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FROM DROPPING BOMBS TO BLASTING BITS: ENVISIONING TACTICAL OPERATIONS IN THE INFORMATION ENVIRONMENT BY EMULATING THE EVOLUTION OF AIR-GROUND INTEGRATION

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THESIS

FROM DROPPING BOMBS TO BLASTING BITS: ENVISIONING TACTICAL OPERATIONS IN THE INFORMATION ENVIRONMENT BY EMULATING THE EVOLUTION OF AIR-GROUND INTEGRATION

by

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December 2022

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A gap exists in the United States military at the tactical level in organization, capabilities, and authorities to conduct operations in the information environment (OIE). This thesis identifies a potential solution by analyzing and applying lessons learned from air-ground integration: a dimension of warfare that was once a novel concept comparable to modern information, cyber, and space. Air-ground integration evolved from strategic reconnaissance in World War I to modern attack helicopters, hand-launched killer drones, and tactical joint terminal attack controllers (JTACs). Today, JTACs provide the ground commander with an air-ground integration expert at the tactical edge, equipped with lethal and nonlethal capabilities, and who falls under authorities that vary by location and type of operation. The JTAC qualification is recognized across the joint force and NATO and minimizes the number of pilots needed at ground units. This thesis argues that creating an information, cyber, and space equivalent to the JTAC could enable the joint force to more effectively conduct tactical OIE. This multi-domain terminal effects controller (MDTEC) would be jointly certified, qualified, and designated to advise ground commanders on the information environment, employ tactical information tools, and leverage joint information, cyber, and space assets to create effects.

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ABSTRACT

A gap exists in the United States military at the tactical level in organization, capabilities, and authorities to conduct operations in the information environment (OIE). This thesis identifies a potential solution by analyzing and applying lessons learned from air-ground integration: a dimension of warfare that was once a novel concept comparable to modern information, cyber, and space. Air-ground integration evolved from strategic reconnaissance in World War I to modern attack helicopters, hand-launched killer drones, and tactical joint terminal attack controllers (JTACs). Today, JTACs provide the ground commander with an air-ground integration expert at the tactical edge, equipped with lethal and nonlethal capabilities, and who falls under authorities that vary by location and type of operation. The JTAC qualification is recognized across the joint force and NATO and minimizes the number of pilots needed at ground units. This thesis argues that creating an information, cyber, and space equivalent to the JTAC could enable the joint force to more effectively conduct tactical OIE. This multi-domain terminal effects controller (MDTEC) would be jointly certified, qualified, and designated to advise ground commanders on the information environment, employ tactical information tools, and leverage joint information, cyber, and space assets to create effects.

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TABLE OF CONTENTS

LIST OF FIGURES

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LIST OF TABLES

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LIST OF ACRONYMS AND ABBREVIATIONS

AI	air interdiction
ALO	air liaison officer
CAS	close air support
CCT	combat control team
CUAS	counter unmanned aerial system
DOD	Department of Defense
GPS	global positioning system
GWOT	Global War on Terrorism
EMSO	electromagnetic spectrum operations
ETAC	enlisted terminal attack controller
FAC	forward air controller
ISIS	Islamic State of Iraq and al-Sham
JFO	joint fires observer
JP	joint publication
JFS ESC	joint close air support executive steering committee
JTAC	joint terminal attack controller
MDTEC	multi-domain terminal effects controller
NATO	North Atlantic Treaty Organization
NLP	natural language processing
OEF	Operation Enduring Freedom
OIE	operations in the information environment
SIGINT	signals intelligence
SOF	special operations forces
TACP	tactical air controller party
UAS	unmanned aerial system
USAF	United States Air Force
USN	United States Navy
USMC	United States Marine Corps
USSOCOM	United States Special Operations Command

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EXECUTIVE SUMMARY

Future competition will increasingly rely on the information environment. While the Department of Defense is improving its information, cyber, and space forces, most contemporary efforts reside at the strategic or operational level. A gap exists at the tactical level in organization, capabilities, and authorities to conduct operations in the information environment (OIE). I identify a potential solution by analyzing and applying lessons learned from a different military field: air-ground integration. I argue that the joint force could more effectively conduct tactical OIE by creating an information, cyber, and space equivalent to the joint terminal attack controller (JTAC).

This multi-domain terminal effects controller (MDTEC) would be jointly *certified*, *qualified*, and *designated* to understand the information environment and request information effects.[1] The MDTEC could advise ground commanders, employ information tools, and leverage joint information, cyber, and space assets to create effects. MDTECs, placed at the infantry battalion or special operations team level, could reduce the requirement for critical information, cyber, and space specialties to be assigned at the tactical level. While the authorities to conduct OIE may vary, the MDTEC model would fill the tactical level gap in OIE.

This solution applies the principal of exaptation to chart a potential path forward in tactical OIE. Exaptation, traditionally a biology term, is now also used to describe any innovation that applies existing knowledge to a new domain.[2] Exaptation encourages the exploitation of existing traits for new purposes.[3] Over 100 years, air-ground integration evolved from strategic reconnaissance in World War I to modern attack helicopters, hand-launched killer drones, and JTACs.

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[1] Terry Traylor and David Nass, "From Bombs to Bits: Air-to-Ground Operations as a Model for the Tactical Information Environment," *War on the Rocks*, March 25, 2022, https://warontherocks.com/.

[2] Pierpaolo Andriani and Gino Cattani, "Exaptation as Source of Creativity, Innovation, and Diversity: Introduction to the Special Section," *Industrial and Corporate Change* 25, no. 1 (February 2016): 121.

[3] Caterina AM La Porta, Stefano Zapperi, and Luciano Pilotti, eds., *Understanding Innovation through Exaptation*, The Frontiers Collection (Cham, Switzerland: Springer, 2020)

JTACs, a military specialty that was codified in 2003, provide the ground commander with an air-ground integration employment expert at the tactical edge of the battlefield.[4] JTACs are *certified* through formal course attendance, *qualified* through regular currency requirements, and *designated* in writing by their commander. The JTAC qualification is recognized across the joint force and NATO and minimizes the need for trained and experienced pilots to serve as ground air controllers. Special operations and conventional forces rely on JTACs to provide timely and accurate air strikes. While the approval level necessary for these strikes has varied, the tactical level capability to advise ground commanders, identify adversary targets, and request air effects has remained steady. When a JTAC announces themselves on a radio in combat, there is immediately a high level of trust, since everyone understands that the JTAC has been trained, evaluated, and assigned in writing as competent.

The MDTEC model presented in this thesis is an opportunity to learn from the past and employ the lessons of air-ground integration today, creating a tactical information capability that would help ensure the United States maintains information dominance in the future.

[4] Joint Chiefs of Staff, *Joint Tactics, Techniques, and Procedures for Close Air Support (CAS)*, JP 3-09.3 (Washington, DC: Joint Chiefs of Staff, 2003), ix.

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I. INTRODUCTION

A. THE PROBLEM

Future strategic competition will increasingly rely on the information environment. The rapid growth of the internet has created a new battlefield where adversaries conduct intelligence operations, deception, influence, and sabotage.[1] After having largely maintained information dominance over its adversaries for the past 50 years, the United States is no longer convinced it will maintain that advantage in the future. The Department of Defense (DOD) has taken numerous steps to address the changing information environment, including elevating information to the seventh joint function and creating joint doctrine to address information in joint operations.[2]

New concepts across the armed forces highlight the need to synchronize ground forces operating at the furthest edge of the battlefield with information, cyber, and space capabilities.[3] While the DOD is improving its information, cyber, and space forces, most current efforts reside at the strategic or operational level. Organizations such as the United States Marine Corps' (USMC) Information Operations Center, the Joint MISO Web Operations Center, and 1st Special Forces Group's Information Warfare Center all help facilitate multi-domain operations; however, they do not address the need for information tools and training at the lowest tactical level.[4] A gap exists at the tactical level in organization, capabilities, and authorities to conduct operations in the information

[1] John Arquilla, *Bitskrieg: The New Challenge of Cyberwarfare* (Cambridge ; Medford: Polity, 2021), xii.

[2] Joint Chiefs of Staff, *Information in Joint Operations*, JP 3-04 (Washington, DC: Joint Chiefs of Staff, 2022); James Mattis, *Information as a Joint Function*, Memorandum (Washington, DC: Secretary of Defense, 2017), https://www.rmda.army.mil/.

[3] Headquarters, United States Marine Corps, *Tentative Manual for Expeditionary Advanced Base Operations* (Washington, DC: United States Marine Corps, 2021), I-(3-4), 5 (1-14); USSOCOM, "Science and Technology Directorate Focus Areas," January 27, 2022, https://www.socom.mil/st/Pages/default.aspx.

[4] Erica Gober, "Marine Corps Information Operations Center Completes Fourth Information Warfighter Exercise," United States Marine Corps Flagship, September 28, 2021, https://www.marines.mil/News/; Joint Chiefs of Staff, *Psychological Operations*, JP 3-13-2 (Washington, DC: Joint Chiefs of Staff, 2010); Mark Pomerleau, "Special Forces to Build 'Influence Artillery' for Online Campaigns," C4ISRNet, February 18, 2021, https://www.c4isrnet.com/information-warfare/.

environment (OIE).[5] The purpose of this thesis is to identify a potential solution to this gap. Identifying how to effectively conduct tactical level OIE would enable ground units to execute bottom-up information targeting and allow operational and strategic units to focus constrained resources on hard or sensitive targets.

B. METHODOLOGY / APPROACH

This thesis will analyze the evolution of air-ground integration from strategic reconnaissance in World War I to tactical platforms in modern warfare and identify how modern air-ground doctrine, organization, and capabilities could be emulated to achieve similar success when conducting OIE. It defines the tactical level or "tactical edge" as the location of ground forces geographically furthest away from higher levels of support. With this definition, the organizational element at the tactical level would be an Army or Marine Corps infantry company or a special operations team. This thesis then uses the principal of exaptation—a theoretical concept derived from biology—to chart a potential path forward in tactical OIE. Exaptation, traditionally a biology term, is now also used to describe innovation that applies existing knowledge to a new domain.[6] Instead of looking for a brand-new solution to a problem, lessons learned from a different field of study can help form the foundation of a solution.

Studying the evolution of air-ground integration over the past century and applying the lessons learned through exaptation to OIE is suitable for multiple reasons. Joint Publication 3-09, *Joint Fire Support,* describes cyberspace, space, electronic attack, and information activities, all OIE elements, as "joint fire support capabilities" in the same sentence as air to ground fire support.[7] Furthermore, OIE and air support can be utilized independently (deep air support or information / cyber / space effects) or in conjunction

[5] The term "authorities" is not defined in doctrine. For the purpose of this thesis, authorities will be used to describe the ability of a commander to approve of an air strike. This is an important distinction as some military practitioners prefer to separate the authority from the permission. In that distinction, authority provides the legal framework for the type of action while a permission authorizes a specific act.

[6] Pierpaolo Andriani and Gino Cattani, "Exaptation as Source of Creativity, Innovation, and Diversity: Introduction to the Special Section," *Industrial and Corporate Change* 25, no. 1 (February 2016): 121.

[7] Joint Chiefs of Staff, *Joint Fire Support*, JP 3-09 (Washington, DC: Joint Chiefs of Staff, 2019), ix–x.

with ground movement and maneuver (close air support or cyber enabled special operations). Lastly, to support ground forces, both fields began by using a similar approach, which was placing subject matter experts at ground units. While all analogies break down in the details, the similarities allow for the successful exaptation of key traits from air-ground integration to OIE.

C. KEY FINDINGS

This thesis finds that modeling a "multi-domain terminal effects controller (MDTEC)" after the joint terminal attack controller (JTAC) would enable tactical forces to more effectively conduct OIE.[8] MDTECs would serve as the OIE employment expert at the tactical edge of the battlefield by advising ground commanders, planning information effects, operating information capabilities, and requesting effects from operational and national-level OIE forces. Modeling the certified, qualified, and designated aspects of the JTAC program would create MDTECs that are standardized across the joint force and the North Atlantic Treaty Organization (NATO), permitting a level of confidence and interoperability between MDTECs and OIE forces.

Capabilities and authorities for the MDTEC could also be patterned after the JTAC. Equipping MDTECs with organically owned information capabilities would allow the ground force to identify information targets, communicate accurate location information, and conduct limited OIE effects. MDTECs should be able to operate this equipment at any time without approval from higher level commands. Maintaining the authorities for any further OIE actions at higher levels would allow more time for coordination and target scrutiny, while pushing authorities to lower levels could enable a faster operational tempo. Nonetheless, the MDTEC would be trained and equipped to identify adversary targets and conduct OIE with approval from a commander at the appropriate level.

[8] Terry Traylor and David Nass, "From Bombs to Bits: Air-to-Ground Operations as a Model for the Tactical Information Environment," *War on the Rocks*, March 25, 2022, https://warontherocks.com/.

D. LITERATURE REVIEW

The military use of information to build battlefield awareness and influence audiences is nothing new; however, the rapid technological advances of the past decade and the exponential growth of the internet have propelled information to a leading topic in national security. Strategists John Arquilla and David Ronfeldt first discussed cyber challenges in 1993, with Arquilla later cautioning that the United States may not always maintain information dominance.[9] Since 2016, the DOD has elevated information to a joint function, included OIE capabilities as a top modernization priority, and released Joint Publication (JP) 3–04 *Information in Joint Operations.*[10] Two civilian-led national-level commissions also provided the DOD recommendations for cybersecurity and next generation artificial intelligence.[11]

JP 3-04 formalized information-related doctrine and terminology that had previously either not been defined or defined differently by each service.[12] The original term, "information warfare," was first introduced in 1992 in the classified DOD directive TS 3600.1. Terminology changed to "information operations" with DOD directive S-3600.1 in 1996, and OIE in 2016.[13] While OIE was loosely defined prior to 2022, JP 3-04

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[9] John Arquilla and David Ronfeldt, "Cyberwar Is Coming!," *Comparative Strategy* 12, no. 2 (April 1993): 144; John Arquilla, "The Strategic Implications of Information Dominance," n.d., 8, 30.

[10] James Mattis, *Information as a Joint Function*; Department of Defense, *Summary of the 2018 National Defense Strategy* (Washington, DC: Department of Defense, 2018), 6, https://dod.defense.gov/; Joint Chiefs of Staff, *Information in Joint Operations*.

[11] U.S. Cyberspace Solarium Commission, *Cyberspace Solarium Commission Executive Summary* (Washington, DC, 2022); National Security Commission on Artificial Intelligence, *Final Report* (Washington, DC: White House, 2021), https://www.nscai.gov/.

[12] Department of Defense, *Strategy for Operations in the Information Environment* (Washington, DC: Department of Defense, 2016), https://dod.defense.gov/; Joint Chiefs of Staff, *Joint Concept for Operations in the Information Environment* (Washington, DC: Joint Chiefs of Staff, 2018); Office of Irregular Warfare and Competition, Joint Staff Joint Force Development and Design Directorate (J-7), *Irregular Warfare Mission Analysis* (Washington, DC: Joint Chiefs of Staff, 2021), 30; Headquarters, United States Marine Corps, *Tentative Manual for Expeditionary Advanced Base Operations*, 5–2 to 5–7; Deputy Commandant, Combat Development and Integration and Deputy Commandant for Information, *Definitions for Information Related Terms*, Joint Memorandum (Washington, DC: Headquarters, USMC, 2020), https://mca-marines.org/.

[13] Herbert Lin, "Doctrinal Confusion and Cultural Dysfunction in DOD: Regarding Information Operations, Cyber Operations, and Related Concepts," *The Cyber Defense Review* 5, no. 2 (2020): 91–92; Department of Defense, *Information Operations*, S-3600.1 (Washington, DC: Department of Defense, 1996); Department of Defense, *Strategy for Operations in the Information Environment*, 3, 7.

formalized the term, which is central to this thesis. OIE are integrated actions that inform, influence, attack, exploit, and protect audiences, actors, and systems.[14]

In line with this emphasis, United States Special Operations Command (USSOCOM) has made next-generation tactical information technologies a top priority. Then USSOCOM Commanding General Richard Clarke stated in 2021 that many of USSOCOM's future challenges would "take place in the information space."[15] Clarke's statement was echoed by the Marine Corps Forces Special Operations Command Commander who anticipated organically owned cyber, electromagnet, and space equipment.[16] USSOCOM's science and technology directorate followed suite by announcing its effort for the future "hyper-enabled operator."[17] The hyper-enabled operator is described as someone who can "intuitively use information made available by next generation sensors, networks, computing and communications systems to rapidly build situation awareness, make timely, well-informed decisions; and take actions inside an adversary's ability to react."[18] All of these technologies are tools to conduct tactical OIE.

