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EXECUTIVE SUMMARY

Title: Air-to-Ground Fratricide Reduction Technology: An Analysis

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Thesis: The family of air-to-ground fratricide reduction systems likely to be fielded in the next decade will be most effective when a joint terminal attack controller (JTAC) identifies targets for attack; the systems will be less effective in reducing fratricide in situations where aircraft must independently identify their targets.

Discussion: The Department of Defense (DoD) failed to make significant improvements in its air-to-ground target identification and situational awareness (SA) capabilities after Operation DESERT STORM. Consequently, U.S.-led coalition forces suffered unnecessary, self-inflicted losses when they went to war in 2001 and 2003 with essentially the same ineffective air-to-ground fratricide reduction technology that was available in 1991. The DoD and several multinational partners are evaluating Radio Frequency Tags and Radio-Based Combat Identification systems for air-to-ground fratricide reduction. Additionally, other DoD programs have significant potential for reducing air-to-ground fratricide as they pursue broader goals of combining SA systems and integrating disparate tactical datalinks. As currently envisioned, the emerging fratricide reduction systems will primarily address JTACs' target identification and SA shortfalls, while providing only a moderate overall improvement in aircraft capabilities.

Conclusion: The DoD must follow through on its fielding plans if it is to succeed in reducing the probability of air-to-ground fratricide. The fratricide trend of the last three wars cannot be reduced with rules of engagement and tactics, techniques, and procedures alone. Equally mature, interoperable, and ubiquitous air-to-ground fratricide reduction systems are required to save friendly lives on future battlefields. The appropriate technology is available and long overdue.

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CHAPTER 1

INTRODUCTION

That was my second time being strafed by an A-10. [In the] first Gulf War, I was strafed. . . . I never thought it would happen again.

--1st Lt Michael Seelye, Charlie Company, 1st Battalion, 2nd Marines

On 23 March 2003, the Forward Air Controller (FAC) for Team Mech, 1st Battalion, 2nd Marine Regiment, directed two A-10 fighter aircraft to attack enemy positions during the battle for An Nasiriyah. Tragically, the FAC was unaware that Charlie Company had advanced in front of Team Mech in the chaos of the urban battle, and he tasked the A-10s to attack these Marines, who were already engaged in a firefight with the enemy. The A-10s did not subsequently identify Charlie Company's Assault Amphibian Vehicles (AAVs) as friendly, and the aircraft attacked the Marines with bombs, guns, and missiles over a 15-minute period.[1] The A-10 attacks killed up to 10 Marines, making the An Nasiriyah incident the single largest U.S. loss to fratricide in Operation IRAQI FREEDOM (OIF).[2]

The An Nasiriyah incident demonstrates the nature of air-to-ground fratricide and the consequences of failing to reduce the probability of fratricide in the future. While every incident is the result of a unique chain of unforeseen events, the root causes of air-to-ground fratricide are

[1]U.S. Central Command (USCENTCOM), *Investigation of Suspected Friendly Fire Incident Near An Nasiriyah, Iraq, 23 March 03* (MacDill AFB, FL: March 2004), Tab L, "Expanded Narrative," L-3 – L-7 [File: Investigation_section 7.pdf, pages 74 – 78], URL: http://www.centcom.mil/CENTCOMNews/Investigation Reports/Default.asp, accessed 8 September 2004.

[2]Many of the Marines in this incident were struck by both enemy and friendly fire. Eight Marines were killed by enemy fire; the investigation board was unable to determine the exact sequence and source of fires that killed the other 10 Marines. USCENTCOM, *An Nasiriyah Investigation*, "Unclassified Executive Summary," 2. [File: Investigation_section 1.pdf, page 4].

well known. According to Joint Publication 3-09.3, *Joint Tactics, Techniques, and Procedures for Close Air Support (CAS)*, "fratricide has usually been the result of confusion on the battlefield. Causes include misidentification of targets, inaccurate target locations or descriptions, target locations incorrectly transmitted or received, and loss of situational awareness."[3] Failures in target identification and situational awareness (SA) were causal factors in the vast majority of air-to-ground fratricide incidents, including those from Operation DESERT STORM, Operation ENDURING FREEDOM (OEF), and OIF.

The persistent air-to-ground fratricide trend of the last three wars can largely be attributed to the failure of the Department of Defense (DoD) to develop and field effective fratricide reduction technology. After DESERT STORM revealed numerous deficiencies in U.S. target identification and SA capabilities, the Pentagon pursued a variety of technical solutions to the fratricide problem. Over the following decade, the DoD made moderate enhancements to its SA systems, but fielded no major technology to improve target identification capabilities. Consequently, U.S.-led coalition forces went to war in OEF and OIF with essentially the same ineffective fratricide reduction technology that was available in 1991.[4]

Current target identification systems are rudimentary and have proved largely ineffective at combating air-to-ground fratricide. Vehicle identification panels are among the most common target identification devices, but they are often ineffective at the ranges required to prevent fratricide.[5] Infrared (IR) strobe lights are a more effective target identification system, as they

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

[4]Jonathan Weisman, "Accident Reminds Some of 1991 War; U.S. Vowed Then to Reduce Friendly Fire," *Washington Post*, 7 April 2003, A18, URL: https://web.lexis-nexis.com, accessed 28 July 2004.

[5]U.S. Joint Forces Command, J85 Combat Identification, *Concept of Operations for Air-to-Ground and Ground-to-Ground Coalition Combat Identification Advanced Technology Concept Technology Demonstration Version 2.5* (Norfolk, VA: 25 October 2004), 42, URL: www.ccidactd.com, accessed 22 November 2004.

are generally visible to aircrews equipped with night vision devices. However, like vehicle identification panels, IR strobes rely on clear weather to function effectively.

Similarly, current SA systems are not ideal for reducing air-to-ground fratricide. During OIF, coalition ground forces used up to nine different blue force tracker (BFT) systems to monitor friendly vehicle locations on computerized map displays. However, not all vehicles had BFT equipment, the network was too slow to accurately represent the locations of moving vehicles, and the resulting displays of friendly force locations were not available at all echelons.[6] Although the DoD has made some progress in making BFT available to FACs and some aircraft, this capability is far from ubiquitous.

Some other systems, including the Situational Awareness Datalink (SADL), numerous digital CAS systems, and high-resolution aircraft targeting pods provide additional target identification and SA capabilities with the potential to reduce air-to-ground fratricide.[7] However, these systems are thinly fielded, niche capabilities that do not constitute a comprehensive, interoperable approach to reducing air-to-ground fratricide.

U.S. Joint Forces Command (USJFCOM) is working with allied nations to develop such a comprehensive approach. USJFCOM is leading the Coalition Combat Identification (CCID) Advanced Concept Technology Demonstration (ACTD) effort to "demonstrate and assess both current and emerging Combat Identification solutions and associated Tactics, Techniques and Procedures (TTPs)."[8] The CCID ACTD views combat identification (CID) as a capability that

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[6]George Cahlink, "Better 'Blue Force' Tracking," *Air Force Magazine*, June 2004, URL: www.afa.org/magazine/june2004/0604blue.html, accessed 29 July 2004.

[7]USJFCOM, *CCID ACTD CONOPS*, 62-70.

[8] Steven Vasica, "An Overview of the CCID ACTD," *Combat Identification Bulletin*, January 2004, 4, URL: www.ccidactd.com, accessed October 2004. The nations participating in the CCID ACTD include Great Britain, Canada, Australia, New Zealand, Germany, France, Italy, Denmark and Sweden.

combines doctrine, TTPs, rules of engagement (ROE), and a family of SA and target identification systems.[9]

In addition to the current systems described above, the CCID ACTD is evaluating several cooperative target identification technologies. None of these emerging concepts provide a non-cooperative target recognition (NCTR) capability—one that would identify friendly or enemy vehicles that had not been modified to "cooperate" with the identification system.[10] Much like aircraft identification, friend or foe (IFF) systems, the CCID ACTD concepts only classify a target as “friendly” or “unknown.” Consequently, operators would still have to rely on existing fire control systems, TTPs, and ROE to classify a target as hostile. Even without providing any additional NCTR capability, however, the CCID ACTD systems have the potential to reduce the probability of fratricide simply by providing additional opportunities to identify friendly forces.

The CCID ACTD is evaluating the utility of Radio Frequency (RF) Tags and Radio Based Combat Identification (RBCI) concepts in reducing air-to-ground fratricide. RF Tags would enable most aircraft radars to directly identify properly equipped friendly vehicles by stimulating and displaying a coded response from the RF Tags. RBCI would enable helicopter- or ground-based interrogators to query Single-Channel Ground and Airborne Radio System (SINCGARS) equipment and establish the position of friendly units.[11] The CCID ACTD is evaluating these developmental systems, as well as ground-to-ground equipment like the Battlefield Target Identification Device (BTID), in a series of tests culminating in a Military Utility Assessment in late 2005.[12]

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[9]USJFCOM, *CCID ACTD CONOPS*, 2-3.

[10]USJFCOM, *CCID ACTD CONOPS*, 3 and 201.

[11]USJFCOM, *CCID ACTD CONOPS*, 56-57 and 71-72.

[12]Vasica, 4.

Given the experimental status of the CCID concepts and the large number of aircraft that would require modification, the best prospects for reducing air-to-ground fratricide in the near term lie with improving the CID and communications capabilities of FACs and other Joint Terminal Attack Controllers (JTACs).[13] Enhancing the JTACs' ability to maintain SA, identify targets, and digitally transmit instructions to attack aircraft would significantly reduce the friction inherent in contemporary CAS voice communications that can lead to fratricide. Such an emphasis would address many situations that lead to air-to-ground fratricide, but a more comprehensive effort would be required to reduce fratricide in scenarios where aircraft must independently identify their targets.

While fratricide reduction requires a holistic approach combining all elements of CID, recent history demonstrates that mature doctrine, TTPs, and ROE cannot reduce the probability of fratricide below its present level without equally mature technology. However, the DoD will only succeed in this effort if it fields a family of effective, interoperable, and ubiquitous fratricide reduction systems. As currently envisioned, the family of systems likely to be fielded in the next decade will be most effective at reducing the probability of fratricide when a JTAC identifies targets for attack; the systems will be less effective in reducing fratricide in situations where aircraft must independently identify their targets.

[13]Joint Pub 3-09.3 introduced the term "JTAC" and defines it 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." (JCS, Joint Pub 3-09.3, GL-12) This paper will follow the Joint Pub's style and refer to personnel controlling CAS generically as JTACs, while using other terms, like FAC, when they are most descriptive.

CHAPTER 2

THE NATURE OF AIR-TO-GROUND FRATRICIDE

The nature of air-to-ground fratricide has not changed substantially since the genesis of air combat: these tragedies usually result from a loss of SA and/or errors in target identification.[14] In order to assess the effectiveness of the future family of fratricide reduction systems, it is important to first examine modern air-to-ground fratricide incidents to understand their causes in more detail. A cross-section of DESERT STORM, OEF, and OIF incidents provides insight into the situations that fratricide reduction technology is intended to prevent.

AIR-TO-GROUND FRATRICIDE IN OPERATION DESERT STORM

DESERT STORM was a watershed event in the public and military view of fratricide. The DoD was hard-pressed to explain why 17% of U.S. military casualties were the result of fratricide, despite the sober reality that this statistic is generally consistent with historical norms.[15] Air-to-ground incidents were less numerous than ground-to-ground fratricide events, but were still a significant concern during the war and in its aftermath (see Table 1). Air-to-ground fratricide caused by anti-radiation missiles are listed Table 1, but will not be further

[14]JCS, Joint Pub 3-09.3, I-4; Enrique Cruz, *Fratricide in Air-Land Operations*, Master's Thesis, Naval Postgraduate School (Monterey, CA: December 1996), 59, URL: http://handle.dtic.mil/100.2/ADA325228, accessed 8 September 2004.

