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Keeping National Missile Defense in Perspective

If we're going to pursue this strategy, let's do so in a realistic way that minimizes the economic and political costs.

The United States is in the midst of its third major debate on nationwide ballistic missile defense—the first culminating in the 1972 ABM Treaty and the second sparked by President Reagan's "Star Wars" speech in 1983. This time the Cold War is over, the objectives for the defense are limited, and technology has advanced to the point where some options may be technically feasible.

However, intercontinental ballistic missiles (ICBMs) are not the primary threat to the United States, as events since September 11 demonstrate. Other homeland defense programs, especially civil defenses against bioterrorism, are more important. Yet emerging missile states may acquire ICBMs some day. To the extent that this is a concern, diplomatic efforts can limit the spread of ballistic missiles, and deterrence can dissuade their use. National missile defense (NMD), then, is insurance against the relatively unlikely event that ICBMs will be launched against the United States.

If the United States decides to deploy a limited NMD, the questions become what type and how much? A midcourse NMD system (one that attempts to intercept missile warheads as they fall through outer space) of the sort proposed for deployment in Alaska is the most technically mature option and would probably work well enough against emerging ICBM threats to justify limited deployment, assuming that the threat materializes. However, such a defense should contain only about 20 interceptors to minimize adverse political reactions from Russia and China. Over the long run, midcourse defenses may be vulnerable to sophisticated countermeasures. Therefore, the United States should place greater emphasis on land, naval, and air-based boost-phase intercept options (defenses that attempt to intercept the ballistic missile while its rocket motors are still burning) because they are more robust to countermeasures and they pose relatively little threat to Russia and China. Space-based boost-phase NMD systems have the advantage of global coverage; however, they are technically more challenging, probably more expensive, and more destabilizing.

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How serious is the threat?

Ballistic missiles, predominately single-stage missiles with ranges less than 1,500 kilometers, are spreading. Indigenously produced variants of the former Soviet Scud B and Scud C missiles are the most common. Missiles with ranges greater than about 1,500 kilometers require two-stage boosters. North Korea has the most advanced missile program of the emerging missile states, and it has been willing to sell ballistic missiles and related technologies abroad. In the past decade, North Korea produced the No Dong missile (with a range of approximately 1,300 kilometers) and has exported components to Pakistan and Iran to help them develop the Gauri and Shahab-3 variants, respectively. On August 31, 1998, North Korea launched a three-stage missile in an attempt to put a small satellite weighing approximately 15 kilograms into orbit. The launch was a failure. However, the first two stages worked and are believed to have been the Taepo Dong-1 missile with a range of approximately 2,000 kilometers. Intelligence estimates project the appearance of a larger Taepo Dong-2 missile with a range of approximately 4,000 kilometers.

Currently, Russia and China are the only states that can threaten the U.S. homeland with long-range ballistic missiles. However, the Rumsfeld Commission report, released in July 1998, and a subsequent 1999 U.S. National Intelligence Estimate on ballistic missile threats argued that North Korea could threaten the U.S. homeland with ICBMs within five years of a decision to do so by deploying a third stage on a Taepo Dong-2 missile. These reports cited Iran as a possible ICBM threat within 5 years and perhaps Iraq within 10 years. They also noted threats from shorter-range missiles launched from ships or territories close to the United States. Little evidence has emerged in the open literature since the publication of these reports to suggest that new ICBM threats will appear in the next few years. Nevertheless, they remain a hypothetical possibility.