Some of the best literature regarding tactical OIE has been published by the RAND Corporation. A 2017 report title *Tactical Cyber* envisioned future Army units with dedicated cyber support to tactical units and a "tethered" cyber operator, who provides ground support to offensive cyber operations.[19] RAND furthered the conversation in 2021 by publishing a quick reference guide for tactical OIE actions.[20] While these reports are needed and useful, they fail to address the current lack of military doctrine and commentary

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[14] Joint Chiefs of Staff, *Information in Joint Operations*, x.

[15] Richard Clarke, *Posture Statement of Commander, United States Special Operations Command* (Washington, DC: Senate Armed Services Committee, 2021), https://www.armed-services.senate.gov/.

[16] Major General James Glynn, *MARSOC Posture Statement* (Washington, DC: Senate Armed Services Committee, 2021), https://www.armed-services.senate.gov/.

[17] USSOCOM, "Science and Technology Directorate Focus Areas."

[18] USSOCOM.

[19] Isaac Porche et al., *Tactical Cyber: Building a Strategy for Cyber Support to Corps and Below*, Research Report, RR-1600-A (Santa Monica, CA: RAND Corporation, 2017), 50.

[20] Michael Schwille et al., *Handbook for Tactical Operations in the Information Environment* (Santa Monica, CA: RAND Corporation, 2021), v–ix.

that led to the research question of this thesis: what organization, training, and capabilities are needed to effectively conduct tactical OIE?

E. CHAPTER OUTLINE

This thesis is organized into five chapters. Chapter II explores the history of tactical air controllers and capabilities from their initial introduction in WWI to the present-day joint terminal attack controller (JTAC). Chapter III analyzes the modern ground controller ecosystem including organization, training, capabilities, and authorities and identifies the key traits of the JTAC program. Chapter IV envisions how the key lessons learned from the JTAC could transfer to the information environment by creating a "multi-domain terminal effects controller (MDTEC)." The key historical trends identified in Chapter II and the key traits of the JTAC ecosystem from Chapter III will be used to conceptualize the MDTEC in Chapter IV. Chapter V will conclude this thesis by reiterating the key findings and identifying areas for future research.

II. THE HISTORY OF AIR GROUND INTEGRATION

This chapter provides a brief history of the evolution of air-ground integration from strategic reconnaissance platforms in WWI to modern-day stealth bombers, attack helicopters, ground employment experts, and hand-launched killer drones. It attempts to document the diversity of air power and its application, something that many cursory histories in other theses struggle to accomplish. Technological changes go hand-in-hand with doctrine and manpower structures. As this chapter will show, it took 100 years for the doctrine, manpower, and technology of air-ground integration to align. Understanding the past in this chapter will set a foundation for the analysis of present air-ground integration in Chapter III and the potential future of operations in the information environment in Chapter IV. The key historical trends and advancements identified in this chapter will be utilized in Chapter IV as a comparison to modern information initiatives.

Air power can be viewed as having three main methods of employment: strategic attack, air interdiction, and close air support. "Strategic attack" is an offensive airstrike used to achieve strategic objectives.[21] Strategic nuclear strikes, preemptive strikes, and strikes targeting specific national infrastructure or military forces would fall under this category. When air strikes are conducted concurrent with ground operations, they are either air interdiction (AI) or close air support (CAS). AI are fires employed to prevent an adversary from using their military assets against friendly forces, while CAS attacks "are in close proximity to friendly forces and require detailed integration."[22] While air-ground integration certainly occurs in the employment of AI, it is most commonly associated with CAS. The doctrine for CAS and air controllers deals with the complexities of employing air power in the "close proximity" area.

[21] United States Air Force, *Strategic Attack*, AFDP 3–70 (Washington, DC: United States Air Force, 2021), 3, https://www.doctrine.af.mil/; William Mitchell, *Winged Defense: The Development and Possibilities of Modern Air Power—Economic and Military* (Tuscaloosa, AL: University of Alabama Press, 2009), 188–89.

[22] Joint Chiefs of Staff, *Joint Interdiction*, JP 3-03 (Washington, DC: Joint Chiefs of Staff, 2016), GL-4; Joint Chiefs of Staff, *Joint Close Air Support*, JP 3-09.3 (Washington, DC: Joint Chiefs of Staff, 2019), xi.

While this thesis will cover some technologies and doctrine that could be associated with any of the above methods of air power employment, it will primarily focus on CAS and associated capabilities, doctrine, organization, and authorities. These four aspects of air-ground integration will be analyzed by period beginning with the U.S. Civil War and ending in 2003 with the establishment of the JTAC. "Doctrine and capabilities" describe the evolution of joint doctrine as well as the technological advances in aircraft platforms and equipment that enables air-ground integration. "Organization" answers the question of how services organized their personnel to conduct close air support; from relying on expert pilots to proliferating training throughout its force. Finally, "authorities" describes how close air strikes were coordinated and approved with higher headquarters. This chapter will show that air-ground integration took 100 years to transform from an untested asset in World War I to an integral aspect of warfare with associated doctrine, capabilities, and organizational manpower models.

A. AERIAL RECONNAISSANCE IN THE U.S. CIVIL WAR

Following the introduction of balloons to warfare by the French in the 1790s, the Union used balloons in the American civil war with modest yet sparse accomplishments. Balloons were regularly flown over Washington, DC, as an early warning network for Confederate attacks. Balloons were also used for reconnaissance over battlefields such as Falls Church, Virginia, and the siege of Yorktown. The effectiveness of the Union balloons forced Confederate positions to refrain from using fires at night and placing their advanced outposts under trees.[23] On September 24, 1861, a reconnaissance balloon was used to observe and report on Confederate positions at Falls Church. Union troops accurately fired on these positions without being able to observe their target, a first in history.[24] In late 1861, the Union placed a balloon aboard a 122-ft long barge, the George Washington Parke Curtis, and conducted aerial reconnaissance of the confederate fleet along the Potomac

[23] John Christopher, *Balloons at War: Gasbags, Flying Bombs & Cold War Secrets* (Stroud: Tempus, 2004), 34.

[24] Hannah Chan, "Civil War Ballooning: The First U.S. War Fought on Land, at Sea, and in the Air," *Federal Aviation Administration*, N.D., 1–4.

River.[25] The G.W. Parke Curtis served as the first known aircraft carrier. One notable tactic that was not used in the Civil War was aerial photography. Despite successful French aerial photography experiments between 1849–1858, the technique is not believed to be used at all in the Civil War.[26]

Manning requirements for the Balloon Corps included trained balloonists, communications experts, maintenance, and administration.[27] While balloonists flew the balloons, communications specialists operated the primary form of communication, the telegraph. The telegraph lines were often run to the local military headquarters and the main battlefield headquarters. Different codes were used to describe enemy positions and actions. The balloons also used written messages and visual signals to pass information.[28] While the military use of balloons has continued to this day, including their use in the Genetrix Project of the 1950s and during the Global War on Terrorism (GWOT), the next major military air-ground integration advancements took place after the Wright Brothers' first flight in 1903.[29]

B. WORLD WAR I

Building on conceptual achievements in the nineteenth century, aircraft demonstrated the operational effectiveness of close air support in World War I. Within five years of the first Wright Brothers' flight, militaries around the world were experimenting with aviation elements. In 1911, U.S. Army aviators tested the first bombsight and Italian

[25] Christopher, *Balloons at War*, 33; Chan, "Civil War Ballooning: The First U.S. War Fought on Land, at Sea, and in the Air," 2.

[26] Christopher, *Balloons at War*, 38–39.

[27] Frederick Stansbury Haydon, *Military Ballooning during the Early Civil War*, Johns Hopkins Paperbacks ed. (Baltimore: Johns Hopkins University Press, 2000), 258–59.

[28] Haydon, 323–29.

[29] Bruce Berkowitz, *The National Reconnaissance Office at 50 Years: A Brief History* (Chantilly, VA: National Reconnaissance Office, Center for the Study of National Reconnaissance, 2011), 3, 35; Graham Bowley, "Spy Balloons Become Part of the Afghanistan Landscape, Stirring Unease," *The New York Times*, May 12, 2012, sec. World, https://www.nytimes.com/.

pilots conducted aerial bombing for the first time in the Italo-Turkish War.[30] Despite these experiments, military planners entered World War I with the understanding that aviation would be used primarily for reconnaissance. This was quickly dispelled as pilots took the initiative to strike enemy positions and trenches. This strafing of enemy trenches is the precursor to today's modern close air support. While aircraft were conducting close air support, the air strike authority and approval channel did not exist during World War I, with airstrikes conducted on an ad hoc basis when pilots saw the opportunity.[31]

The efficacy of these attacks was limited by the inability to communicate with ground troops. Air controller organization structures also did not exist in World War I. Pilots had to rely on visual signals from ground forces such as flares or air panels. While somewhat effective, ground forces were often hesitant to use flares or other signals and give away their position. Pilots would also fly low over friendly forces and drop notes detailing enemy positions. One notable advancement was the use of infantry contact patrol planes. Used first in 1915, these contact patrols were aircraft with a specific mission to follow the front line of friendly forces and relay their position to other attack aircraft. Contact patrols would use visual signals or fly low enough to observe uniform colors and then pass this information through aerial communication.[32] These contact patrols are similar to the eventual employment of forward air controllers (FACs), which have been used extensively since World War I to the present day. By 1918, close air support was entrenched in both the German and British doctrine.[33]

C. THE INTERWAR YEARS

While the interwar years saw major advances in aviation capabilities including aircraft, ordnance, and air support doctrine, minimal advances in communications methods

[30] Benjamin Franklin Cooling, ed., *Case Studies in the Development of Close Air Support*, Special Studies (Washington, DC: Office of Air Force History, U.S. Air Force, 1990), 14; Richard P. Hallion and Richard Mason, *Strike from the Sky: The History of Battlefield Air Attack, 1910–1945* (Tuscaloosa: University of Alabama Press, 2010), 10.

[31] Cooling, *Case Studies in the Development of Close Air Support*, 14–19.

[32] Cooling, 16–19.

[33] Hallion and Mason, *Strike from the Sky*, 23.

hindered substantial advances in air-ground integration. Aviation lethality grew substantially with advances in both the machine gun and aerial bombs. Machine guns on aircraft allowed aircraft to inflict significant damage on troops on the open ground. These new weapons and tactics were observed in practice in the Battle of Inderta in Ethiopia. Italian aircraft caught approximately 7,000 Ethiopian troops in the open near a river crossing and killed nearly 3,000 with repeated bombs and machine gun attacks.[34] Air tactics focused primarily on targeting behind enemy lines, using artillery to cover close ground maneuver.

The one American military service to embrace close air support was the USMC. The USMC was the only air component to see combat in the interwar period while participating in the "Banana Wars." These small-scale conflicts allowed the USMC to implement some of the doctrine adjustments that came out of WWI. The Small Wars Manual, published in 1940, stated that "the Marine air force is thus able to concentrate almost entirely on the close support of ground units."[35] Marines in the Dominican Republic and Haiti were the first to use rudimentary air-to-ground radios for coordination.[36] The USMC's concept for combat aviation differed from the United States Army which viewed offensive or deep air support as the primary aviation mission.

The country that made the most significant advances in air-ground integration during the interwar period was Germany. Many of these advances came through organization constructs first employed during the Spanish Civil War (1936-1939). In Spain, the Germans positioned air officers at the focal point of ground operations, developed direct lines of communication between air and ground forces, and established procedures for bombers to conduct close air support.[37] By the end of the Spanish Civil War, German General Heinz Guderian wrote that "simultaneously with the ground assault the attacker

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[34] Cooling, *Case Studies in the Development of Close Air Support*, 37.

[35] *Small Wars Manual: United States Marine Corps 1940* (Manhattan, KA: Sunflower Univ. Press, 1997), IX(1).

[36] Robert Dorr, "The U.S. Marines Pioneer Air Support in Nicaragua," *Defense Media Network* (blog), April 20, 2010, https://www.defensemedianetwork.com/.

[37] Hallion and Mason, *Strike from the Sky*, 111–14; Cooling, *Case Studies in the Development of Close Air Support,* 40–41.

will strike with his air forces."[38] While air-ground communications methods were still inadequate, the combination of technological and doctrine advances set the stage for major air-ground integration advances in World War II.

D. WORLD WAR II

All major powers entered World War II with CAS as a secondary aviation mission and a lack of communications systems to conduct air-ground integration. By the end of the war, CAS capabilities, organization constructs, and doctrine had all progressed into integral aspects of warfare. The first lessons learned from World War II were from the German use of air-ground integration in the blitzkrieg.[39] The German Air Force, the Luftwaffe, was one of the first air forces to seriously consider CAS as a tactic and recognize its importance for ground forces. During the Polish blitzkrieg, support to the German ground component was the second priority for the Luftwaffe behind the destruction of the Polish Air Force.[40] The Germans placed air liaison officers with German ground forces to help coordinate strikes; however, providing close air support to rapidly maneuvering forces still proved difficult.

The British and American air forces adopted CAS tactics more slowly than the Germans. Allied air forces viewed air superiority and deep targeting to be their primary missions. In 1943, the U.S. War Department issued FM 100–20, *Command and Employment of Air Power*. The manual, often nicknamed the U.S. Air Force's "declaration of independence," listed the tactical air support priorities in order as air superiority, prevention of troops and supply movement (air interdiction), and lastly, combined air and ground forces.[41] Despite these hesitations, air-ground integration tactics and doctrine significantly improved in the later years with the development of new radios, integration

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[38] Heinz Guderian, *Achtung-Panzer! The Development of Armoured Forces, Their Tactics and Operational Potential* (London: New York: Arms and Armour; Distributed in the USA by Sterling Pub. Co, 1995), 202.

[39] Paul M. Kennedy, Engineers of Victory: The Problem Solvers Who Turned the Tide in the Second World War, 1st ed (New York: Random House, 2013), 146.

[40] Cooling, *Case Studies in the Development of Close Air Support*, 79.

[41] War Department, *Command and Employment of Air Power*, FM 100–20 (Washington, DC: United States Government Printing Office, 1943).

tactics such as "armored column cover," and the realization that fighter-bomber aircraft were best suited for close air support. Frontline troops also provided the clearest indication yet of the psychological effect that CAS provided both to friendly and enemy forces.[42]

The manpower systems necessary to facilitate air-ground integration were one of the greatest advancements in World War II. At the breakout of the war, air liaison officers or air command cells at the corps or division level were commonplace. Urgent calls for air support, communication advancements, and the need for coordination drove the democratization of air control. In the Pacific, the Marines first assigned ground air controllers during the Guadalcanal battles. These air controllers were equipped with a radio and pushed to the front lines to mitigate the difficulty of identifying friendly and enemy forces in thick, jungle vegetation. These techniques were also used during the amphibious landing at Bougainville, where ten strikes were conducted between 200–500 meters from friendly forces.[43]

In Europe, three air controller methods became commonplace by 1943: pathfinders, rover teams, and the Horsefly technique. As the U.S. military began adopting paratrooper tactics, they identified that parachute operations had a much higher chance of success if the landing zone was marked. To accomplish this task, the U.S. Army created pathfinders. Pathfinders used radar beacons to mark the landing zone and first contributed to successful airborne operations in Italy in 1943. As the employment methods progressed, the Army created its first combat control team (CCT) in 1945, using it during Operation Varsity and the allied attack across the Rhine River. These CCTs consisted of four glider pilots and one enlisted radio operator who landed in advance and served as air controllers. The pathfinders and initial CCTs of World War II paved the way for the future Air Force CCTs established in the 1950s.[44]

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[42] Hallion and Mason, *Strike from the Sky*, 199, 263–65.

[43] Hallion and Mason, 165–67.

[44] Forrest Marion, *Brothers in Berets: The Evolution of Air Force Special Tactics 1953–2003*, First edition (Maxwell Air Force Base, Alabama: Air University Press, 2012), 1–16.

