SOWING MODERN SEAD:

REAPING SUCCESS OR CHANGING STRAINS?

BY

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ABSTRACT

In this study, I explain suppression of enemy air defense (SEAD) strategy as it interacts with radar-guided surface-to-air missile (SAM) systems. First, I assert that SEAD constitutes a strategy of coercion, and that radar-guided SAM systems respond to SEAD according to a rational decision making process. Next, I use coercion theory to simplify and explain the history of the standoff between SEAD and radar-guided SAM systems spanning from the Vietnam War through Operation Iraqi Freedom. This examination reveals that SEAD has succeeded as a coercion strategy since the Gulf War. Finally, I explore the changing nature of the standoff in the wake of Operation Iraqi Freedom and suggest that changes to US force structure and expectations signal the abandonment of a viable strategy. I conclude with the recommendation that US air forces should carefully consider future SEAD strategy in light of past successes. Furthermore, whatever strategy they select requires careful synchronization with SEAD resources and objectives.

CONTENTS

Introduction

The major combat portion of Operation Iraqi Freedom (OIF) represents a command performance by coalition air forces. In barely three weeks, airpower toppled a regime, supported a thunderous ground force charge, stifled surface-to-surface missile launches, opened and sustained a second front, and provided persistent weapons delivery capability for rapidly emerging targets. Air superiority enabled these feats. While the air component of the Iraqi Air Force did not fly, the ground-based component did contest control of Iraqi airspace. Yet, much to the coalition's surprise, Iraqi surface-to-air missiles (SAM) and anti-aircraft artillery (AAA) mounted far less resistance than anticipated in pre-hostility appraisals.

Coalition suppression of enemy air defense (SEAD) forces' success and the Iraqi air defense system's actions raise several questions. Why did SEAD succeed? Why did Iraqi SAMs relent? How do both sides' actions fit within the larger context of the standoff between SEAD and radar-guided SAM systems? What are the implications of this apparent success for future SEAD strategy? This paper attempts to answer these questions.

Background and Significance

This study examines US air forces' efforts to suppress radar-guided SAMs. Since the first Soviet fielding of a radar-guided SA-2 SAM in 1953, SEAD has posed a perennial challenge for the US anytime it has sought command of the air.[1] The SEAD mission enables air operations. It also forms a component of both counterair and electronic warfare (EW). The SEAD mission itself represents a combination of disruptive and destructive methods. To date, most written work on SEAD examines tactical and operational designs. This study takes a broader approach by examining SEAD as a military strategy.

Within US air forces, the SEAD mission consists of service and joint efforts to enable freedom of maneuver for combat air operations. Joint Publication 1-02 defines SEAD as "that activity that neutralizes, destroys, or temporarily degrades surface-based

[1] Larry Davis, *Wild Weasel* (Carrollton: Squadron/Signal Publications, 1986), 6.

enemy air defenses by destructive and/or disruptive means."[2] Joint Publication 3-01.4, *JTTP for Joint Suppression of Enemy Air Defenses*, further specifies that SEAD and joint SEAD enable airpower employment and do not represent the main effort of air operations.[3] Thus, SEAD helps other air assets survive when opposed by surface-based air defenses. Furthermore, SEAD represents a mission area that contributes to EW. As military action involving the electromagnetic spectrum and directed energy, EW spans electronic attack to include physical attacks, electronic protection, and electronic warfare support.[4] SEAD serves suppression, and contributes to the larger effort that contests the electromagnetic spectrum.

SEAD methods reflect a balance of destruction and disruption. Destructive means attempt to destroy SAM systems and the personnel operating them. Destructive SEAD capabilities include bombs, surface-to-surface missiles, and artillery.[5] Meanwhile, disruptive means attempt to "temporarily deny, degrade, delay, deceive, or neutralize enemy air defense systems to increase aircraft survivability."[6] Disruptive SEAD capabilities include active means such as anti-radiation missiles (ARM), jammers, and decoys, and passive means such as stealth and emissions control. SEAD attempts to wield these means in pursuit of overall air objectives.

SEAD can be conceived of as a tactic, an operational plan, and a strategy. SEAD forms a tactic when it uses platforms and weapons to achieve suppression in a particular air and space environment.[7] Next, SEAD represents an operational strategy that focuses on achieving air superiority over surface-based air defenses within the context of a

[2] Joint Publication (JP) 1-02, *Department of Defense Dictionary of Military and Associated Terms*, 12 April 2001 as amended through 30 Nov 2004, 515.
[3] Joint Publication (JP) 3-01.4, *Joint Tactics, Techniques, and Procedures (JTTP) for Joint Suppression of Enemy Air Defenses (J-SEAD)*, 25 July 1995, I-1.
[4] Joint Publication (JP) 1-02, *Department of Defense Dictionary of Military and Associated Terms*, 12 April 2001 as amended through 30 Nov 2004, 177.
[5] Joint Publication (JP) 3-01.4, *Joint Tactics, Techniques, and Procedures (JTTP) for Joint Suppression of Enemy Air Defenses (J-SEAD)*, 25 July 1995, I-6.
[6] Ibid.
[7] Donald M. Snow and Dennis M. Drew, "National Security Strategy Making" (typescript book submitted for publication, Maxwell AFB, n.d., 35. Snow and Drew provide a taxonomy for characterizing the different levels of strategy. They submit that battlefield strategy constitutes a tactic. Per their taxonomy, this study accounts for SEAD as a battlefield, operational and military strategy, then closely examines the military strategy of SEAD.

campaign fought in a specific theater of operations.[8] Finally, SEAD constitutes a military strategy, developed by both the defense establishment and then each of its services, representing decisions regarding development, deployment, and employment of military means.[9] It is here, at the military strategy level, that this study examines SEAD.

Characterizing the Standoff

To conduct its examination at the military strategy level, this study looks at the broad interaction between SEAD and radar-guided SAM systems. It uses coercion theory to link cause to effect by explaining how SEAD can influence SAM system behavior. Furthermore, since coercion theory assumes the adversary possesses a rational decision calculus, this study uses rational decision-making theory to characterize the choices radar-guided SAM systems make. Coercion theory, and the rational response it assumes, offer a military strategy framework for analyzing the past, present, and future standoff between SEAD and SAMs.

This study argues that the US has leveraged a coercive SEAD strategy since the standoff's inception. Whether neutralization, degradation, or limited destruction, suppression represents the mechanism by which SEAD actions should translate into changed SAM behavior.[10] By design, the suppression mechanism produces changes in a radar-guided SAM system's willingness to engage.

As a requirement of coercion theory, this study argues that radar-guided SAM system behavior is subject to rational decision making. Particularly, SAM operators determine the actions SAM systems take. Unifying SAM operators and their behavior with the equipment they employ, radar-guided SAM systems make cost, benefit, and risk assessments in determining how to contest air superiority. They choose according to a definable calculus consisting of alternatives, consequences, and objectives. Furthermore, in choosing, SAM systems attempt to value-maximize. This study characterizes radar-

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[8] Ibid, 33. See Major Daniel F. Baltrusaitis' SAASS student thesis, *Quest for the High Ground: The Development of SEAD Strategy,* for a value-modeled approach for explaining and developing operational SEAD strategy.

[9] Ibid, 30.

[10] Robert A. Pape, *Bombing to Win: Air Power and Coercion in War*, (Ithaca: Cornell University Press, 1996), 56. Pape states, "Mechanisms provide the intellectual guidance for operational air planners who then translate strategy into actual campaigns with the forces at their disposal." He identifies a means-to-ends chain consisting of force, leveraged against targets, triggering a mechanism, causing behavioral change.

guided SAM systems as rational actors to explain their behavioral changes in response to SEAD strategy.

Thus, two complementary theories shape the framework this paper uses to examine SEAD and radar-guided SAM systems. This framework provides an approach for linking cause to effect when examining the history of the standoff between SEAD and SAMs. Furthermore, this framework has predictive value and can help clarify strategy choices for future US SEAD endeavors.

Methodology

This paper answers the opening questions in three steps. First, it introduces coercion theory as a framework that characterizes the interaction between SEAD and radar-guided SAM systems. Next, it reviews the standoff's history from the Vietnam War until OIF based on the notion that the US SEAD strategy represents one of coercion, and that radar-guided SAM systems respond rationally. Finally, it suggests that the post-OIF environment poses strategy choices to the US based on changes to US air forces' structure and current SAM behavior. Via these steps, this study characterizes the two sides of the standoff, explains the standoff's history, and clarifies US choices for the standoff's future.

Limitations

This study suffers from limitations of depth and breadth. Classification requirements and an emphasis on military strategy limit its depth. In examining just airborne SEAD, the study omits contributions by long-range artillery, aircraft self-protective jamming, and defensive maneuvers. An unclassified discussion of airborne methods of disruption and destruction, along with the IADS response these methods elicit, only covers a portion of this complicated interaction.

Chapter 1

Framing the Standoff

The starting point for studying the standoff between SEAD and radar-guided SAM systems involves selecting a perceptual lens. A tactical perspective would cast the standoff in light of platform and system characteristics such as range, speed, and lethality. An operational assessment would add the dimensions of numbers and time as they affect the clash within the context of a specific campaign. When studying the standoff from a strategic perspective, one must go beyond weapon capabilities and force numbers and address mechanisms and the changes they produce.

This chapter presents coercion theory as a way of characterizing the mechanisms and changes that make up this strategic interaction. Viewed through the lens of coercion theory, SEAD serves a strategy focused on the use of limited force and threats of force for the sake of reducing an IADS' willingness to engage. An implicit assumption of coercion, rational decision theory explains a radar-guided SAM system's willingness to engage as a product of deliberate choice yielded by a value-maximizing calculus. When applied to the standoff, this approach simplifies and explains a portion of the air superiority struggle.

Characterizing SEAD Strategy

US air forces can choose from several mechanism and change approaches when conceiving SEAD strategy. Each SEAD approach wields some combination of destructive and disruptive means.[11] If SEAD strategy exists on a continuum, then annihilation stands at one end and evasion stands at the other. The annihilation strategy focuses on eliminating all radar-guided SAMs to produce complete freedom of operation, and relies heavily on destruction in the form of precision munitions. At the other extreme, evasion strategy focuses on eluding all radar-guided SAMs, and relies mostly on disruption in the form of stealth. Both these extremes represent relatively nascent SEAD strategies because the means they leverage are relatively new to the standoff. Meanwhile, the primary SEAD strategy embraced for the last 40 years stands somewhere in the middle of the spectrum. This section characterizes legacy SEAD as a coercion

[11] Joint Publication (JP) 3-01.4, *Joint Tactics, Techniques, and Procedures (JTTP) for Joint Suppression of Enemy Air Defenses (J-SEAD)*, 25 July 1995, I-6.

strategy. Coercive SEAD strategy focuses on reducing the effectiveness of radar-guided SAMs to make them unwilling to engage, and relies on a balance of destructive and disruptive means.

Coercion Defined

As originally conceived, coercion theory explains one type of interaction between a state's armed forces and a targeted nation. A coercion strategy pursues behavioral change instead of complete destruction. In doing so, coercion targets a rational decision-maker possessing a known calculus derived from the expected utility of its actions. Coercion succeeds when an adversary, minding this calculus, gives in prior to outright defeat. Overall, coercion leverages force and threats to cause an adversary to relent while it still has the means to resist.

Coercion theory hinges on the idea that victory occurs when an adversary relents. Unlike brute force strategies bent on annihilating a rival nation and its forces, coercion strategies minimize destructive methods.[12] A strategy of coercion involves "the use of threatened force, including the limited use of actual force to back up the threat, to induce an adversary to behave differently than it otherwise would."[13] Coercion relies on possessing and threatening to use the power to hurt, without actually causing pain to the full extent of the coercer's capabilities.[14] When a state exercises coercion successfully, the target state retains an unexercised capacity for resistance.[15] Thus, coercion theory links military power to adversary concession via threats and measured force.

Coercion theory links power to behavior by assuming the target behaves rationally. Rational decision theory takes a complex entity like a nation and treats it as a homogenous, unitary actor possessed of a discernible decision calculus.[16] The actor behaves as the result of conscious choice, not as a product of haphazard interactions with the environment. The actor makes choices according to established objectives,

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[12] Daniel L. Byman, Matthew C. Waxman, and Eric Larson, *Air Power as a Coercive Instrument,* RAND Report MR-1061-AF (Santa Monica: RAND, 1999), 13.
[13] Ibid, 10.
[14] Thomas C. Schelling, *Arms and Influence*, (New Haven: Yale University Press, 1966), 2.
[15] Daniel L. Byman, Matthew C. Waxman, and Eric Larson, *Air Power as a Coercive Instrument,* RAND Report MR-1061-AF (Santa Monica: RAND, 1999), 13.
[16] Graham Allison and Philip Zelikow, *Essence of Decision: Explaining the Cuban Missile Crisis*, 2nd ed. (New York: Addison Wesley Longman, Inc., 1999), 24.

alternatives, and prioritized consequences.[17] The calculus these factors produce guides the actor towards "consistent, value-maximizing choice within specified constraints."[18] Overall, rational decision theory unifies a complex entity, builds a cost, benefit, and risk basis for its decisions, and produces a simplified basis for its actions.

The successful application of a coercive strategy requires a careful assessment of the adversary's calculus. Coercive efforts focus on the value the adversary assigns to resisting the coercer's demands based on its perception of costs and benefits.[19] A coercer affects the adversary's behavior by changing this perception.[20] Benefit manipulation succeeds infrequently as benefits often tie to basic values like territory, nationalism, economics, and cultural bonds that will remain static in the short term.[21] On the other hand, a coercer can effectively raise the costs of continued resistance by undermining basic goals or objectives of the state. Additionally, by repeatedly and successfully raising costs, a coercer can establish credibility with the adversary. From the adversary's perspective, credibility raises the probability that the coercer will follow through on subsequent threats.[22] Thus, to leverage a coercive strategy, a state attempts to comprehend an adversary's resistance calculus as well as the inroads to influencing it.

Regardless of leverage, a coercion strategy's measure of success depends on the adversary. "The success or failure of coercion rest[s] in the decision of the target state."[23] Coercion succeeds if the adversary still has the power to resist when it capitulates.[24] If the coercer makes no threats, but if the coercer's other actions or capabilities compel a change in the adversary's behavior, coercion still succeeds.[25] Alternatively, the strategy fails if the target never complies despite continued coercive effort. Naturally, coercion also fails if the coercer relents before the adversary concedes.

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[17] Ibid, 18.
[18] Ibid.
[19] Robert A. Pape, *Bombing to Win: Air Power and Coercion in War*, (Ithaca: Cornell University Press, 1996), 16.
[20] Ibid, 12.
[21] Ibid, 16.
[22] Daniel L. Byman, Matthew C. Waxman, and Eric Larson, *Air Power as a Coercive Instrument,* RAND Report MR-1061-AF (Santa Monica: RAND, 1999), 12-13.
[23] Robert A. Pape, *Bombing to Win: Air Power and Coercion in War*, (Ithaca: Cornell University Press, 1996), 13.
[24] Daniel L. Byman, Matthew C. Waxman, and Eric Larson, *Air Power as a Coercive Instrument,* RAND Report MR-1061-AF (Santa Monica: RAND, 1999), 13.
[25] Robert A. Pape, *Bombing to Win: Air Power and Coercion in War*, (Ithaca: Cornell University Press, 1996), 12.

Finally, if the conflict concludes only after the adversary has been decisively defeated, coercion has failed.[26] The adversary's response and the lengths the coercer went to influence this response determine whether or not a coercive strategy succeeded.

Therefore, coercion balances one nation's ability to inflict pain against its adversary's desire to resist. As a strategy, coercion threatens the use of force to either prevent or change an adversary's behavior. Coercion theory assumes the adversary behaves rationally. To affect adversary behavior, the coercer should understand the decision calculus of its opponent. Coercion offers inroads to this decision calculus through costs and probabilities. Ultimately, coercive strategies succeed when the adversary relents prior to total defeat. In short, coercion theory explains an interaction where objectives, force, threats and resistance coexist.

SEAD Cast in Coercion Theory

Coercion theory fits when applied to the way legacy SEAD strategy interacts with radar-guided SAMs. SEAD succeeds by changing the system's behavior. It does this by manipulating the radar-guided SAM system's calculus through the factors of cost and probability. Ultimately, coercive SEAD achieves its aims when the radar-guided SAM system relents despite its capability to mount further or greater resistance. Casting SEAD within coercion theory's framework helps clarify the standoff.

