EXPLOITING C2I TO ENHANCE TMD ATTACK OPERATIONS

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE

by

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B.S. , University of Manchester Institute of Science and Technology, UK, 1989

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The objective of this study is to evaluate if the command, control, and intelligence (C2I) process for the coalition TMD attack operation during Operation Desert Storm (ODS). In ODS, the TMD infrastrructure and C2I process were immature. The ODS model is therefore a precise, if not an absolute, accurate model of the existing TMD attack operation C2I process of most advanced armies. To accomplish the objective, the study examined the effectiveness of the coalition TMD C23I support in each stage of the decide-defeat-deliver--assess (D3A) targeting methodology to enable a successful attack operation. The intent of the study is to identify specific C2I attributes that are required to enable TMD attack operations to defeat the theater ballistic missile threat in a joint environment. The findings of the study serve to provide a baselinef or identifying the key operational objectives of an effective C2I process. The study concluded that the ODS model is not an effective model for the advanced army. It identified the following attribution on key to an effective C2I process: unity of effort, centralized planning and control at the operational level, proactive planning, decentralized execution at tactical level, establishment of precrisis and long-term intelligence base of enemy TBM capability, prioirtization of required enemy and friendly information, effecive integration of BDA into targeting process, and interoperability.

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

EXPLOITING C2I TO ENHANCE TMD ATTACK OPERATIONS by MAJ Lim Chern Tjunn, Singapore Armed Forces, 106 pages.

The objective of this study is to evaluate if the command, control, and intelligence (C2I) process for the coalition TMD attack operation during Operation Desert Storm (ODS). In ODS, the TMD infrastructure and C2I process were immature. The ODS model is therefore a precise, if not an absolute, accurate model of the existing TMD attack operation C2I process of most advanced armies. To accomplish the objective, the study examined the effectiveness of the coalition TMD C2I support in each stage of the decide-detect-deliver-assess (D3A) targeting methodology to enable a successful attack operation.

The intent of the study is to identify specific C2I attributes that are required to enable TMD attack operations to defeat the theater ballistic missile threat in a joint environment. The findings of the study serve to provide a baseline for identifying the key operational objectives of an effective C2I process.

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CHAPTER 1

INTRODUCTION

> If there is an attitude more dangerous to assume that future wars will be just like the last one, it is to imagine that it will be so utterly different that we can afford to ignore the lessons of the last one.[1]
>
> RAF Marshal Sir John Slessor,
> Doctrine for Joint Theater Missile Defense

Overview

Theater missile defense (TMD) is the capability with which joint forces will destroy an enemy's theater missiles, their supporting infrastructure, and their in-flight airborne launch platforms; will degrade the enemy's theater missile targeting capability; and will protect themselves from the effects of any theater missile attack. TMD includes the identification, integration, and employment of forces supported by theater and national capabilities to detect, identify, locate, track, minimize the effects of, and destroy enemy theater missiles (TMs).[2] TMs may be defined as a set of ballistic missile, cruise missile, or air-to-surface guided missile whose target is within a theater or which is capable of attacking targets within a theater.[3] A theater ballistic missile (TBM) is the ballistic missile subset of TM.

The objectives of TMD at the strategic level are to demonstrate a resolve to deter aggression and to deter the enemy's use of TMs to threaten specific vital interests. At the operational level, the objectives are to enable freedom of action and to prevent the enemy from gaining operational initiative. At the tactical level, the key objectives are to protect the force and to prevent areas of critical interests from a TM attack.[4] To accomplish these objectives, TMD harnesses the synergistic effects of four complementary operational elements:[5]

1. Passive Defense. These are measures taken to provide tactical warning, reduce vulnerability, minimize the effects of damage caused by TM attacks, and enhance recovery and reconstitution of units to the desired level of combat effectiveness following TM attacks.

2. Active Defense. These are operations initiated to protect selected areas and forces by destroying enemy TM airborne launch platforms and TMs in flight.

3. Attack Operations. These are offensive actions to disrupt, neutralize, or destroy the enemy's TMs, TM capabilities, systems, and infrastructure before, during, and after launch. TM capabilities, systems, and infrastructure include launch platforms and their supporting command, control, and communications (C3) systems; logistic structures; and reconnaissance, intelligence, surveillance, and target acquisition (RISTA) platforms. Attack operations include offensive action by air, land, and sea forces and special operations forces (SOF).

4. Battle Management/Command, Control, Communications, Computerization and Intelligence (BM/C4I). This is an integrated system of facilities, communications, computers, and supporting intelligence. The system provides command authorities at all levels with timely and accurate data and systems to plan, monitor, direct, control, and report TMD operations.

The aim of this study is to evaluate if the command, control, and intelligence (C2I) process for the Coalition TMD attack operation during Operation Desert Storm (ODS) is an effective model for the advanced army. In ODS, the TMD infrastructure and C2I process were immature. The ODS model is therefore a precise, if not an absolute, accurate model of the existing TMD attack operation C2I process of most advanced armies. To accomplish the aim, the study will examine the effectiveness of the Coalition TMD C2I support in each stage of the decide-detect-deliver-assess (D3A) targeting methodology to enable a successful attack operation. The intent of the study is to identify specific C2I attributes that are required to enable TMD attack operations to defeat the TBM threat in a joint environment. The findings of the study serve to provide a baseline for identifying the key operational objectives of an effective C2I process.

Background

General Norman Schwarzkopf, Commander-in-Chief, U.S. Central Command (CINCCENT), viewed the Scuds as "militarily irrelevant." Lieutenant General Charles Horner, Joint Force Air Component Commander (JFACC), U.S. Central Command, described the Scuds as "lousy weapons."[6] In spite of the contempt that Central Command (CENTCOM) and Central Command Air Force (CENTAF) planners had for the Scuds, they proved to be Saddam Hussein's most effective weapon in the Gulf War. The Scuds provided him with the only means in the entire Gulf War to exert his influence across all three levels of war: strategic, operational, and tactical.

Strategic Level of War

During the Gulf War, Iraq fired about thirty Scuds at Israel, with the intent to draw Israel into the war. Any autonomous strike in response to the Iraqi Scud attack by the Israelis would have involved Israeli strike aircraft intruding into Jordan's airspace. This would have led to a war between Israel and Jordan and allowed Saddam Hussein to change the complexion of the war from that of liberating Kuwait to another Arab-Israeli conflict. A potentially explosive consequence would have been a nightmare Middle East scenario of a war of all against all. The probable result would have been the downfall of the moderate Jordanian government and the possible establishment of a radical one, thereby upsetting the balance of power in the already volatile Middle East politics. As a result, Washington was obliged to take substantial diplomatic and military measures to keep Israel out of the war. More significantly, Israel's involvement would have placed severe strain on the already fragile Coalition. Immediately after the war, Schwarzkopf said in an interview with David Frost that "had Israel entered the fray [in response to the first Scud attacks], I don't think we could have held [the Coalition] all together."[7]

Operational Level of War

To reassure the Israelis that the American military was dealing with the Scuds, Washington placed extreme pressure on CENTCOM to step up its counterscud efforts. This led to the diversion of air sorties from preplanned targets to enhance the Scud-hunting campaign. This included placing more F-15Es on airborne alert and putting F-16s equipped with Lantirn-targeting pods on Scud-chasing missions. This also included scheduling Joint Surveillance Target Attack Radar System (JSTARS) to track the mobile Scud launchers. This increased Scud-hunting effort siphoned away a large number of missions intended for other key strategic targets. As a consequence, this contributed significantly in retarding the progress of the strategic air campaign in its first week. This major diversion of combat power extended the air campaign by more than a week, and prevented the Army Central Command (ARCENT) from meeting its targeting goals prior to the start of the ground war.[8]

Tactical Level of War

On 25 February 1991, a Scud missile hit a military barracks in Al Khobar in the suburb of Dhahran. This missile strike produced the largest single American casualty toll in the war. It killed twenty-eight troops and wounded another ninety-eight. In another episode, the Iraqis fired a Scud at the docks in the vicinity of Al Jubai during the early morning hours of 16 February 1991. The Scud impacted in the water some 120 meters off the port side of the USS Tarawa as it docked to unload its AV-8 Harrier planes. Fortunately, the missile did not detonate. With the VII Corps redeployment from Germany to Saudi Arabia behind schedule, a large number of troops was waiting for their equipment in crowded transit camps near Al Jubai. Had the missile successfully hit either the port or the transit camps, it would have caused significant personnel and materiel losses. More importantly, it would have desynchronized the force buildup plan and deprived CENTCOM of the critical resources required to achieve its objectives. It was for these reasons that the 1st Armored Division had called the camps at Al Jubai "the Scud Bowl."[9]

Missile Proliferation

Nevertheless, the Allied powers, which included the U.S., had already experienced the destructive impact of TBMs as early as World War II. During the latter periods of World War II, the Germans successfully developed the V-1 "flying bomb" and the V-2 missile. These missiles were used extensively by Adolf Hitler to terrorize Allied targets. Since then, there have been at least three occasions when TBMs were employed on a large-scale basis: the Iran-Iraq missile exchanges between 1980-8; Afghan government forces' use of TBMs against the Mujaheddin forces between 1989-90; and during the 1973 Arab-Israeli War.[10]

After World War II, both the U.S. and the Soviet Union exploited the captured V-weapons from the Germans to further develop their indigenous TBM capabilities. In particular, the Soviet military had been extremely aggressive in the development of TBMs, to redress the correlation of combat power vis-à-vis the U.S. military. Of the various missile systems developed, the Scud B, which drew heavily from the V-2 design, became one of the key TBMs fielded in the Soviet and Warsaw Pact armies. Between the 1970s and 1990s, the Scud B also became one of the most widely proliferated TBMs.

To limit the proliferation of TBMs, vigorous counterproliferation measures were implemented. However, these measures had not been able to stop determined countries from procuring these weapons systems, as manifested by Iraq. These measures merely served to delay the proliferation of such technology. Already an emergence of TBM stockpiles can be seen in many arsenals of both developing and Third World armies.[11] In particular, the most concentrated area of proliferation is centered on the Middle East, with a narrower but equally intense buildup of missile capabilities in Southwest Asia.

Of all the missile importers, Iraq manifested as one of the most active builders of the Scud B and its variants. Apart from the basic Scud B model, Iraq also developed two longer range missiles, the Al-Hussein, with a range of 650 kilometers, and the Al-Abbas, with a range of 950 kilometers. However, the Iraqis made little improvements to the accuracy of the missiles, and the increased ranges were achieved at the expense of the missiles' accuracy. During the Iran-Iraq War between 1980-1988, the Iraqis fired as many as 189 Scuds at six different Iranian cities. Although the weapons did not assist Iraq to break the impasse of the war, Iraq learned many invaluable lessons about the employment of TBMs.[12]

Rationale for Ballistic Missile Acquisition

Third World states acquire TBMs for several reasons. An analysis of the motivation revealed three recurrent themes: prestige, deterrence, and, the most predominant, balance of power.[13] Acquiring TBMs to maintain a regional balance of power was exemplified by former Israeli Defense Minister Itzhak Rabin when he pronounced that Israel not only had the deterrent power to defeat the missile threat presented by Syria, Iraq, and Saudi Arabia, it also had the capability to attack their populated areas to a degree that would overwhelm the combined capabilities of these countries.[14]

For several reasons, TBMs will become the preferred weapon for developing Third World militaries. First, TBMs offer a cost-effective option to alter the correlation of combat potential vis-à-vis a militarily superior opponent. As an example, TBMs and TBM technology are less expensive to acquire than a force of similar combat value, e.g., a modern air force unit. Second, against an opponent with superior airpower, TBMs offer the most feasible alternative to penetrate the opponent's battlespace, as demonstrated in the Gulf War. Hitherto, there is still no antimissile system that can comprehensively intercept and defeat all classes of TBMs. Third, TBM systems are difficult to detect, given their low profile and ephemeral nature, which makes them less vulnerable to counterstrikes. Fourth, TBMs can be operated by militarily unsophisticated forces without extensive training required. Planning, coordinating, and controlling TBM operations for a deep attack are easier than that of other conventional means. Fifth, acquiring a modern air fleet could trigger an arms race. TBMs and their associated technology can be imported covertly and assembled at the decisive time. Lastly, the coercive value offered by TBM attacks against soft targets, e.g., civilians, provides tremendous leverage at the strategic level.[15]

Current Trends

More importantly, nascent trends point toward the employment of TBMs by nations to widen their circumference of *strategic* influence. TRADOC Pamphlet 525-5, Force XXI Operations: A Concept for the Evolution of Full-Dimensional Operations for the Strategic Army of the Early Twenty-First Century (1 August 1994), alluded to the strategic and operational significance of the tactical ballistic missile. The pamphlet contended that the "security challenge having the most serious ramifications for U.S. interests will come from the proliferation of WMD [weapons of mass destruction]. The strategic-political effects of WMD overshadow their military utility. WMD and theater ballistic missiles (TBMs) allow an adversary to extend its operational and strategic reach."[16]

In Arms and Influence, Thomas Schelling noted an increasing number of countries are using their capacity for violence as an instrument of diplomacy--a diplomacy of violence to achieve their strategic objectives.[17] TBM provides these countries that latent capability to influence, compel, and coerce. The "strategy of cities" adopted by Germany in World War II and by Iraq during the Iraq-Iran War exemplified the use of TBMs as instruments of compellance. In World War II, German missile attacks on the United Kingdom and Belgium caused significant civilian casualties. Although it furnished no significant strategic effect on the war effort, TBM attacks on soft targets inflicted immense psychological damage. The level of psychological strain experienced was summarized by Churchill's remarks that the German ballistic missiles "imposed upon the people of London a burden perhaps even heavier than the air raids of 1940 and 1941. Suspense and strain were more prolonged. . . . The blind impersonal nature of the missile made the individual on the ground feel helpless."[18] In the 1988 "War of the Cities," Iraqi missile attacks resulted in widespread disruption of the Iranian economy and sociology. This played a major role in forcing Iran into a peace agreement.[19]

In addition, the strategic reach afforded by TBMs has permeated the security reappraisals of many advanced armies. Some forces previously considered too distant to pose any significant threat must now be taken into account.

FM 100-5, Operations, further predicated the *operational* level threat posed by TBMs by emphasizing

> [The] threat to friendly forces and combat functions is significantly greater than in the past due to weapons of mass destruction and the proliferation of missile technology. The potential for catastrophic loss of soldiers, time, or initiative, which might force a change to operational objectives, requires a greater role for theater missile defense when generating combat power at the operational level.

In particular, the TBM threat at the operational level includes:

Mobilization Phase

The preemptive use of TMD against mobilization centers and war-sustaining industries will immediately paralyze the war-making ability of the advanced army. In addition, the use of TMD against civilian-populated areas may quickly collapse the nation's will to fight.

Deployment Phase

The use of TMD on assembly areas, ports, and airfields will inflict substantial casualties that will severely disrupt war-preparation efforts. If casualties are high, questions will arise as to whether the national objectives are worth the cost and to whether the military strategy and campaign plan are sound and should be continued.

Operation Phase

Used in the deep fight, the adversary will be able to shape the battlefield, destroy reserves, limit freedom of action, and disrupt continuity of operation and sustainment. This will allow the adversary to rapidly seize the initiative by causing the advanced army to conform to his operational tempo and purpose.

The use of TBMs against operational targets was exemplified during the Afghan Civil War and the 1973 October War. In both cases, TBMs were employed ostensibly to attack operational targets to gain operational leverage. As an example, Egypt and Syria used TBMs mainly to attack Israeli military concentrations, command and control (C2) centers, and airfields.[20] However, prevailing missile technology severely limited the operational gain. Nevertheless, while current missile technology may limit the accuracy and payload of the conventionally armed TBM, the addition of an unconventional warhead, i.e., chemical or biological, will increase significantly the lethality of the missile regardless of its circular error of probability (CEP).[21]

In corollary, the potential increase in lethality will also make the TBM the most dangerous threat at the *tactical* level of war. Besides inflicting mass casualties, the use of TBMs in the close fight can restrict the tactical forces' freedom of maneuver and preclude concentration of forces at the decisive time and point on the battlefield. In addition, when unconventional warheads are employed, the troops will be required to wear protective suits. Studies show that these protective suits dramatically reduce the combat efficiency of the troops. Moreover, once contamination occurs, decontamination operations will be required. These operations can be time consuming and may divert forces from other missions.[22]

Theater Missile Defense

On the other hand, developments in antitactical ballistic missile (ATBM) defense experienced a more checkered history. The first ATBM program, Project Plato, was initiated in 1951. Thereafter, a number of trials were conducted on the employment of air defense missile systems for ATBM purposes. The type of air defense systems included the Hawk, Nike-Hercules, and the Mauler. The next major ATBM project was the field army ballistic missile defense system (FABMDS) in 1961. However, given the prevailing technology, these programs failed to meet the established requirements and were terminated. Following this, there was a long period of indecision about the next generation ATBM system. This was largely due to U.S. Secretary of Defense Robert McNamara's emphasis on an exhaustive systems analysis to eliminate all risks before starting any programs.[23]

The current surge in the TMD initiative was a consequence of the U.S. response to the Soviet TBM threat. The initiative proposed "conducting TMD by executing an integrated mix of mutually supporting passive defense, active defense, attack operations, and BM/C4I measures."[24] Such a system was fielded and first tested in the Gulf War against Iraqi's TBM threat. Although there was notable success in the area of active defense, Coalition attack operations produced only minimal results in suppressing Iraqi TBM attacks. During the war, the U.S. military quickly relearned the painful lessons of the psychological and destructive effects produced by TBMs. The experiences in the Gulf War reaffirmed the immediate need to take active measures to upgrade TMD capabilities. This includes a gamut of options.

NATO's preferred option, albeit influenced largely by political concerns, focused primarily on active defense. However, modifying conventional air defense systems to counter a TBM threat would prove to be very cost ineffective. Hitherto, the only air defense system that had succeeded in intercepting TBMs was the Patriot. Even then, the Patriot's successes in the Gulf War must be interpreted within context of the prevailing conditions there. First, Scuds were only fired from very limited directions. Second, rarely were Scuds massed against a single target. This compensated for the Patriot's limited sector of coverage. What was more important was that the Patriot did not have to be called on to defend against mass attacks, which might have otherwise overloaded the Patriot's command and control (C2) system.[25]

Current initiatives in the U.S. military aimed at improving active defense include the development of the theater high altitude area defense (THAAD) system, which is exclusively an anti-TBM interceptor to engage missiles at high altitudes to minimize debris and chemical damage. In addition, an extended range intercept technology (ERINT) missile is also currently being developed. The THAAD will operate in conjunction with the improved Patriot PAC-3 and the ERINT to form an integrated anti-TBM architecture which should provide substantially improved coverage against most TBMs.[26] Nevertheless, these systems are very large and heavy systems and cannot easily keep up with the maneuver forces. This is a serious limitation especially in today's highly fluid, high tempo fast-paced battlefield. More significantly, the system cannot guarantee total reliability against all classes of TBMs.

The second option of upgrading passive defense measures, which includes camouflage, fortifications, dispersal, operation security (OPSEC) and deception, and jamming, favors the cost-exchange ratio of the defender vis-à-vis the attacker. This option also serves to demonstrate resilience, survivability, and recoverability to deprive the attacker of the benefits of employing TBMs. However, this option, if employed in isolation, clearly concedes the initiative to the attacker to employ mass destructive TBM power at the time and place of his choosing.

The remaining alternative is to counter and destroy the TBM threat by attack operations. This option offers a proactive means to counter the TBM threat and provides the attacker the flexibility to preempt the adversary's TBM capabilities. The option therefore offers the advantage of wresting the initiative from the adversary. However, the Gulf War would conclusively demonstrate that, despite the Coalition's technological superiority, the Coalition's attack operations were not successful in neutralizing the Iraqi TBM threat. This could be attributed to various sources. One of the main reasons was the inability to provide timely and accurate intelligence to enable the attack operation to be conducted in a responsive fashion.

