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GUNSHIP DIPLOMACY: CARRIER-BASED CLOSE AIR SUPPORT FOR JOINT EXPEDITIONARY FORCES

by

Taylor C. Emanuel

December, 1994

Thesis Advisor: James J. Wirtz

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This study examines whether current and future strategy, doctrine, and programmed systems are suitable to perform fire support and specifically, close air support (CAS) and close air support/troops-in-contact (CAS/TIC) missions for joint expeditionary warfare. Naval forces will provide the "enabling" power for this new come-as-you-are environment. To offset reductions in organic fire support, more frequent and sustained application of CAS and CAS/TIC will be required by joint expeditionary forces.

To comparatively analyze selected CAS platforms, the study uses four air-to-ground measures of merit (MOM): (1) target detection/recognition; (2) lethality; (3) survivability; and (4) combat persistence. The results paint a bleak picture of current capability. Therefore, a Carrier-Based Gunship (CBG) concept is presented to fill this void. The concept is more important than the selection of one particular platform. For illustrative purposes, three CBG candidates were evaluated using AC-130 gunship systems and employment as a guide coupled with the four MOM as the baseline. The CBG would be situated on a forward-deployed carrier, close enough to the objective area to provide sustained CAS/TIC support for joint expeditionary forces.

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GUNSHIP DIPLOMACY: CARRIER BASED CLOSE AIR SUPPORT FOR JOINT EXPEDITIONARY FORCES

by

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Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF ARTS IN NATIONAL SECURITY AFFAIRS

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ABSTRACT

This study examines whether current and future strategy, doctrine, and programmed systems are suitable to perform fire support and specifically, close air support (CAS) and close air support/troops-in-contact (CAS/TIC) missions for joint expeditionary warfare. Naval forces will provide the "enabling" power for this new come-as-you-are environment. To offset reductions in organic fire support, more frequent and sustained application of CAS and CAS/TIC will be required by joint expeditionary forces.

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Thanks is also extended to Lt. James Greenburg, USN, professional officer and true friend. His expertise, patience, and good humor never failed no matter the aggravation I inflicted upon him.

Finally, I wish to express my grateful appreciation to my wife Cindy, son Taylor, and daughter Sara for their constant loving support, understanding, and long suffering during this most challenging time.

EXECUTIVE SUMMARY

The new expeditionary warfare environment will require more frequent and sustained applications of close air support (CAS) and close air support/troops-in-contact (CAS/TIC) missions because of the reduction in organic firepower and virtually non-existent naval surface fire support (NSFS). Current and future strategy, doctrine, and programmed systems are inadequate to perform joint expeditionary fire support and specifically, CAS and CAS/TIC. The historical record proves that the CAS issue revolves around doctrine, inter-service rivalry, and money. It is clear that CAS and CAS/TIC will be the backbone of joint expeditionary firepower but as budget cuts reduce available airframes, it is uncertain by whom, with what, and how CAS and CAS/TIC will be conducted. Therefore, a Carrier-Based Gunship (CBG) concept is offered to fill this crucial void in America's warfighting capability.

The new military strategy of the United States focuses on a regionally oriented defense posture. The bedrock of this new strategy rests upon joint expeditionary warfare capability. This involves movement of expeditionary forces which are composed of two or more Services across oceans to reach an objective area. Most often, Naval forces are expected to provide the "enabling" power for this come-as-you-are environment.

This study provides analysis that shows a huge reduction in expeditionary fire support capability. The Marine Corps has experienced a 45 percent reduction in cannon artillery, the loss of self-propelled artillery capability, and reductions in tactical aircraft.

The Navy has decommissioned all battleship NSFS 16-inch gun platforms and mine threats coupled with limited littoral water depths will probably make NSFS 5-inch guns a non-factor. To offset this reduction in organic fire support, more frequent and sustained application of CAS and CAS/TIC will be required to ensure victory.

The study uses four air-to-ground measures of merit to comparatively analyze selected CAS platforms: (1) target detection/recognition; (2) lethality; (3) survivability; and (4) combat persistence. The results paint a bleak picture of current CAS and CAS/TIC capability. Therefore, a Carrier-Based Gunship (CBG) concept is presented to fill this void.

The CBG concept is modeled after the USAF AC-130 side-firing gunship with modifications to enable carrier operations, better hard-target kill capability, and increased survivability. It will provide surgical firepower for extended loiter periods, day and night, in poor weather/environmental conditions. Its main missions will be expeditionary CAS/TIC, CAS, battlefield air interdiction, and battle damage assessment. It will be capable of positively identifying friendly positions and delivery of ordnance during poor weather/environmental conditions. The sensor suite consists of a turret mounted forward looking infrared and low-light-level television to provide 360 degree battlefield coverage and to cover the entire electromagnetic spectrum. The weapons suite consists of one 25-MM Bushmaster chain gun for area suppression of personnel and use against light armor, one 30-MM Bushmaster II gun for destruction of vehicles and armored vehicles, and eight *Hellfire* missiles for hard-target kill and forward-firing, non-orbit firing capability. In

addition, the platform will be survivable. It will have state-of-the-art self-defense capability coupled with armor plating and redundant systems. Finally, combat persistence will be good. The CBG will be carrier-capable and have at least a 1,500 nautical mile range.

The CBG concept is more important than the selection of one particular platform. However, for illustrative purposes, this study evaluated modified versions of the E-2C, S-3, and V-22 airframes vis-a-vis the four measures of merit to ascertain the practicality and effectiveness of each in a CBG role. The results showed that all three could be used but with different degrees of effectiveness.

A CBG could be procured using off-the-shelf technology and hardware to replace the loss of organic fire power. This would provide a quantum leap in CAS/TIC capability for joint expeditionary forces.

DEDICATION

Duty is the most sublime word in the English language.
(General Robert E. Lee)

On January 31, 1991, an AC-130H gunship, call sign *Spirit 03*, was conducting an armed reconnaissance mission against Iraqi Army positions near the Saudi Arabian border town of Al Khafji. During the early morning hours, *Spirit 03* was tasked to engage an Iraqi Free Rocket Over Ground (FROG) missile site and the crew suppressed it with 105-MM and 40-MM fire. Their aggressive mission execution prevented an enemy missile attack on Allied forces defending Al Khafji. Soon after this action, *Spirit 03* was shot down and all 14 crew members were killed.

This thesis is dedicated to the brave crew of *Spirit 03* and to the 58 other courageous gunship crew members who have given their lives in the defense of freedom.

...and where the spirit is, there is freedom...

I. INTRODUCTION

> The military student does not seek to learn from history the minutiae of method and technique. In every age these are influenced by the characteristics of weapons currently available and the means at hand for maneuvering, supplying, and controlling combat forces. But research does bring to light those fundamental principles, and their combinations and applications, which, in the past, have produced success.
> (General Douglas MacArthur)

A. BACKGROUND AND PURPOSE

In the decade prior to "...From the Sea"[1], the strategic thinking of the U.S. Navy and U.S. Marine Corps was guided by The Maritime Strategy.[2] This governing concept focused primarily on contributions of the Navy and Marine Corps in defeating the Soviet Union in a global war. That strategy focused on "blue water" or mid-ocean-aspects of the naval war; the littorals (shore or coastal areas) were viewed as adjuncts to be seized and utilized to improve prospects for achieving sea control.[3]

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[1] Department of the Navy, From the Sea: Preparing the Naval Service for the 21st Century, (henceforth cited as From the Sea), (Washington, D.C.: September 1992). This document shifts the U.S. Navy's strategic and doctrinal essence away from planning for war at sea toward joint operations on land. It is the naval equivalent of maneuver warfare.

[2] The Maritime Strategy/Amphibious Warfare Strategy was, for the 1980's, an official statement of policy, on how naval forces, in combination with other services and the forces of our allies, would prepare for, fight, and terminate war on favorable terms.

[3] Kenneth R. McGruther, The Fifth Annual Admiral Charles M. Cooke Conference for Naval Strategists and Planners Conference Report, Newport, RI: U.S. Naval War College, 15 March-17 March 1994), 1.

Following the collapse of the Soviet Union, there is no serious challenge to U.S. Navy/Marine Corps supremacy on the high seas. This has allowed U.S. naval forces to focus on the littoral areas. The term for doing so is "Naval Expeditionary Warfare."[4]

Expeditionary warfare involves movement of expeditionary forces across oceans to reach an objective area. A Naval Expeditionary Force is comprised of Navy and/or Marine Corps forces. A Joint Expeditionary Force includes forces of other Services (Army, Air Force, Coast Guard).[5] The United States National Security Strategy is replacing reliance on forward basing with capability for expeditionary warfare. In this environment, naval forces[6] will become more important in meeting American forward presence requirements. Thus, the National Security Strategy of the United States increasingly will be operationalized by the joint littoral warfare concept. The littoral region is frequently characterized by confined and congested water and air space occupied by friends, adversaries, and neutrals-making target detection/recognition profoundly difficult.

A very important aspect of expeditionary warfare is the absolute necessity of bringing the appropriate force to bear on an enemy at the time and place of our choosing. Realities and requirements of this "new" operational environment place even greater demands on traditional U.S. military reliance on firepower and maneuver to avoid the negative political consequences of casualties normally associated with attrition warfare. Close Air Support (CAS) operationalizes this concept.

CAS is air action by fixed and rotary-winged aircraft against hostile targets that are in close proximity to friendly forces and that require detailed integration of each air

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[4] McGruther, Report, 2.

[5] McGruther, Report, 2.

[6] Hereafter, the term "naval forces" will mean both the Navy and the Marine Corps, and when under Navy operational control, the Coast Guard.

mission with the fire and movement of those forces.[7] CAS is a complicated and difficult mission to perform. It requires detailed integration of friendly air and ground forces for communication, target detection/recognition (day and night), lethality, survivability, combat persistence (loiter time), as well as mitigation of fratricide and collateral damage. A subcategory of the CAS mission is the close air support/troops-in-contact mission (CAS/TIC).[8] The difference in CAS and CAS/TIC is measured in distance, specifically in the proximity to friendly forces.[9] The delivery of ordnance near friendly positions requires complex procedures and uniquely configured airframes. Therefore, the systems and procedures required to integrate CAS/TIC are unique.[10]

CAS/TIC plays a critical role in the joint expeditionary environment. During the initial stages of an amphibious operation, the bulk of the firepower for the Marine Air-Ground Task Force (MAGTF) comes from CAS.[11] Naval Surface Fire Support (NSFS), artillery, and CAS are used to support the ground force penetration. However, NSFS has been greatly reduced due to the decommissioning of all battleships and a beachhead must be established before large caliber artillery can be deployed. Therefore, CAS will play an even more important role in joint expeditionary warfare.

This thesis answers the question: "are current and future strategy, doctrine, and programmed systems suitable to perform fire support and specifically, CAS/TIC missions in the new operational environment that will be encountered by joint expeditionary

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[7] _____. Joint Tactics, Techniques, And Procedures For Close Air Support. Joint Pub 3-09.3, Second Draft, (hereafter cited as Joint Pub 3-09.3), (Washington, D.C.: 1994), I-1.

[8] Troops-in-contact occurs when combatants are actively engaged.

[9] See _____, Joint Pub 3.09.3, V-5. The CAS/TIC mission consists of putting ordnance on a target within a one kilometer radius of a friendly position. There is inherent risk of fratricide and collateral damage.

[10] Pat A. Pentland, "Close Air Support-A Warfighting View," Armed Forces Journal International, September 1988, 92-96.

[11] Neil C. Carns and Stanton S. Coerr, "A True Force in Readiness," U.S. Naval Institute Proceedings, August 1994, 38.

forces?" The analytical framework will examine selected United States Naval Force, United States Air Force (USAF), and United States Army (USA) airframes to determine if they are adequate to fulfill the fluid requirements of expeditionary CAS. Additionally, the thesis tests the feasibility of a Carrier Based Gunship (CBG) concept to perform the expeditionary CAS/TIC mission. The USAF, land based, non-carrier capable, AC-130 Gunship is used as the doctrinal, tactical, and training baseline for a CBG model. The AC-130 is an effective CAS platform with unique nighttime capabilities and long loiter time which make it highly adaptable for a variety of special missions. It provides flexible, mobile firepower by employing accurate ordnance delivery on enemy positions while limiting collateral damage. It is especially effective in CAS/TIC, CAS, air interdiction (AI), and armed reconnaissance missions.[12]

The thesis analyzes three alternative carrier capable technology candidates, employing AC-130 tactics and doctrine, to explore the feasibility of adapting an aircraft or concept for execution of the CAS/TIC mission. Implicit in this analysis will be strengths, weaknesses, constraints, trade-offs, institutional, doctrinal and training concerns associated with acquisition of a CBG.

B. SCOPE OF THE RESEARCH

This research focuses on the assumption that U.S. Naval forces will be an "enabling" force in the new joint expeditionary warfare environment. United States National Security Policy and Military Strategy will be operationalized by the joint littoral warfare concept. The littorals are highly congested and will require more frequent and sustained CAS/TIC applications.

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[12] Department of the Air Force, Operations: AC-130 Gunship Employment, AFSOCR 55-130, Vol. X, (henceforth cited as AFSOCR 55-130, VOL. X), (Hurlburt Field. FL: Air Force Special Operations Command), 3.

An examination of Service roles, missions, doctrines, and force structures will be conducted to ascertain where the fire support mission, and specifically the CAS/TIC mission fits into this new military strategy. Joint Doctrine will be reviewed to determine if a joint CAS/TIC framework has been established. Additionally, innovative concepts like Adaptive Joint Force Packaging (AJFP) [13] will be considered in the context of the joint expeditionary environment.

Analysis will be conducted to determine the context of the new CAS/TIC environment. The thesis will define requirements from the prospective of the "grunt" on the ground. Measures of merit will be established to ascertain the ability of current CAS airframes to perform the expeditionary CAS mission focusing on aircraft target detection/recognition, lethality, survivability, and combat persistence.

Current fire support technology capabilities and limitations will be examined, an AC-130 case study will be accomplished, and a comparative analysis of selected CAS platforms will be undertaken.

A notional CBG concept based on the AC-130 doctrinal, tactical, and training baseline will be offered to comparatively analyze selected carrier-capable candidates to assess the viability of the CBG concept.

C. ORGANIZATION

This thesis begins with an examination of United States National Strategy Guidance for a Uni-Polar World. The fall of the Soviet Union has caused U.S. policy to evolve from containment and forward basing to regionalism and crisis response management. The bedrock of National Military Strategy is now joint expeditionary warfare.

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[13] See Sean A. Bergesen, Adaptive Joint Force Packaging (AJFP): A Critical Analysis, (Monterey, CA: Naval Postgraduate School, December 1993), 1. AJFP is a new concept which envisions using geographically and mission tailored joint forces to conduct forward presence operations.

Naval forces will provide the "enabling" power for the application of this strategy. This environment will be operationalized by more frequent and sustained support of CAS/TIC missions. CAS/TIC force applications and doctrinal concepts will be explored to ascertain if a joint framework has been established for the execution of joint expeditionary fire support. Then, analysis will be conducted on the roles, missions, and functions of the armed forces to examine historical as well as present attitudes toward the application of CAS/TIC. The chapter concludes with an examination of current joint fire support doctrine, training, and force employment to see if these issues have been adequately addressed for future joint expeditionary warfare scenarios.

Chapter III investigates the realities and requirements of the joint expeditionary warfare environment and offers a template for the conduct of "new" joint expeditionary operations. In addition, general criteria for the effective application of CAS is delineated and specific measures of merit for CAS/TIC will be outlined to provide a baseline for the comparison of present CAS/TIC platforms and the CBG concept. Measures of merit again focus on target detection/recognition, lethality, survivability, and combat persistence. The result of this analysis is expected to justify the need for a CBG platform.

Chapter IV analyzes current U.S. fire support capabilities and limitations. An evaluation of artillery, naval surface fire support, and CAS/TIC platforms also is accomplished. A case study of the AC-130 is developed in order to provide background for the side-firing gunship concept, delineate system capabilities and limitations, and employment doctrine. The AC-130 is thus graded against the measures of merit outlined in the previous chapter. AC-130 tactics, doctrine, and measures of merit can then be used as the baseline for the comparative analysis of four selected CAS platforms currently tasked with this mission. [14]

In Chapter V, the CBG concept is developed, requirements for the operational mission are delineated, operational capabilities are outlined, and three concept candidates

[14] However, the CBG must have better hard-target kill capability and survivability than the AC-130.

are examined to fulfill the role of a CBG. Relative strengths and weaknesses can be weighed against AC-130 tactics and doctrine and graded against the measures of merit. Emphasis is then placed on developing a conceptual framework for a CBG, rather than selecting a specific candidate platform. This chapter concludes by defining a concept of operation for the CBG and employment of airpower during joint expeditionary warfare.

The final chapter presents the thesis's final conclusions about joint expeditionary warfare and the viability of a CBG concept. An opportunity may exist to modify a current system or field a new one using off-the-shelf technology to provide CAS/TIC by the use of a CBG concept. The CBG may be ideally suited for the fluid, loiter-intensive nature of the joint expeditionary warfare environment.

D. SOURCES

There is a wealth of source material concerning the employment of U.S. military forces in the aftermath of the Cold War. This researcher was guided by the following: The National Security Strategy of the United States, National Military Strategy of the United States, and The Chairman of the Joint Chiefs of Staff Report on the Roles, Missions, and Functions of the Armed Forces of the United States.

Naval Institute Proceedings provided numerous articles concerning joint expeditionary and littoral warfare. Additional information concerning expeditionary warfare was gleaned from Strategic Review and Air Force Magazine.

The book, Straw Giant: America's Armed Forces, Triumphs and Failures and the paper, "Close Air Support Requirements: A Case of Interservice Rivalry," provided valuable historical perspectives about Service attitudes concerning the role and mission of CAS. Parameters and Armed Forces Journal International provided information defining the context for the operational CAS environment. Joint Pub 3-09.3 provided a veritable "gold mine" for defining the realities and requirements for effective CAS

application. Also, the Gulf War Air Power Survey provided a real-world assessment of current platform capabilities and limitations and included factual data to grade them versus the measures of merit.

The book, Air Commandos: The Quiet Professionals: Air Force Special Operations Command, gave an excellent historical account of AC-130 combat operations. In addition, AFSOCR 55-130, Vol., X, coupled with AC-130 Gunship Conventional Missions Tutorial were used to provide AC-130 equipment capabilities, limitations, and tactics.

To construct a comparative analysis of selected CAS platforms, the Conduct of the Persian Gulf War: Final Report to Congress, Appendix T, was used to analyze real-world capabilities versus the previously outlined measures of merit.

Finally, Jane's All The World's Aircraft was extensively used to extrapolate technical data for the three CBG concept candidates.

II. UNITED STATES STRATEGY FOR A UNI-POLAR WORLD

> The strategist is he who always keeps the objective of the war in sight and the objective of the war is never military and is always political. (Alfred Thayer Mahan)

The bi-polar world political structure has given way to a world centering on the United States as the hegemonic power. For over 40 years, the American grand strategy [15] of containment reflected an era of expanding Soviet power and aggression. Today, Russia is focused on internal crises, but it still remains the only state capable of destroying American society with a single nuclear exchange. Additionally, Russian conventional forces still retain three million men in uniform. However, it is unlikely that Russia will again become the superpower adversary the U.S. faced during the Cold-War. As a result, the end of the bi-polar security environment emphasizes regional military multipolarity.

Shaping United States Security Strategy for this new environment will require developing, building, and deploying military capability as an instrument of policy. In doing so, it is appropriate to be cognizant of the historical lessons of the past with an appreciation of the dangers that lie ahead. This will be a complicated task. One thing is clear: Cold-War containment policy has yielded to military regionalism.

A. NATIONAL STRATEGY GUIDANCE

Grand Strategy is the art and science of options. It can be depicted by the means-ends concept. Simply stated, strategy equals ends (objectives) plus ways (courses of action) plus means (instruments by which some end can be achieved).

---

[15] National (Grand) Strategy is political, economic, and psychological powers of a nation together with its armed forces during peace and war to secure national objectives.

There are four broad objectives that form the basis of current U.S. National Security Policy: (1) the survival of the United States as a free and independent nation, with its fundamental values intact and its institutions and people secure; (2) a healthy and growing U.S. economy to ensure opportunity for individual prosperity and resources for national endeavors at home and abroad; (3) healthy, cooperative, and politically vigorous relations with allies and friendly nations, and (4) a stable and secure world, where political and economic freedom, human rights, and democratic institutions flourish.[16]

The Grand Strategy takes these objectives and develops them into interrelated political, economic, and military instruments of national power. The political instrument of power uses the international political position and diplomatic skills of the state to pursue national interest. The economic instrument of power is the application of a nation's material resources in achieving those ends. The military instrument is the threat or actual employment of armed force to achieve national ends.

1. National Security Strategy

President Clinton's National Security Strategy of Engagement and Enlargement[17] focuses on threats and opportunities offered by the new security environment. Its purpose is to sustain U.S. security with military forces that are ready to fight, to bolster America's economic revitalization, and to promote democracy abroad. These objectives are mutually supportive because secure nations are more likely to support free trade and maintain democratic structures. Nations with growing economies and strong trade ties are more likely to feel secure and to work toward freedom. And democratic states are more inclined to cooperate with U.S. security policy initiatives.

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[16] William J. Clinton, National Security Strategy of the United States, (Washington, D.C.: GPO, 1994), 5.

[17] Clinton, Strategy.

The 1994 National Security Strategy (NSS) of the United States attempts to achieve these objectives by enlarging the community of market democracies while deterring and containing a range of threats to America, its allies and its interests. The premise of this strategy is that the world will be safer and more prosperous if political and economic liberalization take hold on a global scale, particularly in countries of geostrategic importance to American interests.

The 1994 NSS takes these objectives and develops them into political, economic, and military instruments of national power. These basic objectives will guide the allocation of scarce resources. While all instruments of national power are mutually supportive, this chapter will be limited by its focus on the military instrument of national power in the context of joint expeditionary warfare.

To protect and advance U.S. interests, the United States must deploy robust and flexible military forces that can accomplish the following tasks: deal with major regional contingencies; provide a credible overseas presence; counter weapons of mass destruction; contribute to multilateral peace operations; and support counterterrorism efforts and other national security objectives which include punitive attacks, noncombatant evacuation, counter-narcotics operations, nation assistance, and humanitarian and disaster relief operations.[18]

To accomplish these tasks, the U. S. military must be capable of quick response and, if necessary, of fighting and winning. This demands highly qualified and motivated people; modern, well-maintained equipment; realistic training; strategic mobility; and sufficient support and sustainment capabilities.

The focus of planning for major regional contingencies is on deterring and, if necessary, fighting and defeating aggression by hostile regional powers, such as North Korea, Iran, Iraq or lesser regional contingencies in smaller countries like Haiti and

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[18] Clinton, Strategy, 6-7.

Somalia.[19] To deter aggression, prevent coercion of allied or friendly governments and, ultimately, defeat adversaries, the United States must have forces that can deploy quickly and supplement forward deployed forces, along with regional allies, in halting invasions and defeating the aggressor.[20] Additionally, the contributions of allies or coalition partners will vary from place to place and over time. Thus, balanced forces are needed to provide a wide range of complementary capabilities to cope with the unpredictable and unexpected future military environment.

Cold-War threats have diminished, but the United States must remain engaged in an interdependent world to advance its political, military, and economic interests. Domestic renewal will only be accomplished by engaging abroad in open foreign markets, to promote democracy in key countries, and to counter and defeat emerging threats.

2. National Military Strategy

Military strategy involves employment of the armed forces to secure objectives of national policy by the application of force or threat of force. The objective is to deter aggression. This is accomplished on two levels: operational and force development. The operational level is based on existing military capabilities and force development is based on estimates of future threats, objectives, and requirements.

Correct application of military strategy can be equated to three equidistant legs of a triangle. The legs must be balanced to yield the proper establishment of military objectives, formulation of strategic concepts, and the proper use of military resources.

The Goldwater-Nichols Reorganization Act of 1986 charges the Chairman, Joint Chiefs of Staff (CJCS), with the responsibility of assisting the President and Secretary of Defense (SECDEF) in providing strategic direction for the Armed Forces. The current

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[19] Clinton, Strategy, 7.

[20] Clinton, Strategy, 7.

strategy is built upon the four key foundations of the National Defense Strategy: Strategic Deterrence and Defense, Forward Presence, Crisis Response, and Reconstitution. [21]

The National Military Strategy of the United States departs from principles that have shaped the American defense posture since World War II. Most significant is the shift from containing the spread of communism and deterring Soviet aggression to a more diverse, flexible strategy which is regionally oriented and capable of responding to the challenges of this decade. This strategy implements the new regionally focused defense strategy articulated in the President's National Security Strategy of the United States and builds upon the Annual Report to the President and Congress provided by the SECDEF.[22]

Because of the changes in the strategic environment, U.S. plans and resources are primarily focused on deterring and fighting regional rather than global wars. Future threats are uncertain but they will be met with a much smaller U.S. Base Force. [23] This force will be a total joint force structured to work in joint and combined environments which will require flexibility in planning, training, and employment.

The base force is divided into four "force packages" and four "support capabilities." The force packages are those forces that will be directly involved in protecting American vital interests. While two of these packages are geographically oriented, all four are available for worldwide employment.[24]

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[21] See Colin L. Powell, National Military Strategy of the United States, (Washington, D.C.: GPO, 1992). This is the most current edition of the National Military Strategy.

[22] Powell, Military Strategy, 1. The National Military Strategy of the United States is signed by the CJCS. It uses the National Security Strategy of the United States which is signed by the President and the Annual Report to the President and Congress which is signed by the SECDEF as building blocks.

[23] See Powell, Military Strategy, 17. The Base Force is the minimum combination of the active and reserve components of all four services needed to meet America's basic goals. It is a core capability to deter aggression, provide meaningful presence abroad, respond to regional crises, and rebuild a global warfighting capability. It is the building block of the present National Military Strategy.

[24] Kurt A. Cichowski, Doctrine Matures through a Storm: An Analysis of the New Air Force Manual 1-1, (Maxwell AFB, AL: Air University Press, 1993), 36-37.

Adaptive planning will be utilized to provide a range of preplanned options, encompassing all the instruments of national power to clearly demonstrate U.S. resolve, deter potential adversaries, and, if necessary, to deploy and employ forces to fight and win, quickly and decisively.[25]

The United States strategy for the "come-as-you-are" arena of contingency response, requires fully-trained, highly-ready forces that are rapidly deployable and initially self-sufficient. This is the bedrock of joint expeditionary warfare.

3. Force Structure

The Report on the Bottom-Up Review [26] is the vehicle that has defined the strategy, force structure, modernization programs, industrial base, and infrastructure needed to meet new dangers and seize new opportunities in the post-Cold War era. It has been used to build a multi-year plan for America's future security, detailing the forces, programs, and defense budgets the United States requires to protect and advance its interests.

The Bottom-Up Review outlines the following four phases of U.S. combat operations for joint expeditionary warfare: (1) halt the invasion; (2) build up U.S. combat power in the theater while reducing the enemy's; (3) decisively defeat the enemy; and (4) provide for post-war stability.[27] Even though the Bottom-Up Review does not list offensive and/or preemptive operations, U.S. forces must be fully capable to conduct these combat operations.

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[25] Powell, Military Strategy, 12.