SEAD succeeds by creating "favorable conditions for all friendly air operations."[27] To coerce, SEAD uses threatened force and limited actual force to perform neutralization, destruction, and degradation of the radar-guided SAM system. As eliminating defenses is not an end in and of itself, SEAD does not have to pursue complete destruction of the enemy SAM system.[28] Rather, SEAD attempts to keep a radar-guided SAM system from impeding other air operations. By preventing a radar-guided SAM system from employing, or affecting the system's willingness to employ to its fullest potential, SEAD changes the system's behavior. The affected SAM system retains an unexercised capacity for resistance.

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[26] Ibid, 15.

[27] Joint Publication (JP) 3-01.4, *Joint Tactics, Techniques, and Procedures (JTTP) for Joint Suppression of Enemy Air Defenses (J-SEAD)*, 25 July 1995, I-1.

[28] Joint Publication (JP) 3-01.4, *Joint Tactics, Techniques, and Procedures (JTTP) for Joint Suppression of Enemy Air Defenses (J-SEAD)*, 25 July 1995, I-1.

SEAD affects the radar-guided SAM system's decision calculus. As in the case of the broader concept of coercion, the SEAD mission has little ability to manipulate the benefits a radar-guided SAM system derives from deploying against, employing against, or even downing friendly aircraft. The system and the nation fielding it determine these benefits, which remain relatively unchanging in the short term. However, SEAD can raise costs of continued system resistance. If the system emits any radar energy, it increases its chance of being located and subsequently targeted by disruptive or destructive SEAD. If a radar-guided SAM system employs in a guided mode, it increases its vulnerability to anti-radiation missiles (ARM). Even if the system doesn't employ, by remaining static and exposed the system increases its chances of being located by US reconnaissance systems and subsequently targeted. SEAD manipulates the probability of threatened costs by exerting credible suppressive efforts, not only during the conflict at hand, but through its successes in preceding conflicts. Finally, SEAD influences the likelihood that deployment and employment will provide the SAM system its desired benefits by reducing SAM effectiveness. Effective SEAD involves understanding and manipulating the SAM system's resistance calculus.

The radar-guided SAM system decides whether SEAD successfully coerces. If the system stays fielded and either doesn't employ or uses tactics that reduce the system's effectiveness, SEAD has coerced successfully. If SEAD forces do not fly or do not employ but the system still accedes, SEAD has also coerced successfully. Alternatively, if the radar-guided SAM system continues to mount its most effective and most lethal resistance despite SEAD presence, coercive SEAD has failed. When SEAD measures lead to complete destruction of the radar-guided SAM system prior to a change in system behavior, coercive SEAD has also failed. The radar-guided SAM system enables successful coercive SEAD through deliberate changes of behavior that constitute the neutralization, degradation, and disruption SEAD forces seek.

The SEAD mission fits well within a coercion framework. SEAD pursues behavioral change by an enemy radar-guided SAM system through manipulation of the system's decision calculus. To succeed, coercive SEAD must change the way adversary SAMs deploy and employ. When analyzing the SEAD and SAM standoff, coercive SEAD strategy is working when SAM systems relent despite their continued ability to resist. If SAM systems do not relent, or if they suffer utter destruction, then the coercive SEAD strategy failed. The notion that legacy SEAD represents a coercion strategy lends clarity to the study of US air forces' past and future endeavors to achieve air superiority against ground-based air defenses.

SAM Behavior Rationalized

The second piece of the framework characterizing the standoff between SEAD and SAMs involves the radar-guided SAM portion of a nation's IADS. This segment spans an immense range of components, interrelationships, and personnel. The act of detecting, identifying, and engaging an aircraft falls to these components in a manner dependent on the particular system's method of control.[29] The complicated inner workings of a radar-guided SAM system do not lend themselves to straightforward analysis vis-à-vis a SEAD strategy. Furthermore, the notion that SAM systems behave irrationally or randomly proves just as detrimental to broad study. Thus, clarifying radar-guided SAM system actions within rational decision theory allows the analysis of SEAD coercion strategy to proceed.

To establish cause and effect relationships in the standoff between SEAD and SAMs, radar-guided SAM system behavior should be construed as rational. First, all air defense personnel, components, and processes supporting a radar-guided SAM launch should be unified and homogenized as the radar-guided SAM system. Next, SAM employment tactics and engagement decisions should be cast as conscious choices defined by objectives, consequences, and alternatives serving a value-maximizing calculus defined by costs, benefits, and risks. The following section frames radar-guided SAM actions within rational decision theory.

Unifying a radar-guided SAM system requires merging a complex arrangement of command and control relationships, operating procedures, components, and weapons system performance. Conventional IADS possess hierarchical structures consisting of people and equipment.[30] The air defense operations center (ADOC) orchestrates overall

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[29] Major Daniel F. Baltrusaitis, *Quest for the High Ground*, SAAS Thesis (Maxwell AFB, AL: Air University Press, 1997), 27-37.
[30] Michael Puttre, "Good Move: New Thinking in Air Defense Networks Puts SEAD in Check," *Journal of Electronic Defense*, May 2001, 40.

performance of the IADS in defense of a region or the state as a whole.[31] Next, sector operations centers (SOC) control defense operations within specific geographic areas.[32] Within each area, control and reporting centers (CRC) integrate early warning and cueing data and pass them to the SAM batteries.[33] Finally, a group of radars, launchers, and control components constitutes a SAM battery and works together in a coordinated fashion. This study's application of rational decision theory melds these elements into a single entity that defines its behavior by making choices.

A process of deliberation produces each action the radar-guided SAM system takes. SAM employment tactics and each engagement decision represent conscious choices. Furthermore, the system makes these choices as value-maximizing solutions to the air defense problem. In short, the radar-guided SAM system acts to "destroy attacking enemy aircraft or missiles in the Earth's envelope of atmosphere, or to nullify or reduce the effectiveness of such attack."[34]

Several elements make up a radar-guided SAM system's calculus. First, objectives orient the system's decisions. The objectives a SAM system may pursue include destroying the maximum number of enemy aircraft, reducing the effectiveness of enemy attacks against certain targets and in specific sectors, and compelling enemy forces to use more sorties in a support role for the sake of SAM suppression. Additionally, the system may operate for the purpose of boosting the morale of the nation's populace as a visible measure of resistance against enemy attacks. Finally, a radar-guided SAM system may operate in a way that guarantees or improves its chances of survival. Some of these objectives complement each other, while others are mutually exclusive.

Alternatives make up the actions whereby a radar-guided SAM system serves its objectives. Once again, some alternatives complement each other, while others are mutually exclusive. For example, the alternatives serving the objective of destroying maximum numbers of enemy aircraft include system deployment, and full-capabilities

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[31] Group Captain M.B. Elsam, *Air Defence*. (London: Brassey's Defence Publishers, Ltd., 1989), 69-72.
[32] Ibid, 71-74.
[33] Major Daniel F. Baltrusaitis, *Quest for the High Ground: The Development of SEAD Strategy*, SAAS Thesis, (Maxwell AFB: Air University Press, 1997), 32-37.
[34] Joint Publication (JP) 1-02, *Department of Defense Dictionary of Military and Associated Terms*, 12 April 2001 as amended through 30 Nov 2004, 17.

employment.[35] These same actions can serve the objectives of reducing attack effectiveness and compelling an enemy to use more sorties in a support role. Yet, merely deploying the system can necessitate more support sorties to provide suppression of the fielded SAM threat. Likewise, firing missiles ballistically can still reduce attack effectiveness by forcing aircraft to react defensively and even jettison ordnance. Other alternatives include keeping the SAM system in garrison, firing missiles in degraded modes, and moving SAMs frequently, each of which serves SAM system survival. The act of serving its objectives by exercising alternatives manifests itself as SAM system behavior.

The radar-guided SAM system's actions lead to consequences that lend quantifiable utility to system alternatives and the objectives they serve. Thus, the linkage is one of consequence, the alternatives that achieve it, and the objectives that evoke the alternatives. For instance, the consequence that the nation suffers destruction of fewer resources can result from deploying and employing SAMs. This consequence serves objectives including boosted morale for the populace, destruction of enemy aircraft, and reduced attack effectiveness. Other consequences springing from different alternatives include enemy aircraft attrition, the necessity to use enemy aircraft in search and recovery efforts, and an enduring SAM system capacity for contesting air superiority. Ultimately, the radar-guided SAM system will prioritize these consequences, choose the most valuable from among them, and behave according to the alternative or alternatives that produce it.

The radar-guided SAM system prioritizes its consequences based on its estimation of costs, benefits, and risks. SAM system costs and benefits derive from different valuations of elements including survivability, lethality, efficiency, predictability, and detectability. For instance, a radar-guided SAM system's behavior consisting of deploying to a single location and firing in a fully-guided or optimum mode springs from a system calculus that values the benefits of lethality and efficiency over the costs of

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[35] This study defines full-capabilities employment as the radar-guided SAM system engagement mode that maximizes the system's lethality. The mode involves guided engagements, whereby the SAM system uses its radars in their fullest capacity to acquire, track, engage, and destroy targets. Furthermore, for systems that are designed for primarily static deployment and operation (SA-2, SA-3, SA-5, etc), this mode includes infrequent movement, as each battery is inoperable during disassembly, transport, and assembly and thus incapable of engagement.

survivability, predictability, and detectability. For a SAM system, risks qualify trends in the change of this calculus, and may be expressed in terms of increasing predictability, decreased survivability, and so on.

Thus, a radar-guided SAM system may be cast as a rational actor. Unifying the system simplifies this complicated portion of a nation's defenses. Furthermore, rational decision theory allows system behavior characterization within a calculus derived from objective, consequence, and alternative and driven by costs, benefits, and risks. This manner of characterizing SAM system behavior renders it explicable. The resultant radar-guided SAM system model simplifies and explains the standoff between SEAD and SAMs.

Summary

Coercion theory provides an analytical framework for studying the interaction between SEAD and radar-guided SAM systems. SEAD coerces behavior change in a radar-guided SAM system through disruptive and destructive methods. A radar-guided SAM system, meanwhile, gains simplicity when cast as a unitary actor possessed of a definable decision calculus characterized by cost and benefit estimations centered on consequences, alternatives, and objectives. Chapter Two applies this framework to SEAD and radar-guided SAM interactions during conflicts spanning from the Vietnam War to OIF.

Chapter 2

History of the Standoff

The lineage of the standoff between SEAD and radar-guided SAM systems consists of three phases. The first phase spans from initial SA-2 employment by North Vietnam (NVN) in 1965 to the Cold War's thaw in 1990. During this period, radar-guided SAM systems resisted SEAD's coercive efforts in what amounted to attrition warfare. Extending from Desert Storm until just prior to Operation Allied Force (OAF), the second phase witnessed radar-guided SAM systems' reconsideration of steadfast resistance while SEAD made coercive headway employing persistent disruption and occasional destruction. Finally, US conflicts between OAF and OIF revealed relenting SAM systems performing less than full-capabilities engagement while SEAD forces questioned the value of disruption and favored destruction amidst a period of coercive triumph. Taken together, these phases represent the three-step evolution consummating SEAD's success as a coercive strategy.

Phase I – SAM Systems Resist

SEAD and radar-guided SAM system interaction between 1960 and 1990 devolved into a standoff of attrition. The standoff commenced during the Vietnam War as radar-guided SAM systems opposed an air campaign for the first time and US air forces responded by developing the elemental bases of SEAD. In the Cold War years that followed, US SEAD forces capitalized on Vietnam's lessons and sought parity with the Soviet SAM threat, while radar-guided SAM systems grew more capable and better able to provide mobile battlefield air defense to advancing ground forces. Though not a direct US effort, the Arab-Israeli wars provided an archetype for the attrition-based standoff. SEAD as a coercive strategy failed during this period because radar-guided SAM systems showed few signs of backing down.

The Vietnam War set an enduring stage for an attrition-based clash between SEAD and radar-guided SAM systems. The SA-2 had made its debut against US aircraft in 1960 by shooting down Francis G. Powers' U-2 over the Soviet Union.[36] However,

[36] Anthony M. Thornborough and Frank B. Mormillo, *Iron Hand: Smashing the Enemy's Air Defences* (Sparkford: Haynes Publishing, 2002), 3.

the Vietnam War witnessed American air forces' first confrontation with a developed SAM system in an air campaign situation. The NVN SA-2 threat entered the Vietnam conflict with the shootdown of an F-4C on 24 July, 1965, and changed the character of the air war.[37] High altitude no longer provided a sanctuary whereby US aircraft could deny the NVN anti-aircraft artillery (AAA) threat. [38] US air forces found themselves utterly unprepared to counter the new threat.[39] Over the next seven years, the NVN radar-guided SAM system burgeoned to a well-integrated force consisting of over 200 sites.[40] This system directly accounted for 7 percent of US aircraft combat losses, or 110 aircraft, and doubtlessly assisted in downing may more as aircraft entered anti-aircraft artillery envelopes or failed to detect NVN MiGs while avoiding SAMs.[41] US air forces responded by developing airborne standoff jamming, ARMs, and aircraft teams and tactics designed to bomb SAM sites.[42] Both SEAD and radar-guided SAM systems matured during the Vietnam War.

The attrition-based standoff continued in concept as the Soviet Union and United States built up their conventional arsenals during the Cold War. The radar-guided SAM portion of Soviet air defense doctrine hinged on deployment of medium to long range systems in relatively fixed positions to protect strategically important assets. The Soviets also developed mobile short to medium range radar-guided systems designed to provide battlefield air defense to advancing Soviet ground forces. Meanwhile, the US honed its SEAD forces capabilities as it faced the specter of assisting NATO ground forces fighting a numerically superior Soviet threat in central Europe. Drawing on the lessons of Vietnam, the US developed better disruptive SEAD aircraft, improved ARMs, and fielded the first stealth aircraft, the F-117, to strike high value targets protected by air

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[37] Kenneth P. Werrell, *Archie, Flak, AAA, and SAM: A Short Operational History of Ground-Based Air Defense* (Maxwell AFB: Air University Press, 1988), 105.
[38] Ibid, 102. In response to the North Vietnamese AAA threat, aircrew transitioned from the low-level tactics practiced for nuclear weapons delivery in central Europe to employment altitudes of 15,000 to 20,000 feet mean sea level.
[39] Werrell, 107.
[40] Robert F. Futrell, *Ideas, Concept, Doctrine: Basic Thinking in the United States Air Force 1961-1984*, vol. 2 (Maxwell AFB: Air University Press, 1989), 290.
[41] Wayne Thompson,. *To Hanoi and Back: The US Air Force and North Vietnam, 1966-1973*, (Washington, D.C.: Smithsonian Institution Press, 2000), 311.
[42] Lt Col James R. Brungess, *Setting the Context: Suppression of Enemy Air Defenses and Joint War Fighting in an Uncertain World (*Maxwell AFB: Air University Press, 1994), 8.

defenses. Both Soviet and US equipment and employment doctrine proliferated among the nations' allies.

As a Cold War case study, the Arab-Israeli Wars typified the standoff's attritional nature. In 1973, Egypt and Syria attacked Israel intent on maintaining air superiority over their own forces in the face of a superior Israeli Air Force (IAF).[43] With quantity, variety, and mobility, the Egyptians and the Syrians covered their forces' advance with almost 200 radar-guided SAM batteries.[44] The IAF lost approximately 90 aircraft to SAMs and anti-aircraft fire.[45] Eventually, the IAF adapted tactically and worked in concert with the Israeli army to suppress or destroy Arab SAMs. Later, when Syria moved 19 SAM batteries into the Bekka Valley in April 1981, the Israelis capitalized on their lessons of the 1973 war. The IAF executed a carefully coordinated and varied SEAD effort that cost it no more than six aircraft in exchange for approximately 27 Syrian SAM batteries.[46] Though the scales tipped back and forth depending on technological factors and tactical ingenuity, the Arab-Israeli wars provide a microcosm of failed coercive SEAD strategy in the face of recalcitrant radar-guided SAM systems.

During the Cold War, SEAD and radar-guided SAM systems waged wars of attrition. The Vietnam War set the stage as SEAD and radar-guided SAMs transitioned from nascence to maturity in the context of a major conflict. The Cold War furthered the tension in this vein, as the Soviets and US bolstered their respective capabilities. The Arab-Israeli wars reflect the period's attritional conduct with a seesawing of successes based on capabilities and tactics.

