Policy Analysis

Cato Institute Policy Analysis No. 309: Theater Missile Defense: A Limited Capability Is Needed

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Executive Summary

The current Ballistic Missile Defense Organization program emphasizes theater missile defense, or TMD (defense of foreign theaters), rather than defense of the United States (national missile defense). The TMD program is largely designed to protect forward-deployed U.S. forces, as well as friends and allies of the United States. The total cost of the TMD program is an estimated $47.3 billion.

It is no longer reasonable or rational for the United States to maintain forward-deployed forces throughout the world and provide protection for friends and allies. Thus, there is no need to acquire all the systems in the current TMD program. The United States should purchase only those systems that support a national security policy of sending U.S. expeditionary forces to foreign theaters only when vital U.S. national security interests are at stake.

Theater High-Altitude Area Defense is intended to be a forward-deployed, ground-based, wide-area defense system designed primarily to protect allies and other friendly nations. Medium Extended Air Defense System--a mobile defense for ground forces--is plagued with fiscal uncertainty. The Airborne Laser--a system designed to attack missiles just after launch--is fraught with technical uncertainty. Eliminating those systems would save an estimated $30 billion.

A "common-sense" approach is to acquire the Navy Area Defense and the Navy Theaterwide Defense (with a wider area of defense) systems to provide TMD capability for U.S. forces. To protect important military targets that might be beyond sea-based TMD systems, the transportable PAC-3 system should also be acquired. Those three systems would provide the requisite TMD capability at less than half the cost of the current TMD program.

Introduction

In 1983 President Ronald Reagan announced the Strategic Defense Initiative (SDI), challenging the American scientific community to investigate the feasibility of developing a system to defend against ballistic missile attacks using new and emerging technologies. In response to that challenge, the Department of Defense (DoD) established the Strategic Defense Initiative Office (SDIO) to manage the research and development efforts. According to Lt. Gen. Malcolm O'Neill, SDIO's mission was to manage and direct a research program--including the development of advanced technologies--that would allow an informed decision on the feasibility of eliminating the threat posed by nuclear ballistic missiles of all ranges or increasing the contribution of defensive systems to U.S. and allied security, or both.[1]

Although missiles of all ranges implied theater ballistic missile threats (which would require defense against short-range ballistic missile threats in various regions throughout the world), the SDI program was mainly focused on the threat posed by Soviet longer-range nuclear ICBMs (intercontinental ballistic missiles) to the United States (what was then called "strategic" defense but is now known as national missile defense or NMD).

Since 1983 the ballistic missile defense (BMD) research and development program has evolved through four distinct phases (and the SDIO has become the Ballistic Missile Defense Organization, or BMDO). According to O'Neill, the program has had the following components and missions:

- A broad-based technology exploration and demonstration program to identify those technologies ready for development to support an initial multilayer comprehensive defense system and those promising follow-on technologies that could provide resilience against a full range of responsive countermeasures (1984-1986);
- A focused development program, called the Phase 1 Strategic Defense System, initiated in 1987 and aimed toward a significant ground- and space-based, layered defense capability to augment and strengthen deterrence (1987-1990);
- The refocusing of the program toward a Global Protection Against Limited Strikes [GPALS] system, which would protect the [United States], our forces overseas and friends and allies against limited ballistic missile strikes (1991-1992); and
- The reorientation of the BMD program to focus on acquisition and deployment of highly effective theater missile defenses to protect against the ballistic missile threat that is "here and now," and to maintain a technology readiness program for national missile defenses, should the ballistic missile threat to the United States emerge (1993-present).[2]

The breakup of the Soviet Union and the end of the Cold War abrogated the need to focus on the threat posed by a massive Soviet ICBM first strike. But the 1991 Persian Gulf War demonstrated the nature of theater ballistic missile threats, as well as the promise of emerging theater missile defense (TMD) technologies. Although primarily designed and deployed for air defense, the Army's Patriot missile system was used in a TMD role against Iraqi Scud missiles.

The theater ballistic missile threat is real and persistent. It will likely continue to grow, becoming more diverse and lethal. Even with arms control,[3] more countries are likely to acquire ballistic missiles or the technology to build ballistic missiles. According to a report prepared for DoD by Systems Planning Corporation,

> Ballistic missiles are appealing to leaders of developing countries, often serving as status symbols. Their long range, short flight time, flexible payload, and relatively low cost provide unique political as well as military advantages.[4]

More ominous is the possibility that some of those countries might acquire weapons of mass destruction (e.g., nuclear, biological, chemical weapons) and mate those weapons with ballistic missiles.

Should it become necessary to deploy U.S. forces to a theater of operations, there is an increasing likelihood that those forces would be faced with the threat of theater ballistic missiles and, possibly, weapons of mass destruction. Such threats could adversely affect the ability of forces to deploy to the theater, constrain the location of deployments and actions of those forces, and affect the timely success of any military operations.

Therefore, the question is not whether the United States should have TMD capability but rather what TMD capability makes the most sense. Specifically, what TMD capability is best for the post-Cold War era? Theater missile defense, then, must be examined in the broader context of overall U.S. foreign and defense policy and strategy, not simply in terms of TMD weapon system capabilities and effectiveness.

Policy and Strategy Framework

The national security strategy adopted by the United States will be an important factor in determining the number of occasions on which theater missile defenses might have to be used. A more restrained strategy that confined the use of military force to defending vital U.S. interests would minimize that number.

With the demise of the threat to U.S. security that the Soviet Union and Warsaw Pact posed, there is no longer a need for a strong U.S. military presence in Western Europe. The same point could be made about a continued U.S. military presence in South Korea and other parts of the world. In other words, "global leadership" should no longer be the guiding principle for American foreign and defense policy. According to Cato's associate foreign policy analyst Barbara Conry, "Taken to an extreme, global leadership implies U.S. interest in and responsibility for virtually anything, anywhere."[5] Such a policy would require a U.S. military presence in every part of the world where there is a perceived or potential military threat. Perhaps against a perceived omnipresent Soviet threat that had global reach such a policy and strategy made some sense. But that is certainly no longer the case. As Conry states,

> There are several alternatives to global leadership, including greater reliance on regional security organizations and the creation of spheres of influence or regional balance-of-power arrangements. The United States would then act as a balancer of last resort. Such a strategy would preserve U.S. security without the costs and risks of an unrealistic crusade to lead the world.[6]

Conry concludes that, in the post-Cold War era, it is no longer reasonable that the United States get involved in numerous conflicts around the globe and that it do whatever is needed to win to maintain U.S. credibility.[7] Michael Mandelbaum is also skeptical about the efficacy of a policy of intervening anywhere and everywhere in the post-Cold War world.

> While Mother Teresa is an admirable person and social work a noble profession, conducting American foreign policy by her example is an expensive proposition. The world is a big place filled with distressed people, all of whom, by these lights, have a claim to American attention. Putting an end to the suffering in Bosnia, Somalia, and Haiti would have involved addressing its causes, which would have meant deep, protracted, and costly engagement in the tangled political life of each country.[8]

Instead, Conry believes that the United States should emphasize the protection of its vital national interests. She argues that it can achieve that goal better by acting as the "first among equals" in the community of great powers than by insisting that the United States--as the world's only superpower--should take responsibility for events all over the globe. After all, great power status confers not only the capability to get involved in conflicts around the world but also the power to remain aloof from lesser crises. (Ronald Steel agrees with Conry that other major powers can police conflicts in their own regions.)[9]

Such a change in strategy has several important implications. U.S. forces would not be expected to be everywhere at once. With a more restrained military strategy, the United States would not need forward-deployed forces or prepositioned equipment in various theaters of operations. And we should expect only a limited overseas naval presence in any given region at any given time. Moreover, we cannot be dependent on alliance structures to provide requisite or supporting military capabilities. Nor can we always count on host-nation support.

Yet, even with a strategy confined to the defense of vital U.S. national security interests, there may be times when it becomes necessary to deploy U.S. forces to a distant theater. In those instances, we have a moral obligation to protect the safety of U.S. forces in every feasible way.

U.S. forces--including theater missile defenses--will have to be readily deployable, self-reliant, and self-sustaining. Our TMD system choices must support an ability to project military power at places and times of our own choosing, when it is deemed to be vital to U.S. national security interests. More explicitly, if we use a strategy that depends on a U.S.-based military in expeditionary mode, TMD will be needed to protect the forces in the field and the overseas ports and airfields used to deploy the forces.