[26] Les Aspin, Report on the Bottom-up Review, (Hereafter cited as Bottom-Up Review), (Washington, D.C.: 1993).

[27] Aspin, Bottom-Up Review, 7.

During phase I, the bulk of American forces will come from forward-deployed forces augmented from the U.S. mainland. This places a premium on rapidly deployable yet highly lethal forces to blunt an attack. Forces for this phase will be required to accomplish the following tasks: help allied forces establish a viable defense that halts enemy ground forces before they can achieve critical objectives; delay, disrupt, and destroy enemy ground forces and damage lines of communications (LOCs) to halt the attack; and establish a degree of local air-sea superiority, using primarily joint expeditionary forces. Precision fire support will be vital for the successful accomplishment of these objectives.

During phase II, many of the same forces will be used to grind down the enemy's military potential while additional U.S. and other coalition combat power is brought into the region. After more forces have arrived, emphasis will shift from halting the invasion to isolating enemy ground forces and destroying them. This attack must be supplemented with direct and indirect precision fire support from ground, air, and sea forces.

The centerpiece of phase III will be the U.S. and allied counteroffensive, aimed at engaging, enveloping, and destroying or capturing enemy ground forces occupying friendly territory. Tasks could include conducting or threatening an amphibious invasion, dislodging and defeating infantry fighting from dug-in positions, and defeating light infantry in urban terrain. Successful conduct of CAS/TIC will be paramount for success.

Finally, in the last phase, a smaller complement of joint forces will remain in the theater once the enemy has been defeated. These forces might include a carrier battle group, an USAF composite wing, a division or less of ground forces, and special operations forces.

Force enhancements to support this strategy are underway. These enhancements are geared to buttress U.S. ability to conduct a successful initial defense in any major regional conflict. Enhancements include: (1) strategic mobility through more prepositioning and enhancements to airlift and sealift; (2) the strike capabilities of carrier

air wings; (3) the lethality of Army firepower; and (4) the ability of long-range bombers to deliver conventional smart munitions.[28]

The Navy is planning to enhance strike capability by modifying the F-14B *Bombcat* into a precision ground attack aircraft, and by flying additional squadrons of F/A-18 *Hornets* to forward-deployed aircraft carriers.[29] However, these enhancements will not improve CAS/TIC capability. The Army is planning to enhance its firepower lethality by using the *Longbow* fire control radar system to increase the effectiveness and survivability of the AH-64 *Apache* attack helicopter. [30] The AH-64 will not be able to forward deploy fast enough to act as part of a joint expeditionary "enabling" force unless massive airlift is available or there is enough time to deploy them on aircraft carriers via the AJFP concept.

In addition, these enhancements will be done in an era of extremely tight defense budgets. In real terms, the defense budget for 1995 is thirty-five percent smaller than in Fiscal 1985,[31] and 1985 was the peak year for DOD budget authority[32] since the Korean War. The Bottom-Up Review will cut the last Bush administration budget authority estimate by 91.0 billion dollars between FYs 1995-1999.[33] This will have a devastating effect on the procurement of future military hardware.

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[28] Aspin, Bottom-Up Review, 11.

[29] See Tamar A. Mehuron, "Snapshots of the New Budget", Air Force Magazine, April 1994, 10. The F/A-18C/D/E/F fighter program is the number two funding priority for the Navy. $2,579.3 million has been allocated for Fiscal Year (FY) 1995.

[30] See Mehuron, "Budget", 10. The AH-64 is the number two funding priority for the Army. $273.4 million has been allocated for FY 1995.

[31] See Mehuron, "Budget", 9. The defense budget in 1985 was 6.3% of gross domestic product (GDP). In 1995, defense spending is projected to be approximately 3.9 percent of GDP.

[32] Budget authority is the value of new obligations that the government is authorized to incur. These include some obligations to be met in later years.

[33] See Mehuron, "Budget", 11. Amounts are in 1994 dollars. Defense outlays as a share of gross domestic product is projected to be 2.8 percent in 1999.

Also, a new mind-set favoring troops over systems is developing in the Department of Defense and Congress. John Deutch, Deputy Defense Secretary, stated the following, "money is tight; we are choosing people over systems." Deutch identified ten large and costly programs he wants the services to consider killing or delaying. And long-time military ally Rep. John P. Murtha, D-PA., Chairman of the House Defense Appropriations Subcommittee, has suggested eliminating the Navy's F/A-18E and F program. [34] More reductions in military equipment are likely. Therefore, technological advances in precision munitions, improved surveillance and reconnaissance capabilities, better sensors, better use of communications and better coordination of existing systems to bring multiple, quantum improvements in warfighting capabilities for expeditionary warfare and specifically for CAS/TIC are questionable.

B. JOINT EXPEDITIONARY WARFARE IN THE LITTORAL

The new security environment now requires a doctrinal "sea change" in the way the United States approaches warfighting. Naval forces will become more important due to increased expeditionary and forward presence requirements derived from the National Security Strategy. Naval expeditionary forces are offensive in nature. In addition, they are cohesive, self-sustaining, and tactically and strategically mobile. These forces can establish and maintain a forward-based, stabilizing presence around the world. Expeditionary warfare has forced the U.S. Navy to shift from the strategic and doctrinal planning for war-at-sea to support for joint operations on land. In short, expeditionary warfare in the littoral is the naval equivalent of maneuver warfare.[35]

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[34] William Matthews, "New mind-set favors troops over systems", Air Force Times, September 5, 1994, 20.

[35] See Department of the Marine Corps. Warfighting, FMFM1, (Washington, D.C.: March 6, 1989), 59. Maneuver warfare is a warfighting philosophy that seeks to shatter the enemy's cohesion through a series of rapid, violent, and unexpected actions which create a turbulent and rapidly deteriorating situation

Expeditionary warfare places a premium on naval forces because land-based aircraft may have limited operating bases and infrastructure, fewer and less timely diplomatic clearances, longer response times, and less on-station time at the objective area; and heavy Army forces usually supplement or replace the Marines only after the objective area is secure.

Naval forces will provide the initial, "enabling" capability for joint operations in crises and will participate in sustained efforts. From the Sea calls for a shift away from open-ocean warfighting on the sea to joint operations[36] conducted from the sea. It focuses on the "littoral", or "near land" areas of the world's oceans. The littoral region is frequently characterized by confined and congested water and air space occupied by friends, adversaries, and neutrals--making identification of friend or foe (IFF) difficult. This battlefield environment will require more frequent and sustained support of close air support/troops in contact applications. Current naval air assets can be used most cost-effectively for amphibious forcible entry operations (e.g., CAS, battlefield air interdiction (BAI)[37], and general over-the-beach air superiority).

From the Sea defines littoral operations as a primary task for naval forces to contain crises or support land forces in "small" wars into the foreseeable future. [38] Naval forces will be used to "kick in the door" and conduct sustained combat operations until heavy joint forces arrive in the area of operation (AO).

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with which he cannot cope.

[36] McGruther, Report, 2. A joint operation is conducted by a joint force. A joint force is constituted by at least two of the four Services. (Navy, Army, Air Force, and Coast Guard).

[37] For a discussion of BAI see Department of the Air Force, Headquarters Tactical Air Command, TACAIR 89: Conference Book, (Langley Air Force Base, VA, March 3, 1988), 94. BAI is air interdiction attacks against land force targets which have near-term effect on the operations or scheme of maneuver of friendly forces, but are not in close proximity to friendly forces. While BAI missions require coordination in joint planning, they may not require continuous coordination during the execution stage.

[38] Jan S. Breemer, "The End of Naval Strategy: Revolutionary Change and the Future of American Naval Power", Strategic Review, Spring 1994, 44.

C. ROLES, MISSIONS, AND FUNCTIONS OF THE ARMED FORCES

This section describes the CAS portion of military roles and missions. Historically, with the exception of the USMC and later the USA, after its acquisition of attack helicopters, CAS has been shunned as a mission because of its inherent difficulty and the peacetime demand for limited resources that are perceived to yield "bigger dividends" if allocated to more "flashy" missions like air superiority. Today, Joint Pub 3-09.3 defines CAS as follows:

> air action by fixed and rotary-winged aircraft against hostile targets that are in close proximity to friendly forces and which require detailed integration of each air mission with the fire and movement of those forces.[39]

Often, CAS missions are defined as those conducted inside the fire support coordination line (FSCL),[40] while those beyond the FSCL are considered air interdiction (AI)[41] or BAI. The primary difference between BAI and the remainder of the air interdiction effort is the

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[39] _____, Joint Pub 3-09.3, I-1. In a "classic" case, CAS is used as a supporting arm against targets that are directly affecting ground operations; CAS is support to "troops in contact" (TIC). Therefore, CAS/TIC consists of putting ordnance on a target within a one kilometer radius of friendly positions. There is an inherent risk of fratricide and integration is normally through a specially trained Forward Air Controller (FAC).

[40] JCS Pub 1 Definition: A line established by the appropriate ground commander to ensure coordination of fire that is not under his control but may affect current tactical operations. The fire support coordination line is used to coordinate fires of air, ground, or sea weapon systems using any type of ammunition against surface targets. The fire support coordination line should follow well defined terrain features. The establishment of the fire support coordination line must be coordinated with the appropriate tactical air commander and other supporting elements. Supporting elements may attack targets forward of the fire support coordination line without prior coordination with the ground force commander, provided the attack will not produce adverse surface effects on, or to the rear of, the line. Attacks against surface targets behind this line must be coordinated with the appropriate ground force commander.

[41] JCS Pub 1 Definition: Air operations to destroy, neutralize, or delay the enemy's military potential before it can be brought to bear effectively against friendly forces, at such distance from friendly forces that detailed integration of each air mission with the fire and movement of friendly forces is not required.

near-term effect and influence produced against the enemy in support of the land component commander's scheme of maneuver. The Center for Naval Analyses uses the FSCL as a rough divider between CAS and deep air support missions. [42] The Institute for Defense Analysis takes the position that a tactical air strike under forward air controller (FAC) control is CAS, while one not under FAC control is BAI.[43] These definitions can be very confusing but they are extremely important. Therefore, the following are offered to ensure a common frame of reference: CAS/TIC is the delivery of ordnance on an enemy target within a one kilometer radius of friendly positions;[44] CAS is the delivery of ordnance on an enemy target outside a one kilometer radius of friendly positions but within the FSCL; BAI is the delivery of ordnance outside the FSCL but against enemy targets which have a near-term effect on the operations or scheme of maneuver of friendly forces; and AI is the delivery of ordnance to destroy, neutralize or delay the enemy's military potential before it can be brought to bear effectively against friendly forces, at such a distance from friendly forces that detailed integration of each air mission is not required. An understanding of these definitions is crucial because they determine who sets aviation priorities, who selects targets, which weapon systems will be employed, and how tactics will be selected.

CAS is a complicated and difficult mission to perform. In addition to threats faced by the aircraft, it is executed on the swirling, nonlinear battlefield. Most tactical aircraft (TACAIR) [45] pilots agree that the target must be marked by some means and/or somebody. The pilot simply cannot fly at tree-top levels, navigate, maneuver to avoid enemy defense, keep track of friendlies, acquire enemy targets, maneuver to attack enemy targets, and live.[46] Many air power advocates have blurred the distinction between CAS/TIC, CAS, BAI, and AI because most air assets are not capable of performing the CAS/TIC mission. CAS and BAI will intermix across the battlefield but CAS/TIC is really a separate mission. The difference in these two missions is measured in distance, specifically in the proximity of friendly forces to hostile forces. The delivery of ordnance near friendly positions requires standardized procedures that must be adaptable for a fluid

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[42] Center for Naval Analyses, "Marine Corps Desert Storm Reconstruction Report Vol IV: Third Marine Aircraft Wing Operations," (Alexandria, VA: no date), 67.

[43] Institute for Defense Analysis, Document D-1080, (Washington,D.C: no date),16.

[44] See _____, Joint Pub 3.09.3, V-5. the CAS/TIC mission consists of putting ordnance on a target within a one kilometer radius of the friendly position. There is inherent risk of fratricide and collateral damage.

[45] TACAIR is a generic term used for Navy and Air Force multi-role aircraft. The term "fighter" is usually used for aircraft that engage other aircraft as its main mission.

[46] Thomas W. Garrett, "Close Air Support: Which Way Do We Go?", Parameters, December 1990, 29-43.

battlefield in order to reduce collateral damage and decrease the chances of fratricide. Therefore, the systems and procedures needed to integrate CAS/TIC are unique. CAS/TIC, CAS, and BAI type targets routinely consist of dispersed armored vehicles, squads of enemy infantry in fortified positions, and hardened automatic weapon emplacements.

A TACAIR asset that can cope with the threat, accomplish the mission with accuracy in adverse weather or darkness, and has the command and control, navigation, and pilot-workload-reducing systems necessary to integrate itself into the battle at the front line is the most expensive aircraft one can buy.[47] In 1986, the Under Secretary of Defense for Acquisition created the Close Air Support Mission Area Review Group (CASMARG). It was directed to spend $10 million to conduct "feasibility studies of a new CAS aircraft to replace the A-10."[48] The Air Force decided to avoid the high cost of developing a completely new CAS platform and used the multi-mission F-16 airframe. However, CAS/TIC has proven too difficult for a multi-mission airframe that is not specifically configured for the mission and a crew that becomes too "task-saturated" and does not exclusively train for this complex and fluid mission.

1. CAS: A Historical Perspective

From World War II emerged the three basic missions of tactical airpower: Counter Air, AI, and CAS. Although their priority depended upon the battle area and the stage of the war, it was generally in the order listed, because air superiority allowed the other missions to be conducted without interference from the enemy air force. Today, Air Force Manual 1-1 lists Close Air Support as its fifth priority. It is preceded, in order by, Counterair, Counterspace, Strategic Attack, and Interdiction.[49]

When Congress passed the National Security Act of 1947, it established the Air Force as a separate Service and attempted to clarify Service roles and missions to provide a framework for program and budget decisions. This immediately started disagreement

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[47] Garrett, "CAS: Which Way Do We Go?", 29-43.

[48] Pentland, "CAS", 92-96.

[49] Department of the Air Force. Basic Aerospace Doctrine of the United States Air Force, AFM 1-1 Vol I, (Hereafter, cited as AFM 1-1, Vol. I.), (Washington, D.C.: 1992), 7.

among the Services, so, in 1948, the Secretary of Defense, James Forrestal, convened a conference in Key West, Florida, where the Chiefs of the Services hammered out an agreement on roles and functions. The agreement assigned the CAS mission to the Air Force in support of the Army; however, the Navy and Marines managed to retain their aircraft. [50]

During Korea, once air superiority was assured, the Air Force allocated forty-eight percent of its sorties for interdiction missions.[51] The other three services wanted air power applied at the battleline. This sparked controversy about which Service (Air Force or Marines) could supply the most timely, adequate, and accurate close-air support for the ground forces of the United Nations Command.

Control of Marine aviation, when the Marines are committed to a land campaign, has been a difficult and emotional problem. Marine aviation has been justified on the basis of its ability to support an amphibious operation, which the Marines are assigned as a primary mission. Since amphibious forces are without the artillery support normally organic to an Army division constituted for sustained land warfare, Marine landing forces are dependent upon naval gunfire, carrier based air, Marine air, and Air Force air (if within range) for fire support. After the forces hit the beach, Marine air augments the limited organic artillery. Since the Army is responsible for the conduct of prompt and sustained operations on land (in accordance with the Key West Agreement of 1948), its forces will replace Marines after the objective area is secure and the Marines either withdraw or become a part of the Army forces.

An examination of Marine air doctrine shows that it is quite similar to that of the Air Force (e.g., establishing air superiority is the first order of business, and centralized control with decentralized execution is desirable). But there is one big exception - the

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[50] See _____, ACSC Seminar/Correspondence Lesson Book, Vol, IV, (Maxwell AFB, AL: Air University, 1992), 17-17.

[51] William W. Momyer. Air Power in Three Wars: WWII, Korea, Vietnam, (Washington, D.C.: Department of the Air Force, 1978), 163.

Marine Corps' emphasis on CAS. Rather than a last-priority mission, CAS is the main mission, with air superiority de-emphasized but still a necessary prerequisite to both amphibious operations and CAS, as well as other air operations.[52] This was true during Korea but it is even more important today because of an increased emphasis on expeditionary warfare.

During the Korean War, even if the Air Force had reprioritized its CAS allocation, it did not possess the proper airframes or training to conduct it. Arthur Hadley nicely summarized the capabilities of Air Force TACAIR during that war when he stated:

> The jet fighters of the Korean War, the F-84s and F-86s, had been conceived and constructed for air-to-air battles first and as ground support aircraft a reluctant second. At lower altitudes they burned so much fuel they had little time over target. Their guns and rockets, designed for aerial combat, were not highly effective against ground troops. Communications between air and ground had deteriorated since World War II so that as late as the second year of the Korean War, infantry and airplane radios often could not talk to each other.[53]

Multi-mission TACAIR assets were incapable of providing adequate CAS for ground troops. More importantly, these aircraft could not provide CAS/TIC.

After the Korean War, the U.S. developed a policy of nuclear massive retaliation. This shift in doctrine toward strategic and tactical nuclear employment encouraged the Air Force to focus almost exclusively upon strategic bombardment at the expense of tactical air in support of CAS. This prompted the Army to explore ways to form a CAS arm of its own. Additionally, there was virtual nonexistence of joint Army-Air Force doctrine

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[52] U.S. Department of the Navy, Fleet Marine Field Manual 5-1, (Washington, D.C.: August 24, 1979), 1.

[53] Arthur T. Hadley, Straw Giant: America's Armed Forces, Triumphs and Failures (New York, NY: Avon Books, 1986), 112-113.

during this period. Therefore, when America became involved in Southeast Asia, it did not have the proper hardware or doctrine to perform the CAS mission.

As the Vietnam War escalated, the Air Force once again prioritized its missions in the following order: Counter air, interdiction, and close air support. General Curtis E. Lemay, Chief of Staff of the Air Force (CSAF), argued for a concentrated attack against targets in the heart of North Vietnam. Indirect attacks in South Vietnam and Laos, in his judgement, were not apt to be decisive. On the other hand, General Earle G. Wheeler, Army Chief of Staff, thought it was necessary for U.S. troops in South Vietnam to take on more of a combat role. An air campaign, he believed, should be directed at the LOCs near the border of South Vietnam, but not at the heartland of North Vietnam. The main emphasis should be on the Ho Chi Minh Trail and close air support in South Vietnam.[54]

Later in the war, the Air Force's inability to provide adequate close air support was so bad that a congressional investigation was conducted by the House Armed Services Committee.[55] The committee concluded that the Air Force had ignored lessons learned in previous wars about the perennial operational problems of night flying, bad weather, poor communications, target marking, short rounds, and strike assessment. Additionally, the continuous interservice bickering over the single manager for air assets and the complicated rules of engagement (ROE) added to the confusion.

Unable to effectively perform CAS/TIC with multi-mission TACAIR, the Air Force had to "borrow" twenty-five L-19 light observation aircraft from the Army to serve as forward air controller aircraft and the propeller driven A-1 *Skyraider* from the Navy to conduct CAS attacks.[56] Also, the Air Force reluctantly modified propeller driven transport aircraft into fixed-winged gunships. In an age of supersonic jet aircraft, megaton

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[54] Momyer, Air Power, 14.

[55] Robert E. Buhrow, "Close Air Support Requirements: A Case of Interservice Rivalry," Military Study Program paper, (U.S. Army War College, Carlisle Barracks, PA, March 1, 1971), 8.

[56] Buhrow, "CAS Requirements", 8-10.

nuclear weapons, and sophisticated electronic devices, nothing seemed quite so incongruous as a lumbering gunship evolving into a potent weapon system. However, Jack Ballard says that the nature of the war in Vietnam forced the Air Force to take this action in support of CAS because:

> Very simply, the Air Force's combat aircraft of the early 1960s often could not find nor accurately strike enemy targets at night or under cover of the great jungle canopy. The urgent need for such a capability became dramatically obvious as guerrilla warfare expanded in South Vietnam.[57]

America fought a conventional air war with tactics and multi-mission aircraft designed for nuclear warfare until it was forced, by necessity, to conduct CAS operations. This did bring a change in tactics; however, quantitatively few platforms were modified to conduct the CAS mission. The U.S. still preferred to use the multi-role fighter that focused on air-to-air combat instead of a dedicated CAS platform. This point is illuminated by Kenneth Werrell's statement:

> The airmen focused on the weapons on which airmen always focus, where the glamour and glory is, fighters and air-to-air combat. It is true that the North Vietnamese built up their air force. But this air force proved as elusive as the Vietcong, using guerrilla tactics of hit and run, fighting only when circumstances were favorable. Air-to-air combat was neither frequent nor important in the Vietnam war.[58]

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[57] See Jack S. Ballard, Development and Employment of Fixed-Wing Gunships 1962-1972 (Washington, D.C.: GPO, 1982), Preface. Gunships constituted only a minuscule percentage of U.S. Air Force aircraft during the Vietnam War; however, they were a premier CAS/TIC platform.

[58] Kenneth P. Werrell, Archie, Flak, AAA, and SAM: A Short Operational History of Ground-Based Air Defense (Maxwell AFB, AL: Air University Press, 1988), 101-102.

The USAF was locked in an air-to-air mentality: if an airframe is not sleek, does not fly fast, or is ugly, then it is of limited operational value. [59]

The Army, in frustration, developed the attack helicopter and continued to refine it after the war. During the 1970's, the Air Force became worried about losing the CAS mission and reluctantly fielded the A-10 *Thunderbolt II* aircraft, the only dedicated close air support aircraft ever purchased by the Air Force. It is interesting to note that the unofficial name of the A-10 is the *WartHog*. In general, USAF pilots use the *WartHog* as a stepping stone for an assignment to a "real" fighter.[60]

The CAS issue remained "status quo" until the Goldwater-Nichols Act of 1986 required the CJCS to "periodically recommend such changes in the assignment of functions (or roles and missions) as the Chairman considers necessary to achieve maximum effectiveness of the Armed Forces." [61] By the stroke of a pen, Congress had forced the Services to re-evaluate the CAS mission.

During 1989, in compliance with the Act and in response to a congressional call to study close air support (including the feasibility of transferring the mission to the Army), then-CJCS Admiral William Crowe submitted a roles and function report that included the following statement:

> CAS is not an issue only for the Army and the Air Force....All four services perform the CAS function. CAS for naval operations is assigned to both the Navy and the Marine Corps. CAS for land operations was assigned to the Air Force when it became an independent service, and the

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[59] This researcher refers to this as the silk scarf and open cockpit syndrome.

[60] The A-10 is last on the food chain in the USAF fighter community. In general, pilot training students who wish to fly fighters will select it only as a last resort to keep them from being assigned to a bomber, tanker, or cargo aircraft. Most pilots wish to spend only one operational tour in an A-10 unit before they "upgrade" to an F-15 or F-16 aircraft.

[61] Colin L. Powell, Chairman of the Joint Chiefs of Staff Report on the Roles, Missions, and Functions of the Armed Forces of the United States, (Hereafter cited as Report on Roles and Missions), (Washington, D.C.: GPO, 1993), v.

> Army was permitted to maintain organic aviation with relatively unspecified tasks. All four services have CAS-capable aircraft employed under joint doctrine. In this manner we have insured that CAS is available to lower-level ground commanders on a regular basis, while still providing the theater commanders the capability to focus significant combat power in a specified area. The issue cannot be whether to transfer CAS from the Air Force to the Army; it is already present in both services, as well as in the Navy and Marine Corps.[62]

This statement was issued under the new spirit of jointness; however, the Army and Air Force chiefs submitted the following joint dissenting opinion:

> The Army and the Air Force do not regard attack helicopters as CAS weapons systems. Attack helicopter units lack the speed, lethality, and flexibility to enable the theater commander to mass, concentrate, or shift air support intra-theater, which is a vital characteristic of CAS. We both firmly believe that the original concept of Air Force fixed-wing aircraft providing support in close proximity to friendly forces remains valid and properly defines CAS today.[63]

It is understandable how the Chief of Staff of the Air Force could issue this statement; however, it is perplexing that the Chief of Staff of the Army would concur. Especially after the historically poor USAF CAS performance coupled with no planned upgrade to CAS capability. This sounds like bureaucratic politics at the highest levels of the military establishment.

The new CJCS, General Colin Powell, forwarded the roles and functions report, reversing Admiral Crowe's position on CAS and supporting the Army and Air Force

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[62] William J. Crowe, Roles and Functions of the Armed Forces, Report of the Chairman, Joint Chiefs of Staff, to the Secretary of Defense, (Washington,D.C.: U.S. Department of Defense, September 11, 1989).

[63] Carl E. Vuono and Larry D. Welch, Close Air Support, Memorandum for the Chairman, Joint Chiefs of Staff, (Washington,D.C.: Department of the Army and Department of the Air Force, October 11, 1989).

service chiefs. Therefore, General Powell supported the supposition that CAS could only be executed by fixed-wing aircraft.

In the current Report on Roles and Missions, dated February 1993, General Powell says,

> Four key factors--the end of the Cold War, budgetary constraints, the Goldwater-Nichols Act, and the press of new regional crises--converged to provide the opportunity, the necessity, and the authority to address the ways in which all four Services are structured, trained, and employed in combat. As a result, more changes have occurred in the U.S. military in the past three years than in any similar period since the National Security Act of 1947.[64]

As the U.S. adapts to global changes, it is placing more emphasis on rapid response to regional crises. This puts a premium on the expeditionary capabilities of the Marine Corps and the contingency capabilities of Army airborne and light infantry forces. In addition, further reductions in forward stationing of forces will increase the importance of other forward presence operations. For example, the Adaptive Joint Force Packaging concept will use geographically and mission tailored joint forces containing a mix of air, land, special operations, space, and maritime forces to meet the supported commander-in-chiefs' (CINCs) requirements.

Hardware will be supplied after careful study of the trade-offs between new acquisition and the modification of existing systems. In many cases, the replacement of existing systems to maintain a technological advantage is not as critical today. Development programs have been reduced and equipment will be retained for longer periods due to system upgrades and modifications. The Navy's F-14B *Bombcat* is an

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[64] Powell, Report on Roles and Missions, v-vi.

example of this philosophy.[65] This may open a window of opportunity to modify an existing airframe for the exclusive performance of the CAS/TIC mission.

The 1993 CJCS report examines the ability of Air Power to conduct CAS for Expeditionary warfare and forward presence in response to regional military threats. It states that it is important to keep the issue of who provides CAS separate from which type of aircraft will perform the function.[66] Furthermore, all of America's aviation elements, including attack helicopters can and must be prepared to support troops on the ground. Therefore, it recommends inclusion of attack helicopters as CAS assets and realignment and clarification of functions and doctrine to include CAS as a primary mission area for all Services.

The CAS issue has been a real political boomerang. This is the third policy change (during a span of four years) to roles and missions about which service and what kind of platform will provide CAS. Even more perplexing is the fact that the former chiefs of staff of the Army and Air Force do not regard attack helicopters as CAS weapons systems. This is important because CAS will play a critical role in the joint expeditionary environment. It appears that the Chiefs are confused about how, who and what platforms will provide CAS- perhaps this is why no other aspect of roles and missions has sparked more debate since the 1948 Key West Agreement. Why all of the disagreement? Is this bureaucratic politics or the fact that no service can adequately perform the mission? This researcher believes that it some of both.