SEAD Strategy

During this period, SEAD developed and employed the disruptive and destructive elements allowing it to serve a coercion strategy. SEAD strategy favored disruption. Disruptive implements like ARMs, jamming, and decoys emerged as the primary SEAD instruments. For instance, between April and October 1972, US forces fired 2330 ARMs

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[43] Kenneth P. Werrell, *Archie, Flak, AAA, and SAM: A Short Operational History of Ground-Based Air Defense* (Maxwell AFB: Air University Press, 1988), 139. Accounting regarding Israeli losses varies depending on sources. Werrell offers a range of Israeli losses between 82 and 100 aircraft. The text of this study presents the median value.
[44] Ibid, 140.
[45] Ibid, 145.
[46] Ibid, 146. Werrell offers a range of Syrian losses between 19 and 36 SAM batteries. The text of this study presents the median value.

with 160 evaluated or possible hits.[47] US SEAD forces pursued this approach despite the fact that the AGM-45 Shrike, the primary ARM used during Vietnam, often disabled the site for less than 24 hours.[48] Yet, SEAD employed limited destructive measures with some effect. In the first nine months of 1966, 75 strikes against 60 NVN SA-2 sites claimed 25 destroyed and another 25 damaged.[49] In Linebacker II, US air forces performed destructive SEAD against NVN SAM sites, achieving 50 percent damage against two sites. Illustrating the reliance on disruption, the 1967 388th Tactical Fighter Wing tactics manual directed SEAD crews to perform suppression first, with SA-2 site destruction being reserved as a secondary function.[50] Yet, SEAD as a coercive strategy failed during the period due to radar-guided SAM systems' willingness to fight to their full capabilities and accept significant losses. Resultantly, coercive SEAD strategy became shrouded in the exchanges characteristic of attrition warfare.

SAM System Behavior

The Cold War standoff between SEAD and radar-guided SAM systems was one of attrition because SAM systems chose to resist. The SAM system calculus simply valued lethality over survivability. The North Vietnamese, the Soviets, and others increased radar-guided SAM system benefits by fielding and linking large numbers of systems. After US SEAD forces raised costs through destructive means, the NVN system behaved differently by assigning each SAM battalion three alternate sites instead of maintaining fixed locations.[51] Furthermore, the NVN SAM system used everything from fixed area defense methods to "shooting and scooting" after firing single missiles.[52] In response to disruptive SEAD, the Vietnamese system codified efficient radar-employment methods in an attempt to reap the benefits of guided engagements while

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[47] Major William A. Hewitt, *Planting the Seeds of SEAD: The Wild Weasel in Vietnam* (Maxwell AFB: Air University Press, 1992), 28.
[48] Lt Col Robert Belli quoted in Major William A. Hewitt, *Planting the Seeds of SEAD: The Wild Weasel in Vietnam* (Maxwell AFB: Air University Press, 1992), 24.
[49] Kenneth P. Werrell, *Archie, Flak, AAA, and SAM: A Short Operational History of Ground-Based Air Defense* (Maxwell AFB: Air University Press, 1988), 108.
[50] Major William A. Hewitt, *Planting the Seeds of SEAD: The Wild Weasel in Vietnam* (Maxwell AFB: Air University Press, 1992), 24.
[51] Ibid, 29.
[52] Ibid.

decreasing the costs ARMs could exact.[53] Yet, even when actively targeted by SEAD forces during Linebacker II, Vietnamese SAM sites like Hanoi's VN 549 remained fixed.[54] In the 11 days of Linebacker II, the Vietnamese system fired hundreds of SA-2s, downed 15 B-52s and three other aircraft, and suffered damage to two sites. In fact, SAMs around Hanoi apparently emitted launch signals over 1000 times, and stopped firing towards the end of Linebacker II because the system had run out of missiles.[55] Vietnamese, Soviet, and Arab radar-guided SAM systems accepted the consequence of increased losses for the sake of performing full-capabilities employment in pursuit of all the corresponding objectives served by that alternative.

Phase II – SAM Systems Reconsider

The 1990s clashes of mature Cold War equipment and methods commenced a period marked by radar-guided SAM systems' reconsideration of full-capabilities employment while SEAD forces pursued coercion. The Iraqi radar-guided SAM system mounted determined resistance during the opening days of the Gulf War, then noticeably shifted its strategy in the face of a withering coalition SEAD onslaught. The SEAD and Iraqi radar-guided SAM system standoff continued to evolve during the period of United Nations no-fly zone enforcement. By the time the US executed Operation Desert Fox Iraq in December of 1998, the standoff was far from attrition-based. Radar-guided SAM system behavior had changed.

The Gulf War marked the beginning of radar-guided SAM system strategic reconsideration. On 17 January, 1991, coalition air forces faced a modern, integrated Iraqi IADS composed of over 600 surface-to-air missile units. Phase I and Phase II of the air war each included a campaign SEAD effort focused on attaining air superiority over Iraq and Kuwait, respectively.[56] Iraq's radar-guided SAM system initially exhibited full-capabilities employment, downing two or three coalition aircraft.[57] However,

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[53] Marshall L. Michel, III, *The 11 Days of Christmas: America's Last Vietnam Battle* (San Francisco: Encounter Books, 2002), 45.
[54] Kenneth P. Werrell, *Archie, Flak, AAA, and SAM: A Short Operational History of Ground-Based Air Defense* (Maxwell AFB: Air University Press, 1988), 125.
[55] Marshall L. Michel, III, *The 11 Days of Christmas: America's Last Vietnam Battle* (San Francisco: Encounter Books, 2002), 248. Michel cites the number of SA-2s fired as ranging from 239 to 1285 based on large differences between US and NVN reporting. Multiple US accounts favor higher numbers.
[56] "Success from the Air," *Jane's Defence Weekly*, 6 April 1991, 530.
[57] Maj Gen John Corder interview in Hal Gershanoff, "EC in the Gulf War," *Journal of Electronic Defense*, May 1991, 48.

decapitating SEAD attacks on Iraqi command and control and early warning resources left Iraqi radar-guided SAM units searching autonomously. Though they could find their targets using their own radars, they discovered that doing so unacceptably increased their exposure to coalition ARMs. After a few days, the Iraqi radar-guided SAM system limited its transmissions to 20 seconds, hurting its target acquisition capability.[58] Even when engaging targets, the system would radiate for only a few seconds, causing most launches to be ballistic and much less lethal. Yet, coalition forces destroyed only 115 of the 200 fixed Iraqi SAM batteries.[59] In the end, after 43 days of air effort, the Iraqi radar-guided SAM system was more suppressed than it was destroyed, and SEAD as a strategy of coercion was vindicated.

The standoff between coalition SEAD assets and the Iraqi radar-guided SAM system following the Gulf War witnessed a steadfast SEAD strategy and increased evasiveness by the radar-guided SAM system. Iraq consolidated its air defenses between the 33- and 36-degree lines of latitude in response to coalition activities enforcing UN Security Council Resolutions 678 and 687. From the safe haven in the center of the country, the Iraqi radar-guided SAM system deployed batteries to threaten coalition air forces patrolling the no-fly zone. Though the Iraqis never downed an aircraft, the Iraqi IADS frequently fired at coalition planes and conducted over 1,000 attacks between December 1998 and August 2001 alone.[60] Notably, the Iraqi radar-guided SAM system seldom performed full-capabilities employment. Instead, it favored frequent movement and few launches that were predominately ballistic. In response, coalition operating rules required that SEAD aircraft escort other coalition aircraft in the no-fly zones. When the Iraqi SAM system attempted full-capabilities employment against patrolling coalition aircraft, SEAD responded with ARMs and jamming.[61] When US air forces located Iraqi

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[58] "Success from the Air," *Jane's Defence Weekly*, 6 April 1991, 530.

[59] Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 5.

[60] Maj Gen Walter Buchanan, "Air Force Current Operations," briefing to Congressional Air Power Caucus, Bolling AFB, 12 March 2001, in Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 4.

[61] K. Chaisson, "Iraqi Anti-SEAD Techniques Prove Ineffective," *Journal of Electronic Defense*, February 1999, 18. Many anecdotal accounts attest to this period of the standoff. Chaisson's article covers a period

SAM components, they performed destructive SEAD. Overall, by reconsidering its decision-making calculus, the Iraqi radar-guided SAM system progressed further away from the attrition standoff that existed in the opening days of Desert Storm.

The four day Desert Fox effort revealed how much the standoff had changed in the intervening years since the Iraqi SAM system's initial strategic reconsideration. From 16 to 19 December 1998, coalition aircraft attacked almost 100 targets in an attempt to degrade Iraq's weapons of mass destruction capability, and the country's ability to threaten its neighbors with conventional weapons.[62] To maintain air superiority along approaches to more central target areas, coalition aircraft targeted 16 SAM sites and damaged or destroyed nine of them. Aircraft also targeted 18 IADS nodes, destroying or damaging 13.[63] US and British aircraft flew over 650 strike and strike support sorties without a single loss.[64] In fact, the Iraqi radar-guided SAM system fired no more than one or two missiles over the four-day period.[65] In his 19 December, 1998, summary of US actions against the Iraqi SAM system, Admiral Thomas Wilson, Director of Intelligence for the Joint Staff, commented, "There really is no long term need to hit SAMs or integrated air defense for the sake of hitting integrated air defense systems. These systems are important to suppress, degrade, or in some cases destroy to support the strike."[66] The Iraqi radar-guided SAM system essentially relented during Desert Fox's large-scale operations.

In the face of persistent disruptive and opportune destructive SEAD, radar-guided SAM system behavior evolved during the 1990s. Desert Storm witnessed the Iraqi system's strategic reconsideration following early SEAD successes. In the years

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of increased Iraqi surface-to-air defense activity during a period following Operation Desert Fox from 28 Dec 1998 to 7 Jan 1999.

[62] William S. Cohen, "DOD News Briefing, 16 Dec 1998," n.p., on-line, Internet, 1 February 2005, available from http://www.defenselink.mil/transcripts/1998/t12161998_t216gulf.html.

[63] Anthony H. Cordesman, *The Lessons of Desert Fox: A Preliminary Analysis*, CSIS Report (Washington, D.C.: Center for Strategic and International Studies, 16 February 1999), 93.

[64] William S. Cohen, "DOD New Briefing, 19 Dec 1998", n.p. on-line, Internet, 1 February 2005, available from http://www.defenselink.mil/transcripts/1998/t12201998_t1219coh.html.

[65] General Anthony Zinni, as quoted in Anthony H. Cordesman, *The Lessons of Desert Fox: A Preliminary Analysis*, CSIS Report (Washington, D.C.: Center for Strategic and International Studies, 16 February 1999), 80.

[66] Admiral Thomas Wilson, as quoted in Anthony H. Cordesman, *The Lessons of Desert Fox: A Preliminary Analysis*, CSIS Report (Washington, D.C.: Center for Strategic and International Studies, 16 February 1999), 54.

following Desert Storm, SEAD continued disruptive and occasionally destructive methods in the no-fly zones, while the Iraqi system sporadically deployed elements to challenge them. When coalition forces executed Desert Fox, the Iraqi radar-guided SAM system would not challenge large-scale intrusions on Iraqi airspace. The Iraqi radar-guided SAM system's reconsideration led it to a strategy marked by less resistance.

SEAD STRATEGY

As a way of coercing a radar-guided SAM system, SEAD came into its own during this period. First, the technological and tactical instruments of SEAD had improved throughout the Cold War. These changes gave SEAD the ability to raise radar-guided SAM system costs. SEAD forces possessed better sensors to detect SAM system emissions, as well as better ARMs and jamming methods to disrupt and degrade active radars. Furthermore, SEAD forces working in concert with intelligence, surveillance, and reconnaissance (ISR) assets were better able to locate SAM systems when they emitted. Improved location capability led to greater destructive successes, though Gulf War SEAD destroyed barely half of Iraq's fixed SAM systems. Later, destructive attacks damaged 33 of 35 air defense elements prior to August 2001, but these resources were later rebuilt and improved.[67] Destruction still offered limited returns. Next, SEAD forces demonstrated their capabilities repeatedly during frequent contests in Iraq, establishing credibility to the threat posed by SEAD forces' presence. Where SEAD constituted compellence in the face of Iraqi radar-guided SAM system full-capabilities employment at the start of Desert Storm, by Desert Fox the mere presence of SEAD deterred. From the Gulf War through Desert Fox, SEAD became increasingly viable as a coercion strategy.

SAM SYSTEM BEHAVIOR

Ultimately, a change in the Iraqi radar-guided SAM system decision calculus gave SEAD its coercive success. By Desert Fox, the Iraqi system infrequently deployed into the no-fly zone, moved very frequently, performed mostly unguided launches, and contributed little to the defense of Iraqi airspace. Undoubtedly, improved SEAD technology and tactics raised system costs and sustained performance lent SEAD

[67] Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 6.

credibility leading to higher SAM system estimation of survivability risks. Yet, radar-guided SAM system behavioral choices appeared to serve different objectives. By minimizing full-capabilities employment, the Iraqi radar-guided SAM system seemed less intent on destroying maximum coalition aircraft. Instead, the system made choices that better served SAM system survival and boosted civilian morale. Admittedly, Iraqi SAM system behavior yielded the beneficial consequence of requiring numerous SEAD sorties in support of no-fly zone operations.[68] Still, the radar-guided SAM system that rendered Baghdad among the most heavily defended cities in the world did not down any of the 268,000 sorties flown over Iraq from 1992 to 2001. The system relented by mounting far less than its full resistance.

Phase III – SAM Systems Relent

In OAF and OIF, radar-guided SAM systems effectively relented while SEAD forces became disaffected with coercion's success. In OAF, the former Yugoslavian (FRY) radar-guided SAM system retreated, husbanded its resources, and employed only at opportune moments offering high chances of survival. SEAD forces, meanwhile, ably performed persistent disruption and occasional destruction, but lamented their inability to annihilate the enemy system. OIF revealed an even less resistant radar-guided SAM system. The Iraqi system conducted few guided launches and moved very frequently. Yet, coalition SEAD forces virtually abandoned their successful disruptive and destructive methods and made annihilation the main SEAD objective. OAF and OIF revealed entrenched SAM behavioral change and SEAD forces confounded by their strategy's success.

OAF provided large-scale evidence in a different theater of the standoff changes borne out in Iraq. On 24 March, 1999, NATO forces faced robust Serbian air defenses consisting of 16 SA-3 Low Blow and 25 SA-6 Straight Flush fire control radars.[69] Prior to the initial strikes, the Serbian radar-guided SAM system dispersed many of its

[68] Maj Gen Walter Buchanan, "Air Force Current Operations," briefing to Congressional Air Power Caucus, Bolling AFB, 12 March 2001, in Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 5. Of the 268,000 no-fly zone sorties flown from 1992 to 2001 in the southern and northern no-fly zones, 67,000 performed SEAD.
[69] Benjamin S. Lambeth, *NATO's Air War for Kosovo: A Strategic and Operational Assessment*, RAND Report MR-1365-AF (Santa Monica: RAND, 2001), 102.

components away from their regular locations.[70] Throughout the conflict, the system employed sporadically, at times firing dozens of SAMs in one night while at other times employing few.[71] When the system did employ, it fired over two thirds of its missiles in an unguided fashion for fear of being targeted by NATO ARMs.[72] Overall, the Serbian SAM system fired at least 665 radar-guided SAMs over 78 days of conflict, yet downed only two NATO aircraft. To survive, the Serbian radar-guided SAM system hid most of the time and used tactics that limited its lethality.[73]

NATO aircrews viewed Serbian SAM behavior as "problematic" due to their inability to destroy SAM batteries.[74] The system's high mobility, infrequent engagement, and less than full-capabilities employment made it difficult for SEAD forces to detect or engage. Serbian SAM system behavior caused the average NATO aircrew participating in OAF to suffer three times more SAM launches against his aircraft than his Desert Storm predecessor.[75] Because of Serbian radar-guided SAM system persistence, NATO had to dedicate 4,538 sorties, or 21.5 percent of its total air effort, to the SEAD mission.[76] The NATO SEAD forces countered by firing 743 ARMs at the Serbian radar-guided SAM system.[77] The EA-6B's jamming effectiveness against the Serbian system caused General Anthony Zinni to call it "the linchpin in the application of American air power."[78] Disruptive SEAD efforts combined with the threat of destruction caused NATO aircrews to be six times less likely to be shot down than their Desert Storm counterparts.[79] Despite these results, NATO forces waged aggressive destructive SEAD,