Rover teams, first employed by the British and later adopted by the Americans, served as the precursor to the modern- day tactical air controller party (TACP). While the British experimented with Rover teams in North Africa, their employment began in earnest in Italy in 1943. Rover teams combined one combat pilot, one ground army officer, and a radio operator on the front lines to call for and coordinate CAS.[45] Rover teams were often paired with an airborne air control technique called the "Horsefly technique." Established in 1944, the Horsefly technique paired one pilot and one ground officer in an L-5 aircraft to identify and coordinate strikes from the sky. The initial air controller techniques formed throughout World War II formed the foundations for the air controller military specialties and techniques that exist to this day.[46]

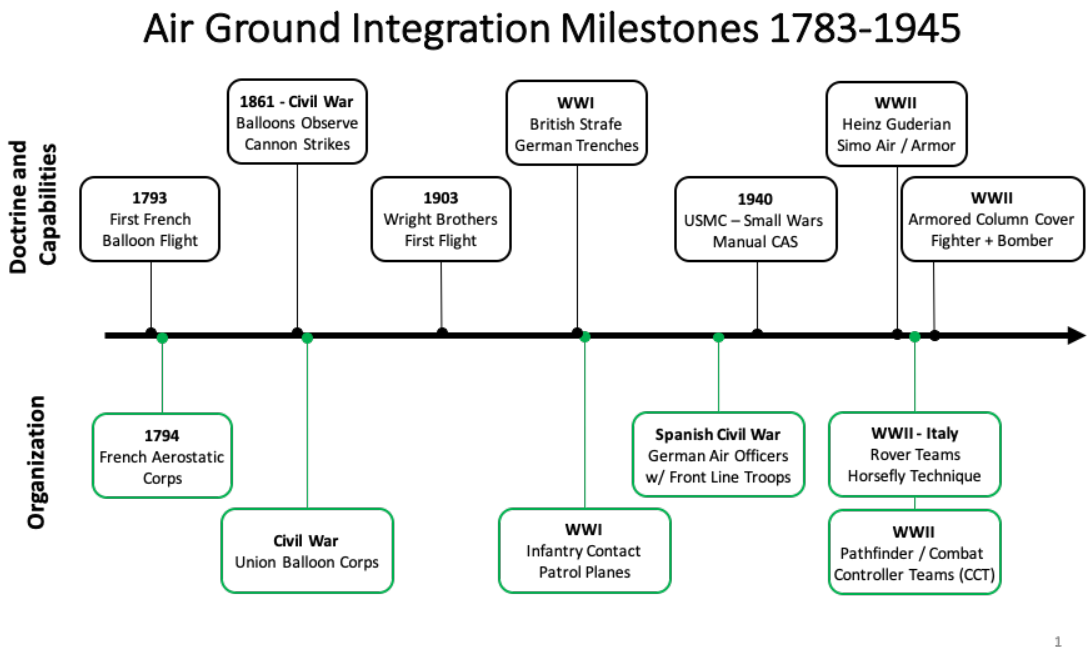
World War II also saw a more structured authorities and approval system for CAS. As joint air and ground command and control cells became commonplace, they became the location for strike approval. During the allied invasion of Normandy, ground strike requests would be forwarded up to the Combined Operations Center, where Army ground and air officers would evaluate and approve of the strike. Once approved, the strike would be disseminated down through the air channels to the appropriate strike unit.[47] In the Pacific, ground commanders were never given authority to control aircraft. Ground commanders would request strikes, but a strike could be denied by the air headquarters.[48] While the authorities over strikes and their control improved from the ad hoc nature of World War I, ground commanders still could not approve strikes within their area of operations. Figure 1 provides a visual representation of doctrine, capabilities, and organizational advancements from 1783-1945.

[45] Cooling, *Case Studies in the Development of Close Air Support,* 208–9; Hallion and Mason, *Strike from the Sky,* 180–81.

[46] Hallion and Mason, *Strike from the Sky*, 181–82; Cooling, *Case Studies in the Development of Close Air Support,* 217–18.

[47] Hallion and Mason, *Strike from the Sky*, 197.

[48] Cooling, *Case Studies in the Development of Close Air Support*, 333.



World War II saw the biggest air-ground advancements as communications methods improved and air controllers proved effective.

Figure 1. Air Ground Integration Milestones 1783 to World War II.

E. THE KOREAN WAR

The newly separated U.S. Air Force (USAF) and the U.S. Army struggled to find common ground on close air support doctrine throughout the Korean War (1950–1953). The dawn of the atomic age saw an Air Force focused on strategic targeting instead of tactical air support. The Marine Corps demonstrated the most effective air-ground integration during the Korean War.[49] Over one four-week period, Marine aviation conducted over half of its strikes within 800 meters of friendly forces.[50] In total, 8% of the sorties flown by the USAF in the Korean war were CAS compared to 30% for the USMC.[51]

[49] Jeremy W Siegel, "The Debate Is Over: Close Air Support in Korea and Vietnam" (Thesis, USMC Command and Staff College, 2011), 2, https://apps.dtic.mil/sti/pdfs/ADA601237.pdf.

[50] Cooling, *Case Studies in the Development of Close Air Support,* 367.

[51] Cooling, 396.

While Korea cemented air-ground integration lessons in the Marine Corps, neither the Air Force nor the Army could agree upon a joint CAS doctrine at its conclusion.[52]

Organizationally, the Korean War furthered the Rover and Horsefly constructs first developed during World War II. Rover air control teams were replaced with tactical air controller parties (TACPs), pairing a pilot with prior experience in CAS with communications personnel and assigning them to the front lines. The Marine Corps regularly employed TACPs at the Battalion level and allowed them, at times, to communicate directly with higher air commands for strike approval. The Air Force maintained fewer TACPs, often at the Brigade level or higher. Even at these beginning stages, the services struggled at manning the appropriate number of TACPs. TACPs on the front lines were often prohibited from traveling between front line positions due to a fear of potentially being killed and studies of the TACP model struggled to see how pilots could fill all the appropriate TACP positions.[53] One step toward a more permanent solution was the Air Force establishment of the first CCT teams in early 1953, which paved the way for modern day Air Force Special Operations Command CCTs.[54]

The Air Force's 6147th Tactical Air Control Group built on the Horsefly technique from World War II to create the airborne FAC Mosquitos in the Korean War.[55] Airborne FACs primarily flew the T-6 training aircraft, identifying enemy targets, and coordinating with fighter and bomber aircraft to help mitigate friendly fire. Airborne FACs worked in close coordination with ground TACPs. As the war progressed, crews modified FAC aircraft with smoke rockets which provided the air controller a target marking capability.[56] In total, over 40,000 FAC Mosquito missions were flown in the Korean War. Despite their

[52] Cooling, 398–99.

[53] Charlie Pocock et al., "A Brief History of Forward Air Controlling," 5, http://www.usafa68.org/.

[54] Marion, *Brown Bag Lessons*, 21–22.

[55] United States Air Force, "Mosquitoes in Korea," National Museum of the United States Air Force, N.D., https://www.nationalmuseum.af.mil/.

[56] Pocock et al., "A Brief History of Forward Air Controlling," 3–6.

overwhelming use, the Air Force disbanded them in 1956, believing that the airborne FAC would not be useful in the jet era.[57]

Authorities during the Korean War were also largely unchanged from World War II. Ground commanders requested strikes up their chain of command to the Joint Operations Center. The Joint Operations Center approved or denied the strike after looking at the available assets and if approved, forwarded the information to the aircraft conducting the strike. The Marine Corps TACP teams streamlined this process at times by allowing the TACPs to coordinate directly with the Tactical Air Control Center. A request that came in this direct manner was assumed to require aviation instead of local artillery.[58] It was not until the next major combat conflict, the Vietnam War, that this decentralization of approval became commonplace.

F. THE VIETNAM WAR

Even in the absence of official doctrine, during the Vietnam War, military technological advances including the armed helicopter, AC-47 gunship, and surveillance drones created a war with more air-ground integration than any before. Helicopters and gunships provided an air platform tailor made for CAS. The performance of these platforms was enhanced by an approval process that was modified to allow ground air controllers quicker access to air strike approval. These advances enabled quicker and more accurate air support to ground forces at the tactical edge.

Helicopters were fundamental to this transformation. The Marine Corps introduced the UH-1E armed helicopter in 1964 and by 1975, after the Vietnam War had concluded, the modern AH-1 Cobra and AH-64 Apache attack helicopters had both been fielded and used extensively in close air support missions.[59] Attack helicopters transformed close air support for two reasons. The speed, altitude, and distance capabilities all lent to CAS being

[57] United States Air Force, "Mosquitoes in Korea."

[58] Cooling, *Case Studies in the Development of Close Air Support*, 348–53.

[59] LtCol William R. Fails, *Marines and Helicopters 1962–1973* (Washington, DC: History and Museums Division, HQ, USMC, 1978), 79–91.

a primary mission instead of interdiction and strategic targeting. Secondly, and specifically for the U.S. Army, helicopters were owned by the Army and not the Air Force. In fact, Army commanders routinely requested helicopters due to their availability and responsiveness.[60]

Close behind the introduction of the attack helicopter was the AC-47 gunship, first used in 1965. The AC-47 demonstrated effectiveness at close air support in support of base defense, convoy escort, and helicopter landing zone operations.[61] Proving value, the AC-47 was upgraded multiple times, eventually using the C-130 platform body that is still used in modern AC-130 variants. Air Force data analysis of aircraft effectiveness by April 1970 showed the AC-130 was approximately 60% more effective at striking enemy vehicles than the best fixed-wing jet.[62]

Lastly, the Vietnam War saw the first major use of unmanned reconnaissance drones. These drones, while not used for CAS, demonstrated the effectiveness of unmanned reconnaissance, a principle that has democratized since Vietnam to the handheld, tactical unmanned drones that are used by modern troops. The main reconnaissance drone used in Vietnam was the AQM-34 "Lightning Bug." Over an 11-year span, the Lightning Bug flew over 3,400 missions, conducting image reconnaissance and signals intelligence. In the later portion of the war, unmanned aircraft also conducted strikes with the AGM-65 Maverick, experimenting with unmanned strike tactics that are routine in the GWOT.[63]

Organizationally, the Vietnam War saw many of the same personnel constructs that were employed in Korea, namely, the ground TACP and the airborne FAC. Ground TACPs were positioned with frontline troops, often at the battalion level, while airborne FACs controlled fires from the skies. Due to the thick vegetation, as much as 95% of the total

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[60] Cooling, *Case Studies in the Development of Close Air Support,* 454.

[61] James Cole, *Project CHECO Southeast Asia Report: Fixed Wing Gunship in SEA* (HQ PACAF, Directorate of Operations Analysis, 1971), 1–17, https://apps.dtic.mil/sti/pdfs/ADA486516.pdf.

[62] Cole, 43.

[63] Laurence R. Newcome, *Unmanned Aviation: A Brief History of Unmanned Aerial Vehicles* (Reston, VA: American Institute of Aeronautics and Astronautics, Inc., 2004), 83–86.

CAS missions were directed by airborne FACs.[64] By 1970, the number of airborne FACs in Southeast Asia grew to as many as 800.[65] The problem with this system, as seen in other conflicts, was that it was difficult to man the number of ground TACP and airborne FAC positions without creating a pilot shortage. One solution was to use enlisted CCTs formalized by the Air Force in 1954. CCTs, consisting of both officer and enlisted controllers, operated extensively throughout Vietnam, performing tasks such as building airfields, controlling air traffic, and training foreign forces in CAS tactics. While Air Force doctrine stipulated that ground FACs had to be pilots, a handful of enlisted CCTs were known to conduct air strikes as part of the Butterfly Program in Laos.[66]

Authorities also expanded during the Vietnam War. At first, the authority to conduct strikes resided at the highest of levels, often through both military and civilian channels. Air strikes were delayed as both the Air Operations Center and the local civilian provincial leadership had to approve strikes. As ground forces became more maneuverable, this became a challenge. A 1962 study found that out of nine randomized close air strikes, only one occurred under 40 minutes and six occurred over 50 minutes after the request.[67] A significant step forward was the 1965 *Concept for Improved Joint Air-Ground Coordination*. Immediate CAS requests could be submitted by a TACP or FAC at the ground level and forwarded directly to the direct support air center. The direct support air center would receive approval for the strike from the collocated Army command center and the strike would be processed.[68] By the war's end, ground commanders thought favorably of the CAS throughout the war, and the advances in capabilities and air doctrine formulated a more joint, integrated approach.

64 Pocock et al., "A Brief History of Forward Air Controlling," 8.

65 Cooling, *Case Studies in the Development of Close Air Support*, 436.

66 Marion, *Brown Bag Lessons*, 61–92.

67 Cooling, *Case Studies in the Development of Close Air Support*, 421.

68 Cooling, 428.

G. POST-VIETNAM TO 1995

Post-Vietnam, doctrine and authorities remained stagnant while manpower systems continued to improve. Two advancements of note are the creation of the joint force through the Goldwater-Nichols Act of 1986 and the Air Force enlisted terminal attack controller program (ETAC). The Goldwater-Nichols Act reorganized the DOD and created the Joint Chiefs of Staff.[69] The office of the Joint Chiefs of Staff was responsible for all joint doctrine, a clear weakness in air-ground integration. 1986 also brought the first major shift from pilot FACs to enlisted controllers occurred when the Air Force initiated the enlisted terminal attack controller (ETAC) program. This was in response to the difficulty in manning ground FAC positions with trained pilots. ETACs were assigned as a member of the Army Battalion TACP full-time. Their primary responsibility was terminal air strike control. ETACs had to pass occasional evaluations and regularly control aircraft to maintain their qualification.[70] While the USAF made this advancement, the Marine Corps did not follow suit, maintaining their reliance on pilot FACs until after the formal creation of the JTAC in 2003.

The 1980s and 1990s also saw CCT expansion from being understaffed to a vital USSOCOM element. CCTs attached to Delta Force in the late 1970s and participated as air controllers in Operation Eagle Claw, the failed hostage rescue attempt in Iran. CCTs served as air controllers during airfield search and seizure in 1989 during Panama, attached to British SAS teams during Operation Desert Storm, and conducted combat search and rescue in Somalia and the Balkans.[71] By the early 21st century, CCTs had proved themselves as vital air-ground integrators and pioneers of air-ground integration tactics writ large. CCT assignment to USSOCOM also separated their employment from ETACs and TACPs, which were assigned to conventional Army Units.

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69 "Goldwater-Nichols Department of Defense Reorganization Act of 1986," H.R. 3622, 99th Cong. § (1986).

70 Raymond Knox, "The Terminal Strike Controller: The Weak Link in Close Air Support" (Fort Leavenworth, Kansas, School of Advanced Military Studies, United States Army Command and General Staff College, 1989), 17–29, https://apps.dtic.mil/sti/pdfs/ADA208256.pdf.