ICBM proliferation is a serious concern only when coupled with nuclear weapons. Conventional ICBMs do not pose a serious threat, at least not one that justifies large expenditures on NMD. Chemical warheads do not approach the lethality of nuclear or biological warheads, because the amount of chemical agent that can be carried by an ICBM is too small to cause widespread effects. In fact, under some meteorological conditions, they may be less lethal than conventional explosives. Biological payloads can be as lethal as nuclear weapons (under some circumstances) and, if released as submunitions, can easily overwhelm midcourse ballistic missile defenses. However, biological weapons are better suited for covert delivery because they are odorless, invisible, and the incubation time before disease symptoms become manifest (typically several days) allows the perpetrators to escape and possibly to elude identification altogether—as the anthrax attacks via the U.S. Postal System in October 2001 illustrate (to date). Ballistic missile delivery allows one to determine the time and location of biological agent release. This improves the efficacy of medical treatment because it can begin shortly after exposure, which considerably increases the chance that exposed individuals will survive. Knowing the territory from which an ICBM is launched makes U.S. threats to retaliate more effective, thereby reducing the likelihood of such attacks in the first place. Consequently, ballistic missile delivery is neither the most likely nor the most effective delivery mode for biological weapons. Covert biological delivery is a far more serious threat. If the United States develops effective civil defenses to protect against the latter, an important priority in the wake of the recent anthrax letters, the former is a less serious concern. Therefore, ballistic missiles armed with nuclear weapons are the most serious proliferation concern.

Accidental or unauthorized Russian missile launches are another possible threat. Chinese accidental or unauthorized missile launches are thought to be less serious, because China does not place warheads on its missiles in peacetime. This, of course, could change, as China deploys mobile ICBMs. Finally, accidental or unauthorized attacks may be a concern with emerging ballistic missile states because their command and control systems are likely to be rudimentary. The problem with these threats as a rationale for NMD is that one doesn't know their likelihood, leading one to wonder whether a defense against large asteroids on a collision course with Earth—an event the probability of which can be determined with reasonable accuracy—should take precedence.

Coping with ballistic missile proliferation

Diplomacy, deterrence, and defense are three complementary approaches for coping with ballistic missile proliferation, although tensions exist between them. Diplomatic initiatives can help prevent the spread of ballistic missiles (and nuclear weapons), thereby eliminating the problem at its source. Moving beyond traditional arms control (such as the Missile Technology Control Regime and the Nuclear Non-Proliferation Treaty), diplomatic efforts should focus on specific states of concern. For example, in 1999 the Clinton administration came close to negotiating a freeze on North Korea's ballistic missile program in exchange for a gradual normalization of relations. Although the deal fell through, North Korea continues to adhere unilaterally to a missile flight test moratorium. Unfortunately, the Bush administration has not pursued this opportunity. The U.S.-Russian Cooperative Threat Reduction Program is another example, in this case aimed primarily at preventing nuclear weapons, nuclear material, and weapon design expertise from leaking out of the former Soviet Union. Parallel efforts should be explored regarding missile technology (and perhaps biological weapons). The United Nations Special Commission charged with dismantling Iraq's weapons of mass destruction and ballistic missiles after the 1991 Gulf War is a third example, albeit one that illustrates the weakness of diplomatic efforts if they lack international consensus. In any case, the potential gains of creative diplomacy are too great for the United States to relegate this approach to the back burner.

ICBMs are not the primary threat to the United States, as events since September 11 demonstrate.

Despite the best diplomatic efforts, ICBMs may still spread. The question then becomes whether they ever will be launched against the United States. This is a question of deterrence. The United States relied on deterrence throughout the Cold War to dissuade the former Soviet Union from launching a nuclear attack. Some people question the efficacy of deterrence against emerging missile states because, so the argument goes, their leaders are irrational and hence cannot be dissuaded by retaliatory threats. This argument distorts the character of regional leaders. They may be ruthless, unsavory characters with little regard for their civilian population. However, they are not suicidal. Effective deterrence depends on the capability and the resolve to carry out retaliatory threats that have been clearly communicated to an opponent. The United States has tremendous retaliatory capability in its conventional military forces. In addition, nuclear response options cannot be ruled out, although the emphasis clearly should be on conventional retaliation. There should be little doubt about U.S. resolve to retaliate after being attacked with an ICBM armed with nuclear (or biological) weapons, especially since the attacker's identity will be known. Therefore, deterrence can dissuade ICBM attacks against the United States under a wide range of circumstances. Rather than eschewing the "grim premise" of deterrence, as President Bush put it, the United States should reformulate deterrence to make it more effective against authoritarian regimes armed with ballistic missiles. Failure to do so ignores an existing tool the United States can wield with considerable effect.