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[70] Ibid.
[71] Ibid, 104.
[72] Ibid, 105.
[73] United States Department of Defense, *Kosovo/Operation Allied Force After-Action Report*, Report to Congress (Washington, D.C.: Department of Defense, 31 Jan 2000), 67.
[74] Ibid, 65.
[75] Ibid.
[76] Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 5.
[77] Benjamin S. Lambeth, *NATO's Air War for Kosovo: A Strategic and Operational Assessment*, RAND Report MR-1365-AF (Santa Monica: RAND, 2001), 110. These 743 HARM shots included 125 employed at EW radars and 20 employed at unknown emitters.
[78] Capt David S. Levensen, LCDR Michael J. Coury, and CAPT Kenneth G. Krech, "SEAD: Operation Allied Force and Beyond", *Journal of Electronic Defense*, January 2000, 53.
[79] Benjamin S. Lambeth, *NATO's Air War for Kosovo: A Strategic and Operational Assessment*, RAND Report MR-1365-AF (Santa Monica: RAND, 2001), 111; United States Department of Defense, *Kosovo/Operation Allied Force After-Action Report*, Report to Congress (Washington, D.C.: Department of Defense, 31 Jan 2000), 65.

but succeeded in destroying only three of Serbia's 25 known SA-6 batteries due to system mobility and emissions control. Though the Serbian system had relented by offering less than full-capabilities resistance, the DoD concluded that it needed to expand its ability to locate and destroy SAMs more effectively.[80] In the words of a Pentagon SEAD program monitor, "We need to go from SEAD to really [*sic*] destruction of enemy air defenses."[81]

Later, the standoff between the Iraqi radar-guided SAM system and coalition SEAD forces exhibited a compliant SAM system. Admittedly, in the intervening 12 years following Desert Storm, the Iraqi system had waged a losing battle for air superiority in the southern and northern no-fly zones. In the months prior to OIF, the system further suffered from increased coalition air attacks against SAM components, information networks, surveillance radars, and command and control components in the no-fly zones.[82] However, on 19 March 2003, the area of Iraq between the 33rd and 36th parallels boasted a robust SAM system consisting of 210 surface-to-air missiles, 150 early warning radars, and an intact command and control structure.[83] US intelligence estimates assessed the overall operational capability of Iraq's surface-to-air assets as "medium to high."[84] Yet, Iraqi SAM radars were a "no-show."[85] The Iraqi system conducted mostly unguided launches. In Brigadier General Vincent Brooks' assessment, "there's a hazard to turning on a radar against one of our aircraft, a very certain hazard, and so the firing crews have decided not to turn on the radar and [to] fire the missiles ballistically."[86] Between 19 March and 18 April 2003, coalition forces observed 1660 SAM and rocket launches and 436 radar-guided SAM radar indications, potentially correlating to a 26 percent guided launch rate.[87] Furthermore, it is likely that Iraqi radar-

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[80] Maj Gen Dennis G. Haines quoted in Robert Wall, "SEAD Concerns Raised in Kosovo," *Aviation Week & Space Technology*, 26 July 1999, 75.
[81] Maj Steve Schneider quoted in Robert Wall, "SEAD Concerns Raised in Kosovo," *Aviation Week & Space Technology*, 26 July 1999, 75.
[82] David A. Fulghum, "New Bag of Tricks," *Aviation Week & Space Technology*, 21 April 2003, 22.
[83] Lt Gen T. Michael Moseley, *Operation Iraqi Freedom - By the Numbers*, USCENTAF data sheet (Prince Sultan AB: USCENTAF, 30 April 2003), 3.
[84] Ibid.
[85] David A. Fulghum, "New Bag of Tricks," *Aviation Week & Space Technology*, 21 April 2003, 22.
[86] Brig Gen Vincent Brooks quoted in Brandon P. Rivers, "Coalition Routs Iraqi Forces Despite Iraq's Lessons Learned, " *Journal of Electronic Defense*, May 2003, 30.
[87] Lt Gen T. Michael Moseley, *Operation Iraqi Freedom - By the Numbers*, USCENTAF data sheet (Prince Sultan AB: USCENTAF, 30 April 2003), 3.

guided SAMs downed no aircraft among the 41,404 sorties flown by coalition aircrews.[88] Rather than employing to its full capabilities, the Iraqi radar-guided SAM system offered substantially less resistance.

Meanwhile, coalition SEAD efforts consisted of initially strong but then waning disruption and moderately effective destruction. Prior to 19 March 2003, CENTCOM planners cautioned that F-16CJ and EA-6B aircraft would be among the most heavily tasked assets based on the need for disruptive SEAD. Yet, by 24 March, SEAD squadrons were already cutting back on loading ARMs. F-16CJs started carrying bombs to fulfill time-sensitive targeting and close air support requirements. EA-6Bs did less radar-guided SAM system jamming, instead providing communications jamming in support of ground forces. SEAD aircraft fired only 408 HARMs from 19 March to 18 April.[89] CENTAF spokespersons announced by early April that the coalition had air superiority over 95 percent of Iraq, with the remaining five percent being contested by existent Iraqi radar-guided SAM system.[90] As a result, coalition forces attempted to destroy SAM components, including them among their highest priority time-sensitive and dynamic targets. As OIF evolved, destructive SEAD maintained relatively high emphasis, while disruptive SEAD abated.

SEAD Strategy

The period between OAF and OIF saw SEAD forces enter a strategic conundrum. The behavior change that SEAD had long sought in radar-guided SAM systems had finally manifested itself in the form of reduced resistance. In OAF, through credible presence, widespread disruptive, and select destructive measures, SEAD coerced the radar-guided SAM into relenting. In the face of success, SEAD strategists focused on what they could not do vice what they achieved, lamenting their inability to annihilate the radar-guided SAM system as an objective that had not been part of SEAD strategy since Vietnam. In OIF, SEAD forces went one step further away from traditional methods by reducing ARM carriage and using an increasing portion of SEAD assets to support land

[88] Ibid, 3-7. USCENTAF data shows seven coalition aircraft losses to enemy fire. In this author's opinion, the four AH-64D Apaches and two AH-1W Cobras were probably lost to small arms and AAA. Unofficial reports at the time suggest that the single A-10 Warthog lost while performing close air support in the vicinity of Baghdad was lost due to AAA or a man-portable air defense system infrared guidance missile.
[89] Ibid, 11.
[90] Brig Gen Vincent Brooks, televised press conference, April 2003.

component objectives and perform time sensitive targeting. In coercion terms, SEAD rescinded limited force and the threat of force to pursue the annihilation of the Iraqi radar-guided SAM system. In analyzing OIF SEAD effectiveness, strategists must realize that the Iraqi system relented despite SEAD forces' drift away from a long-standing coercive strategy. To some extent, SEAD succeeded on reputation alone.

SAM System Behavior

SEAD succeeded out of credibility more than capability because radar-guided SAM systems chose to relent. Their behavioral change indicates a change in radar-guided SAM system decision calculus. A sustained SEAD strategy of coercion had elevated the costs of SAM system resistance to the point that the benefits of full-capabilities employment no longer outweighed them. One manager in the air defense industry commented, "The longer [radar-guided SAM systems] sit in one place and transmit, the more apt [they] are to swallow a missile."[91] FRY and Iraqi SAM systems chose the behavioral alternative of degraded mode employment and frequent mobility, apparently because they valued the consequences of improved system survival and increased SEAD sortie requirements. For example, on the first night of the conflict, the Serbian system launched only a few SAMs at NATO aircraft.[92] Such behavior suggests that the consequences most valued by the SAM systems served objectives like survival and boosting the morale of the nations' populaces. System behavior suggests that SAMs may be pursuing a force in being strategy, whereby the systems serve the objective of diverting air forces resources to performing SEAD by selecting the alternative of avoiding direct confrontation. The third phase of the standoff consummated a radar-guided SAM system behavioral change begun in the early days of the Gulf War.

Summary

Overall, the three phases of the standoff reveal a consistency in SEAD strategy and an evolution in radar-guided SAM system behavior that by the third phase had rendered coercion successful. Over 40 years, SEAD forces raised SAM system costs to a level that required a change in behavior. Despite increasing capabilities yielded by

[91] Charles Pickar quoted in Michael Puttre, "Good Move: New Thinking in Air Defense Networks Puts SEAD in Check," *Journal of Electronic Defense*, May 2001, 40.
[92] Benjamin S. Lambeth, *NATO's Air War for Kosovo: A Strategic and Operational Assessment*, RAND Report MR-1365-AF (Santa Monica: RAND, 2001), 104.

“double-digit” systems, radar-guided SAM systems have relented. A combination of disruptive and destructive SEAD brought the standoff to this point, with disruption exerting the most persistent and enduring coercive force. Yet, as the gelling lessons of OIF attest, US air forces grow more enamored with destruction. Chapter Three examines this change in emphasis along with its implications on the United States’ proven SEAD strategy.

Chapter 3

Future of the Standoff

The standoff between SEAD and radar-guided SAMs continues. The need for threat suppression mounts in the face of airpower's increased use as an instrument of US national power vis-à-vis a burgeoning and increasingly lethal SAM threat. Meanwhile, disruptive SEAD continues a decline begun at the end of the Cold War, suffering neglect as a secondary capability, lacking a staunch single advocate, and emasculated by lessons mislearned from recent conflicts regarding disruptive SEAD's efficacy. At the same time, destructive SEAD represents a growth industry within the larger US military marriage of stealth, precision, and ISR that is somewhat tangential and inconsistent with efforts that have quelled enemy systems to this point. The shift from disruptive to destructive SEAD portends a shift away from a successful coercive strategy.

Growing Demands for SEAD

Radar-guided SAM systems place increasing demands on SEAD as it supports US military operations. At times, the US has relied almost exclusively on its air forces when wielding the military instrument of power. Because the US fields these air forces against a largely surface-based threat, SEAD emerges as perhaps the most critical and relevant subset of the counterair mission.[93] Furthermore, legacy radar-guided SAMs have adapted to retain some lethality while improving their survivability by incorporating better strategies and tactics. To make matters worse, the radar-guided SAM threat grows more lethal as new systems emerge and proliferate. The standoff between SEAD and radar-guided SAM systems intensifies.

The need for SEAD grows as requirements for large-scale and concurrent air operations increase. Recent US national security activities reveal an increased reliance on air power and occasionally place heavy demands on air as the sole force.[94] In the last decade, the US has conducted several military operations – Operation Northern Watch (ONW) and Operation Southern Watch (OSW), Operation Deliberate Force, and OAF, to

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[93] Air Force Doctrine Document (AFDD) 2-1, *Air Warfare*, 22 January 2000, 9. AFDD 2-1 lists SEAD as a subset of the counterair mission alongside fighter sweep, escort, air defense, and surface attack.

[94] Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 2.

name a few – consisting almost exclusively of air forces. Additionally, America conducts more brief operations characterized by approaches pursuing less than all-out attrition.[95] Yet, these operations are no less invasive. Ultimately, the US wields its air forces more frequently, often without friendly ground forces fighting or holding terrain underneath them. Additionally, the fast-paced nature of air operations often requires US air forces to perform other functions before surface-based threats have been quelled, leading to increased exposure to radar-guided SAMs.

More often than not, surface-based threats constitute the only defenses US air forces face. Few countries possess the capability to challenge US air superiority using aircraft. Since World War II, US aircraft combat losses due to enemy air defenses have increased, while losses due to enemy aircraft have decreased. In the Korean and Vietnam wars, surface-based air defenses inflicted 90 percent of US aircraft combat losses while aerial combat losses accounted for only 10 percent.[96] Of 43 coalition fixed- and rotary-wing aircraft combat losses that occurred during Desert Storm, only one may have been a result of air-to-air combat. Finally, of the seven coalition aircraft losses attributed to enemy fire during OIF, none resulted from engagements with Iraqi aircraft.[97] The air superiority onus resides with SEAD for most foreseeable conflicts.

Meanwhile, older SAMs continue changing their employment methods. The force in being strategy, degraded-mode employment, and shoot-and-scoot tactics all represent behavioral manifestations of an unwillingness to engage in attrition warfare with SEAD forces. To retain some measure of defensive capability, nations develop air defenses more resistant to suppression using passive detection and shifting away from site-centric operations.[98] Networked sensors, too, provide SAMs additional capabilities by making no one radar node critical to employment. These multiple nodes allow greater

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[95] Congressman Joseph R. Pitts, "Electronic Warfare: Key to Military Superiority," Electronic Warfare Working Group Issue Brief #1, 27 February 2001, n.p., on-line, Internet, 10 March 2005, available from http://www.house.gov/pitts/initiatives/ew/Library/Briefs/brief1.htm.

[96] Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 2.

[97] Lt Gen T. Michael Moseley, *Operation Iraqi Freedom - By the Numbers*, USCENTAF Data Sheet Assessment and Analysis Division, (Prince Sultan AB: USCENTAF, 30 April 2003), 3.

[98] US General Accounting Office, *Electronic Warfare: Comprehensive Strategy Needed for Suppressing Enemy Air Defenses*, Report to Congressional Requesters GAO-01-28 (Washington, D.C.: General Accounting Office, January 2001), 5.

overall system survivability.[99] Radar-guided SAM systems incorporate countermeasures like terminal-defense Gatling guns to limit ARM effectiveness.[100] Additionally, in the larger arena of EW, radar-guided SAM systems learn new ways of countering US methods, just as they have after every American campaign involving air power. Though relenting, the existent threat is not impotent.

The new and imminent radar-guided SAM threat possesses a lethality and survivability that arguably surpasses current US SEAD assets' ability to counter it. New generation SAMs boast better range, improved guidance schemes, greater radar sensitivity, and enhanced mobility.[101] Better networking and target sharing among systems keep newer radar-guided SAM systems operating in a coordinated manner despite the increased mobility of their individual elements. Both new and old systems abandon hierarchical approaches to air defense, electing instead to operate more flexibly and in a manner that better facilitates autonomous operations.[102] Additionally, a diverse array of countries can possess these systems. Many adversaries do not have to develop improved SAM capabilities indigenously. All they have to do is purchase them.[103] New, more lethal radar-guided SAM systems proliferate.

Overall, the need for SEAD is increasing. US military strategies appear bent on an increased reliance on air forces to conduct sustained invasive aerial operations without the luxury of preparatory enemy IADS attrition. Of the missions that counter enemy surface and air threats, the SEAD mission bears the brunt of today's air superiority burden in most foreseeable conflicts. At the same time, the relenting radar-guided SAM threat continues its search for alternative strategies and tactics to harangue US air operations. New SAM systems constitute a far more formidable threat, especially as they multiply and spread. In the face of standoff intensification, SEAD strategy is gaining importance.

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[99] Charles Pickar quoted in Michael Puttre, "Good Move: New Thinking in Air Defense Networks Puts SEAD in Check," *Journal of Electronic Defense*, May 2001, 40.

[100] Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 3.

[101] Ibid, 2.

[102] Michael Puttre, "Good Move: New Thinking in Air Defense Networks Puts SEAD in Check," *Journal of Electronic Defense*, May 2001, 40.

[103] Congressman Joseph R. Pitts, interviewed by *Journal of Electronic Defense*, May 2001, 47.

Declining Disruptive SEAD

From both force structure and strategy perspectives, US disruptive SEAD declined since the end of the Cold War. The Department of Defense (DoD) viewed stealth as a way of eliminating the need for large-scale SEAD force improvement. In the post-Cold War force draw down, Air Force specialized SEAD aircraft constituted low hanging fruit for those responsible for cutting service aircraft numbers. Cuts by all services left the DoD with too few SEAD platforms. The DoD also eliminated systems without plans for providing comparable replacements. The manner by which services made program tradeoffs caused friction between the DoD and Congress, fueling multiple clashes through the 1990s and into the 21st century. Disunity among the services in terms of SEAD approaches led to piecemeal systems that in aggregate produced a whole almost less than the sum of the parts. Finally, the lessons of recent conflicts reveal a strong US military dissatisfaction with mere suppression. In effect, changing means and desired ends impact a consistent and successful SEAD strategy.

As much as the demise of a conventional peer competitor, the promise of stealth produced a DoD under-reliance on SEAD that manifested itself in SEAD program abeyance. Faced with US hegemony, mandated conventional force cuts, and anticipating a predominately stealthy combat air force, the services accepted a period of vulnerability to advanced SAM systems that would persist from approximately 1999 to 2008.[104] At that point, plans held that stealth platforms would emerge en masse, obviating the need for existent SEAD resources and in effect constituting a new SEAD strategy. Yet, the DoD may expect too much of stealth technology when presenting it as an alternative to SEAD. US Congressman Joseph R. Pitts, co-chairman of the Congressional EW Working Group, commented, "While stealth is an important and strategic necessity, it is not a panacea and cannot be relied upon alone to ensure that our aircraft are safe from enemy forces."[105] Furthermore, stealth aircraft themselves require support from SEAD forces.[106] Jamming and lethal suppression of certain systems significantly enhance

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[104] Lt Col Ken Spaar, "Future SEAD: A USAF Perspective," *Journal of Electronic Defense*, May 1999, 44.
[105] Congressman Joseph R. Pitts, "Electronic Warfare in the Information Age," Electronic Warfare Working Group Issue Brief, 11 July 2001, n.p., on-line, Internet, 10 March 2005, available from http://www.house.gov/pitts/initiatives/ew/Library/Press/000711c-pitts.htm.
[106] Christopher Bolkcom, *Airborne Electronic Warfare: Issues for the 107th Congress*, CRS Report for Congress RL30841 (Washington, D.C.: Congressional Research Service, 9 February 2001), 1.

stealth aircraft survivability.[107] One only has to consider the shootdown of the F-117 by a vintage radar-guided SAM system during OAF to appreciate the fact that stealth mitigates, but doesn't eliminate, enemy air defenses' capability to contest air superiority.

