ concept is that operational air defense may need to be placed under control of a single service. This possibility was the first of the 31 initiatives worked on by US Air Force and Army chiefs of staff in 1983[40]. The major advantage would be a single proponent for all air defense issues which would insure the appropriate mix of air defense systems for use against present and anticipated threats. If we employ operational air defenses under joint and multi-service doctrine, conduct operations within the same airspace, integrate C^2, and coordinate the purchase of air defense systems, then we may gain effectiveness and reduce costs by making the US Air Force the lead service for area air defense. This would include ground based air defenses

except for SHORAD units that are for point defense. The analysis of that possible action is beyond the scope of the present study, but would be a worthwhile study, especially with recent air defense employment concepts that may emerge from the Gulf War.

The joint engagement zone is a useable concept that could be employed at the operational level of war to increase air defense effectiveness. All services should study the joint engagement zone and prepare to use it in future operations once appropriate doctrine and tactics have been developed for the detailed execution of this concept.

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12. Hitler directive (No.17), 1 Aug 1940. "In order to establish the necessary conditions for the final conquest of England (the Luftwaffe must) overpower the English air force with all the forces at its command, in the shortest possible time."

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14. 59 1/2 fighter squadrons (31 Hurricane, 20 Spitfire, 6 Blenheim [night], 2 Defiant, 1/2 Gladiator).

15. Mainly 3.7", 4.5" and old 3" guns.

16. Hough and Richards. pp. 380-6. Appendices contain excellent detailed lists of the orders of battle ror both sides in the campaign.

17. Ibid. p. 112-3.

18. Werrell. p. 5.

19. Hitler's Vengeance weapon 1 was a flying bomb with very small wings. Weapons were initially launched at Britain from Peenemunde. V-1s were later launched at Britain and Brussels from other sites in German controlled Europe.

20. Werrell. p. 18-19.

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GLOSSARY

The following explanation of terms is provided to clarify and assist in understanding the JEZ conceptual framework:

JADO - Friendly interceptors and SAMs operating jointly (but not necessarily in the same airspace) to maximize air defense effectiveness with a minimum risk of fratricide to all types of air missions.

WEZ (weapon engagement zone) - A region of airspace in which the use of particular air defense weapons have preference.

FEZ (fighter engagement zone) - A region of airspace where interceptors have precedence.

MEZ (missile engagement zone) - SAMs given precedence in air defense operations.

JEZ - Friendly interceptors and SAMs operating in the same airspace (specified dimensions) at the same time.

ABBREVIATIONS AND ACRONYMS

AAA	anti-aircraft artillery
AD	air defense
ADCOM	Aerospace Defense Command
AFM	Air Force Manual
ARM	anti-radiation missile
ATP	Allied Tactical Publication
AWACS	airborne warning and control system
C^3	command, control, communications
CAP	combat air patrol
CINC	commander-in-chief
EAF	Egyptian air force
ECM	electronic counter measures
ECCM	electronic counter-countermeasures
EW	electronic warfare
FEZ	fighter engagement zone
FLOT	forward line of own troops

FM	Field Manual
HIMEZ	high altitude missile engagement zone
IADS	integrated air defense system
IAF	Israeli air force
ID	identify or identification
IDF	Israeli defense force
IFF	identification friend or foe
JADO	joint air defense operations
JCS	Joint Chiefs of Staff
JEZ	joint engagement zone
JFACC	joint force air component commander
JFC	joint force commander
JT&E	joint test and evaluation
LCC	land component commander
MEZ	missile engagement zone
NCTR	non-cooperative target recognition
OSD	Office of the Secretary of Defense
PHID	positive hostile identification
RAF	Royal Air Force
ROE	rules of engagement
SAM	surface to air missile
SHORAD	short-range air defense
SIF	selective identification feature
TTP	tactics, techniques and procedures
US	United States
USAFE	United States Air Forces Europe
USCENTAF	United States Central Air Force
USCENTCOM	United States Central Command
USSR	Union of Soviet Socialist Republics
WEZ	weapons engagement zone

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