[15]U.S. Congress, Office of Technology Assessment, *Who Goes There: Friend or Foe?*, OTA-ISC-537 (Washington, DC: GPO, June 1993), 23-26. URL: www.wws.princeton.edu/~ota/disk1/1993/9351_n.html, accessed 1 October 2004.

addressed in this paper; the CID issues involved in those incidents are not relevant to this analysis.

Date	Aircraft	Friendly Forces Attacked	U.S. / Coalition Casualties		Comments	Notes
			KIA*	WIA*		
23 Jan 91	A-10	USMC Observation Post	0	0		16
24 Jan 91	A-10	USMC Convoy	0	2		16
29 Jan 91	A-10	USMC Light Armored Vehicle	7	2	Weapon malfunction during CAS	16
2 Feb 91	A-6E	USMC Convoy	1	2		16
2 Feb 91	F-4G	U.S. Army Radar	0	2	Anti-radiation missile	16
4 Feb 91	Unknown	USS Nicholas	0	0	Anti-radiation missile	16
15 Feb 91	AH-64	Bradley Fighting Vehicle	0	0	Hellfire missed due to pilot error	17
17 Feb 91	AH-64	Bradley and M113	2	6	Target coordinate error	16, 17
23 Feb 91	Unknown	USMC Radar	1	1	Anti-radiation missile	16
24 Feb 91	Unknown	USS Jarrett	0	0	Anti-radiation missile	16
26 Feb 91	A-10	British Armored Vehicles	0 / 9	0 / 11		16
Total Casualties from Air-to-Ground Fratricide:			11 / 9	15 / 11		16
Total Casualties from All Other Fratricide:			23	57		16

*KIA = Killed in Action; WIA = Wounded in Action; Coalition casualties are listed after the slash.

Table 1. Summary of Operation DESERT STORM Air-to-Ground Fratricide Incidents

AH-64 Fratricide Incident, 17 February 1991

Although the specific details of most DESERT STORM fratricide events are not publicly available, the AH-64 Apache incident related here typifies the CID deficiencies that plagued U.S. forces in 1991. Late on 16 February 1991, U.S. Army Task Force (TF) 1-41 was on a counter-reconnaissance mission, 5 kilometers inside Iraq, when they detected suspected Iraqi vehicles in front of their position and engaged them with ground fire. TF 1-41 subsequently lost contact

[16] Barton Gellman, "Gulf War Friendly Fire Tally Triples," *Washington Post*, 14 August 1991, A01, URL: www.proquest.com, accessed 31 December 2004.

[17] General Accounting Office, *Operation Desert Storm: Apache Helicopter Fratricide Incident*, OSI-93-4, (Washington, DC: June 1993), 17, URL: http://161.203.16.4/t2pbat5/149432.pdf, accessed 16 November 2004.

with the targets and requested Apache support to find the enemy. Shortly after midnight on 17 February 1991, 1st Battalion, 1st Aviation Regiment, 4th Aviation Brigade, 1st Infantry Division (1-1 AVN) launched three AH-64 Apache helicopters to conduct reconnaissance in support of TF 1-41. The lead aircraft's callsign was Gunfighter 6; he was accompanied by Blue 6 and Blue 5. The Apaches successfully found the screen line of TF 1-41 armored vehicles and searched the first reported target location (see Figure 1), but the pilots subsequently became disoriented.[18]

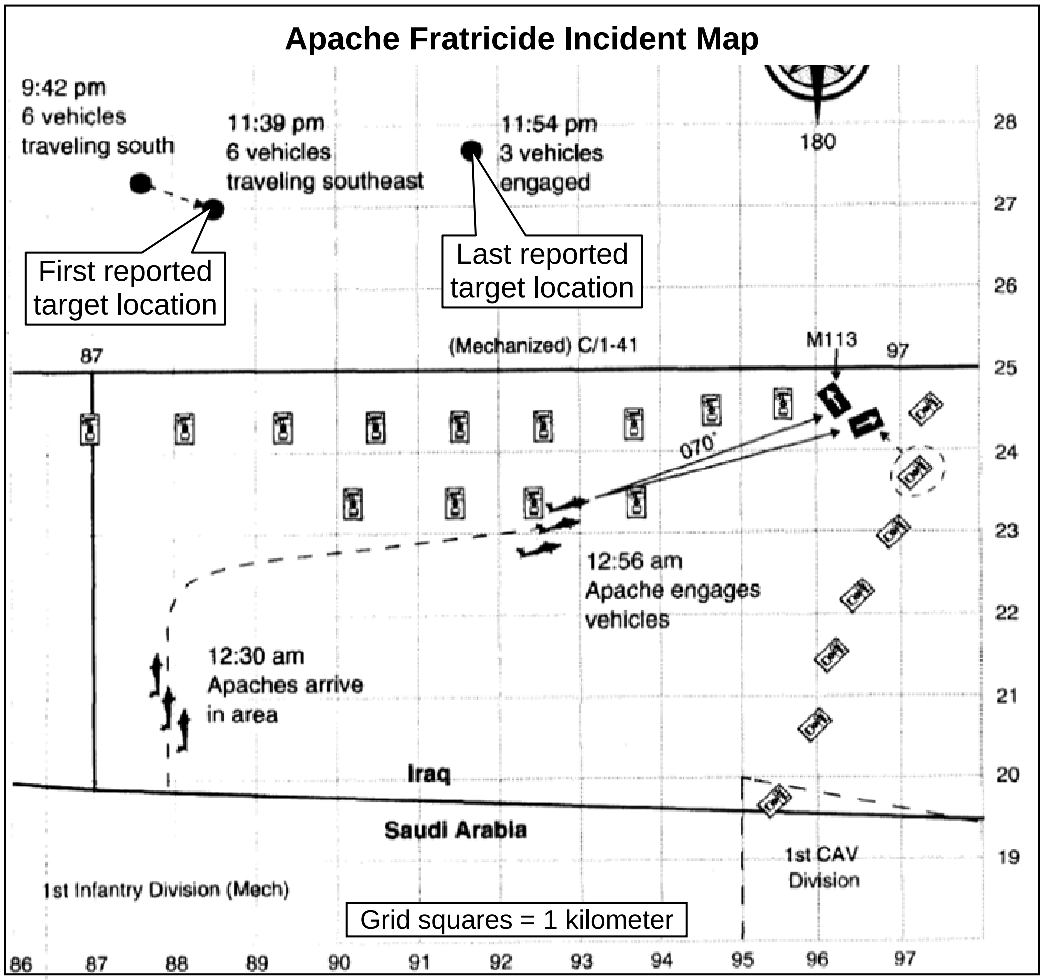

Figure 1. Source: GAO, *Apache Helicopter Fratricide Incident*, 33.

[18]GAO, *Apache Helicopter Fratricide Incident*, 20-36.

As the Apaches turned east and attempted to search the last reported location of the enemy targets, Blue 6 detected two vehicles he believed were four kilometers north of the friendly line. Gunfighter 6 subsequently used his laser target designation system to determine the coordinates of the suspected enemy vehicles. Although this action should have confirmed that the suspect vehicles were located within friendly lines, Gunfighter 6 erroneously read the manually entered coordinates of the last reported enemy location north of the screen line. All subsequent communications between the ground commander and the Apaches failed to clarify the situation, as the coordinates reported by Gunfighter 6 were consistent with the expected enemy location. As a result, the TF 1-41 commander authorized the attack.[19]

Although Blue 6 and Blue 5 were unable to confirm the lead aircraft's coordinates for the suspect vehicles, they failed to recognize Gunfighter 6's target identification error in time to prevent him from attacking friendly forces. Consequently, Gunfighter 6 attacked a Bradley Fighting Vehicle and an M113 Armored Personnel Carrier (APC) with his 30-millemeter gun and Hellfire missiles, killing two and injuring six soldiers.[20]

The U.S. Army investigation concluded that Gunfighter 6's violation of established target acquisition and identification procedures caused the Apache fratricide incident. In response to a previous Apache fratricide incident on 15 February 1991, the 4th Aviation Brigade commander had directed 1-1 AVN to approach all targets from the south (perpendicular to the screen line) in order to ensure that friendly locations were unambiguous. Although Gunfighter 6 and the Blue team initially followed this procedure, their approach to the Bradley and M113 APC was not perpendicular to the screen line. The resulting lack of SA was compounded by a failure in target

[19]GAO, *Apache Helicopter Fratricide Incident*, 36-38.

[20]GAO, *Apache Helicopter Fratricide Incident*, 38-41.

identification.[21] Gunfighter 6's erroneous target coordinates and his inability to identify the friendly vehicles with the Apache forward-looking IR (FLIR) system at a range of approximately two kilometers were the final links in the causal chain.[22]

The Apache incident and similar DESERT STORM fratricide events initially spurred the DoD to pursue improved doctrine, tactics, training, and technology to combat future air-to-ground fratricide.[23] However, competing priorities and the sheer complexity of the issues ensured that little progress was evident 10 years later, in Afghanistan.

AIR-TO-GROUND FRATRICIDE IN OPERATION ENDURING FREEDOM

OEF is a radically different conflict than DESERT STORM: it is characterized by a non-linear battlefield, smaller numbers of U.S. ground forces, and the predominance of precision airpower during the major combat phase. However, fratricide remains a significant problem, as it has caused 7% of total U.S. combat casualties as of 11 December 2004.[24] In a reversal of the DESERT STORM trend, air-to-ground incidents caused 94% of U.S. fratricide casualties (see Table 2). Although the specific circumstances of OEF incidents reflect the unconventional nature of the war, the fundamental causes of fratricide remained constant.

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[21]GAO, *Apache Helicopter Fratricide Incident*, 43-48.

[22]The difficulties in target identification are clear in the transcript of the incident. After learning of the fratricide, Gunfighter 6's co-pilot/gunner asked, "What kind of vehicles were they in? This was not a Bradley. This was not an M1 tank." GAO, *Apache Helicopter Fratricide Incident*, 81.

[23]Stewart Powell, "Friendly Fire," *Air Force Magazine*, December 1991, URL: www.afa.org/magazine/perspectives/desert_storm/1291fire.html, accessed 31 December 2004.

[24]Percentage calculated by author using fratricide figures in Table 2 and KIA/WIA figures from U.S Department of Defense, *Global War On Terrorism - Casualty Summary - Operation Enduring Freedom*, 11 December 2004, URL: http://web1.whs.osd.mil/mmid/casualty/castop.htm, accessed 2 January 2005.

Date	Aircraft	Friendly Forces Attacked	U.S. / Coalition Casualties KIA*	U.S. / Coalition Casualties WIA*	Comments	Notes
26 Nov 01	F/A-18C	Special Ops Forces	0 / 5	5 / Unknown	Target coordinate error	25
5 Dec 01	B-52	Special Ops Forces	3 / 5-25	20 / 18-50	Target coordinate error	26, 27
2 Mar 02	AC-130H	U.S. Army Convoy	1 / 2	3 / 14	Navigation system error; target coordinate error	28
17 Apr 02	F-16C	Canadian Infantry on live fire range	0 / 4	0 / 8	Lack of flight discipline	29
Total Casualties from Air-to-Ground Fratricide:			4 / 16+	28 / 40+		25-29
Total Casualties from All Other Fratricide:			1 / 1	1 / 0		30

*Coalition casualties are listed after the slash.

Table 2. Summary of Operation ENDURING FREEDOM Air-to-Ground Fratricide Incidents

Joint Direct Attack Munition (JDAM) Fratricide Incidents

The precision airpower that allowed the U.S.-led coalition to defeat the Taliban without massive ground forces was also a major source of fratricide. The only fratricide that occurred during OEF's major combat phase were incidents where U.S. aircrews entered friendly rather than enemy coordinates into Global Positioning System (GPS) guided JDAMs. In the 26 November 2001 incident, during the Mazar-E Sharif prison riot, it is not clear whether the

[25]Vernon Loeb, "U.S. Soldiers Recount Smart Bomb's Blunder," *Washington Post*, 6 February 2002, A15, URL: www.proquest.com, accessed 2 January 2005.