The intended gap produced by a DoD forced to reduce aircraft numbers attests in part to the insignificance the services ascribe to the SEAD mission and EW. To some extent, SEAD constitutes a tertiary mission. At the service level, in the Air Force's draw down from 40 to 20 wings, aging and highly specialized SEAD aircraft like the F-4G and EF-111 were surplus.[108] Furthermore, the EW discipline that serves SEAD admits to a public relations problem. The discipline lacks a single advocate, possesses a highly technical and often misunderstood nature, and shrouds itself in secrecy.[109] Additionally, EW renders relatively non-destructive and hence less tangible effects. Pitts also added, "We tend to forget about EW in peacetime."[110] Due to their tertiary, esoteric, and underrepresented stature, SEAD forces bear the brunt of tradeoffs made by a DoD possessing limited resources.

The availability of SEAD aircraft to provide protection for US air operations suffered in the competition for DoD resources. This shortage became readily apparent during OAF. Though touted by senior leaders as indispensable in the war over Kosovo, the EA-6B could not deploy in adequate numbers. Its scarcity occasionally caused cancellation of planned strike packages for lack of available SEAD support.[111] Doubtless, these shortcomings root in the US Navy's continued shorting of EA-6B operations and maintenance.[112] On the lethal suppression side of OAF disruptive SEAD, the Air Force's F-16CJ force fielded adequate aircraft numbers but did so with insufficient personnel and while suffering a shortage of vital high speed anti-radiation

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[107] US General Accounting Office, *Combat Air Power: Funding Priority for Suppression of Enemy Air Defenses May Be Too Low*, Report to Congressional Committees GAO/NSAID-96-128 (Washington, D.C.: General Accounting Office, April 1996), 3.
[108] Maj Gen Bruce Carlson interviewed in John A. Tirpak, "Dealing With Air Defenses," *Air Force Magazine* 82, no. 11 (November 1999): n.p., on-line, Internet, 16 March 2005, available from http://www.afa.org/magazine/nov1999/1199airdefense.asp.
[109] Congressman Joseph R. Pitts, interviewed by *Journal of Electronic Defense*, May 2001, 47-48.
[110] Ibid, 48.
[111] Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 5.
[112] Congressman Joseph R. Pitts, interviewed by *Journal of Electronic Defense*, May 2001, 48.

missile (HARM) Targeting System (HTS) pods.[113] In his article on OAF SEAD performance, author John A. Tirpak surmised, "A major lesson of the Balkan War was that the Air Force's defense suppression assets have been spread thinly." Aside from the purchase of 30 additional F-16CJs, $26 million in HTS pods, and an upgrade to EA-6B aircraft, the SEAD aircraft inventory hasn't changed since.[114]

Additionally, existent SEAD aircraft perform less ably than those they replaced in the post-Cold War draw down. In August of 1992, the DoD acknowledged that it was retiring the F-4G without possessing a sufficient replacement, and that this action constituted an acceptance of increased risk to future air operations.[115] Additionally, though the F-16CJ represented a less-capable initial entry to Air Combat Command's 1993 three-phase plan to address SEAD needs, the Air Force chose not to fund the remaining two phases.[116] Furthermore, the Air Force retired the EF-111 with no replacement stand-off jamming aircraft, instead relying on a joint solution via the less capable EA-6B.[117] A 1999 Joint SEAD Integrated Product Team found that the DoD lacked the quality and quantity of systems necessary to provide aircraft protection across the full range of military conflict."[118] Later, in a 2001 EW Working Group issue briefing, Congressman Pitts assessed, "Current US electronic warfare assets are struggling to keep up with the antique SAM systems (SA-2, SA-3, SA-6) seen in Kosovo, let alone new state-of-the-art systems."[119] By accepting lesser SEAD capabilities, the DoD places some future air operations at greater risk.

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[113] Col Daniel J. Darnell interviewed in John A. Tirpak, "Dealing With Air Defenses," *Air Force Magazine* 82, no. 11 (November 1999): n.p., on-line, Internet, 16 March 2005, available from http://www.afa.org/magazine/nov1999/1199airdefense.asp..

[114] John A. Tirpak, "Dealing With Air Defenses," *Air Force Magazine* 82, no. 11 (November 1999): n.p., on-line, Internet, 16 March 2005, available from http://www.afa.org/magazine/nov1999/1199airdefense.asp.

[115] US General Accounting Office, *Suppression of Enemy Air Defenses: Air Force Plans*, Report to Chairman, Committee on Armed Services, House of Representatives, GAO/NSAID-93-221 (Washington, D.C.: General Accounting Office, September 1993), 1.

[116] Ibid, 12.

[117] US General Accounting Office, *Combat Air Power: Funding Priority for Suppression of Enemy Air Defenses May Be Too Low*, Report to Congressional Committees GAO/NSAID-96-128 (Washington, D.C.: General Accounting Office, April 1996), 2.

[118] US General Accounting Office, *Electronic Warfare: Comprehensive Strategy Needed for Suppressing Enemy Air Defenses*, Report to Congressional Requesters GAO-01-28 (Washington, D.C.: General Accounting Office, January 2001), 2.

[119] Congressman James Gibbons, "F-22X: The Key to Negating Anti-Access Threats," Electronic Warfare Working Group Issue Brief #3, 13 March 2001, n.p., on-line, Internet, 10 March 2005, available from http://www.house.gov/pitts/initiatives/ew/Library/Briefs/brief3.htm.

Since the Cold War, Congressional assessments of US SEAD capabilities form an indictment of DoD SEAD resource priorities and strategy. In 1993, the General Accounting Office (GAO) recommended that the DoD reevaluate its funding priorities in an endeavor to avoid accepting a period of increased risk imposed by overall declining SEAD capabilities.[120] The GAO again alleged that SEAD funding priorities were too low in 1996.[121] In that same report, the GAO recommended that the DoD postpone F-4G and EF-111 retirement pending a reassessment of SEAD funding priorities vis-à-vis other air missions. The DoD non-concurred with this recommendation.[122] Finally, though not representative of friction with the GAO per se, Congressional appropriations in response to the 2001 DoD budget request often met or surpassed those sought by the services for SEAD and EW programs.[123] This obvious and sustained rift between Congress and the DoD caused the GAO to recommend in a 2001 report that the services devise a single, comprehensive strategy for SEAD.

The SEAD mission also faces inter- and intra-service challenges. The US Air Force and Navy pursue notably different paths when addressing how to perform the SEAD mission. For almost a decade, the Air Force has deferred the stand-off jamming role to Navy and Marine Corps EA-6Bs, though this may change should the B-52 be equipped for the mission.[124] With regards to lethal SEAD, the Navy takes a more disruptive approach by endeavoring to improve ARM performance in dealing with non-cooperative enemy radars.[125] The Air Force, meanwhile, focuses on aircraft sensor capabilities, seeking a more destructive approach by using bombs or submunitions to

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[120] US General Accounting Office, *Suppression of Enemy Air Defenses: Air Force Plans*, Report to Chairman, Committee on Armed Services, House of Representatives, GAO/NSAID-93-221 (Washington, D.C.: General Accounting Office, September 1993), 12.
[121] US General Accounting Office, *Combat Air Power: Funding Priority for Suppression of Enemy Air Defenses May Be Too Low*, Report to Congressional Committees GAO/NSAID-96-128 (Washington, D.C.: General Accounting Office, April 1996), 5.
[122] Ibid.
[123] Christopher Bolkcom, *Airborne Electronic Warfare: Issues for the 107th Congress*, CRS Report for Congress RL30841 (Washington, D.C.: Congressional Research Service, 9 February 2001), Summary.
[124] John Andrew Prime, "B-52s Could Get New Mission," *Shreveport Times*, 11 April 2005, n.p., on-line, Internet, 13 May 2005, available from http://www.airforcetimes.com/story.php?f=1-292925-778370.php.
[125] Christopher Bolkcom, *Airborne Electronic Warfare: Issues for the 107th Congress*, CRS Report for Congress RL30841 (Washington, D.C.: Congressional Research Service, 9 February 2001), 21.

destroy SAM sites.[126] In a larger sense, the Navy appears to subscribe to a more incremental change, while the Air Force seems intent on greater leaps in aircraft technology.[127] Finally, within the Air Force, organizational placement of EW under the information operations umbrella runs the risk of causing EW and SEAD to be overshadowed by cyberwarfare.[128] Based on the organizational challenges SEAD faces, it comes as little surprise that the GAO recommended in 2001 that the DoD designate a coordinating entity to synchronize cross-service SEAD efforts.[129] The DoD non-concurred, asserting that centralization of SEAD coordinating authority could cause neglect of unique service requirements.[130]

The final factor contributing to the demise of disruptive SEAD consists of changing expectations as lessons from recent conflicts reveal mounting dissatisfaction with mere suppression. Though critics hailed their performance as a validation of US SEAD dominance, coalition force during the Gulf War successfully destroyed just over half of Iraq's fixed SAM batteries and probably fewer mobile batteries.[131] At the same time, two or three coalition aircraft losses resulted from radar-guided SAMs.[132] Nine years later, US aircraft losses to radar-guided SAMs occurred in similar numbers, but military and civilian critics alike lamented SEAD effectiveness because only 2 of 22 FRY SAM batteries, most of which were mobile, were destroyed. Finally, during OIF, planners and military briefers were quick to call attention to the five percent of the Iraqi landscape in which coalition forces had failed to achieve air superiority because many mobile Iraqi SAMs were still at large.[133] Yet, the coalition lost only seven aircraft to

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[126] Ibid, 22.
[127] Ibid.
[128] Congressman Joseph R. Pitts, interviewed by *Journal of Electronic Defense*, May 2001, 51.
[129] US General Accounting Office, *Electronic Warfare: Comprehensive Strategy Needed for Suppressing Enemy Air Defenses*, Report to Congressional Requesters GAO-01-28 (Washington, D.C.: General Accounting Office, January 2001), 3.
[130] US General Accounting Office, *Electronic Warfare: Comprehensive Strategy Needed for Suppressing Enemy Air Defenses*, Report to Congressional Requesters GAO-01-28 (Washington, D.C.: General Accounting Office, January 2001), 20.
[131] Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 6.
[132] Maj Gen John Corder interview in Hal Gershanoff, "EC in the Gulf War," *Journal of Electronic Defense*, May 1991, 48.
[133] Brig Gen Vincent Brooks, televised press conference, April 2003.

enemy fire, of which only a subset, if any, suffered destruction by radar-guided SAMs.[134] In a 1999 interview, Maj Gen Bruce Carlson, USAF director of operational requirements, commented that SAM system emission control during OAF had reduced SEAD campaign effectiveness. "If they're not emitting, then you're not suppressing very much," he remarked.[135] Interestingly, if the SAM systems aren't emitting, then they are performing less than full-capabilities engagements. Resultantly, their behavioral change amounts to successful suppression, unless of course one makes suppression synonymous with destruction.

A changing expectation constitutes one of the many symptoms and maladies comprising disruptive SEAD's decline as means and ends change. Reductions to numbers and capabilities of US SEAD means reflect DoD risk-taking following the Cold War that hinges on the promise of stealth. Yet, the relationship between stealth and SEAD is one of less dependence, not independence. EW and the SEAD mission suffer benign neglect within the DoD as peripheral pursuits possessed of fractionalized efforts made opposite a disapproving Congress and afflicted by interservice dissent. Finally, as the American way of war has changed, and in doing so become less violent and more casualty averse, the bar for acceptable SEAD performance has moved up from mere suppression to complete SAM system destruction.

Burgeoning Destructive SEAD

The rise of destructive SEAD represents a corollary response to the demise of disruptive SEAD. Though only one element of the joint SEAD definition, destruction of enemy air defenses may supplant all other denotations of the term. A strong impetus exists throughout the DoD to reduce the time required to detect and destroy SAM systems. At the same time, the DoD attests to making a shift away from reactive measures and towards preemptive measures. Within the services, the Air Force leans wholeheartedly toward outright destruction, while the Navy appears more predisposed toward piecemeal destruction and persistent disruption. All in all, the preponderance of

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[134] Lt Gen T. Michael Moseley, *Operation Iraqi Freedom - By the Numbers*, USCENTAF Data Sheet Assessment and Analysis Division, (Prince Sultan AB: USCENTAF, 30 April 2003), 3.
[135] John A. Tirpak, "Dealing With Air Defenses," *Air Force Magazine* 82, no. 11 (November 1999): n.p., on-line, Internet, 16 March 2005, available from http://www.afa.org/magazine/nov1999/1199airdefense.asp.

future SEAD efforts appears inclined toward a combination of stealth, precision, and ISR focused on full-scale SAM annihilation.

Increasingly, the DoD uses the term "SEAD" to denote destruction, just as it assesses recent SEAD operations on the basis of numbers of SAMs destroyed instead of the less tangible effects of suppression. During the Vietnam War, "the actual destruction of SA-2 sites [was] normally of secondary importance in the suppression role and [would] not normally be carried out unless a particular site [could] be destroyed without sacrificing the protective suppression the strike force [required] from other threatening sites."[136] In his description of America's SEAD operations in Desert Storm, Maj Gen John Corder explained how US forces never intended to destroy every SAM near Baghdad, given the infrequency with which packages frequented the area. When coalition packages did operate near Baghdad, SEAD aircraft provided suppression. At the same time, in the Kuwait theater of operations, air support to land forces necessitated that SEAD aircraft perform more destruction.[137] Later, the Air Force submitted that one of its chief lessons from OAF was that it must be able to "detect, track, and kill" integrated systems.[138] Of late, the DoD cultivates an expectation that SEAD forces will destroy enemy SAM systems.

As part of this destructive shift, the DoD seeks acceleration of SAM kill chain reaction timing. Speed has always been the essence of SEAD. One of the selling points of the HARM was its speed advantage over its predecessors. A key performance measure of the HTS pod and other passive electronic emissions detectors has always been the speed with which they have detected, located, and identified radio frequency emissions. Yet, all these measures focused on speeding the pace of threat suppression. Now, however, the focus is quick destruction. "I'd like to see a [radar] signal come up and 20 seconds later a bomb going in on the air defense site," commented a senior USAF officer as quoted in a Congressional Research Service (CRS) report to Congress.[139] The

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136 *F-105 Combat Tactics*, (Korat Royal Thai AFB, 388th Tactical Fighter Wing, 10 September 1967), 6.
137 Maj Gen John Corder interview in Hal Gershanoff, "EC in the Gulf War," *Journal of Electronic Defense*, May 1991, 42.
138 Maj Gen Dennis G. Haines quoted in Robert Wall, "SEAD Concerns Raised in Kosovo," *Aviation Week & Space Technology*, 26 July 1999, 75.
139 Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 6.

desire to destroy SAMs as soon as possible motivates the haste behind the Air Force employment mantra of "find, fix, track, target, engage, assess." The conceived instrument for effecting this speed is ISR sensor fusion mated with data link capabilities to provide SAM location information to aircraft carrying destructive ordnance.[140] By accelerating the SAM destruction sequence of events, it appears that the DoD seeks to replicate or surpass the speed by which it has been able to react to active SAMs using ARMs.

To further accelerate the destruction timeline, emerging DoD approaches pursue preemption instead of reaction.[141] Preemption holds no novelty for SEAD applications. Starting in April of 1972, Wild Weasel SEAD aircrews attempted to curtail the reactive suppression process by launching ARMs preemptively, that is, prior to detecting emissions from enemy radar-guided SAMs.[142] In every conflict since, preemptive ARM employment abbreviated SEAD engagement timelines by providing suppressive weapons ready to guide on radar emissions should the SAM system activate during the missile's time of flight. In the DoD's new concept, destructive munitions will supplant ARMs. Via improved weapons and better targeting sensors, the DoD seeks to locate and destroy radar-guided SAMs before they have a chance to radiate or engage. This new concept alters the nature of preemption. Whereas disruptive preemptive efforts influenced SAM system behavior by making full-capabilities employment a calculated risk to equipment and potentially to the operator, the new preemptive approach holds operators and equipment at risk based on existence alone. Thus, the DoD's preemptive approach imposes new costs on a radar-guided SAM system's decision calculus.

