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Political instability and uncertainty throughout the world highlight the need to guard against a possible missile attack. With the proliferation of missile technology, the threat of a ballistic missile attack by a rogue nation or terrorist group is especially dangerous. Many of these countries have short-range missiles and are now seeking to acquire more sophisticated, long-range missiles. In addition to missiles with conventional warheads. there is also a threat from missiles armed with chemical and biological warheads.

Weapons of mass destruction, and the ballistic and cruise missiles that could deliver them, pose a direct and immediate threat to the security of the United States and its allies. Today, effective anti-missile defense is one of our most complex challenges. It involves locating and destroying enemy missiles before launch and shooting down those in flight.

The United States is responding to this threat by pursuing policies and initiatives designed to both prevent and limit this aggression. Plans to improve the interception of missiles will depend greatly on the effectiveness of quick counterfoce strikes designed to eliminate an adversary's missile attack.

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ANTI-MISSILE DEFENSE: STRATEGIC INTERCEPTION

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FOREWORD

Today, effective anti-missile defense is one of our most complex challenges. Many nations have short-range missiles and are now seeking to acquire more sophisticated, long-range missiles. In addition to missiles with conventional warheads, there is also a threat from missiles armed with chemical and biological warheads.

This edition of The DTIC Review provides a broad overview of some of the policies and initiatives the United States is pursuing to both prevent and limit this aggression.

The editorial staff hope you find this effort of value and appreciate your comments.

Kurt N. Molholm
Administrator

INTRODUCTION

Political instability and uncertainty throughout the world highlight the need to guard against a possible missile attack. With the proliferation of missile technology, the threat of a ballistic missile attack by a rogue nation or terrorist group is especially dangerous. Many of these countries have short-range missiles and are now seeking to acquire more sophisticated, long-range missiles. In addition to missiles with conventional warheads, there is also a threat from missiles armed with chemical and biological warheads.

Weapons of mass destruction, and the ballistic and cruise missiles that could deliver them, pose a direct and immediate threat to the security of the United States and its allies. Today, effective anti-missile defense is one of our most complex challenges. It involves locating and destroying enemy missiles before launch and shooting down those in flight.

The United States is responding to this threat by pursuing policies and initiatives designed to both prevent and limit it. Plans to improve the interception of missiles will depend greatly on the effectiveness of quick counterforce strikes designed to eliminate an adversary's missile attack.

The United States has focused attention on various anti-missile defense systems, programs, projects and initiatives. Deployment of an effective anti-missile system, along with continued research on advanced technologies, is extremely necessary to put an end to the vulnerability of missile attack.

Missile threat stands apart from other warfighting requirements and demands a more focused approach. In the future, space-based lasers could burn through ballistic missiles of all ranges, destroying them in boost phase. But in the near term, several types of ground-based or sea-based interceptors could destroy short-range missiles, while longer-range missiles could be intercepted by ramming them in flight with kinetic energy interceptors.

The editorial staff would like to gratefully acknowledge and thank the staff of our Los Angeles Regional Office for their effort and expertise in compiling and researching this edition of *The DTIC Review*. Their excellent work and comprehensive coverage of the subject area is evident on every page of this issue.

The selected documents and bibliography in this review are a representation of the information available on anti-missile defense from DTIC's extensive collection on this subject. Additional references, including electronic resources, can be found at the end of the volume. In-depth literature searches may be requested by contacting the Reference and Retrieval Services Branch at the Defense Technical Information Center:
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DOCUMENT 1

National Missile Defense (NMD) - Has Its Time Come?

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Jan 1997

Army War College

Carlisle Barracks, PA

STRATEGY
RESEARCH
PROJECT

NATIONAL MISSILE DEFENSE (NMD) -- HAS ITS TIME COME?

BY

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USAWC CLASS OF 1997

U.S. ARMY WAR COLLEGE, CARLISLE BARRACKS, PA 17013-5050

USAWC STRATEGY RESEARCH PROJECT

National Missile Defense (NMD) -- Has Its Time Come?

by

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ABSTRACT

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The issue over deploying national missile defense (NMD) to counter strategic ballistic missiles has been on going since the 1950's. During the Cold War, the debate shifted from considering the viability of deploying territorial defense to counter the Soviet threat to one of agreement by both superpowers to limit missile defenses for fear they would undermine strategic stability and increase the chances for nuclear war. Without missile defenses, it was understood that the populations of both countries would be subject to mutual assured destruction (MAD) should a nuclear war ever break out between the sides.

With the Cold War over, the debate has shifted once again. The issue is whether or not the threat posed by the proliferation of weapons of mass destruction (WMD) and their delivery systems warrants a reevaluation of Cold War arguments against NMD and MAD. Contrary to the views of the current administration, the author outlines that NMD deployment is needed now more than ever for the United States to effectively operate in the 21st Century and to ensure the American population is never again threatened by direct attack.

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Many of the military strategies developed in the long bipolar competition . . . are now obsolete, but they are still debated . . . as if they were relevant."[5]

One of those key debates focuses on whether or not the United States should break with the bipolar deterrent concept of mutual assured destruction (MAD) and begin the process of fielding a national missile defense (NMD) designed to stop strategic ballistic missiles and cruise missiles.

The following paper examines why now, more than ever, the United States should institute a national policy that directs deployment of NMD. Contrary to current administration policy, the need for NMD in the post-Cold War era is more important now than it was during the height of the Cold War. "As we look around the globe, our potential adversaries are ones whose militaries are inferior to ours. Hence, it would seem they would only provoke a conflict with us if they miscalculate our reaction, or believe their total means will prevail over our limited means."[6]

Since this paper focuses on the policy debate, it will not get into the question of the technological feasibility of NMD or the issue of costs associated with deploying NMD. However, the author believes that technology is available at this time to deploy an effective NMD system. Spin-offs from President Reagan's Strategic Defense Initiative (SDI) that are being used to develop theater missile defenses (TMD) will, in turn, lay the foundation for NMD. As to the issue of cost, NMD will be expensive especially in a period of budget constraints. However, the costs for deploying NMD will be much less than the

The President's tone was soft, sad almost, as he addressed the Deputy Secretary of State. "What is the population of Libya?" "Two million, sir, give or take a hundred thousand . . . ." The President turned down the table toward the Chairman of the Joint Chiefs. "Harry, how many people would we lose if a three megaton device went off in New York?" . . . The Chairman reflected a moment. "Between four and five million, sir."

The Fifth Horseman[1]

Henry Kissinger stated in 1977 that "*foreign policy must start with security.* A nation's survival is its first and ultimate responsibility; it cannot be compromised or put to risk."[2] With the end of the Cold War, U.S. foreign policy has shifted from the relative stability of a bipolar world to one of instability where tribal, ethnic, religious and cultural differences form the foundation for a wider number of potential crisis situations. In addition, "technology has grabbed America by the lapels and pulled her into the crowded elevator of nations. Enemies halfway around the world could now visit destruction on the United States thanks to new weapons such as ballistic missiles carrying nuclear, biological, or chemical (NBC) warheads."[3]

To address the post-Cold War era, U.S. national security strategy has shifted from a focus on East-West conflict with the Soviet Union to one of "Engagement and Enlargement." Under this strategy, the Clinton administration believes that the United States ". . . can only address this era's dangers and opportunities if we remain actively engaged in global affairs."[4] To pursue such a strategy, strategic concepts used to deal with the Cold War threat may no longer be viable in a multipolar world of the 21st Century. But unfortunately, "like the Energizer Bunny, some debates just go on and on.

material and non-material costs associated with a direct attack on a U.S. city by a ballistic or cruise missile carrying weapons of mass destruction (WMD).

The ability of the United States to undertake effective decision-making and foreign policy options in the 21st Century will be impacted by three events -- 1) the direct threat to U.S. national security interests posed by the proliferation of WMD and their delivery systems in the hands of third world states; 2) the realization that the threat of nuclear retaliation which maintained stability during the Cold War may no longer provide a viable deterrent against rogue states armed with WMD; and 3) the failure to modify Cold War arms control agreements to account for changes in the post-Cold War environment; specifically, the 1972 Anti-Ballistic Missile (ABM) Treaty. The impact of these three events will become more pronounced as the United States focuses on domestic issues, downsizes its military due to budget constraints, moves away from overseas basing to a continental based force and fails to adequately fund force modernization.

If the United States is to be successful in the 21st Century, it must be able to deter adversaries possessing or planning to possess WMD. If not, threats of WMD use by adversaries will prevent and/or deter the United States and its allies from influencing the course of international events. A third world country need not use WMD, but only threaten its use to be a viable deterrent to U.S. policy. While such threats were rare during the Cold War, they may become the rule, rather than the exception in the future.

It is likely that within the next decade, WMD will be used on a regional battlefield despite the best efforts of the United States to prevent such use. It is also likely the United States itself, will face a valid and real WMD threat to its homeland. Therefore, the question boils down to whether or not circumstances have changed enough to warrant a commitment to deploy NMD now?

The short answer to the question is 'yes.' However, the current administration believes the answer is 'no' under the premise that it has enacted an all encompassing policy to deal with the WMD threat. Recently, the Secretary of Defense reaffirmed administration policy noting that in order "to defend our nation against this insidious threat, we have established three lines of defense. The first . . . prevent or reduce the proliferation threat. The second, if prevention fails . . . deter the threat. And the third, if deterrence fails, . . . defend against the threat."[7]

After three years of working interagency policy issues for the Joint Staff on the ABM Treaty and ballistic missile nonproliferation, the author believes the administration leaves open a very large gap in its' WMD strategy by focusing only on deploying TMD instead of also pursuing NMD deployment. Even though the administration argues that no post-Cold War threat exists to warrant a NMD deployment decision now, justification has been based on continuing long standing Cold War arguments against effective missile defenses -- no viable technological solution to counter offensive missiles; building defensive systems are not cost effective; stability and deterrence with Russia will be undermined, resulting in a new arms race.

The administration has failed to temper these Cold War arguments against the realities of the evolving 21st Century WMD threat. During the Cold War, it was established U.S. policy that the American population would remain open to direct attack by strategic ballistic missiles. In the post-Cold War era, the same policy exists even though in a series of focus groups and opinion polls, the Coalition to Defend America found that "most Americans are unaware their government has chosen, for over two decades, to leave the nation unequipped to intercept ballistic missiles."[8]

A unique opportunity exists to walk back and correct past Cold War deficiencies in missile defense and pursue options that will prevent a situation whereby a rogue state could blackmail or threaten the United States directly with WMD.

<u>Background</u>

The debate over missile defenses[9] has been around since Nazi Germany first developed and used V-2 rockets against England during World War II.[10] This revolution in militar affairs (RMA) destroyed the myth that countries once considered geographically immune from direct attack were no longer safe from unmanned weapons of terror delivered over great distances. After World War II, U.S. and Soviet leaders utilized the capability of V-2 technology to develop a tremendous offensive arsenal of intercontinental range ballistic missiles as instruments of policy during the Cold War.

As the risk of nuclear war increased, the superpowers began the process of walking back the "hair trigger" of the nuclear arms race. As early as 1964[11], U.S. and Soviet leaders explored options to limit the arms race through arms control agreements. By 1972, the sides reached initial agreement to cap offensive weapons under the Strategic Arms Limitation Talks (SALT) and agreed, under the ABM Treaty, to limit the development and fielding of defensive systems designed to stop strategic ballistic missiles.

While these and other arms control agreements instilled some degree of stability in the Cold War relationship, they failed to prevent the massive arms race and the reliance on mutual assured destruction of each others' homeland as the basis for deterrence and defense against offensive ballistic missiles.

There have, and continue to be, three distinct schools of thought on the value of missile defenses: First, are the arms control advocates who conclude that no direct threat exists to the United States to warrant building NMD now or in the future. For them, stability was maintained by not building NMD to counter the Soviet threat during the Cold War, therefore, building NMD now or changing the ABM Treaty risks instability and will result in another arms race. Second, those in the middle who believe that NMD is not necessary until such time as a specific threat arises to warrant a deployment decision. Third, those who believe the threat is here and growing. For them, failure to develop NMD now is irresponsible since it is the government's responsibility to protect its citizens from possible attack.

The Clinton Administration falls into the second school of thought. When the administration arrived in the White House in January 1993, one of their first actions was to undertake a review of ballistic missile defenses and the future of the ABM Treaty. This review examined President Bush's dialogue with Mikhail Gorbachev and then with Boris Yeltsin, over the possibility of pursuing joint development of a scaled down version of President Reagan's SDI program for global missile defenses.[12]

The review also examined Iraqi use of scud missiles during the Gulf War and the growing WMD proliferation threat that led President Bush and a Democratic controlled Congress to pass the Missile Defense Act of 1991.[13] This legislation recognized a changing post-Cold War environment and a need to pursue both theater and national missile defenses. It also recognized a need to modify the ABM Treaty to develop any revised missile defense programs.

Under pressure from anti-missile defense advocates, President Clinton decided in 1993 to reject the missile defense views of previous administrations.[14] He reaffirmed the validity of the ABM Treaty in its current form as the basis for strategic stability with Russia and set forth his missile defense priorities: "1) assigned first priority to theater missile defenses [TMD] and regional threats; 2) downgraded the priority for NMD, changing the focus from an acquisition program to a technology demonstration/readiness program; and 3) give third priority to an advanced technologies program, designed to develop and demonstrate high payoff technologies for TMD and NMD."[15]

The administration justified the move away from NMD based on the view that no direct threat existed to the United States to warrant NMD deployment. This view was later reinforced in a classified November 1995 National

Intelligence Estimate (NIE) which concluded that "no country, other than the major declared nuclear powers, will develop or otherwise acquire a ballistic missile in the next 15 years that will threaten the contiguous 48 states or Canada."[16] Missile defense advocates in Congress were outraged and claimed the NIE was politicized to justify the administration's unwillingness to pursue provisions of the 1991 Missile Defense Act and to foil other missile defense efforts in Congress. Administration critics argued that the NIE failed to address threats posed to Alaska and Hawaii by North Korean long range missiles or that a country might covertly purchase a mobile ballistic missile without having to develop an indigenous missile program from scratch.[17]

To counter the administration's missile defense priorities, the Republican Party in the run-up to the 1994 midterm Congressional elections, outlined its "Contract with America" identifying key issues that would receive emphasis during the first 100 days of a Republican controlled House of Representatives. The top national security issue was the "defend America" pledge which stated: "I recognize that the world-wide proliferation of mass destruction weapons . . . represents a current and growing danger to the United States, our military forces overseas and our allies. I recognize the fact that today we cannot protect the United States, our troops overseas and our allies against even one ballistic missile armed with a nuclear, chemical or biological weapon. If elected, I will support a vigorous U.S. effort to develop and deploy effective defenses . . . as an immediate national priority."[18]

After the Republican victory in Congress, an aggressive agenda to legislate NMD began. The FY 95 Defense Authorization Bill forwarded to the President contained language legislating NMD deployment and negotiations with Russia to modify the ABM Treaty as needed. President Clinton vetoed the bill on 28 December 1995.[19] After shutting down the Federal Government, Congress eventually agreed to strip out NMD provisions that resulted in the Presidential veto. In 1996, the Republicans again undertook efforts to pass legislation requiring NMD deployment. They also attempted to use NMD as a decisive campaign issue in the Presidential election, but with little success. However, several members of Congress were successful in filing suit in Federal Court[20] claiming the administration was in violation of the law by failing to follow missile defense provisions the President signed into law in the final FY 95 Authorization Bill. Action is still pending in the courts.

Proliferation of WMD

The administration's first line of defense in dealing with WMD is to reduce or prevent prolifera ion. On November 12, 1996, President Clinton notified Congress that: "On November 14, 1994 by Executive Order No 12938, I declared a national emergency with respect to the unusual and extraordinary threat to the national security, foreign policy, and economy of the United States posed by the proliferation of nuclear, biological, and chemical weapons ("weapons of mass destruction") and the means of delivering such weapons. Because the proliferation of weapons of mass destruction and the means of delivering them continues to pose an unusual and extraordinary threat . . . the national emergency declared on November 14, 1994, and extended on November 14, 1995, must continue in effect beyond November 14, 1996."[21]

While no one knows the exact numbers, the current trend in WMD proliferation and their delivery systems is increasing rather than decreasing among the third world. While sources may differ, there is general agreement that on average 20-25 nations have ballistic or space launch missiles in their inventories; 20-30 nations have nuclear weapons or research and development programs examining the feasibility for acquiring such weapons; up to 30 nations may have chemical weapons; and up to 10 nations may have biological weapons.[22]

In response to the WMD threat, the Clinton administration put into place policy initiatives designed to continue efforts of previous administrations to stem WMD proliferation. Through arms control agreements, participation in international nonproliferation regimes, pursuit of tighter export controls and enactment of legal sanctions, the United States led the way on the international stage to address the growing WMD threat. However, these actions have had only limited success in stopping WMD programs in rogue states such as Iran, Iraq, North Korea and others. It is likely the proliferation problem will get worse as these states achieve full WMD status and become future proliferators to other state and non-state entities.

As the Joint Staff expert on the Missile Technology Control Regime (MTCR), the author participated directly in administration efforts to stem the proliferation of ballistic missile systems that could deliver WMD. From 1993-

1996, the administration was successful in getting South Africa, Hungary, Argentina and Brazil to terminate ballistic missile programs in exchange for MTCR membership. The administration was also successful in bringing Russia into the regime, however, the jury is still out on whether or not Russia will become a responsible MTCR partner given its current economic difficulties and thriving organized crime. Other attempts were made to bring China, North Korea, Ukraine and South Korea into the regime as well. Currently, negotiations with these countries continue.

The ability of the MTCR to effectively counter the proliferation problem over the long run is hampered because it is a non-binding regime of 27 like-minded states and is not an international treaty. Therefore, it lacks enforcement mechanisms necessary to ensure compliance among regime members. Despite proposals from the United States to tighten up the MTCR guidelines, few nations have shown a willingness to do so for fear it will undermine the ability of a nation's companies to effectively conduct international trade.

Over the last three years, numerous newspaper articles have appeared on the growing illegal and covert transfer of WMD technology and their delivery systems from China, Russia, North Korea, Ukraine and others to rogue states. As the world becomes more intertwined economically, the ability to control this proliferation will become even more difficult. In recent Congressional testimony, the Director of the CIA stated that "the chilling reality is that nuclear materials and technologies are more accessible now than at any other time in history . . . . This problem is exacerbated by the increasing diffusion of modern technology through the growth of the world market, making it harder to detect illicit diversions of materials and technologies relevant to a nuclear weapons program."[23] The same is true for chemical and biological weapons programs, which are easier and less expensive to develop than a nuclear program.

The administration's track record for cracking down and imposing sanctions on key proliferators is not very good. There has been a willingness to crack down on the so called "rogue states" of North Korea, Iran, Libya and Iraq. However, when it comes to proliferators such as Russia and China, the administration has gone out of its way to play down the issue in order not to undermine political and trade relations with those countries. By doing so, the administration has, in effect, given a green light that trade and other issues are more important than stopping proliferation. Unless the United States is willing to take a hard stand with Russia and China, WMD proliferation will not end.

The proliferation problem will always be difficult to solve because "there is no single motive that explains the proliferation decisions of every country. Likewise, no single policy prescription will address every motive."[24] For example, a remarkable description of how committed and successful a rogue state can be in pursuing and acquiring WMD technology can be found by examining what United Nations inspectors found in Iraq after the Gulf War. David A. Kay, a chief inspector on three early UN inspections of Iraq's nuclear program, stated that "the failed efforts of both the International Atomic Energy Agency (IAEA) safeguards inspectors and national intelligence authorities to detect prior to the Persian Gulf War a nuclear weapons program of the magnitude and advanced character of Iraq's, should stand as a monument to the fallibility of on-site inspections and national intelligence when faced by a determined opponent."[25] Even after 5 years with the world's most intrusive inspection regime in place, there is still no full accounting of Iraq's WMD program and whether or not it was permanently destroyed or is hidden away for future use. If Iraq can remain this deceptive, does anyone really believe a full accounting or control over proliferating WMD programs can be made in other closed societies such as Iran, Libya and North Korea?

While the United States will have some success in slowing down WMD proliferation, the reality is that WMD technology and their delivery systems will continue to expand at a rapid rate. Therefore, it would seem the administration's first line of defense -- prevent and reduce the proliferation threat -- will not be successful over the long run.

Deterrence

If WMD proliferation cannot be stopped, the administration will turn to its second line of defense -- deter the threat. Keith Payne, an expert on deterrence theory, stated that ". . . the proliferation of weapons of mass destruction (WMD) and advanced missile systems is causing us to take increasing notice of regional powers . . . the question of how to deter 'rogues' armed with WMD will require our attention whatever our nonproliferation efforts and successes: some countries will see great value in WMD and their means of delivery and persevere until they have acquired them. . . . how to deter such countries may only pique our interest now but it will become paramount in the future."[26] In April 1996, the Secretary of Defense stated: "the bad news is that in this era the simple threat of retaliation that worked during the Cold War may not be enough to deter terrorists or aggressive regimes from using nuclear, biological, and chemical weapons."[27]

The deterrent value of nuclear weapons and effective threats of retaliation are usually based on the belief that one is dealing with a rational adversary who understands and realizes the consequences of his actions, especially when it comes to WMD use.[28] During the Cold War, U.S. and Soviet leaders fully understood the consequences of a conflict between two superpowers -- whether it be conventional or nuclear. Now that the list of potential adversaries is growing, it is unlikely the United States will always face a rational leader in a regional crisis.

Therefore, the effectiveness of the United States nuclear arsenal as a deterrent in the future may become questionable for a variety of reasons: "First, enemy leaders might believe the US and its allies lack the will to win a regional conflict if confronted with the possibility of horrific losses from WMD attack. . . . Second, adversary leaders might misread the degree of political support or political courage possessed by the US president . . . Third, adversary leaders might operate in a world of their own, surrounded by yes-men and cut off from realistic intelligence about the US, its allies, and their intentions. . . . Fourth, some adversary leaders might have such a different worldview or set of values that they would not be deterrable . . . Finally, deterrence assumes that state leaders can control their subordinates. . . ."[29]

If Desert Shield/Desert Storm proved nothing else, it left a lasting impression on other third world countries that you cannot engage the United States in a conventional ground war and win. It was reported after the Gulf War that India's Army Chief of Staff was quoted as saying "never fight the US without nuclear weapons."[30] This may help support why so many third world states are seeking WMD and their delivery systems as a counter balance to U.S. conventional superiority. It may only take the threatened use of WMD to deter the United States and its allies from entering into a future regional conflict. While the United States was successful in deterring Iraq from using its WMD arsenal during the Gulf War, there is no consensus on exactly how or why Iraq was deterred. But what is clear, is the failure of the United States to deter Iraq from invading Kuwait in the first place.[31] It would seem the administration's second line of defense -- deter the threat -- may not prove successful in all cases.

The ABM Treaty

The administration's third line of defense -- defend against the threat -- is dependent on the ability to pursue adequate active and passive defenses. However, the ability to pursue active defenses is impacted by the 1972 ABM Treaty between the United States and the former Soviet Union.

The premise of the treaty was "that defensive systems are inherently destabilizing: if a country deploys effective defenses against ballistic missiles, it could launch a first strike with impunity because whatever retaliatory enemy forces survived the attack would be no match for the attacker's defensive systems. By limiting defensive systems, the ABM Treaty thus reduced the imperative for rapid growth in offensive systems necessary to overwhelm missile defenses."[32] The belief under this premise was that by reaching a state of strategic stability, the sides would then be able to move towards efforts to limit and reduce levels of offensive nuclear weapons. In reality, the ABM Treaty failed to stop the arms race. Even though offensive arms levels increased rapidly after the ABM Treaty's signing, the treaty did form the foundation for follow on arms control agreements (INF, START, CTBT Extension, etc.) that started the process of reducing strategic arms.

With the end of the Cold War; the demise of the Soviet Union; the death of 28 U.S. soldiers by an Iraqi scud missile during the Gulf War; and WMD proliferation, the debate resurfaced over the continuing value of the ABM Treaty in the post-Cold War environment. This was especially true since key provisions of the treaty prevented the deployment of certain types of missile defenses. For example: Article I prevents each party from deploying ABM systems for territorial defense or the basis for such a defense. Article II, as amended by the 1974 Protocol, limits deployment of an ABM system to 100 ABM launchers at one site designated by each party (Moscow for USSR/Grand Forks ICBM field for the United States). Article V prohibits air-, sea-, space- or mobile land-based ABM systems. Finally, Article VI (a) prohibits giving systems other than ABM systems capability to counter strategic ballistic missiles or to test them in an ABM mode.[33]

"The future of the ABM Treaty must be considered in the broader context of long-term U.S. national security planning. . . . the way ahead for the United States . . . could have far reaching implications for U.S.-Russian relations, and more specifically, for U.S.-Russian weapons' disarmament and nuclear restructuring. But, contending assessments of where the greater danger lies -- in rogue actors acquiring an ICBM capability or in a remilitarized Russia . . . "[34] is key to resolving the NMD debate and the determination over whether or not the ABM Treaty should be abrogated, maintained or amended.

a. Abrogating the ABM Treaty. This view is supported by many members of the Republican controlled Congress who have placed a high priority on developing missile defenses. Representative Floyd Spence best summarizes the Republican position: "As for the stated concern that deploying a defense against ballistic missiles could threaten the ABM Treaty, it would seem that the administration is more concerned with preserving antiquated Cold War arms control agreements than with ensuring the security of the American people against post-Cold War threats. In fact, the ABM Treaty was signed 24 years ago with a country that no longer exists under political and military conditions that no longer apply . . . The notion of consciously remaining vulnerable to ballistic missile attack as a matter of national security is as inconsistent with U.S. security interests in the post-Cold War world as it was more than two decades ago."[35]

b. Maintaining the ABM Treaty in its current form. This view is supported by arms control advocates who see the treaty as the cornerstone of strategic stability. Without the treaty, ". . . the large-scale deployment of anti-ballistic missile systems would undermine efforts to shrink strategic arsenals and could even provoke the United States and Russia to increase strategic offensive forces to overcome any perceived threat to their retaliatory capability. A freeze or reversal of the strategic nuclear arms reduction process would, in turn, have a highly negative impact on the attitude of non-nuclear-weapon states toward international nuclear non-proliferation efforts."[36]

c. Amending the ABM Treaty. While the Clinton Administration supports the treaty as the cornerstone of strategic stability with Russia, it has shown a willingness to clarify the treaty when it comes to the development of theater missile defenses. Despite criticism from the other two schools of thought, the administration has been negotiating with Russia since November 1993 to clarify aspects of the ABM Treaty in order to develop and field highly capable TMD to counter third world WMD threats. However, when it comes to Congressional NMD efforts, senior administration officials have stated: ". . . the ABM Treaty needs to be updated to take account of changes in the international security situation, particularly with regard to theater missile defense. . . . we do not . . . see any requirement to amend or modify it to permit a national missile defense that otherwise would not be possible . . . ."[37]

Therefore, it would seem the administration's third line of defense -- defend against the threat -- will be impacted unless the ABM Treaty is modified to allow for deployment of a NMD system.

Why NMD?

Deploying NMD is like having car insurance.[38] It would be nice if you didn't have to buy car insurance until the night before you were going to have an accident. It would also be nice to know with exact certainty when a specific WMD threat would arise so that NMD could be deployed in time to meet that threat. Unfortunately, things don't work out that way. We have to buy car insurance because we don't know exactly when or if we will be involved in an accident. The same is true when it comes to WMD.

Senator Charles S. Robb stated that "history has shown repeatedly that the next major threat can be difficult to predict. Preparation for modern conflict involves major new weapon systems that can take more than a decade to develop and produce -- but the United States has seldom identified potential adversaries in time to permit orderly planning and preparation for war."[39]

The administration's active defense policy of "3+3" does not provide adequate insurance against the WMD threat. Under this policy, the "plan is to develop elements of this system over the next three years. Then, at that point, if we were to see a rogue threat emerging, we could construct this system and have it on site in another three years -- that is, by the year 2003. If, as we expect, we see no such threat emerging, we will continue developing and improving the technologies, all the while retaining the capability to have the system up and running within three years of a decision to deploy. That way, we will be ready and able to field the most advanced system possible to counter missile threats to our nation as fast as they emerge."[40]

The problem with this policy is that it assumes: 1) a WMD threat can be identified in time to make the right deployment decision; 2) the acquisition process will be able to move NMD from R&D to deployment within three years; 3) the R&D process will be able to make a technological breakthrough over the next several years that will make the current approach to missile defense (i.e. missile against missile) obsolete; and 4) negotiations with the Russians are possible and will be successful in modifying the ABM Treaty or other arms control agreements to accommodate NMD deployment requirements.

In reality, it will be extremely difficult to satisfy all these conditions in order to implement the "3+3" NMD approach. First, if rogue states are already undertaking actions to build covert WMD programs, it is very unlikely the timeline for such programs can be assured with any degree of accuracy to make a timely deployment decision. Therefore, it will be difficult to gain intelligence community and interagency consensus on whether an evolving WMD threat is of such a magnitude to warrant a NMD deployment decision. Second, despite efforts by the administration to streamline the acquisition process, it is unlikely it will be reformed in a manner that will substantially reduce the trend that it takes decades to adequately field a major new weapons system. Third, it is unlikely that a major technological breakthrough will take place that will alter the current approach to missile defenses. Planned TMD systems are being developed based on "hit to kill" technology and other SDI technology of the 1980's. In turn, TMD technology will form the foundation for NMD options. Therefore, no significant technology breakthrough is expected any time soon. It is often forgotten that "one of the complicating factors in Defense budgetary planning is that the time horizons are so distant. It is useful to recall that the systems that performed so well in the Persian Gulf largely represented the technology of the 1960's, the development of the 1970's, and the production of the 1980's - all utilized by the people of the 1990's."[41] Lastly, it is unlikely to assume that efforts to modify arms control agreements with Russia can be accomplished quickly. Historically, negotiations between the United States and the Former Soviet Union have been very complicated and taken years to complete. For example, the current ABM/TMD demarcation negotiations with the Russians to clarify fielding of TMD systems under the ABM Treaty have been on going since November 1993 with no accord in sight. If a new NMD agreement is needed, it will have to be completed and ratified before the process of fielding NMD can take place. If the negotiation process is not started well in advance of a NMD deployment decision or until a WMD threat arises, the only option available to the United States would be to withdraw from various arms control agreements with Russia.

Recommendations

"Active defenses stand to play a central and vital role in U.S. defense planning well into the next century. . . . these systems will have a significant impact on our ability to send forces abroad in defense of our national interests, and may even be called upon to defend the United States itself from missile attacks . . . ."[42]

To effectively counter the WMD threat, the administration must revise its policy and take the initiative and opportunity to move the United States away from a policy that leaves the American people open to direct attack by WMD to one that ensures security. First, the United States should execute its right under the ABM Treaty to deploy a limited land-based missile defense system at Grand Forks, North Dakota just as the Russians have done around Moscow.[43] Second, the administration should open immediate negotiations with Russia to modify the ABM Treaty to allow for the deployment of a multi-site NMD using land, sea, air or space-based options as necessary. Third, to ensure stability in the bilateral relationship, the United States may want to restart efforts to work jointly with Russia on NMD programs such as the Global Protection System (GPS) and Global Protection Against Limited Strikes (GPALS) proposals of the 1980's. Fourth, if the Russians are unwilling to negotiate changes to the ABM Treaty or participate in joint NMD development, the United States should execute its right to withdraw from the ABM Treaty in order to deploy NMD.

Even under the worse case of withdrawing from the ABM Treaty, the fear of a new arms race and instability with Russia should be minimal. Even though the Russians will complain a lot, once they realize that the United States is serious about NMD deployment, they will want to participate in the process in order not to be left behind. Both countries have already experienced the devastating consequences of an arms race. It is unlikely a new one will start.

Instead, NMD will be linked to other issues such as START III, NATO expansion and changes in the Conventional Forces Treaty (CFE). Solutions in these areas will allow both sides to address each other's security concerns with NMD. These efforts will eventually help the sides transition from a reliance on offensive weapons to one of defensive systems,[44] thereby, moving the sides away from mutual assured destruction to mutual assured safety.[45]

Since such a process will be time consuming, the United States must not lose focus on the threat from rogue states and their WMD. The scale and pace of any process to appease and negotiate with the Russians must be dependent on the pace of the evolving threat. Regardless of how or when the final decision on NMD is made, preparations for deployment must, as a minimum begin now. The United States cannot wait until the threat arrives before it begins to lay the groundwork for NMD deployment.

Conclusion

If the United States is going to pursue a national security strategy of "Engagement and Enlargement," decision-makers must accept that WMD proliferation will impact the ability of United States to operate and influence events in many regions of the world. "Unlike classical force planning against a hostile nation with conventional forces, coping with weapons of mass destruction is a complex issue, and the tools we have at our disposal are imperfect. Motivations . . . to develop an arsenal of weapons of mass destruction differ from region to region and from country to country."[46] Therefore, the clean, quick victory of Desert Shield/Desert Storm is part of the past and is not necessarily a road map for success in the 21st Century. The proliferation of high technology for WMD development and their delivery systems along with the reduction in the size and capability of U.S. military forces will result in some rogue states believing they can effectively challenge and deter U.S. involvement in a regional conflict.