Theater Ballistic Missile Threats

The first ballistic missile was the German V-2 used against England during World War II. The V-2 was a single-stage, liquid-fueled ballistic missile with an inertial guidance system and a range of about 200 miles. It carried a payload of about 350 pounds of high explosives. It was not very accurate and, therefore, more effective against urban (i.e., civilian) than military targets. Although the V-2 is a primitive system by modern military standards and technology, the ballistic missile that has proliferated the most in the world today, the Soviet Scud, is a descendant of the original German designs of World War II.[10]

The Egyptians were the first to use Scud missiles in combat, against Israel during the October 1973 war. Despite a capability and a range not substantially different from those of the German V-2, Scuds have been used in combat since 1973 by Libya, Iran, Iraq, and Afghanistan. In 1986, following U.S. air strikes on Libya, Libya retaliated by launching two Scuds at the American Coast Guard facility on the island of Lampesuda, off the Italian coast. In the Iran-Iraq war, which lasted from 1980 to 1988, more than 600 Scuds were fired, including those exchanged during the intensive Scud campaigns in the "war of the cities." In November 1988 the Afghan army began using the Scud B against guerrilla bases, reportedly launching more than 2,000 Scuds. In the Gulf War, the Iraqis launched about 90 Scuds against targets in Israel, Saudi Arabia, and elsewhere in the region.[11]

Clearly, the theater ballistic missile threat is real. It is not a question of whether a growing number of countries have ballistic missile capabilities--they do. And it is not a question of whether such countries would use ballistic missiles--they have. The proverbial "genie" is out of the bottle. Over time, more countries will undoubtedly acquire ballistic missile technology and capability. Currently, "the proliferation threat consists largely of either the short-range (less than 300 km) missiles or the long-range (300-600 km) but relatively inaccurate Scud-derived tactical ballistic missiles."[12] However, it would be foolhardy to assume that the theater ballistic missile threat--the numbers of countries that acquire missiles, the numbers of missiles, and their capabilities (range, accuracy, destructive power)--will not grow.

Current Threats

Table 1 illustrates the current extent of theater ballistic missile proliferation. The purpose here is not a threat assessment per se; many of the countries listed in the table are considered friends or allies of the United States. Rather, the table is meant to simply illustrate the point that theater ballistic missile technology and capability are already widespread throughout the world. And we can realistically expect such proliferation to grow.

Table 1
Ballistic Missiles of Developing Countries

Country	System	Status	Range (kilometers)/ Payload (kilograms)	Source
Afghanistan	Scud-B	O/U	300/1,000	Soviet Union
Argentina	Alacran	D/T	200/100	Consortium
	Condor II	C	800-1,000/500	Consortium
Belarus	SS-21	O	120/250	Soviet Union
	Scud-B	O	300/1,000	Soviet Union
Brazil	MB/EE-150	C	150/500	I
	SS-300	C	300/1,000	I
	SS-600	C	600/500	I
Bulgaria	Scud-B	O	300/1,000	Soviet Union
	SS-23	O	500/450	Soviet Union
Czech Republic	SS-21	O	120/250	Soviet Union
	Scud-B	O	300/1,000	Soviet Union
	SS-23	O	500/450	Soviet Union
Egypt	Scud-B	O/U	300/1,000	Soviet Union
	Scud-100/"Project T"	D	600/500	DPRK/UK/I

	Condor II	C	800-1,000/500	Consortium
India	Prithvi-150	O/P	150/1,000	I
	Prithvi-250	D/T	250/500	I
	Agni	D/T	1,500-2,500/ 1,000	I
Iran	Mushak-120	O/U/P	120-130/500	China/DPRK/I
	Mushak-160	O/P	160/NA	China/DPRK/I
	Mushak-200	D	200/NA	China/DPRK/I
	8610/CSS-8	O/P	150/500	China
	Scud-B	O/U	300/1,000	Libya/Syria
	Scud-Mod.B	O	320/1,000	DPRK
	Scud-Mod.C	O	500/700	DPRK
	Iran 700	D	700+/NA	China/I
	Tondar-68	D	1,000/500	China/I
Iraq	Al-Samoud	D	130-140/300	I
	Al-Hussein	C	650/500	I
	Al-Abbas	C	950/300	I
Israel	Lance	O	125/275	United States
	Jericho I	O/P	650/500	France/I
	Jericho II	O/P	1,500/1,000	France/I
Libya	Scud-B	O/U	300/1,000	Soviet Union
	Al-Fatah	D	200/500	Germany/I
North Korea	Scud-B	O	300/1,000	Egypt/Soviet Union
(DPRK)	Scud-Mod.B	O/P	320/1,000	I
	Scud-Mod.C	O/P	500/700	I
	Nodong	D/T	1,000-1,300/1,000	I
	Taep'o-dong	I/D	1,500+/1,000	I
	Taep'o-dong II	D	4,000/1,000	China/I
Pakistan	M-11	Unassembled	290/800	China
	Hatf 2	D/T	300/500	I/France
	Hatf 3	D	600/NA	I/France
	Ghauri	T	1,500/	
Romania	Scud-B	O	300/1,000	Soviet Union
Saudi Arabia	CSS-2/DF-3	O	2,650/2,150	China
Slovakia	SS-21	O	120/250	Soviet Union
	Scud-B	O	300/1,000	Soviet Union
	SS-23	O	500/450	Soviet Union
South Africa	Arniston	C	1,450/1,000	Israel (?)
South Korea	NHK-1	O/P	180/500	United States/I
(ROK)	NHK-2	O/P	180-260/500	United States/I
Syria	SS-21	O	120/250	Soviet Union

	Scud-B	O	300/1,000	Soviet Union
	Scud-Mod.C	O	500/700	DPRK
Taiwan (ROC)	Ching Feng	O/P	100/275	Israel/I
Ukraine	SS-21	O	120/250	Soviet Union
	Scud-B	O	300/1,000	Soviet Union
United Arab Emirates	Scud-B	O	300/1,000	Soviet Union
Yemen	SS-21	O	120/250	Soviet Union
	Scud-B	O/U	300/1,000	Soviet Union

Note: C = cancelled, NA = not available, T = tested, D = under development, O = operational, U = used, I = indigenous program, P = indigenous production.

Source: Arms Control Association, *Arms Control Today*, March 1996, pp. 29-30.

Regional TMD Capabilities. The figures in the Appendix are relatively representative of the ballistic missile capabilities in various potential theaters of operations. They show the reach and capability of ballistic missiles in those theaters. The figures are not intended to indicate that the United States needs to provide extensive TMD capability to deal with all threats in all theaters (the so-called from anywhere to anywhere rationale for the GPALS system). The figures do, however, illustrate that theater ballistic missile capabilities are potentially extensive and will likely permeate all theaters of operations where we might have to deploy U.S. forces.

A hostile nation in possession of even rudimentary ballistic missile capability would most likely be able to hold most of, if not the entire, theater of operations at risk. The actual targets that could be at risk would be a function of the accuracy (guidance technology and targeting information) and lethality (type of warhead) of the missiles. Theater ballistic missile capability also gives a hostile nation the potential to extend its reach, not just over land, but also over water. That is particularly important if U.S. forces are being deployed to a theater via sea; we cannot expect to deploy into a theater of operations with relative impunity. A potential enemy may realize that its best defense against U.S. incursion would be to deny entry of forces into the theater by using ballistic missiles (and potentially weapons of mass destruction) early in the conflict to disrupt U.S. operations and logistics.[13] Thus, the Defense Department notes that

> ballistic missiles are an effective instrument--even the weapon of choice--to threaten the rear of U.S. . . . forces in the face of U.S. air superiority. Missiles are much less expensive than acquiring and maintaining a world-class air force competitive with U.S. military aviation; missiles with a low-profile infrastructure and mobile launchers are much less vulnerable than aircraft to U.S. offensive operations; missiles are easier to control than other means of deep strike; and even when armed with high explosives, missiles can have considerable psychological effects when used against urban targets.[14]

The Threat from Weapons of Mass Destruction. Further compounding the threat posed by theater ballistic missiles is the prospect that weapons of mass destruction (e.g., nuclear, biological, or chemical) could be mated with those delivery systems. The result would be increased capability and lethality. Targets previously considered relatively invulnerable (e.g., because of hardness and/or dispersion) could be potentially threatened. According to a Defense Department report,

> The potential for coercion is perhaps the long-range ballistic missile's greatest value to a proliferator and the greatest challenge for those seeking to restrain that state. Beyond their coercive value in threatening distant cities and ability to drain military resources seeking to counter that coercive threat, missiles--if sufficiently accurate and/or lethal--can also pose major direct military threats.[15]

Table 2
Ballistic Missile and NBC Capabilities of Developing Countries

Developing Country	*Ballistic Missile*	*Chemical Warhead Capable*	*Nuclear Make/Buy Effort*
Afghanistan	Scud B	X	
Argentina	Alacran	X	X
Brazil	SS-300, SS-600	X	X
China	M-9/11	X	Current nuclear power
Egypt	ScudB, Scud 100/"Project T"	X	X
India	Prithvi, Agni	X	X
Iran	Mushak, Scud, Iran 700, Tondar 68	X	X
Iraq	Al Hussein, Al Abbas	X	X
Israel	Jericho I & II	X	X
Libya	Al Fatah, Scud B	X	X
North Korea	Scud, No Dong, Taep'o Dong I/II		X
Pakistan	Hatf, Ghauri	X	X
South Korea	NHK-1/2		X
Syria	Scud B/Mod.C		X
Taiwan	Ching Feng		X

Source: Derived from Systems Planning Corporation, *Ballistic Missile Proliferation: An Emerging Threat*, 1992; and Arms Control Association, *Arms Control Today*, March 1996, pp. 29-30.