Attack Operation Challenges

Attack operations are challenging because TM targets are generally hard to detect. The TM systems are highly mobile, dispersed, electronically quiet, and redundant. Given the ephemeral nature of mobile missile launchers, the key is to be able to reduce the detect-to-attack response time. This includes the seamless coordination and near real-time cross cueing of strategic to tactical level RISTA assets to locate and identify the TBM targets, near real-time processing and dissemination of information to the attack systems to include establishing cross-component sensor-to-shooter links, and monitoring accurate battle damage assessment. To accomplish this, a responsive C2I process, intelligence throughput, and parallel information processing are essential. These requirements pose significant challenges to the existing C2I system of most advanced armies.

Problem Statement and Research Questions

Primary Research Question

The study evaluates if the C2I process for the Coalition TMD attack operation during Operation Desert Storm (ODS) is an effective model for the advanced army.

Secondary Research Questions

1. Was the Coalition TMD attack operation C2I process effective in defeating the TBM threat during ODS?

2. What was the operation environment, the threat profile, and the attack operation high payoff targets during ODS?

3. What was the Coalition TMD attack operation strategy and the C2I process to support that strategy?

4. Was the C2I process effective in supporting the *decide* phase of the attack operation, with emphasis on the intent and concept of the operation, intelligence preparation of the battlefield, target development, and scheduling of assets?

5. Was the C2I process effective in supporting the *detect* phase of the attack operation, with emphasis on the collection, processing, and dissemination of both strategic and operational level intelligence?

6. Was the C2I process effective in supporting the *deliver* phase of the attack operation, with emphasis on battle management and coordination of the attack?

7. Was the C2I process effective in supporting the *assess* phase of the attack operation?

Assumptions

The study is based on the following macro level assumptions:

Advanced Army

The study assumes that an advanced army is capable of complex joint operations. The advanced army is capable of conducting joint strikes using air, sea, and land assets, integrating high technology equipment and weapon systems. However, such an army will have the following critical limitations: First, its C4I systems exhibit a rigid hierarchical structure, with each individual system developed in a stovepipe fashion. Second, the advanced army has limited capability with immature infrastructure and procedures to counter a TBM threat. Third, given the limited distribution of active defense systems, e.g., Patriot missiles, the study assumes that without significant external assistance, the advanced army does not have a significant active defense capability. Its TMD strategy will rely mainly on integrating passive defense and attack operations to counter the TBM threat.

Applicability

The focus will be confined to a localized theater of operation with an underdeveloped TMD system, infrastructure, and procedures.

Level of Conflict

Although the enemy use of TBM may be expected across the entire operational continuum, this study focuses only on the employment of TBM during war. However, this does not preclude the friendly intelligence activities or preemptive actions prior to the declaration of hostilities.

Joint TMD

The advanced army TMD will inherently be joint in nature to exploit the synergy achieved via the integration of joint forces. In addition, its TMD will be also be supported by strategic and national systems, mainly in the area of intelligence.

Attack Operation Strategy

The advanced army adopts the decide-detect-deliver-assess (D3A) targeting methodology to attack enemy TM targets.

Key Definitions

For the purpose of this document, the following definitions apply:

Command and control (C2). Command and control is the exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of the mission. C2 functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission. Command and control comprises three elements: organization, facilities, and process. C2 organization describes the C2 relationship among individual elements which ensures unity of command. C2 facilities are the conduits and channels through which C2 is exercised. C2 process is "made up of a series of actions. . . The process begins with assessing the battlefield situation from available information. Following this assessment, the commander decides on a course of action. The commander then implements this decision by directing and controlling available forces. The final step is evaluating the impact of the action on both friendly and opposing forces. This evaluation then serves as an input into an updated assessment of the situation, and the process continues."[27]

Intelligence. Information is data collected from the environment. Intelligence is the product resulting from the collection, processing, integration, analysis, evaluation, and interpretation of available information. Intelligence provides knowledge which contributes to understanding.[28]

Intelligence Support Process. It is the process through which essential critical intelligence is furnished to support the decision-making process in order to successfully influence the outcome of the operation. It comprises five steps:[29]

1. Plan and direct. This involves establishing the intelligence requirements and the priorities; developing the collection plan; issuing requests for information on collection and production; tasking of collection assets; and monitoring the availability of collecion information.

2. Collect. This includes acquiring information and providing this information to processing and production elements.

3. Process. It is the conversion of collected information into suitable form that can be readily used to produce intelligence.

4. Produce. This involves the integration, evaluation, analysis, and synthesis of information from single or multiple sources into intelligence.

5. Disseminate. This is the conveyance of intelligence to users in a usable form.

C2I Process. It is the procedure through which activities of joint forces are directed, coordinated, and controlled to accomplish the mission. The process encompasses three elements: first, the intelligence support process which provides information that is pertinent, timely, accurate, and in a form that is quickly understood to support decision-making and coordinate actions. Second, the decision-making procedures to analyze the intelligence and to plan for the mission. Third, the battle management procedures and coordinating measures to supervise the execution of the mission.

D3A. The D3A methodology is the U.S. Army's targeting concept. It is also the way the Army conducts TMD attack operations. D3A comprises four functions:[30]

1. Decide. Based on the mission, the commander's intent and concept of operation, the objective of the decide function is to establish priorities for: enemy high payoff targets, RISTA,

information processing, attack means, and target damage assessment. At the end of the decide phase, the commander issues the intelligence requirements and the attack guidance.

2. Detect. During the detect phase, sensors conduct surveillance of named areas of interests (NAIs) to collect TM target signatures, cross cue confirming sensors, analyse TM targets, and alert designated shooters.

3. Deliver. The main objective of this function is to attack the target. During this phase, sensor data delivered to the shooter is processed into the shooter system to engage the target.

4. Assess. The objective of this phase is to determine if the attack achieved the desired outcome. This can be achieved by determining the physical detsruction of the target, or via analysing the effect of the damage inflicted on the target on the enemy's combat effectiveness. The analysis is then used to determine if the target needs to be reattacked.

Limitations and Delimitations

The research for this study was based entirely on unclassified literature and open sources. This study was not intended to examine the following aspects of TMD: (1) political issues governing the employment of TBMs; (2) anti-tactical ballistic missile strategies, e.g., deterrence policies, counterproliferation, and disarmament; and (3) strategic TMD systems such as the Space Defense Initiative (SDI). The study focused only on the operational and tactical aspects of the TMD C2I process for attack operations.

The study focused on mobile TBM systems and their support systems. In addition, the study focused only on the TMD C2I process for attack operations in the Gulf War. This was because the prevailing conditions and status of the TMD system during the war bore essential resemblance to the TMD systems that were generally in place in most advanced armies. Intelligence on the enemy's TBMs was very incomplete. Coalition forces in the Gulf did not have an established TMD system to counter the Iraqi TBM threat; the TMD system was an ad hoc arrangement. And, unlike the systems fielded in Europe that had never been subjected to battlefield conditions, the Coalition system in the Gulf War was placed under severe tests. Examining the Coalition TMD system fielded in the Gulf War would therefore yield invaluable and pragmatic insights.

Significance of Study

The significance of TBM derives from the military reach which it can afford, the surprise it can deliver, the level of destruction that it can inflict, and also from its potential to intimidate. The need to deter such intimidation is likely to give rise to a spiraling arms race. Should deterrence fail, the increasing unwillingness of nations to accept human and materiel losses is likely to lead them to attempt to secure their military objectives without having to tolerate any missile attacks. A precedence was established when the Israeli air force attacked and destroyed the Iraqi Osirak nuclear reactor in 1981. If both sides engage in a climactic contest of destruction as fast as they are capable in order to force the other to yield, the conflict is likely to be one of pain and punishment, with neither side gaining from the pain it inflicts.[31] TBMs therefore undermine stability, escalate regional tension, and make future crises more difficult to control.

TBMs are both political and military weapons. They can be used to hurt with monstrous violence to achieve strategic objectives without first achieving decisive military victory, which makes military engagement academic.[32] In addition, TBMs can also be used to rapidly secure operational and tactical leverage.

To deter strategic intimidation and preclude the enemy from gaining any military advantage, an effective counterforce capability is therefore necessary to defeat the enemy's TBM threat.[33] Failure to defeat the enemy's TBM threat is likely to accelerate his use of his remaining missiles before they are destroyed. Schelling contends that in the closing stages, the victor needs to "induce the enemy to avoid a final, futile orgy of hopeless revenge."[34] The measure of success of the counterforce capability is therefore the speed with which it can destroy and neutralize the enemy's TBMs. This underscores the need for a completely reliable counterforce capability, which can rapidly seize initiative and defeat the threat. TMD attack operation provides the advanced army the only proactive capability to defeat the enemy's TBM threat. The linchpin to successful and reliable attack operations is an effective and responsive C2I process.

Conclusion

Defeating the TBM threat is a major challenge to the advanced army. Consolidating the C2I lessons learned from the study will provide a critical fundamental baseline for developing the operational objectives of a TMD attack operation C2I process.

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[1]Joint Pub 3-01.5, Doctrine for Joint Theater Defense (Washington DC: Office of the Chairman of the Joint Chiefs of Staff, 1996), II-7.

[2]U.S. Army Space and Strategic Defense Command, SSDC Pam 3-01.5, Army Theater Missile Defense Primer (Virginia: U.S. Army Space and Strategic Defense Command, 1995), 7; Joint Pub 3-01.5, Doctrine for Joint Theater Missile Defense (Washington DC: Office of the Chairman of the Joint Chiefs of Staff, 1996), I-2.

[3]Ibid., I-2.

[4]Joint Pub 3-01.5, 1-2; U.S. Army, FM 44-100, U.S. Army Air Defense Operations (Washington DC: HQDA, 1995), 3-9.

[5]Joint Pub 3-01.5, III-6, 7, 10 and 14.

[6]Schwarzkopf, "Talking with David Frost" (transcript of TV interview), 27 Mar 91, 4; Horner, speech at Dadaelian Dinner, 11 Sep 91, 5.

[7]U.S. DOD, Conduct of the Persian Gulf War: Final report to Congress (Washington, DC: U.S. DOD,1992), 223 (cited henceforth as Congress); Schwarzkopf television interview with David Frost, 27 Mar 1991, 3.

[8]Congress, 167.

[9]Michael R. Gordon and Bernard E. Trainor, The General's War (Boston: Little Brown,1995), 239-240.

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[11]U.S. DOD, Proliferation: Threat and Response (Washington, DC: Office of the Secretary of Defense, 1996), 7 (cited henceforth as Proliferation).

[12]Joseph S. Bermudez, Jr, "Iraqi Missile Operations During Desert Storm," Jane's Soviet Intelligence Review, (March 1991), 132.

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[14]Martin Navias, Ballistic Missile Proliferation in the Third World (London: The International Institute for Strategic Studies, 1990), 13.

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USACGSC, 1993), 25; Martin S. Navias, Going Ballistic: The build-up of Missiles in the Middle East (London: Brassey's,1993), 7-13.

[16]U.S. Training and Doctrine Command, TRADOC Pamphlet 525-5, Force XXI Operations: A Concept for the Evolution of Full-Dimensional Operations for the Strategic Army of the Early Twenty-First Century (Ft Monroe, VA: U.S. Army Training and Doctrine Command, 1994), 2-7.

[17]Thomas C. Schelling, Arms and Influence (Connecticut: Yale University Press, 1967), 2-34.

[18] Sir Winston Churchill, Triumph and Tragedy (Cambridge: The Riverside Press,1953) 39. For a discussion on V-1 and V-2 attacks on London, see Ibid., 38-56.

[19]Martin S. Navias, Ballistic Missile Proliferation in the Third World (London: The International Institute for Strategic Studies, 1990), 34.

[20]A. Levran, The Growing Threat to Israel's Rear: The Middle East Military Balance 1987-88 (Boulder: Westview Press, 1988), 222-223.

[21]For a discussion on the military significance of of CW and BW weapons, see Proliferation, A-3 and A-5.

[22]Proliferation, A-3.

[23]William A. Davis, Jr., Regional Security and Anti-Tactical Ballistic Missiles: Political and Technical Issues (Washington DC: Pergamon-Brassey's International Defense Publishers, 1986), 1-11.

[24]SSDC Pam 3-01.5, 7-8.

[25]Jorg Bahnemann and Thomas Enders, "Reconsidering Ballistic Missile Defense," Military Technology (1991), 50-51.

[26]Office of the Assistant Secretary of the Army for Research, Development and Acquisition, "Army Weaponry and Equipment," Army Green Book (1992), 300.

[27]Joint Pub 1-02, DOD Dictionary of Military and Associated Terms with JMTGM changes (Washington DC: Office of the Chairman of the Joint Chiefs of Staff, 1994), 100; U.S. Air Force Combat Air Command, TAC Manual 2-1, Tactical Air Operations (Virginia: Tactical Air Command, 1991), 5-1 - 5-2.

[28]Joint Pub 1-02, 205.

[29]U.S. Army Command and General Staff College, ST 100-3, Battle Book (Ft. Leavenworth, KS: USACGSC,1996), 3-5 - 3-6.

[30] U.S. Army, FM 6-20-10, Tactics, Techniques and Procedures for the Targeting Process (Washington DC: HQDA, 1990), 1-1 - 4-4; SSDC Pam 3-01.5, 35.

[31]Schelling, 201.

[32]Ibid., 22.

[33]The study focuses only on the operational and tactical aspects of TMD attack operations. For a more detailed discussion on the dilemmas of counterforce strategy, see Ibid, 190-208.

[34]Ibid., 205.

CHAPTER 2

LITERATURE REVIEW

> For it is really the acquisition, processing, and dissemination of information that lies at the root of the speed and accuracy with which fire can now be applied.[1]
>
> Brigadier General Richard E. Simpkin,
> Race to the Swift

Introduction

This chapter has two objectives. First, to summarize and evaluate briefly existing research on the research questions. Specifically, the review will look at books and articles that contributed to the development of the thesis in three areas: the Coalition TMD attack operation C2I process during the Gulf War, doctrine and current developments on TMD attack operations, and command and control of joint forces. However, there was no open source that dealt specifically and in detail with the Coalition TMD C2I process. The second objective of this chapter is therefore to use information obtained from the review of available open literature to provide a summary of the Coalition TMD attack operation C2I process in order to facilitate the thesis analysis. The summary will be general in scope. The intent is to provide sufficient background for further examination in chapter 4. Specifically, it will examine the Coalition C2I attack operation process during precrisis planning and during each phase of the targeting cycle.

Literature Review

Coalition TMD Attack Operation C2I Process

During the Gulf War, the Coalition TMD attack operation to defeat the Iraqi-Scud threat was planned and executed as part of the Coalition air campaign. A variety of literature exists on the

Coalition Gulf War air campaign. The best source of information was from the Gulf War Air Power Survey. The survey was commissioned by the United States Air Force after the war to review all aspects of air warfare during the Gulf War. The survey has several volumes and comprised reviews on the air campaign planning, command and control, conduct of operations, effects and effectiveness, logistic support, space support, weapons, and tactics employment.

Gulf War Air Power Survey: Planning provided a comprehensive study on the evolution of the air campaign plan that was executed during the Gulf War. It described the inception of the air campaign concept, the process that translated that concept into the Coalition air campaign plan based on the political objectives and constraints, and theater military strategy. It further described the objectives and priorities in each phase of the air campaign. Colonel John A. Warden III's The Air Campaign: Planning for Combat and Concepts in Airpower for the Campaign Planner, General Charles A. Horner's The Air Campaign, and James Blackwell's Thunder in the Desert: The Strategy and Tactics of the Persian Gulf War provided useful insights into the operational concepts adopted to design the air campaign. In particular, the Iraqi-Scud capability was identified as an Iraqi center of gravity and was included as a target set as part of phase one of the air campaign--the strategic air campaign. The survey also highlighted that a critical intelligence shortfall on the capabilities of the Iraqi Scuds led to a lack of understanding of the Scud threat during planning. This in turn resulted in a lack of command emphasis on the Iraqi Scud capability, which consequently led to significant difficulties in defeating the Scud threat during the war.

Gulf War Air Power Survey: Command and Control detailed excellently the command and control organization that ran the air campaign. It described the functions of each element of the Tactical Air Control Center (TACC) and the relationships among each element in exercising C2 of the air campaign. Specifically, the survey illustrated that unity of command and centralized planning were essential in enabling a coherent air campaign. Moreover, the survey provided useful insights into the C2 operations of the airborne C2 elements, i.e., the AWACS, JSTARS, and ABCCC. It concluded that the airborne C2 elements played a vital C2 role in enabling responsive decentralized operations against the Iraqi mobile Scud targets. An illustrative overview of the C2I coordination among the elements to enable an attack on mobile Scud targets was concisely covered in Richard P. Hallion's Storm Over Iraq. FM 100-1-3-2, TAGS: Multiservice Procedures for the Theater Air-Ground System which described the process involved in synchronizing air power in support of the army and navy, and FM 100-103-1, ICAC2: Multiservice Procedures for Integrated Combat Airspace Command and Control, which described the coordination process of combat airspace, further facilitated an understanding of the operations of each C2 element.

Additionally, the survey described the command and control process employed by the Coalition air component to orchestrate the air campaign and the role of intelligence in support of the air campaign targeting process. The survey indicated that while the process was effective against static Scud targets, it faced considerable challenges against mobile Scud targets. It highlighted that essential information required to enable successful attacks on the mobile Scud targets was not optimally integrated into the C2 process. This strategy predicated the need for a C2 process that could effectively support decentralized execution. Specifically, FM 6-20-10, Tactics, Techniques, and Procedures for The Targeting Process and Joint Pub 3-09, Doctrine for Joint Fire Support, provided the doctrinal information necessary to understand the targeting process. Major Robert F. Kluba's "De-Mystifying Joint Targeting" which provided a useful discussion on the differences between the army's D3A targeting process and the joint targeting process further aided understanding the C2I and targeting process adopted by the Coalition.

Gulf War Air Power Survey: Operations focused on the operational level conduct of the air campaign and the friction experienced during the operation. The survey highlighted the difficulties involved in providing timely sensor-to-shooter information required to enable a successful attack on the elusive Scud targets and described the modification in the attack strategy given the difficulties. Specifically, it concluded that only combat air patrols on station over the Scud target areas were able to respond to the Iraqi mobile Scud targets. HRH Khalid bin Sultan's Desert Warrior provided a glimpse of the approach the Coalition took in reaching this solution. Williamson Murray's Air War in the Persian Gulf also provided a good overview of the air operations. It also examined the C2 process in managing the air campaign. While it covered in significant detail the air operations against the Iraqi static Scud targets, there was little emphasis on Coalition counterscud efforts against mobile Scud targets. Murray was a member of the Gulf War Air Power Survey (GWAPS). As such, the sources used by the study were very similar to those used in the GWAPS. Consequently, the observations and the conclusions established were very similar to those found in the GWAPS.

Gulf War Air Power Survey: Effects and Effectiveness emphasized the operational-strategic effectiveness of the air campaign on the Iraqi targets, including the Iraqi Scud capability. The survey pointed out some tactical limitations in assessing the effectiveness of air attacks against Scud targets. This limitation contributed significantly to the battle damage assessment which affected the targeting process. The survey suggested that "beyond the disruption induced by the level of effort put into the hunt for mobile Scud launchers, Coaltion air power does not appear to have been very effective against this target category."[2]

Gulf War Air Power Survey: Weapons, Tactics, and Training and Gulf War Air Power Survey Space Operations provided good insights on the means employed to acquire Iraqi mobile Scud targets. Both highlighted the critical role played by the Defense Support Program (DSP) in acquiring these targets. In particular, FM 100-18, Space Support to Army Operations, US Army Space Reference Text, and Marcia S. Smith's CRC Report for Congress: Military and Civilian Satellites in Support of Allied Forces in the Persian Gulf War provided useful outlines on how the DSP supported the attack operation on the Scuds.

Gulf War Air Power Survey: Weapons, Tactics, and Training also highlighted the employment of Special Operations Forces (SOF) to target the mobile Scud targets. Gordon and Trainor's The General's War also provided accounts on how SOF were employed to target mobile Scuds. Although these SOF units testified to Congress after the war that they destroyed a dozen mobile Scuds, both books contended that SOF were not as successful as they had claimed.