While the Clinton administration has instituted a three part line of defense to deal with WMD proliferation, it doesn't go far enough. Even the Secretary of Defense has admitted problems with the current policy stating that ". . . preventive measures have reduced the threat from proliferation, but proliferation threats, like cancer, can sometimes elude preventive measures. So we need a second line of defense and that . . . is deterrence. . . . but the reality is that the simple threat of retaliation may not be enough to deter some rogue nations . . . from using these weapons. Thus, we cannot always rely on deterrence: we must be prepared to defend ourselves."[47]

Decision-makers must reevaluate the WMD threat, the value and role of U.S. deterrent capability .o deal with limited threats and the continuing value of Cold War arms control agreements that are not flexible enough to address a changing world environment. "Other nations must not be led to doubt either our strength or our resolution. For how others see us determines the risks they are prepared to run and the degree to which they are willing to place confidence in our policies. If adversaries consider us weak or irresolute, testing and crises are inevitable."[48]

Pursuing "ballistic missile defense is a critical component of the broad U.S. strategy to meet ballistic missile threats to U.S. forces and allies in a theater and to the United States. . . . Effective missile defense systems reduce the incentives for proliferants to develop, acquire, or use ballistic missiles and WMD by reducing the chances that an attack would inflict serious damage on U.S. or allied targets."[49]

Yes, the time has come to put into place an insurance policy that allows for NMD deployment now to ensure that when the WMD threat arises, the United States will have in place some form of national defense for its home territory. If we wait until the threat arises, it will be too late. History has shown repeatedly that the United States generally underestimates its opponents and is usually taken by surprise by an adversary's initiative and determination, regardless of the costs. When it comes to WMD, the United States cannot afford to be taken by surprise. When it comes to NMD deployment, we must remember that ". . . the decisions we make today will to a considerable extent determine the casualties we will suffer in carrying out our national security objectives in the next century. This is a very great responsibility that must be borne by all of us who have fiduciary responsibilities for national security."[50]

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DOCUMENT 2

Report of the Defense Science Board/Policy Board Task Force on Theater Missile Defense

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Defense Science Board

Washington, DC

REPORT

OF THE

DEFENSE SCIENCE BOARD/DEFENSE POLICY BOARD

TASK FORCE

ON

THEATER MISSILE DEFENSE

JANUARY 1996

Office of the Secretary of Defense
Washington, D. C 20301-3140

This report is a product of the Defense Science Board (DSB) and Defense Policy Board (DPB). The DSB/DPB is a Federal Advisory Committee established to provide independent advice to the Secretary of Defense. Statements, opinions, conclusions and recommendations in this report do not necessarily represent the official position of the Department of Defense.

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OFFICE OF THE SECRETARY OF DEFENSE

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MEMORANDUM FOR THE SECRETARY OF DEFENSE

THROUGH: UNDER SECRETARY OF DEFENSE (ACQUISITION AND TECHNOLOGY)
UNDER SECRETARY OF DEFENSE (POLICY)

SUBJECT: Report of the Defense Science Board (DSB)/Defense Policy Board (DPB) Task Force on Theater Missile Defense (TMD)

We are pleased to forward the final report of the DSB/DPB Task Force on TMD, co-chaired by Ted Gold and Dave Jeremiah. The Task Force had a broad charter to review DoD's TMD policies, plans and programs, and its comprehensive report addresses threat issues, arms control considerations, organizational options and program priorities.

The report highlights the progress that the Task Force found in TMD since the Gulf War, but also raises concerns about current deficiencies. The Task Force addressed the problem of coping with uncertainties about the future threat. Its sensible recommendations about threat modeling, red teaming and hedging are not limited to TMD, but applicable to much of DoD's development activities.

The Task Force also tackled the controversial subject of the ABM Treaty and its effect on theater missile defenses. Subsequent to its interim report, which expressed strong concerns about the demarcation path the US was on, the US has modified its course which now may be closer to the Task Force's recommendations. The Task Force remains concerned, and recommends energetic involvement by Policy and Acquisition leadership to overcome the tendencies to establish unnecessary ceilings on TMD system performance.

A particularly serious deficiency identified by the Task Force is the lack of a strong and knowledgeable joint voice in the TMD development process. The Task Force also noted the absence of a joint TMD architecture integrating both cruise and ballistic missile defenses. The Task Force's recommendations to redress these deficiencies include making USACOM a major player in the development of the TMD architecture. We endorse the Task Force's vision of the objective for TMD: to provide some protection of diverse assets against a variety of threats rather than aiming for perfect protection against one (or a few) threats. We also share its concern about the COEA; massive studies obscure rather than illuminate.

The Task Force was concerned that there will not be sufficient funds to field all the systems as proposed, but, at least in the near term, resources can be rearranged to fund their legacy systems and adequate development for the longer term. A more robust threat will generate future resource shifts if necessary.

We support the findings of the Task Force and believe that its recommendations deserve favorable consideration. We also believe that this effort confirms the value of joint DSB/DPB studies (it was only the second such effort). We would thus be pleased to collaborate in other areas where policy and technology intersect.

Dr. Craig Fields
Chairman, Defense Science Board

Dr. Harold Brown
Chairman, Defense Policy Board

OFFICE OF THE SECRETARY OF DEFENSE

WASHINGTON, D.C. 20301

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD
CHAIRMAN, DEFENSE POLICY BOARD

SUBJECT: Report of the Defense Science Board (DSB)/Defense Policy Board (DPB) Joint Task Force on Theater Missile Defense

Attached is the final report of the DSB/DPB Task Force on Theater Missile Defense (TMD). Significant TMD policy, budget and program initiatives were undertaken during our deliberations, and thus we make no pretense at having kept up with these moving targets. The report, reflecting guidance the Task Force received when we delivered an interim report last year, focuses on four topics: coping with uncertainties about futures paths of the theater missile threat, demarcation between theater and strategic missile defenses, meeting the challenge of developing joint TMD, and lastly, setting priorities for specific TMD programs and projects.

The term theater missile belies its import. They are not just another combined arms battlefield weapon. The motives of potential adversaries to possess these weapons are decidedly strategic. They offer a relatively low cost way to threaten population centers and critical military targets like ports and other points of entry in order to coerce neighbors, breakup coalitions and deter US military involvement in their region. They can raise the stakes even higher when they carry chemical, biological or nuclear payloads. The gravity of this threat requires that continued special attention be given to efforts to counter it.

First the good news. The Task Force found much progress since the Gulf War: some improvements already in the field, much more in development, greater involvement by the warfighters, more joint exercises, a comprehensive doctrine for joint TMD.

One feature of the new security landscape -- greater uncertainty about future threats -- presents a great challenge to planning and executing acquisition programs. To meet this challenge, (not unique to the theater missile threat), the Task Force recommends that the intelligence and acquisition communities modify the current threat "validation" process. We prescribe a much greater role for threat modeling and red teaming including an expansion of the sort of skunk works red team that BMDO has underway at the Air Force's Phillips Laboratory. We also recommend more use of hedge programs and other means designed explicitly to deal with uncertainty and surprise.

Compliance criteria for the ABM Treaty, which itself does not limit TMD systems, never-the-less presents the issue of distinguishing theater from strategic ballistic missile defenses. The Task Force expressed strong concern in our interim report that the US was proceeding down a demarcation path that would severely restrict TMD performance. Our concerns included restraints and inhibitions imposed against the use of external sensors and a compliance mentality that resulted in unnecessarily severe restrictions on TMD performance. Subsequent events, including initiatives by the DoD and the May 1995 Clinton/Yelstin Summit Statement, provide a framework to allow much more effective TM defenses consistent with the principles of the ABM treaty. Policy and Acquisition leadership will be needed to make this happen since implied limitations on performance and the use of external sensors remain.

TMD is inherently a joint mission. The Task Force found a vision of joint TMD promulgated by the Joint Staff (in Joint Pub 3 - 01.5) but no joint TMD CONOPS nor complementary comprehensive approach on the developer's side. We did not find a joint architecture which integrates defenses against both ballistic and cruise missiles (nor integrates both into theater air defense). Future CINCs will need such an architecture and we should not count on their being able to kluge one together during a crisis.

To remedy this situation we recommend several steps. Some of these may be controversial, for example, making USACOM a central player in the creation of an overall joint TMD architecture and assigning BMDO additional responsibilities for the development of active defenses against land attack cruise missiles. However, *any* attempt to strengthen the joint voice will likely engender opposition and in any case there will eventually be a high price to pay for continuing the current arrangement. We recognize that TMD is a complex undertaking with each service promoting its own programs and policies. The key to creating and maintaining effective capabilities is to have a single overall vision for TMD, a vision that is grounded in the joint environment and designed for joint (and coalition) warfighting conditions.

The report includes a discussion on how much defense is enough (we conclude that practical and far less than perfect defenses offer considerable value) and raises our concern about the affordability of all the active defense systems in development. The Task Force is also concerned about advanced submunitions and other countermeasures to descent phase ballistic missile defense systems but did not find a coherent and implementable boost phase program in place to counter these threats. The Task Force is particularly enthused about the potential of the advanced airborne radar sensors under development in ARPA to contribute to much more effective cruise and ballistic missile defenses and we also recommend more attention to joint C3 and passive defenses. The report includes other findings and recommendations regarding testing, intelligence collection against real targets, attack operations and the COEA process.

We greatly appreciate the time and effort put in by Task Force members, government advisors and support staff. It has been a pleasure to work with this talented group.

Theodore Gold

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Co-Chairman

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DSB/DPB TASK FORCE ON TMD

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TASKING

Tasking

The Defense Science Board /Defense Policy Board (DSB /DPB) Task Force had a broad charter to review US theater missile defense (TMD), including purpose, threat, plans and programs. The Terms of Reference are shown in Appendix B. Deliberations began in February 1995.

The Task Force, after delivering its interim report in March 1995, received additional guidance from the Deputy Secretary of Defense to focus on:

- the threat projection process
- the Anti-Ballistic Missile Treaty (ABM) and TMD
- the Joint role in TMD requirements and acquisition processes
- setting priorities for the non-core TMD programs

The Task Force was not asked for recommendations on national missile defense.

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General Observations

This report focuses on problems and deficiencies in the TMD program. However, the Task Force also found that the TMD program has made substantial progress in the past several years. We begin by citing examples of this progress before turning to the problems.

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General Observations

1. **There has been considerable progress in the TMD program since the Gulf War** (also since the last DSB/DPB TMD study in 1991)

- **Funding for TMD increased more than tenfold to >$2 billion**
  - as BMDO emphasis shifted from national to theater defenses
- **Improvements to Gulf war capabilities are being fielded**
  - upgrades to PAC-2, Hawk, Space Sensor support
- **More involvement by CINCs**
  - including BMDO's CINC exercise program
- **Recent Joint exercises:**
  - including JTF95, Roving Sands
- **More substantial capabilities in development**
  - PAC-3; Navy Area Defense (SM-2 BLK IVA, formerly Navy Lower Tier); THAAD; Navy Theater Wide Missile Defense (formerly Navy Upper Tier)
  - initial deployments in late 90s
  - some effort on other advanced concepts
- **Technology programs aimed at cruise missile threat**
  - addressed in 1994 DSB Cruise Missile Defense Study
- **Doctrine for Joint TMD (JTMD) published (Pub 3-01.5)**
  - articulates comprehensive vision of TMD

General Observations

2. In Spite of the Progress We Have Concerns About What Is Missing

- **An integrated requirements and development approach to joint theater air and missile defense**
  - it is too much to expect future Joint Force Commanders (JFCs) to kluge together an effective JTMD during a crisis
  - insufficient priority and resources for JTMD C^4I

- **Capability for timely response to plausible emergence of land attack cruise missile threat**
  - although some progress since 1994 DSB Cruise Missile Defense Study

- **Coherent Boost Phase Intercept (BPI) solution to submunitions, and other countermeasures to descent phase intercept**
  - need a viable early deployment option

- **Enough testing and data collection**
  - needed to ensure robustness of hit-to-kill systems
  - too much hubris about models/simulations (e.g., Cost and Operational Effectiveness Analysis(COEA))

- **Sufficient intelligence collection on threat missile characteristics**
  - both radar and infrared

- **Coordination of efforts to improve attack operations**
  - however, finding mobile launchers will remain a very difficult problem

- **Integration of passive defense into TMD**
  - particularly important for chemical/biological warfare (CBW)

General Observations

3. We Also Have Concerns About What Is Amiss

- **US has been on an ABM Treaty demarcation path that could substantially limit TMD capabilities**
  - Clinton/Yeltsin Summit statement and recent Congressional actions may reflect new course

- **A threat projection process preoccupied with observation**
  - a major problem that is not unique to missile defense
  - need more attention to improving ability to anticipate (and shape) future threats beyond the time horizon of current hard data

- **A requirements driven acquisition process that misses opportunities for affordable and useful concepts**
  - also not unique to missile defense but problem exacerbated in ballistic missile defense arena by appetite for "complete" solutions and very low leakage

- **A Capstone TMD COEA which may not yield desired insights of critical issues**
  - scenarios drive results out of proportion to confidence in any ability to foresee the real future

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Findings and Recommendations

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The dimensions of today's theater missile (TM) threat appear to be understood at the senior levels in DoD. Therefore, we will not detail the threat specifics (developers, possessors, characteristics), but instead only briefly touch on the nature of the TM threat, including both it's ballistic and cruise missile variants, and the future paths it may take.

We then focus on the problem and process of projecting threats to guide acquisition efforts in these uncertain times and offer several recommendations, some broadly applicable to DoD.

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The Nature of the Theater Missile Threat

TMs pose a growing danger to US ability to project military power and deal with major regional contingencies

- raises the risks and costs of US intervention
- could be show stopper

TMs appeal to regional and "wannabe" powers as strategic weapons to:

- intimidate neighbors
- deter super power (US) intrusion in their affairs by raising price, coercing coalition partners

For these purposes, TMs are less expensive, more survivable and penetration capable than manned aircraft.

TMs can be effective terror weapons against cities, even if inaccurate and armed only with conventional warheads. TMs become more dangerous yet with nuclear, biological, and chemical (NBC) warheads often categorized collectively as weapons of mass destruction (WMD). In fact these warhead types pose quite different threats, with the chemical warhead being far less dangerous than the other two.

Military targets in theater vulnerable to missile attack include sea and air points of debarkation (PODs), and other large fixed logistic nodes:

- in Gulf War: two sea PODs received over 95 percent of sea cargo; five air PODs handled almost 80 percent of air cargo

We include Unmanned Air Vehicles (UAVs) along with ballistic and cruise missiles, as part of the theater missile threat. UAVs can be used:

- for reconnaissance and targeting to increase US casualties
- more ominously, as platforms to deliver biological warfare (BW) agents (even small BW payloads can be lethal over large areas)

The Theater Missile Threat: Possible Paths

- Today's threat is mostly relatively short-range ballistic missiles and ship-attack cruise missiles
- Also already here, or coming soon, are longer-range Theater Ballistic Missiles (TBMs), land-attack cruise missiles, Unmanned Air Vehicles (UAVs), and penetration aids for all missile types

SCUD type TBMs and anti-ship cruise missiles are widely proliferated.
- world wide totals of tens of thousands
- dozens of possessor nations

Longer-range TBMs have been shipped from China to the Middle East and more are under development (e.g., by North Korea).
- increases strategic reach (more targets for coercion) and survivability (more space to hide)

There is considerable uncertainty about the future path of the TM threat but there are several possibilities for which we must prepare.

We must expect countermeasures to our defense deployments
- advanced submunitions could be particularly stressful
- also maneuvering, decoys and other penetration aids

The land attack cruise missile threat — including low observables — could emerge rapidly
- potential adversaries have motives and means (low cost, survival and penetration features, availability of technology and systems)
- will also present US with combat identification (CID) and fratricide problems that were not present in Desert Storm
- very low observable (VLO) variants later

A major regional adversary could afford thousands of TMs
- Iraq's small-scale (88 launches) use may not be future model
- e.g., Germany launched approximately 20,000 V-1s (cruise missiles) and V-2s (ballistic missiles) during the period from June, 1944 to March, 1945

While the characteristics of future TM threats can be broadly sketched, the uncertainties, particularly questions of "when is the threat?" pose daunting challenges to program planning.

Threat Projections and the Acquisition Process

- The acquisition and intelligence communities have yet to tailor processes for threat projection to the circumstances and greater uncertainties of the new security environment
- A greater role is needed for a disciplined process of analysis and threat modeling
- The community needs to recognize that observed threats, reactive threats, and technologically feasible threats are all components of a "validated" threat

Everyone acknowledges that the threat is more uncertain and threat projection more difficult in the post-Cold War world. Instead of a single threat following familiar acquisition practices, we must now worry about a diverse set of nations and motives, possibly on steep (and thus rapidly changing) learning and acquisition curves for military technologies, using nonstandard acquisition practices, and we must do this with fewer intelligence resources.

This situation affects the roles of evidence and model-based threat projections

- increasing danger of limiting projections to "observed threats"
- absence of evidence is not evidence of absence today or in the future

Goal should be to improve our ability to anticipate — not merely observe — serious threats, in order to:

- guide collection efforts: e.g., potential adversaries' Science and Technology (S&T) infrastructure becomes a more important collection target
- develop hedges: prepare to respond in much less than typical US acquisition timelines
- shape the future threat: US initiatives, programs and demonstrations may help dissuade and deter

Directives (DIA Regulation 55-3) are in place which call for identifying reactive and technologically feasible threats along with the evidence based or observed threat projections

- however, the execution has been uneven at best
- there is strong bias against reactive and technologically feasible threats — the baseline threat is usually the evidence-based or observed threat

A greater role for model-based threat projections must be embodied in a more disciplined process to avoid their own set of dangers: threat exaggeration and multiplicity (the latter can lead to a "threat of the month" environment and program disruption).

Threat Projection and the Acquisition Process (cont.)

- BMDO has a Red Team effort in place to identify reactive and technologically feasible countermeasures to our theater ballistic missile defense

- However, Red Team activities and results are not adequately integrated into the TMD program, and are not yet used as a tool to help manage the overall TMD program

A Red Team Skunk Works effort was:
- established in 1993 in response to a DSB Task Force recommendation and
- includes a small but impressive "Countermeasure Hands-on Skunk Works" (at the Air Force Philips Laboratory)

The Red Team effort (including Skunk Works) has begun to work with respect to advanced submunitions
- identified a serious threat
- demonstrated (designed, built, flown) in experiments
- coordinated effectively with intelligence community
- brought this threat to the attention of senior decision makers

Dealing with Uncertainty and Surprise

Uncertainty and surprise are inevitable
- can exist in threat, defense mission, scenarios, environments and wartime defense performance
- need to attempt to reduce the uncertainties and prepare to deal with surprises arising from the inevitable remaining uncertainties

Ways to reduce uncertainties

Strengthen collection efforts against real targets and effect a closer coupling between intelligence collection, especially Measurement and Signature Intelligence (MASINT), and system design. Design more robustness and graceful degradation into systems — to stay farther away from "known" performance "cliffs" and to hedge against uncertainties, both in where cliffs are and other unknowns.

Test over a wider range of threat possibilities, environments and system performance parameters.

Dealing with surprises from inevitable remaining uncertainties

Systematically assess possible surprises and develop hedges and responses/adaptations, ranging from Pre-planned Product Improvement (P^3I) to pre-planned near-real-time adaptation during war.

Pursue ACTDs specifically as hedges against threat uncertainties.

Develop approaches for near-real-time adaptation during missile-defense campaigns, which may last days or weeks (or longer). For example:

- design system sensors to diagnose engagements, not just conduct them (i.e., view system sensors as real-time MASINT collectors)
- record all sensor data and arrange for it to be rapidly analyzed
- arrange to have design engineers on standby in the continental US (CONUS) (and in theater) during campaigns to help assess situation, design adaptations
- selectively engineer software so that it can be rapidly modified during a campaign
- develop pre-planned software alterations

Pay for more robustness and pre-planned adaptation features by accepting (somewhat) less performance in the nominal design regime.

Threat Projection Support to the Acquisition Process: Recommendations

Define a new process and framework for managing threat projections to avoid the problems of too much dependence on either evidence- or model-based projections. As illustrated in Figure 1, a range of potential threats should be identified:

- based not only on what the adversary has been observed to do, but also what technology and expense would allow him to do
- emphasize threats which could substantially degrade US capabilities with reasonable ease whether or not there is current evidence of such an effort

A ZEROTH ORDER STRATEGY FOR
DEALING WITH A RANGE OF POSITED ADVERSARY
COUNTERS/RESPONSES/EVOLUTIONS

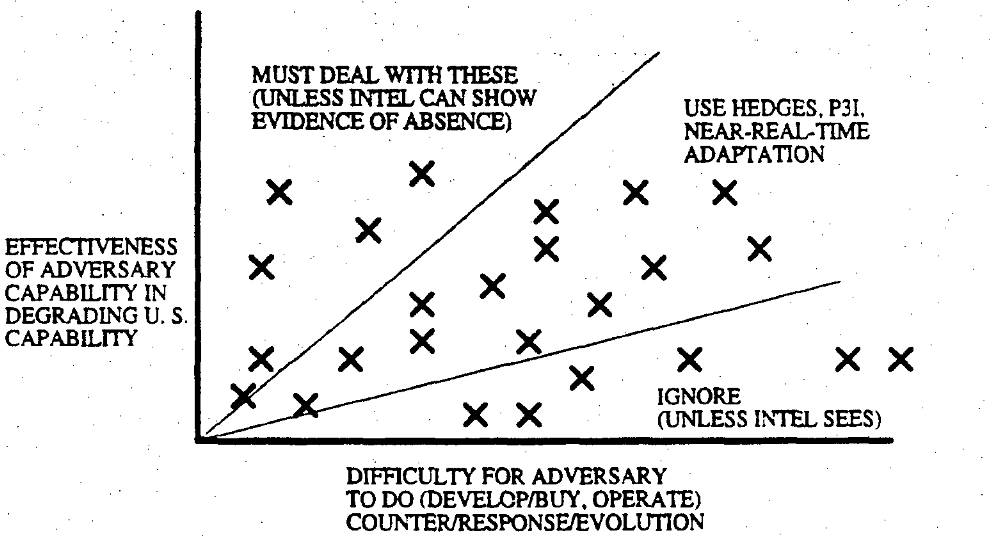

Figure 1

Threat Projection Support to the Acquisition Process: Recommendations (cont.)

- In order to implement this process, a stronger technology projection and threat modeling capability should be developed jointly by the Acquisition and Intelligence communities
  - should involve Red Teams to identify threats (feasibility/cost) and Red/Blue interactions to assess relative effectiveness
- The process should have a broad architectural perspective and not overly focus on vulnerabilities of individual programs
  - all systems have vulnerabilities; there is a need to identify cross-cutting vulnerabilities
- Funding for these activities should be the responsibility of both the Program Managers and DIA
- DIA should retain responsibility for overall quality control of the resulting restructured System Threat Acquisition Report (STAR) process; their technology analysis capability should be expanded
- Under Secretary of Defense, Acquisition and Technology (USD(A&T)) should issue direction requiring Red Team activity across the TMD problem
- USD(A&T) should also task BMDO to expand the charter of it's Red Team activities and provide resources to address both the ballistic and cruise missile threat — (in addition to continuing its TBM countermeasure modeling and experiments)
  - identify and categorize (in format of Figure 1) a range of potential ballistic and cruise missile variants: range, accuracy, RCS, penetration aids, etc.
  - complement with appropriate Skunk Works and other experiments
- The BMDO Director should
  - ensure the involvement of the program offices in assessing results of TMD Red Team activities and their implications for programs
  - issue an annual report of TMD Red Team and associated Red/Blue activity to USD(A&T), which:
    - — characterizes threats in difficulty/effectiveness space (Figure 1)
    - — describes strategy and status of programs to deal with set of threats
    - — addresses possibilities for surprise and plans/programs to deal with them

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The ABM Treaty does not restrict TMD systems per se. The problem is distinguishing theater defenses from ABM systems, which are constrained by the Treaty. We have been concerned that the US was proceeding down a demarcation path which would severely restrict TMD performance.

Subsequent events have changed that course, including the May 1995 Clinton/Yeltsin Summit Statement, which provides basic principles for a less restrictive approach to TMD consistent with the ABM Treaty.

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The ABM Treaty and TMD

- When we began this study, the Task Force found the US on an ABM treaty demarcation path that could severely restrict TMD performance
- Systems were technically constrained and opportunities for more robust and effective TMD were not being exploited
- The Task Force expressed these concerns in its March 1995 Interim Report

- **ABM Treaty does not limit TMD systems per se, but prohibits**
  - giving non-ABM systems capabilities to counter strategic ballistic missiles or their elements during flight
  - testing non-ABM systems in an ABM mode

- **What constitutes "strategic ballistic missiles," "capabilities to counter" and "testing in an ABM mode" are undefined.**

- **The demarcation approach we found would severely limit TMD performance by restricting interceptor velocities and inhibiting use of external sensors and sensor netting**
  - affects THAAD, Navy Theater-Wide defense, use of Cooperative Engagement Concept (CEC)
  - greater than <u>ten-fold</u> difference in defense coverage against certain threats
  - Treaty derived restrictions reinforced other obstacles to desired joint architecture
    - — integrating systems into JTMD difficult enough because of Service stovepipes
    - — Program Managers strive to stay as far away from perceived treaty boundaries as possible to protect their programs
    - — threshold parameters intended to trigger review become instead de facto performance ceilings

- **In evaluating TMD "capabilities to counter" strategic ballistic missiles, the US had focused not on the <u>demonstrated</u> capabilities of TBMD systems, but**
  - Tended to overstate capabilities by using theoretical capabilities (computer simulation based) to determine ABM compliance of TBMD systems in one-on-one intercept conditions, rather than force-on-force, in more realistic conflict settings
- **Included limits on capabilities not verifiable by National Technical Means (NTM)**
  - by contrast, as a historical matter, the US evaluated Soviet systems on demonstrated capabilities as discerned through our verification means (NTM)

The ABM Treaty and TMD: Interim Report Recommendations

- **The effort (upon which the Task Force was briefed) to negotiate, through the Standing Consultative Commission (SCC), a "demarcation line" between ABM and TMD systems was misdirected and should be abandoned**
  - it focused on imposing performance constraints on TMD systems (e.g., limits on velocities, use of external sensors) that would severely constrain both sides from meeting future theater ballistic missile threats
  - it would give the Russians veto power over a key US national security program designed to deal with critical non-Russian threats
  - it seeks to define a line that does not exist because even the most limited TMD system has some capability to counter strategic ballistic missiles

- **The DoD should take the lead in bringing the US government around to a different approach**
  - DoD has had responsibility for US compliance with the treaty since shortly after the ABM Treaty entered into force in 1972

- **Internal DoD guidance should be prepared to provide guidelines for development of TMD components and systems**
  - these guidelines should be based upon "demonstrated" capabilities, not on theoretical capabilities as determined by computer simulations
    - — demonstrated capabilities are those which can be verified by NTM
    - — this is the appropriate standard since the ABM Treaty is verified by NTM alone
  - the guidelines should provide that no US TMD system (or component) will be flight tested against a target missile with parameters in the flight test that are in excess of 5 km/sec velocity and 3,000-3,500 km range.
    - — US TMD systems that have not been so tested will not have been tested in an ABM mode and therefore will not possess the effective capability to counter strategic ballistic missiles that could realistically threaten the credibility of the Russian strategic nuclear deterrent

- **The DoD should identify a list of confidence building measures** (e.g., exchange of early warning or flight test data) and possibly also TMD technology projects or operational exercises which could be pursued with the Russians in conjunction with close US allies. These measures should not include:
  - limits on the configuration, number, deployments or geographical location of TMD systems
  - limits on TMD systems to use data from any source, including sensors external to the TMD systems itself, providing data directly to the interceptor missile

- **This approach builds on current US policy and is consistent with the principles behind the ABM Treaty and the post-Cold War relationship between the US and Russia**
  - two sides no longer openly threaten each other with nuclear destruction by means of ballistic missile attack
  - the TMD systems the US is developing and deploying are not directed at Russia but at defending against threats from other countries

- **These systems will not undermine the basic logic of the ABM Treaty**
  - ABM Treaty sought to reinforce deterrence by ensuring that neither side could use ABM systems to threaten the credibility of the other's nuclear deterrent
  - the TMD systems at issue will not pose a realistic threat to the Russian strategic nuclear deterrent

- **The proper agenda for Russia and the US is not to extend the ABM treaty to limit TMD, but to cooperate in TMD system development**
  - the Joint Statement points in this direction, stating that the two sides "...will consider expanding cooperative efforts in theater missile defense technology and exercises, study ways of sharing data obtained through early warning systems, discuss theater missile defense architecture concepts, and seek opportunities for joint research and development in theater missile defense"
  - a joint effort in this field could, like manned space flight, be an important common project for the two countries

The ABM Treaty and TMD: Current Status

Subsequent to the March Interim Report, DoD initiated actions which led to the May 10, 1995, Clinton/Yeltsin joint statement of principles which provided in part:

"Theater Missile Defenses may be deployed by each side which will not pose a realistic threat to the strategic nuclear force of the other side and will not be tested to give such systems that capability."

Under Secretary of State Lynn Davis and Deputy Minister Georgy Mamedov have developed a framework to guide the Standing Consultative Commission.

By establishing "*realistic* threats" and the "strategic nuclear *force*" as the standards, the joint statement provides a basis to develop and deploy more effective TMD consistent with the principles of the ABM Treaty. The Task Force also believes that the Davis/ Mamedov framework is useful in that it endorses a demonstrated test for determining whether TMD systems had ABM capability (i.e., demonstrated against targets with velocity greater than 5 km/second or ranges in excess of 3,500 km) as recommended by the Task Force. This will be helpful in dealing with the US "compliance community" issues which have dominated internal debate over the last several years. We remain concerned, however, that limits negotiated either with the Russians or derived from compliance decisions taken by the US Government will continue to be imposed on other TMD systems that have not demonstrated this capability.

As the Task Force understands the current situation, two concerns (higher velocity TMD systems such as Navy Theater-wide and external sensors) remain which can place significant limitations upon the continued development of TMD. Although the policy community is attempting to provide better definition which will permit development and deployment of highly effective TMD systems, the Task Force still sees evidence of a disconnect between policy objectives and compliance criteria. Parameter thresholds established for the sole purpose of triggering reviews of potentially ambiguous situations too often become performance ceilings as program managers strive to avoid perceived treaty boundaries in order to protect their programs. These actions by both program managers and the "compliance community" will continue to unnecessarily constrain effective TMD development until such time as either external or internal policy statements and directives make clearer which issues are outside the ABM limitations.

All members of the Task Force agree that the specific restrictions placed on intercept systems that have been historically imposed by the ABM Treaty can and should change as the overall security situation changes. All members also agree on the desirability of gaining the collaboration of Russia and China in restraining the proliferation of offensive missile capabilities. Some members argued further, that because of the legal and political role of the ABM Treaty as a condition for offensive constraint, and because all TBMD systems have some capability against strategic missiles, the broad conditions of TBMD deployments will have to be worked out with both Russia and China.

Organizing For Joint TMD

Tasking
General Observations
Findings and Recommendations
- Threat Projections; Dealing with Uncertainty
- The ABM Treaty and TMD

Organizing for Joint TMD

- TMD Programs/Activities

Summary of Findings and Recommendations
Appendices

TMD is inherently a joint mission, the success of which requires coordinated and integrated exploitation of active and passive defense and attack operations. This vision of JTMD is promulgated in a recent Joint Staff publication on JTMD Doctrine.

In this section, we identify institutional obstacles impeding the realization of this vision and offer recommendations on strengthening the joint voice in the TMD requirements and development processes.

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Joint Theater Missile Defense

- The Joint Staff has provided a vision of JTMD (in JOINT PUB 3 – 01.5)
  - freedom to conduct joint operations without undue interference from enemy TM operations
  - recognizes the political significance of the missile threat, "...in many cases, their political impact may outweigh their military significance"
- We do not, however, see the development of a JTMD CONOPS, nor a corresponding integrated effort in the development community

The Joint Pub identifies TMD as inherently a joint mission including possible (we would say probable) operations within an Alliance or coalition arrangement.

Defines TMD as the "...integration of joint force capabilities to destroy enemy theater missiles in flight or prior to launch or to otherwise disrupt the enemy's theater missile operations through an appropriate mix of mutually supportive:

- passive missile defense,
- active missile defense,
- attack operations, and
- supporting C^4I measures."

Assigns the JFC the responsibility for planning a multi-service integrated JTMD campaign to minimize the effect of theater missile attacks.

JCS Pub 3 - 01.5 outlines what ought to be accomplished for effective TMD. However, it does not institutionalize or provide a basis for developing the means to execute TMD nor for integrating the various systems into a joint capability for successful missile defense.

JTMD Process Responsibilities

RESPONSIBILITY	RESPONSIBLE AGENT
Establish policies, priorities	OSD, JCS
Develop concept, doctrine, needs	JCS, Services
Establish operational architecture	CINCs, Services
Develop engineering architecture	Services, BMDO, role for designated CINC
Execute programs, train, equip,	Services, OSD
Employ, and operate	CINCs, Service Component

The above chart identifies the actors and actions needed to develop and field effective joint theater missile defenses.

Missing items or unassigned responsibilities are:

- a common and consistent set of standards, policies and priorities
- a JCS concept
- current and future operational and engineering architectures

The operational architecture is generally defined as the concept for joint operations elaborated through descriptions of tactics, techniques, and procedures. The engineering architecture can be described as the translation of operational requirements into descriptions of systems, their desired characteristics, and connectivity.

The two activities — development of operational and engineering architectures — must be closely coupled. New technology enables new CONOPS; new CONOPS create opportunities for technical solutions. Indeed, at the broad collection of systems level we are addressing — joint theater missile defense — the distinction is artificial. An overall JTMD architecture must describe the systems, how they should be used and how they must connect together and to the rest of the world to provide effective TMD.

The JTMD architecture — to be useful to the acquisition process — must also provide a road map showing how fielded capabilities can change over time. The road map should not be limited to showing paths to a single "objective system" only. Instead, it should account for the very real uncertainties and multiple plausible futures we face by identifying hedges and providing options that can deal with these alternative futures. However, the current requirements and objective-system-driven acquisition process does not foster such a perspective.