[26]"Sources: Friendly Fire Airstrike Likely Human Error," Cable News Network, 8 January 2002, URL: http://edition.cnn.com/2002/US/01/08/ret.friendly.fire.findings/, accessed 2 January 2005.

[27]John Hendren and Maura Reynolds, "The U.S. Bomb That Almost Killed Karzai," *Los Angeles Times*, 27 March 2002, A1, URL: www.proquest.com, accessed 2 January 2005.

[28]U.S. Central Command, *Results of Investigation Into Death of U.S. Service Member Army Chief Warrant Officer Stanley L. Harriman* (MacDill AFB, FL), "Unclassified Executive Summary," URL: www.centcom.mil/CENTCOMNews/Reports/Friendly_Fire.htm, accessed 10 September 2004.

[29]U.S. Central Command, *Summary of Facts: Tarnak Farms Friendly Fire Incident Near Kandahar, Afghanistan, 17 April 2002* (MacDill AFB, FL), "Summary of Incident," URL: www.centcom.mil/CENTCOMNews/Reports/Tarnak_Farms_Report.htm, accessed 4 September 2004.

[30]Steve Coll, "Barrage of Bullets Drowned Out Cries of Comrades," *Washington Post*, 5 December 2004, A01, URL: www.washingtonpost.com, accessed 5 December 2004.

coordinate mix-up occurred on the ground or in the F/A-18 cockpit.[31] In the 5 December 2001 incident, the Special Operations Forces (SOF) inadvertently transmitted their own coordinates to the B-52; the air controller was apparently unaware that his GPS would default to his own coordinates (rather than retaining the derived target coordinates) after he changed the batteries.[32]

Both JDAM fratricide incidents demonstrate that the effectiveness of the non-visual, precision weapons fielded after DESERT STORM rely almost exclusively on target identification performed by a JTAC or another entity separate from the attacking aircraft. In particular, high-altitude bombers have little ability to confirm target identification or maintain SA on the locations of friendly forces. Most fighter aircraft are similarly limited, unless equipped with an SA system and/or a high-resolution targeting pod. The emergence of JDAM and similar 'bomb-on-coordinate' weapons dramatically increased the DoD's all-weather precision strike capability, but also complicated the CID issues and provided another avenue for air-to-ground fratricide.

AC-130 Fratricide Incident, 2 March 2002

While JDAM incidents are unique to OEF, the AC-130 incident is similar to the 1991 Apache fratricide event. This incident highlights the DoD's lack of progress in addressing CID deficiencies after DESERT STORM.

The AC-130 was escorting a U.S. Army convoy during the beginning of Operation ANACONDA when adjacent friendly units requested CAS. After engaging enemy forces, the

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[31]Loeb, "Smart Bomb's Blunder," A15.

[32]Michael Binney, *Joint Close Air Support in the Low Intensity Conflict*, Master's Thesis, Naval Postgraduate School (Monterey, CA: June 2003), 26-27, URL: http://handle.dtic.mil/100.2/ADA417327, accessed 31 December 2004.

AC-130 attempted to find the original convoy. The convoy requested that the AC-130 perform reconnaissance on a specific coordinate on their planned route. The AC-130 complied, but an aircraft system failure forced the aircrew to navigate manually using ground references. The aircrew subsequently found ground forces at the coordinate the convoy tasked them to observe.

In reality, the aircrew had miscalculated their position, lost SA, and was observing a point north of the intended area. The ground forces in that location were an element of the friendly convoy, but, just as in the Apache incident, the aircrew received permission to fire based on the erroneous target coordinates. The AC-130's target identification error also echoes the 1991 incident: despite an array of advanced imaging systems, the crew was unable to recognize the convoy element as friendly. The resulting attack killed three and injured 17 U.S. and Afghan personnel.[33]

F-16C Fratricide Incident, 17 April 2002

OEF's most recent air-to-ground fratricide incident occurred when an F-16C bombed what the pilot believed was the source of hostile surface-to-air fire. The two F-16Cs, callsign COFFEE 51, had actually observed a friendly, nighttime, live-fire exercise. The attack killed four and injured eight Canadian soldiers. This incident differs from most other OEF and DESERT STORM fratricide incidents because the pilots independently targeted friendly forces. COFFEE flight was not under JTAC control and was not performing CAS.[34]

The incident is also unique because the formal investigation found the fratricide was caused by "the failure of [the pilots], to exercise appropriate flight discipline. This resulted in a

[33] USCENTCOM, *Investigation Into Death of Chief Warrant Officer Harriman*, "Executive Summary."

[34] USCENTCOM, *Tarnak Farms Friendly Fire Incident*, "Summary of Incident."

violation of the rules of engagement and the inappropriate use of lethal force. Under the circumstances, [COFFEE 52] acted with reckless disregard for the foreseeable consequences of his actions, thereby endangering friendly forces."[35] While a lack of flight discipline was the primary cause of this incident, the pilots' lack of SA and subsequent target identification errors created the tragic scenario.

Although air-to-ground fratricide in OEF demonstrated the DoD's continued CID deficiencies, there was little time to address the underlying technological shortfalls before the next war. As the U.S. prepared for OIF, several observers lamented the lack of CID improvements and correctly predicted the fratricide trend would continue.[36]

AIR-TO-GROUND FRATRICIDE IN OPERATION IRAQI FREEDOM

The U.S.-led coalition's rapid victory in the major combat phase of OIF was the product of an unprecedented integration of joint capabilities and a bold war plan. However, despite the war's high-tech character, losses due to fratricide remained substantial. The DoD has not released official fratricide figures, but the available information suggests that at least 10% of U.S. combat casualties and about 18% of U.S. KIA during major combat operations were the result of fratricide (see Table 3).[37] Additionally, 15% of British KIA during major combat were

[35]USCENTCOM, *Tarnak Farms Friendly Fire Incident*, "Causes of the Incident."

[36]Michael Hedges, "Are We Protecting the Troops?", *Houston Chronicle*, 16 February 2003, A01, URL: https://web.lexis-nexis.com, accessed 28 July 2004; Michael Smith, "Gulf Veteran Fears US Friendly Fire Repeat," *The Age*, 7 Jan 03, URL: www.theage.com.au/articles/2003/01/06/1041566358550.html, accessed 8 January 2005.

[37]Percentages calculated by author using fratricide figures in Table 3 and KIA/WIA figures from U.S. Department of Defense, *Operation Iraqi Freedom Military Deaths Through April 30, 2003*, 11 December 2004 and *Operation Iraqi Freedom Military Wounded in Action Through April 30, 2003*, 11 December 2004, URL: http://web1.whs.osd.mil/mmid/casualty/castop.htm, accessed 8 January 2005.

attributed to fratricide.[38] Air-to-ground incidents caused the majority of fratricide deaths, while ground-to-ground incidents were more numerous and caused more injuries.[39]

Date	Aircraft	Friendly Forces Attacked	U.S. / Coalition Casualties		Comments	Notes
			KIA*	WIA*		
20 Mar 03	AH-1W	USMC M1A1 Tank	0	1		40
23 Mar 03	A-10	USMC AAVs	9-10	1	Investigation determined FAC exceeded authority by using Type 3 control	41
24 Mar 03	F-16CJ	U.S. Army Patriot Radar	0	0	Anti-Radiation Missile	42
28 Mar 03	A-10	British Scimitar Armored Vehicles	0 / 1	0 / 5		40, 43
3 Apr 03	F-15E	U.S. Army Multiple Launch Rocket System	3	5	Aircrew misidentified rocket launcher as surface-to-air missile system	40, 44
6 Apr 03	F-15E	U.S. SOF and Kurdish Convoy	3 / 18	0 / 45	CAS Under JTAC control	40, 43
Total Casualties from Air-to-Ground Fratricide:			15+ / 19	7 / 50		40-44
Total Casualties from All Other Fratricide**:			3 / 4	31+ / 4+		40, 43

*Coalition casualties are listed after the slash. **See Note 39.

Table 3. Summary of Operation IRAQI FREEDOM Air-to-Ground Fratricide Incidents

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[38]Percentage calculated by author using figures in Table 3 and KIA figure from United Kingdom Ministry of Defence, *Operations In Iraq: First Reflections*, 7 July 2003, URL: http://www.mod.uk/publications/iraq_lessons/, accessed 8 January 2005.

[39]The ground-to-ground casualties summarized in Table 3 are probably incomplete, as *Jane*'s cites a U.S. Army document that reports a larger number of ground incidents with unspecified casualties. Tim Ripley, "Iraq Friendly Fire Was Worse Than Reported," *Jane's Defence Weekly*, 16 July 2003, URL: www.janes.com, accessed 4 September 2004.

[40]Bobby Cline, "Marine Corps Fratricide Reduction Efforts," *Marine Corps Gazette*, August 2004, 44.

[41]USCENTCOM, *An Nasiriyah Investigation*, "Unclassified Executive Summary," 1-2 [File: Investigation_section 1.pdf, pages 3-4]; Tab A-H, "USCENTAF Friendly Fire Investigation Board", 27. [File: Investigation_section 2.pdf, page 84].

[42]Stephen Trimble, "Coalition Aircrews Add Procedure to Reduce Friendly Fire Incidents," *Aerospace Daily*, 6, URL: www.proquest.com, accessed 5 January 2005.

[43]Gregor McGavin, "Friendly Fire: Deadly Mistakes," *Press Enterprise* (Riverside, CA), 4 May 2003, A01, URL: https://web.lexis-nexis.com, accessed 28 July 2004.

[44]James Dao, "Trail of Pain from Botched Attack In Iraq In '03," New York Times, 15 April 2005, A01, URL: http://www.nytimes.com/2005/04/15/national/15friendly.html, accessed 15 April 2005.

Although USCENTCOM has only released the results of the An Nasiriyah investigation to the public, it is still possible to make some general observations. At least two incidents involved CAS under JTAC control: the An Nasiriyah incident and the 6 April 2003 F-15E attack on a Coalition convoy.[45] In contrast, the other F-15E incident was not under JTAC control—it occurred when aircrew independently targeted what they believed to be an active Iraqi surface-to-air missile system.[46] In most cases, it appears that the aircrews' unfamiliarity with Coalition equipment and/or its similarity to Iraqi equipment may have contributed to their target identification errors.[47] Finally, all the friendly forces attacked were apparently equipped with vehicle identification panels and/or BFT systems.[48] Many of these same issues were also factors in the An Nasiriyah incident.

A-10 Fratricide Incident, 23 March 2003

The Friendly Fire Investigation Board (FFIB) concluded that the An Nasiriyah incident (described in Chapter 1) was caused by "the violation of the FAC, call sign MOUTH, of the . . . standing order that approval authority for Type 3 control[49] of CAS assets rested only with the Battalion Commander."[50] Other causal factors included the disruption of the Battalion's ground

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[45]David Rohde, "18 Die as U.S. Airstrike Mistakenly Hits Kurdish Force," *New York Times*, 7 April 2003, B01, URL: www.proquest.com, accessed 28 July 2004.

[46]James Dao, "Trail of Pain from Botched Attack In Iraq In '03," A01.

[47]Peter Pae, "Friendly Fire Still a Problem," *Los Angels Times*, 16 May 2003, A01, URL: www.proquest.com, accessed 4 January 2005; Douglas Barrie, "Unfriendly Fire," *Aviation Week and Space Technology*, 7 April 2003, 28, URL: https://web.lexis-nexis.com, accessed 10 September 2004.

[48]Christopher Bellamy, "The Iraq Conflict: Do Troops Kill Each Other by Mistake Because We Trained Them Too Hard?", *Independent* (London), 1 April 2003, 4, URL: web.lexis-nexis.com, accessed 10 Sep 2004;

[49]Type 3 control is the least restrictive type of control, a blanket authorization for aircraft to attack targets that meet the restrictions imposed by the JTAC. Type 3 control is used "when the tactical risk assessment indicates that CAS attacks impose low risk of fratricide." (JCS, Joint Pub 3-09.3, V-15.)