In addition, the 1993 CJCS report states that CAS-capable aircraft must be fully incorporated into joint operations. To ensure uniformity of execution, a standardized, joint procedural and control system has been developed. It is hoped that the integration of fixed-wing aircraft and helicopters will allow commanders at all levels to take full advantage of distinctly different, but complementary, capabilities of each type of platform.

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[65] Powell, Report on Roles and Missions, II-17.

[66] Powell, Report on Roles and Missions, III-15.

However, the nature of expeditionary warfare may limit the availability of CAS platforms due to a lack of base infrastructure, diplomatic clearances, response time, loiter time, speed, lethality, and flexibility.

The 1993 CJCS report assigns each Service the CAS mission as a primary function, but each will specialize in the type for which it is currently structured. To effect this change, the report recommends that Service functions be realigned: (1) Air Force provides fixed-wing CAS to the Army and other forces as directed, and provide fixed-wing CAS to amphibious operations; (2) Navy and Marine Corps provide fixed-wing CAS for conduct of naval campaigns and amphibious operations, and provide fixed-wing CAS for other land operations; (3) Army provide rotary-wing CAS for land operations, and provide rotary-wing CAS to Naval campaigns and amphibious operations.[67]

This sounds "joint" in theory; however, there are still disparate views being espoused. General Ronald Fogleman, CSAF recently said,

> The mission of close air support is an area that I think the Air Force would like to start to treat as not a primary mission. In fact with advances that have been made with other battlefield sensors, such as J-STARS, together with wise future investments in our ability to destroy enemy forces as they come toward the battlefield, CAS becomes more of an emergency procedure. We need it in situations where we have allowed the enemy to mass in such numbers that they are threatening to overwhelm our ground forces. We want to remedy this in two ways: Do not let the enemy mass, and give the ground force commander those assets that he needs to do the job when engaged. That means organic firepower, to include helicopters and, if need be and if the Army wants to make the investment, fixed-wing aircraft. This does not mean that the Navy, Marines and Air Force would get out of the close air support business, but

[67] Powell, Report on Roles and Missions, III-16.

> it would not be a primary mission. It would be an emergency type of mission.[68]

This may appear justifiable in hindsight of the *Desert Storm* experience, but what about more demanding major regional conflict (MRC) scenarios and future expeditionary warfare operations like Haiti or Somalia when heavy Army forces function like a follow-on force? If the Army is assigned the primary responsibility for CAS, even innovative concepts like AJFP will not supply enough firepower for expeditionary warfare.

As previous stated, NSFS, artillery, and CAS support Marine amphibious operations and ground force penetration. In that regard, the 1993 CJCS report addresses three other fire support issues. First, Marine Corps organic artillery fire support will be decreased. The Multiple Launch Rocket System (MLRS), as a cost cutting measure, will stay with the Army. It will be available to the Marines only after the Army arrives in the AO. This event coupled with the decommissioning of all battleships will make accurate, sustained, all weather CAS mandatory for expeditionary warfare. Second, Army light infantry forces will be reduced. This may increase the extent of exposure for the Marines in the AO because the there may be a shortage of Army Light Fighters to supplement them. Therefore, the USMC may have to hold territory longer until heavy Army reinforcements arrive to supplement and/or relieve them. Third, Marine Corps aviation will be the "airborne artillery" that provides most of the supporting CAS firepower during an expeditionary operation because USAF units may lack the required base infrastructure, overflight rights, CAS force structure or tanker support to conduct sustained operations. The combination of Navy and Marine TACAIR can increase the sortie rate for aircraft supporting ground forces. However, to save money, Marine F/A-18 squadrons are being reduced and the number of AV-8Bs is being reduced by one quarter. [69] A reduction in

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[68] Ronald R. Fogleman, "Changing Roles and Missions", speech presented to the Air War College National Security Forum, (Maxwell AFB, AL: June 1, 1994).

[69] Powell, Report on Roles and Missions, III-17.

naval force CAS platforms is a step in the wrong direction for the credible conduct of expeditionary warfare. More important, none of the Services possess an adequate CAS/TIC platform.

The historical record suggests that CAS is locked in bureaucratic politics. It revolves around the issues of doctrine, inter-service rivalry, and money. It is clear that CAS will be the backbone of joint expeditionary warfare firepower and it is equally certain that budget cuts will reduce CAS platforms, but it is uncertain by whom, and with what, and how CAS will be conducted.

As long as this "political" issue centers around which Service stands to gain or lose the most, or the doctrinal implications of changes to traditional roles, missions, and functions, future performance of the CAS/TIC mission will be in concert with its historical past. Only one issue really counts, and that is how to ensure that American troops, locked in combat with an enemy, get all the fire support they need. However, despite recognition by some parties of the new reality of conflict in the late twentieth century, resolution of the projected lack of fire support in expeditionary warfare is not currently on the horizon.

D. JOINT FIRE SUPPORT DOCTRINE, TRAINING, AND FORCE EMPLOYMENT

Doctrine is a formal set of guidelines based on experience. While history does not provide specific formulas that can be applied without modification to present and future situations, it does provide the broad conceptual basis for the understanding of war, human nature, and military power. Thus, doctrine is a guide for the exercise of professional judgement rather than a set of rules to be followed blindly. Therefore, it is the starting point for solving contemporary problems.

Doctrine should be alive-growing, evolving, and maturing. New experiences, reinterpretations of former experiences, advances in technology, changes in threats, and cultural

changes can direct alterations to parts of doctrine while other parts remain constant. If thinking about military power stagnates, then doctrine can become dogma.[70] This has been true concerning the application of CAS.

Although neither policy nor strategy, joint doctrine deals with the fundamental issue of how best to employ the national military power to achieve strategic ends. Because U.S. military forces will operate and fight jointly, it is imperative to learn and practice joint doctrine, tactics, techniques, and procedures; feed back to the doctrine process the lessons learned in training, exercises, and operations; and ensure Service doctrine and procedures are consistent. This is critical for present and future effectiveness.[71]

The Goldwater-Nichols Act has gone a long way to ensure that the Services have been integrated into a true joint force. However, this is an iterative process and many obstacles must still be overcome. For example, continued interservice rivalry, the fundamental change in the world security environment, and the role and mission of CAS all cause budget battles within the Department of Defense (DOD).

Although Joint Pub 3-09 articulates procedures for integration of joint fires (artillery, CAS, NSFS), it does not contain any guidance for operations in the joint expeditionary warfare environment. [72] It states that when appropriate, a FSCL will be designated by the land or amphibious force commander and coordinated with the Joint Force Air Component Commander (JFACC) and other supporting elements. The FSCL

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[70] Department of the Air Force, AFM 1-1, Vol.,I, vii.

[71] _____. Joint Warfare of the U.S. Armed Forces, Joint Pub 1., (Washington, D.C.: 1991), 6.

[72] Colin L. Powell, A Doctrinal Statement of Selected Joint Operational Concepts, (Washington, D.C.: 1992), ii.

is a permissive fire support coordination measure used to expedite fires. Short of the FSCL, all fires will be controlled by the land or amphibious force commander, who has the responsibility to execute and integrate all ground fire support operations (employing air, sea, and all ground forces).

Joint Publication 3-0 provides the only guidance for joint operations in the littoral or maritime environment and it addresses the concept in broad, general terms.[73] For example, it states that naval operations in the littoral can provide for the seizure of an adversary's port, naval base, or coastal air base to allow entry of other elements of the joint force. Controlled littorals often offer the best positions from which to begin, sustain and support joint operations, especially in operational areas with poor infrastructure for supporting operations ashore. Naval forces operating in the littoral areas can dominate coastal areas to mass forces rapidly and generate high intensity offensive power at times and in locations required by the Joint Force Commander (JFC). Additionally, even when joint forces are firmly established ashore, littoral operations provide JFCs with excellent operational maneuver from the sea. The positional advantage gained by such maneuver creates an obvious dilemma for the enemy. The mobility of naval forces at sea, coupled with the ability to rapidly land operationally significant forces, can be key to achieving JFC objectives. These capabilities are further enhanced by operational flexibility and the ability to identify and take advantage of fleeting opportunities.[74]

Additionally, Joint Pub 3-0 does not articulate any specific aspects for the operational conduct of littoral warfare. Therefore, a framework for the application of joint fire support in the littoral must be addressed. Since the essence of joint fire support is to achieve the JFC's overall intent, how fire support missions are targeted, and against which level of objectives must be addressed. For example,

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[73] _____, Doctrine For Joint Operations, Joint Pub 3-0, (hereafter cited as Joint Pub 3-0), (Washington, D.C.: 1994), IV-25-26.

[74] _____, Joint Pub 3-0, IV-25-26.

attacks deep in the adversary's rear area will have broader operational effects, but a delayed effect on surface forces. Strikes close to surface forces will more quickly produce discernible results, but only in the vicinity of the attacks. The art of orchestration is in balancing the operational and strategic needs of the JFC with the tactical desires of surface commanders. This will be a fundamental operational objective of littoral warfare.

Today, it is difficult to train for joint littoral warfare because there is no doctrine. Specifically, since there is no joint fire support doctrine, it is impossible to provide appropriate CAS to the JFC. Even if there were adequate doctrine, there are few platforms capable of performing CAS/TIC. This is once again, a case of "back to the future."

Until joint fire support in the littoral is embraced by joint doctrine and a capable force structure is built;[75] joint fire support employment may be a highly ineffective, fragmented procedure at best, and at worst, become a lethal environment for U.S. expeditionary forces.

[75] CAS/TIC capable platforms will be mandatory.

III. REALITIES AND REQUIREMENTS: THE "NEW" OPERATIONAL AIR ENVIRONMENT

One can never have too many guns; one never has enough.
(Napoleon)

The fixed wing and rotary wing capabilities of the Army, Navy, Air Force, and Marine Corps are unique and complementary. The military events of 1993-94 occurring in Bosnia, Somalia, and Haiti, provide a template for the employment of America's airpower. In the future, it will be more important to have combat power in theater than a large retaliatory force waiting in reserve. Aircraft carrier battle groups containing naval tactical aviation wings and amphibious ready groups with special operations-capable Marine Expeditionary Units will be important for prompt and sustained combat operations on and from the sea. In expeditionary warfare, the Marine Air-Ground Task Force (MAGTF) will be the "enabling force" that will dominate and exploit littoral battlespace during the earliest phases of hostilities. The MAGTF will employ rapidly expandable air-ground formations, capable of operating from sea bases or ashore.[76] During the initial stages of an amphibious operation, air support will be needed to protect the operation from enemy aircraft and to support troops ashore. Unless the assault takes place near friendly territory, the bulk of the firepower will be provided by carrier based CAS platforms.[77] Therefore, it should be anticipated that naval platforms will supply most of the CAS for expeditionary forces until Air Force and Army assets arrive in theater to support the campaign.

In the early phase of air operations, the JFC will work to secure air superiority. Establishing control of the air and neutralizing the enemy's air defenses are objectives in

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[76] _____, Employment of Navy and Marine Forces, (Maxwell AFB, AL: Air University Press, 1990), 85-86.

[77] Hereafter, platforms are defined as fixed or rotary-winged aerospace vehicles.

this phase. In general, control of the air is a prerequisite to pursuing other objectives. Once friendly forces can operate without unacceptable hindrance and risk, air operations should focus on neutralizing the enemy center(s) of gravity through strategic attack, AI, BAI, or CAS. But CAS may be the most critical mission for air power, particularly when it is essential to ensure the success or survival of friendly ground forces. [78] For example, in joint expeditionary warfare, if friendly ground forces are engaged at the outset, the primary focus of the air effort should be local air superiority, suppression of enemy air defense (SEAD)[79] systems, CAS/TIC, CAS. BAI, and then AI of closing enemy forces to curtail their ability to sustain the offensive until friendly forces gain the upper hand.

A. CAS REALITIES

From the prospective of the soldier on the ground, CAS is "broken." Problems associated with apportionment, employment, and command and control have not been addressed. Therefore, no ground commander in his right mind would lock himself in mortal combat relying on a key weapon system that may or may not be there to support him. Air superiority in another region, the AI mission, and other ground priorities may receive precedence over CAS. Even if the commander does receive an apportionment of CAS, the perennial problems of weather, light, and timing will degrade his ability to employ it. The command and control of a TACAIR flight requires a difficult

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[78] Department of the Air Force, JFACC Primer, 2 ed., (Washington, D.C.: 1994), 22.

[79] See Joint Pub 3-9.3. The need for SEAD is assessed after evaluating the option for routing the aircraft away from known antiair threats. SEAD is that activity which neutralizes, destroys, or temporarily degrades surface-based enemy air defenses by destructive and/or disruptive means. It may be accomplished through destructive means (e.g., indirect fire, direct fire, air, raids) and disruptive means (e.g., electronic warfare (EW) deception, flight tactics), or a combination of the two.

The primary objective of SEAD is to allow friendly aircraft to operate in airspace defended by an enemy air defense system. SEAD and EW must be coordinated and deconflicted in order to provide necessary support during the time CAS is being conducted. For these reasons, SEAD is another critical timing factor associated with CAS.

coordination drill, under a severe time-constraint: shut down or shift artillery, mark friendlies, pick and identify targets-all for four or six bombs and some 30-MM, and maybe a *Maverick* missile. [80] Most Army ground commanders believe that they will never see CAS, and do not count on it, even in planning.

The Marines, on the other hand, have an air combat element that includes rotary wing as well as fixed wing attack aircraft. The large number of Marine TACAIR platforms are justified due to the lightness of Marine ground forces and their lack of heavy artillery and NSFS. This air package gives Marine ground commanders dedicated air support. However, these platforms have limited utility in the CAS/TIC environment.

Air power advocates have blurred the distinction between CAS/TIC, CAS, and BAI missions because most air assets are not capable of providing CAS/TIC support. Therefore, the bulk of what air power proponents refer to CAS/TIC is really CAS or BAI to the "grunt" on the ground.

The difference between CAS/TIC and BAI devolves to a risk assessment decision. CAS/TIC, from the prospective of the grunt, consists of putting ordnance on target within a one kilometer radius of a friendly position. By contrast, air proponents generally view the mission as air interdiction attacks against ground targets that have a prompt effect on the operations or scheme of maneuver of friendly forces. However, the proximity of ordnance delivery in relation to friendly forces is based on platform capability because most assets are not technologically capable of employing munitions within one kilometer radius of friendly forces without undue risk of fratricide.[81] During *Desert Storm*, approximately 39 percent of the fratricide incidents (11 of 28) appeared to be as a result of target misidentifications. Of the 28 total incidents, 16 were in ground-to-ground

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[80] Garrett, "CAS: Which Way Do We Go?"

[81] See Joint Pub 3-9.3. Fratricide, or casualties to U.S. or multinational forces caused by the effects of friendly fire, is an unwanted and undesirable side effect of warfare. Although occasionally the result of malfunctioning weapons, fratricide has often been the result of confusion on the battlefield. Causes include: misidentification of targets, target location errors, target locations incorrectly transmitted or received, and loss of situational awareness by either the terminal controllers or CAS aircrews.

engagements, with 24 killed and 57 wounded, while nine were in air-to-ground engagements that resulted in 11 killed and 15 wounded.[82] Of the nine air-to-ground incidents, one was from an Army AH-64, four were from USAF aircraft, one from USMC aircraft, and three were from high speed anti-radiation missiles delivered from undetermined sources. These incidents occurred even though limited CAS/TIC applications occurred during the war. After action reports indicate that there is still a need for an identification system that will identify friendly vehicles from the air, as well as a ground-to-ground identification system, at extended ranges in reduced visibility and darkness without betraying these locations to hostile forces.

Only a small percentage of platforms can perform the CAS/TIC mission, and still fewer are night CAS/TIC-capable. Most importantly, only the AC-130U and F-15E are capable of ordnance delivery during all environmental/weather conditions.[83] Specific capabilities and limitations of selected attack platforms are discussed in Chapter IV.

The joint expeditionary warfare environment will require more frequent application of CAS in the TIC role. Since the U.S. currently possesses platforms that can adequately conduct BAI, it is imperative to acquire a CAS/TIC platform that can accomplish the mission in all environmental conditions, day or night, because historically, CAS/TIC, CAS, and BAI have demonstrated a tremendous beneficial synergy. Examples from Korea and Vietnam prove that application of these missions, together have had a devastating impact on the battlefield, particularly in situations where airpower has been able to offset disparities between opposing ground forces.

In Korea, the dichotomy of Air Force and Navy CAS doctrine actually had a synergistic effect for battlefield coverage. The Navy-Marine system provided CAS/TIC

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[82] See Department of Defense, Conduct of the Persian Gulf War: Final Report to Congress, (Washington, D.C.: 1992), M-3/M-4.

[83] Both aircraft have the APG-180 synthetic aperture (SAR) fire control radar which allows precision, all-weather air-to-ground fire control.

support (within 45-183 meters of friendly positions) while the Air Force provided BAI (usually outside one kilometer of friendly positions). Although this caused inter-service rivalry, the system worked fairly well. In Vietnam, application of CAS/BAI in 1968 prevented Khe Sanh from becoming another Dien Bien Phu. Massive and sustained CAS/BAI strikes, in conjunction with desperate ground fighting defeated the North Vietnamese 1972 spring offensive.[84] These examples are instructive for the future doctrinal application of CAS/TIC, CAS, and BAI in expeditionary operations.

Given the great distance to expeditionary warfare operating areas, the bulk of CAS/TIC missions during the "enabling" phase usually will be performed by naval force assets while the majority of BAI will probably be performed by Air Force assets. If properly performed, this arrangement can provide synergistic firepower for the battlefield. But the disturbing fact is that naval forces do not possess doctrine, airframes, or technology to conduct CAS/TIC missions. In reality, historically intransigent doctrinal policies, inter-service rivalry, and funding battles have left the U.S. Armed Forces with few platforms that can conduct the CAS/TIC mission in the expeditionary warfare environment.

B. CONTEXT FOR THE OPERATIONAL CAS ENVIRONMENT

CAS is the air mission that has the greatest immediate impact on the battlefield. It has worldwide applicability. The requirements and capabilities for the mission vary with the spectrum of the threat from low to high intensity.

CAS and CAS/TIC have historically been high-attrition missions. These missions have always involved instances of fratricide including friendly ground forces and the CAS platform. Because of the swirling, nonlinear battlefield, the "fog of war" will be great in

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[84] Richard P. Hallion, "Battlefield Air Support, A Retrospective Assessment," Airpower Journal, Spring 1990.

the expeditionary CAS environment. The proximity of friendly ground forces to targets presents challenges and opportunities.

To exploit these opportunities, a commander must devote great attention to command and control of aerospace and surface forces. These arrangements must provide the close coordination a commander needs to synchronize forces while avoiding any unacceptable risk of fratricide. The success of these arrangements depends largely on how well subordinate aerospace and surface commanders understand the capabilities and limitations of close air support platforms.

CAS can make a great contribution to campaign success. During an offensive, it can make a transition from static to mobile operations easier for surface forces by helping them achieve a breakthrough (as in Operation Cobra's contribution to the Allied breakout from Normandy) and once ground operations are fluid, CAS can help ground forces maintain a high tempo in their advance (as with XIX Tactical Air Command's support of Patton's Third Army in 1944). Similarly, on the defensive, it can prevent an enemy offensive from achieving the mass necessary for success (as at Khe Sanh in 1968) or from maintaining tempo (as in the Battle of the Bulge in World War II). [85] The mastery of CAS and CAS/TIC will be an important challenge in high tempo operations.

CAS and CAS/TIC application must be massed, lethal, continuous, and responsive, but it is not suitable for all targets. It can fill organic firepower shortfalls, or synergistically contribute to ground fires to produce a total effect on the enemy that is both psychological and physical.[86] A representative sample of CAS and CAS/TIC type targets would consist of dispersed armored vehicles, squads of enemy infantry in fortified positions, and hardened automatic weapon emplacements. This target set does not normally include heavy armor.

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[85] Department of the Air Force, Basic Aerospace Doctrine of the United States Air Force, AFM 1-1, Vol II. (Washington, D.C.: 1992), 165-166.

[86] Pat A. Pentland, "CAS", 92-96.

CAS and CAS/TIC should be viewed as a system. It is a war-fighting capability that consists of hardware, training, logistics, and operational concepts that place the weapon system on target with limited collateral damage and without fratricide. Additionally, the employment of airpower in these situations will rely on positive thinking, attitude, and imagination.

Insight into Service attitudes concerning the expeditionary CAS environment can be gleaned from their respective papers, Army Focus 92; the Air Force Global Reach, Global Power; and the Naval and Marine Corps White Paper, From the Sea. [87]

1. The Army

The Army divides war into close, deep, and rear operations. Close operations, which include CAS, are defined as "the efforts of large tactical formations-corps and divisions-to win current battles." [88] The Army believes that "close operations bear the ultimate burden of victory or defeat" and measure the success of deep operations only by their eventual impact on close operations.[89] Therefore, close operations are paramount.

In most cases of expeditionary warfare, the Army will be used as a follow-on force to relieve the Marines after infiltration. The light infantry can be used to augment Marine forces until heavy Army forces may arrive in theater. The Army by doctrine depends on the Air Force for fixed-wing CAS; however, the Air Force will only be able to accomplish this mission if it has access to bases in close proximity to the AO.

Historically, the Army has used attack helicopters as a maneuver element, not as a fully integrated element of the fire support scheme of operations. However, the current

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[87] Powell, Report on Roles and Missions, II-2.

[88] Price T. Bingham, "US Air Interdiction Capability Challenges Ground War Doctrine," Armed Forces Journal International, October 1992, 62.

[89] Bingham, "Air Interdiction Challenges Ground Doctrine," 62.

change in roles and missions integrates them into the fire support scheme. The attack helicopter can provide effective CAS in certain situations, however, there are logistical problems getting it to the AO. Therefore, the Army will still be the customer for fixed-wing CAS and CAS/TIC and, in expeditionary warfare, naval forces will be the main supplier of that precious commodity.

2. The Air Force

The Air Force will conduct expeditionary warfare by using tankers as the lifeblood of global reach, global power. Air refueling will assume increasing importance as a force multiplier in a period of smaller forces and declining forward basing. Tankers will be required to build air bridges and provide support to strike packages which rely on them to extend range and payload. Therefore, land-based tanker forces are indispensable to support a range of theater air operations.[90] However, the Air Force will encounter problems in conducting expeditionary operations: tanker shortfalls; lack of forward operating bases (FOBs); and denial of diplomatic clearances and overflight rights which can hamper operations.

The Air Force will play a large role in AI and to some extent BAI, but, unless bases are available near the AO, it will not contribute significantly to CAS and CAS/TIC missions. Even if the Air Force has FOBs near the AO, with the exception of the AC-130 and F-15E it does not possess airframes capable of performing the CAS/TIC mission.

Recently, the Joint Requirements Oversight Committee (JROC), then chaired by Admiral Jeremiah, Vice Chairman of the Joint Chiefs of Staff, was briefed by the Air Force about a plan that would allow Army helicopters to provide CAS/TIC to minimize fratricide by fast-moving jets. Air Force fixed-wing aircraft specialized for ground attack

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[90] Department of the Air Force, Global Reach, Global Power: The Evolving Air Force Contribution to National Security, (Washington, D.C.: 1992), 7-8.

would conduct attacks from just beyond troops in contact to the farthest artillery range, known as the FSCL.[91] To stress this point, David Fulghum quotes an Air Force official who recently stated,

> CAS with the enemy over the wire, where you have to sort [the combatants] out at night, is only one small part of ground attack, and it is best done by the Army. Instead of focusing on the hardest, least likely thing we do, the Air Force will concentrate on destroying armor scheduled to join the battle hours or days later.[92]

Fulghum suggests that CAS, though important, will rarely create campaign-level effects. Because it functions at the tactical level of warfare, CAS does not fit into the Air Force view of air power influencing the overall war.[93] Air Force doctrine emphasizes the use of AI to destroy enemy forces in depth. It does not anticipate many large-scale BAI operations against massed armor and mechanized forces in future air-land combat because it states that those forces will be neutralized by the AI campaign.[94] However, this may be difficult to achieve early in conflict.

At the initiation of hostilities, the Air Force would send CONUS based bombers (B-1, B-2, B-52, F-111, and F-117) armed with conventional weapons to conduct AI missions supporting expeditionary operations.[95] Later in the conflict, if adequate base facilities are available, the Air Force will conduct the bulk of AI, air superiority and BAI missions. However, with the exception of the AC-130, which is only survivable in a low-

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[91] This is the definition of the BAI mission.

[92] David A. Fulghum, "Night-Fighting CAS Force Gains Preliminary Approval", Aviation Week and Space Technology, 8 February, 1993, 54.

[93] See AFM1-1, Vol.,I for a full discussion of USAF air power applications.

[94] James W. Canan, "Air-Land Options", Air Force Magazine, October 1993, 27.

[95] James W. Canan, "Expeditionary Force," Air Force Magazine, June 1993, 23-24.

to-medium threat environment, and the F-15E, it still lacks the assets to conduct the CAS/TIC mission.

3. Naval Forces

In many future scenarios, the Navy will be the first force on station. As it did in *Desert Storm*, the carrier battle group most likely will provide the initial CAS capability in theater. Historically, CAS has not been a high priority for carrier air wings. In the past, naval doctrine has placed greater emphasis on deep strikes and power projection, but the A-6 *Intruder* is being retired from the fleet. With it will go the Navy's only long-range high-payload bomber.[96] A new kind of carrier air wing (CVW) will make its debut when the USS *Constellation* (CV-64) deploys on November 10, 1994. It will consist of 14 F-14 and 36 F/A-18 C/D TACAIR platforms which is ten fewer aircraft than in the old CVW structure.[97] The new CVW will not be able to conduct deep strike missions; however, it will be better suited for the conduct of expeditionary warfare.

This is in keeping with the Navy's recent focus on littoral warfare. The Navy will use the carrier air wing to provide support for the integrated amphibious ready group (ARG)-Carrier Battle Group (CVBG). This integrated force will then comprise a naval expeditionary force. This also means that CAS will be integrated into the amphibious ready group. Additionally, Marine F/A-18 squadrons have been fully integrated into all CVWs. The gradual merger of Marine tactical aviation into Navy air is clearly the wave of the budget driven future.

Navy and Marine planners have agreed to make available all Marine squadrons for future carrier air wing deployments. Marine tactical aviation squadrons will be integrated into Navy carrier air wings over the 1994-96 period. Including reserve

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[96] _____. "What's Deep Strike?", Navy Times, 31 October, 1994, 29.

[97] Blazar, Ernest, "Is the Navy taking over Marine tac-air?", Navy Times, October 31, 1994, 10.

squadrons, there will be 25 Marine squadrons available to deploy as part of Navy carrier air wings at any time and these joint deployments may even include Marine squadrons of AV-8B *Harrier* "jump-jets."[98] The addition of the AV-8B will give the CVW a more potent CAS capability; however, it is still limited in the CAS/TIC environment.

According to Ernest Blazer, Navy documents state that the consolidation of Marine Corps TACAIR into Navy CVWs will help offset the cost of five proposed Navy F/A-18 squadrons, which were eliminated by budget cuts.[99] This merger will save the Navy about $700 million in procurement costs and $300 million per year in operating costs. But this will mean that Marine Corps squadrons must be ready to perform either Navy or Marine missions. Therefore, to save money, CAS training may suffer, leading to mission deficiencies and potentially increasing the chance of fratricide.