The Role of Joint Force Commanders (JFC)

Although TMD is inherently joint — requiring the right mix of multi-service capabilities to prevent launch, shoot down missiles, and protect against their effects — the joint voice in development activities is much weaker than that of individual Services

A future JFC may be able to meld together an adequate JTMD system from the separate pieces being developed, but we should not count on it. Why should we wait until a war is upon us to create an effective joint capability?

US capabilities (current and in development) are not being integrated across the "seams" of National and Service systems. There are no joint operational or engineering TMD architectures to identify the appropriate mix of JTMD elements to guide development activities and no mechanism to ensure their integration.

- There is some architectural basis for joint active defense against theater ballistic missiles (through BMDO) but it does not include cruise missile defense (even though some of the systems are used for both). Indeed, there is no joint approach at all for overland cruise missile defense.

- Doctrine calls for attack operations but is not clear about the best targets or the best means to find and attack them. There is no integrated joint approach to address these challenges.

- Doctrine also prescribes Command, Control, Communications, Computers, and Intelligence (C^4I) but the means and responsibilities are not identified. BMDO has made some progress in Command and Control (C^2) for TBMD. However, there is no mechanism to aggressively pursue the broader joint problems and opportunities for JTMD C^4I.

- A joint requirements and acquisition approach has been established for CBW defense (directed by Public Law 103-160) but there appears to be no effort to integrate these or other passive defense efforts with the other elements of TMD.

On a more positive note, the CINCs are getting more involved and sponsoring exercises (JTF 95 by USACOM, Roving Sands by CENTCOM) and other relevant JTMD activities ("TMD in a Box" by EUCOM).

Organizing For Joint TMD: Recommendations

For Secretary of Defense

- Direct USD(A&T) to establish policies and priorities for achieving integrated TMD capabilities (complete in 3 months)
- Direct Chairman, JCS, to publish a concept for JTMD that establishes the framework upon which operational concepts and development activities can be based (complete in 6 months)
- Appoint the Director, BMDO as the engineering architect for active overland TMD (including C^4) by adding Cruise Missile (CM) defense to existing BM defense responsibilities. However, this will require further evolution of BMDO from a weapon and sensor technology demonstrator to a Battle Management C^3 integrator and systems engineer
- Direct all the Service Acquisition Executives and Director, BMDO to ensure that applicable development programs operate in the JTMD architecture

For Chairman, JCS

- Direct the Combatant CINCs to develop theater-specific JTMD concepts of operations on the basis of the concept that the CJCS develops (complete in 12 months)

For Secretary of Defense and Chairman, JCS:

Designate USACOM to be the focal point for JTMD

- Make it responsible for developing the overarching JTMD architecture
- Give it a small (10s not 100s) qualified support staff
- Direct BMDO and Services to support USACOM (as managers of passive defense, active defense, attack operations, and C^4I elements)
- Provide funds for tests and exercises
- Assign the National Test Facility to USACOM to help it develop and evaluate concepts and capabilities
- Make the Joint Precision Strike Demonstration live up to its name by making it truly joint

- **USACOM responsibilities should include**
  - — developing (working with other CINCs) CONOPS for current and emerging JTMD
  - — developing a JTMD architecture and road map which encompasses the appropriate mix of passive defense, active defense, and attack operations
  - — ensuring the development, testing, and exercising of C^4I for JTMD

Organizing For Joint TMD: Recommendations (cont.)

The Task Force recognizes the formidable Service opposition to establishing a stronger joint presence in acquisition affairs. While some may suggest Service opposition may be self-serving, there may also be legitimate concern about creating more bureaucracy and split responsibilities. This, however, is a unique joint task which requires unique solutions; problems raised by the Services can be mitigated by assembling a first rate staff, giving them the levers to get things done and creating an environment of mutual trust and cooperative problem solving (in the spirit of Integrated Process Teams (IPTs)).

We also recognize that giving this responsibility to a CINC represents a significant change from past practice. We considered alternatives within the development community — e.g., BMDO or lead Service — but concluded these are ill-suited to bring the joint perspective to the broad TMD challenge. Getting the CINC to look beyond today's problems will require strong direction from the Chairman and OSD, close cooperation with the developers, and sufficient resources. USACOM will also face the challenge of working with the other combatant CINCs to ensure their inputs are considered and integrated into the TMD architecture.

Additional resources are essential. We realize we are calling for additional tasks to be placed on the already full plate of a new command still staking out new responsibilities.

> Note: The recommendations of the 1993 DSB Task Force on Acquisition Reform, which were approved by the Secretary of Defense, directly increased CINC involvement (specifically USACOM) in the weapon system requirements process.

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TMD Programs/Activities

We begin by discussing requirements for TMD (How much is enough?) and then offer observations or recommendations on:
- COEA
- core and non-core active TMD systems
- advanced airborne surveillance and fire control sensors (including Aerostat options)
- C^4I for JTMD
- passive defense
- attack operations

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How Much Defense Is Enough?

Performance goals and thresholds and program schedules and deliverables for active defense against TMs should be established in the context of:

- other delivery means available to adversaries (don't pay for extra locks on the front door if windows remain unlocked)
- other means to mitigate the threat including deterrence, international agreements as well as the other elements of TMD: passive defense and attack operations

There is a tendency in the TMD community, more so than other defense areas, to search for "perfect" or "complete" solutions.

Very low leakage (<10 percent), while a desirable goal, will likely not be a practical overall objective for TMD except against small-scale attacks

- a wide range of civilian and military assets to defend
- many different situations and scenarios
- adversaries will invest in countermeasures
- very expensive, requires multi-tier defense over large areas
- adversaries have other delivery means

Very low leakage is not necessary to reduce effectiveness of conventionally armed TMs as either a military or terror weapon.

Against WMD, particularly nuclear or biological payloads, very low leakage is necessary to negate these weapons, but less than perfect active defense can still contribute though not "solve" the TM/WMD threat. Raising the price to an adversary, while clearly not as satisfactory as denying delivery, is a worthy and practical objective for today's investment decisions.

In spite of the persuasiveness of the multi-tier paradigm, the rationale for the current multi-system TMD program has more to do with providing some defense in situations where otherwise there would be none, rather than contributing to a multi-tier low-leakage defense. The psychological factor of having some defense can be very important (e.g., SCUD attacks against Israel).

The elements of TMD are themselves part of larger non- and counter-proliferation contexts to address the theater missile and WMD threats. For example, international diplomatic suasion (backed by military capabilities) could play an important role in heading off the threat of a regional adversary acquiring thousands of missiles.

Active Theater Ballistic Missile Defense Programs

- Concerns were expressed to the Task Force about affordability and redundancy of active TBMD systems
  - are there too many systems chasing too few $?
  - choices and priorities among systems mainly depend on policy preferences and judgments about the likelihood of threats
- We recommend that BMDO be tasked to explore:
  - new architectures based on using distributed sensors to support several interceptor systems
  - the use of a common kill vehicle in several interceptors

Defensive systems — PAC-3, THAAD, Navy Area and Theater Wide, Medium Extended Air Defense System (MEADS), and Boost Phase Intercept (BPI) — complement each other by:
- defending against different threats
- protecting different assets
- offering some defense in situations which otherwise would have none

Thus the problem is not redundant systems, but rather choosing among alternative objectives.

Affordability is a valid issue. Extensive deployment of all these systems would eventually require substantial increased funding for TMD. However, investments in TMD serve as a hedge against an uncertain future. If the missile threat continues to grow, then the importance of missile defense could well justify increased future funding for substantial deployments. On the other hand, a significant level of current investment may have a dissuasive effect and contribute to a preferred future with a curtailed missile threat.

The affordability challenge in the long term could also be mitigated through new architectures based on distributed sensors shared by different shooters. The advanced airborne radar system under development by Advanced Research Projects Agency (ARPA), for example, could be the prime sensor for BPI (Airborne Intercept [ABI]), MEADS, Patriot, and SM-2 against cruise missiles. A space based mid-course tracking system (Brilliant Eyes), if deployed for National Missile Defense (NMD), could also be the prime sensor for THAAD. Other savings could be achieved by the use of a common kill vehicle for several interceptors, e.g., a variant of the Advanced Interceptor Technology (AIT) kill vehicle might be used for THAAD, Navy Theater-Wide and ABI. We recommend that BMDO be tasked to explore these and similar options.

Choices among the systems mainly depend on policy preferences and judgments about the likelihood of threats and scenarios

- situations when Patriots or THAAD are not available, e.g., early entry lodgments? — then Navy Area Defense
- provide wide area and population defense? — then THAAD and Navy Theater Wide Defense
- long-range TBMs (>1000km) a concern? — then, THAAD and Navy Theater Wide Defense
- protect remote (from the launcher) allied populations against longer-range TBMs? — then Navy Theater-Wide supported by external sensors such as SBIR
- cruise missiles a concern? — then, PAC-3 and Navy Area Defense
- worried about emergence of advanced submunitions? — then BPI
- vulnerability of mobile troops to short range missiles? — then MEADS

These choices will not necessarily be illuminated by a requirements-driven analysis (which assumes the existence of a commonly agreed upon set of requirements) that relies on complex, many-on-many engagement simulations to evaluate the performance of alternative "objective system" TMD architectures.

- this is why we are concerned about the TMD Capstone COEA

The TMD COEA

- Good people involved, addressing some of right issues and undoubtedly serving a useful team-building purpose, bringing people and organizations together, as well as validating models and data
- However, we remain skeptical that, as configured, it will provide the desired insights and understanding of the critical investment decisions

The TMD COEA was briefed several times to the Task Force.
We believe the basic approach is inappropriate

- too massive: it involves 100s of people and promises over 5,000 pages of results.
- too mechanical: identified many 100s of cases to examine by using detailed force-on-force simulations, but these simulations add little to an understanding of most of key issues.
- overly driven by "requirements": does not examine underlying constraints and assumptions.
- biased by weapon system and individual Service perspectives.
- under-emphasizes sensor and Command, Control, and Communications (C^3) options, particularly those which can support new joint architectures (although we have been told these are to be examined in "excursions").
- not conducive to new CONOPS or creative approaches.

At best, it is an inefficient use of resources — create a huge pile, then see if there is a pony inside — that could be better employed.

In our interim report, we recommended that the COEA group be tasked to provide an initial cut at key issues to senior decision-makers and tailor subsequent analysis based on feedback. This does not appear to have been done, but we still believe it worthwhile to constitute a small group to address the critical issues. They should be tasked to evaluate program and investment options in terms of their contributions to managing the risks associated with future uncertainties (instead of, or at least, in addition to meeting objective system requirements).

The Core TBMD Systems

- The three Core TBMD programs — Patriot PAC-3, THAAD and Navy Area System — address critical deficiencies and provide complementary capabilities in today's systems

- We have two concerns
  - insufficient testing and intelligence collection to ensure avoidance of fragile performance: particularly important for hit-to-kill systems
  - THAAD performance inhibited by ABM Treaty derived constraints

Patriot PAC-3 continues the evolution of the Patriot system.
- promises substantially improved capabilities over PAC-2 in defended area and lethality and has CM defense capabilities
- little capability against longer-range TBMs and has deployment constraints

THAAD — the first dedicated TBM defender — promises to be a much more capable TBM defender than PAC-3.
- much larger defended area, particularly against longer-range TBMs
- exo- and endo-atmosphere intercept capability
  — favorable altitude regimes for hit-to-kill intercepts

However, potentially achievable defended footprints are being severely constrained (especially against longer-range TBMs) by ABM Treaty compliance findings that prohibit THAAD's use of external sensors. It does not contribute to low-altitude CM defense and is most expensive TBMD program (accounts for more than 30 percent of the TMD budget over the next 6 years).

Navy Area System wili ₑ.ve TBMD a capability to widely deployed Aegis family
- can provide TBMD in situations where land-based defenses are not in place
- offers CM defense
- the proposed approach, with a fragment warhead, while promising less probability of hit-to-kill, offers growth potential and avoids putting all eggs in one technology basket

Hit-to-kill systems provide substantial advantages, but there are dangers of their being fragile performers. It is important to learn all we can about the flight characteristics of threat missiles and to test our systems in a realistic environment, including both observed and anticipated countermeasures (See pg. 15-17). Intercept environments are challenging even in the absence of deliberate countermeasures. (As evidenced by problems Patriot faced due to the break up and corkscrewing of the Iraqi Scuds during reentry.) As one program manager cautioned, "debris happens."

TBMD Non Core Systems

The three "competing" concepts address very different problems

- MEADS is intended to move with and protect mobile ground forces including their moving support bases
- Navy Theater Wide offers protection of very large areas against longer-range TBMs
- BPI is of great interest because of feasible countermeasures against all the other TBMD systems. We conclude that BPI is in most need of increased attention and investment.

The three concepts are discussed in the following pages.

MEADS (Formerly CORPS SAM)

- **Intended to defend mobile ground forces against short-range missiles and other air threats including UAVs**
- **Has become a major international cooperative development program (involving the US, France, Germany, and Italy) since the initiation of our Task Force**
- **We recommend that serious consideration be given to using new architectures — employing airborne sensors to direct rearward-based Surface-to-Air Missiles (SAMs) to provide coverage of forward mobile forces — to help meet MEADS requirements**

The Army and Marines want a theater missile defense capability when operating out of range of theater missile defense systems. An issue is the vulnerability of mobile ground forces to missile attack. Mobile ground forces are actually moving only a small percentage of time when in combat and do present targets (e.g., forward area assembly areas and helicopter logistics nodes) for missile attack.

However, camouflage, concealment and deception (CCD) and other passive defense measures, suppression of enemy Reconnaissance, Surveillance Target Acquisition (RSTA) and attack operations, can play important roles in mitigating the short range missile threat to our mobile ground forces. (Attack operations have a better chance against the short range missiles because more sensors and shooters can be brought to bear against much smaller and closer operating areas these missiles must launch from.) Furthermore, while missiles pose perhaps the dominant threat to rear areas, mobile ground forces must contend with artillery, rockets and other threats. For these reasons, the missile threat to our mobile ground forces is unlikely to be the show stopper that it could be when targeted against PODs and populations.

Emerging concepts and technology, using airborne sensors to direct SAMs, will allow rearward-based SAMs to defend forward forces even against low flyers. (The concept will be demonstrated in the Mountain Top ACTD.) We recommend that such architectures be seriously considered, in conjunction with, and as a part of, the MEADS program. Using existing and already under development SAMs (e.g., ERINT) in this manner can reduce the demands (capability and quantity) and thus the cost of equipment that has to be made agile and survivable enough to keep up with maneuver forces.

Navy Theater Wide

- Navy Theater-Wide is the most cost-effective approach for protecting large areas against longer-range TBMs
- It is important for the program to develop properly and then be able to deploy quickly
- BMDO and Navy should be tasked to evaluate kill vehicle options accounting for realistic environments and plausible countermeasures, and to recommend preferred approach before committing to a design

Deployment flexibility — ships can be close to launch area and between launch area and defended area — allows defense of very large regions

- particularly against longer-range TBM threats (>1,000 km)
- requires external sensors and high-velocity interceptors (>3 km/sec) to achieve these large footprints

It is more important for the program to develop properly rather than rush to deploy.

The lightest front end (kill vehicle) and therefore the largest theoretical defended footprint (against the longer-range TBMs) are achieved if intercept capabilities are limited to the exo-atmosphere.

However, a capability to intercept in the high endo-atmosphere (e.g., above 30-50 km altitude) as well as above the atmosphere (which could be achieved with a THAAD-like or AIT front end) provides more resilience against countermeasures and can defend against shorter range TBMs.

Boost Phase Intercept Systems

- BPI should be an important element in TMD
  - to deal with advanced submunitions and other threats to defensive mid-course and terminal TMD systems
- However, there is no coherent BPI plan nor any mature concept
- All BPI concepts have warts. However, substantial — albeit far from perfect — capabilities can be developed

Instead of a coherent plan, we found advocacy of particular concepts and an absence of serious CONOPS.

So-called "complete" solutions are chimerical since our adversaries will have other ways to deliver WMD and explosive payloads including Special Operation Forces (SOF), covert means and cruise missiles.

Less-than-perfect BPI capabilities can help deter WMD use, e.g., by causing payload to fall on launcher's own territory.

A key issue is when is BPI needed
- a judgment call but we opt for sooner rather than later
- advanced submunitions can be effective against important target sets, although attacker pays accuracy and payload penalties
- potential for advanced submunition has been demonstrated by BMDO's countermeasures hands-on "Skunk Works"

Because advanced submunitions and other serious threats to US descent phase defense are potential and not yet real, BPI activities should be structured as a hedge program, rather than as a formal acquisition program. The objectives should be to:
- create and sustain options for timely deployment in case the threat materializes, and
- exploit the program's deterrent value to dissuade the development of advanced submunitions and other countermeasures to our descent phase missile defense systems

Boost Phase Intercept Systems — Recommendations

- A robust BPI hedge should include more than one concept.
- To achieve some BPI capability, we recommend that highest priority be accorded to the airborne intercept system (ABI) coupled with airborne sensors (ABR).
  - ABI provides the earliest availability
- Include serious attention to the role of Intelligence Preparation of the Battlefield (IPB) to improve operation area delineation (also important for attack operations against TM).

Lower priority is the Air Borne Laser (ABL):
- introduces new technology which may have high payoff in other missions
- also offers some advantages over ABI, like longer-range kill
- is a well-managed program with strong USAF enthusiasm

However, the ABL:
- has higher technical risk than ABI
- is an imperfect performer (even with optimistic estimates) as is the ABI
- does not provide for post-boost TBM kill (and therefore its effectiveness could be severely degraded by faster burning boosters) and we are skeptical of its utility against low-altitude CMs

Space-Based Laser is an option only in the much longer term:
- impressive technological achievements and offers advantages of continuous availability if enough satellites are in place
- however, is very expensive, and is susceptible to fast-burn boosters and also does not counter cruise missiles

Boost Phase Intercept Systems — Recommendations

- Fighter Aircraft (A/C) and UAVs are both feasible platforms for an ABI system
  - fighters offer earlier availability, while UAVs don't put pilots at risk (unless suppression of enemy air defenses (SEAD) is necessary to ensure UAV survival)
- ABI (on either platform) offers modest effectiveness (very scenario dependent) without additional sensor support
  - unless large numbers of platforms are deployed or superb area delimitation is achieved
- External sensors would enable much more effective ABI
  - also supports cruise missile defense, combat identification and fratricide avoidance, and other TBMD including new architectures for MEADS

Off-board airborne radar sensors would greatly enhance ABI effectiveness.

Without them, the performance of ABI on fighters will be limited by the small "search light" surveillance patterns of on-board radars. Likewise, without them, the performance of ABI on UAVs with IR surveillance sensors will be very dependent on weather conditions. Off-board radar sensors, by eliminating ABI's dependence on the small search light surveillance patterns or clear weather, can increase the all weather area coverage (the launch area that a single ABI platform can defend against) by a factor of 25 - 50 or more. Thus, the area covered per platform, instead of being less than a few thousand km^2 (limited by the on-board sensor), could be as much as 50,000 km^2 (depending on interceptor velocity and threat type).

The number of platforms required to provide high levels of effectiveness in all scenarios would be prohibitive. Rather than asking how many are "required" for coverage, a more useful question is: what capabilities can be achieved with affordable quantities? Analyses indicate that substantial effectiveness can be achieved in many scenarios with aircraft resources on the order of, or even less than, that assigned to SCUD hunting, during the Gulf War.

The timelines for boost phase kinetic intercept are stressful (representative TBMs complete booster burn within 60 - 90 seconds). Furthermore, platforms must overfly hostile territory to achieve substantial effectiveness in most scenarios. However, preliminary modeling and simulation efforts indicate that the short timelines are not a show stopper and that the requisite detection, track, and launch functions can be accomplished in sufficient time to support useful intercept ranges.

Higher interceptor velocities compensate to some extent for the short timelines. Very high velocities (e.g., 5 km/sec) could even increase standoff sufficiently to allow some BPI capability without having to fly over hostile territory (especially against relatively small size countries like North Korea). However, limiting ABI to only such a standoff mode would severely, and unnecessarily, limit its effectiveness. Furthermore, the advantages of very high velocity may be outweighed by its price: fewer missiles per platform, reduced deployment flexibility due to fewer types of platforms that can carry the ABI and delayed availability due to the greater development challenges (e.g., window cooling).

A capability for post-boost (ascent phase) as well as boost phase intercepts also helps deal with the stressful timelines and would substantially increase the coverage and robustness of ABI concepts.

The opportunity costs of the fighter-based ABI might be substantially reduced if this mission can be made compatible with other air missions rather than dedicating a sizable number of aircraft exclusively to BPI. Some missions, SEAD, for example, may not be good multi-mission candidates. Defensive counter-air (DCA) and other air superiority missions as well as transporter-erector-launcher (TEL) hunting (aircraft need to be in the same neighborhood for both BPI and counter-TEL missions) offer more potential for multi-mission compatibility. We did not find evidence of a serious attempt to explore multi-mission opportunities and we recommend that such an effort be made.

The value of fighter-based systems would also be enhanced if both Air Force and Navy aircraft (which may be the first on the scene) can be equipped to carry out the ABI mission.

Successful pursuit of ABI needs a warfighter sponsor and committed developer, neither of which exists today. We believe that fighter-based ABI offers the earliest available BPI capability and a program can be configured to support later carriage on UAVs. However, given the Air Force's apparent lack of interest in such use of fighters, an initial focus on UAV-based ABI concepts may be more bureaucratically practical.

Boost Phase Intercept Systems — Recommendations

For the UAV option, we recommend:

- a careful look at the US funded, Israeli boost phase intercept program to identify opportunities to leverage their effort

- a detailed examination of the survivability of alternative UAVs (recognizing that considerably higher attrition of these platforms than piloted aircraft can be accepted)

- modifying (or exploiting) the Advanced Interceptor Technology (AIT) kill vehicle program to support ABI carriage on UAVs (the current AIT appears too heavy for UAV carriage)

- early and heavy emphasis on CONOPS and BM/C^3

- consideration of the role of external sensors

We realize that there are questions about ABI feasibility. There are strong advocates for both the ABL (the Air Force) and SBL (within BMDO). On the other hand, there appears to be little advocacy for ABI (the proposed ABI ACTD collapsed in part due to lack of Air Force interest).

Still, there remains a real danger of rapidly emerging countermeasures to descent phase TBMD and land attack cruise missile threats. ABR helps with both ballistic and cruise missile threats, ABL and SBL likely won't, while ABI offers the least costly, earliest available path to achieve at least some BPI capability. Far less than perfect BPI capabilities could be important in future conflicts with TBM wielding adversaries.

Advanced Airborne RADAR Sensors

Advanced Airborne Radar Systems, currently an ARPA technology program, can be a major contributor to TMD (especially as part of a CEC-type network)

- detects low-observable CMs
- fire control for surface-based missiles allows intercepts out to their kinematic limits rather than the local radar horizon
  - — increases defended area per SAM site as much as 100-fold
  - — extends defensive range of ship-based SAMs inland
- improved situation awareness and high-resolution capabilities important for combat identification and fratricide avoidance
- enhances fighter-based BPI and supports other TBMD

We examined the role of an Aerostat as a platform for these advanced sensors and reviewed a proposed ACTD for an Aerostat surveillance system. Could an Aerostat substitute for an aircraft, thus avoiding the need for aircraft? If the aircraft is needed, would the Aerostat provide sufficient additional value to warrant the additional cost?

Compared to manned aircraft, the Aerostat offers the potential of lower cost, longer time on station, no air crew at risk, and a shorter time to operational capability.

A suitable Aerostat should be able to operate above 20K feet both to rise above the most turbulent conditions and to achieve adequate coverage. Since the estimated payload is about 25K pounds, a large Aerostat is required. The largest existing Aerostats are about 71 meters in length. ARPA estimates that a 91 meter Aerostat would be needed to satisfy requirements.

A substantial ground facility is required to inflate and manage the Aerostat on the ground and to provide for the ground crew and operations. The ground facility, as well as the Aerostat itself, is subject to attack. Although the Aerostat would presumably be well behind the expanded danger zone and protected by SAMs and fighter aircraft, it is unable to duck or fly away and could be vulnerable to a determined enemy.

Aerostats have limited mobility. A ground site must be prepared consisting of a mooring tower, a vehicle of some sort to hold the tail, and enough space to allow the mooring vehicle to move, keeping the Aerostat facing into the wind. If not already there, these would have to be moved to the theater and set up, requiring some days as well as a safe place far enough from the enemy to be protected. Moving the ground site to keep up with troop movements also takes time, requiring several Aerostats to maintain continual coverage.

Advanced Airborne RADAR Sensors (CONT')

In our opinion, an Aerostat is not an adequate substitute for an aircraft and thus an aircraft is needed in any event

- aircraft provides deployability, flexibility, and survivability advantages
- aircraft can fly higher altitudes providing either greater coverage into enemy territory or greater safety depending on position

The best role for the Aerostat would be to provide coverage before hostilities begin and under benign conditions, saving wear and tear on aircraft and crews, and either reducing the number of aircraft needed or improving their staying power

- surveillance aircraft are expensive to build and operate; thus a fleet of Aerostats could be a money-saving augmentation

The Aerostat should be viewed as a complement, not a substitute, for aircraft:

- unfortunately, the development costs for the two systems are largely additive and would occur in the next few years while the savings accrue in the future
- if there is only money for one, we believe it should be the aircraft

The proposed Aerostat ACTD briefed to the Task Force was directed toward developing and demonstrating a war-fighting capability (including size, altitude, both surveillance and fire control radars, low down time, and rapid mobility). This capability would be costly and involve a number of parallel developments with considerable risk of meeting schedule and budget.

There does not appear to be much work on improving Aerostats

- more effort should be invested toward this end than currently planned. There may well be other uses for Aerostats which would be helped by a much more thorough understanding of shaping, materials, and handling

- We recommend that the advanced airborne radar systems program in ARPA be made more ACTD-like to expedite deployment on fixed winged aircraft (unmanned A/C could be a later option). Emphasis should be first to provide airborne surveillance and fire control (for both fighters and SAMs) against moderate cruise missile threats, with capabilities against VLO threats to come later.

- Since we believe that an Aerostat would be an adjunct to an aircraft system, we also recommend:
  - a wider exploration of the use of existing and improved Aerostats for many military purposes including Electronic Surveillance Measures (ESM), VHF surveillance, and communications relay.
  - in parallel, a substantial effort to develop larger Aerostats using improved technology that could carry larger payloads to higher altitudes.
  - later, light-weight, fire-control/surveillance radar(s) could be developed. The result would be a set of components which could be put together in various ways depending on how each of the component developments came out. A plan of this sort would be less dependent on everything going well.

Joint Theater Missile Defense C^4

- Some progress in TBMD
  - BMDO-led effort to develop Joint Tactical Information Distribution System (JTIDS)-based C^2, disseminate Defense Satellite Program (DSP) data
- The overall JTMD C^4 effort remains sluggish
  - in spite of repeated calls for more attention and some organizational initiatives
  - Service stovepipes an obstacle
- We recommend that USD(A&T) task the Air Force, Army, Navy and BMDO to conduct a comprehensive analysis of the costs and benefits of alternative ways to extend CEC-like capabilities into the JTMD arena

Architecture goal for JTMD should be CEC-like capability

- fuses measurements from distributed sensors
- provides common high-quality, fire-control picture of battle space to distributed shooters

Offers substantial advantages for JTMD

- supports both CM and BM defense
- allows weapons to be fired from remote sensors
- extends coverage
- is more robust against countermeasures
- helps combat identification and fratricide avoidance
- has more deployment flexibility

CEC-like, rather than CEC, because not every participant in the network needs or can afford a full CEC capability

- can have several different levels of participation
- need to develop architecture and implementation plan to extend CEC-like capabilities into the joint arena

Although we note some interest by the other Services in CEC-like capabilities, e.g., the Air Force for AWACs, we saw little evidence of a serious commitment to extend this capability into JTMD.

Passive Defense

- **Comprises many disparate functions**
  - warning, movement, signature control, hardening and dispersal, protection and medical treatment of personnel, redundancy and reconstitution
- **Can be viewed as the foundation for TMD**
  - enables affordable active defense
  - generally provides protection independent of delivery means
- **Remains underexploited**
  - despite its potential for high-cost effectiveness
  - few spokespersons for passive defense

There are many passive defense avenues to pursue; we highlight three of these:

Improve the readiness of reserve forces to operate in CBW environment

- many unprepared for Desert Shield
- anecdotal evidence of continuing problem (e.g., in Roving Sands)
- important Combat Service Support (CSS) role (e.g., as drivers, stevedores) if contract support unwilling to work in face of CBW threat or use

Devote more attention to operating air and sea PODs in face of CBW attack

- conduct field exercises to gather data and evaluate procedures and materiel
- introduce CBW threat into war games to increase awareness
- task Strategic Mobility Joint Warfighting Capability Assessment (JWCA) to address the effects of missile attacks on PODs and points of embarkation (POEs)
- identify options to provide CBW protection to contract/host nation support (part of a much more general problem of protection for allies)

Pursue new ways to deploy and project force to theaters without creating targets like the huge logistics nodes of Desert Shield

- like the Marine's "operational maneuver from the sea" and other concepts such as "pulse" or "just-in-time" logistics

Attack Operations

- Dismal wartime experience against mobile TMs
  - no confirmed kills in thousands of sorties
- Major problem is finding and discriminating
  - significantly better sensors and sensor fusion necessary
  - intelligence preparation of the battlefield is critical. The intelligence community also needs better data and information fusion
- Considerable current activity
  - multi-JWCA, Roving Sands, Joint Test & Evaluation TMD Attack Operations effort, War Breaker and other ARPA and Service programs
- But no integrating mechanism to pull together the various relevant projects, programs and activities into a comprehensive attack operations program

By comprehensive, we mean including SOF, as well as air operations, to locate and attack:

- infrastructure
- TELs in transit to launch location
- TELs preparing to launch
- post-launch TELs fleeing launch site
- the missile during its boost and ascent phase (although Pentagon considers BPI part of active defense, airborne BPI has more in common with attack and related air operations)

Cruise missiles deny or reduce some of these opportunities (e.g., they can be launched from "warehouses").

Attack Operations (cont.)

Given the dismal past performance, what are the expectations for future improvements?

- Finding and destroying mobile missiles (pre-launch) will remain a formidable challenge even with much improved wide area surveillance
  - large operating areas, use of camouflage, concealment and deception (CCD), and small footprints (e.g., compared to a tank battalion)
    - — difficult to quantify effectiveness, let alone guarantee success
    - — very dependent on adversaries' tactics and use of CCD
- Observable and unambiguous launch signatures offer opportunities for successful attacks against post-boost TBM launchers
  - may drive adversaries to expendable launchers
- Major effect may be suppressive rather than kill
  - make adversaries devote considerable energy to survive and thus make it more difficult to launch salvos in large numbers
- Mobile cruise missiles will be even more elusive targets than ballistic missiles
  - reduced operational and launch signatures

In summary, attack operations can be an important adjunct but cannot replace the need for active defense. But, if the US faces missile attacks in future conflicts, we will undoubtedly again devote substantial resources to TMD attack operations

- **we must learn how to do better; if we expect to capitalize on our enormous theater air investment to support TMD**

Attack Operations — Recommendations

- Develop a comprehensive architecture and implementation plan for operational and technological enhancements to TMD attack operations: i.e., how to do better

  - exploit improved capabilities being fielded for other reasons
  - include the role for IPB to improve operational area delimitation (also important for BPI) and gather lessons learned from Roving Sands and other relevant exercises
  - follow on to the JWCA effort on TMD attack operations and the recent Lincoln Lab study for OSD
  - sponsor this effort through the OSD, Joint Staff and USACOM
  - include intelligence, warfighter, and technology personnel
  - emphasize individual experience and expertise, not just organizational participation
  - creative rather than evaluative exercise (one good idea is worth many evaluations)
  - provide sufficient time (e.g., 9 months) to produce this study plan

- After the study provides a road map, then decide on the appropriate management arrangement and responsibilities

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Summary of Findings and Recommendations

We found substantial progress in the TMD program since the Gulf War (also since the last DSB/DPB TMD Task Force in 1991). The progress includes enhancement to fielded capabilities, investment in major new development programs and technology efforts, greater involvement by the CINCs, more joint exercises and the publication of doctrine for JTMD. We also found some problems and deficiencies which are highlighted in the following two pages along with our primary recommendations.

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Summary Of Findings And Recommendations

Threat projections and the Acquisition Process

We found over emphasis on evidence based projections and recommend that:

- USD(A&T) and the Director, DIA provide resources and increase the role for Red Teaming and threat modeling within a disciplined process to characterize threat options
- USD(A&T) direct BMDO to add cruise missiles to the ballistic missile threats it is already examining in its Red Team and Countermeasure Skunk Works activities
- BMDO prepare an annual report to USD(A&T) on the TMD Red Team results, characterizing possible threats and countermeasures according to effectiveness and difficulty and describing the strategy to deal with these threats

The ABM Treaty and TMD

We found TMD capabilities being constrained by the Treaty demarcation path the US had been pursuing and recommend a different approach:

- based on demonstrated — and NTM verifiable — capabilities, achieved by not testing TMD systems against missile targets in excess of 5 km/sec and 3,000 - 3,500 km range
- consistent with the May 1995 Clinton/Yeltsin Summit Statement
- pursuing confidence building measures and cooperative efforts with the Russians and subsequently the Chinese

Organizing for JTMD

We found a comprehensive vision of JTMD promulgated by the Joint Staff, but no Joint CONOPS nor complementary comprehensive approach on the developers' side. To organize more effectively for JTMD, we recommend several steps including:

- assigning USACOM the responsibility for the overall JTMD architecture
- combining land-based cruise and ballistic active theater missile defense development under BMDO

TMD Program and Activities

There are reasonable rationales for each of the six TBMD programs. However, substantially increased budgets for TBMD will be required to produce and deploy all of these systems. We are concerned that the massive Capstone TMD COEA effort will not produce the desired illumination of critical investment decisions.

