Shielded from Oversight

The Disastrous US Approach to Strategic Missile Defense

Union of Concerned Scientists

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Concerned Scientists

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SILO HAZARD ZONE
BASKET WORK ZONE
BASKET WORK ZONE
SILO HAZARD ZONE
WARNING
MISSILE SUPPORT SYSTEM
COMPONENT BELOW

In 2002, the George W. Bush administration announced it would rapidly field the Ground-based Midcourse Defense (GMD) missile defense system with the goal of having an initial operational capability by late 2004.

To meet this tight deadline, it took the unusual step of exempting the system from standard, time-tested rules for developing complex military systems. Today, nearly 15 years later, the program's price tag is $40 billion and counting. Its test record is poor and it has no demonstrated ability to stop an incoming missile under real-world conditions. Insufficient oversight has not only exacerbated the GMD system's problems, but has obscured their full extent, which could encourage politicians and military leaders to make decisions that actually *increase* the risk of a missile attack against the United States.

How did we end up in this position?

Accelerated Deployment, Reduced Oversight

The Bush administration stated its rationale for rushing the GMD system into the field was a response to the ballistic missile programs of "rogue states" such as North Korea. While the decision was controversial, the US political climate after the terrorist attacks of September 11, 2001, made it difficult for Congress or others to question executive decisions about defense and security matters.

The president justified building the GMD system in a drastically different way than other military systems by arguing that the need for strategic missile defense was acute, with no time to be wasted. This less rigorous approach included exempting the system from many of the mandatory oversight, accountability, and financial transparency procedures that Congress and the Pentagon had learned through years of experience are necessary to successfully develop major military systems. Thus, the GMD system's development has not followed the Department of Defense's (DOD's) standard, time-tested "DOD5000" acquisition rules for comparing the risks and costs of alternative ways to meet a military need, setting specific performance requirements, and outlining tests a system must pass before it can be considered operational.

Moreover, the Bush administration delegated much of the responsibility for oversight to the very office developing the GMD system: the Missile Defense Agency (MDA). It gave the MDA authority to set its own requirements; to review its own performance; and to consolidate, establish, or cancel programs at will without outside review. It also exempted the MDA from standard reporting requirements about programs' progress and cost, which allowed the GMD program to proceed without an estimated total cost. This special treatment also permitted most MDA expenditures—including fielding interceptors—to come from research and development funds—funds not subject to the same level of oversight as procurement or construction funds. The interceptors are not required to have been demonstrated to work under operational conditions. The MDA has now fielded 30 interceptors and is preparing to field 14 more under this process.

No Demonstrated Real-World Capability

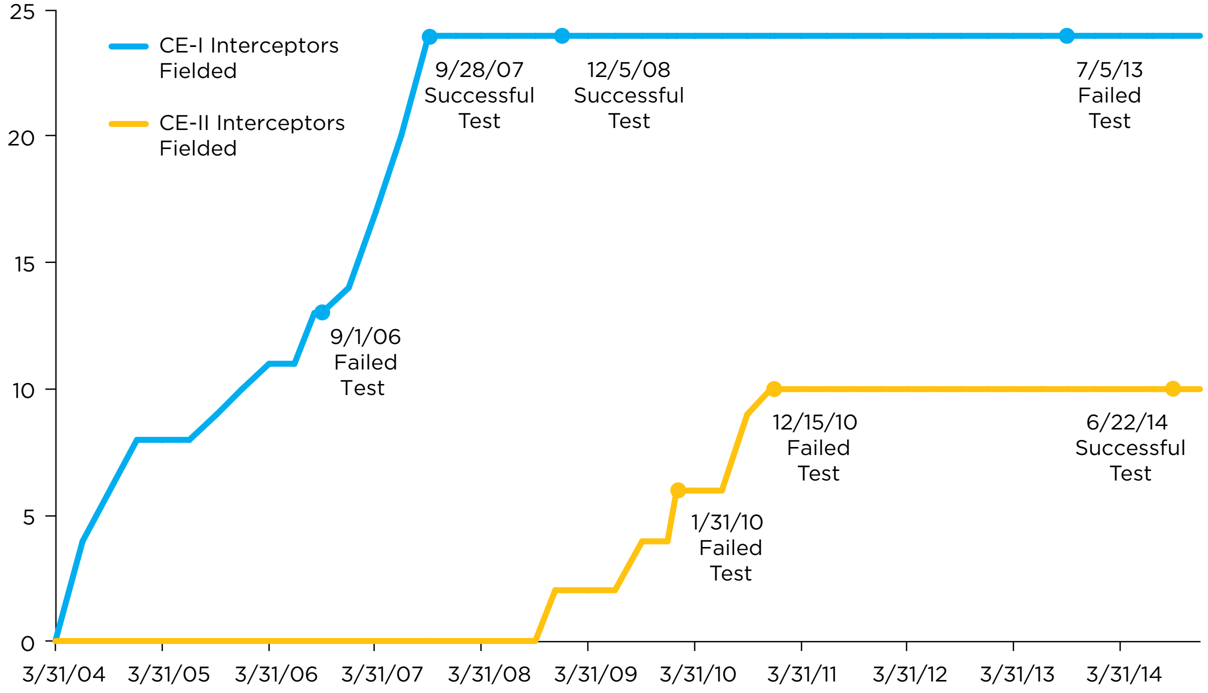
The GMD system's exemption from the proven "fly-before-you-buy" process has had dire and lasting consequences.

Nearly all of its interceptors—the core of its defensive capability today—were fielded before their design had been

Left: Secretary of Defense Robert M. Gates talks to Col. Bond, US Army, at a Ground Based Interceptor missile silo at Fort Greely, Alaska.

Department of Defense

Interceptors Fielded without Successful Tests



Nearly all of the interceptors of the Ground-based Midcourse Defense system were fielded before a single interceptor of their type had been successfully tested. The y-axis shows the cumulative number of interceptors fielded over time (blue for interceptors using the CE-I kill vehicle and orange for those with the CE-II kill vehicle). Marked are the intercept tests for each type of kill vehicle.

Notes: Some interceptors with CE-I kill vehicles were replaced by those with CE-II kill vehicles. The total number of fielded interceptors by late 2010 was thirty. Fielding dates are approximate within the fiscal year quarter. For more information about the 9/1/06 test, see the table, p. 3.

SOURCE: DATA FROM SYRING 2014B AND GAO 2011.

successfully intercept-tested even once. The GMD system's test record has been notably poor despite the fact that the tests have been simplified and scripted (for example, the timing and other details of the simulated attacks are known in advance). Identifying and fixing the cause of these failures has cost considerable time and money. The system has still not been tested against realistic targets such as tumbling warheads, warheads accompanied by credible decoys, or warheads traveling at speeds and from distances similar to that of incoming intercontinental ballistic missiles (ICBMs).

Nearly 15 years after the GMD system was put on the fast track, the Pentagon's own testing officials have said the system has not demonstrated an operationally useful capability to defend the US public from a missile attack. A scathing 2012 National Academy of Sciences study called the system "deficient" with respect to all of its fundamental principles for a cost-effective missile defense, and recommended a complete overhaul of the interceptors, sensors, and concept of operations.

Moreover, given the problems with the current development process, the GMD is not on a credible path to achieving an operationally useful capability.

The Obama administration has continued a similarly lax approach to missile defense. It has declined to bring the GMD system back under standard requirements-setting and DOD5000 acquisition processes. While the Pentagon made some improvements to the MDA's acquisition process, it still lacks the rigor of established processes. And as a result, the current system of oversight has not prevented the recurrence of many of the same problems.

Conclusions and Recommendations

KEY FINDINGS

- The Bush administration exempted missile defense from the normal oversight and accountability processes required of other major military systems, with the goal of quickly fielding the GMD system. This decision allowed the Pentagon to field missile defense systems without undergoing operational testing. Nearly 15 years of this approach has led to an expensive and poorly performing system.

- Obama administration attempts to improve oversight and accountability without bringing missile defense under the normal processes have led to ongoing problems. These include projects that have been started without sufficient vetting and later canceled, and components that are being fielded based on imposed deadlines rather than technical maturity—in some cases with known flaws.

- The MDA has conducted intercept tests of the GMD system at a rate of fewer than one per year since the end of 2002. Moreover, the tests have been conducted under simplified, scripted conditions. Even with the limited objectives of those tests, only a third have been successful since deployment began, and the record is not improving over time. Pentagon testing officials assess that the GMD system has not demonstrated an operationally useful capability.

- The GMD system currently includes 30 fielded interceptors. The majority use a type of kill vehicle (CE-I) that has had only two successful intercept tests in four tries. Its last successful intercept test was in 2008; the most recent one failed. Other interceptors are equipped with the CE-II kill vehicle, which has had only a single successful intercept test in three tries. None of the tests have been operationally realistic.

- The MDA began fielding both the CE-I and CE-II kill vehicles before they underwent any intercept tests.

- The MDA will not be able to test the GMD system often enough and under a broad enough range of conditions to develop a high degree of confidence in its effectiveness under operational conditions and against real-world threats, which may have unknown characteristics. This lack of confidence limits the system's military utility. While computer simulations can help characterize its effectiveness under known, tested conditions, they cannot substitute for actual tests. For example, they cannot reliably predict the system's behavior under conditions or against targets that differ significantly from those used in real-world tests, and cannot uncover weaknesses that are not already known, including quality control and design problems.

- The GMD system was designed to defend against a very limited threat. Modifying it to engage more sophisticated threats would require substantial changes and additions. Even a modified system would face fundamental problems in dealing with countermeasures that an adversarial ballistic-missile state would be expected to field.

The Poor Testing Record of the GMD System

Test	Date	Designation	Kill Vehicle
1	🟩 10/2/99	IFT-3	prototype
2	🟧 1/18/00	IFT-4	prototype
3	🟧 7/7/00	IFT-5	prototype
4	🟩 7/14/01	IFT-6	prototype
5	🟩 12/3/01	IFT-7	prototype
6	🟩 3/15/02	IFT-8	prototype
7	🟩 12/14/02	IFT-9	prototype
8	🟧 12/11/02	IFT-10	prototype
Deployment decision			
9	🟧 12/15/04	IFT-13C	prototype
10	🟧 2/14/05	IFT-14	prototype
11	🟧 9/1/06*	FTG-02	CE-I
12	🟩 9/28/07	FTG-03A	CE-I
13	🟩 12/5/08	FTG-05	CE-I
14	🟧 1/31/10	FTG-06	CE-II
15	🟧 12/15/10	FTG-06A	CE-II
16	🟧 7/5/13	FTG-07	CE-I
17	🟩 6/22/14	FTG-06B	CE-II

GMD interceptors failed to destroy their targets in more than half of their intercept tests, and the record is not improving over time. The table lists all the intercept tests of the GMD system, including Integrated Flight Tests (IFTs) of prototype interceptors (tests 1-10) and Flight Test Ground-based Interceptor (FTG) tests of operationally configured interceptors. Tests in green succeeded; tests in orange failed.

* The interceptor in FTG-02 hit the target with a glancing blow but did not destroy it. MDA rates this test as a "hit" but not a "warhead kill," and counts it as a success. Since the goal of the interception is to destroy the warhead, we do not count this as a successful intercept test.

SOURCE: DATA FROM SYRING 2014B.