[50]USCENTCOM, *An Nasiriyah Investigation*, Tab A-H, "USCENTAF Friendly Fire Investigation Board", 27. [File: Investigation_section 2.pdf, page 84].

maneuver plan, which confused unit commanders and MOUTH as to the true disposition of the maneuver companies; severe communications problems within the Battalion resulting from equipment malfunctions, the interference of urban terrain, and a high volume of transmissions; acute fatigue on the part of MOUTH and other command and control elements; and MOUTH's task misprioritization.[51] Fundamentally, MOUTH's loss of SA led him to believe that no friendly units had advanced across the Saddam Canal, and he authorized the A-10s to attack enemy forces north of the canal out of a sense of urgency and a belief that communications problems precluded obtaining a timely approval for Type 3 control from Battalion Command.[52]

In contrast, the FFIB found that "pilot target identification was not a factor in this incident because the pilots understood the reported disposition of friendly forces and believed they were operating under Type 2 [control of] CAS."[53] The confusion over Type 3 versus Type 2 control resulted in the pilots believing that MOUTH had positively identified the targets as hostile.[54] Additionally, the FFIB stated the A-10s' altitude, which was appropriate to avoid Iraqi surface-to-air fire, also "precluded accurate target identification."[55]

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[51]USCENTCOM, *An Nasiriyah Investigation*, Tab A-H, "USCENTAF Friendly Fire Investigation Board", 20-23. [File: Investigation_section 2.pdf, pages 77-80].

[52]USCENTCOM, *An Nasiriyah Investigation*, Tab A-H, "USCENTAF Friendly Fire Investigation Board", 20-23. [File: Investigation_section 2.pdf, pages 77-80].

[53]USCENTCOM, *An Nasiriyah Investigation*, Tab A-H, "USCENTAF Friendly Fire Investigation Board", 17. [File: Investigation_section 2.pdf, page 74].

[54]Type 2 control is a more restrictive type of control, which requires the JTAC or a surrogate observer to see the target. (JCS, Joint Pub 3-09.3, V-15 – V-17.)

[55]USCENTCOM, *An Nasiriyah Investigation*, Tab A-H, "USCENTAF Friendly Fire Investigation Board", 17. [File: Investigation_section 2.pdf, page 74]. USCENTCOM redacted the specific altitude restriction from the released version of the report. The threat in the area was a Roland surface-to-air missile, which would require the A-10s to operate at a higher altitude than they may have in a lower threat scenario. The pilot interviews in the report refer to operating at 15,000 feet when initially acquiring the targets with handheld binoculars. USCENTCOM, *An Nasiriyah Investigation*, Tab A-H, "USCENTAF Friendly Fire Investigation Board", G-12 – G-16. [File: Investigation_section 3.pdf, pages 36-40].

While the FFIB is correct that the pilots' inability to identify the Charlie Company AAVs as friendly did not *cause* the incident, the A-10s' target identification capabilities were clearly insufficient to *prevent* fratricide once MOUTH set the events in motion. As in the OEF F-16C incident, the violation of established procedures ultimately caused the fratricide, but CID failures were key factors in the chain of events.

SUMMARY

The preceding analysis of DESERT STORM, OEF, and OIF incidents demonstrates the nature of air-to-ground fratricide and the CID deficiencies that fratricide reduction technology must address. While many of the incidents discussed above involved violations of established procedures, the loss of SA and/or target identification errors remain the root causes of fratricide. The DoD attempted to mitigate self-inflicted losses with ad hoc technical solutions that date back to DESERT STORM, but these air-to-ground fratricide reduction systems clearly failed the test of combat in three different wars.

CHAPTER 3

CURRENT AIR-TO-GROUND FRATRICIDE REDUCTION SYSTEMS

The air-to-ground fratricide reduction systems fielded to date range from rudimentary visual signals to networked microcomputers, but all have proved insufficient in combat. Rudimentary target identification systems have typically failed because they are dependent on clear weather and/or because they are not consistently visible to aircraft at tactically useful ranges. SA systems, such as BFT and SADL, have not significantly reduced air-to-ground fratricide because they are thinly fielded and not compatible with the equipment used by many JTACs and CAS aircraft. Digital CAS systems have similar fielding and compatibility deficiencies. While most of the existing systems are effective at enabling target identification or providing SA in some limited capacity, there are still far too many gaps in current CID capabilities.

TARGET IDENTIFICATION SYSTEMS

Visual Identification

The most basic fratricide reduction system is the human ability to visually classify a potential target as friend or foe. However, visual identification has repeatedly proven unreliable as a fratricide reduction measure in both ground-to-ground and air-to-ground operations. The accuracy of air-to-ground visual identification is inherently limited by sensor capabilities, training, and human factors.

U.S. Army experiments have demonstrated that visual identification of military vehicles is unreliable, even at relatively short ranges. A ground observer with unaided vision can typically recognize an armored vehicles' distinguishing characteristics (e.g. number of road wheels, multiple gun tubes, etc.) at ranges less than 800 meters. However, at ranges beyond 1,200 meters, the identity of a vehicle becomes much more ambiguous, as the human eye can usually only determine if the vehicle possesses tracks or wheels and the location of a turret.[56] Subsequent experiments with M1 and Bradley crews reinforced this relationship. The crews demonstrated an accuracy of 79% when identifying armored vehicles in 1st generation FLIR imagery at ranges less than 1,200 meters, but this accuracy dropped to 48% at longer ranges.[57] In a more recent experiment with unmagnified, 2nd generation FLIR imagery, soldiers demonstrated an average visual identification accuracy of 78% at a range of approximately 70 meters, but accuracy dropped to 65% at a range of approximately 265 meters. These results demonstrate the difficulty of the visual identification task, particularly because the soldiers took the test in an environment free from external stress and since the 2nd generation FLIR experiment only used six vehicles.[58]

Visual identification of targets from an aircraft is even more difficult than ground-to-ground recognition. Various studies have demonstrated that an airborne observers' ability to detect and identify tactical targets is significantly degraded at altitudes above approximately

[56] Jean Dyer, Amy Westergren, George Shorter, and Larry Brown, *Combat Vehicle Training with Thermal Imagery*, U.S. Army Research Institute for the Behavioral and Social Sciences (Alexandria VA: November 1997), 69, URL http://handle.dtic.mil/100.2/ADA342559, accessed 13 January 2005.

[57] Dyer et al., *Combat Vehicle Training with Thermal Imagery*, 69.

[58] Dyer et al., *Combat Vehicle Training with Thermal Imagery*, 75-77.

2,000 feet and becomes "relatively ineffective" at approximately 3,000 feet of altitude.[59] Other field tests showed that the probability of target identification is also a function of target size and slant range. Modeling based on this test data indicated that the probability of an airborne observer correctly identifying a tank is approximately 50% at a slant range of 2,000 feet (610 meters) and 20% at a slant range of 3,000 feet (915 meters).[60] Although these figures are generalizations, they demonstrate the inherent limitations of the unaided human eye in air-to-ground identification.

While many attack aircraft are equipped with a FLIR or other sensors to enable longer-range, day-and-night target identification, these systems vary in capability. For example, F-16CG aircraft flying airborne FAC (FAC(A)) missions during Operation ALLIED FORCE were equipped with LANTIRN targeting pods, a 1st generation FLIR that remains in widespread use today. These pilots found it difficult to distinguish Serbian Army vehicles from non-combatant vehicles with the LANTIRN pod, even when operating at the exceptionally low altitude of 5,000 feet.[61] The services are separately acquiring 3rd generation targeting pods like LITENING II and SNIPER XR for their fixed-wing attack aircraft, which theoretically quadruple the target identification range of 1st generation systems.[62]

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[59] Margaret Franklin and John Wittenburg, *Research on Target Detection, Volume 1, Development of an Air-to-Ground Detection/Identification Model,* Human Sciences Research Inc. (Mclean, VA, June 1965), 2 and 24.

[60] The probabilities were calculated for an aircraft at 100 feet with the target in rough terrain. Franklin and Whittenburg, 67.

[61] Jeffery McDaniels, "Viper FAC-A: Effectiveness of the F-16 Block 40," Research Report, Air Command and Staff College (Maxwell AFB, AL: April 2000), 20, URL: http://handle.dtic.mil/100.2/ADA393985, accessed 22 January 2005. LANTIRN stands for "low-altitude navigation and targeting infrared for night."

[62] Jennifer Allen, "Lockheed Martin Receives Contract to Integrate SNIPER XR Targeting Pod Onto A-10 Thunderbolt," *Lockheed Martin Missiles and Fire Control Press Release*, 12 February 2004, URL: www.missilesandfirecontrol.com, accessed 14 January 2005.

Although rotary wing aircraft usually operate at lower altitudes and closer to their targets than fixed-wing aircraft, U.S. attack helicopters have similar target identification deficiencies. All U.S. Army AH-64A/D Apache and USMC AH-1W Super Cobra helicopters still use 1st generation FLIRs, which do not allow pilots to identify targets at the maximum range of the helicopters' weapons. Instead, pilots must maneuver closer to a target to visually identify it, or rely on an off-board source of identification, such as a JTAC.[63] The U.S. Army and USMC are acquiring 2nd and 3rd generation FLIRs for their attack helicopter fleets, respectively.[64] However, even advanced FLIR systems remain limited by external factors that include inclement weather, clutter, camouflage, and the operator's visual identification training.

The difficulty of conducting realistic training further limits the effectiveness of visual identification as a fratricide reduction measure. While the U.S. Army's 2nd generation FLIR experiment achieved a close-range accuracy of 78% with six vehicles, a more realistic training requirement would include at least 24 major friendly and enemy armored vehicles.[65] Additionally, the available visual identification training tools cannot address the nearly unlimited permutations of vehicle variants, environmental conditions, and sensor capabilities. The U.S. Army's Recognition of Combat Vehicles (ROC-V) computer program provides realistic training on the IR and visual signatures of common vehicles, but it still lacks depictions of many friendly

[63] Sandra Erwin, "Gunship Sensors Optimized for Urban Warfare," *National Defense*, July 2001, URL: http://nationaldefense.ndia.org/issues/2001/Jul/Gunship_Sensors.htm, accessed 27 February 2005.

[64] The Army will begin upgrading Apaches with the Arrowhead 2nd generation FLIR in 2005. The USMC will begin fielding completely rebuilt AH-1Z helicopters with the 3rd generation Hawkeye FLIR in 2006. "DRS Technologies to Provide IR Assemblies for Apache Helicopter," *Defense Daily*, 24 June 2004, URL: www.proquest.com, accessed 27 February 2005; Edward Phillips, "H-1 Production," *Aviation Week and Space Technology*, 3 Jan 2005, 30, URL: www.proquest.com, accessed 27 February 2005.

[65] Including artillery/rocket systems and combat service support vehicles in the training would at least double this figure. U.S. Air Force, 388th Fighter Wing, 388th Operations Group Operating Instruction 14-2, *Pilot Intelligence Training* (Hill AFB, UT, 1 May 2004), 19.

vehicles and air-to-ground perspectives.[66] The USAF's equivalent computer-based training program is out-of-date and lacks the ability to simulate how ground vehicles appear in FLIR sensors. In all cases, visual identification is but one of a myriad of training requirements competing for time and resources.

One final factor limits the effectiveness of visual identification in combat: human psychology. Psychological tests show that humans recognize objects by forming a hypothesis and then seeking evidence to prove it; they do not tend to search for evidence that disproves the hypothesis.[67] Thus, if a person expects to find enemy forces in a certain location, they are less likely to recognize the presence of friendly forces. While the ability to visually distinguish between friend and foe will remain critical in combat, visual identification alone is not sufficient protection from air-to-ground fratricide.

Thermal Marking Devices

The U.S. Army used thermal tape in DESERT STORM to aid visual identification of vehicles with FLIRs, and this concept was formalized under the post-war Quick Fix program.[68] Combat Identification Panels (CIPs) and Thermal Identification Panels (TIPs) are the primary day-and-night fratricide reduction systems for ground vehicles. CIPs are attached to the sides of vehicles to improve ground recognition, while TIPs are cloth panels placed on top of vehicles to enable air-to-ground identification. Both panels use low-emissive, thermal material to create a distinctive cold spot on FLIR displays (see Figure 2). The non-thermal side of a TIP is a bright

[66]USJFCOM, *CCID ACTD CONOPS*, 185.