We conclude that very low leakage, while desirable, is unlikely to be a practical TMD goal except against very small attacks. Raising the price to an adversary, while clearly not as satisfactory as denying delivery, is a worthy and practical objective for today's investment decisions.

There is insufficient attention to architectures based on distributed sensors supporting several interceptor systems.

- the advanced airborne radar sensors being developed by ARPA are crucial for defense against land attack cruise missiles and can also make important contributions to TBMD (including BPI and MEADS). We concluded that Aerostat basing could be an important complement to fixed wing A/C and recommend more effort on Aerostat design as well as moving the airborne radar technology closer to a fielded capability in order to hedge against rapid emergence of the land attack cruise missile threat.

- we recommend more aggressive pursuit of CEC-like capabilities for JTMD.

We are concerned about the fragility of hit-to-kill systems in combat and recommend more testing in realistic environments and more intelligence data collection against real targets.

We are concerned about countermeasures to descent phase TBMD and recommend more attention to boost phase intercept, with the highest priority to airborne intercept concepts.

We did not find a coherent, integrated effort to improve attack operations against mobile theater missiles. While we remain skeptical about achieving sufficient effectiveness to substitute for active defense, there are opportunities to improve on dismal past performances. We recommend the development of a comprehensive attack operations architecture and implementation road map that makes better use of new surveillance and C^3 capabilities being fielded for other purposes.

We find that passive defenses continue to be undervalued and suggest several areas for additional attention.

Appendices

APPENDIX A

MEMBERSHIP

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Defense Science Board/Defense Policy Board
Joint Task Force
on
Theater Missile Defense

Members

Chairmen

Dr. Ted Gold and Admiral David Jeremiah, USN (Ret)

Rear Admiral Thomas Brooks, USN (Ret)
Robert Everett
Daniel Fink
Dr. William Graham
General Larry Welch, USAF (Ret)
Hon Sidney Graybeal
Stephen Hadley
General Glenn Otis, USA (Ret)
John Steinbruner

Executive Secretary
Glenn Lamartin
Maj Tim Linehan

DSB Secretariat
Lt Col Keith Larson

DPB Secretariat
Lt Col Clay Stewart

USDP POC
Dr. Frank Dellermann

Advisors

Col Roger Graves
Peter Hoag
COL William Knox
LTC Michael Lloyd
Thomas Perdue
Col Tony Ryan
Maj Michael Vela
COL Alan Hammond
CAPT John Keli
CDR Craig Langman
Marion Oliver
Dr. Bruce Pierce
Paul Scheurich
Dr. David Whelan

Support

Ed Burke
Andrew Hutchins
Hilton Hanson
Denise Strother

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APPENDIX B

TERMS OF REFERENCE

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OFFICE OF THE SECRETARY OF DEFENSE

WASHINGTON, D.C. 20301

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD
CHAIRMAN, DEFENSE POLICY BOARD

SUBJECT: Terms of Reference--Defense Science Board/Defense Policy Board Task Force on Theater Missile Defense (TMD)

You are requested to form a joint Defense Science Board/Defense Policy Board Task Force to review the purposes of the U.S. theater missile defense effort, including the nature of the threat (types and quantities of missiles and payloads); how it might evolve; the degree of defense we should seek; what we should defend; under what circumstances; and to what levels.

The Task Force evaluation should also include, but is not limited to the following issues:

- An assessment of current TMD capabilities, plans and programs (including active and passive defense and counterforce).

-- Do the programs and proposed architectures provide a balanced approach consistent with the purposes?

-- How should theater missile defense activities relate to counterproliferation and associated efforts?

- A review of the implications of the TMD programs and options for the ABM treaty.

-- What are the significance of alternative ABM treaty derived constraints to TMD effectiveness?

- A determination of the relationship of TMD to national missile defense from several perspectives including operational, programmatic, organizational, policy, and political. The Task Force is not being asked to make recommendations about national missile defense.

The Assistant Secretary of Defense for International Security Policy and the Director, Strategic and Tactical Systems, OUSD(A&T) will co-sponsor this Task Force and provide the necessary funding and support contractor arrangements as may be necessary. Dr. Theodore S. Gold and Admiral David Jeremiah, USN (Ret.) will serve as co-chairmen of the Task Force. Mr. Glenn Lamartin, OUSD(A&T), will serve as Executive Secretary, and Dr. Frank Dellermann, OASD(ISP) will serve as the point of contact and representative from OASD(ISP). Lieutenant Colonel Keith Larson, USAF, will serve as the Defense Science Board Secretariat representative and Lieutenant Colonel Clay Stewart, USAF, will serve as the Defense Policy Board Secretariat representative.

It is not anticipated that this Task Force will need to go into any "particular matters" within the meaning of Section 208 of Title 18, U.S. Code, nor will it cause any member to be placed in the position of acting as a procurement official. The Task Force should submit an interim report by early April, and a final report in September 1995.

Paul G Kaminski
USD(A&T)
FEB 0 6 1995

J. W. Cobb, acting
USD(P)
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APPENDIX C

ACRONYMS

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ABBREVIATIONS	MEANING
A&T	Acquisition & Technology
A/C	Aircraft
AADC	Area Air Defense Commander
ABI	Airborne Intercept
ABL	Air Borne Laser
ABR	Airborne Radar
ABM	Anti-Ballistic Missile
ACTD	Advanced Concept Technology Demonstration
ADSAM	Air Defense Surface to Air Missile
AIT	Advanced Interceptor Technology
AO	Area of Operations
API	Ascent Phase Intercept
ARPA	Advanced Research Projects Agency
ASD	Assistant Secretary of Defense
AWAC	Airborne Warning & Control
BM	Ballistic Missile
BMDO	Ballistic Missile Defense Organization
BPI	Boost Phase Intercept
BW	Biological Warfare
C^2	Command and Control
C^3	Command, Control and Communications
C^3I	Command, Control, Communications, and Intelligence
C^4	Command, Control, Communications, Computers
C^4I	Command, Control, Communications, Computers and Intelligence
CBW	Chemical/Biological Warfare
CCD	Camouflage, Concealment & Deception
CEC	Cooperative Engagement Capability
CENTCOM	Central Command
CID	Combat Identification
CINC	Commander in Chief
CJCS	Chairman, Joint Chiefs of Staff
CM	Cruise Missile
COEA	Cost and Operational Effectiveness Analysis
CONOPS	Concept of Operations
CONUS	Continental United States
CSS	Combat Service Support
DCA	Defensive Counterair
DepSecDef	Deputy Secretary of Defense
DIA	Defense Intelligence Agency
DoD	Department of Defense
DPB	Defense Policy Board
DSB	Defense Science Board
DSP	Defense Satellite Program
ESM	Electronic Surveillance Measures
EUCOM	European Command

IPB	Intelligence Preparation of the Battlefield
IPT	Integrated Process Team
JCS	Joint Chiefs of Staff
JFACC	Joint Force Air Component Commander
JFC	Joint Force Commander
JTC	Joint Theater Commander
JTF	Joint Task Force
JTIDS	Joint Tactical Information Distribution System
JTMD	Joint Theater Missile Defense
JWCA	Joint Warfighting Capability Assessment
KKV	Kinetic Kill Vehicle
LEAP	Light Exo-Atmospheric Projectile
LO	Low Observable
MASINT	Measurement and Signature Intelligence
MEADS	Medium Extended Air Defense System
NBC	Nuclear/Biological/Chemical
NTM	National Technical Means
OSD	Office of the Secretary of Defense
PAC-2	Patriot Advanced Capability-2
PAC-3	Patriot Advanced Capability-3
PM	Program Manager
POD	Point of Debarkation
POE	Point of Embarkation
Pub	Publication
RCS	Radar Cross Section
RSTA	Reconnaissance, Surveillance Target Acquisition
S&T	Science and Technology
SAM	Surface to Air Missile
SBL	Spaced Based Laser
SCC	Standing Consultative Commission
SecDef	Secretary of Defense
SM-2 BLK IV A	Standard Missile 2 Block IV A
SOF	Special Operations Forces
STAR	System Threat Assessment Report
T&E	Test and Evaluation
TBMD	Theater Ballistic Missile Defense
TEL	Transporter, Erector, Launcher
THAAD	Theater High Altitude Area Defense
TM	Theater Missile
TMD	Theater Missile Defense
UAV	Unmanned Air Vehicle
UOES	User Operational Evaluation System
USACOM	United States Atlantic Command
V-1	German WW II Cruise Missile
V-2	German WW II Ballistic Missile

VHF	Very High Frequency
VLO	Very Low Observable
WMD	Weapons of Mass Destruction

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DOCUMENT 3

The Poor Man's Air Force: Implications of the Evolving Cruise Missile Threat

AD-A326588

April 1997

Army War College

Carlisle Barracks, PA

STRATEGY RESEARCH PROJECT

THE POOR MAN'S AIR FORCE: IMPLICATIONS OF THE EVOLVING CRUISE MISSILE THREAT

BY

LIEUTENANT COLONEL JOHN T. BOWEN
United States Air Force

USAWC CLASS OF 1997

U.S. ARMY WAR COLLEGE, CARLISLE BARRACKS, PA 17013-5050

USAWC STRATEGY RESEARCH PROJECT

THE POOR MAN'S AIR FORCE: IMPLICATIONS OF THE EVOLVING CRUISE MISSILE THREAT

by

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ABSTRACT

AUTHOR: John T. Bowen (LtCol), USAF

TITLE: The Poor Man's Air Force: Implications of the Evolving Cruise Missile Threat

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For several years, the United States has expended considerable resources on countering the theater ballistic missile threat. During this time, we have relatively ignored a growing land attack cruise missile threat. Land attack cruise missiles have the potential to be even more deadly than ballistic missiles, able to deliver similar payloads over similar distances with much greater accuracy. Advanced cruise missiles can penetrate existing air defenses, giving potential regional adversaries a significant ability to conduct strategic attack and interdiction against our military forces, a poor man's air force. Additionally, cruise missiles, synchronized with employment of ballistic missiles and manned aircraft, can have a synergistic effect. Efforts to prevent cruise missile proliferation have been ineffective, and highly lethal systems will likely be in the arsenals of many Third World nations within the next decade. Our nation needs to pursue theater air defense capability to detect, identify, track, engage, and destroy advanced cruise missiles to be prepared for this evolving threat.

TABLE OF CONTENTS

INTRODUCTION

The Arabian Gulf war of 2003 started off very much like the Desert Storm campaign. Iran, not content with seizing Iraqi lands south of Basra, had also occupied the rich oil fields of Kuwait. The fight with a drastically weakened Iraq merely settled an old score, but the move into Kuwait was a calculated response to two years of United Nations sanctions resulting from the Caspian Sea oil disputes. The U.S. reaction was predictable, forming a coalition of Gulf and European states and beginning a rapid troop buildup in Saudi Arabia. Significant air and naval forces had already deployed to the region, and land forces were arriving. The world press had already predicted a quick victory with the overwhelming technological advantage of America and her Western allies.

The newly formed Iranian War Council was determined not to make the same mistakes as Sadaam Hussein. The first small-scale attack against coalition forces occurred while American forces were offloading at Saudi ports. The vastly superior allied air force had repulsed the Iranian air attack without a single loss. The ballistic missile attack was only somewhat more successful because the majority of missiles were destroyed by land- and ship-based surface-to-air missiles; a tribute to the enormous US expenditure for theater missile defense systems. The missiles that reached their targets did relatively minor damage to port facilities and did not significantly slow the flow of forces.

The Americans were certainly pleased with the first battle, bolstering their predictions of decisive victory. However, the results were not unexpected by Iran. Considering their observations of Desert Storm, they generally viewed these as "use or lose" systems, weapons that would be quickly destroyed by early coalition airstrikes. They realized that

Western technology gave the coalition asymmetric advantages, and had planned for that eventuality for several years. They had sought ways to overcome their technological disadvantage, and felt they had the answer: massive cruise missile launches. Those weapons were now dispersed in preparation for the expected coalition air attack.

"The nation is on track with the development of systems to counter most of the theater ballistic missile threat. Unfortunately, we are missing the mark on the cruise missile, the very short-range ballistic missile, and the reconnaissance/lethal unmanned aerial vehicle (UAV) threat." [1]

For several years, especially after our experience in Desert Storm, the United States has worked diligently at developing defenses against the ballistic missile threat, while maintaining our overwhelming superiority in manned aircraft capability. At the same time, we have been relatively oblivious to a growing cruise missile threat. A major reason we have not addressed the looming cruise missile threat is that political controversy in the US and in Western Europe over ballistic missile defense has fixated the analytical and political communities on the proliferation of ballistic missiles. [2]

Yet the cruise missile has the potential to be a more dangerous threat than ballistic missiles, oviding Third World nations an avenue to develop air power capability not previously available within their resource constraints. This paper will examine implications of that growing threat by discussing the proliferation of cruise missiles, the features that make cruise missiles the growing weapon of choice in the Third World, Western defensive capabilities against the threat, and the effect that synchronized and synergistic use of cruise missiles can have on our air operations.

Merely defining a cruise missile is difficult. The 1987 US-Soviet Intermediate Nuclear Forces Treaty defined it as an "unmanned, self-propelled vehicle that sustains flight through the use aerodynamical lift over most of its flight path." It is commonly understood to be a relatively small, relatively cheap pilotless aircraft used to deliver a rather powerful warhead, more or less precisely, at a distant target. [3]

It generally comes in two varieties, the anti-ship cruise missile (ASCM) and the land attack cruise missile. Both can be launched from several platforms, including aircraft, ships, and ground vehicles. ASCMs have been widely deployed and employed for a number of years, but the proliferation of the land attack variety is a fairly recent phenomenon. It is this addition of these highly lethal, land attack cruise missiles to military inventories that provide potential regional adversaries the means to develop a "poor man's air force."

HISTORY

Cruise missiles have been around for over 50 years. The first cruise missile used in combat was the German V-1 during World War Two. Powered by a pulsejet engine, it carried a 1,870 pound warhead at 375 mph and approximately 2,000 feet altitude for over 150 miles, at which point the engine shut off and the missile dropped into its target area.[4] Between June 1944 and March 1945, the Germans fired approximately 10,000 V-1s at London. Casualties included over 5,000 dead, 40,000 injured, and over 130,000 homes destroyed with more than 720,000 damaged.[5]

After World War Two, the United States attempted to develop a second generation land attack cruise missile. Efforts to field this nuclear-armed weapon system were generally unsuccessful due to technical shortcomings in development of guidance systems. [6] During the 1950s and 1960s the Soviets developed a number of ASCMs to counter US aircraft carriers. The SS-N-2 Styx, fielded in 1956, was the first surface-to-surface ASCM, and the Soviets also fielded several air-to-surface cruise missiles for their bomber forces around this time frame. The Soviets exported several types of ASCMs, as evidenced by an Egyptian Styx sinking the Israeli destroyer *Eliat* in 1967. [7]

It wasn't until the 1970s that several technological advances allowed the US developed a third generation cruise missile. Microelectronics advances solved guidance problems and made possible terrain contour matching, while engine improvements and high energy fuels extended the ranges of cruise missiles. The US Air Force fielded the AGM-86B air launched cruise missile in 1982, while the US Navy developed a sea-launched version. The best known US system, the BGM-109 Tomahawk, entered service in the mid-1980s. Its two variants were the tactical anti-ship missile (TASM) and the Tomahawk land attack missile (TLAM) with conventional warhead, submunitions dispenser, or a nuclear armed warhead. [8]

In addition to the sinking of the *Eliat* in 1967, ASCMs were used successfully in the 1971 Indo-Pakistani war, the Yom Kippur war in 1973, and the 1980-1988 Iran-Iraq war. In 1988 an Iraqi Mirage fired two Exocet ASCMs at the USS *Stark*, killing 37 sailors and heavily damaging the frigate.[9] The most significant employment was during Falklands conflict in 1982. Argentina launched five Exocets, her entire inventory, scoring three hits. Air-launched Exocets hit and sank the destroyer HMS *Sheffield* and the container ship *Atlantic Conveyor*, and a ground-launched Exocet damaged the destroyer HMS *Glamorgan*. [10] In fact, those five Exocets fired in the Falklands conflict did more damage than all the Scud missiles fired during Desert Storm.[11] Although ASCMs have been widely used since 1967, land attack cruise missiles were not used in combat between the V-1s in 1945 and the US Tomahawks launched in Desert Storm. [12]

PROLIFERATION

"Land attack cruise missiles are a technology which, we expect, will proliferate and go into more countries." Secretary of Defense William Perry, 1994[13]

Cruise missiles have become fairly widespread throughout the military arsenals of the world. Over 70 countries currently possess cruise missiles, the majority of those being ASCMs. There are also at least 24 countries that have aerospace industries capable of producing cruise missiles and 15 countries that actually manufacture and sell cruise missiles. Of these numbers, at least 16 countries possess relatively large and diverse cruise missile arsenals. [14] And the number continues to grow.

Intelligence agencies estimate that over 40,000 cruise missiles will be in the inventories of over 100 countries by the year 2000,[15] and these numbers are not just ASCMs. Land attack cruise missiles are rapidly spreading throughout the world. In 1995, Lt Gen Malcolm O'Neill, Director of the Ballistic Missile Defense Office, testified to Congress:

> "Thirteen countries are developing land-attack cruise missiles. Iran is expected to deploy a system that is converted from a UAV by the year 2000. China is working on a system with moderate signature reduction that could be deployed about the same timeframe. Cruise missiles are marketed actively throughout the world, which indicates that very potent systems may reach the hands of potentially hostile countries." [16]

There are a number of reasons for this proliferation of land attack cruise missiles. Previously, longer range land attack cruise missiles required sophisticated guidance systems and significant support capabilities to produce terrain maps. This essentially limited these systems to the superpowers. Now, technologies and new products provide the missing link that allows many Third World nations to pursue their own land attack cruise missile arsenals. These include readily available navigation and imagery from commercial satellites and sophisticated mission planning tools. [17]

Proliferation is not limited to older or less-capable systems either. At the 1995 Paris Air Show and the 1994 Singapore Air Show, the French Apache stealth cruise missile was on display for export. At the 1993 Abu Dhabi Defense Exhibition, a shorter range version of the Russian AS-15 was on sale. [18] Iran already has Chinese Silkworm and Russian SS-N-22 supersonic cruise missiles along the Straits of Hormuz,[19] and is developing an improved Silkworm with a range of 450 km, enough to cover the entire Arabian Gulf and part of the Saudi peninsula.[20] The Chinese are expected to have stealthy cruise missiles for sale soon after the turn of the century.[21] A Defense Department report concluded that several countries, including Iran, will have cruise missiles with some degree of stealth technology between 2000 and 2010.[22]

Nor is the proliferation of cruise missiles the result of irresponsible actions by other nations. The US is the largest cruise missile exporter. We have supplied the Harpoon ASCM to 23 nations, including NATO allies, South America, the Far East and the Middle East, including Iran. The export of ASCMs such as the Harpoon is relevant to proliferation for several reasons. They are adaptable to a land attack role, but perhaps more importantly they provide the technology to serve as a building block for potential adversaries' own cruise missile development efforts.[23]

THE MISSILE TECHNOLOGY CONTROL REGIME AND CRUISE MISSILES

"The MTCR cannot stop the spread of cruise missiles: it can only slow the speed of their proliferation."[24]

The primary means for countering the proliferation of cruise missiles is the 1987 Missile Technology Control Regime (MTCR). This voluntary international agreement is primarily aimed at ballistic missiles, but also limits the export of some cruise missiles and their sub-systems.[25] The restrictions under MTCR are far less for cruise missiles than for ballistic missiles. This is for several reasons. For one, the MTCR intentionally avoids any restriction on manned aircraft sales. This allows potential proliferators to use aircraft purchases to gain the needed components and technology, yet still hide cruise missile development efforts. This, coupled with tremendous growth in computer technology, availability of digital mapping software, and inexpensive precision navigation capability, provides Third World nations with all the tools they need to produce highly effective missiles.[26]

Countries that have the capability to build military aircraft or remotely piloted vehicles (RPV) have the basis to develop a cruise missile production capability.[27] Currently, 91 nations operate aircraft, 45 of these have some form of indigenous aviation industry, 18 build aircraft under license, and 21 design their own aircraft.[28] In addition to Western nations, there are currently at least 11 Third World countries that have military aircraft production capability and 10 that can build RPVs.[29]

The MTCR applies its most restrictive provisions to cruise missiles that are capable of delivering a 500 kg warhead at least 300 km. However, there is a problem defining which systems are restricted, largely due to the very easy trade off between range and payload. Systems that are not restricted because their range is under the limit can easily be modified or their range extended with a lighter warhead. One example is the Apache. French officials claim this stealthy missile does not fall under MTCR restrictions. An adversary equipped with such an advanced cruise missile would prove difficult for Western air defense systems.[30]

CRUISE MISSILES AS THE WEAPON OF CHOICE

"The problem of stopping large numbers of subsonic, ground-hugging, low-observable cruise missiles is considered more intractable, just as likely to occur and certainly less studied, than ballistic missile attack."[31]

Cruise missiles have a number of advantages over both ballistic missiles and manned aircraft as the weapon of choice of Third World nations. These advantages include cost, availability, accuracy, reliability, and survivability. Let's first examine the cruise missile against the ballistic missile.

Cruise missiles are less expensive to develop or purchase and require less support infrastructure to deploy. Cruise missiles can be readily placed in canisters, which makes them well suited to operate in harsh environments. Their exhaust plumes are generally not detectable by space-based sensors, and they require virtually no special launch stability, so they can be launched from almost any platform. Additionally, they fly a zigzag path to their target, so it is difficult for defenders to track them, determine their intended target, or locate their launch site. They generally have an active guidance system, so they are much more accurate than ballistic missiles.[32]

Cruise missiles are becoming more effective and accessible because of the availability of small turbojet engines with increased reliability and fuel efficiency, improved and less-expensive seeker heads, and simple but accurate navigation through Global Positioning System (GPS) or the Russian GLONASS system. Cruise missiles are technologically less complicated than ballistic missiles.[33] They also can be much cheaper. The cruise missile can deliver a similar warhead size over a similar range more accurately and at 10 percent to 35 percent of the total cost of an equivalent ballistic missile.[34] A cruise missile based on an unmanned aerial vehicle could cost less than $100,000. A more advanced weapon, like the highly advanced Apache, might cost $1-2 million.[35]

Additionally, ballistic missiles are becoming less available, due largely to the effectiveness of the MTCR in this area. The former Soviet Union no longer supplies Scuds to client states, and Argentina, Brazil, South Africa, South Korea, and Iraq have halted ballistic missile production programs. Only North Korea still supplies MTCR-restricted ballistic missiles.[36]

Cruise missiles also have advantages over manned aircraft. Proponents of aircraft argue that they deliver munitions more accurately and more cheaply than cruise missiles. For a nation like the US this may be true, but Third World nations facing an opponent with a modern integrated air defense system (IADS) will find greater utility in cruise missiles.

Assume a nation possesses 100 modern attack aircraft worth $30 million each, and flies them two sorties a day with a ten percent combat attrition rate. By day four, over half their aircraft have been destroyed, at a cost of $1.5 billion, not including significant costs such as pilots, training, and munitions. The greater utility of manned aircraft over cruise missiles assumes an extremely low attrition rate. Third World nations, facing modern IADS without the benefit of stealth aircraft, would likely absorb attrition rates high enough to make cruise missiles an attractive alternative. As a minimum, these countries should find a mix of land attack cruise missiles and manned aircraft very effective.

CRUISE MISSILES AND WEAPONS OF MASS DESTRUCTION

SFC Thompson's Avenger team certainly had drawn a great assignment. Defending Prince Sultan Air Base also meant sleeping in a real bed and eating at the Air Force dining hall. His team was on station about two miles north of the airfield when the platoon lieutenant passed him the word that all sectors were now at Air Raid Warning Red, and that the fighters that had launched before dawn were also returning to the base.

It was another half hour before he saw the cruise missile. It was not traveling very fast and was less than a mile east of their position, but his team was unable to react fast enough to get off a shot. He lost sight of the missile behind a sand dune, then saw it reemerge on the other side, heading directly towards the airfield.

The lieutenant acknowledged Thompson's report over the point defense radio net, realizing he had no assets to engage the leaker. He put down his headset and crossed the room looking for the Air Force colonel who was in charge of the Command Post, and thought about how he would break the bad news. Perhaps the missile would miss the *airfield altogether, or maybe it would just blow up a pile of worthless sand. The lieutenant never passed his report to the colonel.*

The warhead detonated about a quarter mile from the middle of the airfield at about 500 feet above ground level. SFC Thompson was temporarily blinded by the flash, for although a ten kiloton yield is not large, he was looking right at the airfield. It would take weeks to put together an accurate casualty list, but if the Iranian War Council was right, two early casualties would be the cohesiveness of US-led coalition and the willingness of the American people to lose their sons and daughters in a war that was not theirs.

Cruise missiles are ideally suited to deliver weapons of mass destruction. Their slow speed and high accuracy allow them to dispense chemical and biological agents either through submunitions or spraying. Cruise missiles are also effective delivery vehicles of nuclear warheads. Using the MTCR threshold of 500kg, there are at least ten cruise missiles that can deliver nuclear weapons.[37]

There is an alarming correlation between countries pursuing cruise missiles and those possessing weapons of mass destruction (WMD), nuclear, chemical, or biological capabilities. In addition to the US, UK, France, China, and Russia, there are at least eleven Third World nations that have the capability to deploy land attack cruise missiles and the capability to produce WMD. Additionally, eight other countries with WMD have ASCM capability.[38]

CRUISE MISSILE DEFENSE SYSTEMS

Lt Cdr Sam "Skittles" Hodges had been on station about 40 minutes, assigned to perform defensive counter air combat air patrol, or DCA CAP as it was listed in the air tasking order. He certainly would rather have taken his F/A-18 as part of the Roosevelt's strike package against the surface-to-air missile sites near Bandar Abbas. Perhaps tomorrow he would get an offensive mission. Another 20 minutes and he and his wingman were scheduled to go to the tanker, then another hour on CAP. The AWACS controller interrupted his thoughts.

"Snake 01 flight, vector 0-7-0, kill, single target 0-8-0, 29 miles, low." Skittles acknowledged the pairing, rolled out headed 0-7-0, and headed down to 10,000 feet above the Arabian Gulf. His wingman deployed to a right echelon position, spread one mile just as they had briefed back in the ready room. The radio crackled "target estimated 0-8-0, 15 miles, mach point seven, low, probable cruise missile." Skittles clicked his mic button in acknowledgment.

The F/A-18 radar detected the target at ten miles and under 1,000 feet altitude. Skittles continued his descent, offset right, and converted to the cruise missile's stern. Half way through the turn he had a brief visual contact with the missile, but lost sight as the missile's color blended well with the water and haze below. Skittles had planned to engage with an AIM-9M Sidewinder missile, but the cruise missile's small engine combined with a diffused, downward-angled exhaust did not put out sufficient heat source for the seeker head of the missile to track it over the relatively warm gulf waters. Skittles broke off right to achieve separation, then turned back to the target. As he came *out of the turn he got another radar lock and pulled the trigger. The AIM-120 Advanced Medium Range Air-Air Missile (AMRAAM) tracked to its target, and both Skittles and his wingman observed the cruise missile break into three pieces as a result of the AMRAAM's detonation. Skittles passed the results, "Fox one, splash one cruise missile, off south with 40 minutes playtime"*

Lt Cdr Hodges wondered what the cruise missile's intended target was, but he did not reflect for long. The AWACS controller interrupted, "Snake 01 flight, kill, multiple targets, northeast, 30 miles, low, probable additional cruise missiles."

"Negating the cruise missile threat will likely prove much more difficult than thwarting (theater ballistic missiles) TBMs. Cruise missiles in the short term will be dealt with similar to enemy aircraft, using airborne interceptors with look-down, shoot-down radars as well as ground defense systems. In the long term, stopping cruise missiles will require a new generation of passive infrared and active radar detection equipment."[39]

The wide use of ASCMs since 1967 have caused most Western navies, including the US, to develop and deploy effective ASCM defenses.[40] But land attack cruise missiles were last used against Western nations in 1945. It is easy to see why emphasis on cruise missile defense would be allowed to whith . Now with a potentially growing threat at the same time as defense budgets in Western nations are shrinking, we are faced with difficult decisions concerning which programs would be sacrificed to fund cruise missile defense improvements. Dependence on arms control measures alone is counterproductive. If we fail to also develop and deploy effective cruise missile defense systems, the proliferators are merely encouraged to pursue offensive capabilities faster and in greater numbers. And it is already clear the MTCR is ineffective in preventing cruise missile proliferation.

Efforts are required in three major areas: improved air-to-air missiles and fire control radars, surface-to-air missile systems, and wide area surveillance systems to detect, identify, track incoming missiles, and cue shooters. For the near term, planners expect that fighters are the best defense against the threat. The US Air Force is exploring a new version of the AMRAAM with a multispectral sensor that searches for infrared and radio signatures of cruise missiles.[41]

Improvements in surface-to-air missile systems are also on the horizon. The first upgrade to our current air defense capability is the Patriot Advanced Capability Level 3 (PAC-3). But PAC-3 was designed to counter high flying ballistic missiles, and will probably have questionable performance against low flying cruise missiles with small radar cross sections.[42] Theater High Altitude Area Air Defense (THAAD) is also designed primarily to counter ballistic missiles. The Medium Extended Area Defense System (MEADS) is being developed cooperatively by the US, France, Germany, and Italy.[43]

MEADS is unique in that it is being designed specifically to have capability against cruise missiles and unmanned aerial vehicles. It is expected to have a significant capability to defend against stealthy air vehicles. However it's ground based radar is a liability because of line of sight limitations to its range. Such restrictions would give it little more than self defense capability. Two options are being examined to overcome this shortfall. One is a helicopter-mounted radar system that would be expected to increase detection ranges against stealthy cruise missiles to 75-100 miles. The second option is an aerostat-mounted radar that, because of its ability to lift heavier payloads, could extend the detect range out to possibly 300 miles.[44]

In fact, Pentagon analysts have been examining the possibility of using aerostats to deploy a combination of radar and other sensors to detect and track of stealthy aircraft and missiles in high clutter environments. An airborne radar system, combined with other sensors, could possibly look down and even detect a moving empty spot created by a nonradar-reflective object. Operating costs of an aerostat-based system would be projected to be around $500 per hour, compared nearly $3,000 for an E-2 and $8,000 for an E-3 AWACS.[45]

Modifications to AWACS may also allow it to detect cruise missiles, combining improved radar with an anticipated infrared sensor upgrade. However, most specialists feel there is no single system that can solve the cruise missile problem and that hurdles exist in fusing information in a timely manner to allow cruise missile engagement.[46] One proposal presented by the editor of Aviation Week and Space Technology urges that the Air Force provide the surveillance portion of the solution while the Army and Navy provide the weaponry, such as Aegis and MEADS. In addressing the sensor requirement, the editorial contends "that combining special-frequency airborne radar with infrared and electro-optical sensors on board existing aircraft would produce the 'extended eyes' capability at a fraction oı the cost." This division of labor saves money by allowing Army and Navy to cut sensor costs, and frees Air Force fighters for other tactical missions.[47]

In 1993, Secretary of Defense Dick Cheney said, "The size and flight profile of cruise missiles can stress the capabilities of air defenses."[48] What is clear is that defending against the next generation of highly accurate, low observable cruise missiles will be many times more difficult. Our current sensors are incapable of adequately detecting and tracking these weapons, and research and development efforts that would lead to improved defensive weapons systems must compete for shrinking funds with the well established and high profile ballistic missile defense programs. With potential adversaries capable of fielding stealthy cruise missiles early in the next decade, time is running out.

EFFECT ON AIR OPERATIONS

Hauptmann Meier's Tornado was low on fuel as it crossed the northern Iranian coastline and went feet wet. Scrambled on an extreme priority mission to search and destroy temporary cruise missile storage facilities near Isfahan, he had become separated from the rest of his four-ship when the German Air Force strike package encountered heavier than expected anti-aircraft fire and then bad weather in the target area. More time for mission planning might have prevented this, but after the shocking Iranian attack at Prince Sultan, his mission took on new importance. Now flying single ship, he followed the minimum risk route over the gulf, decreasing his speed to 300 knots to conserve fuel.

Approaching the Saudi coastline he turned south and climbed to 15,000 feet, hoping to save a little more fuel. He considered diverting to Al Jubayl. As he followed the coastline, his radar warning receiver, which had been active throughout the mission, now displayed indications of an active Patriot radar. Hauptmann Meier was quite familiar with Patriot, his own German Air Force used the system, and he knew missiles were deployed all along the coast, a sort of Maginot air defense line. However, he was very surprised when his radar warning receiver displayed lock-on and launch indications. No *sooner had he rolled his Tornado to the right than he saw the missile streaking towards his jet. Instinctively, he broke hard left and dove for the deck. His futile efforts ended seconds later as the Patriot ripped his Tornado apart. Hauptmann Meier never had a chance to eject.*

The Iranian plan to launch cruise missiles immediately after coalition air attacks was intended to serve two purposes. The Iranian planners thought that such timing might increase confusion, allowing a higher number of missiles to penetrate defenses and hit their targets at a critical time as the fighters and bombers were landing and defenses most vulnerable. The seven coalition aircraft shot down that morning by their own air defenses were a welcome bonus. The 230 cruise missiles wreaked havoc on efforts to identify friend from foe, and in the resulting confusion American fighters and land- and ship-based surface-to-air missiles destroyed two Saudi, three French, one Czech, and one German aircraft. Hauptmann Meier had survived his mission over Iran, only to be killed by friendly IADS.