- The continued development of the GMD system without adequate oversight and accountability, and the continued fielding of interceptors without adequate testing, means the system is not even on a path to achieving a useful ability to intercept ballistic missiles.
- US officials have strong incentives to exaggerate the capability of the GMD system to reassure the public and international allies—and have done so, despite its poor test record.
- The pursuit of a strategic missile defense system can make the United States less safe by encouraging a riskier foreign policy, by encouraging potential adversaries to modernize and increase their arsenals, by short-circuiting creative thinking about solving strategic problems diplomatically, and by interfering in US efforts to cooperate with other nuclear powers on nuclear threat reduction. The United States may incur these costs whether or not the system provides an effective defense.

RECOMMENDATIONS

- The secretary of defense should bring the GMD system under oversight at least as rigorous as that required of other major military systems. We recommend that missile defense systems be returned to the standard, time-tested DOD5000 acquisition process rather than continuing to modify the current, alternate acquisition process.

  A rigorous acquisition process should include:

  - Requiring a rigorous interagency process, including the intelligence community and the State Department, that characterizes the current and projected ballistic missile threat.
  - Specifying the particular missile threats the GMD system is intended to counter and over what timeline, and assessing the system's efficacy, risks, and costs (financial and strategic) compared with alternate methods of countering the threat.
  - Specifying what capability the system must demonstrate against that particular threat in order to merit deployment.
  - Assigning the task of developing operationally realistic and challenging test targets and conditions to a team outside the MDA itself.
  - Requiring the GMD system to undergo extensive and rigorous testing to evaluate its real-world effectiveness, with the highest priority on operational realism. The test program must be certified by the director of operational test and evaluation.
  - Analyzing new missile defense initiatives rigorously on the basis of costs, risks, benefits, and alternatives before funding can be granted. Neither Congress nor the administration should be able to create programs, such as a third interceptor site or a space-based missile defense element, that have not undergone appropriate scrutiny.
- Missile defense development must not be schedule-driven. Congress and the administration must refrain from imposing deadlines that are not based on technical maturity.
- Fielding of the system should not continue to be funded from research and development budgets.
- Congress and the administration should halt the deployment of additional interceptors until all known flaws have been eliminated from those additional interceptors and a testing program shows they are effective and reliable.
- Congressional oversight should involve hearings that include the perspectives of independent experts as well as government experts, as it has in the past.
- The current and future US administrations should work with China and Russia to ensure that development of a strategic missile defense system does not interfere with progress on strategic issues important to all three countries.

In short, the United States must fundamentally change its approach to strategic missile defense. If the GMD system is to be part of addressing the ballistic missile threat, the United States must make its development and deployment a process with clear goals, rigorous testing, and effective oversight and accountability. Components must not be fielded on timetables set by imposed deadlines but by technical maturity. It is time to treat strategic missile defense like the serious military system it is supposed to be. Congress and the president should ensure that taxpayers' dollars are spent in ways that actually make us safer.

[CHAPTER 1]

The True State of Strategic Missile Defense Today

In 2002, the George W. Bush administration announced the United States would develop and field a strategic, long-range missile defense system and do so at a sprint pace—in two years.[1] The president stated this was a response to the ballistic missile programs of "rogue states" such as North Korea, but political motivations were also evident. While the decision was controversial, the political climate after the terrorist attacks of September 11, 2001, made it difficult for Congress or others to question executive decisions about defense and security matters.

The president justified drastic changes to the way the Ground-based Midcourse Defense System (GMD) would be built by arguing that the need for strategic missile defense was acute, with no time to be wasted. Rather than use standard, time-tested "fly-before-you-buy" procedures for developing complex military systems—procedures to ensure the system will work as advertised before it is bought and deployed—the Pentagon created a development process just for missile defense. That new development process exempted the program from many of the mandatory oversight, accountability, and financial transparency procedures for major military projects that Congress and the Pentagon had developed through decades of experience.

The US decision to exempt missile defense from proven fly-before-you-buy requirements has had dire and lasting consequences and created problems that continue to plague the system. Today, with a price tag of $40 billion and counting, and nearly 15 years of effort, the GMD missile defense system is now recognized by both supporters and critics as being in serious disarray. It has no proven capability to defend the US public from missile attack; moreover, it is not even on a credible path to achieving such capability.

How did the GMD system get to such a poor state? What does that story say about the prospects for fixing it? What would fixing it require? If these problems were fixed, could the GMD system make a meaningful contribution to US security? At what cost?

Now—nearly 15 years after Bush's national security directive—is the right time to take a critical look at the US missile defense system. Nearly everything in the plan that was set in motion in 2002—interceptors and sensors—has been fielded. Moreover, 2014 marked 10 years since the Bush administration declared the GMD system had an initial missile defense capability.

Ballistic Missile Defense from the Strategic Defense Initiative to Today

The United States has pursued defenses against long-range ballistic missiles since at least the 1950s. Concerns about a possible arms race and dangerous instabilities resulting from

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[1] *National Security Presidential Directive 23 states that, "In light of the changed security environment and progress made to date in our development efforts, the United States plans to begin deployment of a set of missile defense capabilities in 2004." The capabilities planned for operational use included ground- and sea-based interceptors, Patriot missiles, and sensors (Bush 2002).*

an offense-defense competition led the United States and Soviet Union to sign the 1972 Anti-Ballistic Missile (ABM) Treaty, which "prohibited the deployment of ABM systems for the defense of the nations' entire territory" (Hildreth 2007). The ABM Treaty also banned the "development, testing, and deployment of sea-based, air-based, space-based, or mobile land-based ABM systems and ABM system components" but "placed no restrictions on the development, testing, or deployment of defenses against shorter range missiles" (Hildreth 2007).

> ***The original SDI concept was focused on the unachievable goal of providing an impenetrable barrier against the huge Soviet arsenal.***

However, in March 1983, President Ronald Reagan announced the Strategic Defense Initiative (SDI): an expansive effort to protect the entire United States against a full-scale attack of long-range ballistic missiles; SDI came to be nicknamed "Star Wars" after the hit 1977 science fiction movie. The original SDI concept involved a range of ambitious proposals, such as X-ray lasers and other space-based weapons, and was focused on the unachievable goal of providing an impenetrable barrier against the huge Soviet arsenal, thereby making nuclear weapons "impotent and obsolete" (Reagan 1983). As cost estimates and technical challenges mounted, however, the administration, and the George H.W. Bush administration following it, scaled back the plans.

The collapse of the Soviet Union in 1991 reduced the likelihood of a deliberate Russian attack. But Iraqi Scud missile attacks during the 1991 Gulf War raised concerns about an emerging threat from countries such as Iran and North Korea to US forces and allies in their vicinity. Those international developments led to the pursuit of defenses against such shorter-range missile threats: defenses that evolved into the "theater" or "regional" ballistic missile defenses of today, such as the US Army's Patriot Advanced Capability-3 and its Terminal High Altitude Area Defense, and the US Navy's Aegis Ballistic Missile Defense systems.

However, strategic missile defense has continued to evolve and change names to the present day. It was further scaled back and brought down to Earth, literally, under the Bill Clinton administration, which changed the name to the National Missile Defense (NMD) program in 1996. Rather than space-based interceptors or X-ray lasers, the NMD program was focused on protecting against launches of small numbers of ballistic missiles using Ground Based Interceptors designed to destroy warheads by smashing into them mid-trajectory.

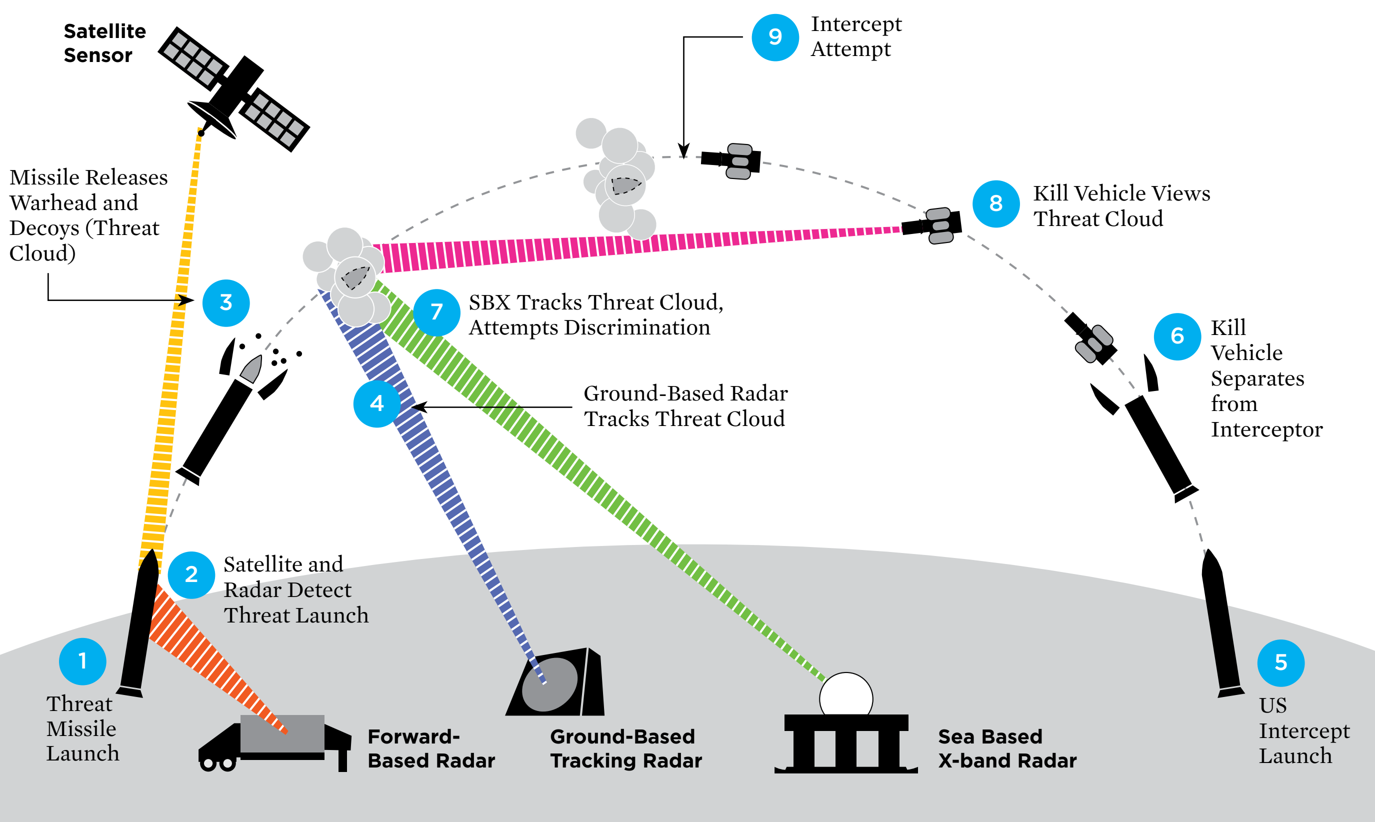
Up to 2000, the "national" and "theater" defenses were entirely separate systems, except for sharing space-based early warning technologies. When George W. Bush entered office, he declared that his administration would no longer describe systems as "national" or "theater;" instead, all of the missile defense systems would be regarded as individual elements of an integrated global Ballistic Missile Defense System (BMDS) (Bush 2002).

The heart of the BMDS was to be the Ground-based Midcourse Defense (GMD) system—the direct heir of NMD: it aimed to hit an enemy missile warhead with a "kill vehicle" released from a defensive interceptor missile. The GMD system is intended to defend the United States homeland (the 50 states) against attack by long-range ballistic missiles: countries such as Iran or North Korea need missiles with intercontinental range (greater than 5,500 km) to strike the United States. These missiles would be launched from thousands of miles away in an arced trajectory that carries them out of the atmosphere into the vacuum of space before they reenter the atmosphere and fall to their targets under the force of gravity. Over the years, such long-range ballistic missile defenses have been variously called "strategic," "national," or "homeland" defenses, but all three adjectives mean the same thing.