Military Lessons of the Gulf War, compiled by Bruce W. Watson, Bruce George, Peter Tsouras, and B. L. Cyr, covered lessons learned from the Gulf War at the strategic and operational level. The study concluded that the concepts of unity of command, centralized planning, and decentralized execution were essential in prosecuting a successful air campaign. It also highlighted the vital role played by the airbrone C2 elements in providing responsive C2 to an otherwise inflexible air campaign. In addition, it concluded that the lack of intelligence on the Iraqi Scud target set, poor battle damage assessment, and excessive intelligence dissemination time complicated the targeting process. It further added that strategic intelligence support was less than adequate in supporting the C2I process. There were also insufficient number of theater reconnaissance assets to provide the necessary theater and tactical intelligence required for effective targeting. Contrary to the GWAPS, it praised the indispensable role played by SOF in locating and destroying Iraqi Scud targets. General Sir Peter De La Billiere's Storm Command further reaffirmed the value played by SOF in attacking Iraqi Scud targets. However, neither the CIA nor DIA would verify those claims.

Norman Friedman's Desert Victory also highlighted some good lessons learned from the air campaign. It concluded that although the ATO played an important role in ensuring close coordination of the air campaign in an exccedingly crowded airspace, it could not respond to targets that exhibited unpredictable patterns of operation, such as the mobile Scuds. It pointed out that the airborne C2 elements played a crucial management role in supporting the rigid ATO process in providing responsive solutions to ephemeral targets such as the mobile Scuds. It also concluded that the lack of intelligence on Iraqi mobile Scud capabilities was key to the difficulties faced by the Coalition in defeating the mobile Scud threat. It added that the lack of sustained real-time reconnaissance over Iraq further complicated the acquisition process. In addition, sensor-to-shooter information dissemination was not adequately responsive to allow successful attacks on the mobile Scuds. Moreover, poor battle damage assessment complicated target analysis. Furthermore, there were no clear guidelines provided on intelligence dissemination. Consequently, certain information did not reach the relevant C2 nodes. This resulted in discrepancies among the various C2 nodes on the understanding of the latest situation in the battlespace. It further concluded that mobile Scuds were most vulnerable when they were concentrated before they were deployed. Once deployed, the greatest payoff was obtained by tracking them after they had fired and attacking them in their rendervous areas where several launchers would be together.

The Final Report to Congress: Conduct of the Persian Gulf War was excellent in providing a broad understanding of the war, particularly the air campaign. It explained the key concepts governing the planning of the air campaign. It also comprehensively covered the tactical operations of the air campaign and evaluated the results on the twelve air campaign target sets, of which the Iraqi Scud capability was one. Additionally, It addressed the key operational considerations of the Coalition's strategy against the mobile Scuds. Furthermore, it provided useful information on the capabilities, employment concept, and performance of the various air attack assets.

The report also provided a good evaluation on intelligence support provided by strategic, theater, and tactical intelligence systems. It highlighted that theater intelligence was not prepared to cope with the volume of intelligence requirements and strategic intelligence was required to assume the role of production guidance, addressing order of battle, targeting, imagery exploitation, estimates, and battle damage assessment. The report concluded that intelligence dissemination at the service and tactical levels was not fast enough to affect decision making. The absence of precise battle damage assessment also complicated theater and tactical targeting.

In addition, the report examined the performance of the various theater and tactical intelligence collection assets and concluded that the Joint Surveillance Target Attack Radar System (JSTARS) provided essential near-real-time targeting information which was essential in enabling a successful attack on the Iraqi mobile Scuds. At the tactical level, it reported that the war validated the ability of the unmanned aerial vehicle (UAV) in providing immediate responsive intelligence collection capability. Nevertheless, there were insufficient theater level collection means to fulfill the intelligence requirements of both theater and tactical commanders.

Major Steve Zappalla's Master of Military Art and Science thesis "An Army Assessment: Joint Theater Missile Defense" evaluated the performance of the Coalition JTMD during the Gulf War in the areas of active defense; passive defense; attack operation; and command, control, communications, and intelligence (C3I), using the concept based requirement system (CBRS). Specifically, CBRS addressed the following: doctrine, training, leadership, organization, and material systems (DTLOM).

This thesis highlighted useful lessons on attack operations and C3I learned from TRADOC's Joint Universal Lessons Learned Systems Reports on Operation, which was not available for this research.

In the area of attack operations, the report concluded that attack guidance and target priorities must be clearly established to enhance the attack response. The study concluded that although Army ATACMs had the capability to attack mobile Scuds, air strike remained the most suitable method because of its superior accuracy, flexibility, and range. To meet the short dwell time of the mobile Scuds, the study recommended armed reconnaissance supported by tactical sensors in predefined Scud target areas.

In the area of C3I, the study concluded that the Coalition theater intelligence architecture was suboptimal to support responsive targeting of the mobile Scuds. In particular, sensor-to-shooter information dissemination could not support the requirements to provide precise target coordinates in near-real-time. In addition, localization, detection, and identification capabilities were inadequate. The study recommended improving localization techniques to narrow the search areas to the point where tactical collection assets could effectively detect and identify the mobile Scuds.

Doctrine and Current Developments on TMD Attack Operations

Joint Pub 3-01.5, Doctrine for Joint Theater Missile Defense, provided the doctrine for the integration of joint theater missile defense capabilities. In particular, it addressed the potential operational environment and the threat that U.S. joint forces would likely encounter in future operations; established the responsibilities and command relationships; provided planning and preparation considerations for JTMD; and afforded guidelines on the execution of the four JTMD mutually suporting operational elements for a succesul defense.

Joint Publication 3-01.5 stipulated that the Joint Force Commander (JFC) was primarily responsible for JTMD. The JFC's concept of operations would specify the JTMD objectives and provide the guidelines for the employment of BM/C4I, attack operations, active defense, and passive defense measures. It also spelled out that the Joint Force Air Component Commander (JFACC) would normally be assigned the responsibility for the planning and execution of JTMD attack operations outside the other component commanders' AOs. In addition, the JFACC should also plan for and maintain visibility on the theater/joint operations area-wide attack operations effort. Within the surface AOs, the component commanders would normally be designated as supported commanders for attack operations. A Joint Targeting Coordination Board (JTCB) could be established to coordinate target information, provide targeting guidance, priorities, and prepare or refine joint target lists. Its TMD role would be to ensure that attack operations were integrated into the components' counterair, strategic attack, interdiction, counterfire, fire support, strike, and special operations, to ensure the JFC's TMD objectives were met.

Joint Publication 3-01.5 emphasized that the objective of attack operations was to prevent the launch of TBMs and the preferred method of countering the enemy TBM threat was to attack and destroy or disrupt the TBMs prior to their launch. It highlighted that attack operations were highly dependent on predictive and developed intelligence and stressed the importance of comprehensive intelligence preparation of the battlespace (IPB). In particular, it highlighted the contribution of IPB to TBM area limitation analysis and automated cuing of TMD sensors and weapon systems. Intelligence localization, coupled with the allocation of the right mix of sensors to search for the TBMs in specific target areas, were critical to the successful conduct of TMD attack operations. To enhance responsiveness, it stressed that rules of engagement (ROE) should be established during the planning. It further stressed that execution of attack operations was the responsibility of subordinate commanders based on the ROE.

To support the attack operation, it accentuated the requirements for absolute horizontal and vertical technical and procedural interoperability. In addition, there was a need for JTMD C4I interoperability among the joint force components.

FM 44-100, U.S. Army Air Defense Operations, is the capstone doctrinal manual for the air defense battlefield operating system. Apart from explaining the army's contributions to the joint counterair efforts, it explained the army's responsibilities, C2 relationships, and planning considerations for army TMD operations, including attack operations, as part of the joint offensive counterair operation. For attack operations, besides attacking TBMs directly on the ground before, during, and after launch, it recommended an indirect approach of attacking the enemy's TBM support facilities, C2 facilities, and electronic warfare systems. In particular, targeting the enemy's C2I systems would interfere with the enemy's decision-making cycle, thereby disrupting his ability to synchronize TBM operations. It also highlighted that army systems may be employed as part of joint suppression of enemy air defense (SEAD) in support of joint attack operations.

Space and Strategic Defense Command Pamphlet 3.01-5, Army Theater Missile Defense Primer, provided a comprehensive study on the army's conduct of TMD operations as part of JTMD. Notably, it disputed the effectiveness of a centralized planning and execution TMD strategy, where a central joint C2 element exploited the information revolution to direct theater-wide TMD operations. It argued that the number of threats coupled by the stringent timelines would overload the entire system. It was therefore in favor of a centrally planned and highly decentralized executed approach. It recommended the establishment of a dedicated TMD element at the component level to plan, coordinate, deconflict, and monitor the execution of TMD operations in the theater. In the army, the TMD element would work in close coodination with the Deep Operations Coordination Center (DOCC) in synchronizing army TMD attack operations. During execution, subordinate units would execute TMD operations in accordance with the attack guidance established by the TMD element. Depending on the attack guidance, enemy missile target information received would be confirmed by imagery or human intelligence. Once the target was confirmed, it would be tracked continuously and the data passed to the attacking unit, e.g., ATACMs battery, to engage the target.

The manual recognized that reducing sensor-to-shooter timelines meant eliminating seams in the C2I process, which might include man-in-the-loop intelligence analysis. It emphasized deciding in advance which targets would be acquired and which weapons would attack them, rather than react after the target had been detected. Attack guidance would be developed during the decide phase. In the detect phase, reconnaissance, surveillance, and target acquisition (RSTA) systems would be assigned for detection and continuous coverage, and weapons paired with targets. To enable successful attack operations, it called for the integration of strategic, operational, and tactical intelligence. It postulated that rapid exchange of critical and accurate information was key to successful TMD attack operation because commanders and battle staffs at each echelon could form a common picture of the battlespace, thereby allowing them to make decisions in a timely manner.

Air Combat Command's Theater Air Defense Vision volume 1: BM/C4I and Theater Air Defense Vision volume 2: Attack Operations and Acive Defense spelled out the Air Force's vision of JTMD attack operations, active defense, and BM/C4I support architecture. It spelled out several critical objectives. First, the development of a Distributed Battle Management (DBM) environment where commanders of key C2 nodes, including the corps fire support element (FSE), the Air Support Operations Center (ASOC), and the Airborne Battlefield Command and Control Center (ABCCC), could dominate the battlespace through shared decision support, information connectivity, and a common view of the battlespace. Second, the introduction of a Combat Integration Cell (CIC) to provide the Air Force ground C2 elements with rapid access to intelligence data, threat warning, and fused missile track data at the execution level. Third, the development of decision aids which would permit rapid identification of an attack to allow the decentralized C2 node to divert them according to the JFC's guidances. Fourth, the development of automatic target recognition on the JSTARS which would enable target characterization to occur at the decentralized BM/C4I node and direct dissemination of target information to the attack systems. Fifth, the installation of datalink in attack systems to improve timeliness and accuracy of target information from the sensor to the shooter.

In addition, the manuals provided a detailed description of the key activities in each TBM operating phase. They further spelled out the potential high payoff targets in each phase, the attack options, and the constraints associated with each option. They also illustrated the BM/C4I information flow involved in a typical air force attack operation. Moreover, they are excellent sources of information on the capabilities, functions and C2 relationships of each air force C2 node and TMD acquisition assets.

Janssen Lok's "Assessing the Fangs of Cobra" and "Turning Theory into Practice" described the TMD initiatives that were being undertaken in Joint Project Optic Cobra (JPOC), a U.S. Central Command initiative. JPOC's exercise Roving Sands 1995 assessed how well advanced sensors could detect, locate, and identify TBM-related target and how timely sensor information could be disseminated to the attack systems. The exercise revealed several useful lessons. First, the target nomination system of the various components must be linked to ensure that there is no duplication of effort. Second, UAVs provided real-time imagery of the target which facilitated the targeting process. Third, U-2R aircraft using datalinks and processing systems provided near-real-time imagery with very precise coordinates to attacking aircraft. This greatly enhanced target identification and engagement. The intent was to furnish attack systems directly with the relevant strategic, operational, and tactical intelligence, prefably in imagery form, so as to enhance the detect-to-attack timelines. John Boatman's "Army Plans for Two Minute Warning" further highlighted that a key objective was to reduce the sensor-to-shooter timeline to two minutes. This was currently being examined in the Joint Precision Strike Demonstration (JPSD) initiative. The initiative examined the common standards, formats, and protocols on all BM/C4I systems. It also looked into the fusion of theater and tactical intelligence collection assets. However, Dennis Steele's "Roving Sands: Duel in the Desert", which reviewed the exercise Roving Sands in 1995, revealed that despite the available technology, detecting the TBMs continued to be extremely difficult.

Other initiatives included the U.S. Air Force ACC's operational concept demonstration which addressed the development of the CIC and the F-15E "in-the-cockpit" imagery of the potential targets, Project Night Vector which focused on the support of strategic surveillance systems to support deployed commands to conduct TMD attack operations, and Advanced Research Project Agency's (ARPA) initiatives which focused on improving data analysis and dissemination to support TMD attack operations. Mark Tapscott's "Finding, Killing Scuds Aim of Precision Strike Thrust" also reported that ARPA was examining capabilities for centralized coordination of attack operation, reducing mission planning time, and ensuring interoperability among the services BM/C4I systems.

While most initiatives seeked to link the sensor to the shooters directly to reduce the detect-to-attack timelines, Major Scott R. McMeen's "Fire Support Doctrine: Sensor to Shooter" suggested that there were several problems associated with this technique. First, it highlighted that most acquisition systems did not have the capability to positively identify the target. As such, information collected by these systems would still require further analysis before they become intelligence that could be exploited. Linking sensors directly to shooters might result in incorrect targets being engaged or even fratricide. Second, since targeting was a dynamic process, the high payoff targets and attack guidance would need to be constantly reviewed according to the changing tactical situation. However, current sensors had limited knowledge of the tactical situations and the fire support status. Third, given the finite resources, linking sensors to shooters would result in very few attack systems available for other fire missions. Fourth, direct sensor-to-shooter links violated fire support principles of considering all attack means in order that the most effective means was selected to attack the target. In general, the study concluded that sensor-to-shooter links did not provide the most optimal fire support response. While the study would apply to most fire support missions, it ignored that the stringent timelines involved in attack operations would often require the most efficient engagement method, as opposed to the most optimal.

Command and Control

Martin van Creveld's Command on War, which used a historical basis to develop a list of five key C2 attributes, provided a good starting point for understanding the characteristics of a good C2 system. The Principles of Command and Control, a collection of works on C2 edited by Jon Boyles and Stephen J. Andrioles, offered further invaluable insights into the properties required of an effective and efficient C2 system. Similarly, Raymond C. Bjorklund's The Dollar and Sense of Command and Control provided a useful list of important C2 characteristics based on studies by Welch, Bohannon, Fincke, and van Creveld. The attributes proposed by the three books may be broadly categorized as follows: dispersion, invulnerability, mobility, responsiveness, and timeliness.

Control of Joint Forces: A New Perspective, edited by Lieutenant General Clarence E. McKnight, provided a collection of views on the challenges and requirements for the C2 of joint forces at the operational level. Part four of the book also offered a detailed discussion on the issue of interoperability, an important tenet for the effective C2 of joint forces.

Summary of the Coalition Counter-Scud Effort During the Gulf War

TBM Concept of Operation

For the purpose of attack operations, the TBM concept of operation may be broadly categorized into three phases: pre-launch uncommitted, pre-launch immediate, and post-launch. During the Gulf War, the Iraqi TBM units followed essentially the same pattern of operation as the Soviet TBM concept of operation. The scope of activity for each phase of the operation is summarized in table 1.[3]

Table 1: Activities in each phase of the Sovet TBM operation.

TM Launch Phase	TM activities
Prelaunch uncommitted	Threats that, in themselves, are benign and do not represent an immediate threat to friendly forces (i.e., they are not ready for launch)
Prelaunch immediate	TMs being deployed and/or readied for launch. Primarily includes mobile TM systems that pose an immediate threat.
Postlaunch	The period after the missile launch when the launch platform is still vulnerable to attack.

The prelaunch uncommitted phase included the peacetime maintenance of the TBM components in the rear area infrastructure up to the movement of the readied TBM system to the forward area hide site to meet the event rendezvous. The key events during this phase were the issuance of orders for attack, checking of components, calibration of guidance systems, mating of the warhead, fueling for liquid fueled TBM, transfer of TBM to TEL or MEL, and movement to a forward-area hide site. The typical timeline for a liquid propellant TBM for this phase beginning with attack orders being issued was approximately 190 minutes. The timeline for the solid propellant TBMs was about 90 minutes, about one-half that of the liquid systems.[4]

The HPTs during this phase included the infrastructures, support systems, and supply systems, the destruction of which would render the long-term support of the TBM operation immediately ineffective.[5] The destruction of the storage sites would also remove the bulk of the TBMs. During the Gulf War, the C2 structure of Iraqi TBM forces was highly centralized. The attack orders came directly from Saddam Hussein. This made the C2 structure a critical vulnerability and a key HPT of the Coalition TMD attack operation.[6]

During this phase, the Iraqis protected the TBM systems with both passive and active measures.[7] Since 1985, Iraq had constructed several elaborate infrastructures to support its TBM operation. The infrastructures consisted of missile production and test facilities, hardened missile storage facilities, fortified TEL/MEL hide areas, and fixed-missile launch pads. For example, the static unit located at the H2/H3 airfield complexes had dedicated, fortified, underground facilities to store, prepare, and hide the missiles. The Iraqis also concealed their mobile Scud launchers in existing infrastructures. In some cases, mobile Scud launchers were dispersed in forward-area hide sites to decrease their vulnerability to detection and preemptive attacks. To further enhance survivability, the mobile Scud launchers, which were only as large as medium-sized trucks, constantly moved to prevent the Coalition intelligence from obtaining fixes on their locations prior to attack. In addition, these missile launchers were protected by dedicated surface-to-air missile and antiaircraft units. Nevertheless, Coalition air supremacy, which greatly degraded Iraqi air defense systems and defensive counterair support, made these active defense measures negligible. However, air supremacy cannot be guaranteed in all future conflicts.

Although the dwell periods between events in this phase offered an opportunity for observation, detection of the locations and the state of readiness of the missile launchers was extremely difficult. This was made more difficult, when there was no knowledge before operation of the capabilities and order of battle of the mobile Scuds.

At the prelaunch immediate stage, the missile was already readied, requiring only immediate prelaunch setup to fire the missile. At the same time, the launch site was prepared, and geodesic and meteorological surveys were conducted simultaneously, although these activities were in most cases prepared in advance. The mobile Scud launcher moved from the forward-area hide site to its respective launch site, where it received its target assignments. The target information and ballistic data were then programmed into the missile guidance system. The entire launch preparation time was no more than forty minutes for liquid propellant TBMs and fifteen minutes for solid-fueled TBMs.