"We thought from the beginning that we would have to attack Scuds. What surprised us was that we put three times the effort that we thought we would on this job." Air Force Chief of Staff Merrill McPeak[49]

Military operations by the US in the past 50 years have been conducted relatively free from enemy air attack. This has provided tremendous freedom of action and allowed us to dictate the pace of operations. An adversary's ability to conduct offensive air operations against us would limit that freedom. Two examples demonstrate the effect that an enemy's offensive air operations have on the planning and conduct of our operations.

Operation Crossbow, from August 1943 to March 1945, was the allied effort to stop German V-1 and V-2 attacks during World War Two. All told, this effort consumed 68,913 sorties and dropped 122,133 tons of bombs. During the first 13 months of the operation, 15% of the bomber effort and 16% of the tactical fighter effort was diverted to defeating V-weapons. Despite this, missile launches continued until ground occupation finally stopped them.[50] It is estimated that the allies' effort to defend against the V-1 cost them four times the amount the Germans expended to conduct the offensive.[51] Modern cruise missiles fly at much lower altitudes, have a radar cross section 100 times smaller, and are two hundred times more accurate.[52]

Additional insight is gained by examining the effort expended in hunting Scuds during Desert Storm. Around 1,500 sorties were flown against known Scud targets, and at one point at least one-third of the 2,000 daily strategic attack sorties were diverted to Scud hunting duties.[53] On average, 6 percent of daily sorties were flown against the Scud threat.[54] All this was against a missile system that was considered militarily insignificant. It could deliver a single 2,000 pound warhead 300 km with a circular error probability of 900 meters.[55]

Although countering the missile threat in both World War Two and Desert Storm siphoned off a significant portion of airpower from other tasks, the other missions were still accomplished in both cases. The next war may not prove the same as Western air forces continue the drawdown. New generation cruise missiles provide potential adversaries the ability to attack us with precession throughout the theater of operations, and that attack may include WMD. The continuing political requirement, now combined with a real military necessity to find and destroy both cruise and ballistic missiles, may drain off so much air power that other critical enemy capabilities are left untargeted.

Finally, our ability to perform combat identification of aircraft, especially in a coalition environment, has not been tested. Identification of our own aircraft using secure identification friend or foe (IFF) systems is fairly reliable, but future warfare will almost assuredly be a coalition undertaking, and allies' aircraft do not possess our IFF systems. This situation is compounded by our increasing reliance on UAVs and RPVs. This mix of manned and unmanned, US and allies, with well-timed enemy air attack including low observable cruise missiles, will be an IFF nightmare.

SYNERGISM

The Defense Support Program satellite orbiting 23,000 miles above the earth detected the infrared signature of three Iranian ballistic missiles. The data was downlinked to the Joint Tactical Ground Station (JTAGS), processed by CENTCOM's theater missile defense cell, and rebroadcast almost simultaneously via a series of tactical data links to every air defense command and control system in the theater.

Within the Air Operations Center, the Senior Air Defense Officer saw the launch indications, followed shortly by three trajectories and predicted impact points. Just as he had rehearsed in many exercises, he declared missile warning for the affected sector, and ordered the engagement of the inbound missiles.

The Patriot battery commander had closely followed the proceedings over her data link display, and knew her unit would be in the best position to engage. Her battery had sat for days in EMCON silent to conceal their whereabouts from the enemy, and now *would finally to get a chance to show their stuff. As soon as the pairing lines showed on her display, she ordered her radar out of standby, and searched the sky for the first target. The new PAC-3 missile would soon leap skyward to destroy the inbound Scud. Everything worked like a well-oiled machine.*

Twenty miles away, other events were taking place that would disrupt that machinery. The small propeller-driven drone had loitered unobserved off the coast for nearly an hour. Now the anti-radiation missile seeker detected the Patriot tracking and acquisition radar signal. The small harassment drone made a beeline for the radar, barely exceeding 80 knots airspeed, well below the moving target threshold of the AWACS at 29,000 feet and 50 miles west of the tiny drone. Although two Patriot missiles would be successfully fired before the drone would crash into the fire control radar, the Iranians had achieved another cruise missile success. A seventy mile wide hole was punched in the coalition's integrated air defense system, and the remaining Iranian Air Force attack aircraft were just getting airborne.

Low observable Tomahawk cruise missiles "made possible direct strikes at the heart of the Iraqi air defense system at the very outset of the war...the Coalition could strike Iraqi air defenses immediately and they never recovered from these initial, stunning blows."[56]

Each air attack system; manned aircraft, ballistic missiles, and cruise missiles, have inherent strengths and weaknesses. A savvy potential adversary will seek to achieve an appropriate balance of the three. Cruise missiles by themselves provide a Third World adversary the ability to strike a modern enemy, like the US, in a regional conflict. But the greater utility is in employing them to be complementary to other systems. We have provided the lesson to the world.

Our use of cruise missiles in initial strikes to disable Iraq's IADS enabled manned aircraft to deliver large quantities of munitions with virtual impunity. A Third World country can achieve similar results, albeit on a smaller scale. Advanced cruise missiles can serve as the enabling tool for operations by manned aircraft and ballistic missiles that would otherwise fall victim to our modern IADS. Carefully synchronized employment of all three types of weapons has the potential to multiply their effectiveness by achieving a high degree of synergism.

CONCLUSIONS

"Today's widespread proliferation of ballistic and cruise missiles has perhaps redefined the notion of 'command of the air' espoused over a half century ago by Giulio Douhet. The possibility now exists that a nation can obtain air control without possessing an air force."[57]

There is a very real prospect that cruise missiles may soon be the "poor man's air force." This should come as no surprise. We have espoused our belief that even if air power cannot win wars by itself, wars cannot be won without it. The ability to control the air at the time and place of one's choosing and the ability to hold your enemy's strategic targets at risk is essential to modern warfighting. We have developed the most powerful air force in the world to ensure we have this capability.

Our actions certainly have not gone unnoticed by potential Third World adversaries. With no hope of matching our technology or resources to develop a manned air force, many turned to ballistic missiles as an alternative. We have reacted decisively to that threat by investing heavily in theater ballistic missile defenses and aggressively fighting ballistic missile proliferation. These actions have driven our competitors toward the next alternative, procurement of modern cruise missiles.

Efforts to thwart this proliferation have been generally ineffective, and the outlook for future nonproliferation efforts is not encouraging. Additionally, our current defenses are not prepared to counter an advanced cruise missile threat. This is particularly dangerous because shrinking defense budgets are forcing difficult decisions in research and development efforts and weapons procurement. The ballistic missile threat has received such a great level of attention that it has overshadowed the evolving cruise missile threat.

The implications are clear. Advanced cruise missiles may soon be commonplace in the inventories of potential adversaries. We must pursue cruise missile defense with a new vigor, likely at the expense of some ballistic missile defense initiatives. The ability to detect, identify, track, engage, and destroy advanced, low-observable cruise missiles is an absolute necessity. Failure to do so will make the regional conflict of the next decade unacceptably dangerous.

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[11] "Integrate Anti-Cruise Missile Planning," Aviation Week and Space Technology , (12 July 1993): 68.

[12] Ranger, 257

[13] Quote from William Perry, United States Secretary of Defense, February 1994, in Ewing, 5.

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[24] W. Seth Carus, Cruise Missile Proliferation in the 1990s, (Washington: Center for Strategic and International Studies, 1992), 92.

[25] Ewing, 22.

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[28]Federation of American Scientisits, "Cruise Missiles: The Other Air Breathing Threat." <http://www.fas.org/spp/aircrat/part05.htm>. 29 Jan 1997, 13.

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[30] Gormley, 28.

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[33] Fulgham, David A., "Cheap Cruise Missiles a Potent New Threat." Aviation Week and Space Technology, (6 September 1993): 54.

[34] Ranger, 256.

[35] Fulgham, 54.

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[38] Ranger, 264-265, extracted from chart, does not imply these weapons are currently able to be delivered via cruise missile, but may be capability nations pursue.

[39] William C. Story, Third World Traps and Pitfalls: Ballistic Missiles, Cruise Missiles, and Land-Based Airpower (Maxwell Air Force Base: Air University Press, 1995.), 44.

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[41] Fulgham, David A., "AMRAAM Sensor Mods Pace Missile Defense," Aviation Week and Space Technology, (29 April 1996), 59.

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[43] Ibid.

[44] Fulgham, David A., "Helos, Aerostats to Push MEADS Range," Aviation Week and Space Technology, (30 October 1995), 53.

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[46] Fulgham, "AMRAAM Sensor Mods Pace Missile Defense," 59.

[47] "Integrate Anti-Cruise Missile Planning," 68.

[48] Ewing, 17.

[49] Quote from Gen Merrill McPeak, Chief of Staff of the Air Force from Dr Keith B. Payne, "Defence Against Missile Proliferation," Jane's Intelligence Review 4, No. 5, (May 1992), 235.

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[55] Ibid., 20.

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DOCUMENT 4

Menace of Anti-Ship Missiles and Shipborne Laser Weapons

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by

Fang Qiwan, Yin Zhixiang, Jiang Chuanfu

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MENACE OF ANTI-SHIP MISSILES AND SHIPBORNE LASER WEAPONS

BY: Fang Qiwan, Yin Zhixiang and Jiang Chuanfu
(Naval Academy of Engineering)

ABSTRACT

This paper discusses the menace of anti-ship missiles, the difficulties of operational shipborne short-range anti-missile defense systems, and a survey of the development of shipborne laser weapons.

I. Introduction

During the Third Middle East War in 19067 Israel's destroyer "Ailate" (phonetic) was sunk by a "Styx" missile launched from a small speedboat. In the 1971 war between India and Pakistan, India launched 13 "Styx" missiles, 12 of which hit their targets. In the 1973 Arab-Israeli war Israel's "Jiaboli" (phonetic) anti-ship missiles sand five arab ships. In the Falkland Island War in 1982 the British destroyer "Sheffield" and transport "Atlantic Transporter" were sunk by "Exocet" missiles. From the third Middle East War to the Gulf War, a total of 170 to 190 anti-ship missiles have been launched, sinking more than 20 ships and boats. Therefore, how to deal with anti-ship capabilities to improve combat capabilities and survivability is the developmental direction for modern naval ships.

II. The ever increasing threat of anti-ship missiles

Anti-ship missiles are flying bombs equipped with guidance systems directed against ships. Modern naval combat has demonstrated that anti-ship missiles are highly reliable and tremendously destructive. According to incomplete statistics at the end of 1990, there were 77 countries in the world which possessed anti-ship missiles, and the total number of anti-ship missiles coming to about 30,000. It is estimated that in 1997 the number of countries with anti-ship missiles will increase to 100, and the total number of anti-ship missiles will grow to 50,000. these missiles have replaced the ship guns as the primary offensive weapon. Their primary characteristics are:

1. Small and light, and can be launched from any platform

Because of the developments in microelectronics, small nuclear warheads and small high efficiency turbojet engine technology, anti-ship missiles are small and light, about one order of magnitude smaller and lighter than a ballistic missile with the same range. Also, because of the powered flight of the missile, launch recoil is light, and they can be launched from the ship deck on the surface of the water, from submarines under the water, or from aircraft (or helicopters) in the air. They can also be launched from trucks on land. Because they are small and light, the various carrier platforms can carry large numbers of these missiles. For example, a submarine or a bomber can carry ten to several dozen to launch a saturation attack, which is extremely difficult to defend against.

2. Small and fast, with strong breakthrough capability

Anti-ship missiles present a small radar cross section, from $0.05m^2$ to $0.10m^2$. Stealth missiles currently being developed may be as small as $0.01m^2$. However, current radars were designed for large cross sectional area aircraft, so fire control radars have an operational range of only several kilometers against anti-ship missiles. At the same time, anti-ship missiles are very fast, currently from sub-Mach speeds to Mach 3, and before long they will reach Mach 2 to 5. Fire control systems currently in service cannot intercept them. Also, anti-ship missiles attack from two blind spots of radars - the ship water line and vertically from above. That is, cruising just above the surface and large angle dive. For example, for a wave-hopping missile with a small radar cross section and a terminal flight altitude of two meters, it would be difficult to detect even by modern radars with moving target display characteristics and can inhibit ocean interference waves and have high detection capabilities. Although fire control radars can track these missiles, when they appear on the scope, the target darts back and forth, and it is difficult to get a precise fix, and precise target parameters cannot be obtained. Surface reflection false return waves can result in proximity fuses detonating at the wrong time, and anti-missile missiles have a hard time in guidance toward the target. Tests and exercises have both demonstrate that even with extremely good ideal conditions, the rate of detection and intercept of anti-ship missiles is very low. In summary, because their radar cross section is becoming smaller and smaller and their speed faster and faster, and with their concealed path, they are not easy to detect, track and intercept. Therefore, anti-ship missiles have a very strong capability to break through defenses.

3. Long range, can be launched outside air defense firepower

Anti-ship missiles have ranges from 30 to 800 kilometers, while the gun with the longest range, the United states 280 mm gun which fires atomic shells has a firing range of 32 kilometers. Therefore, the absolute majority of anti-ship missiles can be launched from outside the range of the ship's air defense fire power. Anti-ship missiles with a range of 30 to 50 kilometers are mounted on small missile launches or escorts and can be launched at a target within the range of the ship's radar. Anti-ship missiles with a range of 500 km or more are mounted on submarines or large surface ships, and can be launched outside the defenses of the targets aerial formation.

4. They are intelligent, and have good combat effectiveness

The terminal homing radar parabolic antenna of anti-ship missiles have the capability of automatically mounting the antenna shield in order to reduce the radar cross section. They can be loaded with launch ballistics in advance in order to conceal the location of the launch platform. Terminal homing radars have frequency shift capability. When the homing radars are jammed, they can automatically switch to tracking jamming sources or to electronic optical automatic modes. They are equipped with logic circuitry to differentiate between radar jamming and the actual target. They are equipped with logic circuits which alter the missile velocity what they come within a certain distance from the target. They are equipped with logic circuits which differentiate between infrared tracers and the real target's characteristics. They can have their terminal attack trajectory programmed in advance, increasing the destructive capability of the bomb, such as avoiding sp··ial armored locations on the enemy ship, and finding weak links in order to increase the combat effectiveness of the warhead.

5. High precision, highly destructive

The destructive capability of missile is determined by the precision of the guidance and the power of the warhead. The guidance of anti-ship missiles is intermediate inertia guidance and terminal frequency shifting radar (active, semi-active or passive), infrared target-seeking, television and laser guidance, as well as low light television and composite guidance currently under development[1]. In addition to semi-active radar target-seeking and television guidance, the other forms all have fire-and-forget capability. Guidance precision is one order of magnitude higher than ballistic missiles, and precision can be within 10 meters. Warheads are shaped charge armor piercing, semi-armor piercing and high explosive. They may also be mixed with nuclear warheads. Hits by one or two anti-ship missiles can destroy a ship.

III. Problems with current anti-missile systems

Current ship gun and missile anti-missile defense systems both are unable to intercept anti-ship missiles.

The Italian Navy with industrial assistance has proposed using a gun as the final line of defense against anti-ship missiles and the ideal terminal defense.

Guns are traditional air-defense weapons. They have wide applications, are cheap, have a high rate of fire, and a broad field of fire. A number of nations use advanced radar and optoelectronic fire control systems on their ships as terminal defense. In the Falkland Island War England's Sheffield was equipped with three dense burst of fire systems which were purchased at a cost of 4.8 million Dollars in an attempt to increase the ship's defensive capabilities. However, these systems have not yet been tested under actual fire.

The eight major foreign close range gun anti-missile systems are the MK15-1 dense burst, the "NAVAL GUARD" (Haishangweishi), the "DADUO" (phonetic), the SAMUSI (phonetic), the MEILUOKA (phonetic), the TELINIDI (phonetic) and the CADS-N-1[2]. The first seven are called first generation shipborne gun anti-missile systems, and the eighth is replacement equipment for former Soviet Union 1970 first generation, and is a second generation ship anti-missile system. It has a rate of fire 1. to 2.5 times faster than first generation systems. All of these systems are direct hit systems and not indirect hit systems. They used zenith technology and a unified structure as well as combined shell and gun, and increased the capacity of the magazine[3]. However, they are barrel energy weapons and there has been no change in their firing accuracy, and the mechanism of direct hit damage has not changed. Therefore, dynamic projectile terminal effect and anti-missile effectiveness both require thorough research, and await testing under actual combat conditions. Whether first or second generation systems, the primary problem with close range ship gun anti-missile systems is the close range and slow reaction time of the detection and tracking of the anti-ship missile, and the inability to intercept. The MEILUOKA (phonetic) system has a response time of 4.2 seconds, but this is only from the time of detection until the guns are directed toward the specified point, and does not include the time required from the launch control system receiving the order to fire until the firing procedure is begun. The dense burst reaction time is six seconds, but some data shows it to be 10 seconds, and other data says it is 3.5 seconds. A definite reaction time is given for the DADU^ (phonetic) system, and a definite picture of the seven time segments which compose reaction time is also given. The "DADUO" (phonetic) system intercept range is 900 to 3000 meters, but the proximity fuse shells theoretically require a minimum of two to 4.5 seconds to destroy the data of the missile guidance system to cause the missile to deviate from its course and miss the target 99 percent of the time. If an "EXOCET" missile travelling at Mach 0.95 attacks, then the close range intercept distance should be 340 X 0.95 X 4.5 = 1500 (meters). The long range intercept time when the target is three kilometers away is 16 seconds. However, within 16 seconds, the target moves 5.2

kilometers closer, and the minimum range for the search radar to detect the target is 8.2 kilometers. When the target is 1.5 kilometers away, short range intercept time is 14.5 seconds, during which time the target will move 4.5 kilometers closer. When it is less than 4.7 kilometers, the continued intercept time is only 4.5 seconds (for a target travelling at Mach 0.95), and only 45 rounds can be fired, limiting firepower. However, anti-ship missiles under development have a radar cross section of only 0.1m^2, and wave-hopping flight speed will be Mach two to Mach three (for large angle dive missiles, the speed will be as much as Mach three to Mach five), then the "DADUO" system detection range will drop from nine kilometers to six kilometers. Then the Mach two or Mach three missile will move 340 X 2 X 4.5 - 3000 (meters) or 340 X 3 X 4.5 - 4600 (meters) closer to the ship from the time it is detected at six kilometers in only 4.5 or 1.4 seconds. This is much less than the sum of the system reaction time and the projectile flight time. Since short range intercept range is equal to or greater than long range intercept tome, intercept range is zero or negative, and reaction is impossible.

Naturally, some of these ship gun anti-missile systems have a direct hit system. This does not require consideration of the aforementioned two to 4.5 second time restriction for the miss_'e to deviate from the target. However, their guns are smaller than those of the "DADUO" system, and effective firing range drops from the 8000 meters of the "DADUO" system to 3000 to 1486 meters, and long range intercept range drops from the 3000 meters of the "DADUO" system to 1800 to 1200 meters. Therefore, in summation, the other seven types of ship gun system also have similar problems to varying degrees. Also, after the shells are fired, they cannot deal with the avoidance maneuvers of the incoming missile. The fuses and charges of the 40 mm, 35 mm and 20 mm guns cannot penetrate missile warheads which are equipped with armor. In summation, close range ship gun systems cannot effectively defend against anti-ship missiles.

Compared to ship guns, shipborne anti-missile have a higher hit rate and are more powerful. However, surface defense missiles do not have the capability to counter anti-ship missiles. This point was demonstrated during sea combat of the Falkland Island War. The British "HAIBIAOQIANG" (phonetic) missiles were unable to detect wave-hopping missiles because of their excessive reaction time, in addition to the search radar reaction time, the reaction time was as much as 19 seconds, and because the missile semi-active homing head did not have look-down capability and could not track wave-hopping targets, and especially because warning radar had poor low altitude capabilities. For example, the "SHEFFIELD"'s warning radar never did detect the long-range "EXOCET" missile which was fired from 70 kilometers away. It was not visually detected until it had approached to 1500 meters. At this time there were only five seconds before impact, and the "HAIBIAOQIANG" missiles were useless, so the crew watched as the ship was hit, exploded, caught fire and sank.

There are a number of different types of point defense missiles wh: h have a certain degree of anti-missile capability. However, the basic design of the widely deployed "Sea Sparrow" missile is fairly old, and it cannot effectively defend against modernized anti-ship missile attacks. However, the first point defense missile believed effective against anti-ship missiles - the "sea Wolf" missile was not effective at all in the Falkland Island War, not shooting down a single anti-ship missile. Because the maximum intercept range of the "Sea Wolf" is five kilometers, and it requires a 15 kilometer warning of a wave-hopping missile attack, and 15 kilometers ordinarily the sighting limits of destroyer or escort radars, nd at the same time, these current radars are not able to discriminate between extremely small wave-hopping missiles and surface noise, and these systems have a long reaction time, generally ten to 14 seconds, and these missiles all have a blind zone, which begins when the missile leaves to tube until it enters the fire control system guidance beam and flies to the required course. Within the blind zone the missile cannot be controlled and cannot be pre-programmed to enter the target's path. Also, the missile requires a fairly long time for power supply time and for preparatory operations, and cannot be launched immediately.

Therefore, close range missile anti-missile systems currently employed have difficulty coping with the current sub-sonic "EXOCET" missile, and if the speeds of the anti-ship missiles exceed Mach 1.8, then they will be useless.

IV. Anti-missile technology always lags behind missile technology

The two currently employed anti-missile systems have limited anti-missile capability. Therefore, facing a missile attack a ship has little hope of survival, especially if there are a number of anti-ship missiles in an almost simultaneous dense saturation attack.

There is also developmental potential in close range missile systems, and it is still possible to make some advances to cope with certain current anti-ship missiles, such as increasing the velocity of the missile, using composite guidance, using a unified search and tracking system, selecting phase controlled array radars, improving capability of detecting super low altitude small targets, switching to helicopter launch mode, shortening reaction time and all directional counterattack capability. However, enhancing the capabilities of defensive missile systems will only encourage advances in attack missiles, and in the 21st century anti-ship missiles will have the following characteristics:

They will use helicopter launch technology, they will have large storage capacity, will have a high launch rate, will be able to launch immediately and will be able to attack in all directions. They will have increased range, increased speed and will take less time to reach the enemy. They will use stealth technology, and in addition to wave-hopping flight, they will also be capable of level snaking flight and of maneuvering high low high and low high low, they will use under water attack at the terminal end, they will use acoustic or magnetic signal for terminal guidance, greatly increasing concealment in their attacks. The missile engines will use exhaust smoke abatement and exhaust gas cooling to reduce the engine's infrared signature. The size of the missiles will become smaller, eliminating the straight angle structure, and the nose surface will be a beehive structure, and the body will be coated with a microwave absorbing material to reduce the radar cross section. Artificial intelligence technology will be used for intelligent capability for terminal guidance and the guidance head will be capable of inference and decision making, to form an artificial intelligence expert system which can automatically search, recognize, capture and track and attack a target in a complex vironment. They will be capable of selecting their own priority target according to degree of threat. They will be equipped with shrapnel warheads with time delay fuses, exploding after they have penetrated the body of the ship to increase their destructive power. They will be equipped with shaped charge warheads which will concentrate energy on a certain point of the ship to destroy the armor protection at an important location on the ship. They will become standardized, interchangeable, systemized and modularized in order to reduce research costs, reduce the refitting cycle and to reduce the amount of space taken up by the system.

Just speaking of increasing missile velocity, the former Soviet Union has continued development of the Mach 5 hyper velocity missile systems the SA-N-6 and the SA-N-7. They can shorten flight time, and thus correspondingly shorten the radar warning time required. However, there are limits to how much the time can be shortened, and the potential for this is not great. However, anti-ship missile velocities are also constantly being increased, and their radar cross sections are being reduced by orders of magnitude, greatly reducing the warning times radars are able to achieve, with the results that they are still not able to react in time. The 5Ma defense missile is similarly unable to a well coordinated dense saturation attack.

Therefore, looking at the development of offensive and defensive missile technologies, the anti-ship missile is unlimited, effective, and cheaper, while the shipborne defensive missiles are restricted, are unable to achieve high effectiveness and are very expensive, as well as being restricted by space aboard ship and costs. Therefore advances in anti-missile technology always lag behind advances in missile technology. For example, the French Universal Corporation and the German MBB Corporation have jointly developed the ANS anti-ship missile which flies at low altitude at speeds of Mach 2 and at intermediate altitudes at Mach 2.5 and has a maximum range of 180 kilometers. It can wave-hop the entire flight, and can fly at Mach 2.5 at intermediate altitudes for 160 kilometers, and approach the target at wave-hopping altitudes for the last 20 kilometers. It is also capable of snaking maneuvers to avoid being intercepted by close-range anti-missile systems. When it encounters heavy ECM jamming, it can use passive infrared guidance mode to search for and attack its target. Foreign publications call it a "hyper velocity, semi-intelligent terminal guidance anti-ship missile". It will replace the French "EXOCET" missiles and the German "Cormorant" missile. It will be placed into use in 1995. As Bixiai (phonetic), maker of the French Universal Corporations "EXOCET" missile stated, at the present time naval offensive power is greater than defensive power, and if defensive systems cannot deal with current missiles, then they will not be able to cope with the hyper velocity missiles currently under development.

In summary, future anti-ship missiles will be longer range, faster, have smaller radar cross sections, have more concealed paths and be more intelligent. Therefore, anti-ship missiles will be more of a threat. In order to turn this situation around, and improve the hit capability and combat power of ship, it will be necessary that they be equipped with a new generation anti-missile weapon, and the one with the best hope is the laser weapon.

V. Characteristics of laser weapons

1. Extremely high speed

Laser weapons fire laser beams which travel at the speed of light, $3X10^5$ km per second. Flight time to the target is almost zero, they hit as soon as they are fired, so there is no problem with lead or lead time.

2. They have a very high firing rate

10,000 laser pulses can be fired every second, and hooked up with a high speed computer, it is possible to fire 10,000 times per second at an incoming missile.

3. Strong mobility

Current ship-borne missiles and ship guns are powerless against a dense saturation attack. However, because laser weapon fire light beams which have a mass of almost zero, and do not generate recoil and are not affected by gravitational fields, they can quickly change the direction of fire by turning a mirror, switching from one target to another in a fraction of a second. They can fire at multiple incoming targets in different directions in a short time, so laser weapons are especially effective against dense saturation attacks by anti-ship missiles.

4. They have a high probability of intercept

Strong laser light can blind the sensors of optical guidance weapons from long range. At fairly close range they can cause the nose cone of the missile to break apart. At close range they can destroy the hard outer shell of the missile. Therefore, multiple firings at an incoming missile at different distances will use different damaging mechanisms against the target, and if the target is hit, it can be destroyed, with a dill rage of almost 100 percent[4].

5. Highly cost effective

U. S. Navy res‹ ‑rchers believe that laser weapons cost less than tactical missiles. They have said: The cost of launching a tactical missile has increased from 50,000 Dollars to 2.5 million Dollars, and a single laser attack, according to estimates, after including hardware and personnel training costs, is only 10,000 Dollars.

6. Support services are simple

Laser weapon systems fire energy, and not traditional shells or missiles. Compared to the shells and missiles of ship gun and missile systems, the fuel they require is insignificant. Therefore, the support services for laser weapons are extremely simple.

Also, the U. S. Navy has another plan. This is to study nuclear reactor pile fired laser. Theoretically, this type of laser will have an unlimited supply of "ammunition".

VI. Status of development of ship-borne laser weapons

The United States Navy has paid a great deal of attention to laser weapons all along. Just as Allen Bage (phonetic), the planning manager at the United States Navy Research Laboratory for the "FIREPOND" laser radar for "Star Wars", stated, in order to deal with incoming weapons which are increasingly concealed and are increasingly faster, the United States Navy is currently doing research on using lasers for target detection, recognition and destruction. The totally electric drive ships being imagined will have about 50 to 100 million Watts of power, and the use of laser weapons would be no problem. Major achievements were reached as early as the seventies. As a close-range anti-missile weapon, its developmental stages and anti-missile testing have been as follow:

1974: The United States Navy began to carry out the plan of the Department of Defense, and launched research into ship-borne laser weapons such as the "Haishi" (phonetic, literally ocean rock) plan. This plan used a deuterium fluoride chemical laser as testing equipment, a large diameter mirror for focussing and the purpose was to study the overall technology of laser weapons and to conduct tests on the destructive power of high energy lasers in order to determine whether or not it would be worthwhile to use laser weapons on ships to intercept aircraft or missiles instead of conventional weapons.

1978: The United States Navy used a 400kW deuterium fluoride laser beam to destroy four TOW missiles in flight, making hits on all four, and hitting a UH-1 helicopter target aircraft.

1983: The United States used a 400kW pneumatic carbon dioxide laser to destroy five SIDEWINDER missiles in flight.

1985: On the night of September 6, the United States Navy used a 2MW deuterium fluoride laser at the White Sands Missile Range in missile destruction test. It destroyed the liquid rocket portion of a stationary ATLAS missile 1000 meters away. The continuous wave continuous operation time of the laser was three to five seconds, and the design standard was P/d=2.2mw/1.8M. When power density $I=10^6 W/cm^2$, range can be as great as 4.7 km, with an equivalent light spot diameter of $1.5cm^2$.

1987: On September 18, the United States Navy used a 2.2MW deuterium fluoride laser at the White Sands Missile Range to shoot down a BQM-34S target aircraft flying at 256 m/s at an altitude of 485 meters. On November 2 of the same year it shot down another target aircraft, this time the altitude was twice as high.

1989: In February, this system shot down a "VANDAL" missile[5] flying at Mach 2.2, thus fully demonstrating the effectiveness of this system. Recent research has indicated that the Navy's intermediate infrared advanced chemical laser and the "HAISHI" (phonetic) light beam direction finder MIRACL/SLBD can be matched together to form a high energy laser weapon system which takes up about the same space as the MK45 5in/54 ship gun and its ammunition hold. Using this high energy laser weapon system components to replace this ship gun system can result in a 15 percent reduction in weight, thus allowing a five percent increasing in ship stability (five percent reduction in pitch torque). This reduction in weight and reduction in pitch torque takes into consideration the increase in structural components. Because laser weapons systems are designed as a type of module, its dimensions and forms are consistent with those of current weapons, therefore, this helps in refitting current ships. The United States Navy is demonstrating the feasibility of a ship-borne laser weapons system advanced technology demonstration and testing plan which began in the 1995 fiscal year. The purpose of this plan is to solve problems with the shipborne adaptation of conceptually mature laser weapons. The United States Navy researchers are pressing for research of a type of experimental missile destroyer -the DDGLX which would be equipped with two high energy laser weapons systems.

1990: The French Navy used laser guns to destroy a missile infrared head and a metal plate representing an aircraft at 700 meters. This laser gun began system testing in 1984. Its fire control computer can execute five mission instructions per second. The model number is 68020. The improved version is 68030. As of the end of 1987 it had been tested more than 50,000 times.

The former Soviet Union has already installed two 3.7μm wavelength deuterium fluoride laser weapons systems which have an effective range of 10 kilometers on their KIROV cruisers.

In summary, because anti-ship missiles are already widely disseminated around the world, their threat is increasingly serious. Anti-missile defenses are becoming more and more difficult, and with current ship guns and missiles unable to ensure the ship's survivability, shipborne lasers have great developmental potential, and will undoubtedly occupy an important position on naval ships in the future.

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DOCUMENT 5

Theater Ballistic Missile Defense: Strengthening the Glue That Holds the Puzzle Together

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Naval War College

Newport, RI

NAVAL WAR COLLEGE
Newport, R.I.

Theater Ballistic Missile Defense: Strengthening the Glue That Holds the Puzzle Together

by

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Commander, USN

A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

Signature: ______________________

14 June 1996

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Joint Pub 3-01.5, Doctrine for Theater Missile Defense defines four elements comprising theater ballistic missile defense (TBMD). Of these, active defense, passive defense, and attack operations are currently being addressed in detail and have met or are moving toward successfully meeting required expectations.

The fourth element; command, control, communications, computers, and intelligence (C4I) needs to be addressed in further detail. This element is the key to bringing the remaining elements together to form a strong, synergistic defense against TBMs.

The theater commander must specifically address what preparations must be undertaken prior to the threat of TBM use becoming a reality. The area of command and control provides the answer through proper intelligence preparation of the battlefield, defining the methods of control during the execution of TBMD and providing for a TBMD cell which can adequately monitor the entire spectrum of TBMD.

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ABSTRACT

The proliferation of theater Ballistic missiles (TBMs) and their use as weapons of terror as demonstrated during the Gulf War clearly demonstrate the need to be able to defend against this type of weapon. The United States military must address this need and demonstrate it's resolve to adequately defend not only it's own forces but friendly forces, cities and populace as well. The potential use of warheads which are nuclear, chemical, or biological further complicate this issue.

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INTRODUCTION

By some accounts the U.S. led coalition that successfully defeated Saddam Hussein's army came dangerously close to disintegration. Had Saddam been able to entice the Israelis into entering the conflict, the Arab members of the coalition would have had to make a difficult choice. Either they remained focused on the objective of defeating an Arab aggressor or they refused to fight alongside the Israelis.

Saddam had chosen a strategy of attacking Israel with theater ballistic missiles (TBMs) to force them into an act of retaliation. This was essentially a direct attack on one of the coalition's strategic centers of gravity. If it had been successful in drawing Israel into the conflict, it may very well have fractured the coalition. He had properly identified that, though vulnerability to ballistic missile attack may not have been militarily critical, politically, this weakness was a major issue. Despite having assembled an overwhelming military force, the coalition lacked adequate TBM defense.

Through extraordinary diplomatic effort and the rapid deployment of Patriot Missile Defense Systems, the U.S. was able to forestall Israeli offensive action. Nonetheless, the minor destruction and terror Saddam was able to inflict brought to the forefront the very real need to strengthen the U.S. ability to counter the TBM threat.