While the initial research and development of these Ground Based Interceptor missiles happened in the previous decade, the Bush administration greatly accelerated the GMD system's development. In late 2001, the president announced the United States would withdraw from the ABM Treaty, and in late 2002, announced that the newly named Missile Defense Agency (MDA) would begin building the GMD system—even though much of the technology was still unproven or existed only in prototypes. The ambitious goal was fielding an initial set of missile defense capabilities to begin operating by late 2004. (For a more detailed discussion of the history of the GMD system, and how the pieces have been fielded, see *Appendix 1: Development of the Ground-based Midcourse System*.)

This report focuses exclusively on the development of the GMD system: the system that the United States hopes to rely on to defend its territory against future long-range missile threats from countries such as Iran and North Korea. The story of this system is a cautionary tale about how the lack of appropriate oversight of a politically charged missile defense program has led to a system in tatters.

FIGURE 1. Anatomy of an Intercept



The GMD system involves a complex, global network of components. The launch of the threat missile (1) is detected by forward-based radars, if present, and satellite-based infrared sensors (2). The threat missile releases its warhead and decoys (in this example the decoys are balloons, and a balloon contains the warhead; together they are referred to as the "threat cloud") (3), and the ground-based radar begins tracking the threat cloud (4). Based on information from this radar, the GMD system launches one or more interceptors (5), each of which releases a kill vehicle (6). If a discrimination radar, such as the Sea Based X-band Radar, is in place it will observe the threat cloud to try to determine which object is the warhead (7) and pass this information to the kill vehicle. The kill vehicle also observes the threat cloud to attempt to determine which object is the warhead (8). It then steers itself into the path of the chosen object and attempts to destroy it with the force of impact (9).

GMD Concept: Anatomy of an Intercept

The job of the GMD system is to detect the launch of an enemy intercontinental ballistic missile (ICBM) and destroy its nuclear weapon-carrying warhead before it can reach the United States. Here's how it is supposed to operate if used against a missile launched from North Korea toward the western United States (Figure 1).

The first notice of the missile launch would come from sensors on early warning satellites detecting the bright flames of the launching missile and from forward-based radars. In this case, those radars would be two TPY-2 X-band radars in Japan or ship-based radars such as the Aegis SPY-1 radars on US Navy destroyers and cruisers, if those happened to be deployed close to the missile launch site. Each of these sensors

> ***The job of the GMD system is to detect the launch of an enemy intercontinental ballistic missile and destroy its nuclear weapon-carrying warhead before it can reach the United States.***

Missile Defense Agency

The Sea Based X-band Radar (SBX), seen here being transported to Pearl Harbor, is a high-resolution radar based on a modified ocean-going oil drilling platform. It is the primary discrimination radar of the GMD system; however, it was designed primarily as a test asset and has a number of serious shortcomings as an operational sensor. For example, its home port is in Hawaii, so it must be moved into place to view a launch from North Korea toward the continental United States; and it has a relatively small field of view, which limits its ability to discriminate the warhead from other objects if more than one threat cloud are launched sequentially.

would detect the missile within about a minute or less after launch begins, and could provide at least preliminary information about the missile's trajectory within tens of additional seconds (Barton et al. 2004, sections 10.1 and 10.2). The information from these sensors would be relayed to the GMD fire control centers at Fort Greely in Alaska and Schriever Air Force Base in Colorado.

After accelerating rapidly up through the atmosphere, the missile's booster burns out, roughly three to five minutes after launch begins. It will then no longer be visible to the early warning satellites, but may still be visible to the forward-based radars. Now in the vacuum of space, the missile releases its warhead and any decoys or other intentional countermeasures it carries. These objects plus the missile's final booster stage and any debris associated with the warhead's release travel through space together, forming a "threat cloud." In the vacuum of space, free-falling objects such as the warhead and decoys travel at the same speed regardless of mass.

The TPY-2 radars in Japan and the Aegis radars can continue to track the missile and accompanying objects until they fly beyond their range or out of their field of view.[2] Depending on the circumstances (for example, whether or not decoys are employed), those radars may or may not be able to identify the warhead within the threat cloud or provide tracking data accurate enough to enable the launch of an interceptor. At a minimum, the radars will provide cueing information for the GMD system's other, larger radars, allowing them to detect the attacking threat cloud more efficiently and at greater ranges.

As the threat cloud coasts through space, it would next be detected by a ground-based tracking radar, in this case the Upgraded Cobra Dane radar on Shemya Island at the western end of the Aleutian island chain, and the Sea Based X-band (SBX) radar—a large radar built on an ocean-going,

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[2] *The two TPY-2 radars in Japan face fixed directions and have an azimuthal field of view of about ±60 degrees or somewhat less. While the four faces of the Aegis radars provide a 360-degree field of view, their ranges are significantly shorter than those of the TPY-2s.*

self-propelled platform—if it has been moved into position. (Normally, it is ported in Hawaii.) Both of those large radars are capable of providing tracking data accurate enough to be used for launching and guiding interceptors. Finally, as the threat cloud approaches the West Coast, it can also be detected and tracked by the upgraded PAVE PAWS early warning radar at Beale Air Force base in Northern California.

The adversary may use decoys or other countermeasures to try to confuse the defense. For example, the threat cloud may include numerous lightweight decoy warheads such as mylar balloons. The warhead itself may be enclosed in a balloon, so that the objects appear yet more similar to each other. The GMD system must try to select the warhead from among these objects. Other than the forward-based TPY-2 radars in Japan, which see only the early part of the attacking missile's trajectory, only the SBX can make high-resolution radar measurements that might be useful for distinguishing the warhead from other objects,[3] but it has a number of serious limitations (see *Appendix 2: The Sea Based X-band Radar*). Under current plans, a new Long Range Discrimination Radar (LRDR) in central Alaska will replace the SBX in about 2020 (see *Appendix 3: The Long Range Discrimination Radar*).

Based on the information from all available sensors, the fire control centers in Alaska and Colorado will attempt to discriminate the warhead from other objects in the threat cloud, determine its trajectory, calculate potential intercept points, and fire one or more interceptors. The number of interceptors initially fired will depend on various factors, including whether the operators believe the warhead has been accurately identified, or if multiple objects will need to be intercepted, and whether there will be time to fire a second round of interceptors after observing the results of the first intercept attempts (called a shoot-look-shoot strategy).

The interceptor(s) would launch from underground silos in Fort Greely in Alaska or Vandenberg Air Force Base in California. They would be accelerated by their powerful boosting rockets toward projected intercept points that the fire control center has calculated. As the interceptor(s) fly toward their target(s), the operators can send updated information on the projected intercept point(s) and the location of the warhead within the threat cloud (if that can be determined). In practice, however, the system currently has limited ability to communicate to the interceptor while it is in flight, although that shortcoming will be ameliorated with the next generation of interceptors that would begin deployment in 2020.

> ***[Only the SBX can make high-resolution radar measurements that might be useful for distinguishing the warhead from other objects, but it has a number of serious limitations.]***

After the interceptor's booster rocket burns out above the atmosphere, it releases a small exo-atmospheric kill vehicle (EKV) that has a mass of about 55 kilograms. The kill vehicle's infrared sensor detects and begins to track the threat cloud. The kill vehicle attempts to select one of the objects as its target using live data from its sensor's two infrared detectors, pre-programmed information about the expected appearance of the warhead and other objects predicted to be in the threat cloud, plus any additional information communicated from the ground. The kill vehicle then fires small rocket thrusters to maneuver itself toward the target to destroy it in a high-speed collision.

Finally, the GMD system's sensors will attempt to perform a kill assessment, that is, determine whether the enemy warhead was successfully destroyed. If the warhead's destruction cannot be confirmed and enough time remains, the GMD system may fire additional interceptors toward the incoming threat cloud.

The entire above sequence of events, from the launch of the attacking missile to the intercept and destruction of the warhead (or the warhead's impact on its target if all interception attempts fail) would take no more than about half an hour.

Playing by the Rules: How Building a Military System Is Supposed to Work

Over decades, Congress and the military developed well-defined procedures for acquiring major military systems. Based on repeated lessons that a rigorous system of accountability is necessary for the successful development of a major weapon system, these time-tested procedures were specifically intended to ensure a fly-before-you-buy process to

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[3] *The Cobra Dane radar is capable of making high-resolution measurements (although with poorer resolution than the SBX), but only in a narrow cone of angles within 22.5 degrees of its boresite, and a missile fired from North Korea to the US West Coast will not pass through this cone (Gronlund et al. 2004; see Figure 3 on p. 37). (Although this figure may appear to show the missile briefly entering this cone of angles, it actually passes well above it.)*

> ***Secretary of Defense Donald Rumsfeld gave the MDA the authority to set its own requirements; to review its own performance against these requirements; and to consolidate, establish, and cancel programs at will without outside review.***

prevent the premature and expensive fielding of unproven systems.

The normal development of a major defense acquisition program, by statute and regulation, follows (1) a "requirements" process to establish, via the Joint Chiefs of Staff, that a capability is needed to mitigate a specific threat or support a specific strategic goal, and (2) an acquisitions process by which competing alternatives for getting that capability are compared with respect to efficacy and cost. The acquisitions process also provides a road map, with specific milestones, for developing and testing that system before it can be considered ready to go into the field.

The requirements for a capability are set through the Joint Capabilities Integration and Development System (CJCS 2015). The acquisition process is guided by the Pentagon's Defense Acquisition System, elaborated in Department of Defense Directive 5000, or commonly "DOD5000."[4] The agent in charge of a project has clear responsibilities for reporting progress and cost. Congress also has numerous oversight responsibilities (see *Appendix 4: Acquisitions Oversight*). Under DOD5000, the level of oversight increases as the cost of the program increases. A program with research and development costs in excess of $480 million or estimated procurement cost greater than $2.79 billion is defined as a Major Defense Acquisition Program. Those criteria would, in theory, encompass not only the Ground-based Midcourse Defense system itself, but also even a sensor that is part of the GMD, such as the Sea Based X-band radar.

Exempting GMD from Standard Operating Procedures

Upon taking office, President George W. Bush directed the secretary of defense to examine the full range of ballistic missile defense technologies; he also directed that such defenses were to be deployed at the earliest possible date (Bush 2002). In January 2002, Secretary of Defense Donald Rumsfeld took steps to expedite deployment of missile defenses. He delegated much of the oversight process to the very organization developing the GMD system: the Missile Defense Agency (MDA) (Rumsfeld 2002).[5] He gave the MDA the authority to set its own requirements; to review its own performance against these requirements; and to consolidate, establish, and cancel programs at will without outside review. He also exempted the MDA from standard reporting requirements about programs' progress and cost (Aldridge 2002).

In addition, Rumsfeld created a shortcut to the field for missile defense equipment by exempting missile defense programs from the obligation to satisfy standard acquisitions milestones and complete operational testing before deployment. Instead, Rumsfeld said the MDA should "use prototype and test assets to provide early capability" (Rumsfeld 2002) and that the under secretary of defense for acquisition, technology and logistics may recommend to the secretary of defense when research and development assets are available "for emergency or contingency use" (DOD 2004). This exemption allowed virtually all MDA expenditures to be classified as research and development (R&D) funds, which are not subject to the same levels of oversight as procurement or construction funds.