It is no coincidence, then, that many of the countries with (or acquiring) ballistic missile capability and technology (particularly longer-range capability) are also seeking to acquire nuclear, biological, or chemical (NBC) capability, as illustrated by Table 2.

Future Threats

Although the current theater ballistic missile threat consists largely of Scud-derived shorter-range missiles, the future threat will feature missiles with longer range, greater accuracy, and increased lethality. Thus, unlike Scud-derived missiles--which are essentially inaccurate terror weapons--the future ballistic missile threat will have the capability to hold military targets and forces at risk.

North Korea is currently developing three long-range missiles: the No Dong (1,000-3,000 km), Taep'o Dong 1 (more than 1,500 km), and Taep'o Dong 2 (4,000 km). According to the Department of Defense, "North Korea supplies missiles and missile-related technology to countries in the Middle East"[16]--notably Iran, Iraq, and Libya.

China already produces four long-range missiles: the CSS-5 (more than 1,000 miles), CSS-2 (more than 1,500 miles), CSS-3 (more than 3,300 miles), and CSS-4 (7,800 miles)--the last actually capable of reaching the continental United States. The Defense Department notes, "China supplies various NBC- and missile-related equipment to countries in the Middle East and South Asia."[17] As a result, "any improvements that China and North Korea make to their NBC weapon or missile capabilities in the coming years could have implications far beyond the region."[18]

India also represents a potential source of long-range ballistic missiles and technology. India has conducted three flight tests of the Agni missile, which has a range of 1,500-2,500 kilometers and a payload of about 1,000 kilograms. India and Pakistan have both tested nuclear weapons. Both countries have substantial nuclear infrastructures, and neither has signed the Nonproliferation Treaty or the Comprehensive Test Ban Treaty. India also has a sizable chemical industry and, in June 1997, declared to the governing body of the Chemical Weapons Convention that it had a chemical warfare program. Referring to both India and Pakistan, Secretary of Defense William S.Cohen has stated that "as they make progress with their indigenous production programs, they could become suppliers of related equipment, technology or expertise to other countries."[19]

The Relationship of Cruise Missiles to Theater Missile Defense

It is important not to ignore the fact that an adversary with ballistic missile capability is also likely to have an aerodynamic--sometimes referred to as "air-breathing"--missile capability (that is, cruise missiles). The major differences between ballistic missiles and cruise missiles are engine and trajectory. A ballistic missile is powered by a rocket motor (either liquid or solid propellant) that accelerates the missile and then burns out. The unpowered missile and warhead then follow a predictable trajectory to the intended target, subject only to the forces of gravity and air resistance. That trajectory usually extends into the upper regions of the earth's atmosphere or outside it.

A cruise missile is powered by a jet engine that operates from launch until the missile reaches its intended target. A cruise missile's trajectory is usually relatively low in the atmosphere, often below radar detection range. Cruise missiles--like aircraft--have the ability to maneuver. As a result, their trajectories and flight paths, which depend on a particular missile's guidance/navigation technology and targeting information, can be unpredictable.

According to the Systems Planning Corporation, there are six reasons to consider aerodynamic missiles in the context of the theater ballistic missile threat and TMD:

- They are available from many suppliers, which makes them easy to obtain. They also tend to be quite easy to deploy and use.
- They have been sold throughout the world to many countries, large and small, making them a constant threat.
- The purchase of aerodynamic missiles and their technology indicates an intent on the part of a country to enter into the world of modern warfare.
- Cruise missiles and their technology provide a first step that supplies some of the technologies that might lead to future ballistic missile programs.
- As the range of cruise missiles increases, their missions and warheads become very similar to those of longer range ballistic missiles.
- *Defensive systems have or can be made to have significant capabilities against both ballistic and cruise missile threats*.[20]

The cruise missile threat is just as real and potentially as dangerous as the theater ballistic missile threat. In fact, from a military operational perspective, they could be considered one and the same. A military commander in a theater of operations is probably less concerned with whether a particular enemy missile is cruise (air breathing) or ballistic. More likely, the commander will be more concerned with what targets the missile can hold at risk, regardless of the delivery system. TMD systems can provide some capability to defend against air-breathing threats, as well as ballistic missiles. But systems that are designed primarily to defend against ballistic missiles should not be expected to be equally effective against cruise missiles. All systems have limitations that must be accepted.

TMD should not be viewed as a panacea against all theater missile threats. Potential adversaries are likely to possess (and employ) both cruise and ballistic missiles. To the extent that TMD systems have some capability against cruise missiles, there is a collateral benefit. But we cannot depend on TMD systems to provide defense against cruise missiles. Therefore, TMD needs to be considered in addition to, not instead of, any air and cruise missile defense systems (and vice versa).

Current BMDO Conceptual Framework for TMD

BMDO and DoD have a conceptual framework for thinking about TMD that is based on four pillars: (1) active defenses; (2) passive defenses; (3) counterforce (also called attack operations); and (4) the command, control, communications, and intelligence (C3I) systems needed to make the other three pillars function effectively. Passive defenses are operational or technical measures designed to minimize the effects of an attacking warhead (e.g., dispersion of forces). Counterforce is the disruption of an adversary's ability to launch ballistic missiles (for example, the destruction of enemy missile launchers before they fire their missiles). While recognizing the importance of all four pillars, this paper is focused on active defense options for TMD--that is, systems that are designed to intercept and destroy a ballistic missile in flight before it reaches its intended target.

Active defenses are designed to intercept a ballistic missile at a specific phase of its trajectory. Boost-phase defenses intercept a missile shortly after it is launched, when it is still under powered flight. Terminal defenses are designed to intercept missiles as they reenter the atmosphere (the dividing line between inside the atmosphere--or endoatmospheric--and outside the atmosphere--or exoatmospheric--is usually defined as about 60 miles altitude). Systems for terminal defense that intercept the missile at relatively low altitudes (up to about 12-15 miles) are called lower-tier systems because the intercept point is in the lower regions of the atmosphere. Therefore, lower-tier systems, in most cases, can defend only relatively well defined point targets, such as an airfield. Systems that can intercept missiles at higher altitudes are called upper-tier systems. Depending on the technical capabilities of the system, upper-tier interceptors might also be able to engage targets during the late midcourse phase before the missile reenters the atmosphere. With their longer ranges, upper-tier systems are called wide-area systems because they can defend a relatively large area rather than just a single target.

An active defense system usually consists of these basic elements: a sensor, a launcher, an interceptor (which includes a seeker and a kill vehicle or warhead), and command and control or fire control. The sensor--usually a radar--detects incoming missiles and guides the interceptors to the intercept point. In terminal defenses, the radar is ground based. The launcher houses the interceptors and launches them on command. Interceptors fly toward the estimated intercept point, as calculated by the command and control center. Once the interceptor gets close to the target, its onboard seeker is activated to guide it to the intercept point. The radar must get the interceptor close enough to allow its own seeker to take over.[21]

This paper is intended to examine active defense weapon system choices and does not specifically address other important TMD issues, such as early warning sensors (for example, the Defense Support Program satellites), external sensors for missile tracking (for example, space-based sensors such as "Brilliant Eyes"), and battle management/command, control, and communications (BM/C3) systems to integrate and operate the various defenses.

Current TMD Programs

The Ballistic Missile Defense Organization's current TMD program (see Table 3) includes six different systems and programs: Patriot PAC-3, Theater High Altitude Area Defense (THAAD), Medium Extended Air Defense System or MEADS (formerly the Corps SAM), Navy Area Defense (previously Navy lower tier), Navy Theaterwide Defense (also known as Navy upper tier), and the Air force Airborne Laser (ABL). BMDO's so-called core TMD programs are PAC-3, THAAD, and Navy Area Defense.

PAC-3

Patriot PAC-3 is an improved version of the Army's Patriot PAC-2 air defense system used during the Persian

Table 3
Summary of BMDO TMD Programs

System	Prime Contractor(s)	Air Defense Role	Defended-Area Radius (km)	Number to Be Deployed	Initial Deployment	Cost ($ billion)
		Lower-Tier (point) Defenses				
				1,200		

PAC-3	Raytheon/ Loral	Substantial	40-50	missiles 54 fire units	1999	$6.2
Navy Area Defense	Raytheon/ Hughes Aircraft	Substantial	50-100	1,500 missiles	2000	$6.2
MEADS	Lockheed Martin or Hughes/Raytheon	Substantial	<10	TBD	TBD	TBD
		Upper-Tier (area) Defenses				
THAAD	Lockheed Martin & Space (Raytheon, radar)	None	167	1,233 missiles 7,711 launchers 11 radars	2006	$12.8
Navy Theater-wide Defense	Standard Missile or Lockheed Martin	None	>a few hundred	650 missiles	TBD	$5
		Boost-Phase Defenses				
Airborne Laser	Boeing Defense & Space	None	Possibly huge	7 aircraft	2006	$6.1

Source: Derived from David E. Mosher, "The Grand Plans," *IEEE Spectrum*, September 1997.