71 Marion, *Brown Bag Lessons*, 208–18, 252, 317.

H. 1995–2003: FORMALIZED DOCTRINE AND ORGANIZATION

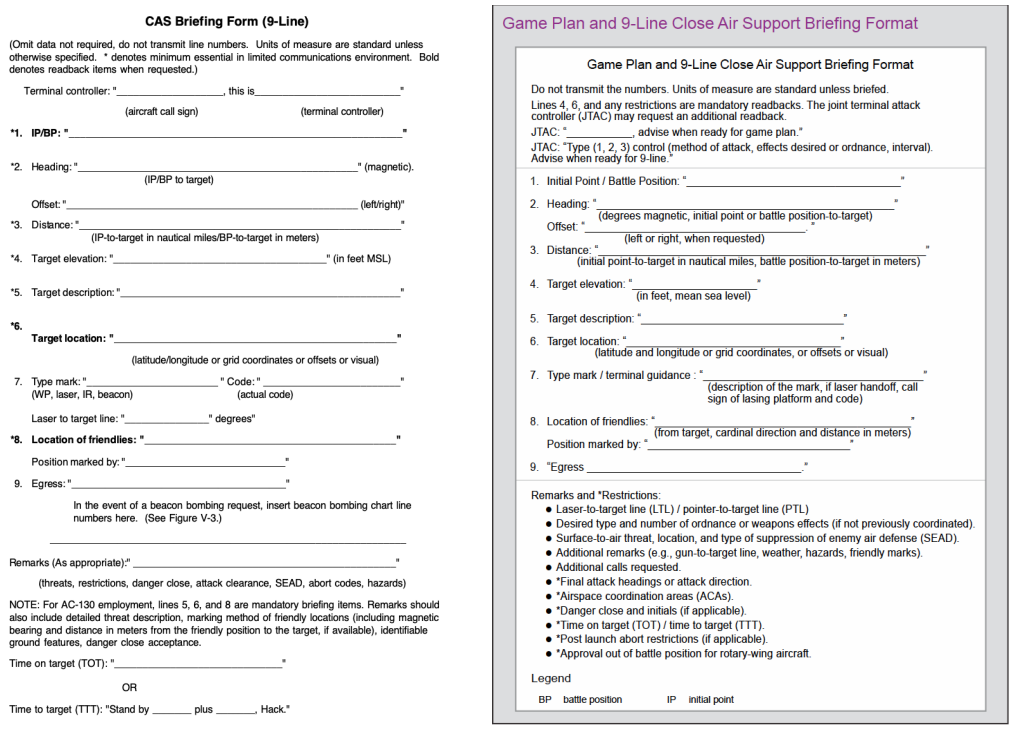
Air ground integration made sweeping changes between 1995 and 2003, formalizing close air support doctrine and creating the JTAC specialty that still exists today. Joint Publication 3-09.3, *Joint Tactics, Techniques, and Procedures for Close Air Support (CAS)*, was released on 1 December 1995. The publication described the close air support process in detail, including the fundamental formats and processes for command and control, requesting air support, and executing close air support.[72] The first J-Fire was released two years later, serving as a tactical guide to the application of air power.[73] As Figure 2 depicts, the fundamental way that CAS is conducted, through the 9-line CAS execution brief, has remained relatively unchanged since 1995. Oversight of CAS expanded in 2000 when the first Joint Close Air Support Executive Steering Committee (JCAS ESC) was chartered. The committee, which expanded to include 18 different nations, still exists, focusing on joint and international fire support doctrine and training standards.[74] JP 3-09.3, initially a 175-page document, was revised in 2003, 2009, 2014, and 2019, adding additional tactics, techniques, and procedures. The latest version, validated in 2021, is over double the original length at 364 pages.[75]

[72] Joint Chiefs of Staff, *Joint Tactics, Techniques, and Procedures for Close Air Support (CAS)*, JP 3-09.3 (Washington, DC: Joint Chiefs of Staff, 1995).

[73] *J-Fire*, FM 9-20, MCRP 3–16.8B, NWP 3-09.2, AFTTP(I) 3–2.6 (Washington, DC: Department of Defense, 1997).

[74] Cary Russell, *Close Air Support: Actions Needed to Enhance Friendly Force Tracking Capabilities and Fully Evaluate Training*, GAO-21-99 (Washington, DC: Government Accountability Office, 2021), 10, https://www.gao.gov/; Joint Chiefs of Staff, *Joint Fire Support Executive Steering Committee Governance and Management*, CJCSI 5127.01A (Washington, DC: Joint Chiefs of Staff, 2018).

[75] Joint Chiefs of Staff, Joint Close Air Support, V24; Joint Chiefs of Staff, Joint Tactics, Techniques, and Procedures for Close Air Support (CAS), 1995, act V–3.



CAS Briefing Form (9-Line)

(Omit data not required, do not transmit line numbers. Units of measure are standard unless otherwise specified. * denotes minimum essential in limited communications environment. Bold denotes readback items when requested.)

Terminal controller: "_____, this is_____"
(aircraft call sign) (terminal controller)

*1. **IP/BP:** "_____"

*2. Heading: "_____" (magnetic).
(IP/BP to target)

Offset: "_____ (left/right)"

*3. Distance: "_____"
(IP-to-target in nautical miles/BP-to-target in meters)

*4. Target elevation: "_____" (in feet MSL)

*5. Target description: "_____"

*6. **Target location:** "_____"
(latitude/longitude or grid coordinates or offsets or visual)

7. Type mark: "_____" Code: "_____"
(WP, laser, IR, beacon) (actual code)

Laser to target line: "_____" degrees"

*8. **Location of friendlies:** "_____"

Position marked by: "_____"

9. Egress: "_____"

In the event of a beacon bombing request, insert beacon bombing chart line numbers here. (See Figure V-3.)

Remarks (As appropriate):" _____"
(threats, restrictions, danger close, attack clearance, SEAD, abort codes, hazards)

NOTE: For AC-130 employment, lines 5, 6, and 8 are mandatory briefing items. Remarks should also include detailed threat description, marking method of friendly locations (including magnetic bearing and distance in meters from the friendly position to the target, if available), identifiable ground features, danger close acceptance.

Time on target (TOT): "_____"

OR

Time to target (TTT): "Stand by _____ plus _____, Hack."

Game Plan and 9-Line Close Air Support Briefing Format

Game Plan and 9-Line Close Air Support Briefing Format

Do not transmit the numbers. Units of measure are standard unless briefed.

Lines 4, 6, and any restrictions are mandatory readbacks. The joint terminal attack controller (JTAC) may request an additional readback.

JTAC: "_____, advise when ready for game plan."

JTAC: "Type (1, 2, 3) control (method of attack, effects desired or ordnance, interval). Advise when ready for 9-line."

1. Initial Point / Battle Position: "_____"
2. Heading: "_____"
(degrees magnetic, initial point or battle position-to-target)
Offset: "_____"
(left or right, when requested)
3. Distance: "_____"
(initial point-to-target in nautical miles, battle position-to-target in meters)
4. Target elevation: "_____"
(in feet, mean sea level)
5. Target description: "_____"
6. Target location: "_____"
(latitude and longitude or grid coordinates, or offsets or visual)
7. Type mark / terminal guidance : "_____"
(description of the mark, if laser handoff, call sign of lasing platform and code)
8. Location of friendlies: "_____"
(from target, cardinal direction and distance in meters)
Position marked by: "_____"
9. "Egress _____."

Remarks and *Restrictions:
- Laser-to-target line (LTL) / pointer-to-target line (PTL)
- Desired type and number of ordnance or weapons effects (if not previously coordinated).
- Surface-to-air threat, location, and type of suppression of enemy air defense (SEAD).
- Additional remarks (e.g., gun-to-target line, weather, hazards, friendly marks).
- Additional calls requested.
- *Final attack headings or attack direction.
- *Airspace coordination areas (ACAs).
- *Danger close and initials (if applicable).
- *Time on target (TOT) / time to target (TTT).
- *Post launch abort restrictions (if applicable).
- *Approval out of battle position for rotary-wing aircraft.

Legend

BP battle position IP initial point

Figure 2. CAS Briefing Form from 1995 (left) and 2019 (right). Source: JP 3-09.3

Shortly after the first joint CAS doctrine, concurrent events propelled the creation of a joint organization construct, the joint terminal attack controller (JTAC). First, GWOT pushed tactical maneuver to a lower level, creating a demand for air controllers that could not be satisfied by FACs and ETACs. The initial phase of GWOT also saw an increase in friendly fire incidents. Between March 2001 and March 2002, four friendly fire incidents occurred, three of which occurred in Afghanistan, killing four and injuring over 27.[76] Two of these strikes involved a Joint Direct Attack Munition, the latest technology that allowed for a precision airstrike using GPS navigation. While a joint plan for air support had called for standardizing controller training in 2001, it was not completed at the time of a scathing

[76] Neal Curtin, *Military Readiness: Lingering Training and Equipment Issues Hamper Air Support of Ground Forces*, GAO-03-505 (Washington, DC: Government Accountability Office, 2003), 34, https://www.gao.gov/assets/gao-03-505.pdf.

Government Accountability Office report in mid-2003.[77] As operations increasingly became joint and even international, air controllers had to be able to control aircraft from any service or NATO partner and use precision to employ highly technical munitions.

All of these factors contributed to the formalization of the JTAC in the 2003 update to JP 3-09.3. A JTAC was defined as:

> A qualified (certified) service member who, from a forward position, directs the action of combat aircraft engaged in close air support and other offensive air operations. A qualified and current joint terminal attack controller will be recognized across the Department of Defense as capable and authorized to perform terminal attack control.[78]

While the services still ran their own JTAC training courses, a common set of principles and training standards were formed. Existing ETACs, CCTs, and FACs were grandfathered in as the first JTACs. SOCOM's Special Operations Tactical Air Controller Course ran its first pilot course in 2002 to train SOCOM operators as JTACs.[79] The USMC followed in 2003 with an order allowing enlisted Marines to finally become JTACs, 17 years after the USAF first started to train ETACs.[80] The air controller transformation from ad hoc service-ran assignment to joint qualification and certification is the basis for modern air-ground integration. The Joint Chiefs of Staff, creating by the Goldwater-Nichols act of 1986, oversees the JTAC program and ensures that each service adheres to the certification and qualification process. Figure 3 provides a visual representation of air-ground integration doctrine, capabilities, and organizational advancements from 1947–2003.

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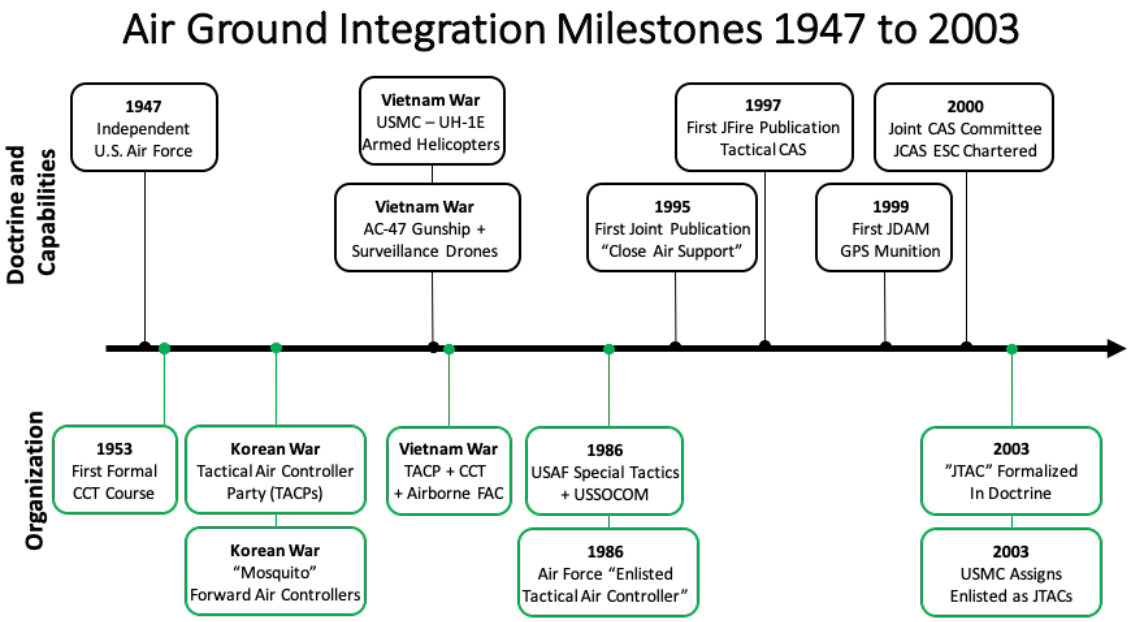
[77] Curtin, Military Readiness: Lingering Training and Equipment Issues Hamper Air Support of Ground Forces.

[78] Joint Chiefs of Staff, *Joint Tactics, Techniques, and Procedures for Close Air Support (CAS)*, JP 3-09.3 (Washington, DC: Joint Chiefs of Staff, 2003), GL-12.

[79] Sean Mulholland, M.A. Singleton, and Shannon Boehm, "SOTACC: Training SF Soldiers in Close Air Support and Terminal Air Control," *Special Warfare* 16, no. 1 (April 2003): 6.

[80] United States Marine Corps. *Corrected Copy: CMC Policy on Non-Aviator Terminal Control of Close Air Support,* ALMAR 028/03 (Washington, DC: United States Marine Corps, 2003).



Joint doctrine solidified the air-ground integration doctrine and organizational advancements made during the last half of the 20th century.

Figure 3. Air-Ground Integration Milestone 1947–2003

I. CONCLUSION

Air-ground integration took 100 years to transform from an untested reconnaissance asset in World War I to an integral aspect of warfare with associated doctrine, capabilities, and manpower systems. The key historical trends and advancements identified in this chapter will be utilized in Chapter IV as a comparison to modern information initiatives. Until the 1980s and 1990s, most advances were made during wartime. World War II saw advances in capabilities such as the fighter bomber combination aircraft and improved communications. The first ground and airborne controllers, Rover teams and the Horsefly technique, were also developed in World War II. The Vietnam War, in particular, brought about major capabilities improvement in the types of aircraft that support ground operations. The attack helicopters, gunships, and drones the U.S. used in Southeast Asia are staples of air-ground integration today. A more decentralized authorities process for CAS was also introduced in Vietnam that produced ground commanders satisfied with air support. Post-Vietnam saw major democratization

in air controllers with the introduction of the ETAC, paving the way for the formalization of the JTAC.

The transformation of doctrine and organization that occurred from 1995 to 2003 set the groundwork for the modern air-ground framework. JP 3-09.3, first published in 1995, remains the foundation for the planning and execution of close air support. In addition, the establishment of the JCAS ESC, now the Joint Fire Support Executive Steering Committee, formalized the oversight of joint training standards for air controllers that have been adopted across the U.S. military and NATO.[81] This committee oversees the alignment of technological capabilities, doctrine, and manpower systems.

Twenty years of the GWOT has led to doctrine refinements, new air capabilities, and a refined authorities and approval process tailored to the scope of combat operations. While these refinements have enhanced air-ground integration, they still rely on the same foundational doctrine (JP 3-09.3) and organization (JTAC) developed in the late 1990s and early 2000s. The next chapter will analyze these modern refinements in order to frame the present air-ground integration framework.

[81] Joint Chiefs of Staff, *Joint Fire Support Executive Steering Committee Governance and Management*; NATO Standardization Organization, *Joint Terminal Attack Controller Program*, Edition B Version 2, ATP-3.3.2.2 (Brussels, Belgium: North Atlantic Treaty Organization, 2018).

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III. CURRENT AIR GROUND INTEGRATION ECOSYSTEM

The modern joint terminal attack controller (JTAC) provides the ground commander with an air-ground integration expert at the tactical edge, equipped with lethal and nonlethal capabilities, and who falls under authorities that vary by location and type of operation. The JTAC advises, plans, and executes close air support. While JP 3-09.3 serves as the base document for the employment of JTACs and CAS, each service has taken a slightly different approach to manage their JTACs.[82] This chapter provides an understanding of the modern ground controller ecosystem by looking at the organization, capabilities, and authorities of modern JTACs. Divided into three sections, this chapter will illuminate how JTACs are certified and qualified, what CAS training other specialties receive, what specific equipment JTACs use, and how JTACs are authorized to conduct air strikes by various ground commanders. Identifying the key elements of the JTAC system in this chapter will set a foundation for the exaptation of these principles to the tactical information environment in the following chapter.

A. MANPOWER SYSTEMS TO CONDUCT CLOSE AIR SUPPORT

1. JTACs as the Foundational Organizational Element

The JTAC is the foundational organizational element of the air-ground integration ecosystem. Doctrine defines a JTAC as "a qualified (certified) service member who, from a forward position, directs the action of combat aircraft engaged in close air support and other offensive air operations."[83] The mission-essential tasks for a JTAC fall into three categories: planning, preparation, and execution. In planning, JTACs advise the ground commander on air power and plan CAS missions to support ground forces. To prepare, JTACs analyze intelligence and air support products and operate their equipment. Finally, and most importantly, JTACs execute CAS during operations by identifying adversary

[82] Joint Chiefs of Staff, *Joint Close Air Support*.

[83] Joint Chiefs of Staff, GL-11.

targets, coordinating air strikes with supporting aircraft, and maintaining the safety of both the aircraft and friendly forces during an aviation strike.[84] These essential tasks are both joint and international, recognized by all the U.S. military services and NATO.

To ensure that every JTAC is able to accomplish these tasks, JTACs are *qualified*, *certified*, and *designated*. JTACs are certified when they complete an approved training curriculum and are qualified by maintaining regular currency and evaluation requirements.[85] The USMC, USN, USAF, USSOCOM, and various NATO countries all run JTAC *certification* courses which consist of multiple weeks of classroom instruction followed by a practical application phase where students control live aircraft.[86] Once certified, JTACs also need to be *qualified* by regularly controlling different types of aircraft and passing an evaluation every 18 months. As an example, the Marine Corps lists 25 different training events a JTAC should complete regularly to maintain the qualification. These events include tasks such as controlling fixed or rotary wing CAS in an urban or night environment, integrating an unmanned aerial system (UAS), marking a target with infrared or laser equipment, and controlling a live ordnance drop.[87] The last step is to be *designated*. Ground commanders "designate" personnel as JTACs through a formal assignment.[88] When a JTAC announces themselves on a radio in combat, everyone

[84] Secretary of the Air Force, *Joint Terminal Attack Controller (JTAC) Training Program*, AFI 13–112, Volume 1 (Washington, DC: Secretary of the Air Force, 2017), 46–66, https://static.e-publishing.af.mil/; NATO Standardization Organization, *Joint Terminal Attack Controller Program*, acts 1–18.