MDA Director Vice Admiral James Syring, for example, discussed the fielding of the GMD system out of research and development funding at a 2016 Senate hearing, saying that he had "gone back and looked at that 2005–2010 timeframe when everything in MDA was R&D, including the fielding of the entire Ground-based Midcourse Defense system" (Syring 2016a).

The Ballistic Missile Defense System (BMDS), including the GMD system, is one of the costliest defense programs[6]—

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[4] *The Defense Acquisition System is governed by Department of Defense Directive 5000.01 and Instruction 5000.02.*

[5] *The MDA is a research, development, and acquisition agency within the Department of Defense. Its stated mission is "to develop, test and field an integrated, layered, ballistic missile defense system (BMDS) to defend the United States, its deployed forces, allies, and friends against all ranges of enemy ballistic missiles in all phases of flight" (Missile Defense Agency 2016a,b).*

[6] *While the GAO does not include it in the rankings of the DOD's costliest programs because the lack of oversight makes it difficult to estimate future costs, the Ballistic Missile Defense System's total cost through 2017 puts it in the top three programs for total estimated acquisition cost (GAO 2013a, 16 Table 5).*

but is the only major defense program that is not subject to DOD5000 acquisitions oversight. While Pentagon officials at the time said that the experimental nature of missile defense made it nearly impossible to produce meaningful cost or schedule estimates and therefore required flexibility, some members of Congress were skeptical. Senator Jack Reed (D-RI) said at the time, "You get the suspicion this is as much to avoid scrutiny of the program as to shield it from adversaries" (Graham 2002).

Indeed, the exemptions introduced by Rumsfeld in January 2002 allowed the Pentagon to field poorly tested equipment, and the haste resulting from Bush's December 2002 directive ensured this would be the case. Today this poorly tested equipment makes up key parts of the fielded GMD system. The GMD system's test record has been notably poor, with just eight successful intercepts out of 17 tries,[7] despite the fact that the tests are heavily scripted for success. The GMD system continues to have major schedule and cost overruns. It has still not been tested against realistic targets, such as tumbling warheads and targets with ICBM range.

Yet, it is not just the execution of the program that has been problematic, it is the approach to the task of hitting a missile with a missile. A scathing 2012 National Academy of Sciences study called the GMD system "deficient" with respect to all of the study's fundamental principles for a cost-effective missile defense, and recommended a complete overhaul of the interceptors, sensors, and concept of operations (NRC 2012).

Even at the highest levels of the Pentagon, the wisdom of the current strategy for strategic missile defense is being questioned. The chief of naval operations and the US Army chief of staff in November 2014 wrote a memo urging the secretary of defense to take a fresh look at the problem of defending against ballistic missiles (Greenert and Odierno 2014). They asked the Pentagon to develop a "more sustainable and cost effective" long-term approach to both strategic and regional missile defenses. As Admiral Gortney, commander of US Northern Command, explained in testimony to the House, the memo's authors question the wisdom and fiscal responsibility of a missile defense strategy that emphasizes "shooting a rocket down with a rocket," feeling the United States will always be on the "wrong side of the cost-curve"—meaning that shooting down ballistic missiles with high-tech interceptors will always be more expensive to the defender than the attacker (Gortney 2015a). In all, five high-ranking US military officers have warned that US missile defenses are unsustainable and cost-ineffective.[8]

Institutional inertia and a political commitment to missile defense create powerful resistance to re-assessing the value and potential of strategic missile defense, even given the experience of the past decade. However, even those who believe that the potential benefits of strategic missile defense outweigh its costs need to understand how limited the capabilities of the GMD system are and how the broken process that led to that result continues to cripple its development.

More than a decade has passed since the GMD system was declared to have a limited missile defense capability, and detailed public information about how it operates is now available. This report uses that information to assess the state and value of the current system and critically review the development and acquisition process that created it. Our review of the detailed history of the system leads to a set of findings and recommendations that policy makers must take into account when considering the future of the system. Pushing ahead without doing so is a recipe for waste and failure.

We discuss below some of the key failures that have contributed to the current problems with the GMD system, including those due to limited oversight, the imposition of a rushed timeline, the lack of clear developmental milestones, and the pursuit of false starts and dead ends.

> ***The exemptions introduced by Rumsfeld in January 2002 allowed the Pentagon to field poorly tested equipment, and the haste resulting from Bush's December 2002 directive ensured this would be the case.***

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[7] *This count differs by one success from the Missile Defense Agency's assessment. As discussed in Chapter 3, we do not count FTG-02, in which the target only struck a glancing blow, as a successful intercept.*

[8] *Former Chief of Naval Operations Admiral Jonathan Greenert, former US Army Chief of Staff General Raymond Odierno, Commander of North American Aerospace Defense Command and US Northern Command Admiral Bill Gortney (Gortney 2015b), former Vice Chairman of the Joint Chiefs of Staff Admiral James A. Winnefeld (Winnefeld 2015), and former Deputy Director of the Missile Defense Agency Brigadier General Kenneth Todorov (Todorov 2016).*

[CHAPTER 2]

The Consequences of Taking Shortcuts

The MDA Has Too Much Control

As noted in the previous chapter, the Bush administration exempted the GMD system from standard acquisition procedures for major military systems and gave the Pentagon unprecedented leeway while building it.

This approach continued in the Obama administration. In 2009, the consolidation of authority in the Missile Defense Agency was reaffirmed and elaborated in an update to the 2004 Department of Defense (DOD) missile defense directive (DOD 2009). In its 2010 Ballistic Missile Defense Review, the Obama administration declined to bring missile defense back under standard requirements-setting and DOD5000 acquisition processes (DOD 2010).

To be sure, urged by Congress, the Pentagon has made some improvements to the MDA's acquisition process in recent years. Improvements have included tasking the director of operational test and evaluation to review the test program each year, creating a Missile Defense Executive Board (MDEB)[9] in 2007 to advise the MDA, and in 2008 increasing the role of the Joint Staff and other military departments in advising the MDA. In addition, the MDA director has sought independent counsel about how to improve the reliability of the interceptors.

However, while these steps are useful, they lack the rigor of established, compulsory processes. Moreover, they have not prevented recurrence of many of the problems that have plagued the development of the GMD system, including concurrent development and deployment (see following section). Both the administration and Congress continue to add new and unvetted initiatives to the missile defense program. Despite soliciting counsel about how to improve the interceptors, interceptors with significant known flaws continue to be fielded.

While the 2009 DOD directive states that management of the GMD system will be "consistent with the principles" of the normal acquisitions process, in truth the processes differ in significant ways. The MDA remains exempt from the Joint Chiefs-led Joint Capabilities Integration and Development System process that establishes and reviews the requirements for major military systems. Instead, the US Strategic Command and the MDA jointly develop a prioritized list of capabilities. The MDA itself then develops a strategy to provide the required capabilities and tracks the execution of the plan (see *Appendix 4: Acquisitions Oversight* for more detail and a comparison of the DOD5000 process with the MDA process).

The MDA continues to have an enormous amount of responsibility. The MDA director fulfills multiple acquisition roles,[10] including that of the head of the agency, the program

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[9] *The MDEB is primarily made up of DOD personnel and chaired by the under secretary of defense for acquisition, technology, and logistics, and includes a representative from the Department of State and advisors from the National Security Staff (DOD 2010, 37, 42).*

[10] *The director of the MDA, under the direction and supervision of the under secretary of defense for acquisition, technology, and logistics will "Formulate acquisition strategy; make program commitments and terminations; conduct source selections; award contracts; analyze performance; make affordability trade-offs; document the BMDS program of work; and report progress. Manage all BMDS development, developmental and combined developmental/operational testing, procurement" (DOD 2009).*

manager, and the acquisition executive (Thornton 2015). Under DOD5000 regulations, the acquisition executive must certify that a military system in development has made sufficient progress to pass each specified milestone, from conception of the idea to technology development to production and deployment. For ballistic missile defense programs, the MDA director is the person who decides that systems can move forward—the very systems that s/he may have failed to adequately develop. The designation of the MDA director as the ballistic missile defense acquisition executive limits outside oversight.

[***While fielding research and development assets allows equipment to get in the field more quickly, it also permits fielding of untested, unreliable, or poorly tested equipment.***]

The MDA director continues to be the acquisition executive up until the system is ready for "initial production," at which time theoretically it would be brought back under the standard oversight procedures laid out in DOD5000. However, BMDS component programs are not considered independent acquisition programs: the entire Ballistic Missile Defense System—including the GMD system and the shorter-range systems—is treated as a single major defense acquisition program rather than a set of individual programs (Rumsfeld 2002). For this reason, it appears that absent a directive to separate the programs, the *entire* missile defense system—the GMD system plus the shorter-range systems—would need to be ready for initial production before it would be brought under normal oversight.

It is not clear that this condition would ever be met; new initiatives get added to the BMDS, which is developed using an "evolutionary, capability-based acquisition approach by applying incremental and spiral development" (DOD 2009), and does not have a well-defined end state. The desire to get some-thing in the field does not provide an incentive for getting missile defense through the "initial production" milestone, because assets can instead be fielded "for emergency or contingency use."

Typically, systems developed under rigorous fly-before-you-buy DOD5000 rules must meet certain conditions before the system can begin production and fielding. For example, to ensure that the system works as required under real-world conditions, normally it must undergo a set of operational tests certified by the director of operational test and evaluation. However, missile defense is allowed to take a different path into the field, which circumvents such operational tests. The under secretary of defense for acquisition, technology and logistics may simply recommend to the secretary of defense that research and development hardware can be fielded for emergency or contingency use (DOD 2009, 6.b.(3)). While fielding research and development assets allows equipment to get in the field more quickly, it also permits fielding of untested, unreliable, or poorly tested equipment.

That is, in fact, how the current GMD system has been fielded. Exacerbating this problem of fielding untested equipment is that the emergency deployment process establishes no clear path for moving the GMD system back to a more rigorous acquisitions path once a perceived emergency has passed.