Within the DoD, the services lack unity in their respective approaches to the notion of destructive SEAD. As the organization responsible for conceiving and articulating the Air Force's SEAD vision, Air Combat Command's SEAD focus reveals a shift from performing reactive SEAD against mobile threats to performing "hard kills" with the effort's success revolving around locating SAM systems with high precision.[143]

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[140] Christopher Bolkcom, *Airborne Electronic Warfare: Issues for the 107th Congress*, CRS Report for Congress RL30841 (Washington, D.C.: Congressional Research Service, 9 February 2001), 19.
[141] Ibid.
[142] Major William A. Hewitt, *Planting the Seeds of SEAD: The Wild Weasel in Vietnam* (Maxwell AFB: Air University Press, 1992), 27.
[143] Lt Col Ken Spaar, "Future SEAD: A USAF Perspective," *Journal of Electronic Defense*, May 1999, 44.

The Navy's approach, meanwhile, centers more on disruption. The service seeks this effect through incremental changes to existing ARMs to improve their ability to impact enemy SAMs that limit their radar emissions.[144] As one report noted, the Air Force is "putting the smarts" in the sensors to engage SAMs using destructive ordnance, while the Navy is "putting the smarts" in the missile to intensify its suppressive credibility.[145] Surprisingly, these two approaches coexist within a unified DoD SEAD effort.

Though each service embraces it differently, destructive SEAD is on the rise. Mission discussions and combat effectiveness evaluations increasingly equate SEAD and radar-guided SAM annihilation. The DoD seems focused on speeding the destructive SEAD process, both by abbreviating detection-to-engagement sequences, and by shifting to preemptive use of "hard-kill" weapons. As of yet, the services have not presented a united front on their approaches to SEAD. These tensions may derive from an underlying absence of a common service SEAD strategy.

Strategy Implications of Shifting Means and Ends

If the DoD's balance between disruptive and destructive SEAD connotes a strategy, then that strategy is changing. Technological tradeoffs and advances alone are not strategies. A mostly disruptive, coercive SEAD strategy has effectively changed SAM system behavior since the Gulf War turning point of the standoff. The shift in emphasis towards destructive SEAD may signal a move towards coercion, or annihilation, depending on how the DoD leverages it. Once recognized, the strategy choice is characterized by several considerations that may sway the DoD one way or the other. After making the choice, the DoD faces obstacles to structuring individual services' resources to best support their linkage to a common desired end. The choice of SEAD strategies is upon the US, and stratified among the levels of military and service strategy.

The fact that SEAD discussion tends to center more around programs and technology than around strategy confounds DoD SEAD efforts. In 1996, the GAO addressed a failure of strategy when it alleged that the DoD failed to assess the cumulative effects to its warfighting capability resulting from cancellation of individual

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[144] Christopher Bolkcom, *Airborne Electronic Warfare: Issues for the 107th Congress*, CRS Report for Congress RL30841 (Washington, D.C.: Congressional Research Service, 9 February 2001), 19.
[145] Ibid, 22.

improvements or replacement.[146] A 2001 GAO report asserted that "no comprehensive strategy exists to address evolving threats."[147] The GAO went on to warn that the gap it perceived between suppression capabilities and needs would exist until the services formulated a strategy.[148] Furthermore, studies have impugned the DoD's strategic agility, holding that the services have failed to adapt to counter emergent advanced air defense systems.[149] Stealth is not a strategy. Specific programs are not strategy. SEAD, whether disruptive or destructive, is not a strategy. The nature of allegations against the DoD suggest that the services need to come to grips with what their SEAD strategy has been, is, and should be.

Nowhere is strategic confusion more evident than in assessments of SEAD combat success. In the May 2001 issue of Journal of Electronic Defense, magazine editors interviewed Congressman Pitts regarding US EW capabilities and strategies. JED editors discussed OAF SEAD efforts, highlighting the fact that 4,500 SEAD sorties had been flown against 42 FRY SAM batteries, and noted that coalition forces had succeeded in destroying only two of them. Furthermore, editors pointed to the fact that, despite ten years of ONW and OSW operations against them, the Iraqis continued to field radar-guided SAMs. Rather than pointing out that OAF SEAD had allowed only two aircraft losses in that conflict's 21,111 sorties, or that no-fly zone SEAD operations over Iraq allowed no aircraft losses in over 268,000 combat sorties, Congressman Pitts cited both SEAD operations' "ineffectiveness and inefficiency."[150] He went on to explain his assessment as a mandate "to provide destruction of enemy air defenses rather than the more elusive SEAD." Paradoxically, it was destructive measures that had failed in both operations. SEAD had performed its role admirably, yielding a 0.0007% attrition rate,

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[146] US General Accounting Office, *Combat Air Power: Funding Priority for Suppression of Enemy Air Defenses May Be Too Low*, Report to Congressional Committees GAO/NSAID-96-128 (Washington, D.C.: General Accounting Office, April 1996), 4.
[147] US General Accounting Office, *Electronic Warfare: Comprehensive Strategy Needed for Suppressing Enemy Air Defenses*, Report to Congressional Requesters GAO-01-28 (Washington, D.C.: General Accounting Office, January 2001), 10.
[148] Ibid.
[149] Ibid, 2.
[150] Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 4; Congressman Joseph R. Pitts, interviewed by *Journal of Electronic Defense*, May 2001, 47.

one one-thousandth that experienced by US Air Force aircraft in the Vietnam conflict.[151] Such revised ends, if sustained, naturally render obsolete existent SEAD's resources and coercive strategy.

Yet, the DoD often solves its inability to achieve its desired ends through new programs and improved technologies. In response to assessment of SEAD shortcomings in Operation Allied Force, General John Jumper, then commander of US Air Forces in Europe, commented, "We need to decide which combination of things – or a platform, if that's what the answer is – is going to give us [the needed capability]."[152] Interestingly, senior Air Force leaders seem inclined to address what they perceive to be a failed SEAD strategy with a new means instead of addressing how the strategy itself might be improved.

With a strategic perspective, one can shed new light on the shift from disruptive to destructive SEAD. Recognized or otherwise, predominately disruptive SEAD has been leveraged successfully as a coercive strategy for over 40 years. Radar-guided SAM systems have changed their behavior in a manner benefiting US air forces' survival because of SEAD persistence characterized by a duration and volume of SEAD presence. Full-scale destruction, meanwhile, constitutes an annihilation strategy that US air forces have yet to pursue successfully. An annihilation strategy focuses on depleting numbers, not changing behavior. Inevitably, radar-guided SAM behavior will change in response to annihilation, potentially in a manner confounding the strategy. Destructive SEAD could become a strategy equivalent to disruptive SEAD if the duration and volume of destructive potential approached that currently achieved by disruptive forces. SEAD forces would also have to focus on delivering hard-kill weapons whenever possible against detected sites, vice establishing as a goal the destruction of every SAM system. Expectations define ends that inexorably impact strategy.

If the DoD pursues destructive SEAD, it must answer several key questions. First, is the DoD SEAD strategy one of annihilation or coercion? If the strategy is one of

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[151] Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 4. In Vietnam, USAF sorties experienced a 0.65% attrition rate.

[152] John A. Tirpak, "Dealing With Air Defenses," *Air Force Magazine* 82, no. 11 (November 1999): n.p., on-line, Internet, 16 March 2005, available from http://www.afa.org/magazine/nov1999/1199airdefense.asp.

annihilation, the DoD must anticipate radar-SAM system counter-strategies and realize that the strategy carries with it expectations based on numbers of destroyed systems. If the strategy is one of coercion, the DoD must be willing to provide sufficient destructive potential in duration and volume equaling that offered by disruptive SEAD. Next, will disruption or destruction provide a better method for countering mobility? An often-invoked objection to currently fielded SEAD forces alleges that they were designed to defeat site-centric air defenses. Finally, how will disruptive SEAD complement destruction, particularly if SEAD serves an annihilation strategy? Disruptive SEAD competes for finite resources and does little to reduce radar-guided SAM system numbers. In effect, these questions force the DoD to make ways, ends, and means choices.

Finally, the DoD must achieve strategic unity across all the services. This is not a well-worn path for the DoD. A 2001 GAO report observed, "Within the [DoD], no comprehensive, cross-service strategy for closing the gap between the services' suppression capabilities and needs exists—and no coordinating entity has been tasked with preparing such a strategy—to identify, among other things, suppression mission objectives, needed solutions, funding, timelines, and mechanisms to track progress."[153] The services must arrive at strategic unity. Historically fragmented, responsibility for SEAD across all services must be centralized in a single coordinating agency. Furthermore, the services long ago dissolved decision-making level bodies possessing EW expertise.[154] Implementation of a unified strategy, and traction for the programs it begets in each service can be achieved when appropriate expertise resides at high levels within each service. By working in concert, the services will elevate the importance ascribed to SEAD.

Summary

The future holds a choice of SEAD strategies for US air forces. Considerable inertia currently propels the DoD towards a strategy change. The DoD must come to

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[153] US General Accounting Office, *Electronic Warfare: Comprehensive Strategy Needed for Suppressing Enemy Air Defenses*, Report to Congressional Requesters GAO-01-28 (Washington, D.C.: General Accounting Office, January 2001), 3.

[154] Congressman Joseph R. Pitts, "Electronic Warfare: Key to Military Superiority," Electronic Warfare Working Group Issue Brief #1, 27 February 2001, n.p., on-line, Internet, 10 March 2005, available from http://www.house.gov/pitts/initiatives/ew/Library/Briefs/brief1.htm.

grips with the strategy choices it faces. The DoD can either choose to extrapolate its previous SEAD efforts, or elect a new strategy that to date boasts a poor record against radar-guided SAM systems. Finally, the DoD must address the overall military and service-level strategies in an endeavor to achieve unity. The Air Force, particularly, is at a point of departure. Its principle unique contribution to the joint fight, air superiority, is at stake.

Chapter 3

Future of the Standoff

The standoff between SEAD and radar-guided SAMs continues. The need for threat suppression mounts in the face of airpower's increased use as an instrument of US national power vis-à-vis a burgeoning and increasingly lethal SAM threat. Meanwhile, disruptive SEAD continues a decline begun at the end of the Cold War, suffering neglect as a secondary capability, lacking a staunch single advocate, and emasculated by lessons mislearned from recent conflicts regarding disruptive SEAD's efficacy. At the same time, destructive SEAD represents a growth industry within the larger US military marriage of stealth, precision, and ISR that is somewhat tangential and inconsistent with efforts that have quelled enemy systems to this point. The shift from disruptive to destructive SEAD portends a shift away from a successful coercive strategy.

Growing Demands for SEAD

Radar-guided SAM systems place increasing demands on SEAD as it supports US military operations. At times, the US has relied almost exclusively on its air forces when wielding the military instrument of power. Because the US fields these air forces against a largely surface-based threat, SEAD emerges as perhaps the most critical and relevant subset of the counterair mission.[155] Furthermore, legacy radar-guided SAMs have adapted to retain some lethality while improving their survivability by incorporating better strategies and tactics. To make matters worse, the radar-guided SAM threat grows more lethal as new systems emerge and proliferate. The standoff between SEAD and radar-guided SAM systems intensifies.

The need for SEAD grows as requirements for large-scale and concurrent air operations increase. Recent US national security activities reveal an increased reliance on air power and occasionally place heavy demands on air as the sole force.[156] In the last decade, the US has conducted several military operations – Operation Northern Watch (ONW) and Operation Southern Watch (OSW), Operation Deliberate Force, and OAF, to

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[155] Air Force Doctrine Document (AFDD) 2-1, *Air Warfare*, 22 January 2000, 9. AFDD 2-1 lists SEAD as a subset of the counterair mission alongside fighter sweep, escort, air defense, and surface attack.

[156] Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 2.

name a few – consisting almost exclusively of air forces. Additionally, America conducts more brief operations characterized by approaches pursuing less than all-out attrition.[157] Yet, these operations are no less invasive. Ultimately, the US wields its air forces more frequently, often without friendly ground forces fighting or holding terrain underneath them. Additionally, the fast-paced nature of air operations often requires US air forces to perform other functions before surface-based threats have been quelled, leading to increased exposure to radar-guided SAMs.

More often than not, surface-based threats constitute the only defenses US air forces face. Few countries possess the capability to challenge US air superiority using aircraft. Since World War II, US aircraft combat losses due to enemy air defenses have increased, while losses due to enemy aircraft have decreased. In the Korean and Vietnam wars, surface-based air defenses inflicted 90 percent of US aircraft combat losses while aerial combat losses accounted for only 10 percent.[158] Of 43 coalition fixed- and rotary-wing aircraft combat losses that occurred during Desert Storm, only one may have been a result of air-to-air combat. Finally, of the seven coalition aircraft losses attributed to enemy fire during OIF, none resulted from engagements with Iraqi aircraft.[159] The air superiority onus resides with SEAD for most foreseeable conflicts.

Meanwhile, older SAMs continue changing their employment methods. The force in being strategy, degraded-mode employment, and shoot-and-scoot tactics all represent behavioral manifestations of an unwillingness to engage in attrition warfare with SEAD forces. To retain some measure of defensive capability, nations develop air defenses more resistant to suppression using passive detection and shifting away from site-centric operations.[160] Networked sensors, too, provide SAMs additional capabilities by making no one radar node critical to employment. These multiple nodes allow greater

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[157] Congressman Joseph R. Pitts, “Electronic Warfare: Key to Military Superiority,” Electronic Warfare Working Group Issue Brief #1, 27 February 2001, n.p., on-line, Internet, 10 March 2005, available from http://www.house.gov/pitts/initiatives/ew/Library/Briefs/brief1.htm.
[158] Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 2.
[159] Lt Gen T. Michael Moseley, *Operation Iraqi Freedom - By the Numbers*, USCENTAF Data Sheet Assessment and Analysis Division, (Prince Sultan AB: USCENTAF, 30 April 2003), 3.
[160] US General Accounting Office, *Electronic Warfare: Comprehensive Strategy Needed for Suppressing Enemy Air Defenses*, Report to Congressional Requesters GAO-01-28 (Washington, D.C.: General Accounting Office, January 2001), 5.

overall system survivability.[161] Radar-guided SAM systems incorporate countermeasures like terminal-defense Gatling guns to limit ARM effectiveness.[162] Additionally, in the larger arena of EW, radar-guided SAM systems learn new ways of countering US methods, just as they have after every American campaign involving air power. Though relenting, the existent threat is not impotent.

The new and imminent radar-guided SAM threat possesses a lethality and survivability that arguably surpasses current US SEAD assets' ability to counter it. New generation SAMs boast better range, improved guidance schemes, greater radar sensitivity, and enhanced mobility.[163] Better networking and target sharing among systems keep newer radar-guided SAM systems operating in a coordinated manner despite the increased mobility of their individual elements. Both new and old systems abandon hierarchical approaches to air defense, electing instead to operate more flexibly and in a manner that better facilitates autonomous operations.[164] Additionally, a diverse array of countries can possess these systems. Many adversaries do not have to develop improved SAM capabilities indigenously. All they have to do is purchase them.[165] New, more lethal radar-guided SAM systems proliferate.

Overall, the need for SEAD is increasing. US military strategies appear bent on an increased reliance on air forces to conduct sustained invasive aerial operations without the luxury of preparatory enemy IADS attrition. Of the missions that counter enemy surface and air threats, the SEAD mission bears the brunt of today's air superiority burden in most foreseeable conflicts. At the same time, the relenting radar-guided SAM threat continues its search for alternative strategies and tactics to harangue US air operations. New SAM systems constitute a far more formidable threat, especially as they multiply and spread. In the face of standoff intensification, SEAD strategy is gaining importance.

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[161] Charles Pickar quoted in Michael Puttre, "Good Move: New Thinking in Air Defense Networks Puts SEAD in Check," *Journal of Electronic Defense*, May 2001, 40.

[162] Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 3.

[163] Ibid, 2.

[164] Michael Puttre, "Good Move: New Thinking in Air Defense Networks Puts SEAD in Check," *Journal of Electronic Defense*, May 2001, 40.

[165] Congressman Joseph R. Pitts, interviewed by *Journal of Electronic Defense*, May 2001, 47.