[85] Joint Chiefs of Staff, Joint Close Air Support (JCAS) Action Plan Memorandum of Agreement 2004–01 Joint Terminal Attack Controller (JTAC) (Ground), JCAS AP MOA 2004–01 (Washington, DC: Joint Chiefs of Staff, 2004), 4.

[86] U.S. Army, "Special Operations Terminal Attack Controllers Course," accessed August 2, 2022, https://www.yuma.army.mil/tenant_sotacc.html; NATO, "NATO Electronic Education and Training Opportunities Catalogue," N.D., https://e-itep.act.nato.int/; C.A. Browning, *2022–2023 EWTGLANT Course Catalog* (Little Creek, VA, 2021), act 51, https://media.defense.gov/2021/Oct/19/2002876244/-1/-1/0/2022-2023%20EWTGLANT%20COURSE%20CATALOG_UPDATED%209-16-21.PDF; Secretary of the Air Force, *Joint Terminal Attack Controller (JTAC) Training Program*, act 17.

[87] Commandant of the Marine Corps, *Marine Corps Tactical Air Control Party (TACP) Program*, MCO 3311.2A (Washington, DC: Headquarters, USMC, 2022), 5-(5-7).

[88] NATO Standardization Organization, *Joint Terminal Attack Controller Program*, E-1.

involved understands that the JTAC has been trained, evaluated, and assigned in writing as competent.

The DOD CAS apparatus also mandates that aircrew maintain proficiency at CAS. The Navy, Marine Corps, and Air Force dictate a minimum number of CAS sorties a pilot must fly to maintain currency.[89] The Air Force in particular mandates that some of these requirements include a JTAC. In 2022, the Marine Corps estimated that certification and currency of its JTACs would require 5,784 live aircraft controls.[90] The currency requirements for both pilots and JTACs create ample cross-training opportunities that increase interoperability and comfortability across the force. In combat, not only can a pilot assume the JTAC is proficient, but the JTAC can also assume the pilot is proficient.

Despite the standardization of training tasks and skills management, each service has its own method of managing JTAC personnel. Table 1 depicts the primary specialties that serve as JTACs by branch. The Air Force trains the most JTACs and sources JTACs to serve at Army Battalions as part of the TACP construct dating back to the Korean War.[91] A distinction between the Air Force and other services lies at the primary versus secondary nature of being a JTAC.

As Table 1 depicts, being a JTAC is a primary function of both the TACP and ALO; however, the other branches assign a secondary specialty of JTAC and only occasionally assign service members to full-time JTAC billets. Of note, no matter if a JTAC is assigned full or part-time, every qualified JTAC must meet the same currency requirements and pass evaluations every 18 months. No distinction is made in doctrine or combat air controlling procedures.

[89] For a fantastic summary of aircrew CAS currency requirements, reference Appendix I in Government Accountability Office report GAO-21-99.

[90] Mark Wise, *2022 United States Marine Corps Aviation Plan* (Washington, DC: United States Marine Corps, 2022), 202, https://www.aviation.marines.mil/.

[91] The term Tactical Air Controller Party is both an Air Force individual occupation and a group of personnel who support Army and Marine Corps Units. As a group, a TACP is a small group of JTACs, Air Officers or Air Liaison Officers, and radio operators.

Table 1. JTAC Personnel Structure by Branch.[92]

Branch	Occupation	Military Specialty Code	JTAC Secondary Code	Officer / Enlisted	Full / Part Time
U.S. Army	Joint Fire Support Specialist	13F	1G	Enlisted	Part
	Special Forces Sergeant	18 (Series)			
U.S. Air Force	Combat Control Operator	1Z2X1	914	Enlisted	Full (In Billet)
	Special Tactics Officer	19ZXA	O9C	Officer	
	Tactical Air Controller Party	1Z3X1	914	Enlisted	Full
	Air Liaison Officer	19ZXB	O9C	Officer	
U.S. Marine Corps	Fire Support Marine	0861	8002	Enlisted	Full (In Billet)
	Reconnaissance Marine	0321			Part
	Critical Skills Operator	0372			
	Artillery Officer	0802		Officer	Full (In Billet)
	Aviator	75XX	7502		
U.S. Navy	Special Warfare Operator	O26 (Series)	822A	Enlisted	Part
	Special Warfare Combatant-Craft Crewman	O52 (Series)			

2. Non-JTAC Manpower Training

Beyond JTACs, modern CAS training includes both baseline training for key specialties and an intermediate qualification as a joint-fires observer (JFO). JFOs are "trained service members who can request, adjust, and control surface-to-surface fires, provide targeting information…and perform autonomous terminal guidance operations."[93] A JFO has many of the same skills as a JTAC, but does not control CAS attacks or approve aircraft to drop munitions. The infantry battalion model for JFO and JTAC integration has a JTAC as part of the TACP at the battalion headquarters and JFOs at the company or platoon level.[94] JFOs provide targeting information to the JTAC and are trained to correlate target location before the JTAC coordinates and approves a munitions drop.[95] Since JFOs

[92] Wise, 2022 United States Marine Corps Aviation Plan, 202; Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards, vol. II, NAVPERS 18068F (Washington, DC: Department of the Navy, 2021), act 266, https://www.mynavyhr.navy.mil/; Department of the Army, Military Occupational Classification and Structure, Pamphlet 611-21 (Washington, DC: Headquarters, USA, 2018), https://milsuite.mil; HQ AFPC, Air Force Enlisted Classification Directory, ASECD (Washington, DC: Department of the Air Force, 2021); HQ AFPC, Air Force Officer Classification Directory, AFOCD (Washington, DC: Department of the Air Force, 2021).

[93] Wise, 2022 United States Marine Corps Aviation Plan, 202.

[94] Shawn Snow, "The Corps Wants Every Rifle Squad Qualified to Direct Air, Naval and Artillery Fire," Marine Corps Times, May 6, 2018, https://www.marinecorpstimes.com/.

[95] C.A. Browning, 2022–2023 EWTGLANT Course Catalog, 31.

do not have to regularly control live aircraft and drop live munitions as part of their currency, the JFO program provides a more cost-effective, intermediate CAS organizational structure that is still overseen by the JFS ESC.[96]

Both the Army and the Marine Corps also include CAS training as a baseline for infantry and SOF. A basic task for a Marine infantry officer is to direct CAS, while an Army infantry officer is tasked to plan fire support to include CAS.[97] Marine Raiders, reconnaissance, snipers, and infantry staff non-commissioned officers also have baseline tasks to either direct CAS, act as an observer, or conduct CAS.[98] Army Special Forces sergeants also direct CAS while Army infantry learn how to provide locational data for surface fires.[99] These tasks form a baseline set of air ground integration skills for troops operating at the forward edge of the battlespace. Everyone is aware of how to employ CAS while some have received advance training and are certified to control and approve aviation fires. This framework of baseline, intermediate, and advanced skillsets allows frontline troops to integration air power effectively at the tactical edge.

B. JTAC SPECIFIC EQUIPMENT AND CAPABILITIES

JTACs are not only specially trained and designated, they are also specially equipped. Operating this equipment is one of the key JTAC tasks.[100] JTAC equipment can be broken down into three categories: communications, target identification, and target

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[96] Joint Chiefs of Staff, Joint Fire Support Executive Steering Committee Governance and Management, A-2.

[97] Commandant of the Marine Corps, *Infantry Training and Readiness Manual*, NAVMC 3500.44D (Washington, DC: Department of the Navy, 2020), 9–33; Department of the Army, *Officer Foundation Standards Manual: Infantry Company-Grade Officers*, STP 7–11 All-OFS (Washington, DC: Department of the Army, 2017), acts 3–5.

[98] Commandant of the Marine Corps, *Infantry Training and Readiness Manual*, 17–37, 8–24; Commandant of the Marine Corps, *Marine Raider Regiment Training and Readiness Manual*, NAVMC 3500.97B (Washington, DC: United States Marine Corps, 2020), acts 9–43; Commandant of the Marine Corps, *Reconnaissance Training and Readiness Manual*, NAVMC 3500.55C (Washington, DC: United States Marine Corps, 2017), acts 8–179.

[99] Department of the Army, *Soldier's Manual and Trainer's Guide: MOS 11B*, STP 7–11B1-SM-TG (Washington, DC: Department of the Army, 2020), 2–11; Department of the Army, *Soldier's Manual and Trainer's Guide: MOS 18*, STP 31–18-SM-TG (Washington, DC: Department of the Army, 2003), acts 3–284.

[100] NATO Standardization Organization, *Joint Terminal Attack Controller Program*, A-(9-10).

marking. JTACs are equipped with multiple radios that facilitate communications with aircraft as well as higher headquarters.[101] Without a radio, a JTAC would not be able to do his or her primary job of controlling aircraft. Included under the broad communications category are full motion video downlinks. These downlinks allow a JTAC on the ground to view the same sensor feed that the pilot will see. Downlinks help a JTAC view a target from the sky, correlate a specific location with a pilot, and help to verify the target location prior to conducting an attack.[102]

JTACs are also equipped with target identification and marking equipment, which enable a JTAC to accurately find a target and relay its position to attacking aircraft. Depending on the munition type, JTACs could pass a target's location through a precise GPS location or by talking the pilot onto the target location for a manual or laser attack. Table 2 lists various JTAC equipment including range finding equipment, laser or IR designators, and global positioning system locators.[103] Many of these equipment items are also issued to regular combat troops. Although a JTAC could use the equipment of the unit(s) they are attached to, having the JTAC organically own the equipment ensure that it is on hand when needed. While not all JTACs are trained to fly UAS, UAS now exist organically at the lowest tactical level and are used extensively for reconnaissance and target locating.[104] UAS provides the ground forces with an organic air reconnaissance capability that augments the other target identification equipment a JTAC carries.

[101] Kevin Seavey, Emilie Reitz, and François Hanne, "Digitally-Aided Close Air Support Capabilities in Simulation: Lessons Learned from a France-U.S. Effort," 2019, 1.

[102] L3Harris, "TACTICAL ROVER®e (TAC-e) | L3Harris™ Fast. Forward.," accessed August 4, 2022, https://www.l3harris.com/.

[103] Commandant of the Marine Corps, Marine Corps Tactical Air Control Party (TACP) Program, 1–1.

[104] Shawn Snow, "The Corps Is Going All in on Small Tactical Drones as It Preps for Future War," Marine Corps Times, January 18, 2019, https://www.marinecorpstimes.com/; B Aviation Program Executive Officer, "Soldier Unmanned Aircraft System (SUAS)" (Redstone Arsenal, AL: United States Army, September 11, 2020).

Table 2. Non-lethal and Lethal JTAC Equipment

JTAC Specialty Equipment	
Non-Lethal	**Lethal**
Communication Equipment	Loiter Munition (Switchblade)
Day / Night Optic	
Range Finding Equipment	
Global Positioning System Locator	
Laser Target Designator	
Infrared Illuminator	
Full Motion Video Downlink	
Digital CAS System	
Unmanned Aerial System	

While almost all JTAC equipment is non-lethal, lethal loiter munitions such as the Switchblade are now being fielded at the lowest tactical levels. USSOCOM has employed the Switchblade for over a decade in places like Afghanistan and Iraq.[105] With the proliferation of Switchblade munitions in Ukraine, the Army and Marine Corps are now looking to field them in conventional infantry units.[106] The Switchblade provides a ground commander with an organic lethal aviation asset to conduct CAS. While the Switchblade can be employed without a JTAC, a requirement for close coordination with other aviation assets means a JTAC will most certainly be in the loop. Loiter munitions add a lethal component to the toolkit of capabilities that enables a JTAC to locate an adversary, communicate the target's location, and execute a CAS attack. Equipping a highly trained air controller creates a unique capability that, if authorized, enables effective CAS. The following section will look at this authority and how JTACs are approved to strike a target.

C. THE AUTHORITY TO APPROVE AIRSTRIKES

JTACs receive approval to conduct CAS strikes by a commander who has been delegated target engagement authority. The ultimate authority to construct airstrikes is

105 John Keller, "U.S. Special Forces Use Unmanned Reconnaissance Drone with Missile Warhead for Reconnaissance and Attack," Military Aerospace, May 11, 2021, https://www.militaryaerospace.com/unmanned/article/14202957/unmanned-missile-warhead-reconnaissance.

106 Scott Cuomo, "On-the-Ground Truth and Force Design 2030 Reconciliation: A Way Forward," War on the Rocks, July 12, 2022, https://warontherocks.com/; John Keller, "Army Orders Switchblade UAV Loitering Munition That Has Achieved Fame in Ukraine as a Smart Mortar Round," Military Aerospace, May 11, 2022, https://www.militaryaerospace.com/.

derived from many different legal and policy documents including United States Code, international law, or military execute orders.[107] This authority is then delegated down to the level of a commander who can approve a strike, be it a captain on the ground to a four-star general in a different country. Approval authority may be delegated writ large during a military campaign or for a limited timeframe, such as a single mission. Approval authority can also be delegated to different levels, where one level of commander can approve some airstrikes while higher levels of command need to approve others.

To illustrate how the authorities for JTACs to conduct airstrikes have changed, this chapter discusses briefly the authorities during the initial phases of Operation Enduring Freedom (OEF) in Afghanistan (2001), mid-OEF (2009, 2013), and during Operation Inherent Resolve in Iraq (2016-2017). These cases are snapshots in time, location, and mission set that provide context to the changing nature of authorities within a single military campaign. In general, they show a tension between commanders that favor higher levels of authority in order to minimize collateral or civilian casualties and commanders who push authorities to the ground tactical level to enable a faster pace in ground operations.

1. Afghanistan Oct–Dec 2001

While the use of small ground teams and air power enabled the U.S. to quickly overthrow the Taliban in late 2001, cumbersome air support approval chains hindered key airstrikes. As troops first arrived in Afghanistan, authority to strike the most significant targets was maintained at U.S. Central Command headquarters in Tampa Bay, Florida. This high level of approval was the result of President Bush's desire to minimize collateral damage. The required level of approval, often from the United States Central Command commander, contributing to ten top Taliban and al-Qaida leaders not being hit in the first

[107] Deployable Training Division, *Authorities: Insights and Best Practices Focus Paper* (Washington, DC: Joint Staff J7, 2016), https://www.jcs.mil/."Armed Forces," U.S.C. Title 10, 112th Congress § (2021); "Authorization for Use of Military Force," S.J. Res.23, 107th Cong. § (2001), http://www.congress.gov/; United Nations, "UN Charter," United Nations (United Nations), accessed August 10, 2022, https://www.un.org/.

six weeks of the war, including Taliban spiritual leader Mullah Omar.[108] Omar was identified in a convoy of vehicles fleeing Kabul and arriving at a house. Requests to destroy the house were denied and only a single missile fired outside the front door was approved.[109]

Non-significant targets could be approved by a forward command headquartered at Prince Sultan Air Base (PSAB) in Saudi Arabia.[110] In the cases of these routine targets, a ground controller would use satellite communications to contact PSAB. PSAB would then analyze the target for potential civilian casualties or prohibited airstrike targets such as mosques or cultural locations before granting approval and relaying this approval back through satellite communications to the ground force.[111] Even a force highly motivated by the aftermath of 9/11 had difficulty scrutinizing each airstrike to minimize civilian casualties while quickly approving on demand targets.

2. OEF, Western and Southern Afghanistan, 2009, 2013

The middle years of the War in Afghanistan exhibited the ebb and flow of airstrike authority as both troop levels and civilian mass casualty events grew. In 2009, ground commanders in Baghdis Province in western Afghanistan could approve any munition that was employed in the self-defense of U.S. forces. Ground commanders could also use tactical drones for aerial surveillance at any time. When not in self-defense, any missile or guided bomb had to be approved by higher headquarters and requested through direct radio or satellite communications.[112] Around the same time, General Stanley McChrystal, the leader of NATO forces in Afghanistan, issued a tactical directive aimed at minimizing civilian casualties, specifically through CAS incidents. The tactical directive directed

[108] Thomas Ricks, "Target Approval Delays Cost Air Force Key Hits," *Journal of Military Ethics* 1, no. 2 (2002): 109.