Given the status of the missile, the HPT in this phase was the launcher. The short dwell activity in this phase required an immediate response, with rapid closure and commitment on the target being essential to prevent the TBM launch. However, this was made difficult by the enemy's control over the time and place of the launch.[8]

During the Gulf War, the launchers were fired from presurveyed launch sites. There were three distinct area of operations: the area bounded by Basra, Al Amarah, Al Nasiriyah, Kuwait City; the area bounded by Baghdad and Tkkrit area; and the area bounded by Al Qaim, Al Haditha and Al Rutba. In particular, the area west of Iraq was rugged, which offered the launchers excellent concealment, using the available ravines, highway underpasses and culverts. The Iraqis also used decoys extensively to divert the Coalition's detection efforts. In addition, the launchers were employed generally during periods of limited visibility. Moreover, they operated under strict communications security measures. The prelaunch dwell time and signatures, which might have made prelaunch detection and attack possible by Coalition forces on the launchers, were thus significantly reduced by the Iraqis. The Iraqi operational approach, as well as employment tactics, techniques, and procedures, greatly complicated in Coalition's detection and attack efforts during this phase of TBM operation.[9]

A missile launch signaled the beginning of the postlaunch phase which initiated a series of postlaunch activities. The key postlaunch activities included packing up the mobile Scud launcher and movement away from the launch site to a predetermined, concealed location to renderzvous with resupply elements to rearm. The entire duration for this phase was usually less than five minutes. The end of this phase reset the TBM operation timeline to the prelaunch uncommitted phase.[10]

Given the plume and light signature produced by the launch, the launch was an obvious cue of the launcher location. The missile launch was a reflection of the failure to prevent TBM employment, but it exposed at least one location of the launcher. That launcher then became the main effort of the attack operation. Given the short dwell time, this required near-real-time fusion of sensor data to identify the launch point and transmission of attack orders to the attack platform. During the Gulf War, the Iraqis adopted the shoot-and-scoot technique. This technique greatly reduced the postlaunch dwell time which posed considerable challenges to the Coalition detect-to-attack capability.[11]

Attack Payoffs and Implications

Attack operations achieve the highest payoff when TBM systems are sufficiently degraded or when TBMs are destroyed during the prelaunch phase. This prevents the missile from being employed. At the same, it provides the opportunity for the attacker to destroy the bulk of the missiles and launchers concentrated over several fixed areas. However, such an option may require a preemptive strike and may not always be strategically acceptable.[12] The following table summarizes the payoffs and implications of the various attack options.

On detecting a TBM system, the attacker has two choices: continue tracking or attack immediately. The decision is dependent on the relative merit of the attack and the availability of attack means. Key considerations for deferring the attack immediately after detection of the mobile Scud launcher include seeking a more favorable opportunity to achieve a higher probability of kill, waiting for TBMs to rendezvous with their supply system before attack to gain a higher yield, or a lack of available attack means to engage the target. In these cases, successful attacks are greatly dependent on the capabilities to continuously track TBM systems until they are destroyed. On the other hand, when only a small number of TBMs are available to the enemy, an attack on one may be very significant. Generally, an immediate attack is conducted following a TBM detection when there is a threat of weapons of mass destruction. Multiple options provide the attacker the flexibility to best meet the diverse threat scenarios.[13]

Operation Environment

During the Gulf War, there were two environmental factors that had significant impacts on the conduct of the air campaign and TMD attack operations.[14] First, the Iraqi mobile Scud launchers operated deep inside their own territory. Thus, attacking aircraft had to fly extended distances to the target area. This often required multiple aerial refuelings. Given the large number of sorties that were

Table 2: Payoffs and implications of the various attack options.

TM Life Cycle	Target	Payoff	Implications
Prelaunch Uncommitted	Production facility	Destroy multiple missiles and production capability	Infrastructure easy to identify and attack. But probably too late after outbreak of hostilities
Prelaunch Uncommitted	Storage sites	Destroy multiple missiles	Infrastructure easy to identify and attack. But probably too late after outbreak of hostilities
Prelaunch Uncommitted	LOCs between storage areas and deployment sites	Impeded flow of multiple missiles	Probably too late after outbreak of hostilities. TELs normally dispersed.
Prelaunch Uncommitted	Deployment area storage and assembly points	Destroy multiple missiles	Deployment area storage and assembly points normally well hidden
Prelaunch Immediate	LOCs between deployment areas - launch sites	Impeded flow of few missiles	Numerous potential deployment areas and launch sites
Prelaunch Immediate	TEL enroute to launch site	Destroy single TEL and missile	Detection of single TEL is difficult
Prelaunch Immediate	TEL setting up to launch	Destroy single TEL and missile	Detection of single TEL is difficult
Postlaunch	TEL cooling down after launch	Destroy single TEL	Short dwell time; availability of responsive intelligence and attack assets
Postlaunch	TEL enroute to forward deployment area storage and assembly point	Destroy single TEL	Availability of responsive intelligence and attack assets; attack vs. tracking TEL to identify storage and assembly point

flown daily during the war, coordination for flight rendezvous of aircraft packages was extremely complex. In addition, because of the depth in which mobile Scud launchers were deployed, Army attack systems that could support TMD attack operations were limited only to the Army Tactical Missile Systems (ATACMs). The distance between the Scud target area and the delivery platform launch area thus limited the type of attack option.

Second, the flat and undifferentiated desert terrain made visual orientation of targets by attack aircraft quite difficult. This was made worse by natural obscurants, such as blowing sand. Moreover, Iraqi exploitation of existing natural terrain features to conceal the mobile Scud launchers and the extensive use of decoys further complicated both visual and infrared observation. This made positive identification of the mobile Scud launchers extremely difficult.[15]

Although the desert was a favorable environment for the application of airpower, certain unique environmental characteristics played a part in degrading the Coalition's TMD attack operation capabilities. The operating environment also limited the attack operations to be conducted largely by air attack platforms.

Coalition Attack Operation C2I Process

To construct the Coalition's attack operation C2I process model, this study examined the key elements of the Coalition's attack operation C2I processes during precrisis planning and in each phase of the targeting cycle.

Precrisis Planning

With the demise of the Warsaw Pact, the newly appointed chairman of the Joint Chiefs of Staff, General Colin Powell, directed CENTCOM to review the precrisis Operation Plan 1002-90, Defense of the Arabian Peninsula, which was premised on an Iraqi threat to the region. The second draft of the plan, less the time-phased force deployment list, was completed by 18 July 1990. The plan underwent a review in July 1990, during CENTCOM's internal exercise, Exercise Internal Look 90, to evaluate the theater C2 procedures.[16]

During the exercise, CENTCOM commanders and planners examined all functional areas of joint, air, ground, and naval combat. In the exercise two target lists were established: the CENTAF list and the CENTCOM composite list using nominations from the service components. A prioritized USCENTAF mission list was also assembled by CENTAF, which detailed the types of mission and the allocation of air resources. The lists were to drive the assembly of target intelligence on the various targets identified. Notable, however, was the negligible emphasis paid to the Scud target set, particularly the mobile Scud threat, which was not considered central to the war envisioned in Internal Look 90. By the end of July 1990, there had been only limited intelligence study on the Iraqi Scud capability by the U.S. intelligence community.[17]

As the CENTCOM and CENTAF target lists were assembled during the exercise, CENTAF targeting officers began to build target folders. They discovered that many of the installation file records, the primary source of targeting information, were incomplete. The records lacked critical target information, such as information on the functions and military significance of the target components of the individual targets. There was also a significant lack of imagery on the targets. In particular, CENTAF planners lacked information on the location and the extent of Scud facilities and on the capabilities and order of battle of the Iraqi mobile Scud threat. The lack of targeting information on mobile Scuds at the start of the crisis contributed in part to CENTAF's lack of emphasis on the mobile Scud threat during the planning phase.[18]

Decide Phase

Mission Analysis

Within a week of the Iraqi invasion of Kuwait, U.S. President George Bush announced four policy objectives that would guide U.S. military actions in the Gulf. First, securing the immediate, unconditional, and complete withdrawal of Iraqi forces from Kuwait. Second, restoring the legitimate government of Kuwait. Third, assuring the security and stability of the Persian Gulf region. Fourth, protecting American lives. Although the National Security Council refrained from interfering directly with the conduct of the operation to avoid the pitfalls of the Rolling Thunder air campaign in Vietnam, several strategic constraints were imposed. A key constraint was the need to neutralize Iraqi Scud (or Scud-derived) short-range ballistic missiles early in the offensive air campaign.[19] Given the strategic objectives and constraints, CINCCENT determined the mission as follows: (1) neutralize Iraqi National Command Authority, (2) eject Iraqi armed forces from Kuwait, (3) destroy the Republican Guard, (4) as early as possible, destroy Iraq's ballistic missile and NBC capability, and (5) assist in the restoration of the legitimate government of Kuwait.[20]

Apart from assigning the mission to defeat the Scuds to Lieutenant General Charles Horner, the Joint Force Air Component Commander (JFACC), very little guidance was provided by General Norman Schwarzkopf, Commander-in-Chief, Central Command (CINCCENT). Before the war, CINCCENT did not take cognizance of the strategic impact of the Scud threat. CENTCOM commanders and staff considered the Scuds to be militarily insignificant.

Organization

During the war, Lieutenant General Horner was designated by CINCCENT as the JFACC to manage the theater air campaign. He exercised C2 over all theater air resources. His responsibilities included making recommendations to the CINC on the use of airpower to accomplish the theater mission, directing air operations in the theater, assigning missions to subordinate units, and coordinating the air assets provided by all the components. He also provided guidelines to deconflict mission data and established policies to prevent coordination problems that occurred when such a large and diverse force operated in such a lucrative target environment. In addition, Lieutenant General Horner was also designated as the area air defense commander, which required him to coordinate all air defense activities in the theater. The intent was to ensure unity of command and a clear focus for the air campaign.[21]

At the start of Desert Shield, Lieutenant General Horner established a special planning group to develop the strategic air campaign plan. The group was known as the Black Hole and was supervised by Brigadier General Buster Glosson.[22] This allowed CENTAF planners to concentrate on planning and preparing the daily ATO for the Coalition air force to meet any potential Iraqi offensive during Operation Desert Shield. More importantly, the compartmentalization ensured operational security. In December, Lieutenant General Horner merged both Black Hole and CENTAF planners under Brigadier General Glosson. Black Hole was responsible for guidance, apportionment, and targeting (GAT). CENTAF planners formed the ATO cell. However, the compartmentalization created some complications as the operation proceeded.

The ATO Process

The air tasking order (ATO) process was the means that air planners used to orchestrate the air campaign. The ATO process was a seventy-two-hour process. It began with the updating of the master attack plan (MAP) based on target intelligence updates, battle damage assessment (BDA) from previous attacks, and targets nominated during the Joint Targeting Coordination Board (JTCB). The MAP served as a coherent plan to achieve the overall desired effect and was the basis for the development of the ATO. Following the JFACC's battle guidance, the ATO was refined and given to the targeting cell to complete the target planning. This included weaponeering, force application, and mission assignment. The plan was then forwarded to the ATO division in the form of a target planning worksheet. The ATO division completed the final coordination, and the orders were transmitted to the units.[23]

Concept of the Air Campaign

Desert Storm comprised three air phases and a ground phase: strategic air campaign, air supremacy in the Kuwaiti theater of operation, battlefield preparation, and the ground offensive campaign.[24] The strategic air campaign, phase one of Desert Storm, was a refined plan developed by Checkmate. The plan focused on three centers of gravity, the destruction or disabling of which would compel the enemy to yield. The centers of gravity were Iraqi National Command Authority; Iraq's chemical, biological, and nuclear capability; and the Republican Guard forces command. The strategic air campaign called for attacks against twelve interrelated target sets aimed at disrupting the Iraqi command and control, thereby causing the loss of confidence in the government and degrading the Iraqi military capabilities.

Part of the objective to destroy Iraq's chemical, biological, and nuclear capability was the plan to destroy Iraq's fixed Scud sites and support facilities. The long-term intent was to eliminate Iraqi offensive capabilities to support the national security strategy in promoting peace and stability in the Persian Gulf region. The short-term purpose was to support the Coalition's objective of destroying Iraq's capability to wage war. Specifically, fixed Scud targets included fixed Scud launchers in the H-2 and H-3 areas, production and fuel facilities west of Baghdad, storage facilities in the vicinity of Al Jarrah, Scud research and development centers, and command and control installations. The CENTAF also expected the attack on Iraqi leadership C3 would sever Saddam's communication link with the ground forces, thereby impairing the coordination of Scud operations.[25] Although CENTCOM planners were aware of the Iraqi mobile TBM threat before the war, there was no specific plan to deal with them. The CENTAF planners calculated that the Coalition aircraft on alert status would suffice to suppress most of the Scud launches using mobile Scud launchers. On 20 December 1990, while briefing the air campaign plan to Secretary of Defense Dick Cheney and General Powell, Lieutenant

General Horner explained that all fixed launch sites would be hit, but some mobile Scuds would likely escape.[26] Although the Coalition attacks on these fixed sites were successful, this contributed very little in neutralizing the Iraqi Scud threat, since the Iraqis relied entirely on mobile Scud launchers to conduct TBM operations. When the Coalition failed to suppress the Scud threat by the third day of the strategic air campaign, a dedicated Scud hunt was launched. The Scud hunt lasted until the end of the war.

Strategy Against Mobile TBM Systems

The process of finding and targeting mobile Scud targets adopted by the Coalition involved a sequence of action that included wide area surveillance, analysis of the data from this surveillance in theater command and control centers, localization and identification of targets, attack, and assessment of results. The wide-area surveillance was successful. The IPB templating and analysis of Iraqi Scud launch patterns allowed CENTAF planners to narrow the Scud launch areas to two specific areas. However, the localization and the identification of mobile Scud targets were not so successful. The CENTAF planners also quickly appreciated that only aircraft flying on station over the launch sites could potentially attack the mobile Scud targets before they escaped. As a result, the Scud attack strategy evolved into two approaches: first, day and night search-and-interdiction of mobile Scud launchers moving from the storage sites to their launch sites; second, airborne patrols to attack the mobile Scud launchers after they had fired their missiles. The difficulties in targeting individual mobile Scud launchers also led to an emphasis on suppressive techniques. This involved scattering bomblets over probable Scud launch areas and attacking potential Scud lines of communications and hide sites using denial ordnance. The purpose was to limit the mobile Scud launchers' freedom of action.

Initially, AC-130 gunships were diverted to Scud areas to search and destroy the mobile Scud targets. However, the near loss of one of those aircraft in the high-threat environment of western Iraq ended that approach. By the end of the first week of the strategic air campaign, the Coalition established a pattern of having four F-15s remain on airborne alert fifteen to twenty minutes in the western Scud area. If no Scud activities were reported, the F-15s then struck Scud-related targets at the same time four F-15s arrived on station. In addition, eight F-15s stood alert at all times to replace the airborne aircraft should they attack suspected Scud targets. A similar pattern was adopted in the east Scud area, except F-16s were used. Meanwhile, twenty-four hours a day, two A-10s conducted route reconnaissance over potential Scud areas, while twelve others stood on ground alert with a one-hour reaction time.[27]

By the end of the war, the Coalition Scud hunt absorbed nearly twenty percent of F-15 sorties, 2 percent of A-10 sorties, and 4 percent of F-16 and F-111F sorties. A significant number of sorties by B-52s, A-6Es, A-7s, F-117s, F/A-18s, and GR-1s also attacked Scud sites and facilities. Nevertheless, the Iraqis were still able to recover in the last days of the war, albeit not reaching the number of launches in the first week. This caused considerable psychological stress. In one attack, a Scud killed twenty-eight U.S. soldiers in Dharan.[28]

Intelligence Support

The initial decision to establish a compartmentalized special planning cell to plan the strategic air campaign contributed to the segregation of the CENTAF intelligence community from the operations planners. In fact, the CENTAF intelligence staff was only given access to the air campaign plan after the JCS had approved it. By being involved at this late stage, the theater intelligence community had little opportunity to influence the plan development. Theater intelligence therefore assumed only a supporting role. The concept was established and intelligence was required only to furnish data on designated targets.[29]

Nevertheless, when the war started, Coalition intelligence estimates correctly identified most Scud fixed launchers, production facilities, and support facilities. However, intelligence remained uncertain about Iraq's mobile Scud capabilities. The first concern was the Scud order of battle, especially the number of mobile Scud launchers the Iraqis possessed, and the number of operational missiles. The second concern was how the Scud was to be employed. The third concern was Iraqi tactics, techniques, and procedures of operating the Scuds.[30]

Detect Phase

Direct

From the beginning of the war, GAT planners had requested that target intelligence and BDA information be produced as soon as possible after each strike, so it could be incorporated into the ATO planning. At the theater level, CENTAF collection managers were primarily responsible for reviewing and integrating GAT's intelligence requirements and for ensuring that the needed data was collected. At the joint level, GAT's intelligence needs were discussed and validated every day at the daily aerial reconnaissance review meeting, chaired by the CENTCOM J-2.[31] However, theater and CENTAF intelligence was unable to meet the intelligence needs of GAT.

As a result, GAT established its own intelligence conduits with strategic intelligence agencies in Washington. Often, the strategic intelligence agencies knew that a target was struck before the theater intelligence community did. Strategic intelligence agencies also provided the required level of expertise to develop the targets for the strategic air campaign, which were often not available in the theater. Strategic intelligence therefore provided the necessary intelligence support for the strategic air campaign. However, intelligence from strategic intelligence agencies to GAT was often not disseminated to the theater intelligence community.

Collect

At the strategic level, the Defense Support Program (DSP) satellites provided early warning of the Scud launches. Originally designed to provide early warning against Soviet long-range intercontinental ballistic missile (ICBM) launches, the DSP system was adapted and proved successful in detecting all eighty-eight Scud launches. During the war, two satellites could generally locate the Scud launch plume within two minutes of firing. However, the location provided was not precise enough to allow the aircraft to locate and attack the mobile Scud launchers. This was further complicated by the Iraqi's extensive use of decoys. Nevertheless, space-based early warning proved critical in enhancing the capabilities of the Coalition's active defense against the Scud threat. After the war, General Thomas S. Moorman, Jr., commander of the USAF Space Command, remarked that space capabilities contributed immensely to the Coalition's TMD operations..[32]

At the tactical level, imagery intelligence was provided by JSTARS, U-2/TR-1s, RF-4Cs, and Royal Air Force (RAF) reconnaissance Tornados. In particular, RAF reconnaissance Tornados paired with strike Tornadoes in look and shoot teams. Special Operations Forces (SOF), which included the British Special Air Service (SAS), Special Boat Service (SBS), and U.S. Army Special Forces, were the main sources of human intelligence. There were some reports that several Scud mobile launchers were destroyed by SOF attacks. Although these reports came from attacks that did destroy objects found in Scud launch areas, most of these objects were later identified as decoys and objects that provided Scud-like signatures.

In some cases, strike aircraft on combat air patrol visually observed some Scud launches, but could not attack because they had no means of determining the precise location of the launches. Of forty-two occasions which Scud launches were visually observed by orbiting strike aircraft, only in eight cases did visual acquisition suffice to allow strike aircraft to attack the targets.[33]

In general, given the competing intelligence collection demands, there was an insufficient number of collection assets to sustain continuous real-time reconnaissance over the Scud boxes. The Coalition's collection assets also lacked the capability to positively identify mobile Scud launchers. As a consequence, the Air Force was largely reduced to reacting to observed Scud launches.

DSP to Shooter

When the satellite detected a Scud launch, the satellite sensor data from the satellite was transmitted to the Space Command processing station in the U.S. Computers analyzed the data to verify the launch. When the operator confirmed the computer analysis, the launch alert was relayed over satellite communications to the CENTCOM headquarters in Saudi Arabia. CENTCOM then relayed the information to the attack platforms via AWACS to initiate a Scud hunt.[34]

JSTARS to Shooter

When JSTARS detected a suspected mobile Scud launcher, the information was relayed directly to the aircraft on combat air patrol or to an Army ATACMs unit, to cue it to the potential target. While the JSTARS's radar could detect most moving vehicles, it could not readily distinguish a Scud mobile launcher from a similar sized vehicle, such as an oil tanker. Since the JSTARS deployed during the Gulf War was a prototype model, there were very few GSMs available to the Army; one was assigned to ARCENT and two to the two corps in theater. Consequently, only ARCENT and the two corps could receive near real-time JSTARS information. Information from JSTARS to the ATACMs unit had to be relayed via ARCENT or the corps headquarters.[35]

Deliver Phase

Control Measures

The theater was divided into kill boxes, each with an area of thirty square nautical miles. The kill boxes became the operating areas for attacking aircraft. Sometimes the aircraft had a designated target within the kill box. At others, the aircraft was left to find the target within the box. Entry of the aircraft into these boxes was controlled by the airborne warning and control system (AWACS). The aircraft were then handed over to either the ABCCC or JSTARS for actual targeting and control. The success of the kill box missions relied heavily on the coordination of AWACS and the JSTARS or ABCCC.