Gulf War. The PAC-3 is a land-based, lower-tier interceptor. It is a point (terminal) defense system with a relatively limited range (defending an area with a radius of approximately 25-30 miles). PAC-3 is intended to protect important military targets in a theater of operations. The projected acquisition cost for Patriot PAC-3 is $6.2 billion. (Cost figures cited in this paper include costs for research, development, testing, and production but exclude costs for operations and support after the system has been deployed.)[22]

THAAD

THAAD (also an Army program) is designed to intercept missiles in the upper or outer atmosphere (during the late midcourse and early terminal phases). The THAAD system consists of a ground-based radar for surveillance and tracking, launchers, interceptors, and BM/C3. This upper-tier system can defend an area with a radius of approximately 100 miles.[23] The projected acquisition cost for THAAD is $12.8 billion.

MEADS

MEADS is a terminal defense system designed to provide 360-degree coverage but only defends an area with a 5- to 6-mile radius. In contrast, the PAC-3 system is oriented in the direction of a particular threat. Also, MEADS is a mobile system designed to be deployed and move with maneuvering forces. On the other hand, PAC-3 is transportable--that is, it can be transported from one place to another usually via aircraft--but it cannot be easily and readily moved. The MEADS program is an international program spun off from the Army Corps Surface-to-Air Missile (Corps SAM) program. The program currently has U.S., French, German, and Italian participation, and costs are split 50/20/20/10. The projected acquisition cost of MEADS is yet to be determined. However, according to a 1994 Congressional Budget Office report, Corps SAM will cost $11.0 billion to develop and purchase.[24] Therefore, it is not unreasonable to expect that MEADS would cost a similar amount.

Navy Area Defense

The Navy Area Defense system is designed to provide a terminal defense capability (similar to what the PAC-3 provides) from Aegis cruisers and destroyers. The radius of defense for the Navy system is about 30-60 miles. The system will use a modified version of the Navy's already existing standard missile. The Navy Area Defense system is the only system that will not use a hit-to-kill interceptor. Rather, it will use a blast fragmentation warhead (like Hawk and PAC-2 air defense systems) so that it will have a capability against aircraft and presumably some cruise missiles.[25] The projected acquisition cost for the system is $6.2 billion.

Navy Theaterwide Defense

The Navy Theaterwide Defense system is designed to provide a THAAD-like capability (that is, long-range intercept and wide-area protection) from Aegis cruisers and destroyers. It is expected that the system will defend an area with a radius of more than 100 miles (i.e., slightly greater than THAAD). The Navy has three options for the configuration of the interceptor: (1) a version of THAAD, (2) a version of THAAD modified with an additional rocket booster to extend its range, and (3) a version of the Lightweight Exoatmospheric Projectile fitted to a Block IV Standard Missile. It should be noted that, according to the Congressional Budget Office,

> an exoatmospheric system such as the Navy's Standard missile tipped with the Lightweight Exoatmospheric Projectile (LEAP)--which has been proposed for the Navy's [Theaterwide Defense]--would only be able to intercept missiles above 80 to 100 kilometers. Thus, it is almost exclusively a midcourse system.[26]

Also, in certain cases, the Navy Theaterwide Defense system "could intercept theater missiles in the early post-boost phase if the ship can position itself near the launch site [that is, in-between the launch point and the target]."[27] The projected acquisition cost for Navy Theaterwide Defense is $5 billion.

Airborne Laser

The Air Force's ABL is the only boost-phase intercept system in BMDO's TMD program. The ABL concept employs a chemical laser, carried in a 747 airplane, that is able to intercept missiles from a few hundred kilometers away.[28] The radius of defense for the ABL is potentially quite large, depending on the range of the laser and the operating area of the aircraft. The projected acquisition cost for the ABL is $6.1 billion.

Common-Sense TMD Choices

BMDO's current overall TMD program will cost at least $36.3 billion, exclusive of external sensors and other BM/C3. The costs, however, could exceed $47 billion. Although the cost of MEADS has yet to be determined, a previous estimate for Corps SAM--the predecessor of MEADS--was $11 billion. Those figures assume that actual program costs can be managed so they stay within the projections. But in a world that doesn't require a U.S. military presence everywhere at once with forward-deployed forces, we do not need to pursue a TMD program designed for the current BMDO program objectives. Those objectives are "to protect *forward-deployed* and expeditionary elements of the armed forces of the United States, *as well as U.S. friends and allies*."[29]

Buy Navy Area and Theaterwide Defense Systems and PAC-3

Instead, we need TMD systems that will allow us to protect our expeditionary forces when--and if--we decide to deploy to any particular theater of operations. If we expect that naval forces are most likely to be the first to deploy to a theater of operations, then it makes sense to give primary consideration to sea-based TMD (i.e., Navy Area Defense and Navy Theaterwide Defense) to protect naval forces en route and naval and land forces as they are deployed into a theater.

Navy Area Defense Program. The Navy Area Defense program is a cost-effective and operationally effective upgrade to an existing air defense system--the Aegis/Standard Missile air defense weapon system. The upgrades include modifications to the Aegis SPY-1B radar for improved detection and tracking of ballistic missiles. BMDO and the Navy have been working together to develop an enhancement to the Aegis/Standard Missile air defense system to provide a sea-based tactical ballistic missile defense capability that is comparable to the defense provided by PAC-3. This a TMD capability can take advantage of existing naval forces and build upon existing Aegis/Standard Missile infrastructure.[30]

There is already a substantial investment in the Aegis weapon system. By 2010, 77 cruisers and destroyers will carry the Aegis system and contain almost 8,000 vertical launcher tubes for Standard Missiles. The Aegis ships that will be equipped for TMD capability will require no additional personnel. In addition, a complete infrastructure already exists for training, logistics, and engineering for the Aegis ships and weapons systems. Hence, it is possible to capitalize on past investment in those systems to provide a near-term TMD capability inexpensively. As Lt. Gen. Malcolm O'Neill explains,

> Naval vessels that are routinely deployed worldwide are currently in potential threat areas or can be rapidly redirected or repositioned. A naval TMD capability can be in place within a region of conflict to provide TMD protection for land-based assets before hostilities erupt or before land-based defenses can be transported to the theater. Our Navy Area Defense program focuses on modifications to enable tactical ballistic missile detection, tracking, and engagement with a modified Standard Missile 2, Block IV.[31]

The Navy Area Defense system will provide Aegis ships with the ability to conduct lower-tier intercepts of tactical ballistic missiles out to ranges of 30-60 miles. That should be sufficient to provide defense of ships at sea, as well as close-in land targets (e.g., ports and airfields to which expeditionary forces are deploying). According to the CBO, "The Navy's lower-tier system [is] a natural choice to protect ports, key areas of coastal cities, and Marine amphibious forces."[32]

Navy Theaterwide Defense. The Navy Area Defense system should be complemented by the Navy Theaterwide Defense system to provide a two-tiered, multilayer defense against theater ballistic missiles. Adding an upper-tier capability would increase the overall effectiveness of the defense, in many cases providing two opportunities to intercept an incoming missile or warhead--one at long range and another at short range. An upper-tier capability would also give a theater commander operational flexibility to make the best use of available resources. For example, a shoot-look-shoot (S-L-S) capability would allow the upper tier to engage a threat first; the success or failure of the engagement could be evaluated and the lower tier employed only if the threat penetrated the upper tier. Table 4 illustrates how the number of layers, as well as two-shot and S-L-S capability, would affect effectiveness.[33]

Table 4 makes one layer, two-shot salvo; one layer, S-L-S; and two layers, each with single shot, appear equally effective. However, there are operational considerations that make a two-layer system (even if each layer only has a single shot) a better choice than a single-layer system with a two-slot salvo or S-L-S capability. It is highly unlikely that a lower-tier, terminal defense system would have an S-L-S capability because of the time and space constraints (compressed battlespace) inherent in engaging warheads so close to the defended target. Therefore, a two-tiered system virtually ensures an S-L-S capability. Although firing interceptors in salvos can increase the effectiveness of a single tier, it also depletes the resources of that tier at a faster rate. As a result, it might be relatively easy for an attacker to overwhelm a one-tiered system by forcing the defender to use all of its interceptors to achieve high effectiveness. Again, a two-tiered system would be more efficient and effective because the lower tier would have to engage only threats that "leaked" through the upper tier.