[109] Rebecca Grant, "An Air War Like No Other," *Air Force Magazine*, November 2022, 34.

[110] Ricks, "Target Approval Delays Cost Air Force Key Hits," 109–11.

[111] Marion, Brown Bag Lessons, 349.

[112] SOF Captain Deployed to Baghdis Province, AF, personal communications, August 1, 2022; SOF Captain Deployed to Bala Murghab, Baghdis Province, AF, personal communication, August 10, 2022.

commanders to scrutinize every air strike, and limited strikes against buildings unless they met very specific criteria.[113]

By 2013, further restrictions had been implemented. Ground commanders in Helmand Province could not approve an airstrike on any compound. As one SOF officer remembered, they could approve helicopter and AC-130 rocket or gun attacks on open areas or wood lines, so long as the airstrikes satisfied the rules of engagement. They could also approve the use of a Switchblade loiter munition, tactical drones for surveillance, or ground mortar fire.[114] In sum, air strike authorities allowed the lowest commander some approval in self-defense situations, but maintained most authorities at a higher level in order to mitigate civilian casualties in line with strategic tactical directives. This was in contrast to Afghanistan in 2001 where all authority resided at a higher level.

3. Iraq (Operation Inherent Resolve) 2016–2017

In late 2016, U.S. forces in Iraq battling the Islamic State of Iraq and al-Sham (ISIS) transitioned airstrike authority from a one-star general level to the lowest tactical levels, propelling the Iraqi Army's eventual defeat of the Islamic State. At the beginning of 2016, authority rested in either of the two "strike cells" located in Baghdad and Erbil. Strike requests from U.S., coalition, or Iraqi units would be sent to the strike cell where the strike was analyzed and either approved or denied by a one-star general. Strike authority was maintained at this high level to minimize civilian and collateral damage. Strikes were submitted via cell phone, military radio, or classified chat application. If a coalition aircraft was used for the strike, that country would also have to approve of the strike.[115]

A major change occurred in late 2016 with the release of *Tactical Directive 1*, which allowed ground commanders who had JTACs to approve strikes at their level. U.S.

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[113] Stanley McChrystal, *Tactical Directive* (Kabul, Afghanistan: Headquarter, ISAF, 2009).

[114] SOF Captain Deployed to Helmand Province, AF, personal communication, August 10, 2022.

[115] This is also known as "red card" approval. If a strike utilized a French fighter, both the one-star general at the strike cell and the French military representative would have to approve. If, for example, Canadian SOF forces were on the ground and a French fighter was dropping munitions, both of these countries would have to approve. Becca Wasser et al., *The Air War against the Islamic State: The Role of Airpower in Operation Inherent Resolve* (Santa Monica, CA: RAND, 2021), 25–26, 36.

ground forces partnered with Iraqi divisions could now approve and employ CAS rapidly as they advanced. The directive allowed for an increase in the pace of Iraqi clearance operations and prioritized operational tempo and trust in ground commanders over high level target scrutiny.[116] The following year, over 90% of all airstrikes were "dynamic" targets (targets that are not planned in advance, often called in by front line troops in contact with an adversary), enabling the ultimate fall of Mosul and the defeat of ISIS.[117] The delegation of authorities in Iraq changed from a centralized high-level approval to a tactical ground level approval in order to maximize the speed and pace of CAS to ground units.

4. Lessons Learned

These three cases provide two primary factors that influence where authority is held for airstrike approval; collateral damage and operational tempo. When commanders or civilian leaders prioritize a reduction in civilian casualties or collateral destruction, authorities are kept at a higher level. This was evident in the beginning stages of the War in Afghanistan with President Bush wanted to minimize collateral damage and when General McChrystal issued his tactical directive in 2009. When commanders prioritize an increased operational tempo, authorities are often pushed to lower levels. The tactical directive issued in Iraq in 2016 is a perfect example of this. Commanders wanted to support the increased pace in Iraqi clearance operations and pushed the approval of airstrikes to the ground commander who were advising these forces. When commanders try to balance between collateral damage and tempo, authorities can reside at different levels, giving ground commanders limited approval while maintain approval of more robust capabilities at higher levels.

D. CONCLUSION

This chapter provided an analysis of the present air ground integration framework. This framework provides the ground commander with a CAS expert at the tactical edge who is equipped with lethal and nonlethal capabilities. This JTAC is certified through

116 Wasser et al., 122–55.

117 Joseph Martin, *Commander's Perspective: CJFLCC Operations in Iraq*. (Fort Leavenworth, Kansas: Center for Army Lessons Learned, 2017), 4, https://usacac.army.mil/.

formal school attendance, qualified through regular currency and evaluation requirements, and designated by a commander in writing. These JTACs are also equipped with communications and target locational equipment that boosts the JTAC's ability to locate adversary targets, coordinate with supporting aircraft, and approve airstrike attacks. In addition to the JTAC, the Army and Marine Corps have baseline and intermediate training for their frontline troops that enhances air ground integration.

The authorities to conduct CAS have varied drastically based on military and civilian leadership objectives, locations, and timeframes. Authority to approve an airstrike is often held at higher levels to minimize collateral damage or civilian casualties and pushed to a lower level to facilitate faster ground tempo. No matter where the authorities lie, the ground forces uses military voice communications to quickly request approval to the appropriate level. Approval allows the JTAC to use his or her training and capabilities to employ air power at the tactical level in support of the ground commander. By understanding this framework for effective air ground integration on the modern battlefield, we can now turn to the tactical information environment and assess the applicability of these principles to new domains.

IV. APPLYING AIR-GROUND INTEGRATION LESSONS TO THE INFORMATION ENVIRONMENT

The joint force could more effectively conduct tactical operations in the information environment (OIE) by creating an information, cyber, and space equivalent to the JTAC. This "multi-domain terminal effects controller (MDTEC)" would be jointly qualified to understand the information environment and leverage joint information, cyber, space, and electromagnetic fires to create information effects.[118] Just as a JTAC leverages CAS to provide aviation fires, an MDTEC could leverage psychological warfare specialists, cyber operators, or space systems operators to provide nonlethal fires. The MDTEC would alleviate the need to assign mission-critical cyber, space, and information specialties to ground units much like JTACs lessened the need for trained and experienced pilots to serve as ground FACs. This MDTEC would help solve core limitations listed in JP 3-04, *Information in Joint Operations*. These limitations include the lack of available OIE units, limited capabilities and authorities, experience in dealing with a certain problem, and joint integration.[119]

This chapter applies one of the three main forms of innovation, exaptation, to chart a potential path forward for the MDTEC.[120] Scholars including La Porta, Zapperi, Pilotti, Andriani, and Cattani argue that exaptation, traditionally a biology term, can also describe innovation.[121] Exaptation encourages the exploitation of existing traits for new purposes.[122] This chapter is divided into four sections. The first section compares current OIE manpower efforts with the historical JTAC manpower efforts described in Chapter II.

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[118] Traylor and Nass, "From Bombs to Bits." JP 3-09 *Joint Fire Support* defines fires as "the use of weapon systems or other actions to create specific lethal or nonlethal effects on a target" and includes aviation capabilities such as fixed and rotary-wing aircraft, artillery, cyberspace operations, electronic attack, and information-related activates.

[119] Joint Chiefs of Staff, *Information in Joint Operations*, VII–2.

[120] Andriani and Cattani, "Exaptation as Source of Creativity, Innovation, and Diversity," 7.

[121] Caterina AM La Porta, Stefano Zapperi, and Luciano Pilotti, eds., *Understanding Innovation through Exaptation*, The Frontiers Collection (Cham, Switzerland: Springer, 2020), 121; Andriani and Cattani, "Exaptation as Source of Creativity, Innovation, and Diversity."

[122] La Porta, Zapperi, and Pilotti, Understanding Innovation through Exaptation.

The remaining three sections mirror Chapter III, looking at the potential organization, capabilities, and authorities of an MDTEC.

A. COMPARING CURRENT OIE MANPOWER EFFORTS WITH HISTORICAL FAC EFFORTS

Current DOD manpower efforts are focused on building greater information, cyber, and space capabilities while slowly assigning experts down to operational and tactical levels. In 2019, the U.S. Army activated the 915th Cyberspace Warfare Battalion, the first "scalable organic expeditionary capability to meet the Army's current and projected tactical Cyberspace Electromagnetic Activities requirements."[123] While billed as providing "tactical" cyber, in practice the units are assigned at the theater component command (general officer) level.[124] Similarly, the USMC activated the new 17XX occupation specialty in March 2022 for cyber, space, and influence operators with the goal of eventually placing influence officers at the Battalion level and space officers at mid-level commands.[125]

These efforts mirror the evolution of air to ground controllers in two respects. First, efforts are service specific instead of joint. As described in Chapter II, the CAS doctrine and manpower efforts of the Marine Corps, Air Force, and Army all varied from the initial use of CAS in World War I until the release of *JP 3-09.3* in 1995. The Marine Corps was quicker to adopt CAS doctrine and employ it effectively during the Korean and Vietnam Wars while the Air Force and Army disagreed over doctrine.[126] The Air Force was responsible for the training and assignment of ground FACs to the Army and did so in a

123 "Army Cyber Fact Sheet: The 915th Cyberspace Warfare Battalion," U.S. Army Cyber Command, May 15, 2019, https://www.arcyber.army.mil/Info/Fact-Sheets/.

124 Mark Pomerleau, "New U.S. Army Cyber Unit Is Building Concepts for Tactical Cyber Operations," C4ISRNet, December 29, 2021, https://www.c4isrnet.com/cyber/.

125 United States Marine Corps, *Establishment of the Information Maneuver 1700 Occupational Field*, MARADMIN 102/22 (Washington, DC: United States Marine Corps, 2022), https://www.marines.mil/News/Messages/; Audrey Callanan, "17XX: Information Maneuver Occupational Field," in *LATMOVE Solicitation Roadshow* (Washington, DC: USMC, DCI, Information Maneuver Division, 2022), 6,8, https://www.hqmc.marines.mil/.

126 *Small Wars Manual*; Siegel, "The Debate Is Over: Close Air Support in Korea and Vietnam," 2.

lesser quantity than the Marine Corps.[127] Only in 1995 did joint doctrine formalize the conduct of CAS. While strategic joint doctrine for information, cyber, and space exists, how to apply these skills at the tactical level is lacking, leading to each branch developing its own talent management and employment strategies.[128]

Secondly, training experts who are then assigned to tactical units is a lengthy process and takes cyber and space operators away from their primary specialties. The Army and Marine Corps spend between 40 and 45 weeks creating baseline enlisted cyber operators.[129] Marine Corps cyber officers require six months of cyber training on top of basic officer training.[130] Advanced schooling and operational experience can take additional months to years. The Marine Corps sends mid-career officers to places like the Naval Postgraduate School for up to two years to obtain information warfare or space operations degrees before assigning them to advise commanders on OIE employment.[131] Once these service members are trained, retaining them in the military is also a challenge. For fiscal year 2023, enlisted Marine cyber operators with 10–14 years of service were offered the highest reenlistment bonus out of any Marine occupational specialty with the same time in service.[132] When these specialists are assigned as advisors to ground units, they are no longer able to conduct cyber or space operations full time.

This manpower challenge mimics that of assigning pilots as ground FACs between 1950–1970. Chapter II described how taking experienced pilots out of the cockpit and assigning them as employment experts at the tactical edge was not sustainable and led to

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[127] Pocock et al., "A Brief History of Forward Air Controlling," 5.

[128] Joint Chiefs of Staff, *Cyberspace Operations*, JP 3-12 (Washington, DC: Joint Chiefs of Staff, 2018); Joint Chiefs of Staff, *Information Operations*, JP 3-13 (Washington, DC: Joint Chiefs of Staff, 2012); Joint Chiefs of Staff, *Space Operations*, JP 3-14 (Washington, DC: Joint Chiefs of Staff, 2018).

[129] Callanan, "17XX: Information Maneuver Occupational Field," 15; "Cyber Operations Specialist," goarmy.com, April 16, 2020, https://www.goarmy.com/.

[130] Callanan, "17XX: Information Maneuver Occupational Field."

[131] Callanan, 5; "Naval Postgraduate School - Information Warfare - Curriculum 595," accessed August 24, 2022, https://nps.smartcatalogiq.com/; "Naval Postgraduate School - Space Systems Operations - Curriculum 366," accessed August 24, 2022, https://nps.smartcatalogiq.com/.

[132] United States Marine Corps, *Fiscal Year 2023 Selective Retention Bonus Program and FY23 Broken Service SRB Program*, MARADMIN 295/22 (Washington, DC: United States Marine Corps, 2022), https://www.marines.mil/News/Messages/.

the creation of the Air Force ETAC and eventually the JTAC. After a 100-year evolution, the air-ground integration model assigned experts at key staff, planning, and oversight billets while relying on JTACs to serve as the employment experts for ground troops at the forward edge of the battlefield. The creation of the JTAC allowed tactical units to possess an air employment expert while minimizing the number of pilots needed at ground units. Applying the lessons learned from the evolution of air-ground integration to OIE holds considerable potential. A multi-domain terminal effects controller (MDTEC) would serve as an OIE employment expert at the tactical edge, enabling the assignment of fewer cyber operators or information warfare specialists writ large and only to key command, staff, and oversight positions.

B. OIE EMPLOYMENT AT THE TACTICAL LEVEL

1. The Multi-domain Terminal Effects Controller Concept

As the JTAC is the foundation of air-ground integration, the MDTEC would serve as the foundation of the multi-domain employment ecosystem. To imitate the definition of a JTAC from *JP 3-09.3*, the MDTEC could be defined as "a qualified (certified) service member who, from a forward position, directs information, cyber, electromagnetic, and space effects in support of tactical maneuver forces."[133] MDTECs would request effects in one of the five OIE areas described in JP 3-04*:* inform, influence, attack, exploit and protect.[134] The mission-essential tasks for an MDTEC would mimic those of a JTAC: planning, preparation, and execution (see Table 3). These essential tasks would be joint and international as opposed to service- or nation-specific.[135]

[133] Joint Chiefs of Staff, *Joint Close Air Support*, GL-11.

[134] Joint Chiefs of Staff, *Information in Joint Operations*, VII–1.

[135] NATO Standardization Organization, *Joint Terminal Attack Controller Program*, A1–18.

Table 3. MDTEC Tasks and Subtasks[136]

Task 1: MDTEC Planning	
1.1	Advise ground force commander on OIE capabilities, limitations, and employment considerations
1.2	Plan OIE effects to support ground scheme of maneuver
1.3	Request preplanned OIE effect from appropriate agencies
Task 2: MDTEC Preparation	
1.1	Operate organic MDTEC software / hardware
1.2	Prepare and test communication plan with OIE support
Task 3: MDTEC Execution	
1.1	Acquire virtual or physical targets for OIE effects
1.2	Ensure target accuracy and match to desired OIE capability
1.3	Coordinate information, cyberspace, electromagnic spectrum, or space effects
1.4	Integrate OIE effects into ground scheme of maneuver
1.5	Provide battle damage assessment of OIE effects

The MDTEC would imitate the JTAC by being *certified*, *qualified*, and *designated* through a joint process. At the strategic level, something similar to the Joint Fire Support–Executive Steering Committee (JFS-ESC) would be required.[137] The JFS-ESC publishes the certification and qualification standards that all JTACs adhere to. Since OIE effects fall under fire support, publishing the MDTEC training standards could be an added responsibility to the current JFS-ESC charter or the responsibility of an OIE-specific committee.[138] Regardless, MDTECs would be *certified* after attending a certification course. An MDTEC would be *qualified* by conducting currency training and passing regular evaluations. Currency training could include regularly utilizing organic MDTEC equipment or controlling simulated cyber or space effects. Regular evaluations would help ensure proficiency at the joint tasks. Lastly, MDTECs would be *designated* in writing by their commanding officer. A deployed service member stating they are an MDTEC would bring an understood level of competence much like a JTAC.

[136] The JTAC training tasks separate specific environmental or platform essential tasks, such as day or night, fixed wing or rotary wing. MDTEC tasks would likely also go into this detail, discussing specific tasks for cyber, information, electromagnetic spectrum, or space. This thesis focus' on the initial concept of the MDTEC and as such only included high level potential essential tasks.