Nevertheless, deterrence can fail, not because the opponent is irrational but because leaders may find themselves in situations where they have nothing left to lose. Deterrence can also fail through misperception, misunderstanding, and miscommunication between emerging missile states and the United States, a realistic concern because regional opponents often misgauge U.S. resolve and vice versa. If one is concerned about deterrence failure, one naturally turns to defense. As insurance against the failure of diplomacy and deterrence, one must ask whether NMD can work and, if so, whether the benefits of deployment outweigh the costs.

Can NMD work?

The question of whether NMD will work is easy to ask but difficult to answer. The answer is neither binary (yes or no) nor static. Nor can an answer be given in the abstract. The NMD architecture and the opponent against whom it is to be effective must be specified. The defense performance criterion is also important, because technical feasibility is inversely correlated with expected performance. Defenses may not have to be perfect to be of value. However, they should be quite effective if they are to provide meaningful protection against nuclear attack (for example, a probability of 0.80 that no warheads leak through the defense for attacks containing fewer than 10 warheads).

The question of whether NMD will work cannot be addressed unless the architecture is specified in detail. This includes the type of defense [such as boost phase, midcourse, or terminal (the latter attempts to intercept warheads as they reenter the atmosphere)]; the lethal mechanism (such as hit-to-kill interceptors or lasers); the basing mode (ground-based, naval, airborne, or space-based); and especially the sensor architecture (such as early-warning radar, X-band tracking radar, or long-wave infrared sensors in space). Moreover, any NMD architecture can and will evolve with time, as will the missile threat.

Whether a given defense architecture works depends on the technical sophistication of the United States relative to that of emerging missile states. The prior question of whether defenses will work on the test range is not the most important issue, despite the political fanfare that surrounds such tests. The real question is whether an NMD system will be effective against a reactive opponent that deploys countermeasures to degrade the defense. This is primarily an issue of sensor architecture performance.

Specifying the opponent is obviously important, because this determines the size of the threat, its technical sophistication, and the economic resources available for the offense-defense competition. Emerging missile states such as North Korea, Iran, and Iraq are appropriate targets for NMD. Such states will have limited arsenals and relatively unsophisticated payloads, at least initially. Moreover, the financial resources available to the United States greatly exceed those available to emerging missile states, suggesting that the United States would be better able to engage in an offense-defense competition even if offensive forces are cost-effective at the margin, as is often the case.

Should a U.S. NMD system be designed against Russia or China? Russia is no longer a mortal enemy of the United States and, in any case, its arsenal is too large for a limited NMD system to be of much use against intentional attacks. A limited defense against accidental or unauthorized Russian missile launches is problematic because it must be effective against Russian countermeasures, thereby posing technical challenges and raising Russian suspicions of U.S. intentions. Consequently, the latter is better addressed by means other than missile defense; for example, by sharing early warning data, detargeting missiles and reducing their alert status, and improving transparency with respect to strategic command and control. Therefore, Russia should not be the focus of U.S. NMD efforts.

China is more complex. Whether China will become a hostile military power or an economic competitor with common interests in regional stability is one of the most important emerging U.S. foreign policy debates. It is premature to assume that military confrontation is inevitable. Moreover, the United States has many long-term economic, political, and strategic interests in common with China: for example, by promoting China's transformation to a more democratic society based on free markets, combating terrorism, preventing the spread of weapons of mass destruction, and avoiding regional conflicts. Therefore, a U.S. NMD system should not be directed against China—not out of deference to a strategy based on mutual assured destruction (the Sino-U.S. strategic relationship has never been one of "mutual" assured destruction) but rather because it may undermine U.S. long-term interests. China may react by building a larger missile force than currently planned, which in turn will pose a greater threat to China's neighbors, specifically India and Japan. If India responds by building a larger, more overt nuclear arsenal, Pakistan will feel pressured to follow suit. This would not promote stability in South Asia. Japanese concerns may reinvigorate a debate about Japan's role in regional security, in particular the wisdom of an independent nuclear option. Besides, a limited U.S. NMD system against China would not remain limited for long, raising the prospect of a long-term offense-defense competition with China. The irony is that if China is a "peer" competitor, this competition will be costly and the end result probably will not be an effective defense. On the other hand, if China remains militarily weak, NMD may be more effective but less necessary. In short, the United States should not deploy an NMD system specifically against China.