Battle Management

The tactical air control system consisted of the AWACS, JSTARS, ABCCC, and rivet joint aircraft. During ODS, the Rivet Joint was controlled by the Strategic Air Command, and its operations were classified. As such, its operation is not covered here, except to mention that it provided real-time intelligence coverage.[36]

The mission of the AWACS was to counter enemy attacks and prevent fratricide. During the Gulf War, the AWACS performed several important C2 functions. The C2 functions which supported attack operations were to monitor the Coalition strike flights entering hostile airspace and exiting from it. The ATO formed the basis for the AWACS to monitor the strike schedules. Second, it monitored aerial refueling. In particular, the amount of time required to generate the ATO kept many units from receiving the ATO until very late in their mission planning cycles, so aircraft that needed to refuel often were not sure precisely where they would find their assigned tankers. The AWACS were therefore given the mission to coordinate aerial refueling. In addition, they also assisted in directing aircraft to the tankers during adverse weather conditions. Third, they monitored and controlled strike aircraft entering the assigned Scud kill boxes, after which the aircraft were handed over to the JSTARS.

Apart from providing intelligence, JSTARS also performed real-time targeting against Scud targets. The employment concept involved the JSTARS crew updating the locations of potential Scud targets as attack aircraft entered the Scud kill box. The JSTARS crew would provide refined target coordinates when the attack aircraft were handed over from the AWACS. However, by the time the attack aircraft arrived, the mobile Scud launchers would have normally moved from the launch site.[37]

Although there was no mention of ABCCC being directly involved in coordinating the air strikes against the mobile Scud targets, its C2 functions in coordinating air strikes in support of land operations merited examination. During the war, ABCCC performed the following important C2 functions. First, air interdiction sorties tasked in the ATO but without a preplanned target were to be directed to kill zones by ABCCC. Second, preplanned CAS sorties whose targets were already struck were open to ABCCC direction into a kill zone. Third, ABCCC was to coordinate and manage "push" CAS assets by assigning attack aircraft to targets requested by ground units via the Air Support Operations Center (ASOC) or through a Tactical Air Control Party (TACP). Most importantly, the ABCCC, under the guidance from the operations deputy at the Tactical Air Control Center (TACC), could shift preplanned air missions to support more immediate requests.

Assess Phase

At the operational level, BDA was a measurement of success or failure of the mission. It was a yardstick to determine whether additional strikes were required to achieve the desired result. BDA would then be incorporated within the ATO planning cycle to tailor the air effort. At the tactical level, BDA was a confirmation that the attack hit the target, or evidence that the next attack had to be conducted differently.

During the war, theater BDA was obtained by inflight pilot reports and postflight mission reports. Inflight reports were transmitted from attacking aircraft at predetermined times or points following attacks on the target to the AWACS or ABCCC. The report was transmitted in the clear and provided unclassified information about the attack, such as whether the attack succeeded or failed. The AWACS and ABCCC then forwarded the data to the TACC. Immediately after each sortie, the aircrew was debriefed using the inflight report, gun camera, radar film, and aircraft videotape recording (AVTR). Unit intelligence personnel then prepared the postflight mission report, which was forwarded to the CENTAF intelligence staff.

At the strategic level, DIA concentrated national assets on strategic targets. Given the limitations of theater intelligence collection capabilities, the DIA joint intelligence center evolved into a BDA cell at the onset of hostilities. This facilitated in-theater retargeting and restrike decisions. However, the theater targeting planners could not always obtain access to these national systems. At the operational level, BDA imagery received was processed by the Joint Imagery Production Center (JIPC).[38]

Prior to the war, CENTAF endeavored to develop a theater BDA software to produce BDA in support of the ATO process. The object of the software was to facilitate fusing of strategic, operational, and tactical BDA information. The purpose was to recommend targets which needed to be reattacked and to provide an estimation of general attrition trends. However, there were problems with the software by the time the strategic air campaign started. The software only allowed the CENTAF BDA cell to produce BDA summaries only every twelve hours, with interim reports every four hours.[39]

Throughout the war, timely and accurate BDA on Scuds proved difficult. By the end of the war, there was an absence of unequivocal evidence concerning the number and nature of mobile Scud targets destroyed. In March 1991, a DIA memorandum highlighted that: "In spite of over a hundred claims of destroyed short range ballistic missile mobile launchers, national intelligence resources did not definitely confirm any of the kills."[40]

Conclusion

This chapter reviewed the Coalition TMD C2I process during the Gulf War. It also examined the operational conditions that impacted on the process. Although the Coalition faced considerable difficulties in neutralizing the Iraqi mobile Scud threat, the ad hoc process established and the linking of the disparate systems into a near real-time C2I network was an achievement. It should be noted that the system became more efficient as the campaign progressed, albeit the effectiveness of the Scud hunt remained debatable. Nevertheless, the characteristics of the mobile TBMs afforded minimal detect-to-attack time, even when everything worked accordingly, as manifested in exercise Roving Sands, 1995.[41]

In particular, the key C2I challenges identified were:

1. Accurately detecting, locating, identifying, and tracking the TBM target;
2. Rapid target coordination and deconfliction;
3. Timely transmission of targeting data to attack systems; and
4. Accurate battle damage assessment.

This chapter also highlighted key developments for the JTMD. By evaluating the lessons from the Coalition attack operation C2I process during the Gulf War, integrating current JTMD developments, and taking cognizance of the capabilities and limitations of the advanced army, the intent was to develop attributes required to establish an effective TMD attack operation C2I process for the advanced army.

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CHAPTER 3

RESEARCH METHODOLOGY

> The issue turned on the time-factor at stage after stage. French countermeasures were repeatedly thrown out of gear because their timing was too slow to catch up with the changing situations. . . The French commanders, trained in the slow-motion methods of 1918, were mentally unfitted to cope with the panzer pace, and it produced a spreading paralysis among them.[1]
>
> Liddel Hart

Introduction

The research methodology for this study broadly parallels the scientific approach of problem identification, research, formulation of hypothesis, hypothesis testing, deriving conclusions, and making recommendations.

Chapter 1 of the study defined the problem. The chapter began by reviewing the emerging threat of the theater ballistic missile at the strategic, operational, and tactical levels of war. The chapter further reviewed the developments of theater missile defense and the four complementary pillars of theater missile defense of passive defense; active defense; attack operations; and battle management/command, control, communications, computers, and intelligence. In particular, chapter 1 highlighted the significance of attack operations in enabling the defender to seize the initiative and protect its high-value targets, especially for the advanced army. Additionally, the chapter established the specific parameters to provide the research framework for the study. The chapter concluded by establishing the objective of the study (the primary research question), the purpose, the desired endstate, and the broad approach adopted for the study.

Chapter 2 reviewed the key research information to shape the focus of the study. Specifically, the objective of the chapter was to construct the Coalition's TMD attack operation C2I process model during the Gulf War. The chapter also reviewed the current developments in the theater missile defense attack operations. The objective was to integrate these developments into the analysis. The purpose was to incorporate pertinent established developments and to exploit emerging concepts into the proposed recommendations. The chapter concluded by establishing the key challenges faced by the Coalition TMD attack operation C2I during the Gulf War.

Chapter 3 detailed the specific research methods and techniques for the study. Its objective was to define the appropriate evaluation criteria to test the hypothesis.

Chapter 4 analyzed the evidence produced by the research design using the evaluation criteria defined in chapter 3. Specifically, the analysis focused on evaluating the effectiveness of the Coalition TMD attack operation C2I process during the Gulf War. The purpose was to establish the main lessons learned about the C2I process adopted by the Coalition. The chapter concluded by interpreting the findings based on the analysis of the research evidence.

Chapter 5 determined if the Coalition TMD attack operation C2I process was an effective model for the advanced army. Based on the lessons derived in chapter 4 and on the cognizance of current developments, the intent was to identify key C2I attributes that are required to enable the advanced army to defeat the theater ballistic missile threat. The endstate was to establish the key operational objectives of an effective C2I process.

Quantitative Evaluation Methodology

The fundamental objective of C2I is mission success. Mission success depends largely on the ability of commanders to effectively manage their means in response to the changes in the enemy threat and the operational environment.[2] C2I therefore serves two primary functions.[3] The first is to support the decision-making process, often in a time pressured dynamic environment, usually with a high volume of conflicting data. In particular, the commander at every level is concerned about three issues: whether he will be informed about the significant events that will impact on his operation; whether he will be able to transform the information he receives into useful and timely decisions; and whether he will be able to execute the decision using the most appropriate means in a timely manner to affect the outcome of his operation successfully.[4] The second is to enable the commander to effectively manage and coordinate his resources in response to the changing environment.

There are four prevailing quantitative approaches for evaluating the contributions of C2I to mission success. They are control theory, fuzzy set theory, catastrophe theory, and information theory. Given the similarity of the C2I characteristics in terms of direction and feedback in a control system, control theory is a favored approach. However, the linear nature of control system modelling makes the approach too mechanical to accommodate the human elements which exhibit nonlinear characteristics. The proponents of the fuzzy set theory believe that this nonlinearity may be represented by fuzzy sets, while proponents of the catastrophe theory believe that the dynamism of the battlefield can be represented as catastrophes. Nevertheless, these two approaches are least understood and are not yet useful. Information theory, while widely studied, has certain limitations. Some key limitations include assuming that the C2 process has perfect information, assuming that the two opposing forces exhibit homogenous characteristics, and portray warfare as rigid deterministic attrition exchanges between two forces.[5] Consequently, these four approaches are not suitable for the purpose of this study.

However, studies conducted using these approaches reaffirmed the following important C2I lessons: (1) keep sensing, processing, and deciding timelines short; (2) establish a shared, common, and accurate information base; and (3) communicate to the forces in time for them to act.

The second quantitative method is to analyze the performance of the Coalition's TMD attack operation's C2I process in enabling the Coalition forces to destroy the Iraqi Scuds during the war. The measure of performance is based on the accuracy of the outputs or estimates provided by the process, the validity of the assumptions that process accepts, the logical structure of the process, and the replicability of the results engendered by the process.[6] However, the lack of accurate data on the input and output data at each critical C2I node complicates this approach.

Study Evaluation Methodology

The primary objective of the C2I system was to support the decision making of the commander. Additionally, prevailing and future C2I systems would be computer based. As such, the study adapted the Air Force C2 assessment model for Computer-Based Decision Aiding Systems and the principles of intelligence system identified in Joint Pub 6-0, Doctrine for Command, Control, Communications, and Computer (C4) Systems Support to Joint Operations, to evaluate the effectiveness of the Coalition's TMD attack operation's C2I process during the Gulf War. In particular, 4 criteria were used.

Produce Unity of Effort

This would include: (1) supporting the employment of joint forces in a manner that would exploit total force capabilities towards a common objective and purpose; (2) providing defined intent to support decentralized operations brought about by geographically separated forces, combat which was fluid in time and space, and increasingly long lethal long range weapons; and (3) satisfying the requirement to maintain contact with the battlefield, to judge the environment and forces status himself, to judge the intentions of the enemy, and to seize initiative.[7]

Respond to the Commander's Need

This would include: (1) providing pertinent fused information to support decision making. The fused information could be correlated from different sources: reports from different sensors at the same time, by same sensors at different times, and by different sensors at different times; (2) providing accurate shared information to all relevant C2 nodes in different functions and echelons and maintaining an adequate shared knowledge base so that information could be exploited to produce a precise estimate of the situation; (3) providing adequate intelligence, but not overload the commander and staff with too much information; and (4) affording adaptability to contingencies and unforeseen needs.[8]

Provide Timely Information

This would include: (1) providing sufficient warning time to allow the commander to make decisions and synchronize operations; (2) facilitating connectivity for prompt exchange of information among relevant C2 nodes; and (3) updating information continuously to ensure that information was kept current.[9]

Provide Intelligence Support

This would include: (1) ensuring that intelligence was incorporated into planning and execution of operations; (2) supporting operations by providing valid assumptions and accurate, timely, and pertinent information.[10]

Conclusion

This study used the evaluation criteria which included unity of effort, responsiveness, timeliness, and providing intelligence support to evaluate the effectiveness of the Coalition TMD attack operation C2I process and identify attributes required to establish an effective C2I process. The parameters of the advanced army were then applied to establish the operational objectives of an efficient TMD attack operation C2I process.

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[6]Gerald W. Hopple, "Air Force Command and Control Assessment Criteria for Computer Based Decision Aiding Systems," Principles of Command and Control (Washington DC: AFCEA International Press, 1987), 95-99.

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[10]Joint Pub 6-0, 2-14 - 2-15.

CHAPTER 4

ANALYSIS

> In a combat environment, winning the information war--exchanging information horizontally and vertically--will enable battle commanders, the supporters, logisticians, and transporters to share a common, real-time situational awareness. We will be able to apply power to the main effort quickly, to attack the enemy simultaneously throughout the battle area, and we will be able to do it over and over again, allowing him no time to react, recover or regroup.[1]
>
> General Gordon R. Sullivan, "Future Vision"

Introduction

This chapter analyzed the effectiveness of the Coalition's TMD attack operation C2I process using unity of effort, responsiveness, timeliness, and providing intelligence support as criteria. In particular, the study evaluated the effectiveness of the process during precrisis planning, and during each phase of the D3A-targeting cycle. The purpose was to identify positive attributes and shortfalls of the Coalition's attack operation C2I process during the Gulf War.

Precrisis Planning

The misinterpretation of the Iraqi Scud capabilities during the precrisis planning was the result of a lack of intelligence about Iraqi Scuds. This was because until the spring of 1990, U.S. intelligence had been focused on the Soviet Union and the Warsaw Pact. Additionally, U.S. intelligence in 1989 had estimated that Iraq was unlikely to invade Kuwait. Only in the fall of 1989 did CENTCOM reorient its regional planning on Iraq. This was followed in the spring of 1990 by U.S. intelligence shifting its resources to gather information on Iraq's military forces, installations, communications, and leadership. However, aggressive Iraqi security and counterintelligence strategy made the collection efforts very difficult.[2] This accounted for CENTCOM's lack of intelligence to effectively target Iraqi strategic targets, which included the Scuds.

During precrisis planning, the misinterpretation of Iraqi Scud capabilities led CENTCOM's commanders and staff to underestimate the potential of the Scuds. They had viewed the Scuds as being militarily insignificant. More significantly, planners did not appreciate the latent strategic potential of the Scuds, a capability that would be exploited by Saddam Hussein during the war in an attempt to split the Coalition. As such, Iraqi Scuds were not envisioned as central to the war during precrisis planning. This myopia led to two critical shortfalls which played a significant role in undermining the Coalition's counterscud efforts.

First, the underestimation of the Iraqi Scud potential resulted in a lack of command emphasis on the theater missile defense and attack strategy to defeat the Iraqi Scud threat. Consequently, when Coalition forces deployed to the Gulf, TMD infrastructures were not planned for, and an ad hoc TMD arrangement had to be established when the strategic phase of the air campaign failed to defeat the Iraqi Scud threat. As a result, the strategic, operational, and tactical level of intelligence could not be optimally integrated into the Coalition's TMD C2I process. Intelligence organizations at each level were not designed to cope with the challenges of TMD attack operations.

At the strategic level, for example, intelligence collection using space technology was only incorporated after the Coalition failed to defeat the Scud threat. This resulted in a cumbersome intelligence dissemination architecture. At the operational level, the original concept was for the Joint Imagery Production Center (JIPC) to process one or two U-2 missions per week. This task was expanded to daily missions and TDA processing, which placed a greater demand on the JIPC. The need to get reorganized, as well as the increasing demand by operational and tactical level users, kept the JIPC from meeting the operational and tactical level users' demand in terms of quality and timeliness. This contributed significantly to difficulties in battle damage assessment (BDA) which affected the overall targeting effort.

Second, the lack of command emphasis on Iraqi Scuds led to a low-intelligence collection priority for Scud targets. In June 1990, USCENTCOM's joint target list (JTL) identified seven Scud targets. However, mobile Scuds were ignored, and the seven targets identified were static

Scud launchers. Although the number of Scud targets saw an apparent dramatic increase, rising from twenty-four entries on 2 August 1990 to some one hundred twenty-one records by 16 January 1991, the increase in targets did not equate to any significant increase in knowledge of the Scud targets. Beginning in December, the DIA issued individual basic encyclopedia target numbers to each launch site and associated facility, rather than using a single number for the whole facility. As such, a Scud site with several launch facilities which would have constituted only one target prior to 1990 contributed multiple entries to the target list in 1991. The increase in the number of Scud targets was due to a change in the target accounting methodology, with no substantive growth in knowledge.[3]

Since most Iraqi mobile Scuds were already dispersed into hide sites in August 1990 before the war,[4] Coalition intelligence collection efforts during the planning phase to collect information on Scud targets remained ineffective. This underscored the imperative of collecting and maintaining precrisis intelligence on elusive enemy targets, such as the mobile Scuds. The reliance on precrisis intelligence on Soviet mobile missile capabilities which enabled effective U.S. monitoring of Soviet adherence to the Strategic Arms Reduction Treaty (START) further reaffirmed the need for a long-term collection effort to create a sound intelligence base and improve target familiarity.[5]

At the conclusion of precrisis planning, intelligence remained uncertain about the Iraqi Scud order of battle (Orbat); the pattern of operation; and Iraqi tactics, techniques, and procedures (TTPs) for operating mobile Scuds. Specifically, the lack of intelligence on the Iraqi Scud Orbat and pattern of operation complicated the Coalition's and of the operational employment concept of mobile Scuds. This complicated the process of localizing the mobile Scud operating area. The lack of intelligence on the Iraqi mobile Scud TTPs also prevented the Coalition planners from identifying tactical level vulnerabilities. They were therefore unable to exploit these vulnerabilities to achieve successful acquisitions and attacks on mobile Scuds. Moreover, it hindered the Coalition planners from thinking through the range of countermeasures and counterresponses that could be adopted to defeat mobile Scuds.

Decide Phase

Mission Analysis

The lack of precrisis intelligence on Iraqi Scud capabilities precipitated several critical incorrect assumptions. First, the lack of understanding of the Iraqi Scud Orbat and operational employment concept complicated the analysis of the Iraqi intent on how Scuds would be employed during the war. This resulted in the incorrect identification of the decisive point of the Scud target set. Coalition planners had assumed that the Iraqis would use their static launchers and therefore massed airpower to destroy them. However, the Iraqis relied entirely on their mobile launchers. This rendered ineffective the Coalition's strategy to defeat the Scud threat.

Second, uncertainty over Iraqi TTPs led to the Coalition planners assuming that Iraqi's Scud operating procedures would resemble Soviet procedures which required several hours to launch a missile. This would provide sufficient time for the Coalition forces to exploit certain distinctive signatures. They also assumed that Iraqi decoys were unlikely to complicate detection. They were therefore not prepared to dilute the strategic air campaign by diverting resources specifically to search and destroy Iraqi mobile Scud launchers. The CENTAF planners calculated that Coalition aircraft on alert status would suffice to suppress most Scud launches using mobile Scud launchers.[6]

When war came, these assumptions proved incorrect. An Iraqi mobile Scud often would arrive at the launch site with precalibrated data, setup in a few minutes, launch, and displace to the next hide site, all within ten minutes. The inherent difficulties with target acquisition without threat localization, coupled with Iraqi divergence from Soviet Scud operating procedures, were further compounded by the Iraqi extensive use of decoys. This prevented responsive cueing necessary to enable successful attacks to be conducted on the mobile Scuds.

Organization

The task to defeat the Iraqi mobile Scuds was delegated to Lieutenant General Charles Horner, Joint Force Air Component Commander (JFACC), CENTCOM. There were three main reasons. First, the depth with which Iraqi Scuds were deployed restricted the types of attack platforms. In particular, only Air Force aircraft, Army ATACMs, attack helicopters, and naval ballistic missiles had the range to engage the Scuds. Second, the air component furnished the preponderance of attack assets. Third, the Coalition commanders were confident that the strategic air campaign could effectively defeat the Iraqi Scud threat.

Although the abundance of air assets in theater meant that the JFACC never had to make difficult decisions on the allocation of air assets, the war manifestly demonstrated that the concept of a single air component commander ensured an effective control over an exceedingly crowded air space. Unity of command also ensured a coherent conduct of the air campaign, with disparate air forces operating in harmony. Most importantly, the centralized approach allowed the commander to concentrate unified firepower on the most important targets. As such, the Coalition was able to swiftly adapt and direct focused efforts against the Iraqi mobile Scud threat, when the original plan failed to suppress the Scud threat after the first three days of the strategic air campaign.