Declining Disruptive SEAD

From both force structure and strategy perspectives, US disruptive SEAD declined since the end of the Cold War. The Department of Defense (DoD) viewed stealth as a way of eliminating the need for large-scale SEAD force improvement. In the post-Cold War force draw down, Air Force specialized SEAD aircraft constituted low hanging fruit for those responsible for cutting service aircraft numbers. Cuts by all services left the DoD with too few SEAD platforms. The DoD also eliminated systems without plans for providing comparable replacements. The manner by which services made program tradeoffs caused friction between the DoD and Congress, fueling multiple clashes through the 1990s and into the 21st century. Disunity among the services in terms of SEAD approaches led to piecemeal systems that in aggregate produced a whole almost less than the sum of the parts. Finally, the lessons of recent conflicts reveal a strong US military dissatisfaction with mere suppression. In effect, changing means and desired ends impact a consistent and successful SEAD strategy.

As much as the demise of a conventional peer competitor, the promise of stealth produced a DoD under-reliance on SEAD that manifested itself in SEAD program abeyance. Faced with US hegemony, mandated conventional force cuts, and anticipating a predominately stealthy combat air force, the services accepted a period of vulnerability to advanced SAM systems that would persist from approximately 1999 to 2008.[166] At that point, plans held that stealth platforms would emerge en masse, obviating the need for existent SEAD resources and in effect constituting a new SEAD strategy. Yet, the DoD may expect too much of stealth technology when presenting it as an alternative to SEAD. US Congressman Joseph R. Pitts, co-chairman of the Congressional EW Working Group, commented, "While stealth is an important and strategic necessity, it is not a panacea and cannot be relied upon alone to ensure that our aircraft are safe from enemy forces."[167] Furthermore, stealth aircraft themselves require support from SEAD forces.[168] Jamming and lethal suppression of certain systems significantly enhance

[166] Lt Col Ken Spaar, "Future SEAD: A USAF Perspective," *Journal of Electronic Defense*, May 1999, 44.
[167] Congressman Joseph R. Pitts, "Electronic Warfare in the Information Age," Electronic Warfare Working Group Issue Brief, 11 July 2001, n.p., on-line, Internet, 10 March 2005, available from http://www.house.gov/pitts/initiatives/ew/Library/Press/000711c-pitts.htm.
[168] Christopher Bolkcom, *Airborne Electronic Warfare: Issues for the 107th Congress*, CRS Report for Congress RL30841 (Washington, D.C.: Congressional Research Service, 9 February 2001), 1.

stealth aircraft survivability.[169] One only has to consider the shootdown of the F-117 by a vintage radar-guided SAM system during OAF to appreciate the fact that stealth mitigates, but doesn't eliminate, enemy air defenses' capability to contest air superiority.

The intended gap produced by a DoD forced to reduce aircraft numbers attests in part to the insignificance the services ascribe to the SEAD mission and EW. To some extent, SEAD constitutes a tertiary mission. At the service level, in the Air Force's draw down from 40 to 20 wings, aging and highly specialized SEAD aircraft like the F-4G and EF-111 were surplus.[170] Furthermore, the EW discipline that serves SEAD admits to a public relations problem. The discipline lacks a single advocate, possesses a highly technical and often misunderstood nature, and shrouds itself in secrecy.[171] Additionally, EW renders relatively non-destructive and hence less tangible effects. Pitts also added, "We tend to forget about EW in peacetime."[172] Due to their tertiary, esoteric, and underrepresented stature, SEAD forces bear the brunt of tradeoffs made by a DoD possessing limited resources.

The availability of SEAD aircraft to provide protection for US air operations suffered in the competition for DoD resources. This shortage became readily apparent during OAF. Though touted by senior leaders as indispensable in the war over Kosovo, the EA-6B could not deploy in adequate numbers. Its scarcity occasionally caused cancellation of planned strike packages for lack of available SEAD support.[173] Doubtless, these shortcomings root in the US Navy's continued shorting of EA-6B operations and maintenance.[174] On the lethal suppression side of OAF disruptive SEAD, the Air Force's F-16CJ force fielded adequate aircraft numbers but did so with insufficient personnel and while suffering a shortage of vital high speed anti-radiation

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[169] US General Accounting Office, *Combat Air Power: Funding Priority for Suppression of Enemy Air Defenses May Be Too Low*, Report to Congressional Committees GAO/NSAID-96-128 (Washington, D.C.: General Accounting Office, April 1996), 3.
[170] Maj Gen Bruce Carlson interviewed in John A. Tirpak, "Dealing With Air Defenses," *Air Force Magazine* 82, no. 11 (November 1999): n.p., on-line, Internet, 16 March 2005, available from http://www.afa.org/magazine/nov1999/1199airdefense.asp.
[171] Congressman Joseph R. Pitts, interviewed by *Journal of Electronic Defense*, May 2001, 47-48.
[172] Ibid, 48.
[173] Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 5.
[174] Congressman Joseph R. Pitts, interviewed by *Journal of Electronic Defense*, May 2001, 48.

missile (HARM) Targeting System (HTS) pods.[175] In his article on OAF SEAD performance, author John A. Tirpak surmised, "A major lesson of the Balkan War was that the Air Force's defense suppression assets have been spread thinly." Aside from the purchase of 30 additional F-16CJs, $26 million in HTS pods, and an upgrade to EA-6B aircraft, the SEAD aircraft inventory hasn't changed since.[176]

Additionally, existent SEAD aircraft perform less ably than those they replaced in the post-Cold War draw down. In August of 1992, the DoD acknowledged that it was retiring the F-4G without possessing a sufficient replacement, and that this action constituted an acceptance of increased risk to future air operations.[177] Additionally, though the F-16CJ represented a less-capable initial entry to Air Combat Command's 1993 three-phase plan to address SEAD needs, the Air Force chose not to fund the remaining two phases.[178] Furthermore, the Air Force retired the EF-111 with no replacement stand-off jamming aircraft, instead relying on a joint solution via the less capable EA-6B.[179] A 1999 Joint SEAD Integrated Product Team found that the DoD lacked the quality and quantity of systems necessary to provide aircraft protection across the full range of military conflict."[180] Later, in a 2001 EW Working Group issue briefing, Congressman Pitts assessed, "Current US electronic warfare assets are struggling to keep up with the antique SAM systems (SA-2, SA-3, SA-6) seen in Kosovo, let alone new state-of-the-art systems."[181] By accepting lesser SEAD capabilities, the DoD places some future air operations at greater risk.

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[175] Col Daniel J. Darnell interviewed in John A. Tirpak, "Dealing With Air Defenses," *Air Force Magazine* 82, no. 11 (November 1999): n.p., on-line, Internet, 16 March 2005, available from http://www.afa.org/magazine/nov1999/1199airdefense.asp..

[176] John A. Tirpak, "Dealing With Air Defenses," *Air Force Magazine* 82, no. 11 (November 1999): n.p., on-line, Internet, 16 March 2005, available from http://www.afa.org/magazine/nov1999/1199airdefense.asp.

[177] US General Accounting Office, *Suppression of Enemy Air Defenses: Air Force Plans*, Report to Chairman, Committee on Armed Services, House of Representatives, GAO/NSAID-93-221 (Washington, D.C.: General Accounting Office, September 1993), 1.

[178] Ibid, 12.

[179] US General Accounting Office, *Combat Air Power: Funding Priority for Suppression of Enemy Air Defenses May Be Too Low*, Report to Congressional Committees GAO/NSAID-96-128 (Washington, D.C.: General Accounting Office, April 1996), 2.

[180] US General Accounting Office, *Electronic Warfare: Comprehensive Strategy Needed for Suppressing Enemy Air Defenses*, Report to Congressional Requesters GAO-01-28 (Washington, D.C.: General Accounting Office, January 2001), 2.

[181] Congressman James Gibbons, "F-22X: The Key to Negating Anti-Access Threats," Electronic Warfare Working Group Issue Brief #3, 13 March 2001, n.p., on-line, Internet, 10 March 2005, available from http://www.house.gov/pitts/initiatives/ew/Library/Briefs/brief3.htm.

Since the Cold War, Congressional assessments of US SEAD capabilities form an indictment of DoD SEAD resource priorities and strategy. In 1993, the General Accounting Office (GAO) recommended that the DoD reevaluate its funding priorities in an endeavor to avoid accepting a period of increased risk imposed by overall declining SEAD capabilities.[182] The GAO again alleged that SEAD funding priorities were too low in 1996.[183] In that same report, the GAO recommended that the DoD postpone F-4G and EF-111 retirement pending a reassessment of SEAD funding priorities vis-à-vis other air missions. The DoD non-concurred with this recommendation.[184] Finally, though not representative of friction with the GAO per se, Congressional appropriations in response to the 2001 DoD budget request often met or surpassed those sought by the services for SEAD and EW programs.[185] This obvious and sustained rift between Congress and the DoD caused the GAO to recommend in a 2001 report that the services devise a single, comprehensive strategy for SEAD.

The SEAD mission also faces inter- and intra-service challenges. The US Air Force and Navy pursue notably different paths when addressing how to perform the SEAD mission. For almost a decade, the Air Force has deferred the stand-off jamming role to Navy and Marine Corps EA-6Bs, though this may change should the B-52 be equipped for the mission.[186] With regards to lethal SEAD, the Navy takes a more disruptive approach by endeavoring to improve ARM performance in dealing with non-cooperative enemy radars.[187] The Air Force, meanwhile, focuses on aircraft sensor capabilities, seeking a more destructive approach by using bombs or submunitions to

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[182] US General Accounting Office, *Suppression of Enemy Air Defenses: Air Force Plans*, Report to Chairman, Committee on Armed Services, House of Representatives, GAO/NSAID-93-221 (Washington, D.C.: General Accounting Office, September 1993), 12.
[183] US General Accounting Office, *Combat Air Power: Funding Priority for Suppression of Enemy Air Defenses May Be Too Low*, Report to Congressional Committees GAO/NSAID-96-128 (Washington, D.C.: General Accounting Office, April 1996), 5.
[184] Ibid.
[185] Christopher Bolkcom, *Airborne Electronic Warfare: Issues for the 107th Congress*, CRS Report for Congress RL30841 (Washington, D.C.: Congressional Research Service, 9 February 2001), Summary.
[186] John Andrew Prime, "B-52s Could Get New Mission," *Shreveport Times*, 11 April 2005, n.p., on-line, Internet, 13 May 2005, available from http://www.airforcetimes.com/story.php?f=1-292925-778370.php.
[187] Christopher Bolkcom, *Airborne Electronic Warfare: Issues for the 107th Congress*, CRS Report for Congress RL30841 (Washington, D.C.: Congressional Research Service, 9 February 2001), 21.

destroy SAM sites.[188] In a larger sense, the Navy appears to subscribe to a more incremental change, while the Air Force seems intent on greater leaps in aircraft technology.[189] Finally, within the Air Force, organizational placement of EW under the information operations umbrella runs the risk of causing EW and SEAD to be overshadowed by cyberwarfare.[190] Based on the organizational challenges SEAD faces, it comes as little surprise that the GAO recommended in 2001 that the DoD designate a coordinating entity to synchronize cross-service SEAD efforts.[191] The DoD non-concurred, asserting that centralization of SEAD coordinating authority could cause neglect of unique service requirements.[192]

The final factor contributing to the demise of disruptive SEAD consists of changing expectations as lessons from recent conflicts reveal mounting dissatisfaction with mere suppression. Though critics hailed their performance as a validation of US SEAD dominance, coalition force during the Gulf War successfully destroyed just over half of Iraq's fixed SAM batteries and probably fewer mobile batteries.[193] At the same time, two or three coalition aircraft losses resulted from radar-guided SAMs.[194] Nine years later, US aircraft losses to radar-guided SAMs occurred in similar numbers, but military and civilian critics alike lamented SEAD effectiveness because only 2 of 22 FRY SAM batteries, most of which were mobile, were destroyed. Finally, during OIF, planners and military briefers were quick to call attention to the five percent of the Iraqi landscape in which coalition forces had failed to achieve air superiority because many mobile Iraqi SAMs were still at large.[195] Yet, the coalition lost only seven aircraft to

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[188] Ibid, 22.
[189] Ibid.
[190] Congressman Joseph R. Pitts, interviewed by *Journal of Electronic Defense*, May 2001, 51.
[191] US General Accounting Office, *Electronic Warfare: Comprehensive Strategy Needed for Suppressing Enemy Air Defenses*, Report to Congressional Requesters GAO-01-28 (Washington, D.C.: General Accounting Office, January 2001), 3.
[192] US General Accounting Office, *Electronic Warfare: Comprehensive Strategy Needed for Suppressing Enemy Air Defenses*, Report to Congressional Requesters GAO-01-28 (Washington, D.C.: General Accounting Office, January 2001), 20.
[193] Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 6.
[194] Maj Gen John Corder interview in Hal Gershanoff, "EC in the Gulf War," *Journal of Electronic Defense*, May 1991, 48.
[195] Brig Gen Vincent Brooks, televised press conference, April 2003.

enemy fire, of which only a subset, if any, suffered destruction by radar-guided SAMs.[196] In a 1999 interview, Maj Gen Bruce Carlson, USAF director of operational requirements, commented that SAM system emission control during OAF had reduced SEAD campaign effectiveness. "If they're not emitting, then you're not suppressing very much," he remarked.[197] Interestingly, if the SAM systems aren't emitting, then they are performing less than full-capabilities engagements. Resultantly, their behavioral change amounts to successful suppression, unless of course one makes suppression synonymous with destruction.

A changing expectation constitutes one of the many symptoms and maladies comprising disruptive SEAD's decline as means and ends change. Reductions to numbers and capabilities of US SEAD means reflect DoD risk-taking following the Cold War that hinges on the promise of stealth. Yet, the relationship between stealth and SEAD is one of less dependence, not independence. EW and the SEAD mission suffer benign neglect within the DoD as peripheral pursuits possessed of fractionalized efforts made opposite a disapproving Congress and afflicted by interservice dissent. Finally, as the American way of war has changed, and in doing so become less violent and more casualty averse, the bar for acceptable SEAD performance has moved up from mere suppression to complete SAM system destruction.

Burgeoning Destructive SEAD

The rise of destructive SEAD represents a corollary response to the demise of disruptive SEAD. Though only one element of the joint SEAD definition, destruction of enemy air defenses may supplant all other denotations of the term. A strong impetus exists throughout the DoD to reduce the time required to detect and destroy SAM systems. At the same time, the DoD attests to making a shift away from reactive measures and towards preemptive measures. Within the services, the Air Force leans wholeheartedly toward outright destruction, while the Navy appears more predisposed toward piecemeal destruction and persistent disruption. All in all, the preponderance of

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[196] Lt Gen T. Michael Moseley, *Operation Iraqi Freedom - By the Numbers*, USCENTAF Data Sheet Assessment and Analysis Division, (Prince Sultan AB: USCENTAF, 30 April 2003), 3.

[197] John A. Tirpak, "Dealing With Air Defenses," *Air Force Magazine* 82, no. 11 (November 1999): n.p., on-line, Internet, 16 March 2005, available from http://www.afa.org/magazine/nov1999/1199airdefense.asp.

future SEAD efforts appears inclined toward a combination of stealth, precision, and ISR focused on full-scale SAM annihilation.

Increasingly, the DoD uses the term "SEAD" to denote destruction, just as it assesses recent SEAD operations on the basis of numbers of SAMs destroyed instead of the less tangible effects of suppression. During the Vietnam War, "the actual destruction of SA-2 sites [was] normally of secondary importance in the suppression role and [would] not normally be carried out unless a particular site [could] be destroyed without sacrificing the protective suppression the strike force [required] from other threatening sites."[198] In his description of America's SEAD operations in Desert Storm, Maj Gen John Corder explained how US forces never intended to destroy every SAM near Baghdad, given the infrequency with which packages frequented the area. When coalition packages did operate near Baghdad, SEAD aircraft provided suppression. At the same time, in the Kuwait theater of operations, air support to land forces necessitated that SEAD aircraft perform more destruction.[199] Later, the Air Force submitted that one of its chief lessons from OAF was that it must be able to "detect, track, and kill" integrated systems.[200] Of late, the DoD cultivates an expectation that SEAD forces will destroy enemy SAM systems.

As part of this destructive shift, the DoD seeks acceleration of SAM kill chain reaction timing. Speed has always been the essence of SEAD. One of the selling points of the HARM was its speed advantage over its predecessors. A key performance measure of the HTS pod and other passive electronic emissions detectors has always been the speed with which they have detected, located, and identified radio frequency emissions. Yet, all these measures focused on speeding the pace of threat suppression. Now, however, the focus is quick destruction. "I'd like to see a [radar] signal come up and 20 seconds later a bomb going in on the air defense site," commented a senior USAF officer as quoted in a Congressional Research Service (CRS) report to Congress.[201] The

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198 *F-105 Combat Tactics*, (Korat Royal Thai AFB, 388th Tactical Fighter Wing, 10 September 1967), 6.
199 Maj Gen John Corder interview in Hal Gershanoff, "EC in the Gulf War," *Journal of Electronic Defense*, May 1991, 42.
200 Maj Gen Dennis G. Haines quoted in Robert Wall, "SEAD Concerns Raised in Kosovo," *Aviation Week & Space Technology*, 26 July 1999, 75.
201 Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 6.

desire to destroy SAMs as soon as possible motivates the haste behind the Air Force employment mantra of "find, fix, track, target, engage, assess." The conceived instrument for effecting this speed is ISR sensor fusion mated with data link capabilities to provide SAM location information to aircraft carrying destructive ordnance.[202] By accelerating the SAM destruction sequence of events, it appears that the DoD seeks to replicate or surpass the speed by which it has been able to react to active SAMs using ARMs.