In addition to increased effectiveness, according to O'Neill,

> The Navy Theaterwide system, which could be among the first deployed missile defense systems in a regional crisis, could provide extensive areas of protection. Specifically, Navy Theaterwide could provide critical wide-area defenses early in a conflict--allowing U.S. and/or coalition forces to fight their way into a theater of operations while under the protective cover of missile defenses.[34]

The CBO states,

> The biggest advantage of this [Navy Theaterwide Defense] sea-based system is that it would not need to rely on the availability of secure airfields to be transported to the theater. . . . In addition, sea-based defenses would not require airlift, which would be in high demand during the early days of a conflict to

> transport other essential forces.[35]

BMDO characterizes the Navy Theaterwide Defense program as "the least mature of all our systems, not only of the upper-tier, but of all the TMD systems taken together."[36] But, as is the case with Navy Area Defense, much of the basic hardware for the system already exists. For example, rather than develop a new radar (as must be done for the THAAD program), the Navy Theaterwide Defense system will upgrade the existing Aegis SPY-lB radar. Navy Theaterwide Defense also has another advantage over the THAAD system: the existing vertical launch system on Aegis ships is longer than the THAAD launcher, which means there is room to extend the length of the interceptor. A longer interceptor with higher speeds and greater range would enable the Navy Theaterwide Defense system to defend a larger area (greater than a few hundred kilometer in radius) than could THAAD--at least within the limitations of their respective radars.[37]

Table 4
Illustrative Single-Shot vs. Two-Shot Salvo vs. S-L-S Effectiveness Comparison

	Interceptor Single-Shot Probability of Kill	Combined Overall Probability of Kill
One layer, single shot	50%	50%
One layer, two-shot salvo	50%	75%
One layer, S-L-S	50%	75%
Two layers, each with single shot	50%	75%
Two layers, upper tier with S-L-S, lower tier with single shot	50%	88%
Two layers, upper tier with S-L-S, lower tier with two shot salvo	50%	94%

Two-Tiered Sea-Based TMD. Therefore, to support a foreign and defense policy that calls for the ability to deploy forces at times and places of our choosing instead of maintaining forward-deployed forces, a two-tiered sea-based TMD approach is the "common-sense" solution. It makes even more sense, given that that such capability can be created by taking advantage of existing systems, thereby reducing costs.

The main limitation of sea-based TMD is that its effectiveness will decrease as the military operation moves further inland. Therefore, it is prudent to have at least some ground-based TMD to protect forces that may be deployed outside the reach (or at the fringes of effectiveness) of the Navy Area Defense and Navy Theaterwide Defense systems.

Purchase PAC-3. PAC-3 is the logical choice for a ground-based TMD system to defend important military targets. Just like Navy Area Defense and Navy Theaterwide Defense, PAC-3 takes advantage of existing systems and programs--namely the Patriot air defense system. According to General O'Neill,

> The PAC-3 system will represent a significant upgrade to an existing air and missile defense system to specifically handle stressing theater-class ballistic missile threats. The PAC-3 system, using hit-to-kill interceptors, will be highly lethal against ballistic missiles including those with weapons of mass destruction.
>
> Improvements to the system will result in increased firepower and lethality, increased bat-tlespace and range, enhanced battlefield awareness, and improved discrimination performance. These critical enhancements will be achieved by improvements to the missile as well as the radar and communications systems. Operational improvements, such as remote launch operations, will also increase the battlespace and range of the PAC-3 system. These enhancements will mark a substantial improvement over our Patriot TMD capabilities during Operation Desert Storm.[38]

Thus, a two-tiered sea-based system, augmented by a deployable ground-based system designed to protect important military targets (PAC-3), can provide sufficient TMD capability to defend U.S. expeditionary forces.[39] Moreover, the cost of those systems would be less than half that of the current BMDO program--$17.4 billion vs. at least $36.3 billion. The costs would be only about one-third of those of the BMDO program if the cost of MEADS added $11 billion to the costs of that program.

Terminate THAAD and MEADS

THAAD, with a projected acquisition cost of $l2.8 billion, is the single most expensive TMD program. MEADS is potentially the second most expensive TMD program if the projected $11 billion acquisition cost of Corps SAM (the predecessor of MEADS) is any indication of the cost for MEADS. Terminating only those two programs would result in about a 50 percent reduction in the overall TMD program costs.

THAAD is a relatively large land-based system that is not readily deployable. The system is more ideally suited to protecting a theater before the deployment of forces begins. Such a system is clearly not consistent with a national security strategy of military restraint, which relies on expeditionary forces rather than forward-deployed forces. The Navy Theaterwide Defense system can provide capability comparable to that of THAAD at lower cost and without the same operational and deployment constraints.

Although MEADS has some features that PAC-3 does not--namely 360-degree coverage and mobility--it provides similar capability but at substantially greater cost ($11 billion vs. $6.2 billion). MEADS also has a much smaller radius of defense than PAC-3 (5-6 miles vs. 25-30 miles). Therefore, for reasons of both cost and strategy, THAAD and MEADS should be terminated. Doing so would save $23.8 billion in the TMD program without sacrificing the ability to support a national security strategy of military restraint. PAC-3 could protect high-value point targets (for example, headquarters or fixed logistics sites); forces in the field could rely on mobility and dispersion as a defense against attacks from ballistic missiles.

Boost-Phase TMD

It is important to briefly address boost-phase intercept for TMD as a separate issue. According to the Congressional Budget Office,

> The idea behind boost-phase defense is appealing: intercept the missile while its rocket motor is still burning (and therefore easy to detect and destroy) and before it has a chance to release multiple warheads or decoys. The challenge, though, is to get the interceptors situated where they will be needed because the time or location that the enemy will choose to launch its mobile missiles is unknown.[40]

Also, "an attack during the boost phase can destroy missiles carrying chemical or biological agents before any smaller warheads (submunitions) are released."[41] In short, the missile could be destroyed over enemy territory rather than over the defended area (that is, friendly territory or forces).

The concept of boost-phase defense was first explored as part of a multilayer approach to counter intercontinental ballistic missiles. Against those long-range threats, all the boost-phase concepts were space-based systems. Against theater ballistic missile threats that have shorter ranges and fly at lower altitudes, space-based interceptors are not as practical. They cannot reach down fast enough or low enough to intercept a relatively short time-of-flight theater ballistic missile that has a lower trajectory than a long-range intercontinental ballistic missile.

As previously stated, the current boost-phase concept for TMD is the Air Force Airborne Laser program. According to physicist Geoffrey E. Forden,

> In operation, each plane--estimated at $1 billion a copy--will patrol friendly airspace. If an enemy missile launch is detected by any of a variety of U.S. sensor systems, the information is relayed to the airplane. Its nose will swivel, and a 1.5-meter mirror inside the nose will focus the beam from a megawatt-class chemical laser onto the missile and keep the beam locked on that small supersonic target perhaps hundreds of kilometers away. If the beam is able to dwell on the same spot for long enough--an interval known as

its dwell time--the metal is fatally weakened.[42]

The ABL has several technical challenges, including

(1) correcting the beam to take into account factors such as water droplets, winds, heatable air, and other components; (2) imaging and tracking, taking into account the relative motion of the ABL and its target; and (3) fitting all of the necessary components inside a 747-size aircraft.[43]

There are also operational considerations with regard to the ABL, such as (1) whether there will be friendly airspace for the ABL to operate in, (2) ABL vulnerability to air-to-air and surface-to-air threats, (3) whether additional resources will have to be devoted to defending the ABL, and (4) the availability of external sensors (and timeliness of information) to provide the ABL with initial launch and tracking data.

Terminate ABL

Technical and operational considerations aside, the ABL is a system that is not entirely consistent with a military strategy that relies on deployable expeditionary forces rather than forward-deployed forces. For example, the ABL will require secure airfields, which may not be available early in a conflict. To make a substantial investment ($6.1 billion) in a system that depends on availability of and access to secure airfields would not be a wise choice, especially if we are already investing in systems that we can be reasonably sure of deploying to the theater.

Because boost-phase intercept takes place so early during a ballistic missile's flight, it might not be possible to know with a high degree of certainty or confidence the missile's intended target. It is entirely possible that the intended target may not be important. Or the intended target could be something that U.S. forces are not (or should not be) responsible for defending. Nonetheless, a boost-phase interceptor (whether it is the ABL or some other system) would be responsible for engaging and destroying the missile. As a result, boost-phase intercept capability could put the United States in the position of providing "umbrella" defense for allies and friends. Even worse, such protection would be provided without their having paid for the system. That problem would be even more severe for any space-based boost-phase defense because of the global coverage such a system might provide. Clearly, such a capability would not be consistent with a U.S. policy of using military forces to protect only vital U.S. national security interests, leaving the defense of security interests of other countries≠-however friendly--the responsibility of those countries.