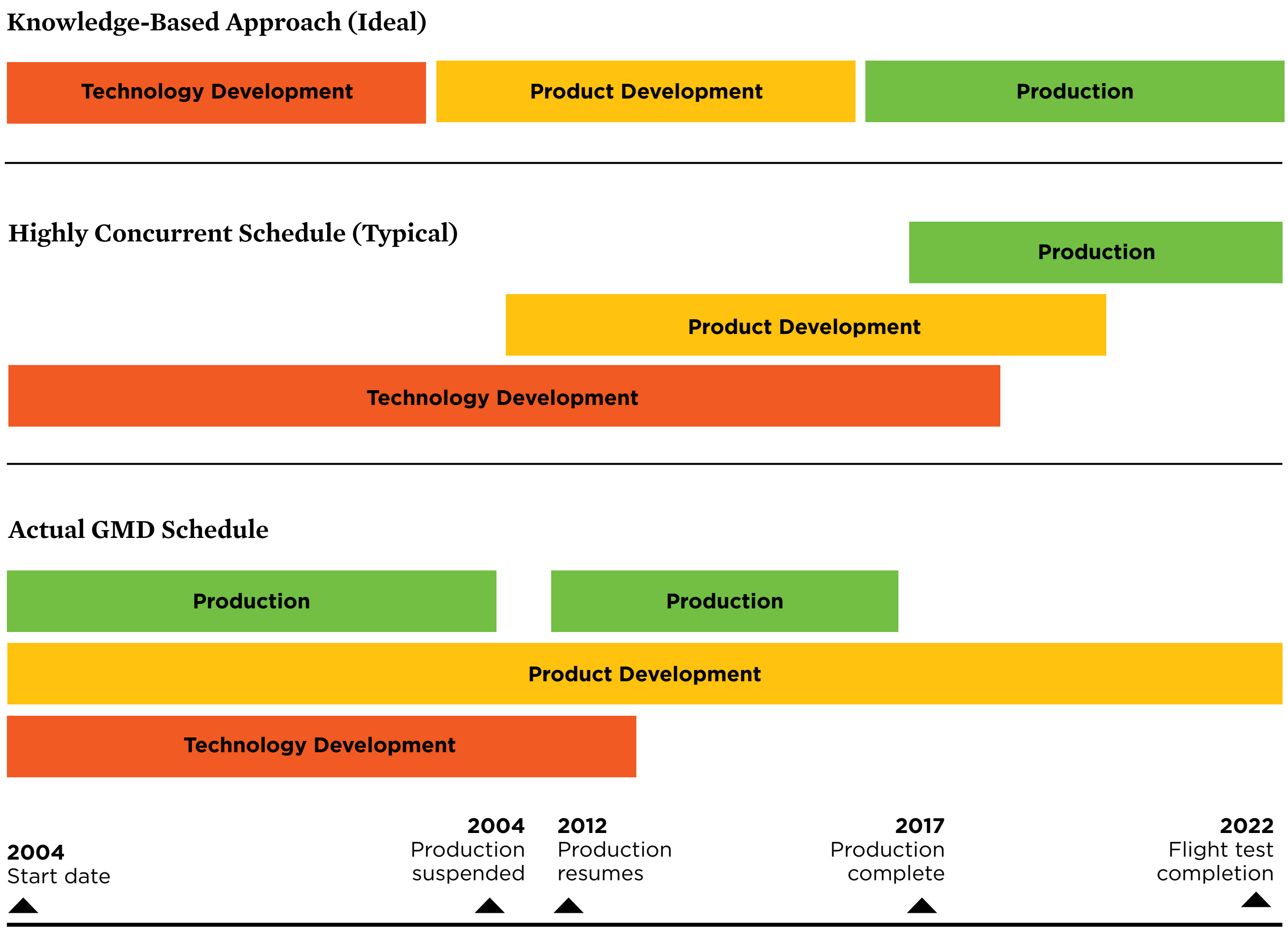
The Government Accountability Office (GAO) is tasked by Congress to report yearly on progress in missile defense acquisitions. The GAO has repeatedly reported on the GMD program's continued use of increasingly high-risk acquisition practices to meet fielding deadlines directed by the president and the secretary of state (GAO 2014a, GAO 2013b, GAO 2012). In its 2016 annual report on the progress of selected major defense projects (GAO 2016a), the GAO discloses how difficult it has been to advise Congress on the progress of the missile defense system:

> *The Missile Defense Agency's Ballistic Missile Defense System is excluded from all analyses [in this review] as the program does not have an integrated long-term baseline, which prevents us from assessing the program's cost progress or comparing it to other major defense acquisition programs* (GAO 2016b).

In the case of strategic missile defense, the accelerated but poorly governed approach has led to a GMD system that is not only unnecessarily expensive (for example, the National Academy of Sciences estimated that the GMD system's Ground Based Interceptors are 30 percent more expensive than they ought to be) (NRC 2012), but also has demonstrated little capability. In addition, a number of missile defense programs such as the Precision Tracking and Space Surveillance system and the Multiple Kill Vehicle program, have had to be canceled or significantly modified after false starts, wasting time and money (Willman 2015a).

Exempting missile defense from established acquisition and oversight policies that the Pentagon has developed over the years did not create a working system quickly. Instead,

FIGURE 2. The Unusual GMD Schedule Began Production in Early Stages of Development



A knowledge-based approach (top) develops a system sequentially: first developing the technology, then developing the product, and finally producing deployable hardware. A highly concurrent schedule (middle) has these activities overlapping significantly. The GMD system's development schedule (bottom) has been highly concurrent, with deployable hardware being produced at the same time technology is being developed, and even before product development is completed.

SOURCE. ADAPTED FROM GAO 2012, 16–17.

reduced accountability has led to higher costs and produced little strategic defense capability.

Best practices—codified in DOD5000—call for the development of military systems to proceed in a methodical sequence: after the requirements for a system are determined and options for fulfilling the requirements are compared, the Pentagon develops the chosen concept, using developmental tests to check that it works as intended and to guide refinements of the design. When the process converges on a stable design, the system undergoes operational testing to certify that it works under the real-world conditions it is expected to operate in and that it is sufficiently survivable. This operational testing must certify that the system works as intended before the system may move into production and deployment.

Ideally, rigorous developmental and operational testing provides information that permits the system's developers to discover problems and limitations early and to fix them or work around them in subsequent designs. This "knowledge-based acquisition" can be contrasted with a "schedule-driven" process in which instead the development is driven by a preset schedule, typically requiring the system to be produced and fielded concurrent with its development (Figure 2).

Rushed Timeline: Concurrent Development, Premature Deployment

To build the GMD system under the compressed timeline (two years) set by the Bush administration in 2002, the MDA used a highly concurrent process. It cut short planning and engineering cycles and put untested equipment into the underground silos.

Concurrent development and deployment runs counter to the hard-won wisdom derived from decades of experience of successfully building complex systems. Rather than building a system to meet clearly defined requirements, the GMD system followed what was called a "spiral development" approach: fielding technology that already existed or could be rapidly acquired, with the intention of improving it incrementally. Limited time for testing of the system meant limited feedback that the MDA could use to discover and correct problems and improve future designs, leaving problems to be discovered later. While intended to put useful technology in the field quickly, this approach simply drove up system costs while fielding ineffective and unreliable hardware.

The administration argued that the need for strategic missile defense was so acute post-9/11 that it had to be built at the same time it was being designed and tested. Similarly, MDA officials stated that "they could not meet the goal to deploy an initial capability in the time frame directed by the President if they did not continue to develop the technology while designing the system" (GAO 2003). The Missile Defense Agency explicitly emphasized that it planned to deploy prototype systems on an emergency basis. According to Air Force Lt. General Ronald T. Kadish, director of the Ballistic Missile Defense Organization (which would become the MDA), the program was designed so that "in an emergency and if directed, we might quickly deploy test assets to defend against a rapidly emerging threat" (Kadish 2001).

Early in the GMD program, the GAO warned about the risks of concurrently developing and deploying the system:

> *Because the ballistic missile threat is rapidly increasing, MDA could always believe it is operating in an emergency environment. Yet, it has never been proven that it takes longer to acquire a weapon system if a knowledge-based acquisition plan is followed. Instead, the opposite should be true, because such a plan decreases the likelihood that deadlines will be missed because critical elements do not work as intended* (GAO 2003).

The rush to deploy the GMD system to meet a politically driven timetable is now widely acknowledged even by proponents to be a primary source of the problems still plaguing the system nearly 15 years later. According to Under Secretary of Defense for Acquisition, Technology, and Logistics Frank Kendall on February 25, 2014, "We recognize the problems we have had with all the currently fielded interceptors. . . . The root cause was a desire to field these things very quickly and really cheaply. The detailed engineering that should have been applied to these early designs wasn't there" (Butler 2014a). He added, "As we go back and understand the failures we're having and why we're having them, we're seeing a lot of bad engineering, frankly" and "It's because there was a rush . . . to get something out" (GSN 2014). In other words, the concurrent approach produced failures, and not "cheaply."

The rush to deploy the GMD system to meet a politically driven timetable is now widely acknowledged even by proponents to be a primary source of the problems still plaguing the system nearly 15 years later.

MDA Director Syring followed up on Kendall's remarks in response to a question at a March 4, 2014, press conference, saying, "I think that—and I know what Mr. Kendall meant, the bad engineering was that we stopped or we shut—we cut short the design cycle. And that had risks. And some of those risks are surfacing in a couple of our flight tests now. And I think, given a full design cycle . . . and all of the things that are part of a developmental missile program, that some of those could have been avoided" (DOD 2014).

Defects in the system from rushing the development process are an especially acute problem for a system the Pentagon expects to rely on for many years. The Department of Defense's Office of the Inspector General observed:

> *The current EKV [kill vehicle] design is the prototype design of 1998 with upgrades for design and manufacturing defects, and obsolescence issues. The immediate need for an initial capability drove an accelerated development process and fielded capability before EKV performance was fully characterized prior to initial fielding. Requirements were viewed as "goals" with little focus on reliability, producibility, and maintainability requirements, which are integral*

> *to strategic systems with a life expectancy similar to GMD* (Inspector General 2014).

In 2015, the GAO found that the GMD system has significant problems from concurrency, noting for example, that:

> *Because the [GMD] program moved forward with producing and fielding interceptors before completing its flight test program, test failures exacerbated the disruptions to the program, causing the program to fall several years behind on its flight test program and increasing the cost to demonstrate the CE-II [kill vehicle] from $236 million—the cost of GMD's first CE-II flight test—to $1.981 billion—the cost to resolve the test failures and implement a retrofit program* (GAO 2015).

Yet, despite a clear awareness in the Pentagon and in Congress of problems posed by concurrency, significant pressures—such as the mandate to field additional interceptors by 2017—continue to fuel the cycle of concurrency, with no process in place to provide pushback and no explicit plan to return the system to the proven knowledge-based acquisitions process.

False Starts and Dead Ends

A well-functioning oversight system should limit the number of false-start ideas that get funded. Normally, before embarking on a new initiative, the Pentagon is required by the DOD5000 acquisitions rules to perform a formal "analysis of alternatives" that compares technical feasibility, costs, and risks of different potential ways to provide a defense capability before choosing one of them for technology development. According to the GAO, analyses of alternatives "provide insight into the technical feasibility and costs of alternatives by determining if a concept can be developed and produced within existing resources" (GAO 2013c, 2). In other words, a rigorous analysis of alternatives weeds out bad ideas.

However, because the MDA is exempted from normal DOD5000 procedures, it is not required to perform these analyses before proceeding on a project, nor until recently has Congress demanded them before funding proposed new missile defense ideas. This deficiency has allowed the MDA to start expensive, poorly vetted initiatives, only to cancel them a few years later after having spent millions of dollars (Willman 2015b). For example, two projects intended to supplement the capability of strategic missile defense, the fourth phase of the European Phased Adaptive Approach missile defense program and the Precision Tracking Space System met this fate (Box 1). Neither was started as the result of a robust analysis of alternatives. Both were cancelled.

[*The MDA has been allowed to start expensive, poorly vetted initiatives, only to cancel them a few years later after having spent millions of dollars.*]

Even when a program is clearly a false start, it can be difficult to shake off. As former Secretary of Defense Robert Gates wrote in 2009, ironically, while defending the EPAA plan:

> *I have found since taking this post that when it comes to missile defense, some hold a view bordering on theology that regards any change of plans or any cancellation of a program as abandonment or even breaking faith. I encountered this in the debate over the Defense Department's budget for the fiscal year 2010 when I ended three programs: the airborne laser, the multiple-kill vehicle, and the kinetic energy interceptor. All were plainly unworkable, prohibitively expensive and could never be practically deployed—but had nonetheless acquired a devoted following (Gates 2009).*

While the Multiple Kill Vehicle program was indeed killed under Secretary Gates in 2009, the MDA revived it as the Multi-Object Kill Vehicle program in 2016.