The Process

Target Nomination

Targets were nominated primarily from three sources: target intelligence updates from strategic and theater intelligence, the joint targeting coordination board (JTCB), and from BDA. When Checkmate was developing the initial air campaign plan Instant Thunder, intelligence was used to define targets within a set of larger, objective-oriented target categories. When Black Hole assumed the responsibility to refine Instant Thunder, it requested theater target intelligence support. However, the lack of theater intelligence collection resources resulted in a lack of up-to-date intelligence. Black Hole therefore refined the air campaign plan based largely on the original target data. They also established their own intelligence conduits, which inevitably tended to confuse the relations between the theater operations and intelligence functions. Furthermore, the late involvement of CENTAF intelligence in the planning of Instant Thunder meant that intelligence could not be effectively incorporated into the operations planning. As such, the air concept of operations was established, and theater intelligence merely furnished data on the designated targets. This prevented Coalition planners from validating the decisive points they had selected for the attack. This further contributed to the Coalition attacking the incorrect decisive point of the Scud target set, which the Coalition planners had identified as the static Scud launchers.

For the strategic air campaign, the guidance, apportionment, and targeting (GAT) operations staff, comprised mainly representatives from the Air Force, selected, ranked, and analyzed targets. They also assigned assets against specific targets. The planners assigned to the Black Hole from the other services provided some oversight of the effort, but there was no formal joint staff review. Although a JTCB was established to prioritize and deconflict joint targets and synchronize attacks against these targets, it was convened ostensibly to identify Army-nominated targets for phase three of the air campaign, battlefield preparation. This, concomitantly with the compartmentalization of the planning effort, reduced the amount of coordination and interaction with CENTCOM and the other services on the overall development of the strategic air campaign.[7] As a result, Army capabilities, such as attack helicopters and ATACMs, were not fully exploited and integrated into the strategy to defeat the Iraqi Scud threat.

Furthermore, accurate and timely BDA on mobile Scuds proved extremely difficult throughout the war. The unreliability of the BDA prevented the Coalition planners from making accurate assessments on the effectiveness of the attacks. This further complicated their decision in nominating a target for reattack. It also prevented GAT from planning and coordinating immediate reattacks, when required, to destroy the mobile Scuds.

Another problem that arose as a result of the compartmentalization between Black Hole and the rest of the CENTAF intelligence community was the difference in the way CENTAF intelligence (especially the targeteering) community and operations planners in Black Hole numbered the targets. The Black Hole target system was based on the target type which facilitated manipulation of the air packages in the master attack plan (MAP) during planning and execution. Nevertheless, the intelligence community identified targets using the Basic Encyclopedia Number (BEN) and insisted on using it. An intelligence officer assigned to the Black Hole explained that

> It is not that we couldn't use the Black Hole's target identification system. It's just that we recognize that anything that you are going to do within the intelligence community if you are going to want any sort of support for target materials or anything else you are going to have to use those basic encyclopedia numbers.[8]

Although efforts were made eventually to use both systems simultaneously, the two distinct target numbering systems posed certain confusion in the target-nomination process throughout the entire operation.

Master Attack Plan

The ATO process was conceived as an alternative to the route package system adopted during the Vietnam War, in which each available unit was assigned its own corridors into and out of the target area. This led to piecemeal commitment of airpower, resulting in an ineffective and incoherent air campaign. During the Gulf War, the ATO process served as the primary tool to synchronize airpower.

In particular, the Master Attack Plan (MAP) formed the basis of the ATO process. The GAT planners used the MAP to plan air operations against nominated targets. Specifically, the MAP listed the strike packages chronologically according to the time on target. It also listed the times on target, mission numbers, target numbers, target names, aircraft types, and the number of aircraft required. The MAP offered a comprehensive and comprehensible picture of the air campaign which enabled GAT to effectively design a coherent air campaign.[9] More significantly, this illustrated the importance of centralized planning at the operational level to produce and build a coherent campaign plan.

Air Tasking Order Process

Throughout the air campaign, the Air Tasking Order (ATO) detailed almost every Coalition fixed-wing sortie scheduled. Given the depth in which the Scuds were employed, aircraft had to fly extended distances which often required multiple refueling. During the air campaign, the majority of the aircraft flew from bases in southern Saudi Arabia and the coastal Gulf states. The aircraft therefore had to fly over seven hundred miles to the Scud boxes to attack the Scuds.

Coupled with the additional requirement for the attack aircraft to loiter in the vicinity of the Scud boxes, this was well beyond the unrefueled combat radius of most attack aircraft.

Moreover, aircraft from one base often had to work in conjunction with aircraft from other distant bases; and the ATO provided the required details, such as call signs, identification codes, authentication codes, air-refueling guidance, and special instructions, to coordinate the organization of these packages. For example, F-16s from Al Minhad in the United Arab Emirates would typically join in a package of aircraft that could include F-15Cs from Tabuk, Saudi Arabia; EF-111s from Taif, Saudi Arabia; F-4Gs from Shaikh Isa, Bahrain; and KC-135s from Seeb, Oman, along with airborne control aircraft from several other bases.[10] Additionally, the packages could also include Navy, Marine, and Coalition aircraft. This further added to the level of complexity involved in the operation.

Given the complexities involved in coordinating air operations in such exceedingly crowded airspace, the ATO served as an important instrument in enabling the Coalition planners to effectively synchronize each event and function of the air campaign. More importantly, this further underscored the criticality of centralized control at the operational level in coordinating a coherent campaign plan.

However, there were several problems with the ATO as a C2 tool.[11] First, given the duration from target nomination to issuance of attack orders, which was typically a seventy-two-hour cycle, the ATO process could not cater to ephemeral mobile targets like the mobile Scud launchers, where the time and location of their appearance on the battlefield could not be predicted accurately. Given the lengthy cycle, an attack on any particular target clearly required an accurate prediction of the target's location at a specific time. This was possible for static targets but extremely difficult for mobile targets, like mobile Scuds. After the war, a Marine Corps spokesman remarked that the ATO was "an attempt to run a minute-by-minute air war at a 72-hour pace."[12]

Second, the abundance of air assets relied on scheduling in advance. As a result, there were times when a Scud target appeared vulnerable, but there was no attack platform available. On 31 January, an NCO recorder in the TACC noted:

> With all of the aircraft in theater, I found it difficult to believe that we were actually short of available aircraft to strike Scuds. We do, however, have that problem. With the number of packages and individual missions scheduled in the ATO, there were, in fact, very few unscheduled aircraft available.[13]

Third, given the rigid scheduling, the ATO could not meet the changes of the dynamic battlefield in a responsive manner. The high number of cancellations after the fourth day of the strategic air campaign suggested difficulties in the ATO process. Specifically, any changes in the ATO normally had a cascading effect on the overall flight plan. This posed considerable problems in the coordination of tankers, SEAD assets, combat air patrols, and maintenance.

The three C2 problems associated with the ATO process alluded that centralized control of tactical level execution could not respond to mobile targets. This highlighted that centralized planning and control at the operational level was important in synchronizing a coherent campaign plan, and that decentralized control and execution was required at the tactical level against mobile targets.

An additional problem faced by the Coalition was the lack of an interoperable secure communication channel between the Air Force and Navy. As such, the ATO had to be flown daily out to the carriers. Although this did not cause severe coordination problems during the war, the lack of interoperability between the components meant that any immediate tasking of naval assets to attack a target of opportunity could not be done in a secured or efficient manner. This suggested that interoperability was cardinal for effective joint operation.

<u>The Strategy</u>

The Coalition strategy of employing combat air patrols (CAPs) for day and night interdiction of mobile Scuds reaffirmed the need for decentralized control and execution at the tactical level. In addition, the extremely stringent detect-to-attack time requirement predicated the need to reduce the "man-in-the-loop." This presaged the need to decide in advance the attack guidance instead of reacting. Attack guidance would include the rules of engagement, trigger event to initiate the attack, and the target selection standard (TSS).[14]

The strategy adopted also suggested that while strategic attacks gained high payoffs, achieving a decision required persistence and time. For time-critical targets, such as mobile Scuds, interdiction was by far the most effective option, albeit costly in terms of resources. Preemptive or preventive attacks would have promised the highest payoffs with the least resources, but this option had the biggest constraint. Specifically, the payoff of a preemptive or preventive attack must outweigh the potential political repercussions associated with such attacks.

Detect Phase

Direct

GAT's targeting intelligence requirements were forwarded by CENTAF intelligence collection managers at the daily aerial reconnaissance review meeting, where they were discussed and validated. Requests for BDA information were then forwarded to agencies controlling the assets for further review and evaluation with other competing demands. This process therefore separated intelligence users from the control of reconnaissance systems. Sensor taskers were unaware of the rationale behind tasking requests or of any last minute changes to attack plans, and users were also unaware of which requests were being approved. As a result, CENTAF's requests were often not satisfied in time to meet the needs of the GAT planners.[15]

Moreover, this was compounded by a lack of an effective working system between GAT operation planners and CENTAF intelligence collection managers. This was due to several reasons. First, GAT operation planners failed to brief clearly to the intelligence collection managers the concept of the air campaign plan and the changes made to the plan over time. Second, GAT operation planners did not specify the priority of intelligence required. This was critical since there were many competing demands for the limited number of intelligence collection assets available. Third, the GAT operation planners were unfamiliar with collection tasking procedures and did not attend the coordinating conferences where collection targets were prioritized. This implied that people not involved with air campaign planning and operations determined the priorities of intelligence collection requirements.[16] The lack of intelligence prioritization meant that certain critical intelligence were not collected in a timely and responsive manner. It also led to an information overload at the intelligence collection and analysis nodes. In addition, a critical piece of intelligence that was obtained might not be disseminated in a timely and responsive manner to the user. After the war, Lieutenant General Horner remarked,"The Army overloaded it immediately with requests for stuff, so I didn't even bother; I mean, I couldn't get my foot in the door, so I just said, 'To hell with it'."[17]

When Black Hole was unable to obtain the necessary target data from the theater intelligence, it exploited its direct link to Checkmate and strategic intelligence organizations in Washington to develop prospective targets. If the target was a priority one target, Brigadier General Glosson might designate a fighter unit on the same day or divert aircraft to this target. The next day, Black Hole would obtain the BDA from Washington. Significantly, such information was not disseminated to the relevant C2I nodes in theater. As such, there were often disparities on targets that were attacked among the various theater C2 nodes. Furthermore, coordinations regarding aerial refueling, electronic countermeasures, and reconnaissance were often omitted given the last minute changes. This resulted in a loss of sorties and effectiveness.[18] Nonetheless, the direct link between Black Hole and Washington which bypassed formal channels provided the essential target data for Black Hole to respond rapidly to the dynamic battlefield.[19]

In addition, given a lack of intelligence dissemination guidelines, theater intelligence was not made available to certain critical tactical C2 nodes. For example, some air wings could not obtain relevant intelligence to conduct their operation and had to rely on fellow wings to obtain that intelligence which caused some inevitable delay. This meant that aircraft could not always be immediately "pulled" to respond to a time-critical target, such as mobile Scuds.

DSP to Shooter Systems

Given the limited number of reconnaissance assets in theater, space sensors, such as satellites, provided significant intelligence collection support for the war. This was an outgrowth of the TENCAP (tactical exploitation of national capabilities) program which was initiated in 1970 to exploit national systems for tactical support. Since the Iraqi TBM was not considered a key threat, there was no TENCAP support for this function. As such, the entire system (DSP and communications systems) was established only after the war had started and was a crude version of the projected U.S. strategic defensive system. Consequently, the information architecture was suboptimal; data from the satellite could not be transmitted directly to the theater to enable a timely response. Instead, information had to be relayed through several nodes before an attack could be initiated. Moreover, the data provided was not precise enough to enable the attack aircraft locate and attack the mobile launchers.

JSTARS to Shooter Systems

JSTARS provided near real time target data to the air attack platforms. However, it did not have the necessary discrimination capability to positively identify a mobile Scud launcher. As such, the target data was insufficiently reliable to enable a successful attack. This difficulty was further compounded by Iraqi employment of decoys and the myriad number of vehicles with similar signature as the mobile Scuds that were scattered over the theater of operation. On the other hand, information from JSTARS had to be relayed through several C2 nodes before it reached Army attack units, such as an ATACMs unit. Consequently, although the Army ATACMs unit could initiate an attack in a decentralized mode in near real time on receipt of the target data, the delay caused by routing the target data through several C2 nodes prevented the Army's ATACMs units from furnishing a timely response.

HUMINT to Shooter Systems

Although HUMINT provided reliable and precise target data, its limitation with regard to its operating range predicated the need for very high resolution threat localization. During the war, a lack of understanding of Iraqi mobile Scud's operation pattern led to difficulties in localizing the threat. Consequently, HUMINTs, in particular SOF units, could not effectively locate the mobile Scuds.

Sensor to Shooter Systems

An evaluation of the Coalition sensor-to-shooter systems for targeting mobile Scuds revealed several important lessons. First, there was a need to exploit the benefits of multiple-sensor systems over the traditional single-sensor approach. The fusion of multiple sensors could include different multiple sensors or multiple common sensors. In both cases, the use of multiple sensors could "enhance overall C2 performance in terms of spatial/temporal coverage, measurement performance and operational robustness."[20] These performance improvements must, however, be weighed against the additional cost, complexity, and interface requirements introduced. In corollary, there would also be a need to integrate and fuse strategic, operational, and tactical intelligence; this further implied a need for an open C2I system architecture to provide virtual connectivity in near real time on demand.[21] Second, interoperability was cardinal in ensuring that the disparate joint assets could effectively communicate with each other. Third, threat localization was critical in ensuring that the search areas would be narrow enough to allow sensors to effectively search the area and locate the target. And fourth, intelligence processing must produce precise intelligence in a form that could be readily used. Joint Project Optic Cobra demonstrated that target data in the form of imagery greatly enhanced target identification and the probability of a successful attack.[22]

In addition, to enhance information responsiveness, the current hierarchical information structure could be restructured to permit a skip-echelon information flow based on established priorities so critical C2 nodes would receive the relevant information in a timely manner. In some extreme cases, direct single source sensor-to-shooter links could be established. However, three conditions must be met. First, the single source sensor must only be confirming a target previously identified by all-source detection. Second, the sensor must be capable of reliable discrimination and accurate target location (target location error within tolerance). And third, the sensor must be capable of rapidly communicating the processed data to the attack unit. The U.S. Army identified some systems that could meet these conditions: Improved Guardrail V (IGR-V), Quicklook with a downlink (QL II), UAV, and JSTARS.[23]

Dissemination

Since imagery had become a standard part of mission preparation material, all pilots had come to expect it, and it was not good enough to have a message that specified the target description in text. Although the intelligence community had been successful in providing imagery-for-target folders for pilots to study in peacetime, it could not meet the wartime demands for imagery or imagery-derived products. As a result, pilots often flew with outdated imagery or no imagery at all. In addition, given the incompatible imagery-dissemination systems in the theater, Black Hole often disseminated to the units aimpoints geographically rectified imagery. However, the resolution of these aimpoints was far lower than that offered by the geodetic Defense Mapping Agency Aerospace Center (DMAAC) through the intelligence channels. These less precise coordinates inevitably led to further friction in the targeting process.[24]

Throughout the war, the ARCENT intelligence center was unable to communicate with intelligence sources at all levels to exchange, disseminate, and rapidly exploit time-sensitive information. There were two primary reasons. First, there was a lack of available connectivity among the nodes. Second and more importantly, priority of information and communication lines were not determined. Consequently, Army units often receive their information late which exceeded the TSS requirements necessary to enable a successful attack.

Deliver Phase

Control Measure

During the war, an important control measure employed to direct attack aircraft to targets beyond the Fire Support Coordination Line (FSCL) was the kill box. Given the featureless terrain and the elusive nature of the mobile Scuds, the kill box simplified the process of vectoring these aircraft to targets. This process reduced the attack response time and enhanced the probability of a successful attack. Since the entry of aircraft into the kill box was controlled by the AWACS, JSTARS, or ABCCC, the success of the attack depended heavily on the coordination between the aircraft and the airborne C2 element. However, frequent communication difficulties were observed between the attack aircraft and the JSTARS or ABCCC. On one mission, it was noted that out of eight sorties that were flown, three were unable to link up with the JSTARS or ABCCC even though the aircraft arrived on schedule. An after-action review on the incident suggested that the failure was due to a lack of interoperability between the aircraft and the airborne C2 elements. [25] During the war, kill boxes known as Scud boxes, were designated over suspected mobile Scud launch areas identified through the process of intelligence estimates, wide-area surveillance, and threat localization. Besides serving to narrow the area of search, Scud boxes were employed to facilitate airborne C2 elements in designating the location of mobile Scuds launchers to attack aircraft. To further enhance the responsiveness of the attack, dedicated aircraft were also assigned to patrol specific Scud boxes.

During the ground offensive, the FSCL was used by ground forces to permit subordinate and supporting units to expeditiously attack targets beyond it. Short of the FSCL, all air-to-ground and surface-to-surface attacks were controlled by the appropriate establishing land component commander (LCC). Beyond the FSCL, ground forces were to coordinate the attack of targets beyond the FSCL with the air component, although inability to effect the coordination did not preclude the ground forces from attacking targets beyond the FSCL. The proper emplacement of FSCL served to protect friendly ground forces from fratricide by friendly air actions. In particular, there were two considerations that governed the establishment of the FSCL. The primary consideration for the placement of an FSCL was that it should be located beyond the ground forces' deep operations area, where it intended to shape the battlefield through selective targeting. Second, the expeditious attack of targets beyond the FSCL should support the overall operations of the ground force.[26]

Since the aircraft could only attack targets short of the FSCL and under the explicit direction of the appropriate establishing LCC, this procedure cost time to coordinate the actions required to execute the attacks. For a nonlinear battlefield where TBMs could be employed within the established FSCL, such a procedure potentially reduced the responsiveness of an engagement using aircraft, thereby jeopardizing the probability of a successful attack. On the other hand, although the FSCL was a "permissive" control measure to allow an expeditious attack beyond it, the introduction of surface long-range attack capabilities, such as the MLRS and ATACMS with maximum ordinates of approximately 30,000 feet and 100,000 feet, respectively, and Army attack helicopters, meant that the old paradigm of "big sky-little bullet" was no longer valid. To avoid fratricide beyond the FSCL, airspace coordination for surface attacks beyond the FSCL became critical. During the war, there were proposals to place Army tactical missiles and attack helicopter attacks beyond the FSCL under the JFACC. Specifically, attempts were made to include such strikes in the ATO. Since the ATO could not respond to mobile targets, such as mobile Scuds, such procedures would have prevented the Army from furnishing an effective response to the TBM threat.[27]

An evaluation of the control measures revealed several features. First, a simple control measure was necessary to enable a responsive attack on mobile Scuds. Besides minimizing the probability of fratricide, simple control measures would also minimize duplication of effort. Specifically, defined areas of responsibilities should be assigned at the outset. When designating areas of responsibilities to a particular component, the commander must take into account the component's ability to effectively acquire and engage the target.

Second, the existing airspace control channel involved an Army airspace command and control (A2C2) element at each command echelon to review the airspace request forwarded by an attacking unit to ensure that the information was complete and the requested control measure supported the commander's concept of operation. The A2C2 element also reviewed the request to determine if the requested control measure when activated affected other airspace users in the area of operation. The request was then forwarded to the A2C2 section at the TACC's airspace control center for further adjustments based on input from the BCD. The requested airspace control measure was then effected when the airspace control authority (ACA) approved the request.[28] As such, the airspace coordination system was a hierarchical system involving a multi-layered processing. Given the short dwell time of mobile Scuds, such a system was cumbersome and could not meet the timelines required to enable a successful attack.