The level of intelligence each side has about the other's capabilities is also important because it allows each side to adapt to the other. However, one must beware of the fallacy of the last move: assuming that one side will have the last opportunity to adapt to the other's system. Frequently, the offense will have the last move because it can adapt to a defense that has been fielded may years before. But this may not always be the case if countermeasures are flight-tested years before the missiles are used in war.

Creative diplomacy can help prevent the spread of ballistic missiles, and deterrence can dissuade their use under a wide range of circumstances.

For example, emerging missile states lack instrumented test ranges, much less precision X-band radar with range resolutions below 10 centimeters and long-wave infrared (LWIR) sensors with which to view their tests in midcourse. In fact, these states will have little knowledge of LWIR signatures for objects in space because the atmosphere precludes LWIR observations from Earth's surface. Cryogenically cooled LWIR focal plane arrays in space are beyond the capability of all but the most advanced spacefaring nations. Laboratory measurements alone are inadequate. Consequently, the United States may learn more about how to defeat countermeasures from an opponent's flight tests than the latter learns about their effectiveness. For this reason, emerging missile states have little incentive to conduct flight tests. Yet without testing they will have little confidence that their countermeasures will work, unless they are purchased fully tested and ready to deploy from more advanced states—a questionable proposition. Therefore, despite the shortcomings in U.S. intelligence capabilities regarding emerging missile threats noted in the Rumsfeld Commission report, U.S. defenses may be able to adapt more quickly to the offense than the other way around.

Midcourse NMD

The Clinton administration originally proposed a midcourse defense with 20 interceptors based in Alaska by 2005, 100 to 125 interceptors by 2010, and a second site with 100 to 125 interceptors deployed by 2011. These ground-based interceptors use kinetic-kill vehicles (KKVs) that home in on warheads as they fall through outer space, using LWIR sensors. To date, three out of five midcourse NMD flight tests have been successful: an impressive technical achievement, appropriately dubbed "hitting a bullet with a bullet." The NMD sensor architecture consisted initially of one X-band tracking radar located on Shemya Island in Alaska, five upgraded early warning radars, and the Space-Based Infrared System–High Earth orbit (SBIRS-High) satellites to replace the Defense Support Program ballistic missile early warning satellites. Up to eight additional X-band radars were to be added later, along with Space-Based Infrared System–Low Earth orbit (SBIRS-Low) satellites to track objects in space with LWIR sensors. A variant of this midcourse NMD system is still under consideration by the Bush administration, which has yet to articulate a clear NMD architectural preference.

The outcome of the technical competition between U.S. midcourse defenses and emerging missile threats is not easy to assess. At a rhetorical level, the argument is often made that any state that can deploy a crude unreliable ICBM can deploy countermeasures that can defeat midcourse NMD architectures. This is not obvious. ICBM development largely involves chemical engineering for propellants and mechanical engineering for structural design of the missile body, rocket motors, and reentry vehicles. On the other hand, effective countermeasures depend on knowledge of radar and optical sensor design, signal processing, discrimination signatures, and discrimination algorithms—branches of engineering in which emerging missile states may have little competence. Knowing an object's signature at different wavelengths in outer space requires extensive test experience or access to data collected by more advanced nations, as noted above for LWIR signatures. As a general proposition, it becomes increasingly difficult to mimic warhead signatures in multiple spectral bands at different viewing angles, as would be required to defeat a sensor architecture with multiple X-band radars and infrared sensors. Therefore, without a closer engineering analysis, it is not obvious that emerging missile states could readily defeat a U.S. midcourse NMD system.