If properly located, carrier-based aircraft can play a useful role early in a short-notice war, helping to establish air superiority in addition to conducting CAS, BAI, and SEAD missions. The Navy is assessing the F/A-18 E/F for electronic warfare, for jamming and destroying enemy surface-to-air (SAM) missile batteries.

The ability to project power ashore, suppress defenses, and establish air defense over arriving forces in the first week of a campaign is very important. This capability can be enhanced by positioning naval forces in close proximity to theaters of operations during the "brewing" phase of conflicts. The current Navy carrier air wing complement of F-14 and F/A-18 aircraft is tailored for air superiority, BAI, and SEAD missions. Due to that training emphasis, even with possible additions of AV-8B aircraft or Army AH-64 helicopters,[100] naval forces will not be able to perform the CAS/TIC mission.

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[98] Blazar, "Is the Navy taking over Marine tac-air?", 10.

[99] Blazar, "Is the Navy taking over Marine tac-air?", 10.

[100] Army helicopters deployed in a carrier air wing under the Adaptive Joint Force Packaging (AJFP) concept during Operation *Restore Democracy* in Haiti.

The Marine Corps will be the "enabling force" for the future. Marine forces are structured, trained and equipped to provide a capability for extended operations from bases at sea (ships) or for entry from the sea (forcible if necessary), and then for operations ashore while being supported from the sea.

This was evident during the initial days of Operation *Desert Shield.* The Marine Corps was used as a force sequencing and enabling force for heavier follow-on forces. First Marine Expeditionary Force (MEF) assumed the northern-most defensive positions along the likely avenue of approach for the Iraqi Army, the high-speed coastal routes into Saudi Arabia. Had it been necessary, I MEF would have used extensive CAS in conjunction with ground forces to counter a numerically superior Iraqi attack. In the initial days of *Desert Shield*, the ability of Marine tactical aircraft to deliver CAS was not only critical to I MEF's ground defenses, but to the defense of Saudi Arabia as well. Destroying the enemy as far forward as possible is always preferred, but CAS provides an insurance policy in the event time does not allow interdiction targeting.[101] In expeditionary warfare, CAS and CAS/TIC will be more the rule than the exception.

For amphibious operations, the Marine Corps will use a new concept called "Operational Maneuver From the Sea." Forces will be brought ashore in a seamless continuum from over-the-horizon (25 miles or more off-shore), well beyond range of most of the enemy's precision-guided weapons. This will be well-supported maneuver power that lands where the enemy is not, and outflanks them. [102] The idea is to maintain tactical surprise. Flexibility will be key to success because it will be critical to implement last minute changes during the process, to exploit newfound enemy vulnerabilities or to avoid just-discovered hazards. The flexibility of CAS and CAS/TIC will help counter these inherent frictions of war.

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[101] Thomas Linn, "Who Really Needs Marine TacAir?", Proceedings, October 1992, 42.

[102] John H. Cushman, "Maneuver ...From the Sea", Proceedings, April 1993, 48.

The expeditionary capabilities of the MAGTF and its tactical aircraft will be increasingly important to the enablement of U.S. air power in an expeditionary environment. The MAGTF is a highly mobile, expeditionary force with its own air arm. It is a valuable asset for unified commanders facing more threats with fewer deployed forces. Such a force provides the theater CINCs with the most complete and readily employable combined arms force at the tactical level.

In some Marine Corps circles, there is a belief that the majority of CAS sorties will originate from an expeditionary airfield (EAF), but the establishment of a true EAF is beyond the logistical capabilities of current amphibious forces.[103] The rapid deployment of air assets to support ground forces during the Gulf War was possible because of the Coalition's access to ports and air bases. The Marines cannot rely solely on the ability to operate from a readily available EAF. Therefore, the doctrinal view of allowing only Marine Corps air assets to support Marine forces, as demonstrated during *Desert Storm*, must be changed to ensure that the joint task force commander's objectives are met in the most efficient manner.

With the integration of Marine TACAIR into CVWs, it appears that Marine doctrine has shifted to support joint objectives, but the F/A-18, AV-8B, and AH-1 do not have the technological capability to provide adequate CAS/TIC in the future expeditionary environment.

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[103] Matthew J. Faletti, "Close Air Support Must Be Joint", Proceedings, September 1994, 56.

C. REQUIREMENTS FOR EFFECTIVE CLOSE AIR SUPPORT

Maneuver force commanders request CAS to augment organic supporting fires. CAS platforms must be able to attack the enemy in adverse weather and poor environmental conditions, day or night.[104] Acquisition of equipment and improvements in tactics, techniques, and procedures must be accomplished to enable proper conduct of the mission and increase chances of platform survival.

The maneuver force commander must consider several factors in planning for CAS. Mission and concept of operations, enemy air defenses and the joint force's ability to counter them, integration with other supporting arms, and types of CAS assets available must be taken into account.

CAS is integrated with other supporting fires to support maneuver forces. Whether conducting offensive or defensive operations, commanders focus CAS at key points throughout the depth of the battlefield. Like all joint force assets, the priority consideration for the assignment of CAS is to support the commander's intent and concept of operation.[105] The organizational structure, missions, and the characteristics of CAS-capable platforms determine how CAS is employed. In a joint force, the integration of CAS-capable platforms allows maneuver force commanders to take advantage of the distinctly different, but complementary, capabilities of each platform to support the fire and maneuver of their units.

Although fixed and rotary-wing platforms can both provide CAS, employment methods for fixed-wing CAS may not be the best for rotary-wing aircraft and vice-versa. Service and functional component commanders should employ CAS assets in the manner

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[104] Adverse weather consists of low ceilings and/or poor visibility, fog, haze, clouds, and precipitation. Poor environmental conditions consist of smoke, dust, sand, and sunrise/sunset.

[105] _____ , Joint Pub 3.09.3, I-8.

that best takes advantage of unique capabilities, and minimizes their limitations.[106] Fixed- and rotary-wing assets must be employed to provide a synergistic effect across the battlefield.

There are nine general considerations for conducting CAS: (1) Air Superiority; (2) Suppression of Enemy Air Defense Systems; (3) Target Detection and Marking; (4) Environmental Conditions; (5) Response; (6) Skill; (7) Ordnance; (8) Communications; and (9) Command and Control (C2).[107]

(1) Air superiority enhances successful execution of CAS. It may range from local or temporary air superiority to control of the air over the entire theater of operations. It involves negation of enemy airborne and ground intercept systems, to include air-to-air, air-to-surface, surface-to-air, and electronic combat systems capable of adversely impacting friendly operations. It will be extremely difficult, if not impossible, to conduct CAS without air superiority.

(2) SEAD may be required for CAS platforms to operate in airspace close to maneuver forces and within the area defended by enemy air defense artillery (ADA). It is vital that CAS platforms implement creative tactics. This includes fighter escorted operations. The primary mission of the escort is anti-aircraft artillery (AAA) suppression; however, the escort should be prepared to attack any threat during the mission and to attack other lucrative targets upon direction of the escorted aircraft.

(3) Target detection and marking must be accomplished in a timely manner. The preferred method of target detection is by multi-spectral sensors (infrared [IR] or low-light-level TV [LLLTV])[108] or by a strike radar. Other methods include: radar beacon

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[106] _____, Joint Pub 3.09.3, I-9.

[107] _____, Joint Pub 3-09.3, I-10/13.

[108] Multi-spectral systems are degraded at twilight, that is, within about thirty minutes of sunrise and sunset. The difficulty of acquiring and attacking targets under low-sun-angle and dim-light conditions is one of the most enduring realities of CAS.

Infrared systems can penetrate haze better than optical systems, but optical systems can penetrate mist and fog better than infrared systems. Therefore, it is essential to have both systems.

forward air controller (RABFAC),[109] night vision goggles (NVGs), and radar. Target marking should be provided for aircraft whenever possible. It can be accomplished by laser marking,[110] infrared marking,[111] "buddy-lasing,"[112] and direct fire weapons. Target marking on the ground includes the following methods: lasers, flares, beacons, direct fire weapons, and infrared (IR) pointers.

(4) Favorable environmental conditions improve aircrew effectiveness regardless of the type of CAS platform. Sensor degradation can occur in poor environmental conditions, adverse weather, and darkness. Ordnance delivery during these conditions may be only available by employing the AC-130U and the F-15E strike radar or the AC-130H, F-16, and F-111 beacon receivers. Poor environmental/adverse weather conditions pose one of the major limiting factors for the successful accomplishment of CAS/TIC missions.

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[109] The RABFAC is a radar beacon that can be used to assist aircraft in acquiring a CAS target or a friendly position. The use of electronic beacons gives CAS platforms the increased capability to continue operations in instrument meteorological conditions (IMC) or adverse environmental conditions. Only the F-16, F-111, and AC-130 can receive beacon transmissions. Beacons are limited by line of sight and any obstruction such as hills or buildings may cause the receiver to break lock.

[110] If the aircraft has a laser spot tracker, the preferred method of marking a target is by laser. The laser ensures the accurate engagement of the target by laser-guided weapons but also assists the CAS aircrew in more accurately delivering unguided ordnance. However, laser spot trackers are degraded by poor environmental/weather conditions.

[111] IR pointers and other IR devices can be used by terminal controllers to mark targets at night for pilots who are using night vision devices (NVDs). Unlike laser designators, these IR devices cannot be used to guide or improve the accuracy of aircraft ordnance. IR pointers must be used with caution as they may expose the terminal controller to an enemy with night vision capability. Additionally, they are degraded by poor environmental/weather conditions.

[112] See Multi-command Manual (MCM) 3-1, Tactical Employment, Vol.VI, F-111 Tactics, October 14, 1988, 2-3. "Buddy-lasing" is a tactic that allows cooperative attack by an airborne platform to designate a target for another platform that carries precision guided munitions (PGMs) which may or may not have a laser designator to guide these munitions to impact. However, even in the daytime, "buddy-lasing" is a highly demanding task that is better suited to multi-crew platforms. Additionally, this tactic is degraded by poor environmental/weather conditions.

(5) Quick response to a "call for fire" is mandatory for effective CAS. Streamlined request and control procedures improve responsiveness. Prompt response allows a commander to exploit fleeting battlefield opportunities. In expeditionary warfare, use of aircraft carriers can decrease the distance
to the operating area and increase loiter time. Also FOBS, when available will increase responsiveness.[113] Placing aircrews on-station (airborne alert) or in a ground alert status can also reduce response time.

(6) CAS execution is complex. Aircrew and terminal controller skills influence mission success. Maintaining a high degree of skill requires that aircrews and terminal controllers practice frequently. Succinctly said, CAS is a full time mission! Successful mission accomplishment hinges on precise coordination with all battlefield and maneuver elements.

(7) Flexibility is key for CAS ordnance selection. To achieve the desired level of destruction, neutralization, or suppression of enemy targets, it is vital for the CAS platform to possess a broad array of weapons as well as complementary munitions. This will allow flexible response across a specific target set to reduce the risk of collateral damage and fratricide.

(8) CAS requires dependable, and interoperable communications between the aircraft, terminal controller and maneuver commander. It is imperative to have secure, redundant radios for successful mission accomplishment.

(9) CAS requires an integrated, flexible C2 structure to process target requirements, assign assets, communicate taskings, deconflict fires and routing, coordinate support, establish airspace control measures, and update or warn of threats to CAS assets.

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[113] Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey Summary Report, (Washington, D.C.: GPO, 1993), 229. During *Desert Storm*, only aircraft such as A-10s and AV-8Bs, flying from the more forward operating bases and attacking targets in the Kuwait theater, could fly back and forth without in-flight refueling.

D. CLOSE AIR SUPPORT/TROOPS IN CONTACT: MEASURES OF MERIT

Modern air-to-ground warfare, as shown in combat operations recently occurring in Panama, the Gulf War, Bosnia, Somalia, and Haiti, has highlighted four measures of merit against which the effectiveness of any CAS/TIC attack platform should be evaluated: Target Detection/Recognition; Lethality; Survivability; and Combat Persistence. These measures reflect a need to provide "surgical" firepower for extended loiter periods, at night, and in adverse weather and poor environmental conditions. It will be necessary to locate targets that are dispersed, mobile and/or hard to detect, to destroy those targets, and to survive in the threat environment. In addition, the issues of urban and guerrilla warfare and other forms of combat associated with conflicts at the low end of the conflict spectrum place a high emphasis on air support being readily available, hence the concept of combat persistence.

Due to the complex nature of the CAS/TIC mission, human factors (i.e., fatigue, workload, coordination, skill, and training, etc.) coupled with system capability will be evaluated on a subjective "total system" concept vis-a-vis the four aforementioned measures of merit (MOM).

1. Target Detection/Recognition

Target Detection/Recognition is the ability of a system to locate and identify targets and to distinguish friend from foe. This capability is important to any combat mission but it is especially critical in the performance of the CAS/TIC mission. Important considerations include: sensors, navigation, command, control and communications (C3), battlefield situational awareness and environmental factors.

Sensor type, resolution, field of view (FOV) and tactical employment of the system affect target detection and recognition.[114] Sensor types include: multi-spectral sensors, strike radar, radar beacons, radar, and night vision devices (NVDs). Experience has proven that the ideal mix of sensors includes both low light-level television (LLLTV) and infrared (IR) systems coupled with a strike radar and electronic sensors (each with a dedicated operator) that provide platforms a method of positively identifying friendly ground forces and ordnance delivery during poor environmental/adverse weather conditions.[115] In addition, it is important to evaluate whether the sensor system will get a "quick look" during a high speed pass by a single TACAIR platform as opposed to a hover or 360 degree orbit that can literally "look under" objects such as highway overpasses to pick out targets that would be overlooked on a straight pass through an area. This is particularly important in an urban environment where sensors are needed to sweep down streets, alleyways and rooftops to search out snipers, vehicles, etc.

The most accurate navigation system is the global positioning system (GPS) which is updated by satellites; however, it is not totally jam-resistant. The inertial navigation system (INS), on the other hand is not as accurate as GPS but cannot be jammed. Therefore, an integrated GPS/INS is the best system because it incorporates the advantages of each system. Also, it is important that the navigation system be able to

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[114] See _____, Gulf War Air Power Survey, Vol., IV., (Washington, D.C.: GPO, 1993), 135. The main physical limitation of multi-spectral systems is target acquisition FOV. Looking for a target with an IR or LLLTV sensor can be described as looking through a soda straw. Without accurate target coordinates and updated systems, finding targets with these systems can be very difficult. The field of view increases with an increase in slant range. For example, using the F-111F Pave Tack IR at 500 feet above ground level (AGL) will display an area of six square yards in narrow FOV and 25 square yards in wide FOV. At 10,000 feet AGL, the narrow FOV covers a little more than a football field, and the wide FOV covers approximately five football fields. However, an aircraft must have precise coordinates and accurate navigation systems to find small targets at long ranges.

[115] To prevent fratricide in a TIC situation, the friendly position should be located by one of the following techniques: ground forces wearing gated laser illuminator for night television (GLINT) tape which is illuminated by a LLLTV; beacons; IR devices; smoke; signal panels; mirror; chemlights; and PRC-112 radios using the personnel locator system (PLS). Additionally, it is vital that target identification be confirmed by the ground party.

locate targets autonomously and that the sensors are integrated into the navigation system to allow position "updates" to improve navigational accuracy. In addition, navigation chart commonality is important for target detection. Ground parties work in universal transverse mercator (UTM) coordinates because they are more accurate than latitude/longitude (Lat/Long) coordinates. [116] Therefore, it is important for attack aircraft have UTM capability because conversion from Lat/Long can be a complicated, laborious task.

Fire control computers and navigation systems that can "store" target coordinates will allow detection of multiple targets without losing them and are invaluable for the timely engagement of multiple targets.

A battle management center that has secure, redundant radios and provides air, ground, and maritime communication frequencies will provide the best airborne C3. Accurate navigation systems coupled with sensor video recorders are invaluable for battle damage assessment (BDA).[117] This facilitates a real-time flow of battlefield intelligence to enhance situational awareness, leading to better coordination between air and ground assets to help locate and engage targets. Combat operations will require the use of flexible, standardized, and above all, simple communications procedures.

The ability to "see" at night, through smoke, fog, or haze is an essential element in target detection/recognition. The execution of night CAS/TIC is one of the most

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[116] Most aircraft navigation systems utilize Lat/Long coordinates. It is imperative that attack aircraft have navigational and chart interoperability with the ground party for proper ordnance delivery and battlefield situational awareness. It is not practical for the pilot of a single seat aircraft to manually convert Lat/Long coordinates to UMT coordinates inflight.

[117] See Joint Pub 3-09.3. BDA is the timely and accurate estimate of damage resulting from the application of military force, either lethal or nonlethal, against a predetermined objective. BDA is primarily an intelligence responsibility with required inputs and coordination from operators. It is composed of physical damage assessment, functional damage assessment, and target system assessment. BDA is used to update the enemy order of battle. Accurate BDA is critical to determine if the target should be reattacked. BDA should include: (1) information relating BDA to a specific target (e.g., target coordinates, target number, mission number); (2) time of attack; (3) damage actually seen (e.g., secondary explosions or fires, enemy casualties, number and type of vehicles/structures damaged or destroyed); and (4) mission accomplishment (desired effects achieved).

difficult missions on the battlefield.[118] Ground forces, both friendly and enemy, conduct operations around the clock. Therefore, U.S. joint forces must provide CAS/TIC at night, during poor environmental conditions, or under adverse weather conditions. CAS/TIC demands rigorous training and detailed mission planning, as well as solid communications and procedural discipline. Successful CAS/TIC at night, or in poor environmental/adverse weather conditions, only accentuates these requirements.[119] Aircraft sensors are relied upon more at night and in adverse weather because of degraded visual target acquisition range and recognition cues. Aircrews and terminal controllers must incorporate redundant methods (e.g., multi-spectrum sensors, strike radars, radar beacons, and lasers) to discriminate between friendly and hostile positions and engage targets. This will decrease target acquisition time and increase positive target identification, reducing fratricide.

2. Lethality

Lethality is the ability of a weapon system to destroy or neutralize a given target. The most important CAS/TIC targets are personnel in the open and under light, medium, and heavy cover, small vehicles, trucks, armored personnel carriers (APCs) and non-ocean going water craft.

The post-*Desert Storm* shift in weapons procurement focus to precision-guided munitions may limit the availability of suitable CAS/TIC ordnance. Multiple lightweight munitions can provide increased flexibility as opposed to heavy, general purpose, and

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[118] See Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, (Washington, D.C., GPO: 1993), 200. During *Desert Storm*, AV-8Bs, A-10s, and F/A-18s flew mostly during the day because of limited night capability.

[119] See Keaney and Cohen, Gulf War, Summary, 172. Particularly in the early days of the Gulf War, as many as half of the sorties did not attack or missed their assigned targets because of poor weather. The A-10s and AV-8Bs returned with their weapons or did not take off at all. Laser guided bombs could not be guided if the target lay beneath fog or clouds. Weather conditions did not remain as severe for the entire war, but the adverse conditions for the first 10 days, and again during most of the ground war, created a vivid impression on flight crews.

precision-guided munitions. For example, in CAS/TIC situations, a *Maverick* missile[120] would not be appropriate against jeeps and troops in the open because of the possibility of fratricide and the cost per kill ratio. However, a 40-MM round shot from an AC-130 would be an appropriate selection.[121] The destruction of some targets by precision weapons will require an enormous and costly effort, especially when the same targets could be functionally destroyed by relatively "dumb" airplanes shooting "dumb" munitions.

Because control of fratricide and collateral damage are critical to the mission, tactically, it is more advantageous to have a "clear" area around the target than run-in headings for safe separation from friendly forces. This enhances ordnance flexibility by allowing delivery of munitions from any direction in relation to friendly forces rather than from just one 90 degree quadrant. [122] Also, a force multiplier effect is provided if the platform is capable of engaging multiple targets, separated by up to a kilometer, simultaneously.

Extreme accuracy is required when working very near structures or objects (e.g., schools, hospitals, religious shrines, etc.) whose destruction or damage could have adverse political consequences. Therefore, the ability to deliver surgical firepower in all conditions is vital. CAS/TIC platforms must have the means to positively identify friend from foe. This can be accomplished by radar beacons or strike radars. The strike radar provides a quantum leap in technology by enabling a true precision all-

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[120] The AGM-65 Maverick missile is a 500 pound, rocket propelled air-to-ground missile. It is used mainly against armored vehicles, bunkers, boats, radar vans, and small hard targets.

[121] The 40-MM round is shot from the Bofors cannon and it is the most accurate weapon system employed on the AC-130. The round dispersion (for 80% of shots within the center mass) is 0.6 milliradians and the round contains 1.12 lbs of HE.

[122] The safe application of ordnance near friendly positions is situationally dependent. It depends on weapon accuracy, lethality, and cover afforded to friendly troops. However, CAS/TIC platforms must be able to deliver ordnance, at night and during periods of poor weather/environmental conditions, within 100 meters of friendly positions without undue risk of fratricide.

weather/environmental attack capability that will locate fixed and mobile targets and deliver ordnance. It may also enable future integration with other targeting assets such as the Joint Surveillance and Target Attack Radar System (JSTARS) to exploit all-weather/environment attack capability. [123] JSTARS uses state-of-the-art radar technology to "see" enemy concentrations regardless of environmental conditions.

3. Survivability

Survivability is the capacity of a weapon system to execute its mission in a threat environment. Proper tactics coupled with good battlefield intelligence is the best method of survival. Most importantly, knowledge of the threat environment is key. Aircraft must avoid rather than absorb hits. Two important rules of survival in a hostile environment are to limit exposure and always expect to be fired upon, especially when firing. [124]

Air superiority and SEAD are critical for survivability as well as mission accomplishment. The threat needs to be
tempered with operational reality to avoid projecting an erroneous high-threat dilemma in which no aircraft, regardless of capabilities, could survive.

There are three basic types of threats: AAA,[125] SAMs, and aircraft. Each have a variety of tracking systems that use radar, infrared, optics, or a combination of the three. Aviators must minimize exposure to high-priority threats, be unpredictable, deal with threats through a see-and-avoid concept, and use the best available resources to suppress

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[123] JSTARS provides near real-time target information to aircraft that are equipped to receive the information. In addition, it can also pass information to C2 facilities. In the future, it should be able to electronically hand off targeting data to attack platforms without voice communication.

[124] Department of the Air Force, AFSOCR 55-130, VOL.,X, 3.

[125] See _____, Gulf War, Vol IV., 147. The key to defeating aimed AAA is to fly the aircraft in a unpredictable (jinking) fashion. Conversely, jinking is not effective against barrage fire. The best tactic against barrage fire is to penetrate and egress as rapidly as possible.

enemy air defenses. Minimizing exposure to known threats is done by flying around, over, or under the known threat envelopes. Unpredictability is used to limit an enemy's ability to anticipate tactics. Finally, see-and-avoid procedures and the use of radar warning receivers (RWRs) in combination with "heads out of the cockpit" navigation will increase the chance of proper recognition and response to enemy threats.[126] Although RWRs can aid in detecting and avoiding radar threats, visual detection is the primary basis for timely and effective reaction.

Survivability is greatly increased by flying at night because it negates optical ADA as well as IR man-portable air defense systems (MANPADS). [127] In general, IR systems are the greatest threat to CAS/TIC platforms because they are not detectable until launch. The only way to detect and defeat IR threats is by visual acquisition and reaction. Additionally, they are the most numerous and mobile threats on the battlefield. These threats must be countered by utilizing the cover of darkness, employing IR signature reduction techniques, and the installation of IRCM devices. Additionally, if sufficient weather conditions are present, IR threats cease to be a factor because hostile forces will not be able to track to platform; however, this requires CAS/TIC systems that are capable of ordnance delivery during periods of adverse weather/environmental conditions.

The ability to gather and receive real-time intelligence can be critical for platform survivability. A threat environment may become survivable or unsurvivable based on the movement of forces, degraded enemy air defense coordination, munitions expenditures, lower system operational rates and lower accuracy while on the move, chaos of war, and attrition due to lethal suppression.

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[126] See _____, Gulf War, Vol IV, 143. RWRs will display on small scopes, the types and relative positions of enemy threat radars. Most aircraft also have self-protection radar jamming capability. When a SAM threat appears on the radar warning scope, the aircrew evaluates the threat and takes appropriate evasive action. Radar warning receivers provide aircrews with two kinds of warnings: the first indicates that the aircraft has been observed or tracked; the second indicates that a missile has been launched.

[127] This is only true if the enemy does not possess NVDs.

CAS/TIC platforms must employ a combination of defensive countermeasures (electronic countermeasures [ECM], infrared countermeasures [IRCM], chaff, flares, maneuvers, speed, standoff capability) to spoof threat system terminal accuracy and thus increase miss distance outside the warhead's lethal envelope. These measures must be employed together to provide a synergistic effect against threats. Additionally, armor plating, redundant systems, and fire resistant hardware will help increase survivability.

Finally, speed and maneuverability coupled with proper tactical techniques can minimize risk and will increase the chances of mission success and survival.

4. Combat Persistence

Combat persistence is defined as the ability of a weapon system to provide coverage/protection of a target area in terms of time-on-station, as well as the number of targets engaged.

Platform range, ammunition load-out, and accuracy will determine how many targets can be engaged and neutralized during this period. The ability to engage a large quantity of targets will be critical when friendly forces are opposed by a numerically superior enemy force.

Fuel is a basic mission planning consideration. Fuel requirements affect range, loiter time, ingress and egress speeds, enemy defense engagement options, and recovery contingencies. Aircrews must plan for potential delays, threat reactions, and responses in case of premature external fuel tank jettison, and tanker or forward area rearm and refuel point (FARP)[128] nonavailability.

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[128] See Joint Pub 3-09.3. CAS helicopters support themselves through FARPs located in the forward area. It extends effective combat radius of attack helicopters and increases their time in the objective area. Preplanned logistics support is vital in order to ensure that sufficient ammunition, fuel, and proper servicing equipment is available when it is needed. In addition, the FARP area must be secure from attack by enemy forces.

Combat persistence also simplifies the problem of maintaining battlefield situational awareness. A single, combat persistent platform can maintain a combat presence for the duration of many ground engagements, by continually establishing and maintaining a knowledge of force deployments while quickly responding to "calls for fire" which will lessen the probability of friendly fire casualties.[129]

FOBs and aircraft carriers can increase response and on-station time by decreasing the distance to the target. In addition, platforms that are inflight refuelable and/or FARP-capable will have increased loiter time and combat radius. These platforms still must leave the objective area during in-flight refueling or FARP procedures which will interrupt battlefield situational awareness and may leave friendly forces exposed during their absence.

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[129] See _____, Gulf War, Vol IV, 264. During *Desert Storm*, according to Iraqi prisoner reports, the principal source of anxiety produced by the A-10 was the aircraft's sustained loitering capability. As long as the A-10 was in the target area, everything within eyesight was subject to attack. Any soldier could suddenly become the target; if he were unfortunate enough to attract the attention of the omnipresent weapon, death seemed certain. The only alternative was defection, and many took it. The lack of any effective air defense gave rise to complete feelings of hopelessness, which magnified the effect.