[137] Joint Chiefs of Staff, Joint Fire Support Executive Steering Committee Governance and Management.

[138] Joint Chiefs of Staff, *Joint Fire Support*, vii.

The requirement for MDTECs to be certified and qualified also produces a secondary benefit of cross-training for information, cyber, and space forces. Much like pilots gain proficiency by conducting regular CAS missions with JTACs, service and national level OIE forces may benefit from regular training exercises with MDTECs. Working together in training builds interoperability and common verbiage that makes integration less complicated in combat. An Army MDTEC could conduct currency training with Navy cyber operators, Space Force guardians, or NATO psychological forces. Current efforts to integrate ground and OIE units are underway, including an August 2022 announcement from Army Space, Cyber, and Special Operations commands to increase interoperability.[139] The MDTEC would create a more formal and joint process to cross-train, ensuring there is mutual confidence between MDTECs and OIE forces.

How services decide to manage MDTECs is less important than the adherence to joint certification and training standards. As Chapter III analyzed, different services have used different talent management models for their JTACs. Services assign some JTACs full-time as part of their specialty, some to a temporary full-time position while in a specific billet, and some as a secondary role in occupations such as SOF. One common thread is that entry-level enlisted service members do not immediately become JTACs. Even in the Army's joint fire support and Air Force tactical air controller party specialties, service members gain experience before becoming JTACs at a higher skill designator.[140]

The management of MDTEC personnel could include designated specialties, part-time billets, and/or secondary roles. The services could look to add MDTEC as an advanced skill designator for high-density specialties such as ground communications or intelligence analysts. Service members could be assigned as full-time MDTECs while in a specific billet before returning to their original specialty. SOF operators could become MDTECs as a secondary specialty. In all cases, further research is warranted on this aspect of the

[139] Jen Judson, "Army Space, Cyber and Special Operations Commands Form 'Triad' to Strike Anywhere, Anytime," *Military Times*, August 11, 2022, https://reader.militarytimes.com/.

[140] Department of the Army, Military Occupational Classification and Structure; HQ AFPC, Air Force Enlisted Classification Directory.

MDTEC and how each service could most effectively man MDTEC billets. Nevertheless, every MDTEC would be jointly certified, qualified, and designated.

2. OIE Intermediate and Baseline Training

Adding baseline training for key specialties and an intermediate "multi-domain observer" could enhance the effectiveness of the MDTEC concept. Multi-domain observers could assist with target identification and target correlation. This targeting information could be passed to an MDTEC for the final effects coordination. Mirroring the JFO and JTAC model, conventional infantry squads and platoons would be manned with a multi-domain observer who works under the supervision of an MDTEC at the Battalion level (see Table 4).[141] For SOF forces, multi-domain observers and MDTECs would be assigned at the team level, providing flexibility to SOF ground commanders regarding how and where they assign their forces. Additionally, multi-domain observers would learn the skills necessary to become successful MDTECs in subsequent tours. Layering the multi-domain observer, MDTEC, and cyber, space, and information experts would give ground commands personnel at every level to conduct OIE.

Table 4. Comparison of Air-Ground Manpower and Potential Multi-domain Manpower[142]

	Conventional Forces			Special Operations Forces		
Air Ground Manpower	**Platoon**	**Battalion**	**Higher HQ**	**Team**	**SOTF**	**Higher HQ**
Joint Fires Observer	X			X		
Joint Terminal Attack Controller		X	X	X	X	X
Air Liason Officer		X	X		X	X
	Conventional Forces			**Special Operations Forces**		
Multi-Domain Manpower	**Platoon**	**Battalion**	**Higher HQ**	**Team**	**SOTF**	**Higher HQ**
Multi-Domain Observer	X			X		
Multi-Domain Terminal Effects Controller		X	X	X	X	X
Information / Psyops Expert		X	X		X	X
Space Expert			X		X	X
Cyber Expert			X		X	X

[141] Wise, 2022 United States Marine Corps Aviation Plan, 202.

[142] Wise, 201–4; Callanan, "17XX: Information Maneuver Occupational Field."

Baseline OIE tasks should also be considered for SOF and infantry personnel. Only one air-ground integration task, direct CAS, is included in most Army and Marine Corps specialties.[143] Filtering information, cyber, electromagnetic, and space capabilities into a single baseline task is a difficult endeavor. While the task assigned for air-ground integration familiarizes ground operators with how to request an effect, an air strike, a single OIE task for requesting an OIE effect may not be as effective. Instead, the baseline task should be to understand how a digital network is built. This baseline task would create an understanding of the three layers of cyberspace: physical network, logical network, and cyber persona.[144] A second related task could be to understand the most common types of cyber-attack such as viruses, phishing, denial of service, and ransomware.[145] By understanding how a network functions and likely attack methods, baseline soldiers and Marines can assist multi-domain observers and MDTEC in conducting OIE. An overarching OIE manpower framework of baseline, intermediate, and advanced OIE employment skillsets would allow front-line troops to integrate OIE effectively at the tactical edge.

C. MDTEC CAPABILITIES

Much like JTACs, MDTECs would also be equipped with specialized gear (hardware and software) to help accomplish their mission-essential tasks. The JTAC is equipped to identify targets, mark targets, and communicate with air assets.[146] Only recently did the services make a more concerted effort to arm the tactical operators with the Switchblade.[147] MDTEC equipment should follow this model, enabling MDTECs to

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[143] Department of the Army, Officer Foundation Standards Manual: Infantry Company-Grade Officers; Commandant of the Marine Corps, Marine Raider Regiment Training and Readiness Manual; Department of the Army, Soldier's Manual and Trainer's Guide: MOS 18.

[144] Joint Chiefs of Staff, *Cyberspace Operations*, I–3.

[145] Small Business Association, "Strengthen Your Cybersecurity," accessed August 31, 2022, https://www.sba.gov/.

[146] Commandant of the Marine Corps, *Tactical Air Control Party Training and Readiness Manual*, NAVMC 3500.42C (Washington, DC: Department of the Navy, 2017), 1–1, https://www.marines.mil/Portals/1/Publications/NAVMC%203500.42C.pdf?ver=2017-04-11-093129-060.

[147] Keller, "Army Orders Switchblade UAV Loitering Munition That Has Achieved Fame in Ukraine as a Smart Mortar Round."

accurately find both physical and digital targets and relay their location to OIE forces who can provide effects. At least initially, effect-producing tools should be limited to those that protect friendly force information, networks, and systems.

Identifying which OIE capabilities an MDTEC needs and which capabilities can be leveraged from external OIE forces is a difficult question and one that could be an independent research question. In 2017, the RAND Corporation recommended four factors when determining if an offensive cyber capability should be at the tactical edge: proximity, frequency, expertise, and containment.[148] This thesis would replace proximity with timeliness and provide the following four criteria:

- Timeliness–Capabilities organically controlled by tactical units provide more timely use. Requests for support to higher echelons have a natural latency. A tool that can provide the ground force with timely access to important information is more likely to reside at lower levels.

- Frequency–An often-used tool will be more beneficial at the tactical level whereas rarely-used tools can be leveraged from higher headquarters.

- Expertise–Tactical OIE tools should be easy to learn and operate. Tools that require an expert will likely reside with higher headquarters.

- Containment–Unlike air strikes, which have a relatively local effect, information effects can be boundless. Tactical OIE tools must ensure use does not collaterally affect non-target populations or other OIE operations.

Not all of the recommended capabilities would be unique to the MDTEC. Much like a JTAC, some of this equipment would also be issued to other units and specialties. Although an MDTEC could use the equipment of the unit(s) they are attached to, having the MDTEC organically own the equipment ensure that it is on hand when needed. Issuing a common suit of technology helps to create a joint uniformity in capability. If every

[148] Isaac Porche et al., *Tactical Cyber: Building a Strategy for Cyber Support to Corps and Below*, Research Report, RR-1600-A (Santa Monica, Calif: RAND Corporation, 2017), 55–58.

MDTEC has different organically owned capabilities, then each MDTEC provides a different skillset. As an example, natural language processing (NLP) tools may be available to most if not all tactical ground troops in the future. Despite this, an MDTEC should also be issued NLP tools so that if or when an MDTEC needs this tool, they are familiar with the specific version and able to employ it. Another example is social media analytics, a tool that might be operated at the tactical level by MDTECs and at the operational or strategic level by intelligence analysts or cyber experts. While each level may the same tool, each will likely be using it for a different set of targets or command objectives.

Table 5 presents a list of potential MDTEC capabilities. Each capability is described in greater detail in Appendix A. Some of these capabilities already exist in the military while some are emerging technology and are still in the research and developmental phase. All of these tools provide a timely outcome to the ground commander, either to produce information or deliver a much-needed defensive effect while minimizing any collateral effect to other OIE operations. None of the tools require extensive expertise to operate. This equipment would enable the MDTEC to locate targets, deliver accurate targeting information to external OIE entities, and provide a limited ability to produce OIE effects to protect friendly forces.

Table 5. List of Potential MDTEC-Specific Capabilities

MDTEC Specific Capabilities	
Non-Effect Producing	**Effect Producing**
Sentiment Analysis	Counter UAS
Social Media Analytics	Localized Electromagnetic Jamming
Commercial Space Imagery	
Natural Language Processing for Exploitation	
Signature Management Tools	
Direction Finding Equipment	

The following two vignettes help illustrate how an MDTEC might be employed and how the proposed capabilities would be used by an MDTEC. Vignette #1 depicts a SOF MDTEC outside of armed conflict while Vignette #2 depicts a conventional MDTEC in conflict.

D. VIGNETTE #1: MDTEC ENABLES SOF RELATIONSHIP BUILDING OUTSIDE OF ARMED CONFLICT

Captain Michaels, an Army Special Forces team commander, had been deployed to Southeast Asia for two weeks and was eager to get to work. "Work" was different here than in other areas, with the team having the mission to train the host nation forces, gather information on near-peer activities, and conduct information operations to support strategic objectives. His Operational Detachment Alpha (ODA) was the first to deploy with an MDTEC, Sergeant First Class Newman. As an MDTEC, Newman brought a level of information expertise and capability that Michaels did not have on his last rotation.

Michaels and Newman discussed how to best use an MDTEC. The two agreed that a first step could be to identify who the local influencers were in the area. To do this, Newman used his social media and sentiment analysis tools to identify locals who had a large number of followers, whose opinions were often shared by military and governmental leaders, and who had a positive view of U.S. and host nation activities. Newman's tools identified a previously unknown 30-year-old male, Christian De La Cruz, who lived in a local village and had thousands of followers on social media, including many military and government leaders. "This is great," thought Michaels, "we should plan a key leader engagement with the ODA, host nation forces, and De La Cruz."

Since the team had never been to this village before, Newman searched for and requested updated space imagery for the intended route and village. The team used this imagery to plan a more accurate route and avoid construction areas along what would have been their preferred route. Newman also preplanned social media analytics along the route to alert the team if any social media posts containing the words "America," "American," or "military vehicles" were found after they departed. This information would alert Captain Michaels that their team had been spotted along the way.

On mission day, the movement to the village went as planned. At the key leader engagement, De La Cruz gave Capt Michaels a sheet of paper with the names and locations of suspected terrorists operating on the outskirts of the village. Using his exploitation software, Newman took a picture and immediately translated it. "Wow," thought Michaels,

"I am not used to this type of rapid exploitation." Michaels used the information to ask follow on questions and gather more detailed information about the terrorists.

The team returned home successfully, and Capt Michaels was happy that De La Cruz was a new friend who could help influence the local population. Capt Michaels asked Newman to coordinate with higher headquarters' psychological warfare specialists to distribute propaganda about the successful meeting and help provide recommendations to De La Cruz. With the help of media experts, De La Cruz could become even more skilled and help spread positive messaging even further.

Capt Michaels was grateful that he had an MDTEC for this deployment. While he could have requested some of the same capabilities from his higher headquarters on a previous deployment, it would not nearly have been as responsive as Newman had been. Having someone with him who could advise him on information activities, request higher headquarters' support, and operate organically owned information capabilities would go a long way towards mission success on this deployment, thought Michaels.

E. VIGNETTE #2: CONVENTIONAL FORCES EMPLOY AN MDTEC IN CONFLICT

Sergeant Jones sat anxiously in the back seat of his armored vehicle, waiting for the mission to start. Jones, the company's MDTEC, had helped to plan this operation for weeks. His infantry company was the main effort for the attack on the enemy-held village. Jones hoped all his training and planning would pay off as this would no doubt be his first time in combat. Much of his focus had been on how to keep the mission a secret and manage the company's physical and electronic signature. There had been no communications checks that morning, and all they were waiting on was the one-word brevity code from the Battalion to advance. His planning seemed to be paying off, he thought, as he monitored local social media for any signs of compromise.

Just then he overheard the word "speakeasy" on the radio and his vehicle moved forward. He could see the other vehicles around him doing the same. Jones continued to monitor social media while also getting ready for his next job, jamming the enemy's communications. Jones had planned and coordinated the next move with his higher

headquarters and U.S. Cyber Command. At precisely 0450, Cyber Command would conduct an offensive cyber-attack, shutting down the power to the adversary's facilities. This would hopefully prevent their radar systems from functioning and detecting Jones' company. At the same time, Jones would turn on his jamming equipment, jamming enemy military communications and cell phones. While turning his jamming equipment on would give away their position, it would also prevent the adversary sentries from communicating with their higher headquarters.

By 0530, things were going better than expected. Most of the enemy had retreated after being surprised and overwhelmed by the ground forces. Jones' anxiety had decreased, and he was starting to become accustomed to the occasional snap of incoming bullets. Just then his computer buzzed; a social media post with the keyword "drone" had been detected. Jones alerted the company commander, who used a brevity word to relay the information to the adjacent forces. Ten minutes later, the gunner on Jones' vehicle spotted the drone. Jones quickly got his counter unmanned aerial system (CUAS) up and running and downed the drone quickly. "Whew!" thought Jones, "I'm glad I knew it was coming! Now let's try to find where it originated." Jones documented the time and location of the drone and sent a request for space-based signals intelligence support. "Hopefully they can help us locate where the UAS originated from," Jones said to his commander, "that way we can target them before they launch another one."

The operation continued as planned until 1015. Over the radio, Jones heard that an artillery round had missed the mark and impacted near a school. There did not appear to be any casualties, and a platoon was dispatched to the area. Jones and his commander discussed what information operations could be used to help the situation. "The enemy could use this against us," Jones said, "we should try to inform the public before they do." Jones' commander agreed. Jones quickly used his secure communications to request information effects from higher headquarters. After the platoon arrived and verified that there were no casualties, Jones relayed pictures to his higher headquarters to include in their message. "Wow," Jones thought, "it's not even noon and I've already coordinated information, cyber, and space!"

F. MDTEC AUTHORITIES

MDTECs would receive approval to conduct OIE from a commander who has been delegated information, cyber, or space authorities. Similar to air strike authority, OIE authorities are derived from different domestic and international legal and policy documents.[149] As an example, declassified documents describing the first acknowledged U.S. cyber offensive, Operation GLOWING SYMPHONY in 2018, reference a top-secret execute order as the authority for execution.[150] Like air strike authorities, OIE authorities can be delegated down to lower levels to support tactical operations.

While similarities exist between air and OIE authorities, OIE presents a unique set of legal challenges that have largely kept authorities at the highest levels. For one, OIE effects can be difficult to limit to one specific target. Electromagnetic jamming can influence a wide range of civilians located near the target. A virus or worm can inadvertently spread from one computer to another. Even more so, adversaries can learn from the techniques of our cyber-attacks and use those same skills against others.[151] A second difference is that while airstrikes are primarily conducted in a declared theater of armed conflict, OIE is frequently used in both peacetime and war. OIE often requires coordination with external entities including the State Department or Central Intelligence Agency. Coordinating and approving OIE in peacetime can be especially challenging.[152]

Despite these differences, OIE authorities at the tactical edge could be effective if they were structured in a similar nature to air strike authorities. JTACs can use their organic equipment without any additional approval authority. In the same manner, MDTECs should be able to utilize their organic capabilities, such as the capabilities proposed in Table 3, without needing additional approval. When requesting effects, keeping OIE authorities at a higher level would allow for more target scrutiny and the prevention of collateral

149 Joint Chiefs of Staff, *Information in Joint Operations*, Chapter III.

150 Heidi Brown, *Authorization to Conduct Operation GLOWING SYMPHONY*, FRAGORD 06 to USSTRATCOM OPORD 8000–17 (Washington, DC: National Security Archive, 2018), https://nsarchive.gwu.edu/.