To further accelerate the destruction timeline, emerging DoD approaches pursue preemption instead of reaction.[203] Preemption holds no novelty for SEAD applications. Starting in April of 1972, Wild Weasel SEAD aircrews attempted to curtail the reactive suppression process by launching ARMs preemptively, that is, prior to detecting emissions from enemy radar-guided SAMs.[204] In every conflict since, preemptive ARM employment abbreviated SEAD engagement timelines by providing suppressive weapons ready to guide on radar emissions should the SAM system activate during the missile's time of flight. In the DoD's new concept, destructive munitions will supplant ARMs. Via improved weapons and better targeting sensors, the DoD seeks to locate and destroy radar-guided SAMs before they have a chance to radiate or engage. This new concept alters the nature of preemption. Whereas disruptive preemptive efforts influenced SAM system behavior by making full-capabilities employment a calculated risk to equipment and potentially to the operator, the new preemptive approach holds operators and equipment at risk based on existence alone. Thus, the DoD's preemptive approach imposes new costs on a radar-guided SAM system's decision calculus.

Within the DoD, the services lack unity in their respective approaches to the notion of destructive SEAD. As the organization responsible for conceiving and articulating the Air Force's SEAD vision, Air Combat Command's SEAD focus reveals a shift from performing reactive SEAD against mobile threats to performing "hard kills" with the effort's success revolving around locating SAM systems with high precision.[205]

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[202] Christopher Bolkcom, *Airborne Electronic Warfare: Issues for the 107th Congress*, CRS Report for Congress RL30841 (Washington, D.C.: Congressional Research Service, 9 February 2001), 19.
[203] Ibid.
[204] Major William A. Hewitt, *Planting the Seeds of SEAD: The Wild Weasel in Vietnam* (Maxwell AFB: Air University Press, 1992), 27.
[205] Lt Col Ken Spaar, "Future SEAD: A USAF Perspective," *Journal of Electronic Defense*, May 1999, 44.

The Navy's approach, meanwhile, centers more on disruption. The service seeks this effect through incremental changes to existing ARMs to improve their ability to impact enemy SAMs that limit their radar emissions.[206] As one report noted, the Air Force is "putting the smarts" in the sensors to engage SAMs using destructive ordnance, while the Navy is "putting the smarts" in the missile to intensify its suppressive credibility.[207] Surprisingly, these two approaches coexist within a unified DoD SEAD effort.

Though each service embraces it differently, destructive SEAD is on the rise. Mission discussions and combat effectiveness evaluations increasingly equate SEAD and radar-guided SAM annihilation. The DoD seems focused on speeding the destructive SEAD process, both by abbreviating detection-to-engagement sequences, and by shifting to preemptive use of "hard-kill" weapons. As of yet, the services have not presented a united front on their approaches to SEAD. These tensions may derive from an underlying absence of a common service SEAD strategy.

Strategy Implications of Shifting Means and Ends

If the DoD's balance between disruptive and destructive SEAD connotes a strategy, then that strategy is changing. Technological tradeoffs and advances alone are not strategies. A mostly disruptive, coercive SEAD strategy has effectively changed SAM system behavior since the Gulf War turning point of the standoff. The shift in emphasis towards destructive SEAD may signal a move towards coercion, or annihilation, depending on how the DoD leverages it. Once recognized, the strategy choice is characterized by several considerations that may sway the DoD one way or the other. After making the choice, the DoD faces obstacles to structuring individual services' resources to best support their linkage to a common desired end. The choice of SEAD strategies is upon the US, and stratified among the levels of military and service strategy.

The fact that SEAD discussion tends to center more around programs and technology than around strategy confounds DoD SEAD efforts. In 1996, the GAO addressed a failure of strategy when it alleged that the DoD failed to assess the cumulative effects to its warfighting capability resulting from cancellation of individual

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[206] Christopher Bolkcom, *Airborne Electronic Warfare: Issues for the 107th Congress*, CRS Report for Congress RL30841 (Washington, D.C.: Congressional Research Service, 9 February 2001), 19.
[207] Ibid, 22.

improvements or replacement.[208] A 2001 GAO report asserted that "no comprehensive strategy exists to address evolving threats."[209] The GAO went on to warn that the gap it perceived between suppression capabilities and needs would exist until the services formulated a strategy.[210] Furthermore, studies have impugned the DoD's strategic agility, holding that the services have failed to adapt to counter emergent advanced air defense systems.[211] Stealth is not a strategy. Specific programs are not strategy. SEAD, whether disruptive or destructive, is not a strategy. The nature of allegations against the DoD suggest that the services need to come to grips with what their SEAD strategy has been, is, and should be.

Nowhere is strategic confusion more evident than in assessments of SEAD combat success. In the May 2001 issue of Journal of Electronic Defense, magazine editors interviewed Congressman Pitts regarding US EW capabilities and strategies. JED editors discussed OAF SEAD efforts, highlighting the fact that 4,500 SEAD sorties had been flown against 42 FRY SAM batteries, and noted that coalition forces had succeeded in destroying only two of them. Furthermore, editors pointed to the fact that, despite ten years of ONW and OSW operations against them, the Iraqis continued to field radar-guided SAMs. Rather than pointing out that OAF SEAD had allowed only two aircraft losses in that conflict's 21,111 sorties, or that no-fly zone SEAD operations over Iraq allowed no aircraft losses in over 268,000 combat sorties, Congressman Pitts cited both SEAD operations' "ineffectiveness and inefficiency."[212] He went on to explain his assessment as a mandate "to provide destruction of enemy air defenses rather than the more elusive SEAD." Paradoxically, it was destructive measures that had failed in both operations. SEAD had performed its role admirably, yielding a 0.0007% attrition rate,

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[208] US General Accounting Office, *Combat Air Power: Funding Priority for Suppression of Enemy Air Defenses May Be Too Low*, Report to Congressional Committees GAO/NSAID-96-128 (Washington, D.C.: General Accounting Office, April 1996), 4.
[209] US General Accounting Office, *Electronic Warfare: Comprehensive Strategy Needed for Suppressing Enemy Air Defenses*, Report to Congressional Requesters GAO-01-28 (Washington, D.C.: General Accounting Office, January 2001), 10.
[210] Ibid.
[211] Ibid, 2.
[212] Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 4; Congressman Joseph R. Pitts, interviewed by *Journal of Electronic Defense*, May 2001, 47.

one one-thousandth that experienced by US Air Force aircraft in the Vietnam conflict.[213] Such revised ends, if sustained, naturally render obsolete existent SEAD's resources and coercive strategy.

Yet, the DoD often solves its inability to achieve its desired ends through new programs and improved technologies. In response to assessment of SEAD shortcomings in Operation Allied Force, General John Jumper, then commander of US Air Forces in Europe, commented, "We need to decide which combination of things – or a platform, if that's what the answer is – is going to give us [the needed capability]."[214] Interestingly, senior Air Force leaders seem inclined to address what they perceive to be a failed SEAD strategy with a new means instead of addressing how the strategy itself might be improved.

With a strategic perspective, one can shed new light on the shift from disruptive to destructive SEAD. Recognized or otherwise, predominately disruptive SEAD has been leveraged successfully as a coercive strategy for over 40 years. Radar-guided SAM systems have changed their behavior in a manner benefiting US air forces' survival because of SEAD persistence characterized by a duration and volume of SEAD presence. Full-scale destruction, meanwhile, constitutes an annihilation strategy that US air forces have yet to pursue successfully. An annihilation strategy focuses on depleting numbers, not changing behavior. Inevitably, radar-guided SAM behavior will change in response to annihilation, potentially in a manner confounding the strategy. Destructive SEAD could become a strategy equivalent to disruptive SEAD if the duration and volume of destructive potential approached that currently achieved by disruptive forces. SEAD forces would also have to focus on delivering hard-kill weapons whenever possible against detected sites, vice establishing as a goal the destruction of every SAM system. Expectations define ends that inexorably impact strategy.

If the DoD pursues destructive SEAD, it must answer several key questions. First, is the DoD SEAD strategy one of annihilation or coercion? If the strategy is one of

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[213] Christopher Bolkcom, *Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs*, CRS Report for Congress RS21141 (Washington, D.C.: Congressional Research Service, 6 February 2002), 4. In Vietnam, USAF sorties experienced a 0.65% attrition rate.
[214] John A. Tirpak, "Dealing With Air Defenses," *Air Force Magazine* 82, no. 11 (November 1999): n.p., on-line, Internet, 16 March 2005, available from http://www.afa.org/magazine/nov1999/1199airdefense.asp.

annihilation, the DoD must anticipate radar-SAM system counter-strategies and realize that the strategy carries with it expectations based on numbers of destroyed systems. If the strategy is one of coercion, the DoD must be willing to provide sufficient destructive potential in duration and volume equaling that offered by disruptive SEAD. Next, will disruption or destruction provide a better method for countering mobility? An often-invoked objection to currently fielded SEAD forces alleges that they were designed to defeat site-centric air defenses. Finally, how will disruptive SEAD complement destruction, particularly if SEAD serves an annihilation strategy? Disruptive SEAD competes for finite resources and does little to reduce radar-guided SAM system numbers. In effect, these questions force the DoD to make ways, ends, and means choices.

Finally, the DoD must achieve strategic unity across all the services. This is not a well-worn path for the DoD. A 2001 GAO report observed, "Within the [DoD], no comprehensive, cross-service strategy for closing the gap between the services' suppression capabilities and needs exists—and no coordinating entity has been tasked with preparing such a strategy—to identify, among other things, suppression mission objectives, needed solutions, funding, timelines, and mechanisms to track progress."[215] The services must arrive at strategic unity. Historically fragmented, responsibility for SEAD across all services must be centralized in a single coordinating agency. Furthermore, the services long ago dissolved decision-making level bodies possessing EW expertise.[216] Implementation of a unified strategy, and traction for the programs it begets in each service can be achieved when appropriate expertise resides at high levels within each service. By working in concert, the services will elevate the importance ascribed to SEAD.

Summary

The future holds a choice of SEAD strategies for US air forces. Considerable inertia currently propels the DoD towards a strategy change. The DoD must come to

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[215] US General Accounting Office, *Electronic Warfare: Comprehensive Strategy Needed for Suppressing Enemy Air Defenses*, Report to Congressional Requesters GAO-01-28 (Washington, D.C.: General Accounting Office, January 2001), 3.

[216] Congressman Joseph R. Pitts, "Electronic Warfare: Key to Military Superiority," Electronic Warfare Working Group Issue Brief #1, 27 February 2001, n.p., on-line, Internet, 10 March 2005, available from http://www.house.gov/pitts/initiatives/ew/Library/Briefs/brief1.htm.

grips with the strategy choices it faces. The DoD can either choose to extrapolate its previous SEAD efforts, or elect a new strategy that to date boasts a poor record against radar-guided SAM systems. Finally, the DoD must address the overall military and service-level strategies in an endeavor to achieve unity. The Air Force, particularly, is at a point of departure. Its principle unique contribution to the joint fight, air superiority, is at stake.

Conclusion

The post-OIF environment opens a crucial phase in the standoff between SEAD and radar-guided SAM systems. Over 41,400 sorties during the opening portion of OIF may have suffered zero losses to Iraqi radar-guided SAMs, yet air planners used SEAD resources for a variety of purposes that did not serve defense suppression. The FRY radar-guided SAM system performed few full-capabilities engagements against NATO aircraft, yet DoD and Congressional leaders lamented SEAD performance based on the number of SAM batteries destroyed. Destructive SEAD programs gain emphasis as part of the larger US Air Force marriage of stealth, precision, and ISR, while disruptive SEAD declines. Meanwhile, legacy radar-guided SAM systems relent but adapt, and new systems boast greater lethality and mobility. In the face of all this, the DoD is searching for improved methods and resources serving capabilities focused on achieving effects.

In clarifying the standoff between SEAD and radar-guided SAM systems, this paper started with intent and effects by analyzing SEAD strategy and radar-guided SAM system actions. As leveraged by the US and its allies, SEAD constitutes coercion by aiming more at deterring or compelling changes in radar-guided SAM system behavior than by achieving the system's demise. SEAD best coerces through credible and persistent disruption and occasional destruction focused on denying the use of key components making the SAM system unwilling to perform full-capabilities engagements. SEAD successfully coerces when a radar-guided SAM system relents, having been driven there through a rational appraisal of costs and benefits. Meanwhile, SAM systems behave according to rational decision theory. They choose to resist based on alternatives, consequences, and objectives. The standoff between SEAD and radar-guided SAM systems represents interplay between coercion strategy and rational response.

Having established this theoretical perspective, this paper examined the history of the standoff between predominately US SEAD and radar-guided SAM systems. Three phases characterizing this interaction emerged. From the Vietnam War until the end of the Cold War, SEAD and radar-guided SAM systems matured and stabilized in attrition-based warfare epitomized by the clashes occurring during the Arab-Israeli wars. Next, from the Gulf War to the period just prior to OAF, SEAD continued its approach from the previous phase and even sacrificed some capabilities, while radar-guided SAM systems began lowering their resistance in a manner typified by the Iraqi's response during Desert Fox. Finally, during the most recent phase spanning from OAF to OIF, radar-guided SAM systems relented and the DoD began questioning the efficacy of its SEAD strategy just as coercion succeeded. Application of the analytical framework to the history of the standoff shows successful radar-guided SAM system coercion through SEAD.

The current, fourth phase reveals a standoff in transition. The US demands more from the SEAD mission due to an increased reliance on air operations, the preponderance of SAMs in most countries' air defenses, and growing capabilities of both legacy and new SAM systems. At the same time, US air forces place less emphasis on disruptive SEAD based on their faith in stealth, the relative importance they assign SEAD among other mission areas, and their willingness to allow SEAD capabilities to wane until the emergence of stealthy and unmanned vehicles. Destructive SEAD, meanwhile, gains favor through its linkage to the stealth, precision, and ISR union. Other forces shifting this balance include differing service perspectives on SEAD methodologies, and a growing dissatisfaction with suppression. The DoD appears to be on the verge of changing its strategy for defeating surface-based air defenses.

As US air forces embark on a path to air superiority that favors destructive SEAD, they must come to grips with the strategy that points their way. SEAD succeeded as a coercive strategy within 25 years of the standoff's inception, and bore fruit for the 15 years subsequent. If destruction will supplant disruption in serving coercive purposes, then destructive SEAD must attain the volume and persistence required for affecting SAM system behavior, regardless of how many SAM components it destroys. If destructive SEAD serves an annihilation strategy, then US air forces must grapple with their resignation to an air superiority strategy that has never borne fruit, and runs somewhat counter to the tenets of effects based operations. Furthermore, US air forces should not go the way of annihilative SEAD without a careful examination of why they abandoned a 40 year-old strategy in its heyday. Indeed, the shift to destructive SEAD may be appropriate, as may be a transition to annihilation. However, US air forces must commence any transition with the best clarity they can attain as to what they seek to do and why.

Glossary

AAA – Anti-Aircraft Artillery
ADOC – AIR DEFENSE OPERATIONS CENTER
ARM – Anti-Radiation Missile
CRC – Control and Reporting Center
CRS – Congressional Research Service
DOD – DEPARTMENT OF DEFENSE
EW – ELECTRONIC WARFARE
FRY – FORMER YUGOSLAVIA
GAO – General Accounting Office
HARM – High Speed Anti-Radiation Missile
HTS – HARM Targeting System
IADS – INTEGRATED AIR DEFENSE SYSTEM
IAF – Israeli Air Force
ISR – Intelligence, Surveillance, and Reconnaissance
J-SEAD – JOINT SUPPRESSION OF ENEMY AIR DEFENSES
NVN – NORTH VIETNAMESE
OAF – Operation Allied Force
OIF – OPERATION IRAQI FREEDOM
ONW – Operation Northern Watch
OSW – Operation Southern Watch
SAM – Surface-to-Air Missile
SEAD – Suppression of Enemy Air Defenses
SOC – Sector Operations Center

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