[67]U.S. Congress, Office of Technology Assessment, *Who Goes There: Friend or Foe?*, 17.

[68]U.S. Congress, Office of Technology Assessment, *Who Goes There: Friend or Foe?*, 78.

orange color.[69] The effectiveness of both panels can be degraded if they are dirty, as well as by adverse weather.[70]

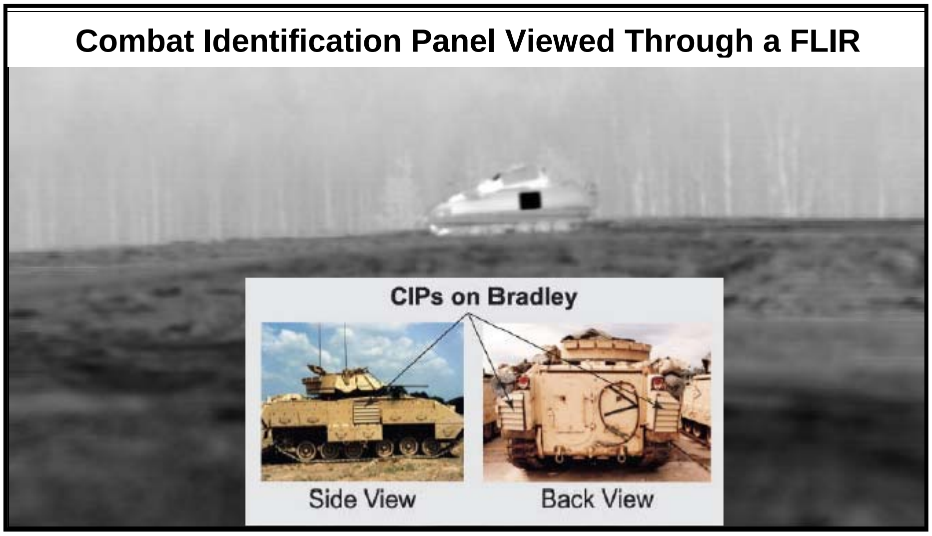

Figure 2. Source: U.S. Army, PM-TIMS.

Although CIPs and TIPs are theoretically visible from ranges of six to eight kilometers, they have only proved effective at much shorter ranges in combat.[71] During OIF, AH-64D attack helicopters were only able to recognize CIPs at approximately three kilometers, far less than the Apache's maximum engagement range.[72] Other reports concluded that the CIPs were only effective in aiding identification by helicopters and ground forces at ranges of one kilometer or less.[73] Fighter aircraft typically find it even more difficult than ground forces or helicopters

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[69]U.S. Army, Product Manager-Target Identification and Meteorological Sciences (PM-TIMS), *Combat Identification* web page, October 2004, URL: https://peoiewswebinfo.monmouth.army.mil/portal_sites/IEWS_Public/TIMS/04 TIMS WEB/Combat ID1.htm, accessed 15 January 2005.

[70]USJFCOM, *CCID ACTD CONOPS*, 121.

[71]U.S. Army, PM-TIMS, *Combat Identification* web page.

[72]"Apache Longbow Battalion Destroyed Two Republican Guard Battalions During OIF," *Defense Daily*, 12 May 2003, URL: www.proquest.com, accessed 26 February 2005.

[73]USJFCOM, *CCID ACTD CONOPS*, 44; U.S. Army, Third Infantry Division (Mechanized), *Third Infantry Division (Mechanized) After Action Report: Operation IRAQI FREEDOM*, July 2003, 59, URL: http://www.globalsecurity.org/military/library/report/2003/3id-aar-jul03.pdf, accessed 26 February 2005.

to detect CIPs and TIPs at tactically useful ranges, unless they are equipped with 3rd generation FLIRs.[74] These variations in effectiveness demonstrate that the visibility of thermal marking devices depends on both FLIR sensitivity and environmental conditions.

In addition to vehicle identification panels, the U.S. Army fielded a few hundred thermal helmet covers just before OIF. Like its vehicle counterparts, the Dismounted Combat Identification Marking System (D-CIMS) creates a distinctive cold spot on a FLIR image. Preliminary testing indicated an OH-58 FLIR could recognize D-CIMS-equipped soldiers at a range of 2 kilometers.[75] However, D-CIMS are subject to the same limitations as CIPs and TIPs.

Infrared Marking Devices

IR strobe lights are the primary night fratricide reduction system for ground forces. These beacons generate a periodic flash in the near-IR spectrum, which is invisible to the unaided eye and FLIR systems.[76] Ground and air forces equipped with night vision devices can detect the flash from an IR strobe at ranges of about four kilometers in clear atmospheric conditions.[77] Of course, IR strobes offer no protection during daylight hours.

Additionally, ground forces frequently mark their uniforms and vehicles with IR-reflective materials, such as Gated Laser Intensifier (GLINT) tape. This passive measure

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[74]USJFCOM, *CCID ACTD CONOPS*, 44. F-16Cs equipped with LITENING II targeting pods during OIF found TIPs were usually visible at tactical employment ranges. Mark Lantz and Scott Dodge, U.S. Air Force Reserve, 419 Fighter Wing, 466 Fighter Squadron, Hill AFB, UT, email interview by author, 23 February 2005.

[75]"New Technology to Prevent Fratricide on the Way to Ground Troops, *Inside the Army*, 10 February 2003, URL: http://defense.iwpnewsstand.com, accessed 5 February 2005.

[76]FLIR systems operate in the far-IR band (8-12 microns) or mid-IR band (3-5 microns), while night vision devices and IR strobes operate in the near-IR band, much closer to the wavelengths of visible light. Thus, TIPs are invisible to night vision devices, and IR strobes are invisible to FLIRs.

[77]U.S. Army, PM-TIMS, *Combat Identification* web page.

increases the visibility of friendly forces to aircrews using night vision devices by reflecting ambient or artificial near-IR illumination.[78]

JTAC Target Identification Equipment

JTACs use a variety of equipment to mark, designate, or derive coordinates for targets in order to direct CAS strikes and reduce the probability of fratricide. Near-IR laser pointers work in the same portion of the spectrum as IR strobes and are only visible in night vision devices. When combined with appropriate communications, laser pointers allow JTACs and CAS aircraft to indicate friendly and enemy positions at night.[79] JTACs use ground laser target designators (GLTDs) to illuminate targets with coded laser energy in order to direct laser-guided weapons or to assist target acquisition by an aircraft with a laser spot tracker capability.[80] JTACs also use target locating devices (TLDs) to determine precise target coordinates for JDAMs and other coordinate-seeking weapons.[81] As voice transmissions of target coordinates are inherently cumbersome and prone to human error, the lack of a joint, interoperable JTAC-to-aircraft datalink limits the effectiveness of TLDs and other JTAC target identification equipment.

[78]JCS, Joint Pub 3-09.3, V-44.

[79]JCS, Joint Pub 3-09.3, V-44. Both JTACs and aircrew can use laser pointers. They may be handheld or integrated into aircraft systems, such as the AC-130 sensor suite and 3rd generation targeting pods.

[80]JCS, Joint Pub 3-09.3, V-55 – V-56. Some A-10 aircraft carry the PAVE PENNY laser spot tracking pod and all 3rd generation targeting pods have this capability.

[81]TLDs consist of a laser range-finder, compass, and GPS receiver. A TLD's target location error ranges from ten meters at one kilometer to 300 meters at maximum range. JCS, Joint Pub 3-09.3, V-55.

JTAC Digital CAS Systems and Datalinks

Although digital CAS systems and JTAC-to-aircraft datalinks dramatically increase CAS effectiveness and reduce the probability of fratricide, the services have not equipped their aircraft or JTACs with standardized equipment.[82] The reasons for this failure are twofold.

First, the services developed a variety of incompatible systems for different types of JTACs. The three primary digital CAS systems (in various stages of fielding and development) were designed for USAF Tactical Air Control Parties (TACPs), USAF Combat Controller Teams (CCTs), and USMC TACPs.[83] All three systems are intended to streamline the CAS process though a portable computer that provides SA on friendly forces, interfaces with the JTACs' TLD, and digitally transmits target coordinates and other instructions to CAS aircraft. Despite this common purpose, the systems have varying capabilities—no one system can communicate with all datalink-capable fixed-wing aircraft.[84]

The second part of the JTAC-to-aircraft datalink problem lies with the number of aircraft datalinks and message formats. Link 16 is the preferred datalink for joint interoperability, but the services also use legacy systems, such as SADL, the Improved Data Modem, the Navy's Digital Communications System, the USMC's Automatic Target Handoff System, and other

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[82]General Accounting Office, *Operation Lingering Training and Equipment Issues Hamper Air Support of Ground Forces*, GAO-03-505 (Washington, DC: May 2003), 19-22, URL: http://www.gao.gov/new.items/d03505.pdf, accessed 9 August 2004; USJFCOM, *CCID ACTD CONOPS*, 61-70.

[83]USAF TACPs primarily support conventional Army units, while CCTs normally operate with SOF. The USAF TACP System is called the Close Air Support System (CASS). The USMC TACP system is called Target Location Digital Handoff System (TLDHS). The CCT system is called the Battlefield Air Operations (BAO) Kit. Part of the interoperability problem stems from the trade-off between additional capability and additional weight. Charles Heidal, U.S. Air Force, Air Combat Command DRR, *USAF TACP Modernization Program UPDATE*, briefing slides, (Langley AFB, VA: December 2004), 8 and 27.

[84]None of the JTAC systems can currently communicate with attack helicopters. An interface with AH-64D helicopters is a planned upgrade to the USAF TACP CASS system. The USMC has an unfunded requirement for a helicopter datalink as part of the AH-1Z upgrade. Charles Heidal, U.S. Air Force, Air Combat Command DRR, Langley AFB, VA, email interview by author, 10 February 2005; Brian Bartholf, Marine Corps Combat Development Center, Quantico MCB, VA, email interview by author, 3 March 2005.

specialized or ad hoc systems.[85] While the amount of overlap and interoperability between the various JTAC systems and aircraft datalinks is increasing, voice communications are still a primary method of controlling CAS.

SITUATIONAL AWARENESS SYSTEMS

Although the DoD made little progress in fielding target identification systems since DESERT STORM, the services procured a variety of BFT systems in the 1990s. The DoD failed to standardize these efforts, however, and U.S.-led coalition forces fought OIF with an inefficient combination of at least nine incompatible BFT systems. Despite their many merits, SA systems still have limited utility for reducing the probability of air-to-ground fratricide, as they suffer from data latency, inadequate fielding, and a lack of interoperability. Additionally, few aircraft can currently display BFT data in the cockpit.

Force XXI Battle Command Brigade-and-Below (FBCB2) Blue Force Tracker

FBCB2 is the U.S. Army's digital command and control (C2) system, part of the Army Battle Command System. FBCB2-equipped vehicles periodically broadcast their GPS-derived position via a Tactical Internet, display friendly locations on a digital moving map display, and exchange C2 messages. The original FBCB2 is based on terrestrial radio communications via

[85]Link 16 is a ultra-high frequency, line-of-sight, digital datalink. It is more secure and has higher data capacity than its predecessors. Link 16 is used to exchange a wide variety of data, including air tracks, targets, and threat data, between ground and air platforms. Mathew McGarry, "Data Link and the Joint Tactical Radio System," Student Paper, 66th Weapons Squadron, USAF Weapons School (Nellis AFB, NV: 14 June 2003), 16.

the Enhanced Position Location and Reporting System (EPLRS) and SINCGARS, but these systems require an unobstructed line-of-sight between units to function.[86]

The U.S. Army fielded FBCB2-BFT in late 2002 to give USCENTCOM an SA capability that is not limited by terrain or distance between units. FBCB2-BFT uses commercial satellite communications rather than line-of-sight radios, making it incompatible with the original FBCB2 system and unable to transmit classified messages.[87] Nevertheless, FBCB2-BFT was very effective as a ground force SA system during the major combat phase of OIF.