Responding to the theater ballistic missile defense (TBMD) challenge, the latest version of Doctrine for Joint Theater

Missile Defense was published in February 1996. The doctrine offers four elements for conducting TBMD:

- Active Defense
- Passive Defense
- Attack Operations
- Command, Control, Computers, Communication and Intelligence (C4I)

This paper will address the problem of TBMD from the perspective of the theater commander today. Following a brief background into the evolution of the TBM threat it will assess current and near term developments in active defense, passive defense, and attack operations. Finally, it will focus on C4I as a key area on which the theater commander must focus. Within C4I there are several issues which if properly addressed will transform this potential vulnerability of TBMD into a clearly demonstrated strength. The first is the necessity for proper intelligence preparation of the battlefield (IPB). The second is whether to use centralized or decentralized control in executing TBMD. Finally, the issue of who should be controlling TBMD assets to optimize all aspects of TBMD in a coherent and coordinated manner is addressed.

The TBMD objective is to negate enemy TBM effectiveness. To be effective, it must, at a minimum, significantly decrease the utility of these weapons to a potential enemy so that he is inclined to remove them form his arsenal.

BACKGROUND

The Iraqi use of TBMs in the 1991 Gulf War was not the first such use of this type of terror weapon. In 1944, a German program known as Aggregate 4, or the V-2, was developed and implemented. During a seven month period the Germans fired around 4,300 of these ballistic missiles, averaging 20 per day directed mainly at Antwerp and Liege in Belgium and at London and south east England. Nearly 2,500 deaths and 6,500 injuries were attributed to these attacks.[1]

Following the defeat of Germany, teams of scientists and engineers employed on the development and production of the V-2 missile were captured by the Russians and Americans. Russia captured both a development site and a production factory as well. The United States took 100 missiles back to the White Sands Missile Test Range. Proliferation had started.[2]

In the ensuing decades the development and enhancement of missile delivered terror continued. They were next employed by Egypt against Israel in 1973 during the Arab/Israel War. Leading up to the Gulf War, Iraq employed over 600 TBMs against Iran between 1986 and 1988. Afghanistan fired at least 200 TBMs against the Mojahedin between 1988 and 1991. Even Libya fired two TBMs against Sicily in 1986.[3]

By March, 1995 there were approximately 12,000 TBMs in the arsenals of 32 countries around the world.[4] These weapons are relatively simple and easy to obtain. Third world operators can be trained to employ them. Availability, affordability, and employability from mobile launchers make TBMs attractive terror weapons for emerging countries attempting to assert themselves in the world's larger military and more sophisticated diplomatic circles.

The type of warhead which can be placed on ballistic missiles is a source of major concern as well. Relatively few countries have the ability to produce nuclear, chemical and biological weapons, commonly grouped together and known as weapons of mass destruction (WMD), but these weapons have great attraction for countries given to terror tactics. More importantly, as demonstrated by the Iraqi leadership during the Iran-Iraq War, there seems to be little moral dissuasion against using these weapons. This trend does not bode well for potential victim countries because of the enormous complications defense against WMDs introduce.

The United States clearly recognizes the threat TBMs represent. Following the creation of the Ballistic Missile Defense Organization (BMDO) from the Reagan era Strategic Defense Initiative Organization (SDIO) in 1992, significant resources have been allocated to ballistic missile defense. Further, BMDO resources for future TBMD programs in fiscal years (FYs) 1997 to 2001, are expected to be on the order of $10 billion.[5]

What can we do to counter this threat? As stated earlier, this problem will be addressed by first assessing the current situation with respect to active defense, passive defense, and attack operations.

TBMD ELEMENTS

ACTIVE DEFENSE

Active defense involves the destruction or neutralization of TBMs in flight.[6] To better bound the task, active defensive systems have been divided into area and theater. Area systems defend within the atmosphere. Theater systems defend in space, above the atmosphere. Together, the systems described comprise the "core" TBMD systems.

Area systems currently in development include the Army's Patriot Advanced Capability (PAC)-3 system and the Navy's Aegis Weapons System. The PAC-3 is the follow-on to the PAC-2 which was deployed to Saudi Arabia and Israel during the Gulf War. The PAC-3 system will improve the current system through a series of upgrades to the radar as well as a new interceptor. PAC-3 will increase detection range, provide better target identification, improve the engagement of targets with reduced radar signatures, increase target handling capability, increase firepower, and enhance survivability.[7] PAC-3 should be deployable in the latter part of F: 1998.

The other area system currently in development involves is the Navy's Aegis Weapon System. Originally that system was not optimized to counter the TBM threat. To achieve full TBMD capability, the Navy is modifying the Aegis Combat System's computer programs, Command and Decision System, display system, SPY-1 Radar System and developing Navy Standard Missile (SM)-2 Block IVA which will be capable of engaging TBMs within the atmosphere.[8] The first fleet units are scheduled to receive operational SM-2 Block IVA interceptors and TBMD tactical programs in FY 2000.

The Army's Theater High Altitude Area Defense (THAAD) system is the final core system and is the theater defense component of the TBMD systems. This system will provide broad surveillance and a large intercept envelope to defeat TBM threats directed against wide areas, dispersed assets and strategic targets such as population centers and industrial facilities. THAAD will engage in space to minimize damage caused by debris and chemical/nuclear munitions. THAAD consists of two separate but closely related programs: the THAAD Weapons System and the Theater Missile Defense Ground Based Radar (TMD-GBR) surveillance and fire control radar system.[9] While area systems will, in almost all instances, allow for only one engagement, because of the high altitude, longer range intercept capability of THAAD, initial intercept will be followed by a kill assessment. If kill assessment warrants reengagement it would be possible by either firing another THAAD weapon or passing the target to an area weapon system foı engagement.[10] THAAD is expected to be operational in FY 2002.

Theater wide employment of the these diverse systems poses a considerable command and control challenge for the theater commander. System inter-operability is the key to the solution. Though the systems are being designed to be fully inter-operable the mere fact that separate services are developing them could pose a problem. Inter-operability demonstration tests and exercises are designed for success and invariably lead to the conclusion that the systems can and will work well together. Still, when the systems are transported to a distant location and tested under fire the results may be different. The services must strive for inter-operability and the theater commander must be knowledgeable enough of this issue to provide the necessary operational work-arounds prior to the first shot being fired.

PASSIVE DEFENSE

The second element the theater commander must concern himself with involves passive defense. "Passive defense is necessary to provide essential individual and collective protection for friendly forces, population centers and critical assets."[11] To accomplish this important aspect of TMD, the theater commander must ensure that two distinct groups, military personnel and civilians, are properly prepared for attack. The first step is early and active involvement with the host nation government in the education of the civilian populace. The threat may be conventional, nuclear, biological or chemical. It may be targeted at population centers, industrial facilities, historical or ethnically significant sites. Warning prior to attack may be extremely short. The key to maximizing passive defense for the civilian population is ensuring information concerning the threat and how to react is disseminated to the maximum extent possible.

Coupled with education is properly provisioning civilians for attack. This includes distribution of protective equipment and construction of bunkers and other safe areas. "Having lived under the threat of imminent attack for many years, the Israeli government has done a credible job in preparing for attack."[12] The challenge the theater commander must meet is to duplicate an effort similar to the Israelis and make target areas as safe as possible prior to attack. This will require a full time team working closely with host nation governments for success.

The second step is ensuring friendly military forces are fully prepared for passive defense against TBM attack. This can be done through a combination of operations security, deception, mobility, hardening, redundancy, or dispersal.[13] Success in this area of passive defense is more easily achieved owing to the inherently disciplined nature of the armed forces and the training and preparation generally received prior to arrival at the scene of a potential conflict.

ATTACK OPERATIONS

The third element for the theater commander to address is attack operations. "Attack operations are characterized by offensive actions intended to destroy and disrupt enemy theater missile capabilities before, during and after launch."[14] Ideally, if the theater commander could pinpoint the exact location of all launchers the problem would be relegated to target assignment and attack. Unfortunately, TBM launcher mobility frustrates this method to defeat them. More often than not the theater commander will know the exact location of, at best, only a few launchers and "location by launch" may prove not timely enough for launcher destruction.

Air superiority alone will not provide the means to eradicate the threat. During Desert Storm, the U.S. led coalition enjoyed satellite intelligence and virtually complete air supremacy over all of Iraq. Nonetheless, though the rate of Iraqi Scud launches declined during the war, the Iraqis still managed to launch 16 missiles in the conflict's last week, with some reports indicating that Iraq still possessed scores of launchers and was preparing for a massive Scud attack against Israel at the very end of the war.[15]

For the theater commander the problem associated with attack operations will not disappear as long as the enemy has the ability to move his launchers. Given the range of TBMs and the associated depth that attack operation assets must penetrate to destroy launchers and their supporting infrastructure; the theater commander must insist on rapid response, multiple means of engagement and timely, accurate threat information to have any chance of neutralizing or destroying enemy TBMs prior to launch.

PUTTING THE PIECES TOGETHER

Unlike the previous elements, C4I, the final element, is more abstract. Active defense, passive defense, and attack operations provide the tools and materials necessary to execute TBMD while C4I offers the blueprint and establishes the command and decision process necessary for execution. C4I cannot be distilled into a finite and clearly defined list of absolutes. However, properly executed command and control can tie the previously discussed elements together into a cohesive defense provided a necessary level of inter-operability can be maintained. Command and control is the glue holding the TBMD puzzle together and the theater commander must make this glue as strong as possible.

With respect to TBMD, the theater commander must concentrate the majority of his effort in C4I if he is to be successful in defeating enemy theater ballistic missiles. No commander can accurately predict the circumstances he will face in future operations against TBMs. He may have anywhere from hours to months of warning prior to entering into actual conflict. Regardless, he should have etched firmly in his mind how he plans to organize his staff and subordinate commands to address the TBM threat. Central to developing C4I for future operations against TBMs is who is controlling the TBMD assets, how are they being controlled and what information is needed going into the conflict to adequately prepare.

Initially the theater commander must address the issue of proper intelligence preparation of the battlefield (IPB). He must have in place the ability to properly assess the threat and determine what course of action is necessary to defeat that threat. The intelligence and information exchange network must be timely enough to allow for proper analysis of the battle area and to predict possible enemy missile launch areas. Reconnaissance, signal intelligence, special forces and airborne sensors will search for clues that enemy missile activity is imminent.[16] There are several systems available for his use in accomplishing this task including: Joint Tactical Information Distribution System (JTIDS), Joint Tactical Ground Station (JTAGS) and Joint Surveillance target Attack Radar System (J-STARS).

The second issue the theater commander must decide upon is how he will control the execution of TBMD within his area of operations. There are arguments for both centralized and decentralized control. On the one hand, centralized control, especially during the execution of active defense, may be required in order to husband vital ammunition. In addition, centralized control may enhance the probability of engaging an incoming ballistic missile with multiple active defense assets while simultaneously preventing the accidental attack (blue-on-blue) on own assets.

On the other hand, when executing attack operations, centralized control is more time consuming and thus, may not be responsive enough to meet reaction time demands. "During Desert Storm the centralized control exercised over attack operations was largely unsuccessful because it was too slow."[17]

The ideal situation might be, during TBMD execution, to centralize control for active defense and decentralize control for attack operations. In theory this may look good on paper. However, the confusion created or the potential for confusion in adopting two diametrically opposed methods of control is counter to the necessity to simplify the TBMD problem to the maximum extent possible. Guidance from the operational level must eliminate confusion for subordinates at the tactical level which could ultimately lead to missed engagements or wasted opportunities.

A proposed solution combines the two methods by exercising centralized control with command by negation similar to Navy battle group anti-air warfare (AAW) operations. Within the battle group the commander delegates defensive AAW to the AAW commander who then, in turn, assigns target engagement according to subordinate system's capabilities to develop threat tracks. In this manner active defense systems would be free to engage targets unless the action was negated by higher authority, perhaps from the theater commander's staff. Similarly, attack operations could be executed immediately upon receipt of threat information without the necessity for an order from the theater commander.

Available communications and data transmission capabilities (including JTIDS, JTAGS and J-STARS) give the theater commander the ability to monitor the threat picture development. He could then oversee the execution without having to intervene at the tactical level unless deemed absolutely necessary. This method would minimize sensor-to-shooter times for attack operations while ensuring active defense did not waste valuable assets by simultaneously engaging single targets with multiple interceptors. This would alleviate the current situation where all assets act more or less independently.

Joint Pub 3-05.1, Joint Doctrine for Theater Missile Defense, does not define a recommended command structure for today's theater commander with respect to TMD. It does address the responsibilities of some key individuals within the TBMD defense organization. Specifically, it states that the Joint Force Commander (JFC) will normally assign overall responsibility for air defense to an Area Air Defense Commander (AADC).[18] It also states that the JFC will normally assign responsibility for the planning and execution of joint theater missile defense (JTMD) attack operations outside the component commanders areas of operations to the Joint Forces Air Component Commander (JFACC).[19] Further amplification states that in some instances the responsibilities of the AADC may be assigned to the JFACC.[20]

Intermeshed with the AADC, JFACC and their staffs are the component commanders and their staffs who are responsible for the planning and execution of combat operations in support of both attack operations and active defense. All of these layers leave some doubt as to who is priortizing the efforts in the execution of the overall theater defense. The systems that will integrate the battlefield and provide a seamless defense will not be used to maximum effect if the effort cannot be properly controlled and coordinated.

It is folly to think that the AADC and/or JFACC will be able to, with 100% accuracy, deconflict the competing requirements during a hot war situation when the threat involves TBMs, cruise missiles and manned aircraft. The time criticality of both attack operations and imminent attack warnings necessitate that a single designated entity focus solely on the ballistic missile threat. This entity could be a cell within the AADC or JFACC staffs or resident with one of the component commanders. Where the TBMD cell resides is secondary to the fact that it must exist.

The overall effect of having this cell will be to provide for rapid assessment of intelligence and better defined and more refined information to the component commanders tasked with both attack operations and active defense. This will be doubly important when the full complement of systems currently in development become available and are integrated. Additionally, a portion of the cell should be devoted to ensuring passive defensive measures for both civilians and military personnel are executed properly.

SUMMARY

Presenting a coherent TBM defense is a challenge for today's theater commander. To do this he will have to ensure he is properly prepared to execute passive defense, active defense, attack operations, and C4I. The active defense systems necessary to defeat the TBM threat are or will soon be deployable. These will provide theater commanders with theater and area defense in depth which allows rapid reaction against TBMs in all theaters. Passive defenses are and will continue to be a concern of the theater commander. Regardless of actions he takes in preparation for TBM attack, the real measure of effectiveness will be if, after the attack, it's effects were successfully nullified.

Attack operations will continue to challenge the theater commander as long as the enemy has mobile launchers. Better cuing, intelligence and minimizing sensor-to-shooter times will enhance future attack operations.

Of the four elements, the one that holds the others together and makes a TBMD possible is C4I. The systems and communications capabilities necessary to link all levels of command together are available now with enhancements due in the near future.

How he will organize his command for TBMD will be crucial to his success. He must ensure provisions are made and responsibilities assigned for which TBMD is the primary thrust. Further, proper intelligence preparation of the battlefield must include focused intelligence data to evaluate the TBMD threat. This will facilitate planning for elimination of any TBM threat.

Given the advances in technology of both ballistic missiles and the defense against those missiles, attempting to say definitively how the problem of TBMD will be solved once and for all is like attempting to hit an erratic target. By continuing to concentrate in the C4I area and making continuous improvements to how the command function is structured, the theater commander will be able to offer a responsive and effective defense against current and future ballistic missile threats.

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Hughes Missile Systems Company in Tucson, Arizona, is the world's leading developer and producer of tactical missile systems and related equipment for ballistic missile defense applications. Information on their Production Programs (AMRAAM, STANDARD MISSILE, SPARROW, RAM, PHALANX) and Development Programs (AIM-9X, ESSM, FMRAAM, GBI/EKV, LEAP, TBMD) is provided. Also, the latest news articles on these systems are available.

Raytheon Missile & Air Defense Systems - ***http://www.raytheon.com/res/def_sys.html***

This site contains information on the Missile & Air Defense Systems products which include the PATRIOT Air Defense System, the Patriot Advanced Capability 3 (PAC-3) Missile, the Hawk, the THAAD Radar, and the Ground Based Radar Prototype (GBR-P) for National Missile Defense.

Lockheed Martin Missiles & Space - ***http://www.lmsc.lockheed.com/***

Under Programs & Initiatives, information is given on the Theater High Altitude Area Defense (THAAD) program which is a defense against Theater Ballistic Missiles (TBM). Also, under About LMMS, check out the latest Press Releases on National Missile Defense (NMD), the Airborne Laser (ABL), and the Space-Based Infrared System (SBIRS), a ballistic missile early warning and surveillance system.

Centre for Defence & International Security Studies (CDISS) -
http://www.cdiss.org/tempor1.htm

Everything you've always wanted to know, and more, about Missile Threats and Responses. A unique one-stop, open-source body of information on ballistic and cruise missile threats, weapons of mass destruction, and the various means of defense against them.

Ballistic Missile Defense Organization (BMDOLINK) -
http://www.acq.osd.mil/bmdo/bmdolink/html/

Within the Department of Defense, the Ballistic Missile Defense Organization is responsible for managing, directing, and executing the Ballistic Missile Defense (BMD) Program. The program focuses on three areas: Theater Missile Defense (TMD), National Missile Defense (NMD), and advanced ballistic missile defense technologies. From these pages you can explore BMDO's mission, programs, and technologies to keep pace with the existing missile threat and improve the performance of theater and NMD systems.

White Sands Missile Range (WSMR) - ***http://www.wsmr.army.mil/***

Click into the Tenants and go to tne HELSTF Home Page to learn about High Energy Laser Systems, including the Mid-Infrared Advanced Chemical Laser (MIRACL), and the SEALITE Beam Director (SLBD). Or click the Public Affairs Office, then Weapon Systems, to find links to missile defense systems such as the PATRIOT, the THAAD, the AMRAAM, the SEA-SPARROW, and the HAWK. The WSMR Directory will lead you to the Materiel Test Directorate which then points you to the Missile Systems Test Division. There you can find valuable information on Theater Missile Defense. Don't miss this site!

U.S. Army Air Defense Artillery School - ***http://bliss-www.army.mil/index.htm***

This site offers the First-To-Fire brochure and newsletter containing information on current ADA weapon systems, such as the Avenger, Patriot, and THAAD.

U.S. Army Space & Strategic Defense Command (USASSDC) - ***http://www.ssdc.army.mil/ssdc/New/orgelements.html***

The U.S. Army Space & Strategic Defense Command serves as the Army's proponent for Space and National Missile Defense, and as the Army's integrator for Theater Missile Defense. The USASSDC oversees a number of Army elements around the globe, namely the U.S. Army Space Command (ARSPACE), the Missile Defense & Space Technology Center (MDSTC), the Space & Missile Defense Battle Lab (SMDBL), the Kwajalein Missile Range (KMR), and the High Energy Laser Systems Test Facility (HELSTF). The USASSDC site is an excellent point of reference for Anti-Missile Defense.

The United States Navy - Navy Fact File - ***http://www.chinfo.navy.mil/navpalib/factfile/missiles/***

If you want the descriptions and general characteristics of Missile Defense Systems and Interceptors, go to the Index of Missiles which points you to the Navy's RIM-7M Sea Sparrow, the Air Force's AIM-7 Sparrow, the AIM-54 Phoenix Missile, the Standard Missile SM-1/SM-2, and the TBMD Program.

Georgia Tech Research Institute (GTRI) - ***http://www.gtri.gatech.edu/missile.htm***

Learn about the anti-ballistic missile research being done at GTRI with news on the THAAD radar, simulating targets for the PATRIOT system, and the Huntsville Research Operations involvement with the PATRIOT, HAWK, and CORPS-SAM.

Rolling Airframe Missile (RAM) - ***http://www.primocom.com/bataan/ram.htm***

The RAM, a self-defense system against anti-ship missiles, has a few of its characteristics (Weight, Diameter, Speed, Range, etc.) listed here.

Synthetic Scene Generation Model (SSGM) - ***http://vader.nrl.navy.mil/ssgm/***

The SSGM aids users in simulating a battlefield environment in which ballistic missiles are detected, acquired, tracked, and engaged. The SSGM has been designed to support, and is used for, Theater Missile Defense and National Missile Defense, as well as innovative ballistic missile defense concepts.

Los Alamos National Laboratory - SAMSON - ***http://sgt-york.lanl.gov/Samson***

SAMSON is a distributed object-oriented simulation environment that provides a means to construct test scenarios, manages tests in real-time, and supplies framework interfaces for players of various types. The Theater Missile Defense (TMD) Scenario to be studied is a scaled-down and highly-idealized example of coordinated theater missile defense using ground- and air-based assets. Check it out!

Office of the Director, Operational Test & Evaluation (DOT&E) - ***http://www.dote.osd.mil/index.html***

Here you will find a listing of DOT&E Annual Reports on various Army, Navy, and Air Force Programs. Select and read a multitude of reports on Anti-Missile Defense, and then come back again next year for an update.

Citizens For a Strong America (CFSA) - ***http://www.cfsa-bmd.org/***

CFSA is a grassroots organization promoting the deployment of a Ballistic Missile Defense for America. Read about the threat, the solution, and the pledge. Then read the book by Vosseler and Kriegel: "Undefended! The Case for Ballistic Missile Defense". It's all here.

The Heritage Foundation - ***http://www.heritage.org/heritage/library/main.html***

The Heritage Foundation is a research and educational institute, a think tank, whose products include publications, articles, lectures, conferences, and meetings. Full text papers are available at the Publications Library. First, click into their National Security page, then go to Missile Defense and Arms Control, and choose your topic.

High Frontier - ***http://www.erols.com/hifront/***

High Frontier is considered by many to be the nation's leading non-government authority on missile defense issues. It was formed to examine the potential for defending America against ballistic missile attack. Explore this page and listen to Ronald Reagan's audio endorsement of High Frontier.

Federation of American Scientists - Space Policy Project - ***http://www.fas.org/spp/***

The FAS Space Policy Project was initiated in the Spring of 1983, in response to President Reagan's announcement of the Strategic Defense Initiative. The political and technical aspects of anti-missile weapons remain a primary focus of the SPP. The Project provides background information and materials, commentary, and interpretation for print and broadcast media. The Project also prepares articles, studies and book chapters, ranging from technical papers to opeds in major newspapers. The Missile Defense Monitor provides a listing of topics ranging from it's Doctrine on countering air and missile threats, to Hot Documents, to Programs and World News Reports. Other resources, such as Advanced Aircraft includes a chapter on Air Defense Effectiveness which analyses the significance of missile proliferation and anti-tactical missile defense.

Phillips Laboratory - The Airborne Laser Program - ***http://www.plk.af.mil/PLhome/TM/tm.html***

The Airborne Laser (ABL) program's mission is to develop a cost effective, flexible airborne high energy laser system which has the capability to acquire, track, and destroy theater ballistic missiles during their powered boost phase of flight. The following information is available for the ABL Program: A Fact Sheet, ABL Initiatives, Critical Design Review, and quarterly Newsletters.

SMC/LAAFB - Space Based Infrared Systems (SBIRS) -
http://www.laafb.af.mil/SMC/MT/sbirs.htm

The SBIRS mission is to develop, deploy, and sustain space-based surveillance systems for missile warning, missile defense, battlespace characterization, and technical intelligence. Link to the Space & Missile Center which will then lead you to the technology status of the Space-Based Laser Project.

Air Force Library - ***http://www.af.mil/lib/***

The Air Force Library's Fact Sheets supply details on anti-missile interceptors, and the library's Publications offers a special study on the National Missile Defense (NMD) Minuteman Missile (MM).

Teledyne Brown Engineering - Ballistic Missile Defense -
http://www.tbe.com/services/defense/bmd/bmd.html

The U.S. Army's largest ballistic missile defense contractor, Teledyne Brown is engaged in many aspects of both National and Theater Missile Defense. This includes a feature article on the development of a low-cost Ground-Based Interceptor (GBI).

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Signal Magazine - ***http://www.us.net/signal/subjectindex/subjectindex.html***

Signal Magazine is AFCEA's journal for Communications, Electronics, Intelligence, and Information Systems Professionals. The Subject Index furnishes topics on Missile Defense and the Strategic Defense Initiative.

ACQWEB - ***http://www.acq.osd.mil/ousda/***

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MAR 97 37P
PERSONAL AUTHORS: BRUCE, ELTON C.

ABSTRACT: (U) (U) The Anti-Ballistic Missile Treaty (ABM), signed by the United States and the Soviet Union in 1972, has for 24 years served as a pillar for nuclear deterrence. Under this treaty both cold war powers agreed to leave their population centers vulnerable to strategic nuclear missile strike by limiting the number of Anti-Ballistic Missile sites. In the post cold war, the United States is clearly the only remaining superpower, however, Russia continues to posses its nuclear arsenals. Under the Strategic Arms Reduction Treaty (START) 1 and 2, the United States and Russia have agreed to reduce their ballistic missile arsenals and no longer target the other's homeland. Although start will reduce the largest nuclear arsenals existing in the world today, the perception of a ballistic missile strike against the United States' homeland by a rogue state has intensified debate over employing national missile defenses which are not ABM Treaty compliant. The ABM Treaty prohibits multiple national missile defense sites. This study will address the ABM Treaty and National Missile Defense issues by analyzing the emerging missile threat along with other pertinent arms control issues; the conclusion being that by year 2010 the United States will no longer adhere to the ABM Treaty.

DESCRIPTORS: *THREAT EVALUATION, *TREATIES, *BALLISTIC MISSILE INTERCEPT SYSTEMS, *NATIONAL DEFENSE, NUCLEAR WARFARE, USSR, , STRATEGIC ANALYSIS, MILITARY CAPABILITIES, STRATEGIC WEAPONS, ARMS CONTROL, STRIKE WARFARE, INTERNATIONAL RELATIONS, INTERNATIONAL LAW, DETERRENCE,

AD NUMBER: A326902

ARMY WAR COLL
CARLISLE BARRACKS PA

NATIONAL MISSILE DEFENSE: A NEW MISSION FOR THE TOTAL FORCE.

APR 96 37P
PERSONAL AUTHORS: UTECHT, RICHARD J.

ABSTRACT: (U) This paper explores the concept of a future National Missile Defense (NMD) System deployed, integrated, and manned by the national guard. It first looks at the current status of the NMD discussion within the context of an emerging threat to north America by other than Russian or former soviet union states. Framed by that foundation, the paper reviews an historical case study concerning the contribution of the national guard in the performance of a similar national defense mission, compared to a proposed concept of operations for NMD. The focus of this comparison is on the success of past performance with an expectation of future capability for this critical mission. The paper concludes with an organizational development analysis of this emerging mission and what key attributes should characterize a weapon system which represents a significant investment of our national treasury directly under the operational control of the reserve component.

DESCRIPTORS: *NUCLEAR WARFARE, *NATIONAL GUARD, *MASS DESTRUCTION WEAPONS, *BALLISTIC MISSILE INTERCEPT SYSTEMS, NUCLEAR PROLIFERATION, NUCLEAR WEAPONS, MILITARY STRATEGY, MILITARY DOCTRINE, COMBAT READINESS, THREAT EVALUATION, CONFLICT, NATIONAL DEFENSE, DETERRENCE.

AD NUMBER: A326672

NAVAL POSTGRADUATE SCHOOL
MONTEREY CA

PREVENTING BALLISTIC MISSILE PROLIFERATION: LESSONS FROM IRAQ.

DEC 96 115P
PERSONAL AUTHORS: TALAY, BRIAN J.

ABSTRACT: (U) The proliferation of weapons of mass destruction and ballistic missiles is now one of the greatest threats to the United States and its allies. Efforts to contain WMD proliferation, particularly the Missile Technology Control Regime (MTCR), have had limited success and must be improved to deal with new arms proliferation challenges. This thesis examines the case of Iraq to assess the performance of the missile nonproliferation regime since 1970. By analyzing the methods used by Iraq to obtain missile systems and missile technology, this thesis assesses the ability of the international community to prevent ballistic missile proliferation. Understanding Iraq's past capabilities as well as its post-war efforts to rebuild weapons programs and procurement networks, this thesis provides suggestions for improving the regime' s performance. This thesis finds that (1) prior to 1992 the MTCR failed in its attempts to prevent proliferation; (2) the existence of the MTCR, while necessary to slow proliferation, is not sufficient to prevent proliferation; and (3) additional enforcement is needed to counter WMD acquisition by resourceful and determined states.

DESCRIPTORS: *IRAQ, *INTERNATIONAL POLITICS, *ANTIMISSILE DEFENSE SYSTEMS, *ARMS CONTROL, NUCLEAR PROLIFERATION, MILITARY HISTORY, NATIONAL SECURITY, THESES, THREAT EVALUATION, MASS DESTRUCTION WEAPONS, MILITARY PROCUREMENT, INTERNATIONAL RELATIONS,

♦AD NUMBER: A326588

ARMY WAR COLL
CARLISLE BARRACKS PA

THE POOR MAN'S AIR FORCE: IMPLICATIONS OF THE EVOLVING CRUISE MISSILE THREAT.

APR 97 33P
PERSONAL AUTHORS: BOWEN, JOHN T.

ABSTRACT: (U) For several years, the United States has expended considerable resources on countering The Theater Ballistic Missile Threat. During this time, we have relatively ignored a growing land attack Cruise Missile threat. Land attack Cruise Missiles have the potential to be even more deadly than Ballistic Missiles, able to deliver similar payloads over similar distances with much greater accuracy. advanced Cruise Missiles can penetrate existing air defenses, giving potential regional adversaries a significant ability to conduct strategic attack and interdiction against our Military Forces, a Poor Man's Air Force. additionally, Cruise Missiles, synchronized with employment of Ballistic Missiles and manned aircraft, can have a synergistic effect. Efforts to prevent Cruise Missile proliferation have been ineffective, and highly lethal systems will likely be in the arsenals of many third world nations within the next decade. Our nation needs to pursue Theater Air Defense capability to detect, identify, track, engage, and destroy advanced Cruise Missiles to be prepared for this evolving threat.

DESCRIPTORS: *UNITED STATES, *ANTIMISSILE DEFENSE SYSTEMS, *CRUISE MISSILES, *DEFENSE PLANNING, AIR DEFENSE, AIR FORCE, THEATER LEVEL OPERATIONS, AIRCRAFT, EMPLOYMENT, THREATS, INTERDICTION, ATTACK, ARMY FACILITIES, ACCURACY, MASS DESTRUCTION WEAPONS, LETHALITY, STRATEGIC WARFARE, ORDNANCE, MANNED, ADVANCED WEAPONS, LAND AREAS, SYNERGISM.

♦Included in ***The DTIC Review***, December 1997

♦AD NUMBER: A326401

ARMY WAR COLL
CARLISLE BARRACKS PA

NATIONAL MISSILE DEFENSE (NMD) -- HAS ITS TIME COME?

JAN 97 37P
PERSONAL AUTHORS: BARRETT, DAVID K.

ABSTRACT: (U) The issue over deploying National Missile Defense (NMD) to counter strategic Ballistic Missiles has been on going since the 1950's. During the Cold War, the debate shifted from considering the viability of deploying territorial defense to counter the Soviet threat to one of agreement by both superpowers to limit missile defenses for fear they would undermine strategic stability and increase the chances for nuclear war. Without missile defenses, it was understood that the populations of both countries would be subject to Mutual Assured Destruction (MAD) should a nuclear war ever break out between the sides. With the Cold War over, the debate has shifted once again. The issue is whether or not the threat posed by the proliferation of Weapons of Mass Destruction (WMD) and their delivery systems warrants a reevaluation of cold war arguments against NMD and MAD. Contrary to the views of the current administration, the author outlines that NMD deployment is needed now more than ever for the United States to effectively operate in the 21st Century and to ensure the American population is never again threatened by direct attack.

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, *NATIONAL DEFENSE, NUCLEAR PROLIFERATION, DEPLOYMENT, POLICIES, NATIONAL SECURITY, THREAT EVALUATION, STRATEGIC WEAPONS, MASS DESTRUCTION WEAPONS, STRATEGIC WARFARE, MILITARY PLANNING

♦Included in *The DTIC Review*, December 1997

AD NUMBER: A326358

NYLAND ENTERPRISES
IDAHO SPRINGS CO

ASPECTS OF THE FREEDOM TO MIX CONCEPT.

FEB 97 28P
PERSONAL AUTHORS: NYLAND, F. S.

ABSTRACT: (U) The purpose of this report is to examine certain aspects of a concept called freedom to mix offensive and defensive forces. Under this concept, the Russians and the United States would be free to reduce elements of their strategic offensive forces, and replace deactivated warheads with Anti-Ballistic Missile (ABM) interceptors.

DESCRIPTORS: *NATIONAL SECURITY, *ARMS CONTROL, MILITARY FORCES(UNITED STATES), GUIDED MISSILES, STABILITY, UNITED STATES, ANTIMISSILE DEFENSE SYSTEMS, REDUCTION, RUSSIA, STRATEGIC WARFARE, NUCLEAR WARHEADS.

AD NUMBER: A325993

NAVAL POSTGRADUATE SCHOOL MONTEREY CA

BALLISTIC MISSILE DEFENSE AND NATO ALLIANCE RELATIONS.

DEC 96 134P
PERSONAL AUTHORS: RAFFIER, JOHN P.

ABSTRACT: (U) Short-range missiles in third world arsenals pose a serious threat to forward employed U.S. and Allied Military Forces. The acquisition of longer-range missiles has the potential to extend that threat to the population and territory of the United States and its allies. while NATO member states have agreed to develop Theater Missile Defense (TMD) Systems to support forward-deployed troops, they continue to dispute which TMD Systems ought to be developed and whether territorial or population defenses ought to be built. in this long-standing dispute, the United States has often found itself at odds with its European allies. This thesis argues that Ballistic Missile Defense remains a potential source of friction between the United States and its European allies, but for substantially different reasons than in the Cold War era.