Even if sophisticated countermeasures such as anti-simulation techniques (whereby warheads are made to look like decoys) could be devised, it is still possible that the defense could adapt to defeat them. For example, mass is the fundamental discriminate for anti-simulation countermeasures. The defense might be able to detect subtle differences in motion due to random forces during decoy release that might discriminate light objects from heavy objects; to accurately track the payload's center of mass trajectory before decoy release, then select the decoy that lies closest to the center of mass trajectory, which necessarily contains the warhead; or to apply an external force and observe the resulting motion. The very-high-range resolution of modern X-band radar makes these discrimination techniques worth exploring. The point is not to suggest that midcourse defenses can necessarily defeat sophisticated countermeasures. Rather, the offense-defense competition is dynamic, and the outcome is difficult to predict using arguments from elementary physics alone. Engineering details matter. Without access to experimental data, if not classified information, it is difficult to determine the outcome of this competition with any degree of rigor. Ultimately, flight test data against a range of plausible countermeasures must be collected to shed light on the likely outcome of the offense-defense competition. Clearly this should occur before any decision on midcourse NMD deployment is made.

Midcourse NMD systems probably will work against simple threats with unsophisticated countermeasures; however, their performance against sophisticated countermeasures remains to be determined. This implies that NMD deployment should be judged more on whether the benefits outweigh the financial and political costs. The principal benefit of a limited NMD system is to reduce the risks associated with regional intervention against states armed with nuclear-tipped ICBMs, especially if these conflicts turn into wars to topple the opponent's regime, because deterrence is apt to fail under these circumstances. In this regard, NMD is important for an interventionist U.S. foreign policy.

The financial costs associated with midcourse NMD systems of the sort proposed by President Clinton range between $25 billion and $70 billion (20-year life cycle costs), depending on the number of sites and the number of interceptors deployed. The larger figure represents an average annual expenditure of $3 billion to $4 billion. The United States currently spends $5.4 billion annually on national and theater missile defense. This was increased to $8.3 billion in fiscal year 2002. It is debatable whether this higher spending level is prudent in light of other important defense needs (for example, improved homeland security and conventional force modernization); however, it is not obvious that annual NMD expenditures of $3 billion to $4 billion are unaffordable. More robust architectures, including space-based weapons, may not be affordable.

The geopolitical costs are more important. Russian and Chinese opposition to U.S. midcourse NMD deployment, especially in light of the Bush administration's decision to unilaterally abrogate the ABM Treaty, will strain relations with these major powers, undermining cooperation in other areas that affect U.S. security. Even some NATO allies have opposed unilateral U.S. NMD deployment. Russia's objections are less pronounced than China's for the simple reason that such a defense poses very little threat to the current and projected Russian strategic nuclear force. Russia's concern with NMD breakout can be mitigated by U.S. transparency measures and by allowing Russia to retain warheads in its stockpile as a hedge. The Russian strategic bomber force also acts as a hedge. Nevertheless, Russia remains opposed to a U.S. midcourse NMD system. Thus, unilateral deployment over Russia's objections may hinder cooperation on counterterrorism, weapons proliferation, and regional security issues extending from Europe to the Far East.

China's opposition is stronger because its strategic arsenal is small, currently consisting of approximately 20 DF-5 ICBMs. China is modernizing its force with the addition of the DF-31 and DF-41 solid-propellant mobile ICBMs and a new submarine carrying longer-range JL-2 SLBMs. The future size of this arsenal is unknown, although estimates between 100 and 200 warheads seem reasonable. Even with this modernized force, a limited NMD system could substantially reduce the effectiveness of China's deterrent. Therefore, China may increase the size of its strategic arsenal beyond current plans. This could have an adverse impact on India and Japan, as noted above. Sino-Russian military cooperation may increase and China too may become less cooperative on a range of regional and global security issues of interest to the United States. Ultimately, Sino-U.S. relations may become dominated by military competition to the exclusion of political and economic cooperation.