The DoD distributed over 1,000 FBCB2-BFT systems to U.S. Army, USMC, and British ground forces just prior to OIF. Although limited by thin fielding among these large units, Army officers credited the system with simplifying navigation and reducing the chance of fratricide by enhancing their SA on the positions of friendly forces. However, satellite bandwidth limitations prevented the real-time exchange of GPS data, as the system took several minutes to reflect friendly movements. Additionally, FBCB2-BFT's data latency could give a vehicle commander the false impression that he was in front of all other friendly vehicles while moving.[88]

Since OIF, the U.S. Army has focused on expanding FBC2B-BFT and integrating the system with other service capabilities. During OIF, most USMC units used a separate, radio-based network that displayed BFT data on Data Automated Communications Terminals. In 2004, the Joint Requirements Oversight Council instructed the Army and Marines to merge their

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[86]"Force XXI Battle Command Brigade-and-Below—Blue Force Tracking," *Jane's C4I Systems*, 15 April 2004, URL: www.janes.com, accessed 4 September 2004.

[87]James Conatser and Thane St. Clair, "Blue Force Tracking—Combat Proven," *Armor*, October 2003, 20-23, URL: http://infoweb.newsbank.com, accessed 4 September 2004.

[88]John Charlton, "Digital Battle Command: Baptism By Fire," *Military Intelligence Professional Bulletin*, March 2004, 15, URL: http://infoweb.newsbank.com, accessed 4 September 2004.

systems into a single BFT system, retaining the name FBCB2-BFT.[89] Although the Army is expanding the system to many of its helicopters through BFT-Aviation (BFT-A), the joint effort to send BFT information to fixed-wing aircraft over Link 16 is still experimental.[90]

Situational Awareness Datalink

The Air National Guard and Air Force Reserve purchased SADL as a low-cost alternative to Link 16. SADL allows most F-16C Block 30 and some A-10 aircraft to network with other SADL-equipped aircraft and EPLRS-equipped ground forces. SADL-equipped aircraft can connect to the EPLRS Tactical Internet and display the five friendly units closest to a target on the aircraft's heads-up display and multi-function displays.[91] Although the DoD tested a JTAC-to-aircraft datalink system using SADL, it was not fielded.[92] Instead, JTACs using fielded digital CAS systems can only transmit messages to SADL if another piece of ground equipment, such as a Battlefield Universal Gateway Equipment (BUG-E), is available to translate.[93]

While SADL provides pilots with nearly ideal SA on friendly force locations and functionality for digital CAS, the system remains a niche capability that lacks true interoperability. Although the USAF had planned to equip active-duty A-10s with SADL, the Office of the Secretary of Defense directed the procurement of the Joint Tactical Radio System

[89]Cahlink, "Better 'Blue Force' Tracking."

[90]"U.S. Forces Expand BFT Rollout," *Jane's International Defense Review*, 1 December 2003, URL: www.janes.com, accessed 9 September 2004; Cahlink, "Better 'Blue Force' Tracking."

[91]"Situational Awareness Datalink," *Jane's Military Communications*, 1 September 2004, URL: www.janes.com, accessed 9 September 2004.

[92]USJFCOM, *CCID ACTD CONOPS*, 63.

[93]Chuck Paone, "BUG-E Played Key Role is Rapid OIF Attack Pace," *Air Force Material Command News Service*, Release 0502, 1 May 2003, URL: http://www.afmc-pub.wpafb.af.mil/HQ-AFMC/PA/news/archive/2003/May/0502-03.htm, accessed 6 February 2005.

(JTRS) for the A-10 to ensure future compatibility with Link 16 and other datalinks.[94] Additionally, the U.S. Army's decision to de-emphasize EPLRS in favor of satellite communications for broadcasting ground unit positional data has left SADL unable to directly interface with FBCB2-BFT. The USAF has fielded a limited number of Joint Range Extension Transparent Multi-platform Gateway systems that can translate messages between SADL and Link 16 networks.[95] This capability may allow SADL-equipped aircraft to maintain SA on friendly forces once the DoD fields a robust capability to transmit BFT data over Link 16.

SUMMARY

The DoD has long recognized the deficiencies in their target identification and SA systems. While this realization motivated crisis-response fielding of much of the equipment detailed in this chapter, these efforts do not represent a family of effective, interoperable, and ubiquitous fratricide reduction systems. Only a unified development and procurement effort from the U.S. armed services and CCID member nations can address the longstanding CID deficiencies that have failed to reduce air-to-ground fratricide.

[94]Once fielded in the A-10, the JTRS Cluster 1 radio will be programmed to communicate with EPLRS for a 'SADL-like' capability. McGarry, "Data Link and the Joint Tactical Radio System," 1-2.

[95]Daryl Mayer, "ESC Joint Program Links C2, Land, Air, Naval Forces," *Air Force Material Command News Service*, Release 0418, 13 April 2004, URL: www.hanscom.af.mil/hansconian/Articles/2004Arts/04022004-01.htm, accessed 16 January 2005.

CHAPTER 4

EMERGING AIR-TO-GROUND FRATRICIDE REDUCTION SYSTEMS

One of the most urgent imbalances between weapon system capabilities and the requirements of high-tech warfare is inadequate means of distinguishing enemy from friendly forces.

-- House Armed Services Committee, 1992

The beauty of the [Advanced Concept Technology] Demonstration is the way it can speed technology into the hands of the warfighters."

-- Technical Manager of Joint Combat Identification ACTD, 1999

The DoD is pursuing fratricide reduction technology through several interrelated, but separate, programs. The CCID ACTD is a USJFCOM-led, multinational effort to evaluate target identification and SA system concepts with the primary purpose of reducing the probability of fratricide. The CCID is evaluating RF Tags and RBCI for air-to-ground fratricide reduction. Additionally, other DoD programs have significant potential for reducing air-to-ground fratricide as they pursue broader goals of combining SA systems and integrating disparate tactical datalinks. While there is some opportunity for progress in the next few years, the majority of the CID systems and technologies under consideration are long-term projects that will not be fully realized until more than two decades after DESERT STORM.

COALITION CID ADVANCED CONCEPT TECHNOLOGY DEMONSTRATION

Radio Frequency Tags

RF Tags are a relatively new concept, but if testing and development match their theoretical utility, RF Tags may figure prominently in a future family of systems. RF Tags are designed to allow radar-equipped aircraft to identify RF Tag-equipped friendly forces. RF Tags respond to stimulation from an air-to-ground radar with a modulated version of the original signal. The radar then displays the RF Tag response in the appropriate location to indicate the presence of friendly forces.[96] RF Tags are intended to serve two purposes: to provide tactical aircraft with a long-range target identification capability and to enable ISR sensors to update SA systems with RF Tag-derived BFT data.[97]

The CCID ACTD still has many issues to resolve in its effort to develop the RF Tag concept. There are four separate RF Tag designs from four different government laboratory and industry partnerships undergoing evaluation.[98] While the RF Tags tested to date have successfully created a radar return on the aircraft's radar display, more comprehensive testing is required to determine the RF Tags' effectiveness in a cluttered, multi-radar environment. Additionally, the CCID ACTD must determine if a raw return showing an RF Tag location is tactically useful by itself. To prevent confusion with ground clutter and legitimate targets, each aircraft radar may require a software modification to display an icon representing the RF Tag.[99]

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[96] USJFCOM, *CCID ACTD CONOPS*, 71-72.

[97] U.S. Army Research, Development, and Engineering Command, Radar/Combat ID Division, *RF Tags Fixed Wing Tactical Demo,* briefing slides, January 2005, 2, URL: www.ccidactd.com, accessed 17 January 2005.

[98] U.S. Army, *RF Tags Fixed Wing Tactical Demo*, 14.

[99] Craig Petersen, U.S. Joint Forces Command, J85 CCID ACTD Branch, Norfolk, VA, email interview by author, 18 November 2004.

RF Tags are potentially useful as an air-to-ground fratricide reduction system because they can theoretically provide an all-weather, long-range CID capability with existing airborne radars. If the concept performs well in the Military Utility Assessment, the DoD must determine whether and to what extent to integrate RF Tags into the larger family of systems. As with all fratricide reduction systems, however, there is a danger that if the resulting equipment is too expensive, the DoD will be unable to equip all ground forces with this single-purpose system.

Radio-Based Combat Identification (RBCI)

The RBCI concept shows more short-term promise than RF Tags, as RBCI requires no new equipment and has already been tested in joint exercises. RBCI is a software modification to SINCGARS Advanced System Improvement Program (ASIP) radios that allows JTACs or other fire support personnel to interrogate other RBCI-enabled SINCGARS radios to ensure no friendly forces are near an intended target.[100] There is also potential to install RBCI software on other radios, such as the British BOWMAN, ARC-210, and future JTRS.[101]

An RBCI interrogation consists of a message that includes the target coordinates and a selectable radius (80 – 5,000 meters) around the target. Upon receiving this message, all RBCI-enabled SINCGARS within line-of-sight compare their own GPS coordinates with the area defined by the interrogation message. If an RBCI-enabled SINCGARS determines that it is within the targeted area, it will reply, and a friendly response will appear on the interrogator's digital map display. The entire process takes less than three seconds.[102]

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[100]USJFCOM, *CCID ACTD CONOPS*, 56.

[101]Robert Wall, "Lifting the Fog," *Aviation Week and Space Technology*, 21 June 2004, URL: http://search.epnet.com, accessed 29 July 2004.

[102]USJFCOM, *CCID ACTD CONOPS*, 57.

Since line-of-sight problems could potentially prevent a ground-based RBCI interrogation from reaching friendly forces, the CCID ACTD has also tested the system on aircraft. In a June 2004 exercise, an RBCI-equipped Apache helicopter successfully interrogated properly equipped ground forces and displayed friendly replies on a personal digital assistant.[103] Although the exercise also included testing of RBCI on a C-12 transport plane, it is unclear at this point if the system is appropriate for fixed-wing aircraft. The 2005 CCID ACTD Military Utility Assessment will only test RBCI using ground forces and helicopters.[104]

RBCI has great potential for reducing the probability of air-to-ground fratricide, as it would provide a much-needed increase in JTACs' CID capabilities. RBCI enables a JTAC to deconflict CAS fires from friendly forces in real time, rather than depending on the accuracy of voice reports or a BFT picture that is several minutes old. Although the system must still complete testing, RBCI appears to be the CCID ACTD's air-to-ground concept with the best potential for short-term fielding.

Battlefield Target Identification Device (BTID)

Although BTID is a concept with exclusively ground-to-ground applications, it will impact air-to-ground operations if it is fielded with JTACs. Additionally, BTID demonstrates the type of target identification capability that aircraft will continue to lack on future battlefields.

BTID is a question-and-answer cooperative identification system that uses millimeter wave interrogators and transponders; it functions very much like an aircraft IFF system. Unlike its cancelled U.S. predecessor, the Battlefield Combat Identification System (BCIS), BTID

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[103]Wall, "Lifting the Fog."

[104]USJFCOM, "FY05 Demonstration Technology Overview," a slides, 7 December 2004, 6-7, URL: www.ccidactd.com, accessed 19 December 2004.

complies with a NATO Standardization Agreement—several CCID member nations are testing interoperable systems.[105] The primary purpose of BTID is to enable a direct-fire gunner to identify a vehicle viewed through the weapon sights as a "friendly" or an "unknown" target. As with all cooperative target identification systems, the system cannot identify a vehicle as hostile; the operator must apply ROE for that purpose.[106]

The CCID ACTD is not currently evaluating BTID for air-to-ground use, although their *Concept of Operations* document does advocate equipping JTACs with BTID for both self-protection and target identification.[107] The United Kingdom has expressed interest in equipping its attack helicopters and unmanned aerial vehicles (UAV) with BTID—a 2000 British study even found the technology suitable for integration into a fighter targeting pod.[108] However, the U.S. Army apparently concluded that air-to-ground BTID is not a viable option.[109]

While equipping JTACs with BTID would improve their target identification capabilities, this approach will not directly prevent a pilot from misidentifying friendly forces as the target assigned by a JTAC. Without an air-to-ground BTID, future improvements in aircraft target identification will depend on the success of RF Tags and/or RBCI, as well as those CID capabilities that may emerge from the larger family of systems.