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, DEVELOPING NATIONS, NATO, SOURCES, UNITED STATES, THREATS, POLITICAL ALLIANCES, ARMY FACILITIES, THESES, POPULATION, COLD WAR, ORDNANCE, FRICTION, THEATER MISSILE DEFENSE.

AD NUMBER: A325793

NAVAL WAR COLL NEWPORT RI

COMMAND AND CONTROL OF THEATER MISSILE DEFENSE: JOINT DOCTRINAL IMPERATIVE.

FEB 97 21P
PERSONAL AUTHORS: SPACY, WILLIAM L., II

ABSTRACT: (U) The theater Ballistic Missile (TBM) threat is serious and growing. to counter this threat, the United States intends to build an integrated Joint Theater Missile Defense (JTMD) with an active defense system capable of operating in a fully automated mode. since doctrine, by definition, prescribes the method for employing combat forces, it is incumbent on the U.S. Military to determine the best doctrine for employing this JTMD system. Current doctrine is inadequate in that it fails to provide the Joint Force Commander (JFC) with the guidance necessary to organize the theater for JTMD. future doctrine should, as a minimum, guide the JFC in making the organizational, informational and operational decisions necessary to deploy the JTMD system. In light of the continued rapid proliferation of TBMS, this doctrine must give the JFC the guidance necessary to make optimum use of JTMD assets.

DESCRIPTORS: *THEATER LEVEL OPERATIONS, *ANTIMISSILE DEFENSE SYSTEMS, GUIDED MISSILES, UNITED STATES, OPTIMIZATION, AUTOMATION, DECISION MAKING, DEFENSE SYSTEMS, ACTIVE DEFENSE, MILITARY DOCTRINE, COMMAND AND CONTROL SYSTEMS, CENTRALIZED, COMBAT FORCES, THEATER MISSILE DEFENSE.

AD NUMBER: A323638

ARMY CONCEPTS ANALYSIS AGENCY
BETHESDA MD

ACTIVE, PASSIVE, ATTACK OPERATIONS, BATTLE MANAGEMENT/COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS, AND INTELLIGENCE - PILLAR INTEGRATION (APAB-PI).

AUG 96 41P
PERSONAL AUTHORS: ENGELMANN, KARSTEN

ABSTRACT: (U) In 1995, the U.S. Army Space and Strategic Defense Command and the U.S. Army Concepts Analysis Agency Rapid Response Low-Resolution Theater-Level Theater Missile Defense Model. This report discusses how the active, passive attack operations battle management/command, control, communications, computers, and intelligence - pillar integration (APAB-PI) model was developed to meet these objectives. the purpose of the APAB-PI study was to develop a methodology and a supporting model which simulated all of the missile battles that together comprise the missile defense campaign for an entire theater. A process which allows the examination of the entire campaign enables analysts to answer decision makers' questions regarding the effect of different aspects of the Tactical Ballistic Missile/Theater Missile Defense on that campaign.

DESCRIPTORS: *COMMAND CONTROL COMMUNICATIONS, *ARMY OPERATIONS, *ARMY INTELLIGENCE, *THEATER MISSILE DEFENSE, COMPUTERIZED SIMULATION, SOFTWARE ENGINEERING, SCENARIOS, THEATER LEVEL OPERATIONS, ATTACK, SURFACE TO AIR MISSILES

AD NUMBER: A322454

GENERAL ACCOUNTING OFFICE
WASHINGTON DC

NATIONAL SECURITY AND INTERNATIONAL AFFAIRS DIV
NATIONAL MISSILE DEFENSE: RISK AND FUNDING IMPLICATIONS FOR THE SPACE-BASED INFRARED LOW COMPONENT.

FEB 97 32P

ABSTRACT: (U) In 1995, the Department of Defense (DoD) made plans for the Space and Missile Tracking System-the low satellite component of the Space-Based Infrared System (SBRIS)-to be deployed in fiscal year 2006. In February 1996, the Congress directed the secretary of Defense to restructure the SBRIS program and deploy the first Space and Missile Tracking System (hereafter referred to as SBRIS-Low) satellite in fiscal year 2002. The Congress also appropriated $264 million above DoD's fiscal year 1996 and 1997 budget requests to support this deployment acceleration. The purpose was to ensure that the Space and Missile Tracking System provided support to national and Theater Ballistic Missile defenses sooner, rather than later.

DESCRIPTORS: *INFRARED EQUIPMENT, *LAUNCH VEHICLES, *AIR FORCE BUDGETS, *SATELLITE TRACKING SYSTEMS, GUIDED MISSILES, CONGRESS, DEPARTMENT OF DEFENSE, DEPLOYMENT, THEATER LEVEL OPERATIONS, RISK, DEFENSE SYSTEMS, ACCELERATION, INFRARED RADIATION, NATIONAL DEFENSE, SPACE BASED.

AD NUMBER: A320857

NATIONAL AIR INTELLIGENCE CENTER WRIGHT-PATTERSON AFB OH

MATHEMATICAL SIMULATION OF USING DECOYING AND KILLING MISSILES TO COUNTER ANTI-RADIATION MISSILES.

JAN 97 14P

PERSONAL AUTHORS: ZHOU, SHUIGENG; TAO, BENREN

ABSTRACT: (U) A new method of intercepting Anti-Radiation Missiles (ARM) using Decoying and Killing Missiles (DKM) is proposed in this paper. (Decoying and Killing Missiles are actually Surface-to-Air Missiles with their guidance heads replaced by decoying jammers.) A mathematical model is set up to carry out a mathematical simulation of the physical process of using DKMS to intercept arms. Simulation results show that this plan is theoretically feasible.

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, *GUIDED MISSILE COUNTERMEASURES, *ANTIRADIATION MISSILES, COMPUTERIZED SIMULATION, TRANSLATIONS, SURFACE TO AIR MISSILES, RADAR SIGNALS, RADAR JAMMING, CHINA, RADAR DECOYS, CHINESE LANGUAGE.

AD NUMBER: A320754

ARMY MISSILE COMMAND REDSTONE ARSENAL AL

SYSTEMS SIMULATION AND DEVELOPMENT DIRECTORATE

PAC-3 MISSILE 30-YEAR LIFE CYCLE AND STREAMLINING.

JAN 97 13

PERSONAL AUTHORS: DANESH, MOHAMMAND H.

ABSTRACT: (U) (U) This report will provide an overview of the problems, approaches, and solutions applied to developing a product assurance program for the Patriot Pac-3 Missile. The Pac-3 Missile System requires hit to kill capability and is being developed/procured under acquisition streamlining.

DESCRIPTORS: *WEAPON SYSTEM EFFECTIVENESS, *SURFACE TO AIR MISSILES, *QUALITY ASSURANCE, ACQUISITION, KILL PROBABILITIES, HIT PROBABILITIES, STREAMLINE SHAPE.

AD NUMBER: A320272

PRATT AND WHITNEY SAN JOSE CA
CHEMICAL SYSTEMS DIV

HIGH PERFORMANCE BOOST PROPULSION FOR NAVY THEATER MISSILE DEFENSE,

SEP 96 8P
PERSONAL AUTHORS: KEARNEY, W. J.; CASILLAS, E. D.

ABSTRACT: (U) Future Tactical and Defensive Missile Propulsion Systems must provide a high degree of mission versatility and robustness at low cost with minimum development risk. Th^ Navy's Standard Missile has successfully demonstrated an evolutionary philosophy of guidance and propulsion upgrades over its long operational history. Replacing the existing 13.5-in diameter MK 104 Dual Thrust Rocket Motor (DTRM) with a full 21 -in. Diameter high performance motor offers increased propulsion capability and weapon system options. An improved performance stage-two motor, consistent with the MK 72 booster's 21-in. Diameter, provides an upgraded Missile System with expanded range, greater throw weight and higher velocity increments. Expanded propulsion capability can be achieved with low development risk commensurate with improvements in the Vertical Launch System (VLS) canister. The benefits of this upgraded full Caliber Motor compatible with the existing MK72 booster and VLS interfaces is presented.

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, GUIDED MISSILES, THEATER LEVEL OPERATIONS, BOOST PHASE, LOW COSTS, WEAPON SYSTEMS, PROPULSION SYSTEMS, VERTICAL ORIENTATION, MISSIONS, HISTORY, LAUNCHING, EVOLUTION(GENERAL), GUIDANCE, TACTICAL

AD NUMBER: A320002

RAND CORP SANTA MONICA CA

AIRBORNE INTERCEPT: BOOST- AND ASCENT-PHASE OPTIONS AND ISSUES.

96 42P
PERSONAL AUTHORS: VAUGHAN, DAVID R.; ISAUCSON, JEFFREY A.; KVITKY, JOEL S.

ABSTRACT: (U) This report documents an analysis of countering Theater Ballistic Missiles (TBMS) by using manned aircraft with onboard radar sensors in an airborne intercept role. Although current defense planning does not anticipate such a role for manned aircraft, more-advanced airborne intercept options harbor significant uncertainties with respect to development, and it remains to be demonstrated that they will prove practicable in the decade ahead. Thus, the approaches we analyzed and similar ones may be revisited as nearer- term options in the future. Moreover, although recent discussions have focused almost exclusively on Boost-Phase Intercept (BPI), Ascent-Phase Intercept (API) has significant operational merits that should not be dismissed wholesale. Indeed, our analysis suggests that the development of a dual BPI-API capability should be strongly considered for the reasons cited in this report.

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, *BOOST PHASE, *INTERCEPTORS, *BOOSTER ROCKET ENGINES, GUIDED MISSILES, THEATER LEVEL OPERATIONS, EMERGENCIES, AIRCRAFT, DEFENSE SYSTEMS, AIRBORNE, INTERCEPTION, PATHS, RADAR, SEQUENCES, EXOSPHERE, ONBOARD, ARMOR PIERCING AMMUNITION, MANNED.

AD NUMBER: A319989

DEPARTMENT OF THE AIR FORCE
WASHINGTON DC

NMD DEPLOYMENT READINESS PROGRAM OVERVIEW,

SEP 96 10P
PERSONAL AUTHORS: MCNIERNEY, DAVID F.

ABSTRACT: (U) This paper summarizes America's National Missile Defense Deployment readiness program and describes the defenses we are developing to defend the United States against ICBMS from the Third World. Some countries, including North Korea, are developing ICBMS indigenously but relatively slowly, while others could obtain ICBMS in the near term through proliferation. Effective defenses against such threats would include space based and ground based sensors for early warning, ground-based sensors at sites within the United States and, if needed, at forward bases, for identifying and tracking threat objects, ground based interceptors at one or more sites, and a battle management, command, control, and communications system for controlling the architecture and relaying its messages. Such a system, even with only one interceptor site, could defend all 50 states with high effectiveness against a few missiles from a Third World country. The uncertainties associated with when such a threat might appear, and from where, and with what characteristics, have dictated that we adopt a highly flexible and evolutionary "Deployment Readiness" Acquisition Program.

DESCRIPTORS: *DEPLOYMENT, *ANTIMISSILE DEFENSE SYSTEMS, *COMBAT READINESS, *OPERATIONAL READINESS, *GUIDED MISSILE DEFENSE SYSTEMS, DEVELOPING NATIONS, NORTH KOREA, FORWARD AREAS, MILITARY FACILITIES, UNITED STATES, DETECTORS, DECISION MAKING, THREATS, SITES, TRACKING, LONG RANGE(DISTANCE)

AD NUMBER: A319966

TEXTRON SYSTEMS DIV
WILMINGTON MA

GROUND-BASED PORTABLE MINIATURE INTERCEPTOR FOR CRUISE MISSILE DEFENSE,

SEP 96 9P
PERSONAL AUTHORS: THYSON, NOEL A.; SHUI, VEN H.; FLAHERTY, ROBERT J.

ABSTRACT: (U) A ground-based Portable Miniature Interceptor Weapon System has been conceptualized to fulfill the important mission of killing/negating cruise missiles in flight. A preliminary PMI design concept offers a weapon weighing under 150 pounds with an approximately hemispherical intercept volume having a diameter of about 10 miles. The paper describes the CONOPS, PMI design, component characteristics and packaging, and performance against cruise missiles in a representative mission scenario.

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, *CRUISE MISSILES, SCENARIOS, PORTABLE EQUIPMENT, DEFENSE SYSTEMS, INTERCEPTION, MISSIONS, INFLIGHT, PACKAGING, GROUND BASED, INTERCEPTORS, HEMISPHERES, MINIATURIZATION.

AD NUMBER: A319965
AEROSPACE CORP LOS ANGELES CA

INTERCEPTOR CONCEPTS FOR THE US UAV BPI PROGRAM,

SEP 96 12P
PERSONAL AUTHORS: BROWN, STEVE; ZONDERVAN, KEVIN L.; BARRERA, MARK; URBANO, REYNALDO; SVOREC, RAY

ABSTRACT: (U) The Ballistic Missile Defense Organization (BMDO) is managing the us Unmanned Aerial Vehicle (UAV) Boost Phase Intercept (BPI) program. the program's goal is to investigate the potential of UAV-Based Interceptors to provide a boost-phase defensive tier against Theater Ballistic Missiles. A technology assessment and risk mitigation effort is underway to determine the requirements of a UAV BPI System. The Advanced Systems Directorate, Space and Missile Systems Center, Air Force Material Command (AFMC/SMC/ADE) has been selected to lead the Interceptor Integrated Product Team (IPT) . The Interceptor IPT's efforts during its first year have been focused on surfacing attractive interceptor conceptual designs and selecting a preliminary design. this paper presents the requirements and rationale leading to the preliminary interceptor design. The pros and cons of the alternative interceptor concepts are examined, leading to a single concept. A preliminary interceptor design is then presented for this concept.

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, INTERCEPTORS, REMOTELY PILOTED VEHICLES, GUIDED MISSILES, MILITARY REQUIREMENTS, *THEATER LEVEL OPERATIONS, *INTEGRATED SYSTEMS, AIRCRAFT, RISK, DEFENSE SYSTEMS, BOOST PHASE, AIRBORNE, INTERCEPTION, SURFACES, UNMANNED VEHICLES

AD NUMBER: A319962

ROME LAB ROME NY

COMMUNICATIONS ENGINEERING FOR THE GROUND BASED INTERCEPTOR,

SEP 96 8P
PERSONAL AUTHORS: HADYNSKI, GREGORY J.

ABSTRACT: (U) (U) The task of developing a communications system to support the Ballistic Missile Defense Organization's (BMDO) Ground Based Interceptor (GBI) program is a challenging one. The majority of the challenge stems from the fact that the communications link must be designed to be survivable in the potentially nuclear scintillated environment of a National Missile Defense (NMD) System. Operation in a potentially nuclear environment requires the use of Extremely High Frequency (EHF) communications technology with a waveform optimized for survivability. A communications system of this type has never been built for an application with the stringent size, weight, and power requirements of a Ballistic Missile interceptor, but the air Force's Rome Laboratory is responsible for developing a prototype transceiver for BMDO. The prototype transceiver will consist of 44 ghz uplink components, 20 ghz down link components, and a modem, which is capable of the required waveform.

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, COMMUNICATION AND RADIO SYSTEMS, *INTERCEPTORS, GUIDED MISSILES ENGINEERING, GROUND BASED, *BALLISTIC MISSILE INTERCEPT SYSTEMS, EXTREMELY HIGH FREQUENCY.

AD NUMBER: A319961

LITTON SYSTEMS INC
AGOURA HILLS CA

DATA SYSTEMS DIV TMD BATTLE MANAGEMENT,

SEP 96 11P
PERSONAL AUTHORS: ARMENIAN, H. K.; COLLIER, J. D.; DENNIS, P. W.; FAGARASAN, J. T.; SIMON, B. J.

ABSTRACT: (U) A key objective of Theater Missile Defense (TMD) is to defend multiple assets spread over a wide theater, simultaneously threatened by numerous Ballistic Missiles. battle management, therefore, has to efficiently assign weapons and sensors to incoming threats to achieve intercepts, minimizing total leakage or total damage to assets. To analyze the TMD battle management problem to counter Theater Ballistic Missiles (TBM), threat propagation and radar models to predict antenna occupancy and track accuracy are developed. interceptor flyouts are modeled to support candidate one-on-one fire control solutions. in addition, algorithms are developed for threat assessment, battle space-time analysis to determine shot opportunities satisfying system constraints, many-on- many weapon-target-sensor assignment to achieve optimality of the objective function, as well as engagement scheduling to determine the best intercept position and time.

DESCRIPTORS: *THEATER LEVEL OPERATIONS, *ANTIMISSILE DEFENSE SYSTEMS, BATTLE MANAGEMENT, ALGORITHMS, GUIDED MISSILES, SCENARIOS, PROPAGATION, POSITION(LOCATION), TEST BEDS, COMPUTATIONS, DETECTORS, DEFENSE SYSTEMS, MODELS, INTERCEPTION, ATTACK, ACCURACY, RADAR, WEAPON SYSTEM EFFECTIVENESS, THREAT EVALUATION, ANTENNAS, *GUIDED MISSILE COUNTERMEASURES.

AD NUMBER: A319957

LOCKHEED MARTIN VOUGHT SYSTEMS CORP DALLAS TX

THE PATRIOT PAC-3 MISSILE PROGRAM - AN AFFORDABLE INTEGRATION APPROACH,

SEP 96 13P
PERSONAL AUTHORS: O'REILLY, PATRICK; WALTERS, ED

ABSTRACT: (U) The affordable Pac-3 System upgrade approach is based on innovative, joint consolidation and integration of existing industry and government assets. through the integrated use of a network of geographically dispersed simulation, hardware in the loop, and test facilities, the Pac-3 Missile design and performance is being analyzed and verified prior to first missile flight. This process begins with the thorough and rigorous testing of missile components. it then continues with the use of integrated simulations which is a key activity to verify and predict patriot system performance with Pac-3 upgrades. the process is culminated with system level and flight testing conducted at white sands missile range, New Mexico. During the Gulf War, the Patriot Air Defense System made its now-famous battlefield debut against Tactical Ballistic Missiles (TBMS). Through a succession of improvements and modifications to refocus its mission on missile defense, patriot helped defend coalition forces and Israeli territory from Iraqi Scud Missile attacks.

DESCRIPTORS: *INTEGRATED SYSTEMS, SYSTEMS APPROACH, *SURFACE TO AIR MISSILES,*BALLISTIC MISSILE INTERCEPT SYSTEMS, AIR DEFENSE, SIMULATION, WARFARE, IRAQ, INDUSTRIES, MODIFICATION, ATTACK, RADAR, INTEGRATION, RECORDING SYSTEMS, LETHALITY, NEW MEXICO, RANGE(DISTANCE), BATTLES, AUTOMATIC, TACTICAL WEAPONS, TEST FACILITIES, GUIDED MISSILE COMPONENTS, ADVANCED WEAPONS, WARHEADS.

AD NUMBER: A319955

ELECTRONIC SYSTEMS CENTER
HANSCOM AFB MA

LESSONS LEARNED FROM THE FIRST CAPABILITY INCREMENT OF THE NATIONAL MISSILE DEFENSE (NMD) BATTLE MANAGEMENT/COMMAND, CONTROL, AND COMMUNICATIONS (BMC3) SOFTWARE,

SEP 96 11P
PERSONAL AUTHORS: BLANK, JEFF; URBAN, MARY L.; WILKINSON, CHARLES K.

ABSTRACT: (U) A demonstrator system for the battle management, command, control, and communications element of the national missile defense system is being built in seven increments. this paper reports lessons learned from development of the first increment. four lessons are discussed. first, a relatively informal requirements baseline, generated and iterated by the contractor, was found to meet the needs of the program. second, benefits from use of object oriented methods and ADA 95 will not be realized until later increments. third, there were successful alternatives to the reviews and documents eliminated in acquisition streamlining. Lastly, vigilance to keep process versus product emphasis in balance was needed. the aim of the National Missile Defense (NMD) program is to develop a system of systems with the capability to defend the nation from the threat of limited Ballistic Missile attacks.

DESCRIPTORS: *COMMAND CONTROL COMMUNICATIONS, LESSONS LEARNED, *GUIDED MISSILE DEFENSE SYSTEMS, BATTLE MANAGEMENT, COMPUTER PROGRAMS, REQUIREMENTS, DEPLOYMENT, DETECTORS, DECISION MAKING, ACQUISITION, *DEFENSE SYSTEMS, SPACE ENVIRONMENTS, DEMONSTRATIONS, VIGILANCE, ATTACK, BASE LINES, GROUND BASED, INTERCEPTORS, *NATIONAL DEFENSE, SPACE BASED.

AD NUMBER: A319953

OFFICE OF THE PROJECT MANAGER
PATRIOT AIR DEFENSE MISSILE SYSTEM
REDSTONE ARS ENAL AL

INTEGRATION OF THE PAC-3 MISSILE SEGMENT INTO THE PATRIOT AIR DEFENSE SYSTEM,

SEP 96 10P
PERSONAL AUTHORS: NESLINE, MARK; LINZ, JOHN; KENGER, MARTIN; COOK, FELICIA

ABSTRACT: (U) The Patriot Air Defense System has been developed as a modular system with a high level of integrated software-driven functionality providing a broad range of inherent flexibility. The system has evolved from its initial, basic design which provided defense against the Air Breathing Threat in complex countermeasure environments with a single patriot missile type to the Patriot Advanced Capability 2 (Pac-2) which provides defense against a combination of the Air Breathing and Tactical Ballistic Missile threats utilizing four missile types. The Patriot Air Defense System continues to evolve to the Patriot Advanced Capability 3 (Pac-3) configuration which incorporates radar and communication upgrades as well as the Lockheed Martin Vought Systems (LMVS) Pac-3 Missile, a fifth missile type. as part of this capability, scheduled to be fielded in 1999, the Patriot Project Office (PPO) and the Ballistic Missile Defense Organization (BMDO) have contracted with Raytheon for the integration of the Pac-3 Missile segment into the Patriot Air Defense System.

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, *SURFACE TO AIR MISSILES, SOFTWARE ENGINEERING, COMMAND CONTROL COMMUNICATIONS, OPTIMIZATION, KILL PROBABILITIES, *COMPUTER AIDED DESIGN, COMPUTER ARCHITECTURE, SYSTEMS ANALYSIS, DATA LINKS, ANTIAIRCRAFT DEFENSE SYSTEMS, FIRE CONTROL RADAR.

AD NUMBER: A319950

SPACE WARFARE CENTER
FALCON AFB CO

SHIELD PHASE II. TRANSFERS SUCCESSFUL LEGACY FOR NATIONAL MISSILE DEFENSE APPLICATIONS,

SEP 96 13P
PERSONAL AUTHORS: FRASER, CHRISTOPHER; MCCLUNG, SEAN D.

ABSTRACT: (U) The purpose of this paper is to identify how the successful legacy of the shield project is being directly applied to the development and transition to operations of an emergency response system for National Missile Defense (NMD) Battle Management, Command, Control, and Communications (BMC3), and how existing elements and infrastructures are being optimized to provide a functional, capable system in the near-term for use in the execution of NMD. Most NMD functions are not unique to the Air Force nor to Air Force Space Command (AFSPC). Surveillance and warning, event detection, threat assessment, and attack characterization all currently exist in AF support architectures for Theater and ITTW/ infrastructures. in addition, the AF MMIII has been shown to be an accurate and effective weapon which can be of significant use during the reapportionment of existing strategic resources for defensive purposes.

DESCRIPTORS: *COMMAND CONTROL COMMUNICATIONS, CRISIS MANAGEMENT, INFORMATION EXCHANGE, *GUIDED MISSILE DEFENSE SYSTEMS, *AIR FORCE PLANNING, MEASUREMENT, GLOBAL, EMERGENCIES, DETECTION, DETECTORS, RISK, COST EFFECTIVENESS, SPACE SYSTEMS, INTEROPERABILITY, STRUCTURES, RESPONSE, THREAT EVALUATION, RESOURCES, TRANSITIONS, NORMALIZING(STATISTICS), ARCHITECTURE, NATIONAL DEFENSE, STRATEGIC MATERIALS, BATTLE MANAGEMENT, INFRASTRUCTURE.

AD NUMBER: A319376

NYLAND ENTERPRISES
IDAHO SPRINGS CO

BALLISTIC MISSILE DEFENSES AND RUSSIAN RETALIATION ISSUES.

MAR 96 33P
PERSONAL AUTHORS: NYLAND, F. S.

ABSTRACT: (U) An examination of the degradation of a Russian Retaliatory Nuclear strike if the U.S. and Russia were to deploy theater or anti-ballistic missile defenses in their homelands. Consideration is given to efforts for restoring the effectiveness of a Russian retaliation, and the effects on first strike stability of deployments of theater missile defenses in one or both homelands.

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, *NUCLEAR WARFARE, GUIDED MISSILES, USSR, STABILITY, DEPLOYMENT, THEATER LEVEL OPERATIONS, *DEFENSE SYSTEMS, DECOYS, RUSSIA, STRIKE WARFARE, FIRST STRIKE CAPABILITY.

AD NUMBER: A319248

NAVAL POSTGRADUATE SCHOOL
MONTEREY CA

EFFECTIVENESS OF OFF-BOARD ACTIVE DECOYS AGAINST ANTI-SHIPPING MISSILES.

SEP 96 56P
PERSONAL AUTHORS: TAN, TUN-HOU

ABSTRACT: (U) Radar Guided Anti-Shipping Missiles are the primary threat for most modern navies. The inherent nature of the Monopulse Radar employed by most Anti-Shipping Missiles makes it highly resistant to active ECM techniques. Decoys are attractive because they provide a source of radiation that can capture the radar seeker and direct the missile away from the ship. However the time and direction of launch are critical parameters which determine the operational success of the decoy. this thesis evaluates the protection provided by active off-board decoys which are deployed by ships during an engagement against a Radar Guided Anti-Shipping Missile. The research emphasizes launching active decoys. Many of the operational characteristics of the launching decoy are investigated, including direction of launch, timing of launch and the RF characteristics of the decoy.

DESCRIPTORS: *COMPUTERIZED SIMULATION, *RADAR COUNTERMEASURES, *ANTISHIP MISSILES, SHIP DEFENSE SYSTEMS, RADAR DECOYS, GUIDED MISSILE COUNTERMEASURES, SCENARIOS, SOURCES, RADIATION, DEPLOYMENT, SHIPS, THREATS, PARAMETERS, THESES, LAUNCHING, MONOPULSE RADAR, RADAR HOMING, MODEMS, SHIP MODELS, RADIOFREQUENCY, BUOYS.

AD NUMBER: A318780

INSTITUTE FOR DEFENSE ANALYSES
ALEXANDRIA VA

WEAPONS SYSTEMS EFFECTIVENESS AND MINIMUM COST FOR BALLISTIC MISSILE DEFENSE ALTERNATIVES,

96 10P
PERSONAL AUTHORS: KOHLBERG, IRA; GREER, WILLIAM

ABSTRACT: (U) The use of Scud Missiles by the Iraqis in the 1991 Gulf War signaled the emergence of a new threat against which current U.S. Defenses are limited. One message from the Gulf War is that defending ports, strategic off-load air fields, marshaling areas, and population centers against Theater Ballistic Missiles (TBM) will be of mounting concern in future conflicts. The Ballistic Missile Defense Organization (BMDO), in conjunction with the military services, is currently evaluating various Theater Ballistic Missile Defense (TBMD) Systems to defend critical friendly assets (called targets in this paper) against current and projected short range, medium range, and long range TBMS. The cost for defending these assets depends on the number and type of threat TBMS that emerge, and the mix of defensive missiles arrayed against them. There are several problems associated with designing the most cost effective mix of TBMD Systems.

DESCRIPTORS: *COST EFFECTIVENESS, *ANTIMISSILE DEFENSE SYSTEMS, WEAPON SYSTEM EFFECTIVENESS, *MILITARY FORCES(UNITED STATES), *GUIDED MISSILES, NUCLEAR EXPLOSIONS THEATER LEVEL OPERATIONS, STRATEGY, SURVIVABILITY, LONG RANGE(TIME), TIME, LONG RANGE(DISTANCE), TARGETING, SHORT RANGE(DISTANCE)

AD NUMBER: A318704

LITTON SYSTEMS INC AGOURA HILLS CA DATA SYSTEMS DIV TMD DEFENSE PLANNING,

96 12P
PERSONAL AUTHORS: ARMENIAN, H. K.; COLLIER, J. D.; DENNIS, P. W.; SIMON, B. J.; YIN, M.

ABSTRACT: (U) A key objective of Theater Missile Defense (TMD) is to defend multiple assets spread over a wide theater, simultaneously threatened by numerous missiles. To counter such scenarios, BM/C3 is decomposed into the battle management and defense planning problems. The objective of battle management - analyzed in previous studies - is to assign weapons and sensors to minimize total damage as the battle unfolds in real-time, while the objectives of defense planning are to evaluate the effectiveness of specified defense designs against given attack scenarios, and determine improved interceptor launcher and sensor plans. This study focuses on the TMD Land-Sea Based defense planning problem where multiple Theater Ballistic Missiles (TBM) and Theater Cruise Missiles (TCM) are launched from numerous Missile Threat Origins (MTO) against many assets, and are countered by Upper Tier (UT) and Lower Tier (LT) sensors and weapons located at different sites.

DESCRIPTORS: *THEATER LEVEL OPERATIONS, *ANTIMISSILE DEFENSE SYSTEMS, DEFENSE PLANNING, BATTLE MANAGEMENT, TEST AND EVALUATION, WEAPONS, ALGORITHMS, COMPUTERIZED SIMULATION, GUIDED MISSILES, SCENARIOS, TEST BEDS, DETECTORS, THREATS, DISTRIBUTION, ATTACK, PROTOTYPES, PROBLEM SOLVING, INTEGRATION, CRUISE MISSILES, INVENTORY, INTERCEPTORS, LAUNCHERS.

AD NUMBER: A318703

NAVAL SURFACE WARFARE CENTER DAHLGREN DIV VA

OPTIMAL THRUST ALLOCATION FOR TBM INTERCEPTOR MIDCOURSE GUIDANCE,

96 13P
PERSONAL AUTHORS: LAWTON, JOHN A.; MARTELL, CRAIG A.; JESIONOWSKI, ROBERT J.

ABSTRACT: (U) Interceptors for Tactical Ballistic Missile Defense typically are conceived to have midcourse phases that make corrections to the original interceptor free-flight path based on updated threat state estimates from the filter associated with a remote sensor. some concepts call for one midcourse correction, while others call for more frequent corrections. The goal of this study is to find the optimal frequency of midcourse corrections from the point of view of minimizing the terminal error, as well as to determine, for a given design, the optimal allocation of thrust resources. It is found that the more frequently the corrections are made, the less the errors are that are handed over to the terminal phase. Furthermore, even when less fuel is available than that required to take out all known errors, the optimal strategy is to make corrections as soon as the amount of correction required just equals the amount of divert available for each burn, until midcourse divert fuel is exhausted.

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, INTERCEPTORS, *MIDCOURSE GUIDANCE, FREQUENCY, *GUIDED MISSILES, OPTIMIZATION, STRATEGY, *DEFENSE SYSTEMS, THREATS, , FUELS, REMOTE SENSORS

♦AD NUMBER: A318537

DEFENSE SCIENCE BOARD WASHINGTON DC

REPORT OF THE DEFENSE SCIENCE BOARD/POLICY BOARD TASK FORCE ON THEATER MISSILE DEFENSE.

JAN 96 86P

ABSTRACT: (U) Attached is the final report of the DSB/DPB Task Force on Theater Missile Defense (TMD). significant TMD policy, budget and program initiatives were undertaken during our deliberations, and thus we make no pretense at having kept up with these moving targets. The report, reflecting guidance the task force received when we delivered an interim report last year, focuses on four topics: coping with uncertainties about futures paths of the Theater Missile Threat, demarcation between Theater and Strategic Missile Defenses, meeting the challenge of developing joint TMD, and lastly, setting priorities for specific TMD programs and projects.

DESCRIPTORS: THEATER LEVEL OPERATIONS, ANTIMISSILE DEFENSE SYSTEMS, TASK FORCES, GUIDED MISSILES, DEFENSE SYSTEMS, THREATS, MOVING TARGETS, REFLECTION, STRATEGIC WEAPONS, GUIDANCE.

♦Included in ***The DTIC Review***, December 1997

AD NUMBER: A317760

GENERAL ACCOUNTING OFFICE WASHINGTON DC

NATIONAL SECURITY AND INTERNATIONAL A FFAIRS DIV
FOREIGN MISSILE THREATS: ANALYTIC SOUNDNESS OF CERTAIN NATIONAL INTELLIGENCE ESTIMATES.

AUG 96 17P

ABSTRACT: (U) The General Accounting Office was asked to evaluate certain National Intelligence Estimates (NIE) prepared by the U.S. Intelligence Community (IC) that analyze the threat to the United States from Foreign Missile Systems. GAO's reporting objectives were to compare the content and conclusions of NIE 95-19, emerging missile threats to North America during the next 15 years, November 1995, with the content and conclusions of two previous NIES prepared in 1993; to evaluate whether these three NIES appear to be objective and supported by facts; and to describe the conclusions of recent, unclassified studies on the threat to the United States from Foreign Missile Systems. This report supplements a June 12, 1996, briefing and is an unclassified version of GAO's classified report.

DESCRIPTORS: GUIDED MISSILES, FOREIGN, ANTIMISSILE DEFENSE SYSTEMS, THREAT EVALUATION, ENEMY, MILITARY INTELLIGENCE, UNITED STATES, THREATS, ESTIMATES, NORTH AMERICA.

AD NUMBER: A314548

ARMY RESEARCH LAB FORT HUACHUCA AZ

FORT HUACHUCA FIELD ELEMENT INFORMATION DETAIL AND DISPLAY CONCEPTS FOR CRITICAL DECISIONS IN BALLISTIC MISSILE DEFENSE COMMAND AND CONTROL.