To facilitate surface attacks against targets beyond the FSCL, the airspace coordination process must therefore be reviewed to permit direct coordination between a designated attacking unit and the A2C2 element and BCD at the TACC. Such a bottom-up skip-echelon procedure would allow an airspace request for an attack against TBM targets beyond the FSCL using surface attack assets to bypass the multilayered processing system thereby enhancing the responsiveness of the attack.

Beyond the battlespace of the surface commanders, the only attack assets that could engage the mobile Scuds were air attack assets. Consequently, a permissive control measure (LCC forward boundary) could be established beyond the battlespace of the surface component to allow air attack assets to immediately engage TBM targets beyond it without having to be concerned with the airspace requirements of the surface components. As such, the battlefield organization at the theater level could be divided primarily into two areas: the surface component area of operation (AO) and the air component AO. While the air component would plan for theaterwide attack operations, within the surface component AO the designated surface component commander would be the supported commander. Between the FSCL and the LCC forward boundary, a coordinating authority responsible for coordinating airspace requirements would be designated by the JFC to ensure unity of effort. In corollary, in the air component AO, the air component commander would be the supported commander.

Third, to ensure the effective positive control, an airborne C2 element must not only have the capability to locate, track, and identify the airspace user, it must also have the ability to establish and maintain communications with the users. This again underscored the importance of interoperability among the various elements involved.

Air Battle Management

The employment concept of the ABCCC allowed airpower to be intelligently applied in a dynamic situation. More importantly, it provided the necessary flexibility for commanders to immediately direct attacks using the available joint assets against the elusive enemy HPTs, such as mobile Scud launchers, when the opportunity arose. This observation was noted in an after-action review where an ABCCC directed a Navy mission to attack an Army target when there were no Air Force assets immediately available. It noted that "so now you have an Army target, off the Army target list, struck by Navy A-6s, scrounged up by the Marine liaison officer via an Air Force C2 platform. And if that ain't purple, I don't know what is."[29]

Since the ABCCC could effectively divert an aircraft from a preplanned mission to attack a more immediate target, the key challenge to this system, as demonstrated during the war, was that there must be defined rules of engagement to balance the requirements between preplanned and immediate missions. Additionally, the TACC must be updated of any changes to the missions. During the Gulf War, the ABCCC crews were often subjected to a number of simultaneous demands for air support, and they were diverting the aircraft to different targets in a manner which the TACC often could not follow. Moreover, the ABCCC must have the capability to communicate with the aircraft that it was monitoring and directing.

During the war, the ABCCC performed effectively as the battle manager when the TACC could keep track of the changes of the air missions directed by the ABCCC, when the TACC could monitor the targets that were hit, and also when strike aircraft did not have to cue up while waiting for the ABCCC to coordinate the target coordinates and to redirect them to the kill zones. This predicated the importance of accurate, shared intelligence between the tactical as well as the operational level C2 nodes. More significantly, it highlighted that while centralized planning and control at the operational level via the ATO was crucial in achieving a unity of purpose and in enhancing the optimization of the scarce resource available, decentralized control and execution at the tactical level was critical in enhancing the flexibility and responsiveness of an attack.[30]

Ground Battle Management

During the war, essential battlefield data including intelligence, friendly force location, and status, terrain, and tactical ballistic missile cues, were delayed in getting to the commanders. This was due to several reasons.[31] An important factor was that the mobile subscriber equipment (MSE) that was fielded was unable to keep pace with maneuver units. In addition, the range of combat net radio (CNR) was insufficient to support mobile and deep operations at division and echelons above division.

More importantly, there was a lack of interoperability among the various ground C2I nodes. First, the MSE, which employed a different architecture from that of the triservice tactical communications system, did not operate well with triservice tactical communications system. An interface equipment and software had to be connected to the MSE nodes to enable it to achieve effective connectivity with the triservice tactical communications system. Second, there was a large variety of databases and intelligence systems employed. These databases and systems differed in communications media, used different software data, and had different control standards and protocols for data sharing and connectivity. The fact that the ATO could not be transmitted to the carrier-based air wings and had to be flown daily to the carriers bore testimony to the stovepipe approach adopted by the services in developing their respective C4I systems, which led to the poor interoperability among the services. Third, the joint communications electronic operating instruction (JCEOI) could not provide the required information necessary to make the C3 system work efficiently.

As a result, there was often no accurate, timely, or uniform assessment of the status of friendly and enemy forces to allow the commanders' effectively task units to attack targets on a near real time basis. Accurate, shared information on the current situation among C2 nodes to promote better situation awareness and to enable commanders to make better and faster decisions was manifestly lacking.

Liaison

During the war, space technology was exploited to the fullest extent to lever situation's awareness. Specifically, space technology enabled joint forces to determine with a very high degree of certainty their location using the global positioning system. It also allowed joint forces to establish communications over great distances using the military satellite communications (MILSATCOM) system. In addition, the DSP provided the necessary tactical ballistic missile warnings to the theater. To ensure effective exploitation of space technology, liaison teams from USSPACECOM were fielded in service headquarters to furnish expert advice on the capabilities and limitations of space assets, offer recommendations on how space capabilities could best support the operation; and serve as conduits for coordinating the use of space assets. In particular, liaison teams provided an effective interface between the users and the system which served to enhance interoperability.

Assessment Phase

Combat assessment (CA) composed of three elements: battle damage assessment (BDA), munition effects assessment (MEA), and reattack recommendations. The purpose of battle damage assessment (BDA) was to determine the effect of an attack on a target. Specifically, BDA took three forms. First, the physical damage assessment estimated the quantitive extent of physical damage occurring through munition blasts, fragmentation, and fire damage effects on a target. Second, the functional damage assessment estimated the effects of an attack on the functional or operational capability of the target to perform its intended mission compared to the operational established against the target. Third, the target system assessment assessed the overall impact and effectiveness of the full spectrum of military operations against an entire target system's capability. The purpose of an MEA was to assess the military force applied in terms of the weapon systems and munitions effectiveness to determine if any changes were required to the attack methodology, weapon system, munitions, and weapon delivery parameters to increase force effectiveness.[32] Should the attack on a target fail to meet the desired effect, the target would be recommended to be reattacked.

After the war, General Schwarzkopf informed Congress that BDA was a major area of confusion. Reports from the Air Force, Navy, and Marine Corps also indicated that they received little or no BDA on targets that they attacked during the war. There were many shortfalls that contributed to this.[33]

During the war, the intelligence community was not prepared for the enormous tasks due to a lack of an insufficient staff who are qualified to perform BDA. In addition, there was no established procedure in CENTCOM for the management of BDA. An architecture existed only in concept, but it did not prescribe the necessary working guidelines. Although Exercise Internal Look 90 was meant to evaluate the theater C2, it did not provide a preview of the problem because BDA data was simulated to simplify and shorten the wargame. Consequently, the theater BDA system suffered from a cold start due to a lack of adequate manpower and established procedure. As such, CENTAF operational planners could not anticipate the timelines required for BDA and did not integrate it into the targeting process.[34]

Given the BDA requirements, the BDA process manifestly required some basic intelligence about the target and mission, such as information on the layout and appearance of the target, the types of weapons used against it, the method of attack, and the aimpoint. The theater BDA analysts got their information from the ATO and relied on postmission reports on how the mission was conducted. Missing or inaccurate data therefore reduced the validity of the BDA. However, they often received only fragments of the ATO. They were also often not updated with the changes to the plan, because many of the changes were made by GAT over secure lines to the air wings. As a result, BDA provided on attacks made on Scud targets by the theater BDA analysts were often inadequate to meet both operational and tactical level requirements.[35]

At the strategic level, the lack of intelligence dissemination guidelines during the war led to a lack of accurate, shared BDA information among the various C2 nodes. This resulted notably in disagreements between strategic and theater assessments as to what was accomplished.[36] Given the limited number of operational and tactical reconnaissance systems, there was a heavy reliance on strategic intelligence to provide the bulk of target intelligence and BDA data for the counterscud effort. However, operational intelligence agencies in theater found their access to strategic intelligence impeded. The discrepancies between strategic and theater intelligence therefore led to an inefficient duplication of effort. More importantly, this undermined the decision process of the targeting cycle. After the war, General Schwarzkopf attributed this failure to the strategic system's inflexible adherence to information dissemination directives from Washington, which did not respond to the needs of the theater. General Powell also expressed frustration over the lack of coordination and the timeliness of intelligence collected at the national level.[37] In particular, a significant amount of intelligence material generated in Washington was never disseminated to the theater and operational wings.[38]

At the operational level, a key source of BDA information was obtained from the inflight pilot reports and postflight mission reports. However, there were cases where discrepancies existed between inflight reports and the subsequent postflight mission reports, especially for attacks occurring at night. This suggested the difficulty in reliably assessing damages during the night. This was further compounded by poor weather which sometimes obscured targets from the imagery system. Although the videotapes served as useful BDA tools, there were certain inherent limitations. The imagery systems mounted on the aircraft delivering the munitions were often blanked out by the flash of their weapons. Moreover, A-10 and F-16 AVTRs only taped the heads-up display that was projected on the pilot's windscreen. In these cases, the weapon releases were recorded, but not the impacts.[39] In addition, unless the imagery showed a catastrophic kill, it was often difficult to evaluate if the target hit suffered a mobility kill, personnel kill, or firepower kill. These observations suggested a need to provide duplicate assets to confirm the damage inflicted on the target, particularly for high-priority targets and to further simplify the damage criteria.

Furthermore, theater BDA information from mission reports was never passed to the strategic intelligence agencies. This prevented strategic intelligence agencies from fully appreciating operational-level intelligence requirements. At the same time, the BDA software that had been established to fuse BDA information at the strategic, operational, and tactical level broke down on the first day of the air campaign. This hampered the theater intelligence community's capability to fuse intelligence and provide accurate and timely BDA to support the targeting process.

When theater intelligence failed to provide the necessary BDA support to GAT once the air campaign started, GAT planners began performing their own BDA with assistance from strategic intelligence agencies. In some cases, this led to GAT planners misusing the scarce theater intelligence collection assets available to validate targets.

Conclusions

Initiative is the key tenet of Army operations. FM 100-5, Operations highlights that "initiative requires a constant effort to force the enemy to conform to the commander's operational purposes and tempos, while retaining freedom of action."[40] To achieve this, it emphasizes that it requires leaders to anticipate events so they and their units can react within the decision-making cycle of the enemy. Specifically, FM 100-5 pointed out that "obtaining and synthesizing battlefield information prior to beginning operations is a vital task. Assembling an accurate picture of the battlefield requires centralized direction, simultaneous action at all levels of command, and timely distribution of information throughout the command."[41] An evaluation of the Coalition TMD attack operation's C2I process manifestly revealed that the C2I process did not meet these characteristics. Consequently, the Coalition could not seize the initiative against the Iraqi's Scud threat and could only react to it albeit being superior in all aspects of warfighting: doctrine, training, leadership, organizational, and material systems (DTLOM).[42]

The primary shortfall that led to an ineffective TMD attack operation's C2I process was the lack of precrisis intelligence on Iraqi's Scud capabilities. At the strategic level, the failure to identify the potentials of the threat prior to hostilities led to contempt among the leaders and planners and to the subsequent lack of emphasis to establish a TMD architecture required to defeat the threat. At the operational level, the lack of precrisis appreciation of Iraqi's Scud capabilities and order of battle prevented the Coalition's leaders and planners from developing an appropriate strategy to defeat the threat. At the tactical level, the failure to establish the Iraqi Scud concept of operation resulted in the Coalition's inability to localize the threat and focus the limited acquisition and attack resources available to defeat the Scud threat.

Although the Coalition targeted the Iraqi Scud target set as part of its strategic air campaign, there was essentially no established TMD attack operation architecture. When the strategic air campaign failed to defeat the Scud threat, an adhoc arrangement was established. Consequently, information and information flow requirements were not clearly established. First, information required for targeting the Scuds was not prioritized. Besides causing an overload in the intelligence system, it prevented pertinent information from being collected and fused in a timely manner. Second, there was a lack of information dissemination guidelines. Vertically, critical C2I nodes at the strategic, operational, and tactical level did not have an accurate shared knowledge of the battlespace, particularly in the area of BDA. This undermined the targeting process and resulted in duplication of effort. Laterally, it degraded the unity of effort and the commander's ability to make timely decisions. Additionally, a lack of information dissemination guidelines, coupled with technological shortfalls, prevented critical pertinent information from being delivered directly to the user. Instead, the C2I process was hierarchical, multilayered, and could not respond to the dynamic battlefield conditions in a timely manner. For example, most sensor-to-shooter links were cumbersome where target data had to be routed through several C2I nodes before being furnished to the attacking unit. This delayed the detect-to-attack timelines. Third, various elements of the C2I process could not be effectively integrated due to a lack of interoperability among the systems within the architecture. Since buffers and translatives were required to breach differences in systems and procedures, decision-making timelines were also correspondingly increased. As a result, the coordination and information flow was often delayed. As the quantity of information available increased, there was a need to process it more rapidly and pass critical pertinent elements of the information to units capable of furnishing the required response. The advantage would overwhelmingly go to the side that could fuse information from many sources, update the information base, and rapidly act on perishable data.[43] During the war, the lack of information prioritization, information dissemination guidelines, and interoperability therefore prevented the Coalition from levering its information capabilities to defeat the Iraqi Scud threat.

Since the intelligence system could not respond to the dynamic conditions of the battlefield, it could not proactively participate in the planning and execution of the counterscud effort. During the planning phase, intelligence merely furnished target data to support operations planning. At the strategic level, since intelligence was not incorporated into operations planning, the selection of the static Scuds as the decisive point of the Scud target set was not validated. At the operational level, the lack of BDA prevented the Coalition planners from effectively evaluating the counterscud strategy during the war. At the tactical level, it prevented the wings from evaluating the effectiveness of their tactical approach to destroy the mobile Scuds.

Throughout the war, the attempt to plan and control execution centrally to defeat mobile Scuds using the ATO process was unsuccessful. For the seventy-two-hour ATO cycle to work, predictive intelligence was required. However, the Coalition could not discern the operating pattern of Iraqi Scuds. This was compounded by the ephemeral characteristic of the Scuds. Consequently, such a centralized approach could not respond to the dynamic nature of the threat.

Nevertheless, the counterscud effort illustrated that unity of command was critical in establishing policies to achieve a unity of purpose, to deconflict mission requirements, and to prevent coordination problems in an exceedingly complex and crowded battlefield. It also demonstrated while centralized planning and control at the operational level was important to optimize the limited assets available and synchronize a coherent campaign plan, decentralized control and execution was cardinal at the tactical level to ensure timely responses against mobile targets, such as mobile Scuds. It further highlighted that a simple plan, with defined rules of engagement, unambiguous attack guidance, and simple control measures was essential to facilitate a timely response. Most significantly, it underscored the importance of planning in advance instead of reacting, so as to allow the attacker to seize the initiative and to exploit opportunities when they were presented.

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[3]Alexander S. Cochran, Lawrence M. Greenberg, and others, Gulf War Air Power Survey Vol I: Planning (Washington DC: U.S. DOD, 1993), 200, 212-214, 217.

[4]DIA analysts who have gone back over the evidence believe that the Iraqis sent their mobile launchers as early as August 1990.

[5]Jill L. Jermano and Susan E. Springer, "Monitoring Road-Mobile Missiles under START: Lessons from the Gulf War," Parameters (Spring 1993): 70-79.

[6]Cochran, Greenberg, and others, 102-104; Barry D. Watts, Williamson Murray, and others, Gulf War Air Power Survey Volume II: Operations (Washington DC: U.S. DOD, 1993), 182.

[7]Hone, Mandeles, and Terry, 170-172; Major Steve Zappalla, "Joint Theater Missile Defense: An Army Assessment," MMAS Thesis (Ft Leavenworth, KS: USACGSC,1993), 62-63.

[8]Hone, Mandeles, and Terry, 176.

[9]Keaney and Cohen, 128.

[10]Keaney and Cohen, 141-143.

[11]For a detailed discussion on the difficulties faced for changes made to the ATO, see Thomas C. Hone, Mark D. Mandeles, and LTC Sanford S. Terry, Gulf War Air Power Survey Vol I: Command and Control (Washington DC: U.S. DOD, 1993), 54, 212-224; Murray, 146-148.

[12]Keaney and Cohen, 128.

[13]Watts, Murray, and others, 186-187.

[14]TSS is the criteria established to decide whether targets identified by the various sources should be attacked; see U.S. Army, FM 6-20-10, Tactics, Techniques, and Procedures for the Targeting Process (Washington DC: HQDA, 1990), 2-7.

[15]Hone, Mandeles, and Terry, 255, 274-275.

[16] Hone, Mandeles, and Terry, 282, 290-291.

[17]Hone, Mandeles, and Terry, 254.

[18]Keaney and Cohen, 196-197.

[19]Hone, Mandeles, and Terry, 294-295.

[20]Edward L. Waltz and Dennis M. Buede, "Data Fusion and Decision Support for Command and Control", Principles of Command and Control (Washington DC: AFCEA International Press, 1987), 215-216.

[21]U.S. Armed Forces Joint Pub 6-0, Doctrine for Command, Control, Communications, and Computer (C4) Systems Support to Joint Operations (Washington DC: Office of the Chairman of the Joint Chiefs of Staff, 1995), 2-15.

[22]Joris Janssen Lok, "Turning Theory into Practice," International Defense Review (August 19950): 36.

[23]U.S. Army Command and General Staff College, A304, Advanced Fires (Ft Leavenworth: USACGSC, 1997), 50.

[24]Keaney and Cohen, 117.

[25]Hone, Mandeles, and Terry, 36-39.

[26]A304, 44-45.

[27]Keaney and Cohen, 131-132.

[28]U.S. Army, FM100-103, Army Airspace Command and Control in a Combat Zone (Washington DC: HQDA, 1987), 2-7 - 2-8.

[29]Hones, Mandele, and Terry, 312-313.

[30]Zappalla, 97-98.

[31]Edison, M. Cesar, Strategies for Defining the Army's Objective Vision of Command and Control for the 21st Century (Santa Monica, CA: RAND, 1995), 3-6.

[32]A304, 29-31.

[33]Keaney and Cohen, 119-120.

[34]Hone, Mandeles, and Terry, 277.

[35]Hone, Mandeles, and Terry, 266-268; FM 6-20-10, 4-3 - 4-4.

[36]Hone, Mandeles, and Terry, 303.

[37] Keaney and Cohen, 115.

[38]Hone, Mandeles, and Terry, 282, 291, 294; Keaney and Cohen, 114-115, 121; Murray, 131-132.

[39]Hone, Mandeles and Terry, 36-39, 269, 297.

[40]U.S. Army, FM 100-5, Operations (Washington DC: HQDA, 1993), 2-6.

[41]FM 100-5, 2-12.

[42]DTLOM constitutes the elements of the concept-based requirement system (CBRS) employed to identify and prioritize army warfighting requirements in the force development process.

[43]Keaney and Cohen, 216.

CHAPTER 5

CONCLUSIONS

> Decision making thus becomes a time competitive process, and timeliness of decisions becomes essential to generating tempo. . . We must spare no effort to accelerate our decision-making ability.[1]
>
> FMFM 1, Warfighting

Introduction

The evalution of the Coalition's TMD attack operation's C2I process during the Gulf War revealed significant flaws in the process which degraded the overall effectiveness of the attack operation to defeat the Iraqi Scuds. This reinforced the conclusions established by the Gulf War Air Power Survey, which contended that, "beyond the disruption induced by the level of effort put into the hunt for mobile Scud launchers, Coalition air power does not appear to have been very effective against this target category."[2] Consequently, the Coalition TMD attack operation C2I process was not an effective model for the advanced army. Nevertheless, the analysis of the process highlighted several important concepts that could be adopted by the advanced army to develop its TMD attack operation C2I process.

The purpose of this chapter is to establish the operational objectives of an advanced army C2I process. This is achieved by applying the concepts derived from the analysis, incorporating developments from current initiatives, and taking cognizance of the limitations of the advanced army.