Congress contributes to the creation of such wasteful programs in two ways. First, Congress is not providing strict enough oversight of Pentagon proposals, being neither skeptical enough nor requiring robust analyses of alternatives up front, with in-depth analysis of feasibility, costs, and risks. Second, the weakened oversight system and the politicized nature of missile defense leave strategic missile defense vulnerable to Congress adding its own unnecessary or unvetted projects to the missile defense budget.

Indeed, several times Congress has generated new and unasked-for efforts, such as a proposal for a third continental interceptor site on the US East Coast (see *Appendix 5: East Coast Missile Defense Site*). Despite having no validated requirement for such a site, and in spite of testimony from the MDA director that other priorities for improving strategic missile defense are more pressing, congressional advocates of an East Coast site have included mandates in budget legislation intended to fast-track the process for building a third site and have added unasked-for money to the budget for it each year since 2012.

BOX 1.

Dead Ends in the European Phased Adaptive Approach and Precision Tracking Space System

In September, 2009, President Obama unveiled his plan for the European Phased Adaptive Approach (EPAA), a Europe-based missile defense against Iranian ballistic missiles. Although formally a NATO system, it consists primarily of US interceptors and sensors. Its plan for deployment had four phases: the first two phases, meant to defend Europe from short- and medium-range missile threats, are now operational and the third, meant to extend the defense to counter intermediate-range missiles, is scheduled for 2018. A fourth phase, originally planned for 2020, would have deployed faster Standard Missile-3 Block IIB (SM-3 IIB) interceptors in Europe to defend the United States against Iranian intercontinental-range ballistic missiles, which interceptors deployed in the earlier phases of the EPAA were unable to intercept. The fourth phase of the EPAA was thus intended to provide an extra layer of homeland defense.

The Precision Tracking Space System (PTSS) was to be a set of satellite-based infrared sensors meant to provide missile tracking data over almost the entire northern hemisphere. It could thus have facilitated earlier launches of GMD interceptors as well as supported regional defense systems.

However, in 2013, the Obama administration cancelled the fourth phase of the EPAA, citing delays due to funding cuts, and eliminating the SM-3 Block IIB. It also cancelled the PTSS (Hagel 2013).

That entire expensive SM-3 IIB diversion could have been avoided. When asked by Congress to look into the rigor of the evaluation of alternatives that produced the European missile defense program, the GAO found that the original impetus came from comparing policy alternatives, not from a technical analysis (GAO 2013c). It also found that subsequent technical studies considered only a narrow range of alternatives to begin with and did not compare programmatic risks or cost-effectiveness of those alternatives.

In the case of the fourth phase of the EPAA, the Pentagon initially decided to focus narrowly on options for land-based SM-3 IIB missiles in Poland and Romania. But it eventually needed to revisit that early decision, as subsequent analyses showed these locations were not geographically optimal for strategic defense: positioning missiles in Poland would require developing a new capability for them. A better location would be on a ship in the North Sea. As a result, designs for the new SM-3 IIB interceptor were then required to be compatible with both ship- and land-basing. However, making the designs compatible with both ground- and sea-based launch platforms led to unanticipated and undesirable technical and operational limitations. To achieve the desired capabilities, some proposed designs for the SM-3 IIB missile would use liquid fuel, but the Navy has banned liquid propellants on ships since 1988 for safety and cost reasons. The new plans would have required either a redesign of the missiles to be solid fuel only or a change in policy and equipment for the Navy host ships.

The PTSS story is similar. In its 2012 report, the National Academy of Sciences described the PTSS program, established in 2009, as "a solution looking for a problem" (NRC 2012). Moreover, the co-chairs of the study urged Congress to cancel the satellite system because it "is too far away from the threat to provide useful discrimination data, does not avoid the need for overhead persistent infrared cueing, and is very expensive" (Montague and Slocombe 2012). In the fiscal year 2013 budget, Congress required the DOD's director of cost assessment and program evaluation to conduct an evaluation of PTSS alternatives; Congress also limited funds for the program until the Pentagon had submitted a formal plan for the evaluation of alternatives for the program. The program was soon canceled.

Congress has also pressed for a return to discarded ideas, such as the Bush plan for land-based Ground Based Interceptors in Eastern Europe or space-based boost-phase interceptors. Congress added money to the fiscal year 2016 budget to study the feasibility of a space-based boost-phase missile defense layer—despite having several years ago received the advice it solicited from the National Academy of Sciences on this very question. The NAS recommendation on space-based boost-phase missile defense, which it estimated would cost at least $300 billion for a limited capability, was unequivocal:

> *The total life-cycle cost of placing and sustaining the [space-based boost-phase] constellation in orbit is at least an order of magnitude greater than that of any other alternative and impractical for that reason alone (NRC 2012).*

The 2012 National Academy report makes this point generally about the GMD system:

> *There has been little evidence either of serious cost-benefit analysis or of systems analysis and engineering before*

> *embarking on new initiatives within MDA . . . the current GMD system architecture [is a] classic example. The concept of spiral development in no way justifies not defining the objectives and requirements for the desired end state. MDA's efforts have spawned an almost "hobby shop" approach, with many false starts on poorly analyzed concepts (NRC 2012).*

[*Inadequate congressional oversight, rushed deployment, and poorly vetted projects have led to the GMD program's current state of disarray.*]

At a Senate missile defense hearing in spring 2014, subcommittee chairman Senator Mark Udall said:

> *In order to avoid repeating any of the previous mistakes, we also need a rigorous acquisition approach with stringent engineering design and testing to be confident it will work before we deploy it (Udall 2014).*

Congress members have also "fought doggedly" to continue funding for expensive and technically limited missile defense projects that benefitted their districts or states "even after their shortcomings became obvious" (Willman 2015a).

In short, inadequate congressional oversight, presidential administrations that push for a rushed deployment, and few impediments to starting poorly vetted projects have led to the GMD program's current state of disarray. Continuing the missile defense enterprise with so little scrutiny undercuts efforts to increase the security of the US public.

[CHAPTER 3]

More Consequences: The Story of the Ground Based Interceptors

The poor stewardship of strategic missile defense has not just wasted time and money. It has produced a Ground-based Midcourse Defense system in disarray, with many of its components having questionable reliability and little demonstrated effectiveness.

To illustrate the origin and magnitude of the problems, we discuss in depth the problems with a critical component of the GMD system: the Ground Based Interceptors (GBIs). The problems illustrate how the decision to rush the GMD into the field and to exempt it from standard oversight didn't lead to fielding a working system quickly, rather it led to costly failures and a system with key components—the interceptors—with low reliability.

The GBIs consist of a rocket booster and the exo-atmospheric kill vehicle (EKV) carried on top of the booster. The booster is launched, flies out of the atmosphere toward the "threat cloud" target (the warhead plus decoys), and releases the kill vehicle, which must guide itself to collide with the incoming missile warhead (see Chapter 1). If either the booster or the kill vehicle does not work effectively and reliably, the GMD system cannot provide an effective defense.

The reliability of the GBI has been limited by rushed, careless, and highly concurrent development. Since development began in 2002, a consistent pattern has emerged: field significant numbers of untested interceptors built from existing technology, repair them later to fix the problems identified in subsequent tests, and at the same time build and field incrementally improved interceptors (for details, see *Appendix 6: Ground Based Interceptor and Kill Vehicle*).

> *"We took a system that was still in development—it was a prototype—and it was declared to be 'operational' for political reasons."*
>
> — Anonymous retired senior military official

At the time of President Bush's December 2002 announcement of the plan to deploy the GMD in two years, both the interceptor's rocket booster and the kill vehicle were still under development. The demanding accelerated time scale necessitated moving these systems almost immediately into production, foregoing further testing and development. As one unnamed recently retired senior military official observed to the *Los Angeles Times* a decade later, "We took a system that was still in development—it was a prototype—and it was declared to be 'operational' for political reasons."[11] Because of the tight deadlines, he said, "At that point, you couldn't argue anymore that you still needed to develop and change things. You just needed to build them" (Willman 2014).

Ultimately, on September 30, 2004, with five interceptors deployed in silos in Alaska, the Bush administration declared that it had achieved a national missile defense "limited deployment option" capability (Gilmore 2012a). By the end of

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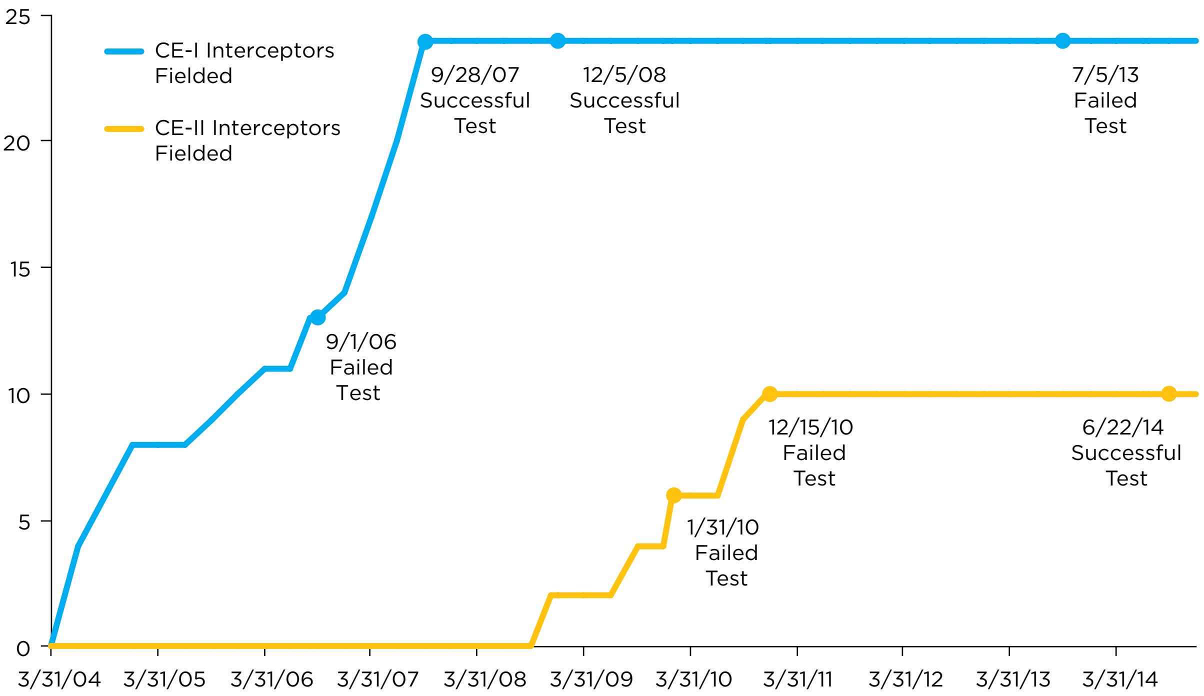
[11] *The timing of the rushed deployment deadline raised eyebrows at the time since it was just weeks before the 2004 presidential election.*

FIGURE 3. Ground Based Interceptor Fleet Deployment



Nearly all of the interceptors of the Ground-based Midcourse Defense system were fielded before a single interceptor of their type had been successfully tested. The y-axis shows the cumulative number of interceptors fielded over time (blue for interceptors using the CE-I kill vehicle and orange for those with the CE-II kill vehicle). Marked are the intercept tests for each type of kill vehicle.

Notes: Some interceptors with CE-I kill vehicles were replaced by those with CE-II kill vehicles. The total number of fielded interceptors by late 2010 was thirty. Fielding dates are approximate within the fiscal year quarter. For more information about the 9/1/06 test, see the table, p. 22.