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[105]After ten years of development and $169 million expended, the Army cancelled BCIS due to the cost to equip each vehicle ($50,000) and lack of interoperability with BTID. Dale Eisman, "`Friendly Fire' Deaths Fueling Debate on How to Prevent Them," *Virginian-Pilot*, A1, URL: https://web.lexis-nexis.com, accessed 28 July 2004.

[106]USJFCOM, *CCID ACTD CONOPS*, 152-153.

[107]USJFCOM, *CCID ACTD CONOPS*, 155.

[108]Mark Hewish and Rupert Pengelley, "Taking the Guesswork Out of Combat Identification," *Jane's International Defense Review*, 1 April 2003, URL: www.janes.com, accessed 4 September 2004.

[109]Petersen, email interview.

RELATED DEPARTMENT OF DEFENSE PROGRAMS

Joint Blue Force Situational Awareness (JBFSA)

In addition to the CCID ACTD, the DoD's broader effort to merge existing BFT systems has the potential to reduce fratricide. The JBFSA ACTD intends to provide "software interfaces and connectivity, which enable integration of existing and emerging [BFT] Systems via the Global Command and Control System (GCCS) Common Operational Picture (COP)."[110] In March 2004, the JBFSA ACTD successfully integrated eight separate BFT feeds into a single display at Exercise FOAL EAGLE in South Korea, and has plans to integrate a British BFT system in the summer of 2005.[111] Integrating allied data and providing a Coalition COP are also priorities for the JBFSA effort.[112]

Joint Datalink Information and Combat Execution (JDICE)

The DoD's JDICE Joint Test and Evaluation (JT&E) program will potentially complement JBFSA by providing the means and techniques for effectively distributing SA and target identification data. The JDICE JT&E mission is to "improve the Joint Force Commander's battlespace situational awareness by developing, testing, evaluating and institutionalizing Joint and Service [TTPs] that provide critical mission information across multi-

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[110]Office of the Secretary of Defense, *AcqWeb*, "Advanced Concept Technology Demonstrations," URL: http://www.acq.osd.mil/actd/descript.htm, accessed 17 January 2005.

[111]Dennis Beebe, "Battle Lab Manager Makes Great Strides and Receives Recognition," *U.S. Army Space and Missile Command Public Affairs Release*, 12 December 2004, URL: http://www.smdc-armyforces.army.mil/news/newsdetail.asp?HL=2&NID=1027&dc=3& , accessed 16 January 2005.

[112]U.S. Army Space and Missile Command, "JBFSA ACTD," Fact Sheet, undated, URL: www.smdc.army.mil, accessed 19 November 2004.

platform, fielded, tactical air and ground data links."[113] The JT&E is focused on "integrating the various service stovepipe information flows via the already existing Link 16 network."[114]

A JDICE Mini-Test demonstrated this capability in October 2004. In the test, the USMC Tactical Air Command Center was able to transmit BFT data and enemy locations to Link 16-equipped F/A-18, F-15E, and F-16CJ aircraft. Additionally, the USAF TACP was able to digitally control the fighter aircraft via Link 16, dramatically improving the effectiveness of the CAS missions and reducing the probability of fratricide.[115] Although this test was relatively small, it demonstrates the potential impact of fusing mature SA systems, datalinks, and TTPs.

However, the future success of the JDICE effort relies largely on the availability of Link 16-equipped aircraft. The USAF has upgraded all of its F-15C/E fighters with Link 16 and has begun the upgrade of its active-duty F-16C aircraft. Other aircraft planned for the Link 16 upgrade include B-1B and B-2 bombers, as well as future Link 16 functionality in the A-10 through JTRS.[116] The Navy has also started a Link 16 upgrade for its aircraft, including F/A-18 fighters. The North Atlantic Treaty Organization (NATO) has adopted Link 16 as a datalink standard. Many nations, including the United Kingdom, Belgium, and Norway, are integrating

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[113]Office of the Secretary of Defense, *Charter for the Joint Datalink Information Combat Execution (JDICE) Joint Test and Evaluation (JT&E) Projec*t, 11 April 2003, URL: http://www.jdice.jte.osd.mil/Charter.htm, accessed 16 January 2005.

[114]Joint Datalink Information Combat Execution, *JDICE Test Plan Executive Summary*, undated, URL: http://www.jdice.jte.osd.mil/Charter.htm, accessed 16 January 2005.

[115]Joint Datalink Information Combat Execution, message, subject: "Quick Look Report of Joint Datalink Information Combat Execution (JDICE) Joint Test and Evaluation (JT&E) Mini-Test A Marine Forces (MARFOR) Phase Rmks," 27 January 2005.

[116]Martha Petersante, "Fighters Benefit from Link 16," *Air Force Print News*, 26 September 2003, URL: www.af.mil/news/story_print.asp?storyID=123005690, accessed 20 January 2005; "Northrup Grumman and Air Force Ponder GSCI Initiative for B-2," *Defense Daily*, 1 March 2004, URL: www.proquest.com, accessed 20 January 2005; Mathew McGarry, "Data Link and the Joint Tactical Radio System."

the system on their fighter aircraft.[117] Despite this apparent progress, the Link 16 upgrade is an expensive, long-term commitment—aircraft without access to this potential flow of CID information will still be common on future battlefields.

SUMMARY

The emerging fratricide reduction systems discussed in this chapter show great promise, but their future availability and effectiveness hinges on the CCID ACTD assessment results and the DoD's procurement decisions. It appears unlikely that aircraft will receive a target identification system comparable to BTID. Instead, the best prospects for short term CID improvements lie with fielding RBCI to JTACs. RF Tags may play a role in the more distant future, but the associated technology is immature and limited by the fact that not all attack aircraft have radars. The DoD's broader, long-term efforts to improve SA systems and integrate datalinks are also key to the fratricide reduction effort. Yet, the success of the DoD's efforts to reduce the probability of air-to-ground fratricide relies on combining these disparate elements into a functioning family of systems.

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[117] "Data Link Solutions Awarded Contract for MIDS Terminals," *Aerospace Daily*, 12 Nov 2003, 5, URL: www.proquest.com, accessed 20 January 2005.

CHAPTER 5

ANALYSIS AND RECOMMENDATIONS

The committee found it useful to think of combat ID as a layered defense. . . . reduced fratricide is achieved by adding more combat ID layers at increasing complexity and cost.

-- *Defense Science Board Task Force on Combat Identification*

The emerging air-to-ground fratricide reduction systems will not prove a panacea that prevents air-to-ground fratricide, nor will they reduce the probability of self-inflicted losses equally in all situations. As currently envisioned, the family of systems likely to be fielded in the next decade will be most effective at reducing the probability of fratricide when a JTAC identifies targets for attack; the systems will be less effective in reducing fratricide in situations where aircraft must independently identify their targets.

THE FUTURE FAMILY OF SYSTEMS

The DoD and CCID member nations will almost certainly field some emerging fratricide reduction systems in the next decade, but the realities of military procurement and systems integration will ensure that progress is slow and incremental. While it is impossible to predict the future of any acquisition program, the general trends discussed in previous chapters suggest what the future family of systems may look like.

Projected Situational Awareness and Datalink Systems

As the JBFSA effort unifies today's disparate BFT feeds, SA systems should become more available, especially to C2 agencies like JTACs. Additionally, Link 16-equipped aircraft will be more common on future battlefields and more likely to receive a BFT feed in the cockpit. A majority of JTACs and other C2 agencies will be able to transmit target coordinates and friendly force locations to Link 16-equipped aircraft; some other aircraft will be datalink-capable through BFT-A or legacy systems like SADL. However, a large number of aircraft will continue to rely on voice communications for SA and off-board target identification data.

Projected Target Identification Systems

Future fielding of target identification systems will probably focus on improving JTACs' capabilities. RBCI is the best candidate for rapid fielding to JTACs, as it takes advantage of existing radio equipment. Although there is much momentum for fielding BTID to reduce ground-to-ground fratricide, the cost of vehicle equipment will probably limit its deployment to selected maneuver units and their associated JTACs.[118] These capabilities, combined with the proliferation of SA systems will dramatically improve JTACs' CID capabilities.

The outlook for improving aircraft target identification with CCID ACTD concepts is much less favorable. Some attack helicopters may be RBCI-equipped, but the integration of this technology in fixed-wing aircraft seems less likely. If fielded, RF Tags will probably lag several years behind more mature concepts like RBCI and BTID. Although RF Tags are billed as a low-cost system, it may be too expensive to equip all vehicles with these devices, particularly since the DoD will already be expending considerable resources to equip those same vehicles with

[118]BTID is estimated to cost over $20,000 per vehicle, a little less than half the cost of BCIS when it was cancelled. Hewish and Pengelley, "Taking the Guesswork Out of Combat Identification."

BFT and/or BTID. As with BTID, equipment cost may limit the fielding of RF Tags to select units. Finally, unless there is a major reversal in the current trend, BTID will not be installed in aircraft.

Although the impact of CCID systems on fixed-wing aircraft will be limited, the continued fielding of 3rd generation targeting pods and upgraded attack helicopter FLIRs will significantly improve the clear weather target identification capabilities of most attack aircraft. Yet, these FLIRs remain subject to the inherent limitations of visual identification, and they do not provide an RBCI- or BTID-like ability to cooperatively identify friendly forces. The future family of target identification and SA systems will provide more "layers" of air-to-ground fratricide reduction than contemporary capabilities (see Figure 3), but their effectiveness will vary with the situation.

EFFECTIVENESS ANALYSIS

JTAC Identification

The emerging fratricide reduction technologies will likely be most effective in situations where a JTAC has identified the target. These situations would normally indicate Type 1 control, where a JTAC must visually identify the target, or Type 2 control, where a JTAC must "see" the target directly or through another observer (e.g. SOF, UAV).[119] In these cases, the family of fratricide reduction systems would have the greatest impact, as the JTAC could compare the target location with BFT in an SA system, query target identification with RBCI and/or BTID, and then digitally datalink the coordinates to a CAS aircraft. If the aircraft has a