Therefore, like THAAD and MEADS, the ABL should be terminated for fiscal and technical reasons, as well as policy reasons. The result would be an additional $6.1 billion savings in the TMD program.

How TMD Relates to NMD

National missile defense should not be thought of as simply providing a defense against missiles for the theater known as the United States. In addition to the obstacles raised by Anti-Ballistic Missile Treaty considerations,[44] there is the fact that TMD systems used to provide military capability for overseas theaters cannot simply be transferred or applied to the problem of defending the United States.[45] Rather, NMD must be considered on its own merits and apart from TMD.

NMD is very different from TMD. Theater missile defense is concerned with providing protection for military forces and important military targets in a theater of military operations. It is implicitly understood that TMD--like other weapon systems--will not be perfect. On the other hand, national missile defense is concerned with protecting the United States, making civilian targets just as important as (if not more important than) military targets. As such, NMD systems may be held to a more stringent requirement (that is, more nearly perfect) than TMD systems because they may be tasked with protecting the civilian population. Although it may be militarily acceptable to lose assets such as tanks and airplanes if a TMD interceptors fails, it will likely be politically unacceptable to spend a large sum of money on an NMD system that has only a partial capability to defend people.

TMD systems--even if they possess the technical capability to intercept a strategic missile[46]--that are designed to provide military capability probably cannot provide high levels of protection for the continental United States (defense of Hawaii and Alaska raises even more issues) against a variety of ballistic missile threats. That problem exists even if the threats are relatively benign or have a low probability of occurrence. It would be a mistake to simply assume that effective TMD systems can be used for effective NMD. Careful consideration must be given to choosing what, if any, systems are appropriate for NMD. An ineffective or partially effective NMD might not be any better--and will certainly be more expensive--than no NMD at all.

Conclusion

During the Cold War era, the Soviet threat largely dictated America's foreign and military policy, as well as its thinking about defense against ballistic missiles. The focus was on the threat posed by Soviet intercontinental ballistic missiles and submarine-launched ballistic missiles. The result was the proposed Phase 1 Strategic Defense System--a significant ground- and space-based layered defense system.

In the immediate post-Soviet world, our thinking about ballistic missile defense was reoriented to protecting the United States, U.S. forces overseas, and friends and allies against limited ballistic missile strikes. The result was the proposed Global Protection Against Limited Strikes system that integrated strategic and theater defenses to defend against ballistic missile threats from anywhere to anywhere.

The current Ballistic Missile Defense Organization program emphasizes theater missile defense (TMD) and is structured to respond to "here and now" missile threats and to "enable deployment of an effective and rapidly relocatable advanced theater missile defense capability to protect *forward-deployed* and expeditionary elements of the armed forces of the United States *as well as friends and allies of the United States*."[47]

But it is no longer reasonable or feasible for the United States to assume the responsibility of defending the world--that is, having forward-deployed forces throughout the world and providing protection for friends and allies. Our primary focus should be on protecting vital U.S. interests; U.S. friends and allies must be held responsible for protecting their own interests. Our foreign and military policies must reflect that distinction. Our military forces should be designed to support a more selective and rigorous national security policy. And our theater ballistic missile defense choices must provide real military capability and be consistent with our policies and forces.

Acquiring all the systems in the current TMD program is unnecessary. Theater High-Altitude Area Defense is intended to be a forward-deployed, ground-based, wide-area defense system designed primarily to defend allies and other friendly nations. The Medium Extended Air Defense System is a cooperative international terminal defense program that would largely duplicate the capability of PAC-3 (but with a smaller radius of defense) at potentially nearly twice the cost. The Airborne Laser is a boost-phase concept that has both technical and operational uncertainty. Eliminating those systems would save at least $18.9 billion. Savings could be $29.9 billion if the $ll billion cost estimate for Corps SAM is indicative of the MEADS program acquisition cost.

A sea-based approach to TMD makes the most sense. The Aegis/Standard Missile system that is already deployed and operational on Aegis cruisers and destroyers can provide the basis for sea-based TMD. Both the Navy Area Defense and Navy Theaterwide Defense programs build on the existing Aegis/Standard Missile weapons system to provide a multi-layer TMD capability.

Because sea-based TMD may not be able to carry the entire burden of protecting land-based forces, it is also prudent to "balance" the Navy Area Defense and Navy Theaterwide Defense systems with the PAC-3 ground-based system. That system would provide protection of important military targets on land. Like the Navy systems, PAC-3 builds on existing technology, systems, and infrastructure.

Limiting investment in TMD to those three programs is cost-effective and minimizes risk. The cost to deploy those three systems is estimated at $17.4 billion, compared to an estimated cost of $47.3 billion for the current TMD program. Thus, the requisite TMD capability can be obtained at substantially lower cost.

Appendix: Ballistic Missile Capabilities in Various Theaters of Operations

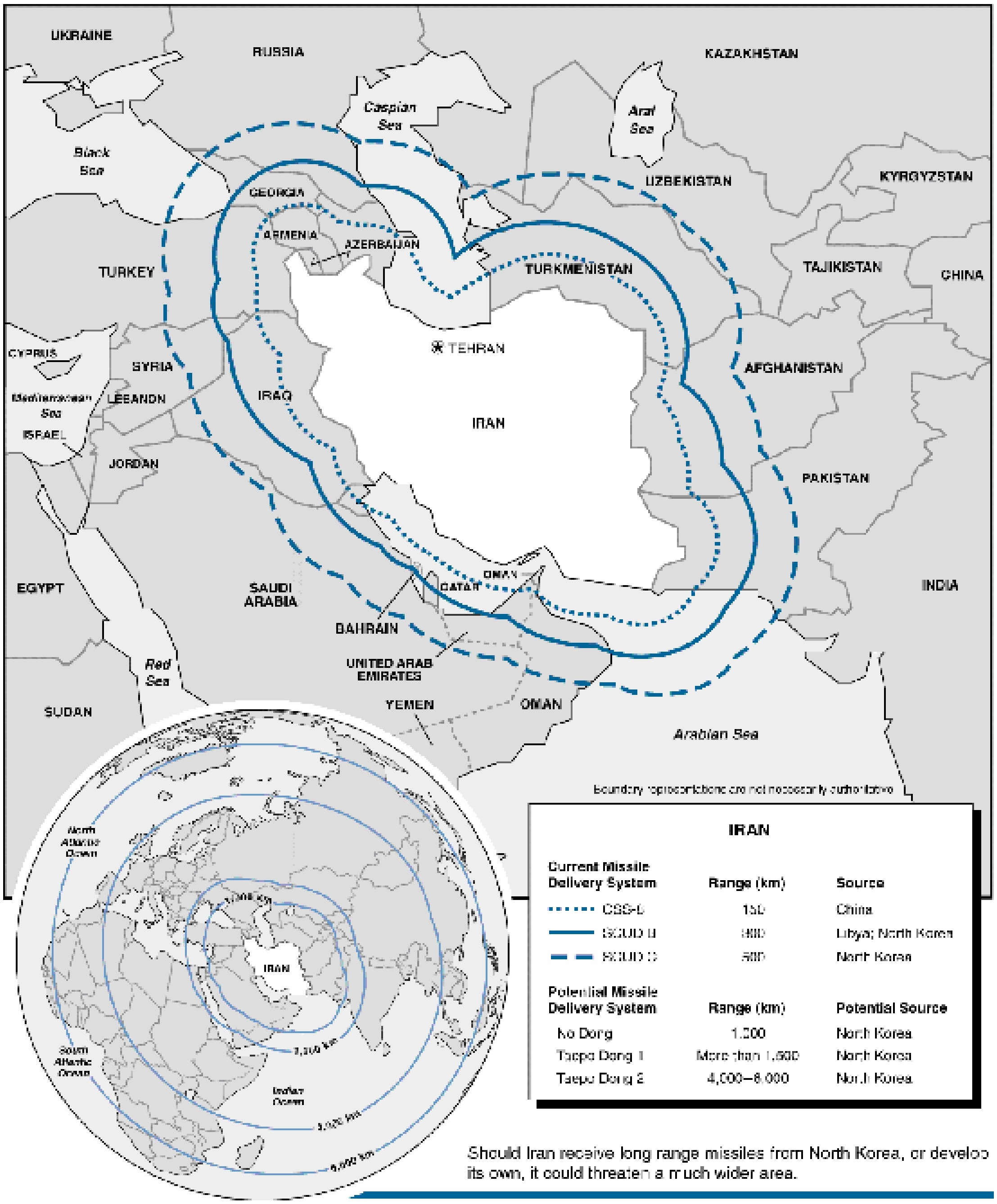
Figure 1

India: Current and Future Ballistic Missile Capability

India continues to test and improve its ballistic missile force.