IV. CURRENT FIRE SUPPORT TECHNOLOGY CAPABILITIES AND LIMITATIONS

> If a man's trust is in a robot that will go around the earth of its own volition and utterly destroy even the largest cities on impact, he is still pitiably vulnerable to the enemy who appears on his doorstep, equipped and willing to cut his throat with a penknife, or beat him to death with a cobblestone. It is well to remember two things: no weapon is absolute, and the second of even greater import-no weapon, whose potential is once recognized as of any degree of value, ever becomes obsolete.
> (J.M. Cameron)

This chapter explores both the capabilities and limitations of fire support systems in the context of the expeditionary warfare environment. Firepower, be it surface or air, provides destructive force; it is essential in defeating the enemy's ability and will to fight.[130] Integrated as part of the commander's concept, firepower includes the fire support functions that may be used with maneuver to destroy the enemy. Delivery of fire support may be provided by artillery, NSFS, missile or CAS platforms in an integrated effort.

A. PRECISION FIRE SUPPORT

The use of precision fires requires detailed planning and coordination with observers, firing units, and the air mission commander. Firepower in any form is a force multiplier or equalizer, but precise firepower will be important in expeditionary warfare

[130] Firepower is the amount of fire that may be delivered by a position, unit or weapon system. It may be direct or indirect. Direct firepower can be delivered by aircraft or helicopters. Indirect firepower can be delivered by artillery, missiles, mortars, and/or naval gunfire. In general, direct firepower is a more accurate method of delivery.

because of frequent troops-in-contact situations. Indirect fire support should be used to augment the firepower of direct CAS platforms.[131] It should be planned and used for fires within the FSCL but outside TIC. This will have a near-term effect on the operations or scheme of maneuver of friendly forces. However, indirect fire should not be employed in close proximity to friendly forces due to the high risk of fratricide. This must be accomplished by CAS/TIC-capable platforms to provide precision synergistic firepower across the entire battlefield.

1. Artillery

A principal means of fire support in fire and maneuver is field artillery. It not only provides fires with cannon, rocket, and missile systems but also integrates all means of available fire support. Field artillery can neutralize, suppress or destroy enemy direct fire forces, attack enemy artillery, missile, rocket and mortar positions.

Field artillery units contribute to attacking the enemy throughout the depth of his formations and suppress enemy air defense systems. As mobile as the maneuver force it supports, field artillery can provide continuous fires in support of the commander's schemes of maneuver. [132]

The extended range and precision of indirect fire weapon systems, using laser-guided munitions like *Copperhead,*[133] and sense-and-destroy anti-radiation munitions

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[131] See _____, Multi-Service Procedures For Joint Air Attack Team Operations, TACP 50-20, (Langley AFB, VA: 1991), vii. Direct fire support should be a coordinated attack involving a combination of attack helicopters and fixed-wing aircraft, normally supported by artillery or naval gunfire, operating together with a maneuver force to locate and attack surface targets. Direct fire platforms provide more flexibility than indirect systems.

[132] Headquarters Department of the Army, FM 100-5 Operations, (Washington, D.C.: 1993), 2-23.

[133] See Air University, U.S. Army Forces, (Maxwell Air Force Base, AL: Air University Press, 1989), B-69. Copperhead, a cannon-launched guided projectile, is a 155mm artillery projectile designed to destroy stationary or moving enemy tanks and other high-value targets. It can be fired from any current or planned

(SADARM) coupled with integrated target acquisition systems, make firepower more lethal than in the past. [134] This will have a near-term effect on the operations or scheme of maneuver of friendly forces. However, there are problems associated with laser-guided artillery munitions: limited projectile range and ordnance selection, limited mobility of artillery pieces, and complex coordination to place the projectile on target.

During *Desert Storm*, the Army and Marines were more interested in Iraqi indirect fire systems-artillery, free rocket over ground (FROG) systems, and multiple-launch rocket systems (MLRS)- than in direct fire systems such as tanks and armor.[135] The rationale behind this prioritization of targets was that Iraqi artillery had the ability to mass fire and deliver chemical weapons that could seriously endanger U.S. ground forces. This will continue to be a concern in future conflicts, but expeditionary warfare may see more applications of such firepower in the neutralization of direct fire systems as well as support of troops-in-contact.

During the weeks prior to ground-day (G-day), Marine units, including artillery, reconnaissance and combined arms task forces, were busy disrupting Iraqi defensive positions. Marine artillery and Army MLRS,[136] using Air Force airborne spotters as well

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155mm-howitzer. When the projectile reaches the vicinity of the target, it searches for and acquires the reflection of a laser beam projected on the target by a friendly observer. Its maximum range is 16 kilometers and weight is 137 pounds.

[134] See Eliot A. Cohen, Gulf War Air Power Survey, Vol II., (Washington, D.C.: GPO, 1993), 305. During Desert Storm, on 25 February, 1991, one Brigade of the First Armored Division destroyed forty to fifty Iraqi tanks by firing artillery and rockets during a ten minute time frame. This was accomplished within the FSCL but outside one kilometer of friendly forces.

[135] Eliot A. Cohen, et al., Gulf War Air Power Survey, Vol IV. (Washington, D.C.: GPO, 1993), 215.

[136] See Air University, U.S. Army, B-65. The MLRS is a free-flight, area fire, artillery rocket system developed to fill an existing void in conventional fire support. The primary missions of MLRS are counterfire and suppression of enemy air defenses (max range is 30,000M). It supplements cannon artillery fires by delivering large volumes of firepower in a short time against critical, time-sensitive targets. The basic warhead carries improved conventional submunitions. During *Desert Storm*, the MLRS was used for long-range artillery barrages against Iraqi dug-in positions. The Marine Corps does not have the MLRS and must rely on the Army to provide this system.

as Marine forward and aerial observers and clandestine reconnaissance teams inside enemy territory, had success with artillery raids and roving gun tactics. These artillery raids were designed to provoke a reaction among Iraqi forces and then hammer them when they came out of their fortified positions and returned fire.[137] However, Iraqi artillery had greater range than either Army or Marine Corps artillery, so most counter fire attacks were conducted by aircraft.[138] This is a vital weakness in U.S. artillery.

It is important to note that the Army has always invested heavily in artillery support for front line units; the Marines on the other hand, have placed resources into support for their own air component.[139] Consequently, when the Marines are an "enabling" force, they must have CAS at all times, while Army units rely more on artillery to help fight the close in battle.

2. Naval Surface Fire Support

To defend against amphibious landing by Coalition forces during *Desert Storm*, Iraq positioned a large proportion of its troops and weapons along the Kuwaiti coastline. This exposed Iraqi forces to naval gunfire. However, the combination of local

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[137] See Air University, U.S. Army, B-59,B-63,B-78. The 105mm M119 provides fire support for the light infantry divisions and other rapid deployment forces. Maximum range is 14,000 M. Probability of a hit on a stationary target from 3,000M with a 105mm unguided projectile is only .03% and proportionally less with an increase in range. In contrast, the 105mm M101A1 supports USMC forces and has a maximum range of 11,000 M. The 155m M109A3 is a Self-Propelled Howitzer that is designed to provide the primary indirect fire support to the maneuver brigades of the armor and mechanized infantry divisions. It has a maximum range of 18,100 M.

[138] Cohen, Gulf War Vol, IV., 236.

[139] See Powell, Report on Roles and Missions, III-38. In 1989, the Marine Corps selected the MLRS in exchange for a 45% reduction in cannon artillery, the loss of self-propelled capability, and reductions in tactical aviation which it traditionally depended on to make up for shortfalls in artillery. However, the Marine Corps will not acquire the MLRS. This event coupled with the decommissioning of all battleship NSFS platforms, will leave the Marine Corps vitally dependent on extremely limited CAS assets.

hydrographic features and the Iraqi mine threat precluded the effective use of most US surface combatants which only employ the 5-inch gun against shore targets.
Therefore the battleship's 16-inch gun was used primarily for NSFS. [140] Still, only six percent of 16-inch gun missions were fired in direct support of ground forces. This small percentage of direct fire missions was due primarily to the ground force's inland position being beyond NSFS range.[141] Naval gunfire from the battleships *USS Missouri* and *USS Wisconsin* provided effective delivery of ordnance against various BAI type targets. Unfortunately, since then, all battleships have been decommissioned. "Operational maneuver from the sea," potential mine threats, and limited littoral water depths will probably make the 5-inch gun impotent in the NSFS role. The Navy is thus actively seeking alternative NSFS solutions.

3. Rotary-Wing CAS

The primary purpose of attack helicopters is the destruction of enemy armor, artillery, and suppression of infantry attacks. They are most effective when used in mass in continuous operations on the enemy's flanks and rear.[142] The helicopter's ability to provide CAS regardless of terrain features, operate from unprepared fields, operate at night and its close association with CAS/TIC missions are its strengths.

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[140] The limited water depths in the area held ships several miles off the coast, out of the 5-inch gun's effective range, while the Iraqi mine threat prevented free movement of ships up and down the coast.

[141] See _____, Conduct of the Persian Gulf War: Final report to Congress, Appendix T, (Washington, D.C., GPO: 1992), 215. The maximum effective range of the Battleship's 16-inch gun is 20 miles. The maximum range of a 5-inch gun is 13 miles (effective range is less).

[142] See _____, ACSC Lesson Book, Vol. IV, 17-23. Mock battles at the National Training Center have shown that attack helicopters used head to head against enemy forces at the Forward Line of Own Troops (FLOT) are ineffective. When properly employed, that is, used as maneuver forces to attack the enemy flanks and rear or in depth, their effectiveness increases dramatically.

Attack helicopters operate in the forward areas of the battlefield. Like fixed-wing aircraft, attack helicopters may also have main operating bases, but these bases must be fairly close to the battle area. Basing requirements and support systems are austere and flexible for helicopters compared to those required by TACAIR. Helicopters may support themselves through FARPs located in the forward area. The FARP extends the effective combat radius of attack helicopters and increases their time in the objective area. Preplanned logistics support is vital to ensuring that sufficient ammunition, fuel, and the proper servicing equipment are available when it is needed. However, it will be difficult to get helicopters to the AO in a timely manner since they do not self-deploy. Additionally, the logistical problems of basing will be more pronounced than for TACAIR because helicopters do not have the range to conduct missions from distant bases.[143]

Timing is critical in employing attack helicopters. Employed too early, they may be forced to disengage before mission completion because of low fuel or ammunition; employed too late, they may miss part or all of the targeted unit and fail to destroy the enemy forces at a critical time and place.

During troops-in-contact situations, to help prevent fratricide, direct communication between ground forces and the helicopter is required. The pilot must receive authority from the ground commander prior to expending ordnance on a target (usually delegated to a ground or airborne forward air controller).

Helicopters have some clear advantages over TACAIR. They can more effectively use terrain to mask themselves from detection and enemy weapons, although they must generally expose themselves to employ their own weapons. However, this is partially offset by the increasing range of stand-off weapon systems. At the present time,

[143] Innovative concepts like AJFP used in Haiti demonstrated that attack helicopters can be transported on aircraft carriers; however, there must be adequate time to preposition them and aircraft from the carrier air wing must be proportionally tailored.

helicopters have a decided edge over TACAIR in night and adverse weather conditions. [144] Most importantly, by flying in a hover and/or flying at slower speeds, helicopters have better target acquisition capability than TACAIR. In addition, helicopters have two crew members vice one for most TACAIR. This enables better situational awareness and a reduction in human factor errors. Finally, since helicopters are cheaper than CAS-capable modern fighters, more can be purchased.

4. Tactical Aircraft CAS

TACAIR are typically tasked and employed in terms of aircraft sorties. A sortie is defined as a single aircraft performing a single mission. Fixed-wing CAS sorties are usually flown in groups of two or four aircraft. The range, speed, and wide array of weapons available to TACAIR represent a distinct advantage over helicopters. TACAIR can carry the required mass of ordnance, over the necessary distances, in a timely manner to perform the theater CAS mission, but these aircraft may be hampered by short loiter times in the target area, and there may be problems acquiring basing/overflight rights as well as diplomatic clearances.

During TIC situations, to help prevent fratricide, direct communication between ground forces and the aircraft are required. The pilot must receive authority from the ground commander prior to expending ordnance on a target. At night, problems increase exponentially. Also, sensor systems such as the Low-Altitude Navigation and Targeting

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[144] See Brian W. McLean, Joint Training For Night Warfare, (Maxwell AFB, AL, Air University Press: 1992), 34. As revealed in the 25 February 1991 issue of the *Air Force Times*, Army AH-64 Apache helicopters armed with laser guided *Hellfire* missiles knocked out three Iraqi early-warning radars along the Saudi Arabian border at approximately 0130L, 17 January 1991, just as the first wave of USAF aircraft turned north from their holding points. This opened a blind spot in the Iraqi coverage, allowing the first waves of F-15Es to cross into Iraq basically undetected. However, MH-53Js were used to lead the AH-64s because they lacked GPS navigation.

See also McLean, Night Warfare, 36. The AH-64 and the AV-8B, with integral forward looking infrared (FLIR) and NVGs can conduct night CAS without the aid of external illumination. This allows better situational awareness and target acquisition.

Infrared (system) for Night (LANTIRN) can only "see" straight ahead. [145] This limits field of view and target acquisition. During *Desert Storm*, TACAIR were unable to conduct the CAS/TIC mission at night.[146] This still remains a problem today.

To conduct CAS, flight paths must be deconflicted with artillery fires, usually through the establishment of a FSCL[147] and/or an Airspace Coordination Area (ACA).[148] This can be a cumbersome process.

TACAIR have more speed, maneuverability, and defensive systems which generally allow higher probabilities of survival than for helicopters, which are more vulnerable to small arms, artillery, and even tank main gun fire. [149] However, speed can be a mixed blessing because its complicates the primary mission of putting ordnance accurately on the target. In most cases, TACAIR needs FACs to guide them to the target. This presents problems of coordination and survivability of the FAC. Additionally,

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[145] The F-16C/D and F-15E carry the LANTIRN navigational pod externally either under a wing or fuselage. The pod contains a wide field of view FLIR and terrain-following radar. The FLIR imagery is displayed on a wide field-of-view holographic heads-up display (HUD) in the cockpit. This allows target acquisition and delivery of unguided munitions at night.

See McLean, Night Air Warfare, 49. LANTIRN pods are optimized for use straight ahead and have a comparatively narrow FOV. In the dynamic CAS environment, the pilot must be able to acquire and attack targets that may not be directly ahead of the aircraft. Since exact target location will probably not be known before reaching the target area, it may not be known before reaching the target area and it may not be possible to preplan an attack axis that ensures the target is within a narrow forward-fixed FOV.

[146] See _____, Survey Vol I., 323. After Desert Storm, the 8th Air Support Operations Group noted that once the Army units moved against the enemy, the problem of fratricide was never overcome. Despite the use of orange markers, GPS receivers, signal mirrors, dedicated FACs, and Tactical Air Control Parties, there was no guaranteed way of avoiding attacks on friendly forces. "The problems in friendly vehicle identification at night were enormous, and in most cases insurmountable. As a result, night [close air support] sorties flown during the ground offensive were all employed well forward of the FLOT- 5Km or more."

[147] While within the FSCL, fixed-wing CAS assets will not attack a target without prior coordination with the ground commander.

[148] The ACA is a block of airspace in the target area in which friendly aircraft are reasonably safe from friendly surface fire. ACAs allow for simultaneous attack of targets by multiple fire support means, one of which is CAS.

[149] _____, ACSC Lesson Book, Vol. IV, 17-23.

integrating a CAS attack into the swirling combined arms battle is also no easy task for the ground commander.[150] If a FAC is unavailable, it is very difficult for TACAIR to fly the CAS mission while self-designating targets. Therefore, fixed-wing TACAIR CAS sorties are heavily FAC dependent.

TACAIR have a distinct payload advantage over helicopters. However, the post-*Desert Storm* shift in weapons procurement to PGMs may limit the availability of suitable CAS ordnance. In addition, the MK-82 500 pound bomb is the smallest bomb carried by TACAIR. There may be situations where fratricide concerns preclude the use of large munitions.

Today, the best method of conducting CAS is by using a combination of helicopter and fixed-wing assets coupled with field artillery to take advantage of each weapon system's strengths. This is only a stop-gap measure because the ability to provide effective CAS/TIC remains poor during the day and even worse at night.

5. Land versus Carrier-Based CAS Platforms

Land-based CAS platforms can play the dominant role in U.S. combat operations within a few days of the start of hostilities provided that they have adequate forward basing, overflight rights, and tanker support.[151] This strength derives from large numbers, modern munitions, and large payloads which can rapidly destroy large enemy maneuver formations and fixed targets. During a sustained conflict, fully deployed land-based

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[150] See _____, ACSC Lesson Book, Vol. IV, 17-20. If a ground maneuver is going well, it is often easier to scrub the fighters than shut down everything so they can attack. If the ground units are in trouble, command and control are usually also breaking down; thus setting up a fighter attack "by the book" may be impossible.

[151] As of December 1994, Navy aircraft can only aerial refuel from certain Air Force tankers whereas Air Force fixed-wing aircraft cannot refuel from any Navy tankers.

aircraft can provide the majority of air power if survivable/sustainable forward bases are available.

Land-based CAS platforms are sensitive to the ability of the airlift fleet to deliver large quantities of military material over long distances. For example, two or three wings of USAF fighters will use a substantial portion of the entire airlift fleet just to keep their munitions replenished during a conflict.[152] Therefore, prepositioning of munitions is essential for sustained land-based TACAIR operations.

If properly located, carrier-based aircraft can provide an early response in a short-warning conflict by quickly establishing an air defense and conducting initial strikes on surface targets. Later, as hostilities progress into a sustained war, these assets can supplement the follow-on arrival of land-based airpower.

Effective fire support in expeditionary warfare will require fully interoperable joint and coalition forces. Since Naval forces will probably be the "enabling" power for this come-as-you-are environment, interoperability will be a critical force multiplier.

B. AC-130 GUNSHIP: A CASE STUDY

The AC-130 *Spectre*[153] gunship is an extensively modified version of the Lockheed C-130. It has four left-side mounted guns and multi-spectral and electromagnetic sensors. This aircraft is an extremely effective CAS/TIC platform with unique nighttime capabilities, coupled with high combat persistence which make it highly adaptable for a variety of special missions. It provides flexible, mobile and precision application of firepower on enemy positions while limiting collateral damage. Its primary missions are close air support, air interdiction, and armed reconnaissance. It also provides perimeter

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[152] David Ochmanek and John Bordeau, "The Lion's Share of Power Projection," Air Force Magazine, June 1993, 42.

[153] Spectre: (spek'ter), n. 1. a spirit of a terrifying nature. 2. some object or source of terror or dread.

and point defense, armed escort, forward air control, landing zone support, limited command, control, and communications (C3) and combat search and rescue (CSAR) support.

The gunship's main mission is to provide precision, close air support in a closely defined mission profile. As a *Spectre* pilot states:

> [I]f you just need something destroyed, there are other airplanes with bigger punch that move a lot faster and can even deliver precision weapons at night. But if you have somebody on the ground who needs fire support close to his position...then that is where the gunship really performs a special mission. [154]

This "special" mission is the accurate application of firepower in a CAS/TIC environment at night and in poor environmental/weather conditions with little risk of fratricide and limited collateral damage.

Currently, there are two versions of the gunship; nine AC-130H's are located at Hurlburt Field, FL and ten older AC-130A's are located at Duke Field, FL. The AC-130H is armed with two 20-MM Vulcan guns set to fire 2500 rounds per minute each, one 40-MM Bofors cannon set to fire at 100 rounds per minute and one 105mm crew loaded Howitzer able to fire as fast as it can be loaded; about seven rounds per minute. The "A" model carries two 20-MM guns, two 40-MM Bofors cannons and two 7.62-MM miniguns.[155]

The latest version of the gunship, the AC-130U is scheduled to enter service in late 1994. Thirteen are on order and when the delivery is completed, the "A" models will

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[154] Randy Jolly, Air Commandos: The Quiet Professionals Air Force Special Operations Command, (Garland, TX, Aero Graphics, Inc.: 1994), 167.

[155] Jolly, Air Commandos, 158.

be retired from service.[156] The "U" model will have a true all-weather/environment capability with an attack radar similar to the one used on the F-15E *Strike Eagle*. Additionally, the weapon configuration differs from the "H" model. The AC-130U will have one trainable 25-MM Gatling gun instead of the two fixed 20-MM guns on the "H" model. The 25-MM gun will give *Spectre* increased standoff range and improve survivability.[157]

The AC-130 features an integrated sensor suite consisting of an all-light level television sensor and an infrared sensor. [158] Radar and electronic sensors also give the gunship a method of positively identifying friendly ground forces while delivering ordnance at night and in adverse weather. Navigational equipment includes the inertial navigation system (INS) and global positioning system which allows the gunship to position itself with an accuracy measured in dozens of feet.[159] The AC-130 has a basic crew of two pilots, a navigator (NAV), a fire control officer (FCO), an electronic warfare officer (EWO), a flight engineer (FE), infrared (IR) sensor and low-light-level television (LLLTV) sensor operators, five gunners, and a loadmaster (LM).[160]

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[156] Jolly, Air Commandos, 160. The AC-130H/U are air-refuelable. The older AC-130A is not capable of aerial refueling.

[157] Jolly, Air Commandos, 160.

[158] The AC-130U has an all-light-level-television. It has better resolution than the low-light-level television on the AC-130H.

[159] The AC-130U has an integrated INS/GPS. The AC-130H has stand-alone INS and GPS systems.

[160] This is the basic crew for a AC-130H. The AC-130U has a basic crew of 13. The 25-MM gun requires only one gunner vice two for the 20-MM guns on the AC-130H.

Crew coordination is an essential part of the gunship mission. [161] The pilots fly the airplane while the aircraft commander actually fires the weapons; the navigator directs the aircraft to and from the target and maintains command and control (C2) with the supported ground commander; the flight engineer ensures that all aircraft systems are operating smoothly; the sensor operator identifies friendly positions and targets; the fire control officer is in charge of weapon selection and relays tactical information to the crew; the electronic warfare officer is responsible for threat detection and threat avoidance; the gunners load and maintain the weapons; and the loadmaster keeps constant vigil in the tail bubble for any potential threats.[162]

1. Background

Spe*ctre's* lineage can be traced back to the AC-47 *Puffs* and *Spookies* and the AC-119G *Shadows* and AC-119/K *Stingers*. Very simply, the Air Force's other combat aircraft of the early 1960s often could not find or accurately strike targets at night or under cover of a triple canopy jungle. The urgent need for such a capability became dramatically obvious as guerrilla warfare expanded in South Vietnam.[163] The enemy used the cover of darkness and the jungle to mask his supply movements and attacks on South Vietnamese forts, hamlets, and forces. When the statement of operational need was received in the summer of 1968, it took only five months to modify and

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[161] See Department of the Air Force, Air Force Special Operations Command, Operations: AC-130 Gunship Employment. AFSOCR 55-130, Vol. X, (Hereafter cited as AFSOCR 55-130, Vol. X), (Hurlburt Field, FL: 1991), 3. Crew coordination and discipline are major factors in gunship operations. The highly complex systems and the large number of crew members will cause confusion and loss of mission effectiveness unless coordination and discipline are stressed at all times.

[162] Jolly, Air Commandos, 160.

[163] Ballard, Gunships, v.

field an AC-130 into the "Surprise Package" version.[164] *Spectre* first saw action in December 1968 in Vietnam.[165] For the first time in warfare, its advanced electronic sensors stripped the cover of darkness away from the enemy. Spectre became an extremely effective night interdiction CAS/TIC weapon system.

Gunship tactics consist of flying an airplane in a pylon turn to aim side-mounted guns at a fixed point on the ground. This unlikely conversion of the relatively slow, large-cabin aircraft into a heavily armed aerial firing platform filled the need for an air weapon system that could direct saturating, extremely accurate firepower on generally small-even fleeting-targets in difficult terrain, varying weather, and particularly during hours of darkness. Because the gunship could orbit, lock on a target with special sensors, and carefully apply firepower, it became a vital weapon in the overall U.S.-South Vietnamese war strategy. It quickly proved its worth as night protector of friendly villages, bases, and forces. Additionally, it became the preeminent truck-killer of the war.[166]

With their tremendous rate of firepower, the gunships proved highly effective in close air support operations. [167] However, their slow airspeeds and poor maneuverability

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[164] Ballard, Gunships, 127. The "Surprise Package" provided greater standoff range to improve its survival. Two 20-MM Gatling guns and two 40-MM Bofors cannons replaced the standard AC-130A armament of four 20-MM guns and four 7.62-MM miniguns. Also a low-light-level television and improved infrared equipment complemented the added firepower to enhance night vision and detection capability.

See also Ballard, Gunships, 127-129. The "Surprise Package" concept was formally presented on July 18, 1969. Modification began on September 2, 1969 and test flights were accomplished on 15 October-28 November 1969. The AC-130 "Surprise Package" flew its first combat mission in Laos on December 12, 1969.

See also Ballard, Gunships, 231. In February 1972, one 40-MM cannon was replaced by a 105-MM howitzer.

[165] Ballard, Gunships, 129.

[166] Jolly, Air Commandos, 160. AC-130s destroyed more than 10,000 enemy vehicles and were credited with many life-saving close air support missions.

[167] See A.J.C. Lavalle, Airpower and the 1972 Spring Invasion, (Washington, D.C., Office of Air Force History: 1985), 92-93. At An Loc, from a bunker in the rubble, an American voice asked for a single 40-mm round at an easily-seen fountain; verifying the burst, the voice next called for a second round at an

rendered them unsuitable for some phases of CAS. Nevertheless, when used appropriately, such as in night or bad weather defense of isolated outposts, the gunship played a key role in the war. [168] One Air Force study calculated a twenty-four minute average response time for gunships as compared with a forty-minute average for TACAIR. Quick response is key to effective CAS.

As with any successful application of air power, gunship successes sparked enemy countermeasures, especially along the Ho Chi Minh Trail in Laos.[169] But the Air Force countered with better tactics to cope with enemy defenses. For example, because of its slower speed and vulnerability, each AC-130 was normally assigned three F-4 escort aircraft to cover its operations over heavily defended areas of the Ho Chi Minh Trail. The primary purpose of these escorts was to suppress enemy antiaircraft artillery activity so that the gunship could continue pursuit and attack of enemy targets.[170] The escorts enabled the operation of this effective weapon system in a higher threat environment in which it could not normally survive.[171] In any military operation, necessity is the mother of invention, but this is especially true in the CAS/TIC environment.

The first trial by fire since Vietnam occurred when gunships from Hurlburt Field, FL departed on the evening of 24 October, 1983, to participate in Operation *Urgent Fury*.

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intersection two blocks east. Finally, the voice prescribed a particular house and corner. The [AC-130] crew thereupon destroyed the building with 20-mm, 40-mm, and 105mm fire. The crew expressed concern during the firing, after learning that friendly forces were directly across the street. The voice below assured then that all was going well, excitedly calling for the crew to "keep it coming."

[168] Cooling, Close Air Support, 445.

[169] Ballard, Gunships, vi. See also, Ballard, Gunships, 246. Aeronautical Systems Division experts studied more sophisticated ways to nullify the SA-7, among them a radar-type detector, radiation intelligence detectors, and an infrared transmitter. Changing the type and color of aircraft paint was another possibility in reducing the gunship's infrared "signature" (especially by sun glint).

[170] Herman L. Gilster, The Air War in Southeast Asia: Case Studies of Selected Campaigns, (Maxwell AFB, AL, Air University Press: 1993), 36.
Also see Momyer, Air Power, 213. The AC-130 could also "buddy lase" for F-4 fighters.