Advanced Army TMD Attack Operation C2I

Unity of Effort

TMD in the next war will be a joint enterprise. This is especially so for the advanced army which must rely on the synergy achieved via synchronizing the full spectrum of joint capabilities to offset its limited resources in order to meet the increasing gamut of disparate threats that the enemy will present in the future battlefield. To achieve unity of command, the joint force commander (JFC) must therefore be responsible for TMD and TMD attack operation. In particular, the JFC must specify his intent for a TMD attack operation to provide unity of focus through harmonious initiative and lateral coordination.[3]

First, the JFC must define the objectives and endstate of the TMD attack operation to achieve unity of purpose. The objectives identified must contribute directly to the defeat of the center of gravity of the enemy's TBM capability and assist in achieving the endstate. The JFC balances the payoffs with the constraints and risks in selecting the objectives to be attacked.

Second, the JFC must establish the attack operation concept of operation. General William De Puy highlighted that the commander's concept is the supreme contribution to the prospect of victory on the battlefield at the operational and tactical level, a prerequisite which cannot be compensated by any amount of "command presence, personal flair, years of rectitude, demonstrated integrity, advanced degrees, perfectly managed assignments, warrior spirit, personal courage, weapons proficiency or troop morale."[4] Given the need for extensive decentralized action to achieve the responsiveness required to defeat the TBM threat, the concept serves to propogate the central idea throughout the joint force to ensure unity of effort.

Third, the JFC must establish the area of responsibility (AOR) between the surface component commander and the air component commander. Given that the air component provides the preponderance of the attack operation assets in an advanced army beyond the fire support coordination line (FSCL), the theater area of operation (AO) should be subdivided into two AORs using the FSCL as the line of demarcation to simplify coordination and enhance responsiveness. The AO short of the FSCL is designated as the surface component AO and the surface component commander is the supported commander. The AO beyond the FSCL is designated as the air component AOR where the air component becomes the supported commander.

Fourth, the JFC must determine the level of risk that is acceptable. An important consideration is the information threshold required to initiate an attack. In a dynamic battlefield, the uncertainties that surround an assessment of the prevailing situation are many. This may be due to information being incomplete, conflicting, or ambiguous. While uncertainty may be reduced over time as amplifying reports arrive, a responsive attack decision will often have to be made long before situational uncertainties can be completely resolved to exploit the short dwell times of the TBM system. Although a high threshold prevents the risk of fratricide and minimizes duplication of effort, it also lengthens the detect-to-attack timelines. On the other hand, a low threshold increases the responsiveness of an attack but reduces efficiency in the employment of the scarce resources available. A second consideration is to balance the risks between attacking the TBM launcher during a particular stage of the TBM operation and the associated constraints. For example, the JFC may choose not to attack a TBM launcher during the prelaunch stage and attack it only in the postlaunch phase after the TBM launcher has rendezvoused with the other TBM launchers and the support vehicles in a hide site. Although the payoff will be much higher, friendly forces run the risks of being hit by the TBM. Moreover, the TBM launcher may be able to evade tracking by friendly sensors, thus preventing a successful postlaunch attack. By specifying the acceptable risks, the JFC establishes the critical decision thresholds required to initiate an attack.

Fifth, given the scarce resources available to the advanced army, the JFC must ascertain the means to achieve the objectives of the TMD attack operation. This will include C4I support, acquisition means, and lethal, as well as nonlethal, attack systems. If the resources apportioned are limited, the attack operation will have to be sequenced, and the JFC must establish the priority of effort in each phase of the operation. However, the list of priorities must be subjected to constant reevaluation, and any adherence to a single idea must be avoided.[5] More significantly, the JFC must accept the risk that not all enemy TBM systems can be simultaneously neutralized and those that are not attacked will be capable of posing a considerable threat to friendly forces.

Centralized Planning and Control at the Operational Level

As manifested in the study, centralized planning and control at the operational level are cardinal to the establishment of a coherent attack operation campaign plan to defeat the TBM threat and ensure harmonious operation among the large number of disparate systems operating in an exceedingly crowded battlespace.

At the joint level, a joint TMD element (JTMDE) is established to plan, monitor, and coordinate the overall attack operation campaign plan. The primary role of the JTMDE is to establish, based on the JFC's intent, clear and unambiguous attack operation policies, such as rules of engagement (ROE), and to disseminate the execution directives which sets in motion carefully timed employment activities. It also works in conjunction with the joint targeting coordination board (JTCB) to develop, deconflict, and refine attack operation targets. The role of the JTCB in TMD attack operations is to ensure that attack operation targets directed from top-down or nominated by the components are prioritized and integrated into the components' strategic air attack, offensive counterair, interdiction, counterfire, fire support, and special operation direct action missions. In addition, it also ensures that all joint capabilities are being exploited and optimized to defeat the TBM threat.

The JTMDE also works with the joint staffs to establish the required policies, priorities, and procedures to enable successful attack operations.[6] It coordinates with the theater J2 to ensure timely preparation and dissemination of IPB products tailored to support attack operations, establish the required priority of information (PIR) for target acquisition and CA, and ascertain the information management policies which include procedures for information correlation and timely dissemination of targeting information between sensors and shooters. To ensure that the enemy TBM threat could be localized, it works closely with the J2 prior to the breakout of hostilities to maintain an information base on the enemy TBM activities during peacetime. In addition, the JTMDE works with the J3 to ensure that the attack operation is integrated into the overall joint operations. It coordinates with the J3 to develop and prioritize the targeting guidance and objectives for JFC's approval. It also coordinates with the J3 to monitor the location and operational status of the joint force's attack assets. Furthermore, the JTMDE coordinates with the J6 to ensure vertical and horizontal C4I connectivity among the critical C2 nodes at the strategic, operational, and tactical levels. It also assures that the C4I for attack operation RSTA is integrated into the overall C4I architecture.

Although the C2I process exhibits hierarchichal characteristics, it comprises a multi-layered series of close loop (but interdependent) processes at each echelon of command. The dynamism is most pronounced during operations when real time feedback of target intelligence and force status permit changes to the attack operation strategy to exploit certain enemy vulnerabilities. The JTMDE plays an important role in ensuring a coherent strategy by providing new execution directives, changes in the rules of engagement, or planning guidance to the components which set off new relations as fresh courses of action alters the posture of both friendly and enemy forces.[7]

The components contribute to ensuring a coherent campaign plan by centrally controlling the allocation of scarce resources available and the use of the battlespace. The purpose is to provide self-contained units that are capable of making independent decisions at a low level within their assigned AOR. This self-containment reduces the need for coordination and information processing within the unit and with higher headquarters; it also serves to ensure errors when made are limited in scope. By virtue of eliminating much of the need for coordination, the detect-to-attack timeline is reduced thus enhancing the responsiveness of an attack.[8] Specifically, the components coordinate the use of battlespace and synchronize the right mix of sensors and attack assets (based on the resources apportioned by the JFC) to mass effects at the decisive time and place. The use of the master attack plan (MAP) and the air-tasking order (ATO) to configure the right mix of aircraft packages, coordinate aerial refueling, coordinate airspace, and thereafter allocate them to the airborne C2 elements for employment as push CAS at the decisive time and place to destroy enemy mobile units exemplifies centralized control at the operational level to establish conditions for a successful tactical execution.

Proactive Planning

The short dwell time of mobile TBMs predicates the necessity to reduce the involvement of man-in-the-decision-loop. While technology speeds inductive processing, the requirement to reconstruct the hypothesis each time that new information is received delays the decision time. In addition, it does not adequately address the problem of "fog" as described by Clausewitz:

> Great part of the information obtained in war is contradictory, a still greater part is false, and by far the greatest part is of a doubtful character. . . It is much worse for the inexperienced when the accident does not render him this service, but one report supports another, confirms it, magnifies it, finishes off the picture with fresh touches of colour, until necessity in urgent haste forces from us a resolution which soon be discovered to be folly, all those reports having been lies, exaggerations, errors, etc., etc.[9]

Consequently, an inductive C2 process is reactive and consumes time and resources before a reliable picture of the situation is achieved.

Instead, the attack operation C2 process must be proactive and seek to derive a set of attack criteria (deductive sifter) in advance based on an inductive assessment of the TBM target, using precrisis intelligence and continuous intelligence preparation of the battlefield (IPB). Target information obtained during battle is then compared with the attack criteria that is derived in advance to identify if it conforms to the criteria for attack. Thus marrying the deductive and inductive processess results in a management-by-exception approach which enhances the responsiveness of the attack operation C2 process.

In particular, the D3A targeting methdology is a useful process to predetermine the attack criteria. The attack criteria includes the TSS and attack guidance matrix. The TSS specifies the accuracy and timeliness standards that must be met before targets developed by various sources are attacked. It forms the basis for rapid cross-cueing of sensors to revalidate targets if the they do not meet TSS requirements. The AGM identifies in advance what targets to kill, where the targets will be based on threat localization, what collection means to acquire them, and what delivery systems to attack them. A proactive C2 process therefore identifies the likely enemy operations, supports real-time assessment of inherent enemy vulnerabilities, coordinates rapid target validation, and provides the commander the agility to immediately seize initiative and attack the mobile TBM in a timely manner.[10] The attack criteria forms the basis for decentralized execution and control at the tactical level.

Decentralized Execution and Control at the Tactical Level

The analysis manifestly demonstrated that despite the technological advances made to the communication systems, the flow of information to and from the units was never sufficiently detailed or fast enough to permit centralized control. As such, centralized control of tactical execution could not adequately respond to the inherent uncertainties in the target intelligence given the ephemeral nature of the TBMs and the time contrained detect-to-attack timelines required to destroy the TBMs. The analysis further demonstrated that the stringent detect-to-attack timelines could only be met when control of tactical execution was decentralized, which lowers the decision threshold, reduces coordination, and allows freedom of tactical action. This serves to enhance responsiveness. This was exemplified by the JSTARS targeting concept against moving enemy ground units. In addition, decentralized operation affords the commander the ability to meet the changing tactical situation and satisfy unforseen requirements, as illustrated by the employment concept of the ABCCC in managing "push" CAS during the war. As van Creveld suggests,

> As long as command systems remain imperfect--and imperfect they must remain until there is nothing left to command--both ways [centralized and decentralized control of tactical execution] of coping with uncertainty will remain open to commanders at all levels. If 25 centuries of historical experience are any guide, the second way will be superior to the first.[11]

The high performances of the Roman legion, Napoleon's Grand Armee, Motlke's army, and Ludendorff's storm detachments were due to a willingness of the higher headquarters to accept more uncertainty while simultaneously reducing it at the lower level.

However, to make this decentralization in control possible, accurate shared information is required. In particular, the analysis revealed that there was a need for regular reporting from the top-down as well as from the bottom-up. However, the extent of the routine reports demanded from the subordinate headquarters should be limited to the indispensable minimum and must be relevant to the higher headquarter's needs. This requires the JTMDE to be very specific with the intelligence required on the enemy (PIR) and the status of friendly units (FFIR). Additionally, there was a need for the higher headquarters to actively search for information to supplement the information routinely passed to it by subordinate units. By seeking the information that it needs at the time it is needed, it reduces the need for subordinate headquarters to report on everything all the time. This not only saves time for subordinate units, it also prevents information overload. At the same time, by cutting through repeated summarization of information as it is filtered upward, it assures both immediacy and veracity. "In the absence of such a telescope superior headquarters stands in danger of becoming a prisoner of its own reporting system; without it, too, no means will be available to counteract the natural tendency of any decentralized organization to degenerate into a set of semi-independent units where decision making becomes a bargaining process."[12]

Simple Tactical Control Measures

The analysis further pointed out that simple tactical control measures serve to enhance the responsiveness of a tactical execution. The Scud box was a simple control measure used during the war to facilitate the airborne C2 element to vector aircraft to the target location. For the advanced army, a similar tactical control measure should be adopted. Specifically, the TBM boxes should be identified based on threat localization using precrisis intelligence and continuous IPB. Besides serving as a reference location for the airborne C2 element and the attack unit, it serves to narrow the search area to allow effective acquisition. In addition, boxes identified as critical may serve as AORs for dedicated attack units.

Intelligence Management

The advanced army must ensure that pertinent, accurate, and timely intelligence is made available to the relevant C2 nodes to support decision making. It must define in advance what information is required to support the decision-making process, who to provide this information, when the information must be provided, and how it is to be translated into decisions and actions. The philosophy must be that the decisions must be decisive based on "about right" information. In particular, there are several important intelligence aspects which the advanced army must address.

Precrisis Intelligence

The advanced army must establish a long-term collection effort prior to hostilities to create a sound intelligence base of enemy TBM capabilities and to improve target familiarity. An understanding of the enemy order of battle (Orbat) allows the advanced army to allocate the right mix of sensors in search of specfic targets and the right configuration of attack package to destroy the target. The knowledge of the enemy's TBM pattern of operation allows the advanced army to localize the threat to facilitate acquisition and cueing. Precrisis intelligence is a prerequisite for proactive planning and forms the basis for proactive development of targets and attack criteria.

Prioritization of Information

Prioritization of information is important because the advanced army has only limited intelligence collection assets and finite C4 system capacity. More significantly, it serves as a filter to prevent the commander and staff from being overloaded with information, thereby degrading their decision-making capability. Consequently, it is the responsibility of the commanders at all levels to prioritize information. Prioritization of information provides the necessary discipline to control information flow and processing among C2 nodes. It also serves to establish the C4 network sizing and systems requirement of each C2 node.[13]

Data Fusion

As mentioned earlier, to support proactive planning, data fusion is to be achieved via integrating both dedutive and inductive processes to allow information to be managed-by-exception. The management-by-exception approach serves to lower the decision timelines to initiate an attack.

Information Dissemination

It is predicted that the data requirements will rise dramatically over the next decade, in the order of ten or more times that of the overall communications traffic during the Gulf War. Consequently, all information dissemination must be prioritized to prevent another Vietnam "superflash" phenomenon which caused a slowdown of the command process.[14] In addition, this must be enhanced by replacing person-to-person (PtP) communications, which is common in most advanced armies, by digital data (CtC) exchanges to transmit target data from the sensor to the shooter. The use of CtC allows such transmission to be accomplished within an extremely brief period which facilitates exceedingly time-constrained operation.[15]

In addition, a nonhierarchical information architecture is required to link relevant critical C2 nodes vertically from the strategic to the tactical level and horizontally across all services and among lateral units. However, to simply open the information system and allow the information to move freely will not automatically increase military capabilities. A disciplined structure via standard reports and information priority is essential to support fusion and correlation and to provide an accurate and responsive shared perception among the critical C2 nodes.[16]

To reduce the detect-to-attack timelines, direct sensor-to-shooter links should be established where possible, especially if the sensor had a reliable discrimination capability, met the TSS requirements, and was used to confirm targets previously identified by all-source sensors. Furthermore, target information from the sensor to the shooter should preferably be in the form of imagery. Joint Project Optic Cobra demonstrated the value of imagery in enhancing target identification. Without the type of sophisticated technology like JSTARs, the advanced army should exploit the unmanned aerial vehicle (UAV) which proved during Exercise Roving Sands '95 to improve the responsiveness of an attack by providing invaluable, near real-time target imagery directly to the attacking unit. Nevertheless, imagery consumes a very large tranmission bandwidth, and spectrum management is instrumental in ensuring that the demands for continuous and uninterrupted access to the electromagnetic spectrum by the joint force is fulfilled.

CA Assessment

The advanced army must assure that the CA process is integrated into the planning and execution of attack operations. For effective CA, it may be necessary to have duplicate BDA collection assets for critical targets. In addition, there must be accurate and complete sharing of target, mission, attack strategy, and aimpoint information between the operations planner and the CA analysts to permit meaningful CA. Moreover, a simple BDA criteria is required to assess the damage inflicted on the TBMs and to facilitate reattack if required.

The advanced army must also ensure that BDA information obtained from strategic, operational, and tactical assets are fused and shared by all critical C2 nodes at each level. An accurate, shared picture of the CA prevents duplication of effort. It further allows a responsive evaluation of the effectiveness of the overall campaign, so that midcourse corrections in the strategy can be made immediately to defeat the TBM threat.

Interoperability

Central to an effective C2I is the need for vertical and horizontal interoperability among the C2 nodes. Based on the lessons learned from the analysis, the advanced army must ensure that the addition of buffering, translative, or similar process and device for the purpose of achieving workable interface connections is minimized to enable the timely exchange of information and responsive decision making. Specifically, the advanced army must examine the following:

Liaison. "No amount of technology can replace the face-to-face exchange of information between commanders."[17] Given the pace of TMD attack operations, the commander's presence can be extended through the liaison. Specifically, at the operational level, liaison should be established between the JTMDE and the respective component and between the JTMDE and the respective joint staff to facilitate coordination. By conducting immediate coordination, making timely corrections, and providing responsive advice to the command to which it is attached, the liaison teams serve to enhance the overall responsiveness of the C2I process.

Standardization. To further enhance interoperability, standards must be developed for interfaces, required information to be exchanged, protocol for information transfer, and operational procedures. The TADIL J message standard for the joint tactical information distribution system (JTIDS) is one example which the advanced army should develop to form the basis for interoperability among the C2 nodes.

Future Study

While it is important to develop a military capability to defeat the TBM threat, it is equally important to examine how proliferation of TBMs and their technology can be controlled before they can be employed. In particular, there is a need to reevaluate the MTCR to examine if the conditions and agreements espoused by it remain relevant given the changing threat environment.

More applicable to the military community is the need to examine how information technology may be levered to enhance the capability of TMD attack operations. The concept that higher relative tempo equates to increased military leverage is not new. What is new is the emerging information technologies that increase the detect-to-attack cycle by orders of magnitude compared with past capabilities. Specifically, there is a need to study how information management and distribution can facilitate the horizontal integration of battlefield functions and allow nonhierarchichal dissemination of intelligence, targeting, and operational-level data to further reduce the timelines of command cycles.

Another important issue is to examine the potential of levering information technology and precision-guided technology to simultaneously identify and destroy a significant portion of the enemy's TBM critical vulnerabilities so that he recognizes defeat not through sequential attitrion but by inducing systemic shock on his TBM operating and control systems. Implicit in this study is the need to examine if the political-decision-making process can accommodate the pace of such parallel shock warfare without being enslaved by such a capability.

Closing

Based on the evidence from the analysis, the Coalition's TMD attack operation's C2I process during the Gulf War was not an effective model for the advanced army. However, the analysis offered several important C2I concepts that could be adopted and modified to enable the advanced army to defeat the TBM threat. From these findings, observations of developments in TBM attack operations and assumptions about the future operating environment, the study recommends the following attack operation C2I operational objectives:

1. Unity of command. JFC has primary responsibility for attack operations and establishes the objectives, concept, acceptable risks, means, and AOR.

2. Centralized planning and control at the operational level. The JTMDE plans, monitors, and coordinates a coherent attack operation campaign plan. It establishes a central attack operation policy to ensure unity of effort. Components provide the right mix of sensors and attack systems and establishes conditions for successful tactical execution by centrally controlling the allocation of scarce resources available and the use of the battlespace.

3. Proactive planning. Predefine TSS to facilitate cross-cueing of sensors. Integrate deductive and inductive data fusion processes to allow information management by exception. Predefine attack criteria to enable decision by exception.

4. Decentralized control and execution at the tactical level. Control of tactical execution is decentralized based on clear, predefined attack guidance and ROE. Implicit to the success of decentralized execution is the need for simple control measures, accurate shared perception of the battlespace vertically and horizontally among the critical C2 nodes, and active search of information by higher headquarters to supplement the routine reports furnished by the subordinate headquarters.

5. Establishment of precrisis and long-term intelligence base of enemy TBM capability. The intent is to localize the threat, narrow the search area to enable acquisition by multiple sensors, and facilitate cueing of sensors and attack systems.

6. Prioritization of required enemy and friendly information. This also includes establishing dissemination guidelines to permit the nonhierarchical flow of intelligence, targeting, and operational information. When conditions permit, direct sensor-to-shooter links should be established.

7. BDA integration. Ensure accurate shared information of BDA data and analysis to allow effective integration of BDA results into the targeting process.

8. Interoperability. Provide system and procedural interoperability for all relevant C2 nodes.

These objectives serves to form the basis for the development of the advanced army TMD attack operation C2I process.

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