AUG 96 38P

PERSONAL AUTHORS: MARKERT, WENDY J.; KNAPP, BEVERLY G.; REYNOLDS, KENNETH C.

ABSTRACT: (U) The Theater High Altitude Area Defense (THD) System is a Missile Defense System being developed for the United States Army. Previous studies have been conducted regarding (a) information categorization, (b) attention direction and focusing, and (c) information criticality in order to aid designers in interface display design for the thd Operator System Interface (OSI). In particular, results from these studies have told designers (a) what information areas were critical and needed to be presented at a high level in the display, and (b) what information items within these information areas were critical and needed to be displayed in a prominent manner.

DESCRIPTORS: ANTIMISSILE DEFENSE SYSTEMS, COMMAND AND CONTROL SYSTEMS, MILITARY FORCES(UNITED STATES), GUIDED MISSILES, DECISION MAKING, DEFENSE SYSTEMS, INTERFACES, DISPLAY SYSTEMS, AMPLIFICATION, ARMY, OPERATORS(PERSONNEL), ATTENTION. LIMITATIONS (ALPHA): AVAILABILITY: DOCUMENT PARTIALLY ILLEGIBLE.

AD NUMBER: A314531

NAVAL POSTGRADUATE SCHOOL MONTEREY CA

NAVAL THEATER BALLISTIC MISSILE DEFENSE (TBMD)--DEVELOPMENT OF THE INFORMATION EXCHANGE REQUIREMENTS.

JUN 96 155P

PERSONAL AUTHORS: BRINTZINGHOFFER, DANIEL M.

ABSTRACT: (U) As the United States moves into the next century one of the biggest threats facing her national interests is the proliferation of Theater Ballistic Missile (TBM) Systems, with their potential for carrying Weapons of Mass Destruction (WMD). In order for the United States to 'project power', the Navy must play a large role in the protection of friendly assets from TBM attacks. Thus, the Navy is continuing to develop new systems and technologies as it attempts to migrate older weapons systems to fulfill this mission into its initial Ballistic Missile Defense concept, Navy Area Defense (NAD). This thesis looks at the differences between the current 'As Is' physical/information architectures for the Anti-Air Warfare Commander and the future 'To Be' physical/information architectures for Theater Ballistic Missile Defense Commander.

DESCRIPTORS: INFORMATION EXCHANGE, ANTIMISSILE DEFENSE SYSTEMS, AIR DEFENSE, GUIDED MISSILES, REQUIREMENTS, DEPARTMENT OF DEFENSE, MILITARY REQUIREMENTS, THEATER LEVEL OPERATIONS, UNITED STATES, ACQUISITION, WEAPON SYSTEMS, PHYSICAL PROPERTIES, THESES, PLATFORMS, CONVENTIONAL WARFARE, INFORMATION CENTERS, POWER, ARCHITECTURE, AREA DEFENSE, ONBOARD, INFORMATION PROCESSING. LIMITATIONS (ALPHA): AVAILABILITY: DOCUMENT PARTIALLY ILLEGIBLE.

♦AD NUMBER: A313312

NATIONAL AIR INTELLIGENCE CENTER
WRIGHT-PATTERSON AFB OH

MENACE OF ANTI-SHIP MISSILES AND SHIPBORNE LASER WEAPONS,

JUL 96 20P
PERSONAL AUTHORS: QIWAN, FANG; ZHIXIANG, YIN; CHUANFU, JIANG

ABSTRACT: (U) This paper discusses the menace of Antiship Missiles, the difficulties of Operational Shipborne Short Range Antimissile Defense Systems, and a survey of the development of Shipborne Laser Weapons.

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, *ANTISHIP MISSILES, *LASER WEAPONS, SHIP DEFENSE SYSTEMS, SHIPBOARD, TRANSLATIONS, SHORT RANGE(DISTANCE), CHINA.

AD NUMBER: A312387

NAVAL POSTGRADUATE SCHOOL
MONTEREY CA

THE ROLE OF SPECIAL OPERATIONS FORCES IN OPERATIONS AGAINST THEATER MISSILES.

MAR 96 187P
PERSONAL AUTHORS: RILEY, CRAIG A.

ABSTRACT: (U) The U.S. Military has never been able to prevent Theater Missiles (TMS) from being launched at U.S. and Allied or Coalition Forces and citizens. Post-War analysis of interdiction efforts during World War II and the Persian Gulf War could not identify a single instance where either a German V Weapon or an Iraqi Scud Missile was destroyed before launch. During the Cuban Missile Crisis, the best estimate that the Air Force could provide the National Command Authority was that ninety percent of the Soviet Missiles in Cuba would be destroyed by an airstrike. To correct this deficiency, the military developed Joint Theater Missile Defense (JTMD) Doctrine. This doctrine attempts to integrate synergistically all U.S. Military assets and capabilities. However, this doctrine does not fully integrate Special Operations Forces (SOF) into attack operations against TMS. additionally, the Joint Tactics, Techniques, and Procedures (JTTPS) needed to implement this doctrine have not been developed.

DESCRIPTORS: *THEATER LEVEL OPERATIONS, *SPECIAL OPERATIONS FORCES, WEAPONS, GUIDED MISSILES, USSR, WARFARE, AIR FORCE, IRAQ, RECOVERY, CRISIS MANAGEMENT, ANTIMISSILE DEFENSE SYSTEMS, PERSIAN GULF, TARGET ACQUISITION, INTERDICTION, ATTACK, THESES, AIR STRIKES, CUBA, MILITARY TACTICS, POSTWAR OPERATIONS, MATERIALS RECOVERY, GERMANY(EAST AND WEST).

♦Included in ***The DTIC Review***, December 1997

AD NUMBER: A312236

NAVAL WAR COLL NEWPORT RI

IMPROVING THEATER BALLISTIC MISSILE DEFENSE AT THE OPERATIONAL LEVEL OF WAR.

MAY 96 29P
PERSONAL AUTHORS: SCHLIENTZ, STEVEN C.

ABSTRACT: (U) The proliferation of Theater Ballistic Missiles (TBMS) and Weapons of Mass Destruction (WMD) throughout developing nations is so widespread that over 20 states may have an operational capability to deliver WMD using TBMS by the turn of the century. As was amply demonstrated during the Gulf War, even cheap, unsophisticated, and militarily insignificant TBMS such as the Al Hussein (Modified Scud-B) can pose a psychological impact so severe that a strategic center of gravity such as the cohesion of alliances and coalitions may be threatened. the enormity of this threat will rapidly exacerbate with improvements in the accuracy, range, and lethality of TBMS. In recognition of this emerging threat, Congress has drastically increased funding for the development of various robust systems for Joint Theater Missile Defense (JTMD). However, the first active defense systems and supporting space-based sensors that will provide a true area protection will be fielded no earlier than the middle of the next decade. Joint Force Commanders (JFCS) cannot rely solely on Patriot.

DESCRIPTORS: *THEATER LEVEL OPERATIONS,*ANTIMISSILE DEFENSE SYSTEMS,*MASS DESTRUCTION WEAPONS, WEAPONS, DEVELOPING NATIONS, *GUIDED MISSILES, CENTER OF GRAVITY, WARFARE, CONGRESS, DETECTORS, *DEFENSE SYSTEMS, IMPACT, ACTIVE DEFENSE, PERSIAN GULF, COMPUTERS, ATTACK, ACCURACY, PROTECTION, SURFACE TO AIR MISSILES, LETHALITY,

◆AD NUMBER: A312226

NAVAL WAR COLL NEWPORT RI

THEATER BALLISTIC MISSILE DEFENSE: STRENGTHENING THE GLUE THAT HOLDS THE PUZZLE TOGETHER.

MAY 96 24P
PERSONAL AUTHORS: ROWDEN, THOMAS S.

ABSTRACT: (U) The proliferation of Theater Ballistic Missiles (TBMS) and their use as Weapons of Terror as demonstrated during the Gulf War clearly demonstrate the need to be able to defend against this type of weapon. The United States Military must address this need and demonstrate it's resolve to adequately defend not only it's own forces but friendly forces, cities and populace as well. The potential use of Warheads which are Nuclear, Chemical, or Biological further complicate this issue.

DESCRIPTORS: *THEATER LEVEL OPERATIONS, *ANTIMISSILE DEFENSE SYSTEMS, COMPUTER COMMUNICATIONS, *COMMAND AND CONTROL SYSTEMS, *COMMUNICATIONS INTELLIGENCE, *NUCLEAR WARFARE, NUCLEAR WEAPONS, *GUIDED MISSILES, UNITED STATES, DEFENSE SYSTEMS, PREPARATION, ACTIVE DEFENSE, MILITARY DOCTRINE, BATTLEFIELDS, ATTACK, POPULATION, SYNERGISM, WARHEADS, PASSIVE DEFENSE, FRIENDLY FIRE.

◆Included in The DTIC Review, December 1997

AD NUMBER: A311233

ARMY WAR COLL
CARLISLE BARRACKS PA

TWIXT SCILLA AND CHARYBDIS: THEATER MISSILE DEFENSE AND THE ABM TREATY.

JAN 96 51P
PERSONAL AUTHORS: FAGGIOLI, VINCENT J.

ABSTRACT: (U) In 1972 the U.S. and the Soviet Union agreed to leave their territories vulnerable to Strategic Missile Attack. This agreement was manifest in the Antiballistic Missile (ABM) Treaty. This treaty prohibits deployment of nation-wide defenses against Strategic Missiles. Since then a new threat has arisen, Theater Missiles (TBMS), which threaten U.S. deployed forces and may impede the freedom of movement of those forces. In response to this new threat the U.S. has proposed a formidable response - state of the art Theater Missile Defense (TMD). In order to clarify the interplay between the ABM Treaty and TMD President Clinton has proposed a 'Demonstrated Capability' standard to distinguish between prohibited Strategic Missile Defense and permitted Theater Missile Defense.

DESCRIPTORS: USSR, ANTIMISSILE DEFENSE SYSTEMS, TREATIES, POLITICAL NEGOTIATIONS, MILITARY FORCES(UNITED STATES), GUIDED MISSILES, DEPLOYMENT, MILITARY STRATEGY, THEATER LEVEL OPERATIONS, DEFENSE SYSTEMS, COMMUNITIES, THREATS, ATTACK, STRATEGIC WEAPONS, ARMS CONTROL, STRATEGIC WARFARE.

AD NUMBER: A311147

GENERAL ACCOUNTING OFFICE
WASHINGTON DC

NATIONAL SECURITY AND INTERNATIONAL A FFAIRS DIV
BALLISTIC MISSILE DEFENSE: ISSUES CONCERNING ACQUISITION OF THD PROTOTYPE SYSTEM.

JUL 96 17P

ABSTRACT: (U) The Ballistic Missile Defense Organization and the Army Plan to acquire a Theater High Altitude Area Defense (THD) User Operational Evaluation System (UOES)-an early prototype version of the final THD System. UOES is intended to (1) allow military users to influence the THD System design, (2) permit an early operational assessment of the system's capabilities, and (3) provide a system that could be deployed in a national emergency. UOES will consist primarily of refurbished components acquired for the system's demonstration and validation phase, although the Army plans to purchase 40 UOES interceptors to provide the deployable system capability.

DESCRIPTORS: *ACQUISITION, PROTOTYPES, *BALLISTIC MISSILE INTERCEPT SYSTEMS, AREA DEFENSE, ARMY PROCUREMENT, *CONGRESS, *DEPARTMENT OF DEFENSE, DEPLOYMENT, SYSTEMS ENGINEERING, *NATIONAL SECURITY, EMERGENCIES, PRODUCTION, VALIDATION, DEMONSTRATIONS, OPERATIONAL EFFECTIVENESS, HIGH ALTITUDE, USER NEEDS, INTERCEPTORS, ARMY PLANNING.

AD NUMBER: A311138

NAVAL POSTGRADUATE SCHOOL
MONTEREY CA

PROBABILITY MODELS FOR ASSESSING THE VALUE OF BATTLE DAMAGE ASSESSMENT IN THE DEFENSE AGAINST SEQUENTIAL THEATER MISSILE ATTACKS.

MAR 96 60P
PERSONAL AUTHORS: SONG, SHING-JEN

ABSTRACT: (U) This thesis seeks to use probability models TOM investigate the effects and value of Battle Damage Assessment (BDA) information availability on sequential tasks encountered in the defense against missile attacks. Different levels of information will have different impacts on the outcome of the battle. Additional information could increase the effectiveness of the Defensive Weapon System. On the other hand, the enemy could use deception techniques, Electronic Warfare (EW) and decoy measures on the information-gathering methods to disrupt the acquisition of information which would decrease the effectiveness of defensive weapons. In the models, we show how to best allocate limited resources; i.e. the available kill time, to maximize the reward.

DESCRIPTORS: *MATHEMATICAL MODELS, *ANTIMISSILE DEFENSE SYSTEMS, KILL PROBABILITIES, DAMAGE ASSESSMENT, WEAPONS, GUIDED MISSILES, MEASUREMENT, ELECTRONIC WARFARE, *THEATER LEVEL OPERATIONS, DECISION MAKING, ACQUISITION, WEAPON SYSTEMS, PROBABILITY, ATTACK, THESES, SEQUENCES, TIME, AVAILABILITY, DECOYS, BATTLES, DECEPTION.

AD NUMBER: A310979

NYLAND ENTERPRISES
IDAHO SPRINGS CO

THE ABM TREATY AND NATIONAL BALLISTIC MISSILE DEFENSE OPPORTUNITIES.

MAY 96 30P
PERSONAL AUTHORS: NYLAND, F. S.

ABSTRACT: (U) This report provides an examination of the potential capabilities of Ballistic Missile Defense Systems that comply with the ABM Treaty, methods of analyzing the effects and consequences of various doctrines for allocating interceptors are derived. Attacks by Russia, China, or Third World Nations are considered. Limited Missile Defense Systems with up to 100 interceptors based at one site, given that they meet certain performance goals, could be used to counter threats envisioned in the post cold-war world.

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, *GUIDED MISSILES, DEFENSE SYSTEMS, THREATS, SITES, ATTACK, ALLOCATIONS, DECOYS, RUSSIA, *TREATIES, *GUIDED MISSILE DEFENSE SYSTEMS, INTERCEPTORS, COUNTERMEASURES, CHINA.

AD NUMBER: A310623

NATIONAL AIR INTELLIGENCE CENTER
WRIGHT-PATTERSON AFB OH

DISCUSSION OF RADAR ANTI-ANTIRADIATION MISSILE TECHNOLOGY--ALARMING PLUS DECOY SYSTEM,

JUL 96 25P
PERSONAL AUTHORS: LIAN, WEIJIE

ABSTRACT: (U) This paper briefly introduces the current development of Antiradiation Missiles (ARM) in overseas military circles, as well as some major tactic technical measures, taken in some countries in the area of Anti-Arm Threat Air-Defense Radar, also it discusses the necessity, feasibility and key techniques of ARM Threat Alarming plus decoy arrangement, the effectiveness of deception type ARM Decoy System and the significant role it plays in simplifying alarming equipment. Finally, it advances several basic ideas which are worth noticing in designing Anti-Arm Threat measures.

DESCRIPTORS: *ANTIRADIATION MISSILES, *AIR DEFENSE, DECOYS, TRANSLATIONS, CHINA, OVERSEAS, CIRCLES.

AD NUMBER: A310542

NATIONAL AIR INTELLIGENCE CENTER
WRIGHT-PATTERSON AFB OH

DEVELOPMENT OF TACTICAL AIR DEFENSE LASER WEAPONS AT HOME AND ABROAD: AN OUTLINE,

MAY 96 18P
PERSONAL AUTHORS: JI, SHIFAN

ABSTRACT: (U) This article describes Tactical Missile Defense as an important task of Modern Air Defense and Tactical Air Defense Laser Weapons as effective weapons. It also details the history and present condition of Laser Weapons developed by the three branches of the U.S. Armed Forces and briefs the research and development of Laser Weapons in the Soviet Union, Germany, France and the People's Republic of China.

DESCRIPTORS: *AIR DEFENSE, FOREIGN TECHNOLOGY, *LASER WEAPONS, CHINA, USSR, *ANTIMISSILE DEFENSE SYSTEMS, FRANCE, GERMANY, TRANSLATIONS, TACTICAL WARFARE.

AD NUMBER: A310409

NATIONAL AIR INTELLIGENCE CENTER WRIGHT-PATTERSON AFB OH

LASER TECHNOLOGY (SELECTED ARTICLES).

APR 96 49P

ABSTRACT: (U) This paper presents High-Energy CW HF/DF Chemical Lasers developed under the U.S. Navy Sealite Program and the Alpha program of the DARPA Triad Program, and a brief account of Soviet Chemical Lasers. continuous Wave HF/DF Chemical Lasers were developed starting in the late sixties as high-power lasers of consistent interest to military circles. These are lasers that have the most matured technology among present-day high-energy lasers. It is hoped that in the near future CW HF/DF Chemical Lasers can be developed into a Space Laser Weapon to deal with ICBMS. CW HF/DF Chemical Lasers are an integration of technologies in gas dynamics, chemistry, fluid chemistry, optics, and lasers. by using the branching chain reaction of heat liberation, inversion of the population ratio is generated to obtain lasers.

DESCRIPTORS: *LASER WEAPONS, *STRATEGIC DEFENSE INITIATIVE, *CHEMICAL LASERS, HIGH POWER, *ANTIMISSILE DEFENSE SYSTEMS, SPACE SYSTEMS, SURVIVABILITY, GAS DYNAMICS, TRANSLATIONS, SURFACE TO SURFACE MISSILES, CHAIN REACTIONS, CHINA, CONTINUOUS WAVE LASERS, CHINESE LANGUAGE.

AD NUMBER: A309930

RAND CORP SANTA MONICA CA

ESTIMATION AND PREDICTION OF BALLISTIC MISSILE TRAJECTORIES.

96 94P

PERSONAL AUTHORS: ISCSON, JEFFREY A.; VAUGHAN, DAVID R.

ABSTRACT: (U) To examine the capabilities satellites can bring to bear in a Theater Missile Defense (TMD) environment, the authors describe a methodology, based on Kalman Filtering, for the estimation and prediction of Ballistic Missile trajectories and then apply the methodology to a National Theater Ballistic Missile. One useful application is in estimating the uncertainty associated with the location of a missile launch. Determining missile location uncertainty at any point along the trajectory is another application. filters optimized for random errors alone as well as random plus bias errors are outlined. Harnessed in a theater of operations, the type of information described in this report can be used to enhance the capability of active and passive defenses and attack operations.

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, PREDICTIONS, ESTIMATES, *GUIDED MISSILE DEFENSE SYSTEMS, *BALLISTIC TRAJECTORIES, COMMAND CONTROL COMMUNICATIONS, *GUIDED MISSILES, POSITION(LOCATION), UNCERTAINTY, THEATER LEVEL OPERATIONS, *KALMAN FILTERING, PASSIVE SYSTEMS, OPERATIONAL EFFECTIVENESS, ERRORS, LAUNCHING. LIMITATIONS (ALPHA): AVAILABILITY: DOCUMENT PARTIALLY ILLEGIBLE.

AD NUMBER: A309658

ARMY WAR COLL
CARLISLE BARRACKS PA

JOINT THEATER MISSILE DEFENSE.

96 31P
PERSONAL AUTHORS: HARMATZ, HOWARD I.

ABSTRACT: (U) Since the 1991 Gulf War, the United States has recognized the critical need for a Joint Theater Missile Defense (JTMD) capability. The Department of Defense (DoD) has subsequently taken appropriate steps to develop it. In 1994, DoD established a joint organization to manage JTMD Research and Development (R&D), Acquisition, and Structure. then the Joint Staff developed the Joint Doctrine required for the conduct of Synchronized Theater Missile Defense (TMD) throughout the depth of a Theater of Operations. This paper briefly presents U.S. TMD initiatives to date. it identifies the threat, reviews current joint doctrine, and then presents a case that only through a true joint approach and effort will U.S. JTMD be postured to defeat any future employment of Weapons of Mass Destruction (WMD) by Theater Missiles (TM) against U.S. Forces or our Allies. It also makes the point that DoD needs to further take the initiative to establish a JTMD operational proponent to best synchronize JTMD operations for Theater Warfighting CINCS.

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, *MILITARY INTELLIGENCE, *AIR DEFENSE, COMMAND CONTROL COMMUNICATIONS, *THEATER LEVEL OPERATIONS, *MILITARY DOCTRINE, *CRUISE MISSILES, JOINT MILITARY ACTIVITIES, MASS DESTRUCTION WEAPONS, SURFACE TO AIR MISSILES, *BALLISTIC MISSILE INTERCEPT SYSTEMS, *AIR TO SURFACE MISSILES.

AD NUMBER: A307733

NAVAL POSTGRADUATE SCHOOL
MONTEREY CA

THEATER MISSILE DEFENSE: THE EFFECTS OF TMD ON U.S.-JAPANESE SECURITY RELATIONS.

MAR 96 111P
PERSONAL AUTHORS: SPURLOCK, KENNETH R.

ABSTRACT: (U) This thesis examines the continued pursuit of Co- Production efforts by the United States with Japan. The President has identified the development of Theater Missile Defenses (TMD) as a priority to counter the proliferation of Theater Ballistic Missiles (TBM) and Weapons of Mass Destruction (WMD). in keeping with the priorities set forth by the President. The Secretary of Defense has made several proposals to the Japanese government in regards to the purchase, increased technical exchanges and Co-Production of TMD Systems. This study reviews the potential impact such efforts may pose on the future of the U.S.-Japan Security relationship and the ability of the United States to exert its influence in the Asia-Pacific region. The environment which led to the initial Security Agreement in 1951 has been significantly altered and many believe that TMD may be the necessary tool to restore stability to the relationship. Through the Application of Three Alliance Theories this thesis analyzes the U.S. decision to pursue Joint TMD production with Japan. This thesis provides background information for three theories and applies them to the history of the U.S.-Japan Alliance the FS-X Co-Production effort and the extended TMD proposals. based on this application and analysis this study concludes that Co-Production of TMD will impede the production of TMD, and therefore not in the direct interest of the United States.

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, INTERNATIONAL RELATIONS, *THEATER LEVEL OPERATIONS, *NATIONAL SECURITY, FOREIGN TECHNOLOGY, INFORMATION EXCHANGE, TECHNOLOGY TRANSFER, POLITICAL ALLIANCES, THESES, JAPAN, THREAT EVALUATION,

AD NUMBER: A307605

NAVAL WAR COLL
NEWPORT RI

JOINT MILITARY OPERATIONS DEPT
MAXIMIZING OPERATIONAL PROTECTION IN THE FACE OF THE THEATER BALLISTIC MISSILE THREAT: 1996-2006.

FEB 96 19P
PERSONAL AUTHORS: STEINDL, DAVID F.

ABSTRACT: (U) In response to the proliferation of Theater Ballistic Missiles, the U.S. has invested a great deal of technological resources into the development of Theater Ballistic Missile Defense (TBMD) Systems. but this technological focus can prove ineffectual if the broader TBMD issues at the operational level of war are not also addressed. TBMD is a vital element of operational protection and contributes to the successful accomplishment of many of the principal components of operational protection.

DESCRIPTORS: * THEATER LEVEL OPERATIONS, *ANTIMISSILE DEFENSE SYSTEMS, MILITARY FORCES(UNITED STATES), *GUIDED MISSILES, CENTER OF GRAVITY, DEPLOYMENT, THREATS, PASSIVE SYSTEMS, PROTECTION, AREA DEFENSE.

AD NUMBER: A307604

NAVAL WAR COLL
NEWPORT RI

DISJOINTED: U.S. DOCTRINE FOR COUNTERING AIR AND MISSILE THREATS.

FEB 96 17P
PERSONAL AUTHORS: BEAUMONT, WILLIAM W.

ABSTRACT: (U) In the wake of the Cold War, the United States is reexamining the roles and missions of the Armed Services. Doctrine published by the Chairman of the Joint Chiefs of Staff (CJCS) establishes different missions by the responsibilities and procedures necessary to conduct joint operations. Unfortunately, current U. S. Doctrine for countering air and missile threats is disjointed because the Armed Services: do not share the same vision on how Theater Air Defense should he conducted, do not trust how the doctrine will be implemented, and do not have impartial representation on the Joint Force Air Component Commander's (JFACC) staff. Charges of parochialism have plagued Joint Doctrine since its inception. Under the Goldwater-Nichols Act of 1986, CJCS selected services to act as 'lead agents' in developing the various joint publications. CJCS should abolish the 'lead agent' concept establish a joint command to forge a central vision for multiservice operations. The Unified Commander-in-Chiefs can assist in promoting trust in joint counterair operations by establishing a Theater JFACC staff. This joint staff will ensure impartial service representation, end ease Inter-Theater cooperation and training. with the decline of the military budget, joint defense offers the best solution for providing the U.S. with the decisive combat power it needs to defeat future air and missile threats.

DESCRIPTORS: *THEATER LEVEL OPERATIONS, *ANTIMISSILE DEFENSE SYSTEMS, MILITARY DOCTRINE, AIR DEFENSE, COMBAT EFFECTIVENESS, *UNITED STATES, THREATS, FORGING, *JOINT MILITARY ACTIVITIES, COLD WAR, MILITARY BUDGETS, *AERIAL WARFARE, COOPERATION, MILITARY TRAINING.

AD NUMBER: A307443

NAVAL WAR COLL NEWPORT RI

JOINT MILITARY OPERATIONS DEPT
A CRITICAL ANALYSIS: OPERATIONAL SCHEME AND JOINT THEATER MISSILE DEFENSE ATTACK CAPABILITIES,

JUN 96 30P
PERSONAL AUTHORS: DI GESU, GARY F.

ABSTRACT: (U) Following the Gulf War in 1991, U.S. Military and civilian leaders identified significant shortcomings in the conduct of U.S. Joint Theater Missile Defense (JTMD) Operations and applied the lessons learned to improve the Joint Force Commander's (JFC) ability to execute such operations more effectively in the future. Four pillars of JTMD were doctrinally established: passive defense, active defense, attack operations, and C41. This scope of this paper is specifically limited to JTMD attack operations and related C41 capabilities which are designed to be employed against an adversary capable of launching Ground-Based Theater Missiles at U.S. Forces and/or their allies during a regional conflict. to be effective, procedural improvements and the execution of JTMD attack operations cannot be implemented in a vacuum; they must be coordinated and integrated as part of a JFC's overall operational design. thus, by using four integral elements of operational scheme (application of forces and assets; synchronization; coordination; and operational fires) as a framework of analysis, this paper will critically evaluate the present/near-future effectiveness of JTMD Attack Systems and C41 capabilities to support and implement the JFC's overall operational design.

DESCRIPTORS: *LESSONS LEARNED, *ANTIMISSILE DEFENSE SYSTEMS, *MILITARY DOCTRINE, MILITARY CAPABILITIES, JOINT MILITARY ACTIVITIES, *GUIDED MISSILE DEFENSE SYSTEMS, MILITARY INTELLIGENCE, COMMAND CONTROL COMMUNICATIONS, *GUIDED MISSILES, WARFARE, THEATER LEVEL OPERATIONS, ACTIVE DEFENSE, ATTACK, LAUNCHING, CONFLICT, GROUND BASED

AD NUMBER: A307336

NAVAL WAR COLL NEWPORT RI

JOINT MILITARY OPERATIONS DEPT
SECURITY FROM LAND-ATTACK CRUISE MISSILE THREATS: CONSIDERATIONS FOR THE OPERATIONAL COMMANDER.

FEB 96 21P
PERSONAL AUTHORS: O'NEAL, JAMES, JR

ABSTRACT: (U) The United States will increasingly find itself faced with deploying combat forces in response to major regional contingencies. at the operational level, it is inevitable that U.S. Operational Commanders will contend with one or more hostile powers intent on threatening order and stability using advanced weaponry. With proliferation of Land-Attack Cruise Missiles, the Operational Commander is now faced with a ever burgeoning, and quite capable threat to his forward deployed forces. As with any other military threat, once recognized and validated, careful planning must be accomplished to mitigate the potential effects. currently, the United States continues to place emphasis on neutralizing the Tactical Ballistic Missile threat to forward deployed forces. But, the tide is turning, and many third world players are acquiring Cruise Missiles to replace or complement their Ballistic Missile inventories. thus, the Operational Commander must fully recognize this threat and accomplish effective planning within the framework of current Joint Theater Missile Defense Doctrine to obviate it.

DESCRIPTORS: *DEVELOPING NATIONS, *ANTIMISSILE DEFENSE SYSTEMS, THREATS, MILITARY FORCES(UNITED STATES), COMBAT EFFECTIVENESS, DEPLOYMENT, *LAND WARFARE, *CRUISE MISSILES, MILITARY APPLICATIONS, INVENTORY, MILITARY COMMANDERS, COMBAT FORCES, TACTICAL WEAPONS, LAND AREAS.

AD NUMBER: A306465

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DEVELOPMENT OF FOREIGN HIGH-POWERED MICROWAVE WEAPONS AND PROSPECTS OF FUTURE APPLICATIONS IN SPACE-BASED TARGET DEFENSE AND AIR DEFENSE,

MAR 96 34P
PERSONAL AUTHORS: LI, HUI; WANG, ZIBIN

ABSTRACT: (U) This paper outlines the development of Foreign High- Power Microwave Weapons and their technologies and, by introducing High-Power Microwave sources and effects, analyzes the prospects of their applications in space-based target defense and air defense.

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, MICROWAVES, ELECTRONIC *COUNTERMEASURES, *DIRECTED ENERGY WEAPONS, MICROWAVE INTERFEROMETRY, HIGH POWER, AIR DEFENSE, USSR, UNITED STATES, FOREIGN TECHNOLOGY, *TRANSLATIONS, CHINA, ELECTROMAGNETIC PULSES, CHINESE LANGUAGE, *SPACE BASED.

AD NUMBER: A306460

NATIONAL AIR INTELLIGENCE CENTER
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STRATEGIC DEFENSE INITIATIVE REVIEW FOR THE YEARS 1993 TO 1994,

MAR 96 43P
PERSONAL AUTHORS: LI, ZHONGBO

ABSTRACT: (U) This document discusses the Russian Missile Defense Systems, cooperation between the United States and Russia, Russia's attitude toward global protection and Antimissile Systems, and Treaties.

DESCRIPTORS: *STRATEGIC DEFENSE INITIATIVE, *AIR DEFENSE, *FOREIGN POLICY, UNITED STATES, *ANTIMISSILE DEFENSE SYSTEMS, RUSSIA, TRANSLATIONS, TREATIES, INTERCEPTORS, CHINA, EARLY WARNING SYSTEMS, CHINESE LANGUAGE.

AD NUMBER: A306427

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WRIGHT-PATTERSON AFB OH

A TYPE OF METHOD USED TO STUDY ANTIBALLISTIC WEAPONS SYSTEM PRECISION,

FEB 96 19P
PERSONAL AUTHORS: NINGPING, LIU

ABSTRACT: (U) This article presents one type of method for studying precision--the Montecarlo method. It discusses in detail several keys to utilizing Montecarlo methods--the production of initial state sets, the introduction of error, the selection of statistical sets. Finally, it gives two examples of the use of Montecarlo methods.

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, *FIRE CONTROL SYSTEMS, *MONTE CARLO METHOD, PRECISION, TRANSLATIONS, CHINA, AEROBALLISTICS, CHINESE LANGUAGE.

AD NUMBER: A306336

NATIONAL AIR INTELLIGENCE CENTER
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HIGH SPEED ANTIMISSILE COMMAND INERTIAL PRECISION GUIDANCE SYSTEMS,

FEB 96 10P
PERSONAL AUTHORS: ZHIHONG, ZHANG

ABSTRACT: (U) This article is a written translation of a voice recording of a lecture made by the author at the Moscow International Ballistic Missile Defense Symposium on 24 November 1993. It primarily discusses guidance and control methods associated with close and medium range high speed Antimissile Missiles to intercept in the atmosphere Ballistic type missile warheads. Exposition is primarily of command inertial guidance methods opted for to use in High Speed Missiles within dense atmosphere as well as control methods associated with predetermined impact points. It gives the structures currently associated with this type of guidance method control system. The author of the lecture is a member of the Russian 'Trail Blazer' (Honarop Design Bureau, specializing in the development of High Speed Antimissile) missiles. As far as the lack of illustrations in the original article is concerned, the appended Fig.'s in the article were added as supplements by the translator on the basis of the contents of the recorded lecture and the principles it concentrated on. They are only provided for reference.

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, *INERTIAL GUIDANCE, *GUIDED MISSILES, USSR, CONTROL, *CONTROL SYSTEMS, RUSSIAN LANGUAGE, GRAPHICS, RECORDING SYSTEMS, TRANSLATIONS, GUIDANCE, ATMOSPHERES, *VOICE COMMUNICATIONS, IMPACT POINT, COMMAND GUIDANCE, LECTURES, DENSE GASES.

AD NUMBER: A305993

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ARLINGTON VA

SETA SUPPORT FOR SDIO KEY
TECHNOLOGIES.

APR 96 43P
PERSONAL AUTHORS: STROBEL, ERIC L.

ABSTRACT: (U) Work performed under this contract was in support of the Lethality and Target Hardening (LTH) Program. This activity addressed the effects of LTH Program data and results on government Ballistic Missile Defense (BMD) efforts in other areas, supporting the program manager's efforts to impress upon the BMD community the broad relevance of LTH products. This activity also performed special studies as directed by the LTH Program management. due to the varied nature of this effort, as well as the duration of the contract, only a sampling of support items are presented, along with summaries of several key analyses. (mm)

DESCRIPTORS: *ANTIMISSILE DEFENSE SYSTEMS, *STRATEGIC DEFENSE INITIATIVE, ALGORITHMS, KILL PROBABILITIES, HIGH ALTITUDE, LETHALITY, *INTERCEPTORS, KINETIC ENERGY PROJECTILES, *AREA DEFENSE, HARDENING.

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