Therefore, deploying a limited midcourse NMD system as insurance against threats from small powers risks alienating the world's major powers. Russia and China should not have a veto over U.S. NMD deployment. However, the long-term security consequences should be carefully weighed before the United States proceeds with deployment. A midcourse NMD system, if deployed, should be limited to about 20 interceptors—enough to handle a few emerging ICBMs. Beyond this, NMD alternatives should be considered that have fewer political, if not economic, costs.

Deployment of a midcourse system should be limited to about 20 interceptors in Alaska until an ICBM threat becomes clear.

Boost-phase alternatives

Land, sea, and air-based boost-phase interceptors have been suggested as alternatives to a midcourse NMD system because they are less vulnerable to countermeasures and they have fewer geopolitical costs. Boost-phase interceptors attempt to destroy their target while the ballistic missile is still in powered flight, using a KKV that homes in on and collides with the booster seconds before missile burnout. The size of such interceptors is determined by the KKV mass and the interceptor flight speed. Boost-phase KKVs probably can be built with a mass between 25 and 50 kilograms. This implies that all three terrestrial options are feasible. For example, a two-stage airborne interceptor weighing approximately 850 kilograms and traveling 4 to 5 kilometers per second should have ICBM intercept ranges on the order of 450 to 600 kilometers. A two-stage naval interceptor that fits in existing vertical launch tubes of Aegis cruisers should also have flight speeds of 4 to 5 kilometers per second and ICBM intercept ranges between approximately 350 and 500 kilometers. Larger naval or ground-based interceptors with interceptors up to 10,000 kilograms and flight speeds up to 8 kilometers per second could have ICBM intercept ranges between 700 and 1,000 kilometers. Therefore, a hypothetical North Korean ICBM can be intercepted by airborne or naval boost-phase interceptors launched from the Sea of Japan or by ground-based boost-phase interceptors cooperatively deployed with Russia at sites near Vladivostok. Although reliable cost estimates for terrestrial boost-phase options are not available, they may be comparable to those of land-based midcourse NMD systems, or possibly less.

Boost-phase interceptors are more resilient to countermeasures, because booster decoys are difficult to build, fast-burn solid-propellant ICBMs will not be readily available to emerging missile states, and maneuvering boosters may not outmaneuver agile homing KKVs. More important, terrestrial boost-phase options are less threatening to Russia and China than midcourse defenses, because the interceptors cannot reach all possible ICBM and SLBM launch locations. Airborne interceptors are mobile; however, they lack the range to threaten ICBMs located deep within Russia or China. Russia and China also have extensive strategic air defenses. Naval boost-phase interceptors may pose a threat to Russian or Chinese SLBMs; however, they don't threaten their ICBMs. Land-based boost-phase interceptors clearly cannot reach Russian or Chinese strategic missiles.

Terrestrial boost-phase options do not constitute a near-term NMD option, because several technical hurdles exist. First, KKVs with sufficient divert capability (high lateral thrust and sufficient fuel) to home in on an accelerating booster target must be designed and tested. A sensor architecture must also be designed to quickly and accurately track ICBM boosters. In flight, the KKV must switch from homing in on the ICBM rocket plume to homing in on the missile body, a difficult challenge because the plume is so much brighter than the infrared signature of the missile body. Intercepting a booster several seconds before burnout may cause the debris to land on allied or friendly territory.

Although it is not obvious that a warhead can survive the collapse of a booster after intercept, it is also difficult to prove that it will be inert. To avoid having a live warhead reenter the atmosphere, KKVs can be designed to collide with the payload section of an ICBM. However, this places greater demands on KKV homing accuracy and lethality.