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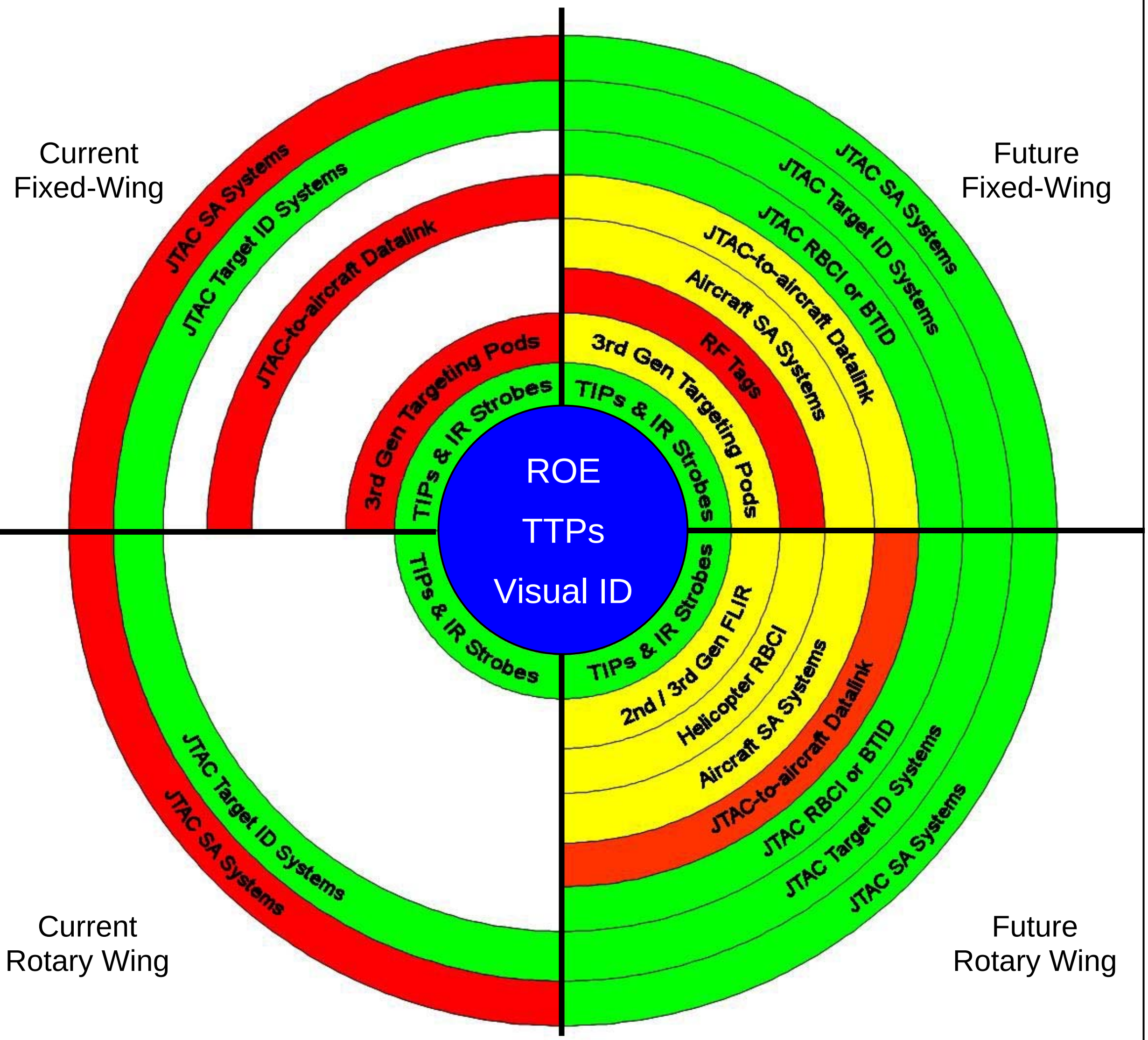
[119]JCS, Joint Pub 3-09.3, V-16 – V-18.

“Layers” of Air-to-Ground Fratricide Reduction Systems



Key:

Color codes reflect the author’s assessment of the systems’ availability, as follows:

- (green) 75 – 100%
- (yellow) 50 – 74%
- (red) 10 – 49%
- (white) 0 – 10%

Notes:

- The future is defined as approximately 2015.
- “Availability” is the rough percentage of aircraft and JTACs that will be equipped with the system.
- The blue core of the diagram represents fratricide reduction procedures, not systems.
- The availability of 1st generation FLIRs is not reflected in this diagram.
- “JTAC Target ID Systems” refers to currently fielded near-IR laser pointers, GLTDs, and TLDs.

Figure 3.

SA system and/or a target identification capability, this only increases the number of safeguards in the process. While fratricide is still a very real possibility in all combat operations, the emerging technologies clearly achieve a significant reduction in the probability of air-to-ground fratricide when a JTAC has identified the target.

Independent Aircraft Identification

However, JTACs do not identify all targets. In Type 3 control of CAS, "JTACs grant a 'blanket' weapons release clearance to an aircraft or flight attacking a target or targets which meet the prescribed restrictions set by the JTAC."[120] Thus, Type 3 control is usually much more dependent on an aircraft's inherent target identification and SA capabilities than Type 1 and Type 2 control. FAC(A) aircraft may also acquire targets and control other CAS aircraft independently or in coordination with a JTAC. Other attack missions that require aircrew to identify fleeting targets without JTAC target identification include: airstrikes against time-sensitive targets (TSTs), airborne alert interdiction (XINT), strike coordination and reconnaissance (SCAR), and killer scout.[121] While all of these non-CAS missions are supposed to be inherently deconflicted from the ground scheme of maneuver, there is still potential for conflict with SOF or other unexpected friendly forces. These conflicts may occur because of

[120]JCS, Joint Pub 3-09.3, V-15.

[121]TSTs are "targets requiring immediate response because they pose (or will soon pose) a danger to friendly forces or are highly lucrative, fleeting targets of opportunity." Joint Chiefs of Staff, Joint Publication 1-02, *Department of Defense Dictionary of Military and Associated Terms* (Washington, DC: GPO, 5 June 2003), 538. XINT missions are air interdiction sorties flown without preplanned targets. SCAR missions are "flown for the purpose of acquiring and reporting deep air support targets and coordinating armed reconnaissance or air interdiction missions upon those targets." U.S. Marine Corps, Marine Corps Warfighting Publication 3-23.2, *Deep Air Support*, (Washington, DC: USMC, 4 January 2001), G-17. The current doctrinal USAF term, "killer scout" is very similar to SCAR, and the USAF may adopt the term SCAR in the ongoing revision of Air Force Doctrine Document 2-1.3, *Counterland*. David Deptula, Gary Crowder, and George Stamper Jr., "Direct Attack: Enhancing Counterland Doctrine and Joint Air-Ground Operations," *Air & Space Power Journal* (Maxwell AFB, AL: Winter 2003), URL: www.airpower.maxwell.af.mil/airchronicles/apj/apj03/win03/deptula.html, accessed 24 May 2004.

human error, the non-linear nature of the battlefield, and/or because the applicable aerospace control measures do not reflect the true disposition of friendly forces.

The emerging fratricide reduction technologies will likely be less effective in the above situations, where an aircraft must autonomously identify a target. While Link 16-equipped aircraft will probably have access to BFT data for SA, the only emerging target identification systems that may be a factor are RBCI and RF Tags. Helicopters with RBCI will be well-equipped for autonomous operations, but fixed-wing aircraft will be reliant on RF Tags. If RF Tags are not present or not compatible with the attacking aircraft, the aircrew will have to rely on their inherent target identification capabilities (and any supporting intelligence, surveillance and reconnaissance assets) to avoid fratricide. In short, there will usually be fewer "layers" of systems to reduce the probability of air-to-ground fratricide when aircraft must identify their own targets without CID support from a JTAC (see Figure 3).

RECOMMENDATIONS

The CCID ACTD and related efforts appear to be making reasonable progress toward the longstanding goal of reducing the probability of air-to-ground fratricide. Even so, the DoD and CCID member nations should:

- Procure modular versions of the emerging fratricide reduction systems. This will allow a coalition to pool its CID resources for a contingency. Modular systems would also give a Joint Force Commander the flexibility to allocate CID resources appropriately.
- Commit more resources to visual identification training. Efforts should include developing a comprehensive computer-based training program that can realistically

simulate the appearance of military vehicles from the air-to-ground perspective in a variety of sensors, terrain, and weather conditions. Additionally, training ranges should provide high-resolution targets for visual identification training. Regional Combatant Commanders and force providers should establish specific visual identification training and testing requirements for their assigned and gained forces.

- Experiment with air-to-ground versions of BTID and RBCI on both helicopters and fixed-wing aircraft. If either technology is deemed appropriate for air-to-ground use, the DoD should equip its current and future attack aircraft and possibly ISR platforms with the appropriate system(s). While permanent installation of BTID and/or RBCI equipment in all aircraft would be ideal, procurement of modular systems that can be carried on external weapons stations would provide a more flexible capability in the near term.
- Increase the number, frequency, and realism of joint and combined exercises to increase forces' proficiency with ROE, TTPs, and fratricide reduction systems.

CONCLUSION

While there is no "solution," technical or otherwise, to the enduring problem of air-to-ground fratricide, it is clearly within the capability and interest of the DoD to reduce the probability of these tragedies. In the 14 years that have passed since DESERT STORM, U.S.-led coalition forces have suffered unnecessary losses for the lack of air-to-ground fratricide reduction systems they so clearly needed in 1991. The DoD has repeatedly failed to unify the services' acquisition efforts to procure the interoperable family of target identification and SA systems required for joint and combined warfare. Instead, the services pursued disparate and incompatible CID technologies that fail to consistently address the root causes of air-to-ground fratricide. As a result, the DoD has been left scrambling in vain for ad hoc technical solutions prior to every armed conflict.

The DoD's current plans for a family of fratricide reduction systems show more promise than its past performance. However, any optimism about the emerging fratricide reduction systems must be tempered with the knowledge that it will take many years to field new systems, assuming that the programs can successfully compete for resources against the services' other budgetary priorities. As currently envisioned, the CCID ACTD systems will primarily address JTACs' target identification shortfalls, while providing only a moderate overall improvement in aircraft target identification capabilities. Other DoD programs will ideally make SA systems more accurate and accessible to C2 agencies and aircraft, but will remain limited by bandwidth, data latency, and legacy technologies.

Despite these limitations, the DoD must follow through on its fielding plans if it is to succeed in reducing the probability of air-to-ground fratricide. The air-to-ground fratricide trend of the last three wars clearly cannot be reduced with TTPs and ROE alone. Equally mature, interoperable, and ubiquitous fratricide reduction systems are required to increase air-to-ground CID capabilities and save friendly lives on future battlefields. The appropriate technology is available and long overdue.

APPENDIX A:

ABBREVIATIONS

1-1 AVN	1st Battalion, 1st Aviation Regiment, 4th Aviation Brigade, 1st Infantry Division
AAV	Assault Amphibian Vehicle
ACTD	Advanced Concept Technology Demonstration
AFB	Air Force Base
APC	armored personnel carrier
ASIP	Advanced System Improvement Program
BCIS	Battlefield Combat Identification System
BFSA	blue force situational awareness
BFT	blue force tracker
BFT-A	blue force tracker—aviation
BTID	Battlefield Target Identification Device
BUG-E	Battlefield Universal Gateway Equipment
C2	command and control
CAS	close air support
CCID	Coalition Combat Identification
CCT	Combat Controller Team
CID	combat identification
CIP	Combat Identification Panels
D-CIMS	Dismounted Combat Identification Marking System
DoD	Department of Defense
EPLRS	Enhanced Position Location and Reporting System
FAC	forward air controller
FAC(A)	forward air controller (airborne)
FBCB2	Force XXI Battle Command Brigade-and-Below
FFIB	Friendly Fire Investigation Board
FLIR	forward-looking infrared
GLINT	IR Gated Laser Intensifier
GLTD	ground laser target designator
GPS	Global Positioning System
ID	identification
IFF	identification, friend or foe
IR	infrared
JBFSA	Joint Blue Force Situational Awareness
JDAM	Joint Direct Attack Munition
JDICE	Joint Datalink Information and Combat Execution
JT&E	Joint Test and Evaluation
JTAC	joint terminal attack controller
JTIDS	Joint Tactical Information Distribution System

JTRS	Joint Tactical Radio System
LANTIRN	low-altitude navigation and targeting infrared for night
NCTR	non-cooperative target recognition
OEF	Operation ENDURING FREEDOM
OIF	Operation IRAQI FREEDOM
RBCI	Radio Based Combat Identification
RF	Radio Frequency
ROC-V	Recognition of Combat Vehicles
ROE	rules of engagement
SA	situational awareness
SADL	Situational Awareness Datalink
SCAR	strike coordination and reconnaissance
SINCGARS	Single-Channel Ground and Airborne Radio System
SOF	Special Operations Forces
TACP	Tactical Air Control Party
TF	Task Force
TIP	Thermal Identification Panels
TLD	target locating device
TST	time-sensitive targets
TTPs	tactics, techniques and procedures
USAF	United States Air Force
USMC	Unites States Marine Corps
UAV	unmanned aerial vehicles
USCENTCOM	U.S. Central Command
USJFCOM	U.S. Joint Forces Command
VMF	variable message format
XINT	airborne alert interdiction

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