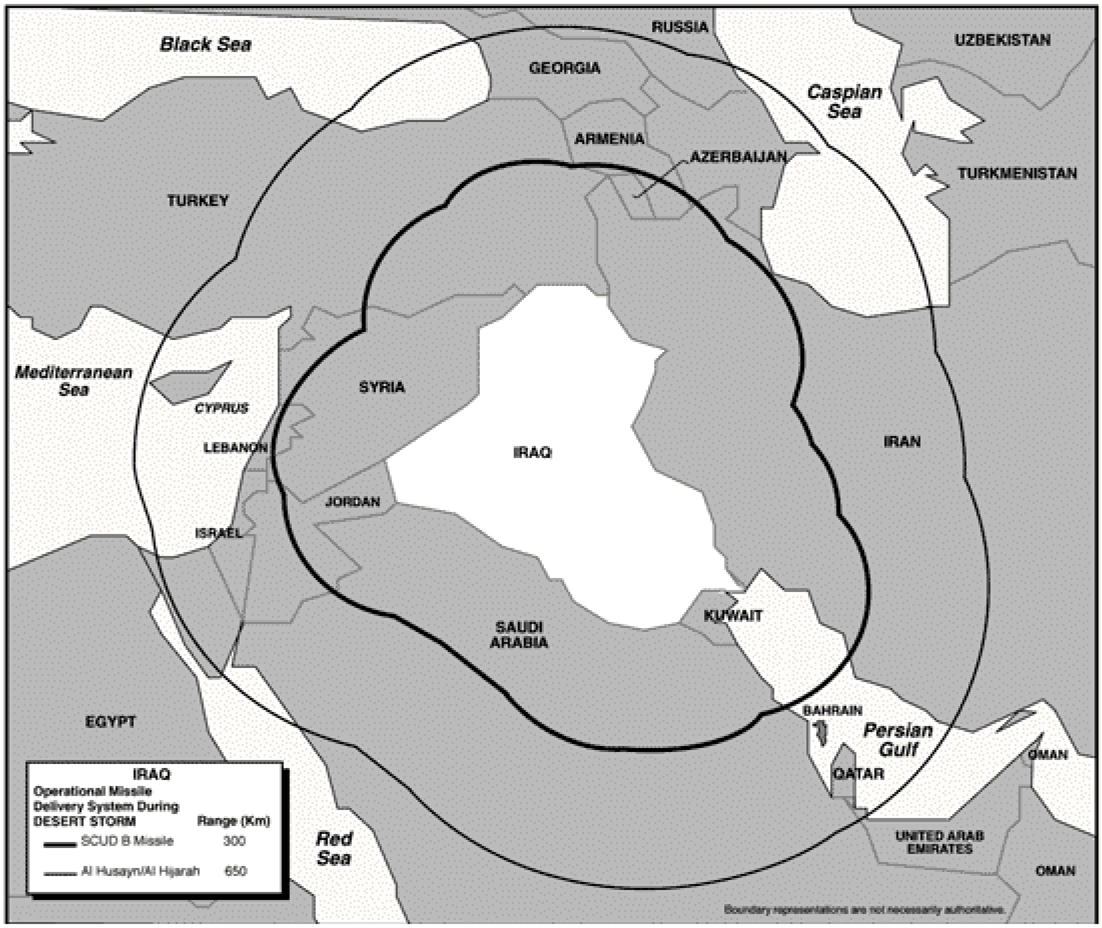
Source: Office of the Secretary of Defense, *Proliferation: Threat and Response*, 1997.

Figure 2
Iran: Current and Future Ballistic Missile Capability



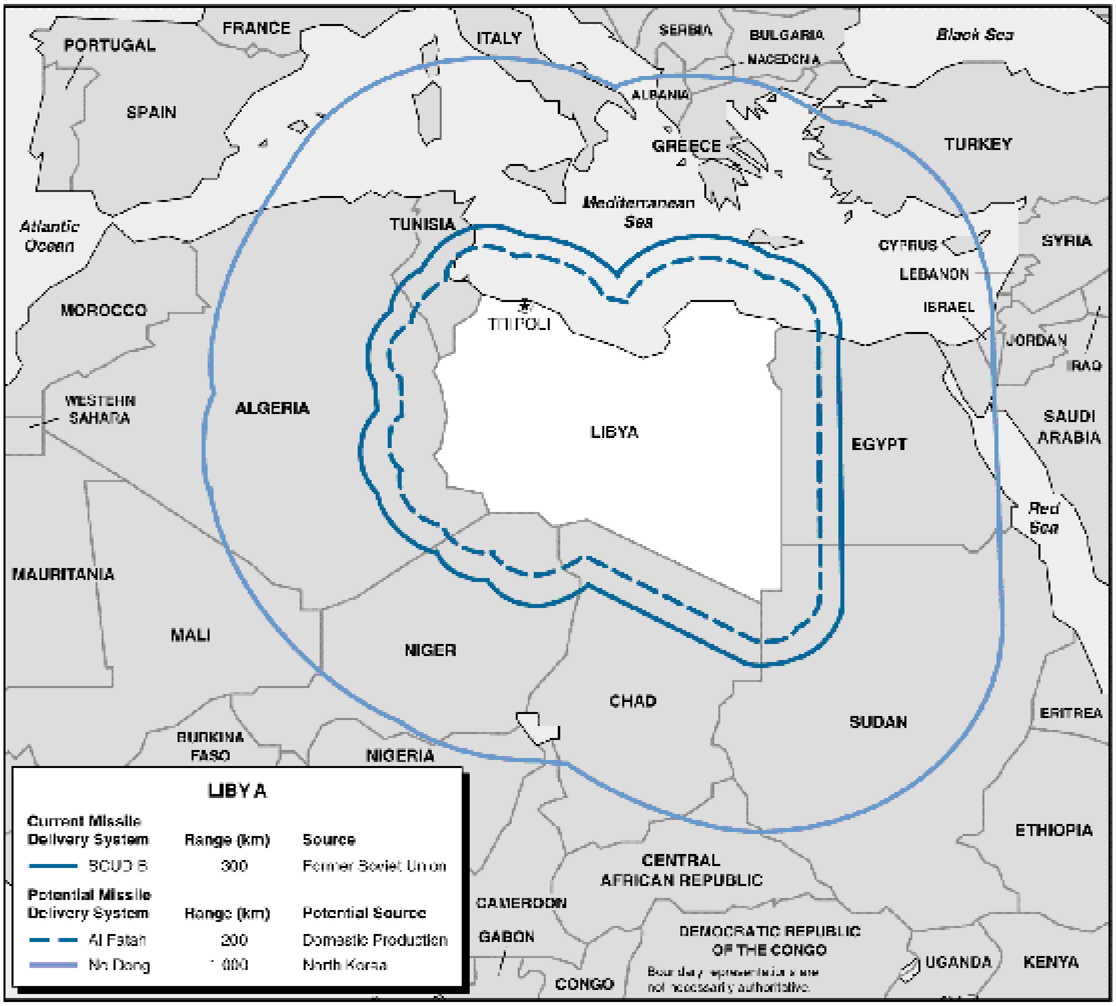
Source: Office of the Secretary of Defense, *Proliferation: Threat and Response*, 1997.