151 Nicole Perlroth, This Is How They Tell Me the World Ends: The Cyberweapons Arms Race (New York: Bloomsbury Publishing, 2021).

152 Joint Chiefs of Staff, Information in Joint Operations, xi.

damage. This type of approval process would be more appropriate during peacetime when there are additional legal considerations. Pushing OIE authorities to the lowest level would be more effective in conflict to increase the operational tempo. If authorities during conflict are kept at the highest levels, some targets will not be actioned much like U.S. forces missed their chance to target Mullah Omar in Afghanistan.[153]

The authority to approve OIE effects could also vary by capability much like the air strike approval process in Afghanistan between 2009–2012. Using the "containment" criteria as a guide, OIE tools that are easy to contain could be pushed to the tactical level while tools that are difficult to contain are approved at higher levels. Tactical commanders could approve the release of an influence message or the conduct of a limited cyber-attack against a single target. Higher-level commanders could maintain approval of more widespread electronic warfare or cyber-attack capabilities. Regardless of where these authorities lie, MDTECs could use their organic capabilities to identify targets and request the appropriate effects. The only difference is who can ultimately approve of that effect and how long it might take to do so.

G. CONCLUSION

Creating an MDTEC modeled after the JTAC would enable tactical forces to more effectively conduct OIE. These MDTECs would serve as the OIE employment experts at the tactical edge of the battlefield by advising ground commanders, planning information effects, operating organic information capabilities, and requesting effects from operational and national-level OIE forces. Modeling the certified, qualified, and designated aspects of the JTAC program would create MDTECs that are standardized across the joint force and NATO, permitting a level of confidence and interoperability between MDTECs and OIE forces.

Equipping MDTECs with organic information capabilities would allow the ground force to identify information targets, communicate accurate location information, and conduct limited OIE effects. The purpose of this equipment would be to provide a timely

[153] Ricks, "Target Approval Delays Cost Air Force Key Hits," 109.

and frequent capability to the ground commander that does not require an expert to operate. Special consideration should be given to the ability of the tool to be contained within the target area. Recommended MDTEC equipment includes software such as sentiment and social media analysis and hardware such as counter UAS and direction-finding equipment. This equipment would enable MDTECs to accurately find both physical and digital targets and relay their location to OIE forces who can provide effects.

While OIE presents a unique set of challenges, tactical approval of OIE could also be modeled after air-ground integration. MDTECs should be able to operate their organic tools at any time without approval. Maintaining authorities at higher levels would allow more time for coordination and target scrutiny while pushing authorities to lower levels could enable a faster operational tempo. The approval to employ OIE could also reside at different levels, allowing ground commanders to approve of some effects while maintaining authority for more complex or advanced effects at higher levels. Nonetheless, the MDTEC would be trained and equipped to identify adversary informational targets and conduct OIE with approval from a commander at the appropriate level.

V. CONCLUSION AND POSSIBLE FUTURE RESEARCH AREAS

The rapid growth in the internet over the past 25 years has created a new battlefield and propelled information to a leading topic in national security. As a result, the United States is no longer convinced that it will maintain information dominance on the future battlefield. New operational concepts across the DOD have highlighted the need to synchronize ground forces operating at the tactical edge with information, cyber, and space capabilities.[154] Current efforts by the DOD to expand OIE forces focus at the strategic or operational level. A gap exists for how to integrate and conduct OIE at the tactical edge.

This thesis identifies a potential solution to this gap by analyzing and applying lessons learned from a different military field: air-ground integration. Air-ground integration evolved from strategic reconnaissance in World War I to modern attack helicopters, hand-launched killer drones, and tactical joint terminal attack controllers (JTACs). JTACs provide the ground commander with an air-ground integration expert at the tactical edge, equipped with lethal and nonlethal capabilities, who falls under authorities that vary by location and type of operation. Both SOF and conventional forces rely on the JTAC to provide timely and accurate air strikes. The creation of the JTAC allowed tactical units to possess an air employment expert while minimizing the number of pilots needed at ground units. This thesis focused on four key characteristics of the JTAC program:

- The JTAC qualification is recognized across the joint force and NATO.[155]
- JTACs and CAS aircraft regularly train together to maintain currency.[156]

[154] Headquarters, United States Marine Corps, *Tentative Manual for Expeditionary Advanced Base Operations*; USSOCOM, "Science and Technology Directorate Focus Areas."

[155] NATO Standardization Organization, Joint Terminal Attack Controller Program.

[156] Russell, Close Air Support: Actions Needed to Enhance Friendly Force Tracking Capabilities and Fully Evaluate Training, 56–60.

- JTACs are specially equipped with equipment for target locating, marking, and communication.[157]

- The authority level to approve airstrikes has varied. Commanders balance between collateral damage and operational tempo.

This thesis finds that creating an MDTEC modeled after the JTAC would enable tactical forces to more effectively conduct OIE. MDTECs would serve as the OIE employment experts at the tactical edge by advising ground forces, employing information tools, and leveraging operational and strategic level information, cyber, and space forces. An MDTEC would fill the need for tactical OIE experts while minimizing the number of information, cyber, and space experts needed at ground units.

As with JTACs, creating MDTECs that are jointly certified, qualified, and designated would increase confidence and interoperability between MDTECs and OIE forces by creating regular currency requirements. Equipping MDTECs with information tools would enable them to accurately locate and transmit adversary information targets to supporting OIE forces who can provide effects. MDTECs should be able to operate this equipment at any time without approval. Maintaining OIE authorities at higher levels would allow more time for coordination and target scrutiny while pushing authorities to lower levels that could enable a faster operational tempo. Additionally, authority to conduct some OIE effects could reside at lower levels while maintaining authority of more complex or advanced effects at higher levels. Nonetheless, the MDTEC would be trained and equipped to identify adversary informational targets and conduct OIE with approval from a commander at the appropriate level.

While the case to create an MDTEC is compelling, no analogy is perfect and there is much further research needed to propel this concept to adoption. For one, close air support is allocated to a ground force by location and time.[158] This is not the same with information, cyber, and space forces that have global reach and whose affects can be

[157] Commandant of the Marine Corps, Marine Corps Tactical Air Control Party (TACP) Program, 1–1.

[158] Joint Chiefs of Staff, *Joint Close Air Support*, Chapter III.

boundless. Secondly, JTACs specialize in one specific field, CAS, while the MDTEC would have to specialize in many different fields. Research is needed into what baseline and advanced skills an MDTEC would have, what would be included in the MDTEC initial certification course, and what qualification and currency standards would need to be maintained. While research is also needed into which military specialties could become MDTECs, this thesis has presented that the joint nature of the qualification is more important than the service specific manpower systems.

While the JTAC is a staple of modern tactical combat power, it took 100 years from the Wright Brothers' first flight to create this essential capability: to effectively and consistently apply airpower to the tactical edge. Military leaders across the joint force, international partners, civilian DOD leadership, and the academic community all understand the role of the JTAC. The MDTEC model presented in this thesis is an opportunity to learn from the past and employ the lessons of air-ground integration today, creating a tactical information capability that would help ensure the United States maintains information dominance in the future.

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APPENDIX. DESCRIPTION OF MDTEC CAPABILITIES

This Appendix provides more detail on each of the multi-domain terminal attack controller (MDTEC) capabilities offered in Chapter IV.

A. DIRECTION FINDING EQUIPMENT

Direction-finding equipment has long been used by the military in the signals intelligence (SIGINT) field. As high-end SIGINT technology increases, assigning baseline direction-finding equipment to the MDTEC would allow for both a tactical SIGINT capability and tether to higher-end SIGINT support. Examples of these systems include the Wolfhound and Mongoose ground systems or the Silent Echo UAS system.[159] These systems would allow an MDTEC to detect adversary military or push-to-talk communications. While this type of capability meets the needs for timeliness, frequency, and containment, it would require the MDTEC to have a higher level of expertise than other equipment.

B. SIGNATURE MANAGEMENT TOOLS

Friendly force signature management would be an important role for the MDTEC to protect friendly force information, networks, and systems. MDTECs should be trained on how to manage signatures both physically and technically as well as likely avenues for enemy exploitation. The Russo-Ukraine crisis has provided ample case studies including how Russian forces are targeting Ukrainian cell phones on the front lines.[160] Signature management can be done through non-tool-based techniques such as brevity, lower power, directional antennas, and terrain masking.[161] MDTECs could also be given signature

[159] "Products," Praemittias Systems, LLC, accessed September 1, 2022, https://www.praemittias-systems.com/products/; David Breede, "Special Reconnaissance, Surveillance, and Exploitation" (Special Operations Forces Industry Conference, Tampa Bay, FL, 2017), 52, https://ndiastorage.blob.core.usgovcloudapi.net/ndia/2017/sofic/May17Breede.pdf.

[160] Kieran Devine, "Ukraine War: Mobile Networks Being Weaponized to Target Troops on Both Sides of Conflict," Sky News, April 1, 2022, https://news.sky.com/.

[161] Luke Klena, "Technical Signature Management for Small Units," *Marine Corps Gazette* 105, no. 5 (May 2021): 32–34.

management tools such as the Navy Research Laboratory's Interactive Scenario Builder, which could be used in planning to assess likely radio frequency footprint.[162]

C. COMMERCIAL SPACE IMAGERY

Training MDTECs on how to access and request commercial space imagery would provide the ground forces with the capability to obtain up-to-date imagery that can be shared with partners and allies. In 2022, the National Reconnaissance Office signed a decades-long contract with commercial space entities to provide overhead imaging.[163] This expansion into the commercial sector has the potential to "shatter the paradigms" in national security, allowing low-density government space assets to focus on strategic targets while commercial space supports tactical-level imaging.[164] The unclassified nature of commercial imaging is especially important for MDTECs working by, with, or through partner nation forces. Training MDTECs on how to access this imagery through systems like the National Geospatial Intelligence Agency's (NGA) G-EGD system as well as how to request new imagery would provide a tactical space capability to the ground commander.[165]

D. TACTICAL COUNTER UAS (CUAS)

The proliferation of small UAS across commercial, governmental, and non-state actors has driven a need for tactical CUAS technology at the tactical level. This proliferation has also increased the need for trained air defense personnel at all levels. While air-defense specialists will continue to operate niche, high end air defense systems, a ground level air defense operator will be needed for the smallest tactical units. The MDTEC could serve as this primary employment expert. In 2017, ISIS modified

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162 "Interactive Scenario Builder," Navy Research Laboratories, accessed September 1, 2022, https://builder.nrl.navy.mil/login.

163 National Reconnaissance Office, *NRO Announces Largest Award of Commercial Imagery Contracts*, 05–22 (Chantilly, Virginia: National Reconnaissance Office, 2022), https://www.nro.gov/.

164 Todd Harrison and Matthew Strohmeyer, "Commercial Space Remote Sensing and Its Role in National Security," *Center for Strategic and International Studies*, n.d., 3–4.

165 National Geospatial-Intelligence Agency, *NGA's Primary Commercial Imagery Delivery System Now Includes Small Satellites*, 20–704 (Springfield, VA: National Geospatial-Intelligence Agency, 2020), https://www.nga.mil/news/.

commercial drones to drop grenades on Iraqi and coalition troops with deadly effects.[166] In the more conventional military setting of the Russo-Ukraine conflict, Ukraine is using crowd-sourcing to field drones across the battlefield.[167] CUAS technology is rapidly expanding, with the DOD spending eight times more money on CUAS research and development in 2023 than on acquisition.[168] CUAS technology is exceptionally timely and needs to be at the tactical level to provide the quickest support. MDTECs could take on the role of employment expert for these potentially complicated systems.

E. LOCALIZED ELECTROMAGNETIC JAMMING

MDTECs could also be equipped with electromagnetic jamming equipment to jam adversary communications signals in various wavelengths for a limited time. This capability could prevent an adversary from contacting reinforcements, accessing a wireless network, or activating a remote system. Tactical units used this type of equipment in both Operation Iraqi Freedom and Operation Enduring Freedom, jamming enemy cell phones used to initiate remote-controlled improvised explosive devices.[169] While airborne electronic warfare assets can also provide this capability, future air superiority is no longer a given and a ground system could provide a similar capability. Electromagnetic jamming is locally contained, does not require an expert to operate, and needs to be closely coordinated with ground maneuver.

F. NEAR REAL-TIME SOCIAL MEDIA ANALYTICS

Near real-time social media analytics is a particularly timely and frequent capability for the MDTEC. This capability could allow the MDTEC to geofence a particular area and receive live notifications if keywords are identified. For example, U.S. forces with an

166 Dan Rassler, *The Islamic State and Drones: Supply, Scale, and Future Threats* (West Point, NY: Combating Terrorism Center, 2018), 1–3.

167 Inder Bisht, "Ukraine Seeks to Crowdsource 'Thousands of Drones' for Battlefield," *The Defense Post*, August 31, 2022, https://www.thedefensepost.com/2022/08/31/ukraine-drone-project-expansion/.

168 John R Hoehn and Kelley M Sayler, *Department of Defense Counter-Unmanned Aircraft Systems*, CRS Report #IF11426 (Washington, DC: Congressional Research Service, 2022), https://sgp.fas.org/crs/weapons/IF11426.pdf.

169 Michael Schwille et al., *Handbook for Tactical Operations in the Information Environment* (Santa Monica, CA: RAND Corporation, 2021), 57–58.

MDTEC who are conducting a helicopter-borne operation could be alerted if social media accounts posts are identified with keywords such as "America," "helicopter," or "raid." If one of these keywords is identified in social media, it might prompt the ground force to alter their insert or extract locations. Real-time tracking of social media has been used extensively by both military and civilian organizations to track Russian movements in Ukraine.[170] Much like sentiment analysis, this type of tool is contained, timely, used frequently, and would not require an expert to operate.

G. EXPLOITATION SOFTWARE

Equipping MDTECs with natural language processing (NLP) software at the point of gathering or exploitation could allow for quick analysis and identification of further targets. Exploit is one of the primary OIE actions, and often the language barrier at the point of collection is the first difficulty.[171] With NLP, an MDTEC could quickly translate a document during a key leader engagement or translate captured enemy material on-site to allow for follow on targeting. The rapid exploitation of captured media was the number one use case for tactical cyber in RAND's 2017 assessment.[172] The timeliness of this capability is the most important factor in its use by an MDTEC, as its use would be less frequent than other capabilities. The expertise needed to use this type of software would be low, and it does not impact other OIE capabilities.

H. SENTIMENT ANALYSIS

MDTECs could use sentiment analysis to identify positive or negative reactions to U.S., partner, or adversary actions or to identify influential locals. Sentiment analysis can be used to understand the public's opinion on a specific individual, event, or political movement.[173] For frontline troops, sentiment analysis would be combined with other

170 "Ukraine Interactive Map - Ukraine Latest News on Live Map," liveuamap.com, accessed September 1, 2022, https://liveuamap.com/; Glen Owen, "British Spies Use Grindr to Track Vladimir Putin's Soldiers," Daily Mail Online, March 6, 2022, https://www.dailymail.co.uk/.

171 Joint Chiefs of Staff, *Information in Joint Operations*, VII–1.

172 Porche et al., *Tactical Cyber*, 2017, 6.

173 Lin Yue et al., "A Survey of Sentiment Analysis in Social Media," *Knowledge and Information Systems* 60, no. 2 (August 2019): 617–63, https://doi.org/10.1007/s10115-018-1236-4.

perception gathering methods such as conducting key leader engagements, leveraging partner nation forces, and conducting human intelligence operations. While sentiment analysis is still an emerging technology, it is one technology that USSOCOM is investing in to understand the environment to conduct inform or influence operations.[174] Sentiment analysis is a timely technology, could be used frequently, and is contained. While the underlying science behind sentiment analysis can be complex, the right tool could be easy to use and operate. The maturation of sentiment analysis technology and the ever-expanding information environment make this a likely technology for MDTECs in the future.

[174] Patrick Tucker, "Special Operators Want AI to Help Discern Public Opinion," Defense One, May 20, 2022, https://www.defenseone.com/technology/2022/05/special-operators-want-ai-help-discern-public-opinion/367105/.

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