[171] Gilster, The Air War in Southeast Asia, 36.

The all-night flight from Florida to Grenada took almost ten hours and required two heavyweight inflight refuelings.[172] One gunship entered the fight over Grenada and immediately responded to calls for fire support. In spite of heavy AAA fire, the gunship destroyed five enemy buildings and a manned bunker near the airfield where several fires and secondary explosions were observed following their attack. The crew also provided vectors for a U.S. Navy helicopter as it searched for a downed U.S. Army helicopter. When the crash site was found, the gunship provided aircover as multiple rescue flights evacuated the wounded helicopter crew members and passengers.[173] Later, the aircraft halted enemy advances on friendly positions with highly accurate 20-MM gun fire and silenced two anti-aircraft sites with its 105-MM cannon. Responding to an urgent call for assistance, the crew destroyed three enemy armored personnel carriers advancing on a parked C-141. All three vehicles were destroyed when the gunship crew fired four rounds of 105-MM.[174]

During Operation *Just Cause*, on 20 December 1989, in spite of small arms and heavy machine gun fire, an AC-130 crew brought their 20-mm guns to bear to halt a Panama Defense Force (PDF) battalion advance-sometimes firing within 80 meters of the friendly position. In addition, the aircraft destroyed nine vehicles and inflicted heavy casualties on the enemy force and was instrumental in preventing any friendly casualties.[175]

In another engagement, two gunships took out six targets in the La Comandancia compound in less than five minutes. Even though the compound was situated in a heavily populated area, post-battle surveys by U.S. Army personnel testified that "[T]he headquarters compound was virtually obliterated while adjacent structures received little

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[172] Jolly, Air Commandos, 160.

[173] Jolly, Air Commandos, 164.

[174] Jolly, Air Commandos, 166-167.

[175] Jolly, Air Commandos, 169.

or no damage at all." [176] With the destruction of the compound, the single highest-valued target during *Just Cause*, PDF personnel were dispersed, command and control was severed and enemy troops were generally demoralized. The gunship crew continued their barrage of 40-mm cannon fire, destroying two separate PDF positions that were firing rocket propelled grenades at U.S. soldiers 20 meters away. Their attack silenced the opposition, prevented reinforcement, and allowed U.S. forces to advance and hold positions on the main street in front of the La Comandancia. [177] There were numerous other incidents of TIC support as well as the relay of valuable situation updates to various command and control centers.

Operation *Just Cause* supplied an ideal setting for the gunship. The fact that much of the fighting took place in and around highly populated areas only served to emphasize Spectre's ability to provide massive, yet surgically accurate firepower. Its ability to "see" at night and distinguish friendly from enemy forces ensured mission success and saved the lives of many U.S. troops.[178]

Gunship crews were called into action again as Operation *Desert Shield* evolved into the shooting war of *Desert Storm*. This war was different from Grenada and Panama in that the threat environment was much greater. Air superiority was achieved; however, surface-to-air threats were very hazardous to gunship operations. Gunship operations in an integrated air defense environment must be tempered with operational reality to avoid projecting an erroneous high-threat dilemma in which the aircraft cannot survive.

In this type of environment, air superiority and/or combat air patrol (CAP), SEAD, and escort missions <u>must</u> be accomplished to allow gunship operations. During *Desert*

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[176] Jolly, <u>Air Commandos</u>, 170.

[177] Jolly, <u>Air Commandos</u>, 170.

[178] Jolly, <u>Air Commandos</u>, 187.

Storm, the most successful gunship operations were preplanned interdiction missions executed according to specific battle plans. [179]

The battle for the city of Al Khafji was the first significant opportunity for the gunship to support ground operations. Five sorties were flown in support of coalition forces and numerous targets were destroyed. U.S. Marines involved in the battle stated that the gunships did an outstanding job in keeping Iraqi reinforcements away from the area.[180] Tragically however, on 31 January 1991, an AC-130 was shot down by a IR missile in the early morning hours as it attempted to engage an Iraqi free rocket over ground (FROG) missile site threatening U.S. Marines. All 14 crew members were killed.[181]

Despite the very short, four day ground phase of the war, gunships continued to contribute to the war effort. However, their employment was tempered by operational reality vis-a-vis the threat environment. During the Iraqi retreat from Kuwait City, gunships flew armed reconnaissance missions and destroyed over 20 enemy trucks and four APCs.[182]

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[179] Jolly, Air Commandos, 187. See also, _____, Survey, Vol. IV., 118. During *Desert Storm*, AC-130s flew 104 sorties comprising close air support, special operations support, and on-call air interdiction missions.

[180] Jolly, Air Commandos, 188.

[181] Jolly, Air Commandos, 188.

[182] Jolly, Air Commandos, 201.

2. Measures of Merit

The AC-130 can accurately locate and identify targets and distinguish friend from foe. The relatively slow speed of the AC-130, its multi-spectral sensors[183] (each with a dedicated operator), inherent command, control and communications capability, and precision navigation make it an optimal platform for rapidly sorting out friendly from enemy forces. Coupled with its excellent combat persistence, the AC-130 is unsurpassed at maintaining situational awareness of the dynamic battlefield usually associated with the CAS/TIC mission.[184]

In addition, in its reconnaissance role, the sensor, communication, and navigation capabilities allow it to detect targets that could elude other platforms. Both sensors are turret mounted, allowing for 360 degree coverage. Since the aircraft orbits the target area, the sensors are allowed a complete look angle which can identify targets that may be overlooked on a straight pass. The gunship can receive friendly locator beacons and "see" gated laser illuminator for night TV (GLINT)[185] tape employed by friendly ground forces to preclude incidents of fratricide.

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[183] James M. Johnson, AC-130 Gunship Conventional Missions Tutorial, (Ft. Walton Beach, FL: 12 May 1994). AC-130 sensors were designed to complement each other across various portions of the electromagnetic spectrum. Experience has shown that this broad coverage is invaluable in detecting and identifying concealed targets. All sensors are capable of being slaved to each other to allow the operators to view a suspect area in different parts of the spectrum simultaneously, thus enhancing target resolution. All sensor imagery is capable of being recorded on video recorders to assist in both BDA and intelligence gathering. The TV provides 360 degree coverage and has a gated laser illuminator and laser rangefinder that allows target detection/recognition in the visual spectrum, illumination for friendly forces, designation for laser guided weapons, and ranging for fire control solutions. The IR provides 360 degree coverage in the IR spectrum. The APG-180 fire control radar (AC-130U only) provides precision, all-weather air-to-ground fire control with beacon track/interrogation capability.

[184] See _____, AFSOC Operational Concepts, (Hurlburt Field, FL: 10 Oct 1991). The AC-130 has a battle management center with secure redundant radios, and precision integrated INS/GPS navigational systems that can work in LAT/LONG or UTM coordinates.

[185] GLINT tape is not visible to the naked eye.

The AC-130 lacks the killing punch of a 2,000 pound bomb, but it is extremely lethal against targets up through lightly armored vehicles and small vessels, as well as a variety of structures.[186] The armament of the AC-130U consists of 25-MM, 3,000 rounds; 40-MM, 256 rounds; and 105-MM, 100 rounds.[187] The armament of the AC-130H consists of 20-MM, 3,000 rounds; 40MM, 416 rounds; and 105-MM, 100 rounds.[188] While these rounds do offer flexibility and limit collateral damage, the gunship lacks a true hard target kill capability. This could be a serious weakness.

Control of collateral damage is critical to CAS/TIC missions. As a result of its weapons being side-mounted, the gunship fires rounds that impact almost vertically. Therefore, there is little chance of ordnance ricocheting off a target. Rather than referencing a run-in heading as required in TACAIR strafing or bombing, the gunship merely has to have a "clear" area around the target to provide safe separation from friendly forces. If ground personnel are behind sufficient cover to be protected from the blast-fragmentation of the warhead, the gunship can fire in extremely close proximity (in some cases less than 100 meters) to friendly troops; otherwise, a safe radius defined by the area covered by the blast pattern for a particular round is considered a safe separation distance.

The major disadvantage of the gunship is its lack of survivability. It lacks speed and maneuverability and has a large IR signature and radar cross-section.[189] However, proper tactics and countermeasures will allow the AC-130 to operate in a low-to-medium

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[186] See Johnson, Tutorial. The guns on the AC-130 were designed to provide both precise firepower for point targets and area coverage capability against dispersed targets. All guns on the AC-130U are installed on trainable gun mounts (the 20-MMs on the AC-130H are not trainable) that greatly increase their accuracy. Any gun may be fired with any sensor providing the fire control inputs. In addition, the fire control system provides a dual target attack capability (AC-130U only) that allows it to engage two targets, separated by up to a kilometer, simultaneously with highly accurate fire.

[187] Johnson, Tutorial.

[188] _____, AFSOC Operational Concepts, 21.

[189] To help reduce the IR signature, the AC-130 uses engine heat shields and IR reducing paint.

threat environment with a good chance of survival.[190] Additional survivability enhancements include the extensive use of armor plating, redundant hydraulics, and fire retardant fuel tanks.

As the threat environment dictates, SEAD missions must be flown to ensure survivability and mission success. Escort tactics will allow gunships to operate in a higher threat environment.

Since IR MANPADS are the greatest threat to gunship survival, it must utilize the cover of darkness and use proper IR reduction techniques to have a high probability of survival. Additionally, if sufficient weather conditions are present, IR threats cease to be a factor because the enemy will be unable to optically acquire the aircraft.

The combat persistence of the AC-130 is excellent provided that basing is not too far away from the objective area. The aircraft is in-flight refuelable so its range is only limited by crew endurance and tanker availability. [191]

Combat persistence is critical in CAS/TIC roles where ground forces are engaged, and equally so in an armed reconnaissance mission where hostile forces may be attempting to employ or relocate targets from concealed positions. Persistent air coverage will deny hostile forces a window of opportunity to effect such movements without air interdiction.

Normally, one AC-130 can provide four or more hours of continuous coverage of the combat area providing CAS/TIC, CAS or an equivalent amount of armed reconnaissance coverage. The large ammunition load-out and accuracy of the AC-130 allow it to engage and neutralize a large number of (potentially over 100) targets during

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190 _____, AFSOC Operational Concepts, 23. The AC-130 is equipped with the following defensive equipment: radar warning, electronic countermeasures, chaff dispensers, flare dispensers, and IR jammers. However, these systems still do not allow employment in a threat environment above low to medium without SEAD or escort.

191 _____, AFSOC Operational Concepts, 24. The AC-130 has space to carry four augmenting crew members. Normal mission time is five hours unless the aircraft is air refueled.

this period. [192] The ability to engage such a large quantity of targets may be critical when friendly forces are opposed by a numerically superior enemy.

Combat persistence also simplifies the problem of maintaining situational awareness of the combat environment. A single crew can maintain a presence for the duration of many ground engagements. By quickly establishing and maintaining a knowledge of force deployments, the gunship can quickly respond to calls for fire while lessening the probability of fratricide.

To employ the AC-130, it is imperative to fully understand the weapon system's capabilities and limitations. It is designed to be an integral part of a force package whereby its distinctive capabilities of target detection/recognition, precision strike, and combat persistence are balanced against the issue of survivability. The gunship is designed to fight at night and in adverse weather. It should only be employed on daylight missions in benign threat environments.

As a conventional asset, the gunship can perform three missions. In the direct action role, it provides accurate firepower. As a reconnaissance platform, it can collect intelligence and targeting information. As a command and control aircraft, it works synergistically with other assets in an overall campaign strategy. These different missions are not mutually exclusive; in fact, they are often performed simultaneously. There are also subsets of these capabilities, such as armed escort and Combat Search and Rescue (CSAR), that are more mission specific, but draw upon the gunship capabilities of target detection, precision firepower, and command and control.

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[192] Johnson, Tutorial.

C. COMPARATIVE ANALYSIS: SELECTED CLOSE AIR SUPPORT PLATFORMS (FA-18, AV-8B, A-10, AH-64)

These platforms were selected because they are the most capable and likely platforms to perform CAS in the expeditionary warfare environment.[193] Each platform will be analyzed on its capabilities vis-a-vis the four measures of merit (target detection/recognition, lethality, survivability, and combat persistence) as well as its employment doctrine.

1. The F/A-18 *Hornet*

The F/A-18 strike fighter is a twin-engine, twin-tail, high performance, multi-mission tactical aircraft operated by both the Navy and Marine Corps. The *Hornet* uses selected external equipment to accomplish specific fighter or attack missions. When used as a fighter, the F/A-18 provides cover for tactical air projection over land and sea and complements fleet air defense. The primary attack missions are interdiction, CAS, defense suppression, and strikes against land/seaborne targets.

There are approximately 525 F/A-18 A/C in the U.S. inventory. The aircraft is manned by one pilot and has a combat radius of 390 miles for the fighter mission and 500 miles in the TACAIR role. The F/A-18D is a two-seat USMC aircraft. [194]

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[193] In the expeditionary CAS environment, the AH-64 is more capable than the AH-1 and the A-10 is more capable than the F-16. The F-16 will most likely be a follow-on asset.

[194] _____, Conduct of the Persian Gulf War: Final Report to Congress, Appendix T, (Washington, D.C.: 1992), T-77. The F/A-18D is a two-seat, day/night USMC aircraft. Its mission is to destroy surface targets, conduct multi-sensor imagery reconnaissance, supporting arms coordination, and intercept and engage enemy aircraft. There are approximately 29 aircraft in the U.S. inventory. It has the same performance characteristics as the F/A-A/C model and can carry the same armament. During *Desert Storm*, these aircraft were used in the tactical air coordinator and airborne forward air control roles. These aircraft flew to target areas ahead of Coalition strike aircraft to locate and identify high value targets during tactical air missions. In addition, they provided almost 24-hour battlefield coverage for CAS missions.

The F/A-18 carries ordnance on nine external stations including two wingtip stations for AIM-9 Sidewinders; two outboard wing stations for an assortment of air-to-air and air-to-ground weapons, including AIM-7s, AIM-9s, AGM-84 Harpoons, AGM-88 HARMS, and AGM-65 Mavericks; two inboard wing stations for external fuel tanks or air-to-ground weapons; two nacelle fuselage stations for either AIM-7s, a Laser Detector Tracker Strike Camera, a targeting FLIR, or navigational FLIR; and a center station for a fuel tank or air-to-ground weapons. Air-to-ground weaponry includes laser-guided GBU-10/12s, MK-80 series general purpose bombs, cluster bombs, and a 20-MM six-barrel gun with 540 rounds of ammunition.[195]

The F/A-18 has no beacon capability, but it is equipped with GPS and a bombing radar. Also, the pilot can wear NVGs in the night environment.

a. Measures of Merit

The F/A-18 has limited target detection/recognition capability in the CAS/TIC environment. The aircraft has a FLIR pod and the pilot can wear NVGs, but he is too task saturated to adequately perform the mission. [196]

The pilot must fly the aircraft, stay clear of threats, identify the target, and talk with the ground party. This is a highly complicated task for one person to accomplish, however, the aircraft now has GPS which helps to maintain situational awareness.

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[195] _____, Survey, Vol. IV., 59.

[196] The FLIR does not provide 360 degree coverage. NVGs help but the pilot is too task saturated to adequately search and confirm targets. In addition, the aircraft is not equipped with a TV sensor. Most important, it cannot receive beacons. This seriously limits its night/adverse weather capability and increases the time to identify friendly locations.

See also Department of the Navy, Naval Warfare Publication 55-5-F/A18, Vol. I., (Rev C), (Washington, D.C.: 1992), 5-87. Generally, the all-weather mission is not conducted in close proximity to friendly forces because of limitations on accuracy of all-weather weapons delivery.

The F/A-18 is a highly lethal aircraft-too lethal for the CAS/TIC environment. Although it can carry a wide variety of ordnance, including laser guided bombs, the smallest bomb it carries is the 500 pound bomb.[197] In many cases the blast/frag pattern will be too big for TIC situations. The 20-MM gun offers area suppression, however, there are problems with ricocheting rounds and collateral damage.

The F/A-18 is a highly survivable aircraft. Its speed and maneuverability coupled with electronic countermeasures equipment (a radar warning receiver, chaff/flare dispensing unit, and an electronic jammer) and self-escort capability
reduce the need for support assets that might otherwise be required to execute the mission. However it, like all aircraft, remains vulnerable to IR SAMS. During *Desert Storm*, despite flying 157 strikes performing SEAD missions, 217 strikes on airfields performing offensive counter air (OCA), and 557 FAC missions, only three USMC F/A-18s were damaged by SAMs and one by AAA and all returned to base and flew again within 36 hours. Only one Navy F/A-18 was lost in combat.[198]

Combat persistence is poor. It takes time (generally a minimum of five minutes) to set-up for a bomb run or gun pass. This does not allow for the engagement of many targets before the aircraft must depart for fuel. Even though the *Hornet* demonstrated exceptional flexibility and rapid turn-around times during *Desert Storm*, battlefield situational awareness was lost as aircraft departed and were replaced. [199]

The Hornet is an excellent multi-role fighter. It excels in the air-to-air, SEAD, BAI, and AI missions. During *Desert Storm*, it projected tactical air over land and sea and complemented fleet air defense. In addition, F/A-18s conducted 10 intercepts

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[197] Department of the Air Force, AFSOCR 55-130, VOL. X, 38. The destruction area for a 500 pound MK-82 bomb is 30 feet. The blast/frag area is much larger.

[198] _____, Survey, Vol. IV., 58-59.

[199] See _____, Gulf War, Appendix T, T-78. F/A-18 availability was near a continuous 99 percent.

(established radar contact) against hostile aircraft, with two air-to-air shoot downs.[200] It flew highly effective SEAD missions against the Iraqi integrated air defense system (IADS) and was successful in attacking airfields, bunkers, and aircraft revetments.

2. The AV-8B *Harrier*

The AV-8B is a Marine Corps is a vertical/short-takeoff and landing (VSTOL) attack aircraft. The Harrier conducts deep and close air support, armed reconnaissance, air defense, and helicopter escort missions. It can operate from suitable seagoing platforms, advanced bases, expeditionary airfields, and remote tactical landing sites. Using VSTOL technology for basing flexibility, it can respond quickly to the ground commanders's need for timely CAS. There are approximately 170 AV-8Bs in the U.S. inventory. The aircraft is manned by one pilot and has a 500 mile combat radius. [201]

The *Harrier* has a 25-MM gatling gun and can carry a wide range of ordnance which consists of MK-80 series iron bombs, MK-20 Rockeye cluster bombs, AIM-9 sidewinder heat seeking missiles, the new Advanced Medium Range Air-to-Air Missile (AMRAAM), MK-77 firebombs; 2.75" and 5" rockets; AGM-65E *Maverick*; mines; CBU-72 fuel air explosives; and laser-guided bombs.

During *Desert Storm*, land-based AV-8Bs were equipped with a 25-MM Gatling gun and carried a typical combat bomb load of six MK-82s or four MK-83s or six MK-20

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200 _____, Gulf War, Appendix T, T-79.

201 _____, Gulf War, Appendix T, T-21.

Rockeyes.[202] In addition to the gun, the ship-based Harriers normally carried four MK-82s, or two MK-83s, or four MK-20s.[203]

Its attack avionics system uses a nose-mounted angle rate bombing set, which has a TV/laser target seeker and tracker, but cannot self-designate for laser-guided munitions.[204] The pilot can use NVGs and has GPS for navigation but the aircraft has no beacon-receive capability.

During *Desert Storm*, AV-8Bs operated from main bases, amphibious assault ships (LHAs) and unimproved forward airfields (offering FARP but only minor maintenance repair capability) to provide CAS for Coalition ground forces. Basing flexibility allowed the AV-8Bs to be the northern most deployed fixed-wing aircraft in theater. Basing closer to the front lines eliminated the requirement for air refueling and provided quick response times.[205]

a. Measures of Merit

The AV-8B has relatively good target detection/recognition capability because of its slower speed coupled with its GPS navigation system. In the night environment, the integral NVG/FLIR helps locate targets but the pilot can become task-saturated flying the aircraft while trying to locate targets. The *Harrier* lacks an adverse

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202 _____, Survey, Vol. IV., 224. The MK-82s and Rockeyes were delivered using medium-to-high altitude dive bomb tactics. The MK-82s were used against artillery, trucks, and other soft targets and Rockeyes against armored and light armored vehicles. Early problems with delivering MK-20s were corrected and accuracy improved as the war progressed. MK-83s with nose plugs and delayed fuzes were used against bunkers and similar hardened targets. Guns were employed mainly to suppress low-level point defenses during delivery of other weapons.

203 _____, Survey Vol. IV., 224.

204 _____, Joint Pub 3-09.3, D-1. The AV-8B "plus" has a FLIR, radar, and the pilot uses NVGs, however it has no laser target designator capability or beacon receiver.

205 _____, Gulf War, Appendix, T, T-22. The U.S. may not have this luxury in future conflicts.

weather/environmental target identification capability because it has no beacon receiver. This is a major limiting factor for TIC applications.

The AV-8B has good lethality but lacks the ability to self-designate for its laser-guided bombs. Therefore, it can not "buddy lase" for other aircraft. The smallest bomb it carries is the 500 pound bomb and the 25-MM gun offers good area suppression but there are problems with ricochets, small ammunition load-outs, and collateral damage.[206]

The survivability of the *Harrier* is marginal. During the first two phases of the air war in *Desert Storm*, AV-8Bs generally flew medium-altitude profiles between 10,000 to 20,000 feet. They would occasionally drop to a lower altitude to locate and engage targets at less than 8,000 feet. During battlefield preparation and ground war phases, *Harriers* flew at lower altitudes to ensure target acquisition and increase weapons effectiveness and accuracy. At these lower altitudes, five aircraft were lost to enemy action. [207] Therefore, an inverse tactical relationship between better target acquisition and accuracy versus survivability was encountered during the war.

The Combat persistence of the *Harrier* is fair. AV-8Bs based at the front of the battle area during *Desert Storm* provided quick response to air requests and were not delayed by air refueling. Time on station however, was only about 30 minutes before the aircraft had to leave for a FARP area or return to base.[208] Even though AV-8Bs were rearmed and refueled in an average of 20 to 25 minutes,[209] this

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[206] _____, Gulf War, Appendix T, T-22. During *Desert Storm*, the AV-8B only carried 300 rounds of 25-MM.

[207] _____, Survey Vol. IV., 60. Even though the AV-8B does have ECM capability.

[208] _____, Gulf War, Appendix T, T-22. In addition, a combat load of six bombs and 300 rounds of ammunition does not allow the engagement of many targets.

[209] _____, Gulf War, Appendix T, T-22.

degraded battlefield situational awareness because aircraft had to depart the tactical environment relatively quickly.

The AV-8B excels in the BAI and CAS role. During *Desert Storm*, they were effective in neutralizing Iraqi long-range artillery which was the Marine Corps' main concern for its ground troops. [210] In addition, they used their guns to strafe targets at the Battle of Al Khafji.[211] However, they lack the accuracy, munition load-out, combat persistence, and adverse weather/environment capability to adequately perform the TIC mission.

3. The A-10 *Thunderbolt II*

The A-10 is the first Air Force aircraft to be specifically designed for CAS of ground forces. The aircraft is highly maneuverable at low airspeeds and altitudes. Also, the pilot is encircled by a titanium "bathtub" that protects him and other vital parts of the flight control system.

The A-10 can strike all ground targets, including artillery, tanks, other armored vehicles, trucks, and ground troops. The OA-10 provides airborne control of tactical air assets that perform CAS missions. The OA-10 and A-10 are the same airframe.

There are approximately 565 A-10s in the U.S. inventory. The aircraft is manned by one pilot and has a combat radius of 250 miles with 9,500 pounds of ordnance and 1.8 hours of loiter time in the target area. [212]

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[210] _____, Gulf War, Appendix T, T-23.

[211] _____, Summary, Vol., IV., 224.

[212] _____, Gulf War, Appendix T, T-9.

The aircraft has a 30-MM gatling gun that was specifically designed to provide the A-10 with a tank killing capability.[213] The gun fires armor-piercing projectiles to kill tanks and high-explosive ammunition, to destroy trucks and various other targets. The aircraft has 11 external hard-points for carrying most conventional munitions. [214] Its weapons delivery system includes a heads-up display (HUD) and a *Pave Penny* laser tracking pod.[215]

The A-10 has no beacon capability and only has an INS. During *Desert Storm*, one of the six A-10 squadrons operated exclusively at night using NVGs and the infrared video of the Maverick missile as a "poor man's FLIR".[216]

a. Measures of Merit

During *Desert Storm*, in daytime, the A-10 had relatively good visual target detection capability because of its slower speed. But at medium altitudes (15,000 feet), target identification-discriminating a tank or self-propelled artillery piece from a truck-proved a constant challenge. [217]

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[213] _____, Survey Vol. IV., 55. The A-10 can carry 1,170 rounds of 30-MM ammunition.

[214] _____, Survey, Vol. IV., 222. During Desert Storm, A-10s carried the AGM-65 Maverick missile (preferred munition for armor), MK-20 Rockeyes (for armor), M-82s (for artillery), and cluster bomb units (CBUs) (for soft targets, vehicles, personnel in the open, and artillery).

[215] _____, Survey, Vol. IV., 223. The *Pave Penny* laser receiver/tracker was operational on all the A-10 aircraft used in *Desert Storm. Pave Penny* is a day and night target detection set used to detect the reflected energy from a laser designator. Used in conjunction with a laser designation system (either ground-based or in cooperation with aircraft), it can rapidly designate specific targets for attack. The system provides accurate steering data on the (HUD) to assist the pilot in delivering unguided or laser-guided weapons.

[216] _____, Survey Vol. IV., 55.

[217] See _____, Survey, Vol. IV., 55. Some pilots used binoculars to assist in target identification; others remarked that the magnification was too little or that the plane vibrated excessively. The A-10 pilot almost always visually acquired the desired priority target and used either a precision munition or area

The A-10 has a very limited night target detection/recognition capability. The INS, IR *Maverick*, and NVGs are inadequate for the night TIC mission. [218]

The A-10 is too lethal for the TIC mission. During *Desert Storm*, *Maverick* attacks were permitted only if over two kilometers from coalition forces, guns when over one kilometer from friendly forces.[219]

While its slower speed and long loiter time over the battlefield made it susceptible to enemy fire during *Desert Storm*, the A-10s small vulnerable area and redundant systems allowed many battle-damaged aircraft to return to base. The aircraft also carries IR countermeasure flares, ECM chaff, and jammer pods.[220] But its day mission and lack of flexibility make it vulnerable in medium or high threat environments. Therefore, its survivability is only fair.

Combat persistence is only fair because, even with a reduced threat of radar-guided SAMs during *Desert Storm*, the A-10 was only able to engage an average of four to five targets per sortie.[221]

The A-10 excels in the AI, BAI, CAS, and FAC role. During *Desert Storm*, A-10s flew 3,367 day and night strikes against Iraqi artillery and armor units, 135

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weapon to destroy it.

[218] See Survey Vol. IV., 223. During Desert Storm, the A-10s were equipped with the Pave Penny system, but very few pilots had an opportunity to use the system on a CAS mission. The A-10s were also limited during night attacks by not having OA-10s available to find targets, since they did not operate at night. Most night targets were fixed artillery, fixed armor, and moving convoys.

[219] _____, Survey, Vol. IV., 223. This is the CAS mission. Based on this rule of engagement, the A-10 was unable to perform CAS/TIC missions.