SOURCE: DATA FROM SYRING 2014B AND GAO 2011.

2004 a total of eight interceptors had been fielded: six in Alaska, two in California.

Yet, very little was known about the capability of those interceptors. By the time of the deployment decision in 2002, the MDA had conducted only eight intercept flight tests using GBI prototypes, five of which were successful. After deployment of the system began, an additional two prototype intercept tests failed on December 15, 2004, and February 15, 2005. The next successful intercept test—and the first one using the version of the kill vehicle that was actually deployed in Alaska and California—did not occur until September 2007, three years after deployment had begun (see Figure 3 and *Appendix 7: Testing*).

In other words, while the MDA was getting technology into the field quickly, it had essentially no idea what the actual capability of that technology was for defending the United States against a potential real attack.

CE-I Kill Vehicles: Fielded Prototypes

Mandated by the administration to achieve an operational capability by the end of 2004, the MDA began deploying interceptors with the untested Capability Enhancement-I (CE-I) version of the kill vehicle in the summer of 2004. Since the program was exempted from the usual acquisition rules, no fly-before-you-buy requirements were in place to prevent this rush to failure.

The CE-Is were the first "operationally configured" kill vehicles. The interceptors tested up to that point had used hardware and software that was not representative of what actually would be used in mass production. The prototype interceptors were all essentially hand-built, and only 67 percent of the kill vehicle hardware and 62 percent of the software had been flight-tested at the time deployment began (Obering 2005). Additionally, because of delays in the development of the GBI's rocket booster, all of the prototype intercept tests used lower-speed surrogate boosters, which subjected the kill vehicle to less stress during launch than would be expected in an actual intercept attempt.

Once having achieved an initial capability with eight deployed interceptors in December 2004, the MDA could have paused its deployment of interceptors to allow testing of the kill vehicle. But it didn't. The first flight of a CE-I equipped interceptor (which was also described as the first flight of an operationally configured interceptor) did not take place until December 2005, nearly a year and a half after the first of these interceptors was fielded—but that test did not attempt to intercept a target. The MDA continued to deploy interceptors with CE-I kill vehicles—which had never demonstrated a successful interception—at a steady pace through September 2007.

The result of continuing to field interceptors while delaying testing was that the MDA fielded nearly all the CE-I kill vehicles it planned to deploy (24) before conducting a single successful intercept test of the design (Figure 3). The CE-I kill vehicle's first intercept test, FTG-02 in 2006, resulted in a "glancing blow,"[12] in which the kill vehicle struck but did not destroy the mock warhead (Gilmore 2012b). The first successful destruction of a test target by an operationally configured interceptor did not take place until late September 2007—nearly three years after declaring the GMD system had an initial capability. The second was in December 2008.

Although the MDA formally describes the interceptors equipped with CE-I kill vehicles as "operationally configured," fundamentally they are still prototypes. In March 2011, MDA Director Lt. General Patrick O'Reilly stated that the deployed GBIs were "more akin to prototypes than production-representative missiles in the field" (O'Reilly 2011a). Norm Montaño, EKV program director at the Raytheon Company, said in 2014 that, "The EKV was deployed . . . in 2004 while it was still in prototype status" (Wichner 2014).

In 2007, the MDA initiated a program to refurbish the CE-I kill vehicles, replacing problematic components and incorporating some improvements. This refurbished kill vehicle, which contained roughly two dozen improvements, was flown in an intercept test in July 2013. The goal of the test was both to evaluate the new configuration and also to vet the kill vehicle under more stressful conditions than previous tests, including a longer time of flight (Syring 2013). The test failed when the kill vehicle did not separate from its booster—the third time a test was unsuccessful because of a failure to separate. The failure review board subsequently "found several issues of concern associated with the design of the kill vehicle" (Gilmore 2014), with the MDA ascribing the failure to voltage fluctuations caused by a battery leak (Syring 2014a). The Pentagon's developmental test and evaluation office, however, expressed skepticism that the cause of the failure had been definitively identified (see *Appendix 7: Testing*).

Missile Defense Agency

The kill vehicle from the October 14, 2002 intercept test, a prototype, is shown here. The kill vehicles are time consuming to build and take apart, with more than 100,000 process steps. Thus, repairs are costly, and can make the kill vehicle vulnerable to quality control failures.

The MDA indicated it would correct the problems identified in the July 2013 test on all affected interceptors, and has since installed new software on all the fielded CE-I equipped interceptors to address the battery problem (Syring 2015). However, as of this writing, no flight test has confirmed the refurbishments and fixes. Moreover, the GAO has stated that even these refurbishments "do not fix all known issues" with the CE-I kill vehicle (GAO 2014b).

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[12] *Director of Operational Test and Evaluation J. Michael Gilmore stated that, "The EKV achieved a 'glancing blow' on the RV. Subsequent analysis indicated that the 'glancing blow' would not have resulted in a kill. I score the FTG-02 flight test a hit, but not a kill" (Gilmore 2012b).*

In summary, the current situation is this: a majority of the fielded interceptors today are equipped with a kill vehicle, the CE-I, that has had only four intercept tests, with only half being successful (see table). Worse, the refurbished version of the CE-I kill vehicle has failed its sole intercept test. The last successful test of an interceptor equipped with a CE-I kill vehicle was in 2008.

And yet today this kill vehicle forms the core of the GMD system defending the United States against enemy intercontinental ballistic missiles.

CE-II Kill Vehicles: Persistent Systemic Issues

By 2005, the MDA recognized that it must develop a new kill vehicle and could not simply continue to modify and refurbish the CE-I kill vehicles, because some parts in the original CE-I kill vehicle had become obsolete (O'Reilly 2011). That year, it began developing the new Capability Enhancement-II (CE-II) kill vehicle. The MDA's plan was to start by deploying additional interceptors equipped with the CE-II kill vehicle to bring the total number of deployed interceptors up to 30, while leaving the interceptors with CE-I kill vehicles in place. As additional CE-II kill vehicles were produced, the MDA would then replace the fielded CE-I kill vehicles.

Continuing its practice established years earlier with the fielding of the CE-I kill vehicle, the MDA rushed the CE-II kill vehicle into the field before a single flight test had been attempted—and well before a successful intercept test could provide confidence in the new hardware. The MDA began deploying interceptors equipped with the untested CE-II kill vehicle in January 2010 and continued through 2010—despite the January test failure. Incredibly, it would be more than five and a half years after fielding of the CE-II kill vehicle began before it successfully intercepted a target (Figure 3, p. 20).

The Poor Testing Record of the GMD System

Test	Date	Designation	Kill Vehicle
1	🟩 10/2/99	IFT-3	prototype
2	🟧 1/18/00	IFT-4	prototype
3	🟧 7/7/00	IFT-5	prototype
4	🟩 7/14/01	IFT-6	prototype
5	🟩 12/3/01	IFT-7	prototype
6	🟩 3/15/02	IFT-8	prototype
7	🟩 12/14/02	IFT-9	prototype
8	🟧 12/11/02	IFT-10	prototype
Deployment decision			
9	🟧 12/15/04	IFT-13C	prototype
10	🟧 2/14/05	IFT-14	prototype
11	🟧 9/1/06*	FTG-02	CE-I
12	🟩 9/28/07	FTG-03A	CE-I
13	🟩 12/5/08	FTG-05	CE-I
14	🟧 1/31/10	FTG-06	CE-II
15	🟧 12/15/10	FTG-06A	CE-II
16	🟧 7/5/13	FTG-07	CE-I
17	🟩 6/22/14	FTG-06B	CE-II

GMD interceptors failed to destroy their targets in more than half of their intercept tests, and the record is not improving over time. The table lists all the intercept tests of the GMD system, including Integrated Flight Tests (IFTs) of prototype interceptors (tests 1-10) and Flight Test Ground-based Interceptor (FTG) tests of operationally configured interceptors. Tests in green succeeded; tests in orange failed.

* The interceptor in FTG-02 hit the target with a glancing blow but did not destroy it. MDA rates this test as a "hit" but not a "warhead kill," and counts it as a success. Since the goal of the interception is to destroy the warhead, we do not count this as a successful intercept test.

SOURCE: DATA FROM SYRING 2014B.

> ***Incredibly, it would be more than five and a half years after fielding of the CE-II kill vehicle began before it successfully intercepted a target.***

This focus on getting hardware into the field as opposed to rigorously building a working defense is a hallmark of nearly 15 years of building the GMD system. As a result, there was simply no evidence for statements such as that in the Department of Defense's 2010 *Ballistic Missile Defense Review Report* that, "The United States is currently protected against limited ICBM attacks" (DOD 2010). In late 2010, at the time of the second CE-II kill vehicle test failure, 10 of the 30 deployed GBIs carried the CE-II version of the kill vehicle, which had no successful tests, and 20 had CE-I kill vehicles with just two successful tests (GAO 2011).

Following a second consecutive CE-II test failure (due to a different problem with the kill vehicle) in December 2010, then-MDA Director O'Reilly halted the delivery of CE-II-equipped interceptors that were intended to replace those with CE-I kill vehicles. He required a successful intercept test of the CE-II kill vehicle before delivery of new interceptors could continue.

The stories behind the two CE-II kill vehicle failures in 2010 are important because they are emblematic of the shortcomings that result from rushed development and poor accountability.

QUALITY CONTROL PROBLEMS

Most of the GMD system's flight test failures have been attributed to quality control problems. For example, the MDA eventually attributed the January 2010 failure to a small part, or "lockwire," that Raytheon failed to install (Inspector General 2014).

Quality control is an ongoing problem in the manufacture of the interceptors. Describing the initial set of fielded interceptors, the MDA stated in 2007 that poor quality control procedures—which it attributed to the streamlining of the acquisition process and to schedule pressures—had caused "test failures and slowed production" (GAO 2007). Indeed, the year before, the MDA withheld payments of around $100 million from the Boeing Company, the prime contractor for the interceptor, and Raytheon, the company that manufactures the kill vehicle, because of "immature production processes and faulty program oversight by Boeing along with flight test failures, late deliveries, and quality problems" by Raytheon (Weisman 2006).

After the January 2010 test failure was attributed to a quality control lapse, the Department of Defense's inspector general initiated an assessment of the quality control processes at Raytheon and Boeing. The inspector general's 2014 report found numerous violations serious enough to affect the kill vehicle's reliability and predictability (Inspector General 2014).

Kill vehicles are complex pieces of equipment, and the report emphasizes the scope of the problem:

> *A combination of cost constraints and failure-driven program restructures has kept the [GBI] program in a state of change. Schedule and cost priorities drove a culture of "Use-As-Is" leaving the EKV as a manufacturing challenge. With more than 1,800 unique parts, 10,000 pages of work instructions, and 130,000 process steps for the current configuration, EKV repairs and refurbishments are considered by the [GMD] Program to be costly and problematic and make the EKV susceptible to quality assurance failures* (Inspector General 2014).

The complexity of the kill vehicle's manufacturing process compounds quality control problems. Typically, it takes at least a year to disassemble, repair, and reassemble a kill vehicle. A mistake in any step of the assembly could lead to failure.

Moreover, according to a *Los Angeles Times* investigation, "Because each of the kill vehicles is handmade, no two are identical. A fix that works with one interceptor might not solve problems with others" (Willman 2014). Such lack of uniformity is especially concerning, according to the inspector general's report, since changes to the kill vehicles were not always documented well, leading to "some uncertainty in fielded configurations" (Inspector General 2014, Willman 2014). These issues make it more difficult to estimate the reliability of the fleet of interceptors from tests of a subset of them (see Chapter 4).