All three terrestrial boost-phase concepts are viable options in principle. Airborne interceptors have the advantage that they can perform theater missile defense, in addition to national missile defense, by flying over an opponent's airspace; an important advantage, because threats from theater-range ballistic missiles already exist. On the other hand, airborne interceptors have limited endurance, their design is inherently less robust to KKV mass increases because the interceptors are small, and one must ensure their survival against advanced air defenses. Naval boost-phase interceptors generally are not effective for theater missile defense, because naval platforms cannot get close enough to the launch sites. In some cases, naval platforms may even lack accessible waters for national missile defense. Moreover, they require protection from antiship cruise missiles and diesel attack submarines. On the other hand, naval boost-phase interceptors have substantial endurance and can accommodate heavier interceptors for heavier KKVs or higher interceptor speeds. Ground-based boost-phase interceptors cannot intercept theater-range missiles, and host nation support may not be forthcoming for some emerging ICBM threats, such as Iran. In addition, ground-based interceptors are potentially vulnerable to attack by short-range ballistic missiles, cruise missiles, or covert attack. On the other hand, ground-based interceptors have excellent endurance and can accommodate large interceptors for heavier KKVs and higher speeds. The principal drawback with all terrestrial boost-phase systems is that they offer no protection against accidental or unauthorized Russian and Chinese missile launches, although they may offer protection against such launches by emerging missile states.

In contrast, space-based interceptors (formerly known as "Brilliant Pebbles") and space-based lasers offer global protection against accidental and unauthorized ICBM launches. However, they are technically more challenging because they must remain reliable for years in orbit, and they are more expensive. More important, space-based boost-phase systems threaten Russian and Chinese strategic missiles, thereby eliminating the geopolitical benefits associated with terrestrial boost-phase options, although proposals have been made based on orbital inclination and sparsely populated constellations to minimize this effect.

Balanced approach needed

In the wake of September 11 and the subsequent anthrax attacks, it is difficult to argue that ballistic missiles pose a more clear and present danger than terrorism, especially bioterrorism. Consequently, the United States should reevaluate the priority it assigns to long-range ballistic missile threats. To the extent that this threat still is of concern, creative diplomacy can help prevent the spread of ballistic missiles, and deterrence can dissuade their use under a wide range of circumstances. If new ICBM threats appear, midcourse NMD systems may be effective enough to warrant deployment as a form of insurance. However, concerns exist about their effectiveness against sophisticated countermeasures. Hence, early deployment should be discouraged until the test program demonstrates greater confidence in the underlying technology. More important, deployment may undermine relations with Russia and especially China. Hence, deployment should be limited to about 20 interceptors in Alaska until the emerging ICBM threat becomes clear—thereby providing protection against a few ICBMs without threatening China. Beyond a very limited midcourse NMD system, greater emphasis should be placed on terrestrial boost-phase options because they are more resistant to countermeasures; they create a thin, layered defense when used in conjunction with a midcourse defense; and, most important, they pose little threat to Russia and China. Therefore, an effective NMD against emerging missile states does not come at the expense of relations with the major powers. Airborne boost-phase options are among the most attractive because they can perform national and theater missile defense simultaneously.

Recommended reading

The Federation of American Scientists' Web site at www.fas.org/spp/starwars/program.

Geoffry Forden, *Budgetary and Technical Implica-*

tions of the Administration's Plan for National Missile Defense (Washington, D.C.: Congressional Budget Office, April 2000).

Jack Mendelson et al., *White Paper on National Missile Defense* (Washington, D.C.: Lawyers Alliance for World Security, Spring 2000).

Andrew Sessler et al., *Countermeasures* (Cambridge, Mass.: MIT/Union of Concerned Scientists, April 2000).

Michael O'Hanlon, "Star Wars Strikes Back," *Foreign Affairs* 78, no. 6 (November/December 1999).

David Tanks, *National Missile Defense: Policy Issues and Technological Capabilities* (Cambridge, Mass.: The Institute for Foreign Policy Analysis, July 2000).

Bob Walpole, *Foreign Missile Developments and the Ballistic Missile Threat to the United States Through 2015* (U.S. National Intelligence Council, Central Intelligence Agency, Langley, Va., September 1999).

Dean Wilkening, *Ballistic Missile Defence and Strategic Stability* (Adelphi Paper 334, International Institute for Strategic Studies, London, May 2000).