[220] See Gulf War, Appendix T, T-10. The A-10 is susceptible to threats due to the longer exposure time caused by insufficient engine thrust which limits rate-of-climb, acceleration and maneuver, and cruising speed.

[221] See _____, Gulf War, Appendix T., T-10. The A-10s long loiter and large payload capability made it ideal for missions such as day SCUD hunting and combat search and rescue (CSAR) escort. During the rescue of an F-14 pilot, A-10s escorting a Special Operations Forces (SOF) CSAR helicopter destroyed an Iraqi radio intercept truck that was searching for the pilot.

strikes on Soviet-made surface-to-surface missile (Scud) CAP and anti-SCUD armed reconnaissance missions, and 656 FAC missions. [222]

4. AH-64 *Apache*

The AH-64 is the Army's primary anti-armor attack helicopter. It is able to locate, engage and destroy enemy armored vehicles and other enemy targets in day, night, and other limited visibility conditions by using its integral FLIR and NVG system.

The *Apache's* primary armament is the *Hellfire* modular missile system, a laser-guided, anti-armor weapon. It can designate targets itself or receive designations from remote sources. Hydra 70, 2.75-inch folding fin aerial rockets are carried in addition to, or instead of, *Hellfires*. A chin-turret-mounted 30-MM cannon is controlled by a sight in the pilot's helmet.[223]

There are approximately 616 AH-64's in the U.S. inventory. It has two crew members and has a combat radius of 160 miles. [224] In addition, it has defensive IR and radar jamming systems.

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[222] _____, Survey, Vol. IV., 53-54.

[223] _____, Survey, Vol. IV., 62.
See also,_____, US Army Forces, B-29. The Apache is equipped with a target acquisition designation sight and pilot night vision sensor (TADS/PNVS) that permit its two-member crew to navigate and attack in darkness and in adverse weather conditions. It also has a laser spot tracker.

[224] _____, Gulf War, Appendix T, T-17.

a. Measures of Merit

The integral FLIR and NVG system gives the AH-64 a good target detection/recognition capability.[225] Its slower speed and the addition of another crew member also helps in this task. However, the INS limits its situational awareness. In addition, it has no beacon receive capability.

The Hellfire missile is accurate and lethal. The 30-MM chain gun is also accurate.[226] But the *Apache* can only carry a relatively small payload which limits its flexibility. Therefore, lethality for the TIC environment is good, however, the ordnance load is very limited.

Survivability in a TIC environment is poor. Although the AH-64 can use terrain masking and fire the *Hellfire* missile from long standoff ranges, it must generally expose itself to employ its weapons. [227] Therefore, the AH-64 is vulnerable to small arms, artillery, and even tank main gun fire.

Combat persistence is poor. The *Apache* only has 1.8 hours of endurance and a top speed of only 145 knots which limits flexibility. [228] FARPs help but this interrupts battlefield situational awareness. In addition, operations during *Desert Storm*

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225 _____, Gulf War, Appendix T, T-17. During *Desert Storm*, the AH-64 was used in poor weather, thick smoke, and low visibility as an armed reconnaissance asset because other aircraft could not perform the mission.

See also, _____, Gulf War Air Power Survey, Vol. II, (Washington, D.C.: 1993), 243. During *Desert Storm*, the AH-64 were counted on for performing the closest of the close air support, since their ability to maneuver and keep close contact with ground forces made them the most suitable for attacking targets close to the front lines.

226 _____, Gulf War, Appendix T, T-18. The AH-64 is credited with destroying numerous tanks, trucks, and armored vehicles during *Desert Storm*. However, the 30-MM chain gun shoots rounds at a relatively flat trajectory which can cause ricochets and collateral damage/fratricide.

227 Provided there is terrain to use.

228 _____, Gulf War, Appendix T, T-17.

highlighted the following system limitations: the AH-64s auxiliary power unit, environmental control unit, and shaft driven compressor lacked adequate filtration systems to counter the harsh desert environment.[229]

The AH-64 excels in target acquisition/detection and *Hellfire* delivery in the CAS/TIC environment, however, it lacks flexibility in range and payload. In addition, survivability is suspect in the performance of the TIC mission.

D. SYNTHESIS OF CURRENT SYSTEMS

Artillery can provide adequate fire support but it must be available to be useful. In addition, it must have a greater effective range than the enemy's. The Marines will have neither in the beginning stages of an expeditionary conflict.

Unless the Navy finds some way to design a new gun or field a new type of fire support ship, its NSFS capability will remain extremely limited because the last NSFS battleship was decommissioned in April of 1992.

Attack helicopters need strategic lift in order to get to the AO. They also require basing near the objective area. Helicopters have good target detection/recognition capability and provide accurate, lethal munitions but their payload is too limited. In addition, they lack the flexibility to perform theater CAS and have low combat persistence. They are most effective when used in support of a maneuver force to attack the enemy's flanks and rear.

Land-based TACAIR can self-deploy, however, they require significant levels of non-organic tanker support as well as bases near the AO. In addition, they need a large base infrastructure and extensive airlift to sustain operations. They can carry large

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229 _____, Gulf War, Appendix T, T-18. When graded against fixed-wing platforms, helicopters have much lower mission capable rates. This limits usable airframes.

payloads and they have flexibility, however, they lack adequate target detection/recognition capability and cause too much collateral damage.

If properly located, carrier-based TACAIR can provide an early response in a short-warning conflict by establishing an air defense and conducting initial strikes on surface targets. But like land-based TACAIR, they do not have adequate target detection/recognition capability and cause too much collateral damage. In addition, they are constrained by limited numbers of strike aircraft, deck cycle time, and sortie generation rates.

The AC-130 is the best night CAS/TIC platform but it requires basing fairly near the AO for sustained operations. Additionally, without SEAD and/or escort it is only survivable in low-to-medium threat environments.

This analysis shows that the U.S. lacks precision fire support for expeditionary warfare, and specifically for the troops-in-contact mission. A potential answer to this problem is the development of a carrier-based fixed-wing gunship.

V. CARRIER-BASED GUNSHIP CONCEPT

> When you seem to be most prodigal of the soldier's blood, you spare it, by supporting your attacks well and by pushing them with the greatest vigor to prevent time from augmenting your losses.
> (Frederick the Great)

A Carrier Based Gunship (CBG) concept can help solve the problem of inadequate precision fire support for troops-in- contact situations during expeditionary warfare operations. The CBG should be modeled after the AC-130 side-firing gunship with some modifications to enable better hard-target kill capability and survivability.[230] This chapter delineates a CBG system definition, the operational mission, operational capabilities, concept candidates, and a concept of operations.

A. SYSTEM DEFINITION

To be effective, any CBG must excel in the four measures of merit: target detection/recognition, lethality, survivability, and combat persistence. To accomplish this, a CBG must have an appropriate blend of crew complement, sensors, weapons and fire control system, avionics, defensive systems, and battle command station capabilities.

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[230] The AC-130 is the best platform for night TIC. Its side-firing weapons provide precision fire power with munitions that have low risk of collateral damage. The sensor system covers the entire electromagnetic spectrum and its long combat persistence coupled with a battle management center provides for sustained combat situational awareness.

1. Crew Complement

The ideal crew complement would consist of six crew members: one pilot, one co-pilot, one systems operator, electronic warfare officer, and two sensor operators.[231] Minimum crew complement would total four crew members: one pilot, one co-pilot, one systems operator, and one sensor operator. [232] Four crew members will be very task-saturated but crew complement will be dictated by airframe space and systems. [233]

2. Sensors

The sensors must be turret mounted to provide 360 degree coverage. Sensor options should include multi-spectral sensors (FLIR, blended FLIR/LLLTV, or ALLTV with active illumination);[234] navigation/weather radar with beacon tracking and offset attack; synthetic aperture radar with beacon tracking for adverse weather/environmental

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[231] The pilot flies the aircraft and positions it to shoot the guns; the co-pilot monitors the aircraft systems, radios, and fires the *Hellfire* missiles; the systems specialist is the navigator, tactician and offensive specialist; the electronic warfare officer is the defensive specialist and monitors the radios; and the sensor operators ensure full sensor performance.

[232] The pilot flies the aircraft and positions it to shoot the guns; the co-pilot navigates, monitors systems, monitors the radios, fires the *Hellfire* missiles, and is the defensive specialist; the systems specialist is the tactician, offensive specialist, navigates in the tactical environment, operates the tactical radios, and operates one sensor; the sensor operator works all other sensor systems.

[233] Because of the complex nature of the weapon system and the high work load, the loss of any crew member will decrease operational effectiveness.

[234] The CBG must have at least one FLIR and one TV or combination of both to cover the entire spectrum. IR systems penetrate haze better than optical systems but optical systems can penetrate mist and fog better than IR systems.

conditions with attack and offset attack. Video recording for BDA. Laser designator/ranger for fire control accuracy and cooperative attack. [235]

3. Weapons and Fire Control

The CBG will have left-side firing weapons[236] coupled with a Hellfire missile system. The targets which the CBG must kill will drive the gun suite configuration. The target set includes troops in the open, under light, medium, and heavy cover; trucks, APCs and AAA sites.

The M-242 25-MM Bushmaster chain gun is the best small gun selection for area suppression of personnel and use against light armor. It weighs 244 pounds (not including mount or ammunition storage and handling system) and has a rate-of-fire of 500 shots per minute (SPM).[237] Each round weighs 1.10 pounds and a wide variety of ammunition is currently available for the weapon.[238] This gun is extremely accurate with

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[235] Sensors should be designed to complement each other across various portions of the electromagnetic spectrum. Ideally, the aircraft should be equipped with all four sensors, however, beacon tracking capability is critical to allow positive identification of friendly positions as well as accurate ordnance delivery in adverse weather/environmental conditions. Experience has shown that broad coverage of the electromagnetic spectrum is invaluable in detecting and identifying concealed targets. All sensors should be capable of slaving to each other to allow the operator to view a suspect area in different parts of the spectrum simultaneously, thus enhancing target resolution.

[236] All guns will be trainable to provide pinpoint accuracy. All guns will be autoloading.

[237] James Johnson, AC-130U Area Coverage Weapons Options, (Shalimar, FL: no date). The M242 is a single barrel gun. To provide more area coverage, a single mount, twin gun system could be used to give 1,000 SPM. Aircraft weight and hydraulic system capability must be evaluated to ascertain if this option is feasible.

[238] _____, Bushmaster Automatic Cannon, (Mesa, AZ: McDonnell Douglas Helicopter Company, no date), 30. This gun uses the Bushmaster family of ammunition, which includes an effective armor penetrating round (4462 feet per second muzzle velocity) as well as an extremely useful HE (3610 feet per second muzzle velocity) round.

only a 0.5 milliradian dispersion.[239] Recommended load-out will be 3,000 rounds, however, this will be based on aircraft gross weight capability.

The 30-MM Bushmaster II is a good medium gun selection for destruction of vehicles, armored vehicles and AAA sites.[240] The gun weighs 325 pounds (not including mount or ammunition storage and handling system) and has a rate-of-fire of 200 SPM (single shot) and 400 SPM with an additional eight horsepower motor. The Bushmaster II fires a wide variety of 30-MM GAU-8/40-MM super shot rounds, each weighing 1.51 pounds.[241] The dispersion of this gun is also less than 0.5 milliradians which gives an excellent probability of a single-shot kill.[242] Recommended load-out would be 250 rounds, however, this must be based on aircraft gross weight capability.

The fire control system must be an accurate computer corrected system with autonomous spotting/impact correction. It should have two computers dedicated to fire control, with each running an independent fire control solution. For single target attack, AC-130 experience has shown that the trainable box should be eight degrees.[243] However, the trainable box must be enlarged for dual target attack capability. The trainable box size will depend on the position of the guns in relation to each other and the wing of the platform. Mathematical techniques can be used to provide a fire control solution for off-center targets. The end result is a CBG that can simultaneously attack two targets

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[239] The AC-130U uses the modified GAU-12/U 25-MM gun. Normal rate-of fire of the GAU-12/U is 4200 SPM but it has been slowed to 1,800 SPM to increase accuracy. In this configuration, gun dispersion is less than two milliradians. The ammunition storage and handling system (ASHS) on the AC-130U holds 3,000 rounds of 25-MM ammunition. The ASHS (or a derivative) could be used for the CBG.

[240] The 35-MM Bushmaster may also be a viable candidate.

It can shoot 30-MM HEI and armor piercing incendiary (API) at a muzzle velocity of 3,400 feet per second; 30-MM armor piercing discarding sabot (APDS) at a muzzle velocity of 4,000 feet per second; and 40-MM super shot at a muzzle velocity of 4,500 feet per second.

[242] _____, Bushmaster Automatic Cannon, 27.

[243] The trainable box is the degrees of azimuth and elevation that a selected gun can move in conjunction with the sensor sight line. The sensor sight line is the center of where the sensor is looking.

separated by up to nearly one kilometer. This capability is called dual target attack (DTA).

In addition, the CBG should have attack guidance that will enhance survivability and operational capability through a partial sector attack guidance (PSAG) capability. This capability allows the crew to fly a portion of an orbit to a specific radial (point) and then commands a right hand turn out to reacquire the orbit at some other predesignated radial. This will allow the CBG to operate close to threats or high terrain but remain out of harm's way. Second, slant range attack guidance (SRAG), where the minimum slant range to the target is used as a warning advisory. This is useful in staying beyond the lethal range of certain threats.

Hellfire missiles will increase the flexibility of the CBG by giving it a hard target kill capability and a forward-firing, non-orbit firing capability. They could also be used during a low-level ingress and pop-up to fire on hostile targets. [244] *Hellfires* could be used for high priority targets or hard targets that cannot be neutralized by the 30-MM Bushmaster gun. Recommended load-out is eight missiles, however, this would be based on gross weight capability. [245]

4. Avionics

Cockpit avionics must have an integrated INS/GPS, radio aids to navigation, and sensor update position capability. A heads-up display should be mounted on the left side

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[244] See John W.R. Taylor, ed., Jane's Weapon Systems, (Alexandria,VA: 1988), 726. The *Hellfire* Missile has 20 pounds of HE. Some *Hellfire* missiles are not limited to direct line-of-sight attack. In the indirect mode, the laser *Hellfire* missile is launched without seeker lock-on. It climbs over obstacles, searches for its target, then locks on automatically and impacts with no degradation in terminal accuracy.

[245] *Hellfire* hardware (MAU-12, TER 9A, M272 4 rail launcher) weighs 300 pounds per wing. One *Hellfire* missile weighs 110 pounds. Therefore, total weight for eight *Hellfire* missiles is 1480 pounds.

of the cockpit (pilot side). Communications must include all air, ground, and maritime frequencies (including SATCOM) with secure capability.

5. Defensive Systems

To survive in the threat environment and execute its mission, the CBG must have state-of-the-art ECM and IRCM (including light-weight ceramic engine shields) systems.[246] Additionally, armor plating, redundant systems, and self-sealing tanks must be used to increase the probability of survival if hits are taken.

6. Battle Management Center

The CBG battle management center (BMC) can be based on the general arrangement of the AC-130U BMC. The AC-130 BMC features an integrated surveillance and attack crew system housing the navigator, fire control officer, electronic warfare officer, and two sensor operators.[247] The BMC should be computer controlled with high resolution video displays. In addition, it should include computer controlled electronic warfare systems and all air, land, and maritime radio frequencies.

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[246] James W. Canan, "The Infrared Battleground," Air Force Magazine, July 1993, 45. The Advanced Strategic and Tactical IR (ASTI) program is developing flares to meet second-and third generation threats. These small, self-propelled, maneuverable IR-jammer decoys will be used to supplant or augment existing pyrotechnic flares. Other programs will go beyond ASTI and this technology must be utilized.

[247] This is the ideal BMC crew complement. It is advantageous to have all crew members (except the pilot and co-pilot) in the BMC. However, space requirements/limitations may dictate other crew arrangements.

B. OPERATIONAL MISSION

The operational mission of the CBG is to provide surgical firepower for extended loiter periods, day[248] and night, in poor weather/environmental conditions.[249]
The main missions are CAS/TIC, CAS, BAI and BDA. These missions should be accomplished by the surgical application of airborne fire power to minimize collateral damage. The CBG will be able to apply heavy fire power to targets. In addition, it will be able to spot and correct its own rounds.

C. OPERATIONAL CAPABILITIES

The CBG will have the capability to identify friendly from enemy positions and deliver ordnance during poor weather/environmental conditions using radar with beacon track and/or beacon receive capability. Navigation accuracy will be precise with the integrated INS/GPS system.

The platform will be highly lethal. It will be equipped with two precision gun systems coupled with the hard target kill capability of laser designated missiles. These missiles can be self-launched and/or used for cooperative attack.

The platform will and have state-of-the-art defensive/self-protection capability coupled with armor plating and redundant systems to increase survivability. Additionally,

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[248] Day missions are extremely hazardous. Caution: Current IRCM techniques and hardware probably will not allow mission accomplishment in the day when IR SAMS are present. However, this will depend on the platform IR signature as well as self-protection countermeasures.

[249] Missions will be only be undertaken after a thorough threat analysis has been accomplished. CBG operations in an integrated air defense environment must be tempered with operational reality to avoid projecting an erroneous high-threat dilemma in which the CBG cannot perform its mission and survive. As the threat environment dictates, SEAD missions must be flown to ensure survivability and mission success. Escort tactics will allow the CBG to operate in a higher threat environment.

combat persistence must be good. The platform will be carrier-capable with a minimum of 1,500 nautical mile (NM) range. [250]

The aircraft should be highly maintainable. It should have fault detection/isolation on mission avionics and engineered with easy ground/air access to mission systems.

D. CONCEPT CANDIDATES

For illustrative purposes the thesis examines the E-2C, S-3, and V-22 platforms. This is by no means an exhaustive list of CBG candidates; there may be other airframes that have been decommissioned, currently in service, or on the drawing board that could be modified into a CBG.

1. Technical Considerations

Two of the most important considerations for a CBG candidate are the airframe maximum gross weight and cabin dimensions. The following are the approximate weights for CBG specific equipment: [251]

1.	NVG Cockpit Lighting	25 LBS
2.	INS/GPS	75
3.	HUD	55
4.	Cockpit Multi-Function Displays	30
5.	EWO/NAV/FCO/(2) Sensor Consoles (5 total)	750
6.	EW Warning Equipment (RWR, IRWR)	100

[250] Aerial refueling capability would be highly desirable.

[251] Johnson, Weapons Options.

7.	Removable Air Refueling Probe	100
8.	ECM	300
9.	Radar Beacon	25
10.	Lightweight Armor Crew Seats (7 Seats)	700
11.	Fuel Tank Inerting System or Foam Filler	175
12.	IRCM	300
13.	IR Signature Reduction (2 Bathtubs)	300
14.	Infrared Detection Set	160
15.	Low-Light-Level TV	200
16.	Seven Crew Members	1400
17.	25-MM Gun/ASHS/Gas Purge System	2040
18.	3,000 Rounds of 25-MM	3530
19.	60 Chaff and 120 Flares	360
20.	30-mm Gun/ASHS/Gas Purge System	2115
21.	250 Rounds of 30-MM	380
22.	8 *Hellfire* Missiles and Associated Hardware	1500
23.	Miscellaneous	680
	TOTAL	**15,300 LBS**

Additionally, the cabin height must be at least five feet high for full articulation of the M242 Bushmaster 25-MM gun and at least five and one-half feet high for full articulation of the 30-MM Bushmaster II gun. [252]

[252] See Johnson, Weapons Options. These heights are based on the gun sitting on its mount. This is the minimum required cabin height for each gun to fully articulate.

2. E-2C *Hawkeye*

The E-2C is a high-wing carrier-based twin-turboprop early warning and control aircraft. [253] It is the same general airframe as the C-2A *Greyhound*,[254] however, almost every system has been upgraded and it has a rotodome. In addition, the E-2C is still in production. The rotodome and associated early warning equipment would be removed for the CBG mission.

The aircraft has a nose-tow catapult attachment, arrester hook and tail bumper. Parts of the tail are made of composites to reduce radar reflection.

The power plant consists of two 3,803 kW (5,100 ehp) Allison turboprops, driving Hamilton Standard type four-blade fully feathering reversible-pitch constant-speed propellers. Performance (at max T/O weight of 57,500 pounds [#]): maximum level speed 338 knots (389 mph); maximum cruising speed 325 knots (374 mph); service ceiling 37,000 feet; ferry range 1,541 nm; time on station with a 175 nm combat radius is 4 hours 25 minutes; and endurance with maximum fuel 6 hours 15 minutes.[255]

Aircraft avionics include the Litton AN/ASN-92 CAINS carrier aircraft INS, GPS, Marconi standard central air data computer, and AN/APN-171 radar altimeter.[256]

External aircraft dimensions: length, 56 feet 10 inches; height, overall 15 feet 10 inches. Internal aircraft dimensions: cargo compartment length, 27 feet 6 inches; cargo

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[253] See Mark Lambert, ed., Jane's All The World's Aircraft, (Alexandria, VA: 1993), 480. The Navy ordered 174 aircraft and as of 1993, 154 had been delivered. Six per year will be produced through 1995.

[254] See John W.R. Taylor, ed., Jane's All The World's Aircraft, (Alexandria, VA: 1989), 417. The C-2A Greyhound is a carrier on-board delivery (COD) aircraft. It carries cargo, passengers, and mail from the mainland to the carrier. There are approximately 41 aircraft in the U.S. Navy inventory. This version is no longer in production.

[255] Mark Lambert, ed., Jane's All the World's Aircraft, (Alexandria, VA: 1993), 481.

[256] Lambert, ed., Jane's, 1993, 481.

compartment maximum width, 7 feet 4 inches; cargo compartment maximum height, 5 feet 5 inches.[257]

Aircraft weights: empty, 36,345#; internal fuel weight, 12,400#; maximum payload 15,000#; maximum takeoff weight 57,500#.[258]

The E-2C has weight and space limitations that must be considered when configuring it for the CBG role. The space limitations dictate a crew of five people. [259] The height of the cabin would probably be able to handle full articulation of both guns depending on where each gun is placed. Therefore, both guns could be included but the 25-MM gun would only have a combat load of 1500 rounds to save weight. The basic aircraft weight plus CBG specific hardware would weigh approximately 49,245#.[260] This would leave 8255# for fuel because of maximum gross weight restrictions.[261] This will cut endurance by approximately 33 percent. [262]

The disadvantages of modifying the E-2C into a CBG are: relatively small payload (1500 rounds of 25-MM vice 3000); reduced combat persistence because of weight for fuel trade-off (unless aerial refueling is accomplished); the aircraft will always be heavy because of the CBG unique equipment (this will cause sluggish aerodynamic

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[257] See John W.R. Taylor, ed., Jane's All the World's Aircraft, (Alexandria, VA: 1989), 417. These vital statistics are for the basic C-2A airframe.

[258] See Taylor, ed., Jane's, 1989, 417. These vital statistics are for the basic C-2A airframe. C-2A statistics were used vice E-2C because all E-2C specific equipment would be removed for modification into a CBG.

[259] The crew should consist of pilot, copilot, systems operator, IR and TV operator.

[260] This is the estimated weight based on existing systems contained in the basic aircraft weight, a crew complement of five people, and CBG systems to support the specified CBG configuration.

[261] Maximum gross weight is 57,500# and the maximum fuel load that can be carried is 12,400#. The airframe could be modified to allow in-flight refueling. If this is accomplished, then the aircraft could "top-off" immediately after takeoff or in-flight refuel enroute to the objective area. In addition, weight trade-offs could be made by substituting the *Hellfire* missile system (1500#) for more armor or fuel.

[262] Time on station with 175nm combat radius would be cut from 4+25 to 3+00.

response); the hydraulic system is the only redundant system; heavy weight single engine performance is questionable; and it has no ejection seats.

The advantages of modifying the E-2C into a CBG are: the basic airframe is still in production; it is a proven carrier-capable (folding wings) aircraft with good range; it has a high-strength cargo compartment floor (stressed to 300 lb/sq ft); [263] it has a low radar cross-section and low IR signature; and it is a high-wing aircraft (the wing will not interfere with the firing envelope of the guns).

3. S-3A/B *Viking*

The S-3 is a high-wing, carrier-based, multi-mission aircraft designed to provide the carrier battle force with quick-reaction antisubmarine warfare, anti-surface warfare, surveillance, and attack capability. The S-3 design meets the need for an aircraft that can cruise at patrol speeds for long periods of time, carry a comprehensive set of sensors and weapons, takeoff and land on a carrier deck, and occupy as little deck and hangar space as possible.

A CBG could be based on the S-3A COD airframe. It has a removable air refueling probe, catapult towbar and arrester hook. Shipboard maintenance is simplified by the provision of computerized fault-finding equipment, built-in test equipment (BITE), and versatile avionic shop test (VAST) compatibility. Complete deck-level servicing accessibility contributes to the attainment of a quick turn-around time.

The power plant consists of General Electric TF-34-GE-2 high bypass ration turbofan engines, pylon-mounted beneath the wings. Performance (at maximum takeoff weight of 52,540#): maximum level speed at 20,000 feet is 450 knots (518 mph); loiter

[263] Taylor, ed., Jane's, 1989, 417.

speed is 160 knots; service ceiling 40,000 feet; range at maximum weight is 2,000 nm; and maximum ferry range is 3,230 nm. [264]

Aircraft systems include: two independent hydraulic pumps; gas turbine auxiliary power unit (APU) for emergency electrical power; retractable turreted FLIR; inverse synthetic aperture radar (ISAR: on S-3B only)[265]; CAINS INS; radar altimeter; and HF, VHF, UHF (secure) radios.[266]

External aircraft dimensions: length, 53 feet 4 inches; height 22 feet 9 inches. Internal aircraft dimensions: passenger cabin maximum height, 7 feet 6 inches; passenger cabin maximum width, 7 feet 2 inches.[267]

Aircraft weights: empty, 24,150#; maximum fuel weight, 12,920#; maximum takeoff weight 52,540#.[268]

The S-3 has space limitations that must be considered when configuring it for the CBG role. It could accommodate a crew of only four,[269] however, the seats would be ejection capable. The aircraft could support a 25-MM gun, 30-MM gun, and eight *Hellfire* missiles.[270]

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[264] John W.R. Taylor, ed., Jane's All The World's Aircraft, (Alexandria, VA: 1977), 331.

[265] See _____, The United States Navy in Desert Shield/Desert Storm, (Washington,D.C.: Office of the Chief of Naval Operations, 1991), 38. During *Desert Storm*, an S-3B used its ISAR radar to pin-point the position of a high-speed, heavily-armed enemy vessel and subsequently sank it.

[266] Taylor, ed., Jane's, 1977, 331.

[267] Taylor, ed., Jane's, 1977, 331.

[268] Taylor, ed., Jane's, 1977, 331.

[269] The crew should consist of a pilot, copilot, systems operator, and a sensor operator.

[270] It could handle a full combat load of 25-MM (3,000) rounds, 30-MM (250) rounds, and 8 *Hellfire* missiles. The basic aircraft weight plus CBG specific hardware would weight approximately 38,100#. A full fuel load of 12,920# would bring the aircraft gross weight to approximately 51,020#.

The disadvantages of modifying the S-3 into a CBG are: the airframe is no longer in production; a relatively large IR signature; and four crew members will have a very high workload.