Figure 3
Iraq: Ballistic Missile Capability during Operation Desert Storm



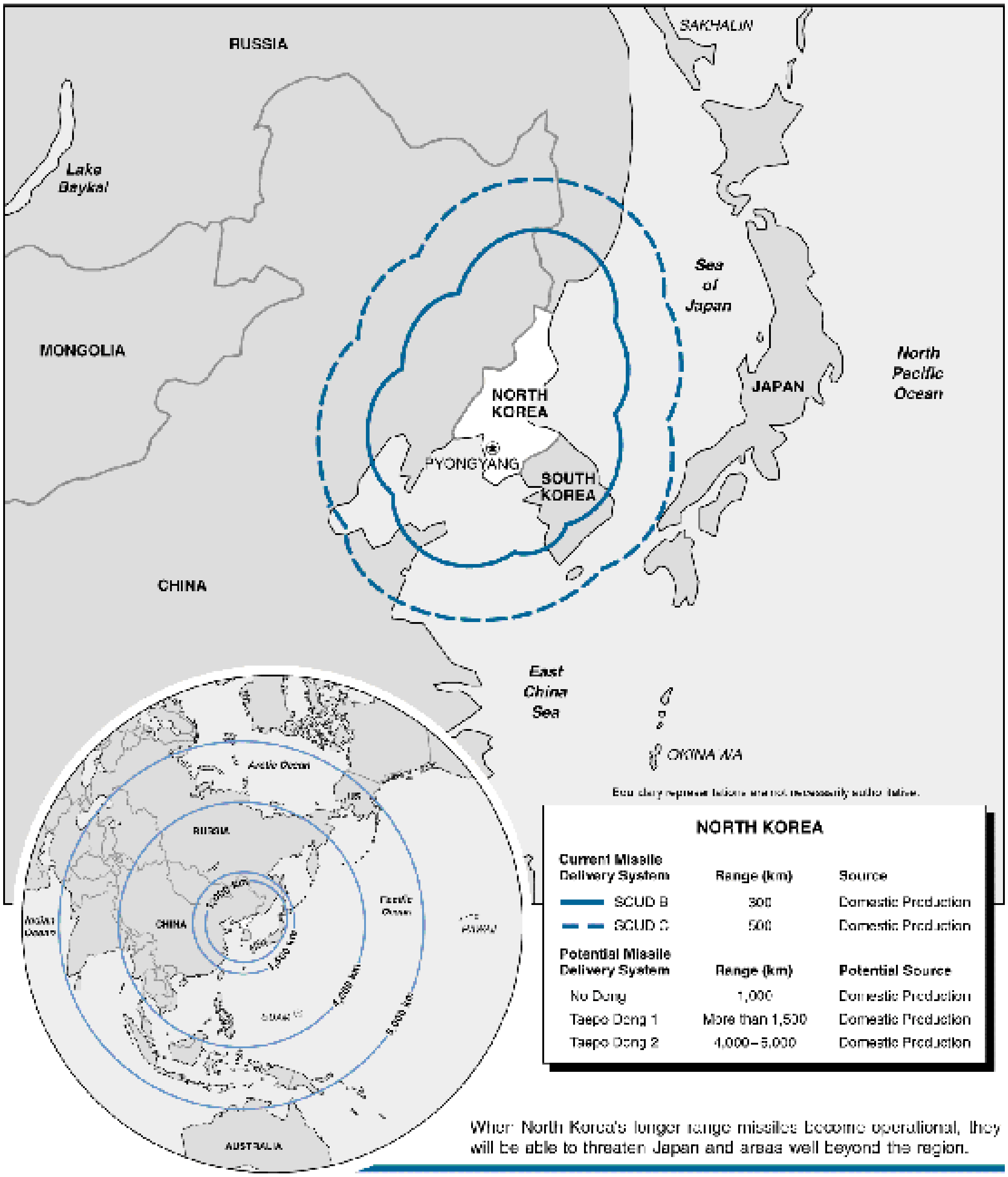
Source: Office of the Secretary of Defense, *Proliferation: Threat and Response*, 1996.

Figure 4
Libya: Current and Future Ballistic Missile Capability



Source: Office of the Secretary of Defense, *Proliferation: Threat and Response*, 1997.

Figure 5
North Korea: Current and Future Ballistic Missile Capability



Source: Office of the secretary of Defense, *Proliferation: Threat and Response*, 1997.

Figure 6
Pakistan: Current and Future Ballistic Missile Capability

Source: Office of the Secretary of Defense, *Proliferation: Threat and Response*, 1997.

Notes

1. Malcolm O'Neill, "Ballistic Missile Defense: 12 Years of Achievement," *Defense Issues* 10, no. 37 (1995),www.defenselink.mil/pubs/di_index.html.

2. Ibid.

3. For example, the Cooperative Threat Reduction Program is designed to reduce the proliferation threat posed by the collapse of the former Soviet Union by assisting in the removal or elimination of actual weapons and delivery systems. The Missile Technology Control Regime is a voluntary nonproliferation arrangement among 29 states to establish export controls on technology relevant to ballistic missile development, production, and operation.

4. Systems Planning Corporation,"Ballistic Missile Proliferation: An Emerging Threat," Arlington, Virginia, 1992, p. 1.

5. Barbara Conry, "U.S. Global Leadership: A Euphemism for World Policeman," Cato Institute Policy Analysis no. 267, February 5, 1997, p. 1.

6. Ibid.

7. Ibid., p. 13.

8. Michael Mandelbaum, "Foreign Policy as Social Work," *Foreign Affairs* 75, no. 1 (January-February 1996): 18. See also Christopher Layne and Benjamin Schwarz, "American He- gemony--Without an Enemy," *Foreign Policy* 92 (Fall 1993): 21-23.

9. Conry, p. 13; and Ronald Steel, "The Domestic Core of Foreign Policy," *Atlantic Monthly*, June 1995, p. 92.

10. Systems Planning Corporation, p. 5.

11. Ibid., p. 7.

12. Ibid.

13. William S. Cohen, "Report of the Quadrennial Defense Review," May 1997.

14. Office of the Secretary of Defense, *Proliferation: Threat and Response*, April 1996, Technical Annex.

15. Ibid.

16. Ibid., p. 4.

17. Ibid.

18. Ibid.

19. Ibid., p. 21.

20. Systems Planning Corporation, p. 78. Emphasis added.

21. Congressional Budget Office, "The Future of Theater Missile Defense," June 1994, p. 14.

22. David E. Mosher, "The Grand Plans," *IEEE Spectrum*, September 1977, p. 33. This and subsequent program acquisition cost figures are based on BMDO data.

23. It is important to note that the defended area for long-range interceptors, such as THAAD, is dependent on multiple factors, not just the range of the interceptor itself. Radar acquisition and track range is critical to being able to intercept at extended ranges. Claims of greatly extended ranges (and thus increased defended-area radius) are often possible only if the ground-based radar is based forward of the interceptor battery or the ground-based radar receives cuing information from external sensors, usually space based, or both.

24. Congressional Budget Office, p. xvi.

25. The difference between a hit-to-kill interceptor and a blast fragmentation warhead is that a hit-to-kill interceptor, as its name implies, must actually physically hit the target to destroy it. Such a system will work against threats with predictable trajectories (i.e., ballistic missiles) but not against maneuvering objects (i.e., aircraft or cruise missiles). A blast fragmentation warhead, on the other hand, uses the explosive and concussive effects of the warhead, as well as fragmenting debris, to destroy the target. The interceptor does not have to make a direct hit but only detonate "close enough," which gives a blast fragmentation warhead a capability against maneuvering targets.

26. Ibid., p. 10.

27. Mosher, p. 36.

28. Ibid.

29. William S. Cohen, "Annual Report to the President and the Congress," April 1997, p. 214. Emphasis added.

30. Malcolm R. O'Neill, "Staying Prepared against Ballistic Missiles," *Defense Issues* 11, no. 18 (1996), www.defenselink.mil/pubs/di_index.html.

31. Ibid.

32. Congressional Budget Office, p. 24.

33. The overall probability of kill, or OPk, is calculated by the equation: $OPk = l - (l - SSPk)^n$, where SSPk is the single-shot probability of kill for an interceptor and n is the number of shots. It should be noted that the SSPk value of 50 percent is chosen for illustrative purposes only and is not meant to indicate the effectiveness of any particular system. Also, in this example both the upper-tier and lower-tier interceptors are given the same SSPk. In reality, one might have a higher SSPk than the other. It is also possible that the first shot in S-L-S case might have a different SSPk than the second shot.

34. O'Neill, "Ballistic Missile Defense."

35. Congressional Budget Office, p. 28.

36. O'Neill, "Staying Prepared against Ballistic Missiles."

37. To be fair, it should be noted that Navy Theaterwide Defense and THAAD share a common "Achilles heel." The effective range of both systems will depend, in large part, on the availability and quality of missile track information from external sensors, particularly space-based sensors. Claims of greatly increased defended area footprints for either THAAD or Navy Theaterwide Defense are usually critically dependent on cuing data from space-based midcourse sensors that allow the intereceptor radar to "focus" on a known attack trajectory rather than have to "sweep" a larger area to acquire and track the missile. It is important to ensure that comparisons of the relative capabilities of the two systems are "apples-to-apples" comparisons; otherwise it is possible to make it appear that THAAD is substantially more capable than Navy Theaterwide Defense (or vice-versa).

38. O'Neill, "Staying Prepared against Ballistic Missiles."

39. The other TMD systems in the current BMDO program are designed more to support a policy and strategy that call for forward-deployed forces.

40. Congressional Budget Office, p. 30.

41. Geoffrey F. Forden, "The Airborne Laser," *IEEE Spectrum*, September 1997, p. 40.

42. Ibid.

43. Ibid.

44. Although it does not explicitly address theater missile defense, the ABM Treaty prohibits giving non-ABM (i.e., non-"strategic") missiles, launchers, and radars the ability to intercept strategic missiles. Furthermore, the ABM Treaty prohibits sea-based ABM systems.

45. Former Reagan administration officials Frank Gaffney (now with the Center for Security Policy) and Sven Kraemer (now with Global Challenge 2000) are both vocal advocates of using Navy TMD systems for national missile defense. The Navy has explored using sea-based systems for NMD in a briefing titled "Naval Missile Defense: Forward . . . From the Sea," April 24, 1996. See also Missile Defense Study Team, "Defending America: Ending America's Vulnerability to Ballistic Missiles," Heritage Foundation Backgrounder no. 1074, 1996.

46. As a general rule, TMD systems are unable to engage longer-range (that is, strategic) ballistic missiles because of the extreme differences in reentry angles and velocities between theater and strategic weapons.

47. O'Neill, "Ballistic Missile Defense." Emphasis added.