The advantages of modifying the S-3 into a CBG are: it is a proven carrier-capable high-wing multi-mission aircraft that can cruise for long periods of time, carry a comprehensive set of sensors and weapons (already has FLIR and ISAR radar), and occupies very little deck space; computerized maintenance equipment (for quick turn time); good speed (provides excellent flexibility); relatively small radar cross-section; and it can carry full complement of CBG weapons and full combat munition load.

4. V-22 *Osprey*

The V-22 is a twin-engined, high-wing, tilt-rotor, multi-mission short takeoff (STO) and vertical takeoff (VTO) aircraft. The planned buy is for 912 aircraft and initial operational capability (IOC) is slated for 1998. The US Navy version will replace the S-3 aircraft and the per unit cost will be between $5-12 million (1992 U.S. Navy estimate).[271]

Approximately fifty-nine percent of the airframe is made of composites and just 1,000 pounds of empty weight is metal. When compared to a helicopter, it is twice as fast, carries three times more payload, and has five times more range. In addition, the floor loading is stressed to 300lb/sq ft. [272] Also, it has an in-flight refueling probe in the lower starboard side of the forward fuselage.

The power plant consists of two Allison turboshafts, each with a takeoff and intermediate power rating of 4,586 kW (6,150 shaft horsepower (shp) and a maximum continuous rating of 4,392 kw (5,890 shp). The power plant is installed in Bell-built tilting nacelles at each wingtip which drive a three-blade proprotor. A cross-shaft keeps

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[271] Lambert, ed., Jane's, 1993, 439.

[272] _____, The V-22 Osprey, (Boeing Defense and Space Group: 1993).

both proprotors turning after engine loss. Each nacelle has a Garrett infrared emission suppressor at the rear. Performance (estimated): maximum cruising speed at sea level in helicopter mode is 100 knots (115 mph), airplane mode is 275 knots (316 mph); maximum cruising speed at optimum altitude in airplane mode is 314 knots (361 mph); service ceiling is 26,000 feet; take off run at normal STO weight is less than 500 feet; range VTO at 46,619# gross weight, including a 12,000# payload is 1,200 nm; range STO at 55,000# gross weight including a 20,000 payload is 1,800nm; and STO maximum ferry range at 60,500# with no payload is 2,100 nm.[273]

Aircraft systems include: three hydraulic systems (two independent main systems and one standby); triple redundant fly-by-wire flight control system; and crashworthy armored crew seats capable of withstanding strikes from 0.30 inch armor piercing ammunition and 30g forward and 14.5g vertical decelerations.[274]

Aircraft avionics include: VHF/AM-FM, HF/SSB and UHF secure radios; AAR-47 missile warning system; radar infrared warning system; AAQ-16 FLIR; APQ-174 terrain following multi-function radar with multi-function displays; pilot's night vision system and integrated helmet display system; and chaff and flare dispensers.[275]

External aircraft dimensions: length, fuselage (except probe) 57 feet 4 inches; height, nacelles vertical 22 feet 7.5 inches. Internal aircraft dimensions: cabin length, 24 feet 2 inches; maximum width 5 feet 11 inches; maximum height 6 feet 0 inches.[276]

Aircraft weights: empty, equipped, 31,886#; maximum fuel weight, standard, 13,700#; maximum takeoff weight, VTO 47,500/STO 55,000#.[277]

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[273] Lambert, ed., Jane's, 1993, 440.

[274] Lambert, ed., Jane's, 1993, 440.

[275] Lambert, ed., Jane's, 1993, 440.

[276] Lambert, ed., Jane's, 1993, 440.

[277] Lambert, ed., Jane's, 1993, 440.

The V-22 can support five crew members.[278] The aircraft could support a 25-MM gun, 30-MM gun, and eight *Hellfire* missiles.[279]

The disadvantages for using the V-22 airframe in a CBG configuration are: the weapon system is not yet in full production and may not perform to its advertised specifications; and it must be in the helicopter mode in order to fire its *Hellfire* missiles. [280]

The major advantage of using the V-22 airframe for a CBG is that it could be engineered and manufactured exclusively for the CBG mission.[281] The basic airframe already has many of the systems that can make it a CBG; computerized maintenance (for quick turn-around time); it will be carrier-capable and occupy very little deck space; it will have small radar and IR cross-sections; it can carry a full complement of CBG weapons and full combat munition load; it will be able to operate from unprepared fields and is FARP capable;[282] and airplane/helicopter capability offers the flexibility of both systems.

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[278] The crew should consist of a pilot, copilot, systems specialist, and two sensor operators.

[279] It could handle a full combat load of 25-MM (3,000) rounds, 30-MM (250) rounds, and 8 *Hellfire* missiles. The basic aircraft weight plus CBG specific hardware would weigh approximately 44,436#. A fuel load of 10,564# (maximum fuel load is 13,700#) would bring the aircraft to maximum STO gross takeoff weight of 55,000#. This would still allow the aircraft to have approximately a 1,600 nm unrefueled range.

[280] There is only eight feet between proproters. The *Hellfire* missiles must be located at the approximate center of each wing. Therefore, they are within the proprotor arc in the airplane mode. The *Hellfire* system must have a safety circuit that disables the firing mechanism in the airplane mode and only allows *Hellfire* launch during helicopter mode.

[281] Unlike the other aircraft candidates, the V-22 would roll off the assembly line in a CBG configuration. This would save money, weight, and provide increased operational capability.

[282] This will allow quick rearming/refueling near the objective area and preclude the necessity of in-flight refueling and/or return to the carrier.

E. CONCEPT OF OPERATIONS

This thesis has found that current and future strategy, doctrine, and programmed systems are inadequate to perform fire support and specifically, close air support missions in the new operational environment that will be encountered by joint expeditionary forces. A CBG would become the premier CAS and CAS/TIC platform for expeditionary warfare. However, a concept of operations must integrate the CBG into the total fire support system to provide force multiplication and synergism.

1. Artillery

The use of precision fires requires detailed planning and coordination. Indirect fire support should be used to augment the firepower of direct CAS platforms. Artillery should be planned and used for fires within the FSCL but outside troops-in-contact because inaccuracies in artillery systems could cause unacceptable collateral damage and fratricide.

During the "enabling" phase of expeditionary warfare, the Marines will lack organic artillery and will not have the MLRS system. Therefore, they will not have much artillery support until heavy Army forces arrive in the AO. Consequently. the Marines must have CAS and CAS/TIC at all times to offset the lack of indirect fire systems. However, joint fire support coordination procedures must be implemented to increase mission effectiveness and reduce fratricide. Indirect fire support should be coordinated with direct fire systems to operate with a maneuver force in order to locate and attack surface targets.

2. Air Force Assets

During expeditionary warfare, at the beginning of hostilities, the Air Force should perform the AI and deep strike missions. This would could be conducted from the

CONUS with tanker support until forward bases are established in theater. After forward bases are established, the Air Force could probably perform the majority of air superiority, deep strike, AI, BAI, SEAD, EW, FAC, C3, CAP, and reconnaissance missions.

In low-to-medium threat environments, AC-130 gunships and the CBG could be used to complement each other during night missions. In some situations, AC-130s may have more flexibility than the CBG, especially if the carrier task force is not in the vicinity of the AO. However, during sustained operations, the CBG will be more flexible if the AC-130 does not have basing near the AO. In higher threat environments, AC-130 missions must be tempered with operational reality before conducting them to ensure realistic chances of survival vis-a-vis mission accomplishment. Therefore, joint doctrine and tactics must take advantage of the strengths and weaknesses of both the AC-130 and the CBG.

3. Naval Assets

In the beginning of expeditionary warfare, naval air assets could be tasked with the majority of the following missions: air superiority, fleet air defense, BAI, CAS, SEAD, EW, and CAP. The F/A-18 A/C models would be used to conduct air superiority, fleet air defense, CAS, SEAD, and BAI missions. In addition, these aircraft could be used to escort the CBG and/or the AC-130. If the F/A-18 E or F versions are funded, then they could be used for the EW mission. The F-14 should be used for air superiority, fleet air defense, and combat air patrol. If the 14B *Bombcat* does come to fruition, then it could be employed for BAI and SEAD missions. The S-3 would be used for EW and the E-2C would be used for airborne early warning and command and control of naval air assets. Navy *Tomahawk* cruise missiles would be used for deep strike missions and interdiction of static hard targets.

As forward bases are established, naval assets would augment Air Force aircraft but retain fleet air defense, air superiority, CAS, BAI, and SEAD as its major missions.

4. Marine Air

Marine F/A-18 A/C models would be used in the same role as their Navy counterparts. The Marine F/A-18D would be used for the BAI, CAS, and FAC role. AV-8Bs would be used primarily for the BAI and CAS mission.

5. Attack Helicopters

The AH-1 should be used for day CAS, anti-armor, armed reconnaissance, and helicopter escort missions. In addition, it can provide day CAS/TIC with *Hellfire* and/or tube-launched, optically-tracked, wire guided (*TOW*) missiles. The AH-64 should be used during day or night for destruction of armor, artillery, and infantry units. In addition, is could be used for day or night CAS/TIC by employment of *Hellfire* missiles. [283]

6. The CBG

A CBG would perform the CAS/TIC, CAS, BAI, and BDA missions during expeditionary warfare. It would be a force multiplier by providing surgical firepower for extended loiter periods, day and night, in poor weather/environmental conditions. This would give troops on the ground the required replacement for the loss of organic artillery

[283] The Navy has a lot of "slick" helicopters. It would be a very good idea to provide some of these with attack capabilities because Army *AH-64 Apache's* may not be available or loaded via AJFP and the Marines do not have enough of the less capable AH-1W *Cobra* helicopters to fulfill all likely expeditionary warfare CAS and CAS/TIC requirements.

and a quantum leap in the application of CAS/TIC support. The CBG would be forward-deployed and thus, ready to perform the CAS/TIC mission during the earliest stages of expeditionary warfare. In addition, it could also support any Special Operation Forces (SOF) missions that may presage amphibious/expeditionary operations. Depending on the distance to the AO, threat environment, and the clandestine nature of the mission, it could work alone or in concert with the AC-130. When the situation is favorable for both assets to work together, they can provide each other excellent mutual support.

VI. CONCLUSIONS

> Adherence to dogmas has destroyed more armies and cost more battles than anything in war.
> (J.F.C. Fuller)

The bi-polar world political structure has given way to a world centering on the United States as the hegemonic power. Thus, Cold-War containment policies have transitioned to military regionalism with joint expeditionary warfare becoming the bedrock of the U.S. National Military Strategy. Naval forces will be used to "enable" operations during joint expeditionary warfare. They will "kick in the door" and conduct sustained combat operations until heavy joint forces arrive in the area of operations. These operations will be conducted in the littoral areas of the world. Littoral areas are characterized by confined and congested water and air space occupied by friends, adversaries, and neutrals, which will complicate the identification of friend and foe. This battlefield environment will require more frequent and sustained support using CAS and CAS/TIC applications.

CAS is a complicated and difficult mission to perform. Many air power advocates have blurred the distinction between CAS/TIC, CAS, and BAI, because few air assets are capable of performing the CAS/TIC mission. The bulk of what air power proponents define as CAS/TIC is really BAI to ground forces. The difference between CAS/TIC and BAI devolves to a risk assessment decision. CAS/TIC, from the ground force prospective, consists of putting ordnance on a target within a one kilometer radius of a friendly position. However, air proponents generally view the mission as air interdiction attacks against surface targets that have a near-term effect on operations or the scheme of maneuver of friendly forces. Proximity of ordnance delivery in relation to friendly forces is based on platform capability because most assets are not technologically capable of employing munitions within a one kilometer radius without undue risk of fratricide

and/or unacceptable collateral damage. The delivery of ordnance within a one kilometer radius of friendly troops requires standardized procedures that are adaptable for the fluid expeditionary battlefield, unique systems, and dedicated training to reduce collateral damage and decrease the chances of fratricide.

Instead of developing a dedicated CAS/TIC fixed-wing platform, the Services have opted for multi-mission TACAIR CAS assets because of fiscal considerations and bureaucratic politics. However, the CAS/TIC mission has proven too difficult for a multi-mission airframe that is not specifically configured for the mission or a task-saturated pilot who does not exclusively train for this complex environment. The historical record shows that the CAS issue revolves around doctrine, inter-service rivalry, and money. It is clear that CAS and CAS/TIC will be the backbone of joint expeditionary firepower but, as budget cuts reduce available airframes, it is uncertain by whom, with what, and how CAS/TIC will be conducted.

The joint expeditionary warfare environment places great demands on the traditional U.S. military reliance on firepower and maneuver to avoid the negative political consequences of casualties associated with attrition warfare. The concepts of CAS and CAS/TIC operationalizes this idea. Additionally, these are the air missions that have the greatest immediate impact on the battlefield. Historically, CAS/TIC, CAS, BAI, and AI have demonstrated a beneficial synergy. Since the United States has platforms that can conduct AI, BAI and marginally conduct CAS, it is imperative to acquire a CAS/TIC platform that can accomplish the mission in all environmental conditions, during day or night. The reality of expeditionary warfare is that the bulk of CAS/TIC, CAS, and BAI during the "enabling" phase will usually be performed by naval force assets while the majority of AI will usually be performed by Air Force assets due to the required employment distances. If properly performed, this arrangement can provide synergistic firepower for the battlefield. However, naval forces do not possess the doctrine, airframes, or technology to conduct CAS/TIC missions.

Modern air-to-ground warfare has highlighted four measures of merit to evaluate the effectiveness of CAS/TIC platforms. These are target detection/recognition, lethality, survivability, and combat persistence. These measures reflect a need to provide "surgical" firepower for extended loiter periods, at night, and in adverse weather conditions. It will be necessary to locate targets that are dispersed and mobile to destroy them with little risk of fratricide and limited collateral damage.

Precision navigation and the ability to "see" at night, through smoke, fog, or haze are essential elements in target detection/recognition. CAS and CAS/TIC platforms must incorporate redundant multi-spectral sensors, strike radars, and radar beacon receivers to discriminate between friendly and enemy positions and to engage targets. This will decrease target acquisition time and increase positive target identification thus, reducing the errors that contribute to fratricide.

Lethality is the ability of a weapon system to destroy or neutralize a given target. Multiple lightweight munitions can provide increased flexibility as opposed to heavy, general purpose, and precision-guided munitions. In most situations,
the standard 500 pound bomb will be too large for CAS/TIC missions. An additional force multiplier effect is provided if the CAS/TIC platform is dual target attack-capable. Also, the ability to deliver firepower under poor environmental conditions is vital.

Survivability is the ability of a weapon system to execute its mission in a threat environment. Proper tactics coupled with good battlefield intelligence is the best method for survival. CAS/TIC platforms must avoid rather than absorb hits from threat systems. Two important rules of survival in a hostile environment are to limit exposure and always expect to be fired upon; especially when firing. CAS/TIC platforms must employ a combination of state-of-the-art defensive countermeasures, maneuver, speed, and ordnance delivery standoff range to provide a synergistic effect against potential threats. Additionally, survivability is greatly increased by flying at night and in adverse weather because it negates optical ADA as well as IR MANPADS. Finally, air superiority is mandatory for successful mission accomplishment. SEAD reduces the threat and escort

procedures will allow CAS/TIC missions to be accomplished in a higher threat environment.

Combat persistence is the ability of a weapon system to provide coverage/protection of a target area in terms of time on station as well as the number of targets engaged. The ability to engage a large number of targets will be critical when friendly forces are opposed by a numerically superior enemy. Combat persistence also simplifies the maintenance of battlefield situational awareness because a single crew can maintain a combat presence for the duration of many ground engagements. This knowledge of force deployments will enable timely application of TIC firepower and lessen the probability of fratricide.

Target detection/recognition, lethality, survivability, and combat persistence were used to build an analytical framework to compare current U.S. fire support technology capabilities and the Carrier-Based Gunship concept.

Fire support can be divided into two categories: indirect and direct. Indirect firepower can be delivered by artillery, missiles, mortars, or naval gunfire while direct firepower can be delivered by aircraft or helicopters. In general, direct firepower is a more accurate method of delivery.

The extended range and precision of indirect fire systems, using laser-guided munitions coupled with integrated target acquisition systems, have made indirect firepower more lethal than in the past. However, the problems with laser-guided artillery munitions are limited projectile range and ordnance selection, limited mobility of artillery pieces, and complex coordination to place the projectile on target. Most important, U.S. artillery pieces have shorter effective range than their Russian-built counterparts. In addition, due to the projected acquisition of the MLRS, the Marine Corps reduced its cannon artillery by 45 percent, reduced self-propelled artillery, and reduced tactical aviation. However, the Marines did not field the MLRS and now must rely on the Army to provide the system after heavy Army forces arrive in the AO. This event, coupled

with the decommissioning of all battleship NSFS platforms, will leave the Marine Corps vitally dependent on extremely limited CAS assets.

The primary purpose of attack helicopters is the destruction of enemy armored, artillery, and infantry units. They can provide CAS regardless of terrain features, operate from unprepared fields, and operate at night. Most importantly, they can provide CAS/TIC because they fly at slow
speeds and have capable sensors that allow good target detection/recognition. However, helicopters require strategic lift to get them into the AO, basing near the objective area to sustain operations, and are vulnerable to small arms fire. In addition, they lack combat persistence, flexible range, and have relatively small munition load-outs.

TACAIR can carry a large amount of heavy ordnance over long distances with speed, maneuverability, and defensive systems which generally increase their chances of survival. But they are hampered by poor target detection/recognition, pilot task saturation, munitions that cause too much collateral damage, and short loiter times.

Land-based TACAIR can play the dominant role in U.S. combat operations within a few days of the start of hostilities provided they can use adequate forward basing, are afforded overflight rights, and have tanker support. This strength derives from their large numbers, modern munitions, and heavy payloads that can rapidly destroy major maneuver formations and fixed targets. During a sustained conflict, fully deployed land-based aircraft can provide most of the required air power if forward bases are available. But these platforms are sensitive to the ability of the airlift fleet to deliver large quantities of military material over long distances. Munition prepositioning and access to a large survivable base infrastructure is essential for sustained land-based TACAIR operations.

If properly located, carrier-based TACAIR can provide an early response in a short-warning conflict by quickly establishing an air defense and conducting initial strikes on surface targets. Later, as hostilities progress into a sustained war, these assets can supplement the follow-on arrival of land-based airpower. But carrier-based TACAIR is

constrained by a limited number of strike aircraft, deck cycle time, sortie generation rates, and modest payloads whose type can cause too much collateral damage.

The ability to project power ashore, suppress enemy defenses, and establish an air defense over arriving forces in the first week of a campaign is very important. This capability can be enhanced by positioning naval forces in proximity to the theater of operations during the time of crisis preceding a conflict.

Analysis from the AC-130 case study demonstrated that it is an effective CAS/TIC platform with unique night capabilities, a large munition load-out, and long combat persistence that make it adaptable for a variety of special missions. It can provide flexible, mobile, firepower and it can limit collateral damage with little risk of fratricide. It is especially effective in CAS/TIC, CAS, BAI, and armed reconnaissance missions.

The AC-130 gunship is the best night CAS/TIC platform currently in the U.S. inventory. It can locate and identify targets and distinguish friend from foe. Redundant 360 degree sensor coverage, multi-spectral sensors, strike radar, and precision navigation make it the optimal platform for rapidly sorting out friendly and enemy forces. Most importantly, the gunship can receive friendly locator beacons and "see" GLINT tape employed by friendly ground forces to preclude incidents of fratricide.

Control of collateral damage is critical to CAS/TIC missions, and the AC-130 is able to work close to friendly forces. Because the side-firing weapons on the gunship shoot rounds that impact almost vertically, there is little chance of them ricocheting off a target. If ground personnel are behind sufficient cover to be protected from the blast-fragmentation of the warhead, the gunship can fire in extremely close proximity (less than 100 meters) to friendly troops.

The AC-130 lacks the killing punch of a 2,000 pound bomb, but it is extremely lethal against targets up through lightly armored vehicles and small vessels, as well as a wide variety of structures. While the large combat load offers flexibility and limits collateral damage, the gunship lacks a true hard target kill capability which is a serious weakness.

The major disadvantage of the gunship is lack of survivability. It lacks speed, maneuverability and also has a large IR signature and radar cross-section. The proper use of tactics and the adoption of countermeasures will allow the AC-130 to operate in a low-to-medium threat environment with a good chance of survival. As the threat environment dictates, SEAD missions must be flown to ensure survivability and mission success. Escort tactics will allow gunships to operate in a higher threat environment. But operational employment must be tempered with operational reality to avoid projecting an erroneous high-threat dilemma in which the aircraft will not survive.

The combat persistence of the AC-130 is excellent provided that basing is not too far away from its objectives. The aircraft is in-flight refuelable; its range is only limited by crew endurance and tanker availability. Normally, one AC-130 can provide four or more hours of continuous coverage of a combat area providing CAS/TIC, CAS, or an equivalent amount of armed reconnaissance coverage. The large ammunition load-out and accuracy of the AC-130 allow it to engage and neutralize a large number (potentially over 100) of targets during this period.

The AC-130 is designed to be an integral part of a force package whereby its distinctive capabilities of target detection/recognition, precision strike, and high combat persistence are balanced against the issue of survivability in the threat environment. It should never be employed on a daylight mission if there are known threats. Therefore, the AC-130 is currently the best night CAS/TIC platform but it must have basing fairly near the AO for sustained operations and it is only survivable in a low-to-medium threat environment. It does not have the required responsiveness or survivability for the increasingly uncertain expeditionary warfare environment.

A comparative analysis of the F/A-18, AV-8B, A-10, and AH-64 was conducted based on the four CAS/TIC measures of merit. The results paint a bleak picture for the current state of U.S. CAS/TIC capability.

The F/A-18 has limited target detection/recognition capability because it flies too fast, has marginal sensor performance, and the pilot is task-saturated. It can carry a wide

variety of heavy ordnance but it is too lethal for the CAS/TIC environment. While the strength of the F/A-18 is its survivability, it still remains vulnerable to IR SAMS. Combat persistence is poor because it takes time (generally a minimum of five minutes) to set-up for a bomb run or gun pass. Therefore, few targets can be engaged before it must depart for fuel. This severely hampers battlefield situational awareness in sustained CAS/TIC circumstances.

The F/A-18 is an excellent multi-role fighter. It excels in the air-to-air, SEAD, BAI, and AI missions. However, it fails three of the four CAS/TIC measures of merit.

The AV-8B has relatively good target detection/recognition capability because of its slower speed and GPS navigation system. The integral NVG/FLIR helps locate targets but its single pilot can still become task-saturated. Additionally, it lacks an adverse weather/environmental capability because it has no beacon receiver. The AV-8B is lethal. Its smallest bomb is 500 pounds and the 25-MM gun offers good area suppression but has problems with ricochets, collateral damage, and small ammunition load-outs. Survivability is marginal. In general, it is more survivable than a helicopter but less than TACAIR. If forward-basing and/or FARPs are available, then combat persistence is fair. However, if neither of these options are available, then combat persistence is poor.

The AV-8B excels in the BAI and CAS roles. It performs well in target detection/recognition but fails the other measures of merit.

The A-10 has relatively good day visual target detection capability but poor night capability. The INS, IR *Maverick*, and NVGs are inadequate for the night TIC mission. It is too lethal. During *Desert Storm*, *Maverick* attacks were permitted only if over two kilometers and guns only when over one kilometer from friendly positions. It has marginal survivability because its slower speed and long loiter time make it susceptible to enemy fire; however, its small vulnerable area and redundant systems allow many battle-damaged aircraft to safely recover. Combat persistence is only fair because even with a relatively long loiter time over the battlefield, it cannot engage many targets before

it must in-flight refuel or return to base. The A-10 excels in the AI, BAI, CAS, and FAC role but it fails all measures of merit for CAS/TIC.

The AH-64 has good target detection/recognition capability because of its slow speed and integrated FLIR and NVG system. The additional crew member also reduces task saturation. The *Hellfire* missile is very accurate and lethal but the 30-MM chain gun shoots at a relatively flat trajectory which causes ricochets. In addition, the 30-MM load-out is too small. Its survivability is poor because it is vulnerable to almost every weapon on the battlefield. Combat persistence is also poor because it has only 1.8 hours of endurance with a top speed of 145 knots.

The AH-64 excels in target acquisition/detection and *Hellfire* delivery in the CAS/TIC environment. However, it lacks flexibility in range and payload and it is vulnerable to all battlefield threats.

This analysis shows that the United States still lacks precision fire support for expeditionary warfare, and specifically for the troops-in-contact mission. A CBG concept, modeled after the AC-130 including modifications to enable better hard-target kill capability and survivability, offers a potential solution to this problem.

To be effective, any CBG must excel in the aforementioned measures of merit. It must have an appropriate blend of sensors, crew complement, weapons and fire control systems, avionics, defensive systems, and battle command station capabilities.

The operational mission of a CBG will be to provide surgical firepower for extended loiter periods, in poor weather/environmental conditions, with limited collateral damage, and with little risk of fratricide. Its main missions will be CAS/TIC, CAS, BAI, and BDA.

A CBG must have the capability to identify friendly positions using radar with beacon track and/or beacon receive capability. Navigation accuracy will be precise with an integrated INS/GPS system. The platform will be highly lethal. It would be equipped with two precision gun systems that will deliver heavy fire power to autonomously located

targets with the capability to spot and correct its own rounds. In addition, it will employ laser designated missiles to kill hard targets. These will be self-launched or used for cooperative attack. The platform will be survivable. It will have state-of-the-art defensive/self-protection capability coupled with armor plating and redundant systems. Combat persistence will be good. The platform will be carrier-capable with a minimum of 1,500 NM range.

The CBG concept is more important than the selection of a particular platform. However, for illustrative purposes, this thesis evaluated modified versions of the E-2C, S-3, and V-22 airframes to ascertain the practicality and effectiveness of each in a CBG role. The results showed that all of these platforms could be used as a CBG but with different degrees of effectiveness. Also, this analysis has highlighted the following technical requirements that any potential CBG must be capable of fulfilling: high-wing; carrier-capable; high-strength cabin floor; maximum aircraft gross weight that can accommodate a minimum of 15,300 pounds of CBG-specific equipment; cabin dimensions large enough for weapons suite and crew complement; appropriate range; and combat persistence.

The new expeditionary warfare environment will require more frequent and sustained applications of CAS and CAS/TIC missions because of the reduction in organic firepower and virtually non-existent NSFS. Current and future strategy, doctrine, and programmed systems are inadequate to perform joint expeditionary fire support and specifically, close air support missions. A CBG could become the premier CAS and CAS/TIC platform to fill this crucial void in America's warfighting capability. Acquisition of a CBG would give joint expeditionary ground forces a feasible replacement for the loss of organic fire power and provide a quantum leap in CAS/TIC capability.

Today, a window of opportunity exists to procure a CBG using off-the-shelf technology and hardware. It could also be fielded in a timely manner. The AC-130 "Surprise Package" can be cited as a textbook case to prove this point. It was flying combat missions in Vietnam less than five months after the concept was first presented

to Air Force Systems Command. However, as long as the CAS and CAS/TIC issue centers around which Service stands to gain or lose the most, or the doctrinal implications of changes to traditional roles, missions, and functions, future performance of the CAS/TIC mission will be in jeopardy. Only one issue really counts, and that is how to ensure that American troops, locked in combat with the enemy, get all the fire support and specifically all the CAS/TIC support that they will require for the joint expeditionary battlefield.

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