[*The December 2010 failure was eventually attributed to a systemic problem that affects all the GMD interceptors.*]

In February 2015, the GMD system's project manager called out quality control as an area of special concern to him, reporting:

> *We have a history of quality escapes where vendors have provided noncompliant parts, and our management process did not detect those escapes until after they were installed in subsystems and, in some cases, after we delivered GBIs* (DOD 2015).

Failures due to quality control are particularly pernicious because they can mask other problems that a test would otherwise have been able to uncover. Such masking may have happened in the January 2010 test failure. The interceptors equipped with CE-II kill vehicles. While the January test failed due to a problem with the assembly of the kill vehicle, the December failure was eventually attributed to a systemic problem (the track gate anomaly described in the following section) that affects all the GMD interceptors. If this systemic problem had been identified in January, it might have saved a year of development time and a signficant amount of money.

The interceptors have other known problems due to quality control. For example, while assembly of the

CE-II-equipped interceptors restarted at Raytheon following the June 2014 test, defects in manufacturing quality control were identified that leave critical wiring in all CE-II interceptors (fielded and currently in production) vulnerable to corrosion that can cause the kill vehicle to fail (Willman 2015c). The MDA has decided to accept this risk, meaning that currently fielded CE-I and CE-II kill vehicles and those to be deployed soon will retain this flaw.

> ***Chasing down the track gate anomaly problem and fixing the CE-II kill vehicles that have already been produced has cost nearly $2 billion.***

SYSTEMIC PROBLEMS

The systemic problem uncovered in December 2010 was a design flaw in the inertial guidance system of the kill vehicle that rendered it susceptible to vibrations produced by its divert thrusters—the thrusters that enable the kill vehicle to maneuver in flight to hit its target (the enemy warhead). The vibrations from the divert thrusters could cause the inertial measurement unit to incorrectly predict the future location of the target on its infrared detector. Such a guidance error could make the kill vehicle miss its target.

While the December 2010 failure was the first directly attributed to such a "track gate anomaly," the flaw was not new. Indeed, the anomaly had been observed in eight previous tests over nine years, starting in 2001 (Syring 2014b), and the MDA attempted numerous hardware and software fixes over the years (Inspector General 2014, Table 1). Yet the MDA continued to deploy kill vehicles with this critical known problem. The CE-II kill vehicle uses a new guidance unit that is more sensitive to the vibrations, making it even more susceptible to the track gate anomaly. The increased vulnerability of the new type of kill vehicle might have been identified in the January 2010 test, had the kill vehicle not failed first because of poor construction.

While the December 2010 test gave more clues to the underlying cause of the track gate anomaly, limitations of the missile defense ground-test facilities slowed the process of identifying its nature more precisely and proposing a remedy. At least initially, the problem could not be replicated on the ground (O'Reilly 2011b). In response to the December test failure, Boeing developed a new test facility to subject components to higher frequency vibrations that would better reproduce flight conditions, and the MDA performed a number of individual and mechanical tests on the system components.

Even though by the end of 2012 it still was not clear if the problem was ever successfully replicated on the ground (DOT&E 2012), the MDA settled on a fix. A successful January 2013 flight (non-intercept) test provided evidence that the proposed repair worked and paved the way for an intercept test using a repaired CE-II kill vehicle. That test in June 2014 was successful. The price tag for chasing down the track gate anomaly problem and fixing the CE-II kill vehicles that have already been produced? Nearly $2 billion (GAO 2015).

However, addressing the track gate anomaly is far from the only hurdle to demonstrating that the interceptor is reliable.

All of the kill vehicles—the 30 that are fielded as well as those CE-IIs under production—are reported to be susceptible to an additional systemic flaw: an unspecified issue with the divert thrusters. According to a *Los Angeles Times* investigation, this systemic flaw is a different problem from the thruster vibrations that produced the track gate anomaly (Willman 2015c).

The Problems Continue

In March 2013, Secretary of Defense Chuck Hagel announced that in response to advances in the North Korean ballistic missile program, 14 additional interceptors would be fielded by the end of 2017 (Hagel 2013). His announcement significantly increased the pressure to get interceptors fielded.

Just as in the GMD system's first decade, a timeline imposed by considerations other than technical maturity of the technology continues to affect the quality of the system. For example, all the currently deployed CE-I- and CE-II-equipped interceptors need upgrades and fixes to address problems uncovered in test failures. However, to meet the 2017 deadline, as well as to offset some of the unplanned expense of fixing the CE-II kill vehicles, the MDA plans to delay completion of fixing the track gate anomaly problem in the fielded CE-II interceptors until late 2016 (GAO 2015, 63), and will not make further repairs to the currently fielded CE-I interceptors at all, as it intends to replace them with new interceptors beginning in 2020.

The scope of these repairs, however, does not include fixing either the defective wiring or the divert thruster problem on any of the currently deployed or soon to be fielded CE-II-equipped interceptors—even though both problems can keep the kill vehicle from doing its job and undermine the reliability of the system.

The conclusion: the GMD kill vehicles continue to suffer both from known problems that have plagued the system for years, and potentially from those yet to be uncovered because the testing is so limited. Reliable kill vehicles are the key to a working ballistic missile defense, but the United States is accepting a high level of risk from problem-ridden and untested hardware to keep on an artificially strict schedule.

[*As it has repeatedly done in the past, to avoid delays the MDA has made some risky choices, omitting critical parts of the design process.*]

CE-II Block 1: A Compromised Redesign

In 2010, the MDA began a program to redesign the kill vehicle, intended both to deal with obsolescence issues and to improve the producibility, reliability, availability, and maintainability of the kill vehicles (GAO 2015, 65). But the mandate to deploy additional interceptors by 2017 is adversely affecting this redesign effort as well. Many of the initial objectives of this redesign have been subsequently deferred, and the program has been scaled back to making more limited improvements to components. The resulting compromised kill vehicle is designated the CE-II Block 1.

The CE-II Block 1 kill vehicle will, at a minimum, incorporate new components to address the track gate anomaly guidance failure in the December 2010 test of the CE-II kill vehicle and the battery-related failure in the 2013 CE-I kill vehicle test. It will also incorporate a new alternate divert thruster system, flight tested in January 2016, to address the divert thruster problem in the earlier kill vehicles. It has not been publicly stated if it will resolve the problem of the wiring susceptible to corrosion in the CE-II kill vehicles. The Block 1 is also reported to include reliability improvements to its inertial measurement unit and avionics compared with the original CE-II kill vehicle.

However, the CE-II Block 1 program has encountered setbacks that have significantly altered its timeline, including problems with the new divert thruster system. As it has repeatedly done in the past, to avoid delays the MDA has made some risky choices, omitting critical parts of the design process (GAO 2015, 22). In 2015, to avoid problems arising from concurrent development and production, the GAO recommended delaying production of the CE-II Block 1 kill vehicles until at least one successful intercept test for the design had been completed (GAO 2015, 29).

Despite the GAO's sensible recommendation, the Pentagon, in its official comments to the GAO's report, stated that it will delay "emplacing" the kill vehicles in the field but will not wait for a successful intercept test before producing them. The Pentagon's rationale was that delaying the production and integration until a successful flight test is conducted "would unacceptably increase the risk to reaching the Secretary of Defense mandate to achieve 44 emplaced interceptors by the end of 2017" (GAO 2015, 30).

The narrative is all too familiar: the administration is prioritizing meeting a schedule-driven deadline over a step-by-step development and testing process needed to produce a system demonstrated to operate as required. Just as in the past, such a schedule-driven approach is likely to lead to an ineffective system, delays, and additional costs.

The MDA's decision to build additional untested interceptors rather than systematically fix all known flaws also ignores specific advice on how best to balance a sense of urgency with the responsibility to build a cost-effective and high-quality system, which was a top-level recommendation of the 2008 "Welch report" (produced by a panel headed by retired Air Force Chief of Staff General Larry Welch) on missile defense:

> *For mid-course intercept systems, the balance between qualitative improvements and deploying more of existing capabilities should be strongly in favor of qualitative improvements. Without such a focus, the current system capabilities will become obsolete regardless of the numbers of interceptors deployed (Welch and Briggs 2008).*

For the GMD system, however, the balance has been strongly in favor of building more of the existing capabilities; 30 interceptors have been deployed with 14 more to come. Yet even after the 10 Block 1 interceptors have been deployed, the system will still rely on the CE-I kill vehicle, which has had only two successful intercept tests—the last one in 2008—in four tries and the CE-II kill vehicle, with only a single successful intercept test in three tries.

In response to the many failures of the CE-I and CE-II kill vehicles, the Obama administration requested $99.5 million in the fiscal year 2015 budget for a brand new program, the redesigned kill vehicle (RKV), which would use a modular design to increase reliability. While a more dependable kill vehicle is needed, it is unclear that the RKV will be more successful than past efforts in the absence of better acquisition rigor and oversight. The pace set for the RKV's development is as unrealistic as those for the CE-I and CE-II kill vehicles: the first RKV flight test would be in 2018, an intercept test is planned for 2019, and fielding would begin in 2020 (Gruss 2016).

According to the GAO, the RKV initiative marks the seventh time in 15 years that the MDA has made a major effort to fix the kill vehicle (GAO 2015), so far at great expense and without clear success. While the MDA says many of the right things about its intention to pursue rigorous engineering processes, it has a history of incorrectly claiming to be using a fly-before-you-buy approach. In April 2008, MDA Director Lt. General Henry Obering III told Congress, "Our capability-based acquisition model actually follows a 'fly-before-you-buy' construct" (Obering 2008). Six months later, the MDA began deploying interceptors equipped with CE-II kill vehicles that had never been flight tested. In April 2010, the MDA was continuing to deploy the CE-II-equipped interceptor, even though it had failed its only flight and intercept test, when Obering's successor, Lt. General Patrick O'Reilly, told the Senate Armed Services Committee, "We have submitted a comprehensive integrated master test plan—signed by Dr. Gilmore, the services' operational test agencies and the commander of US Strategic Command—to ensure we fly our missiles before we buy them" (O'Reilly 2010).

AP Photo/Susan Walsh

Then-Director of the Missile Defense Agency Lt. Gen. Patrick O'Reilly testifies before the Senate Armed Services committee during its hearing on ballistic missile defense authorization on June 16, 2009.

[*Reliable kill vehicles are the key to a working ballistic missile defense, but the United States is accepting a high level of risk from problem-ridden and untested hardware to keep on an artificially strict schedule.*]

Without stringent oversight procedures, there is nothing to guarantee that future development will be any more rigorous than past development has been. Repeatedly, the Pentagon has sacrificed quality, shortened engineering cycles, and sidestepped acquisitions best practices to meet a deadline imposed by political rationales rather than technical realities.

[CHAPTER 4]

Assessing the Current State of the GMD System

Inadequate Testing Results in Unknown System Capabilities

To assess the result of more than a decade of development and deployment, an obvious question is what the current GMD system can do. A different but more critical question is: what has the GMD system been *demonstrated* to be able to do?

For a strategic missile defense to provide meaningful protection, it must be very effective: it must work as intended the first time, against a nuclear threat, and facing an adversary that likely will take steps to defeat it. To be able to understand how useful a missile defense system would be in military planning, decision makers must know its actual, real-world effectiveness. For strategic missile defense, one of the most complex and challenging military systems ever built, acquiring knowledge useful for assessment is a formidable task. Rigorous testing must quantify the ability of the sensor systems, interceptors, and command and control to perform separately and together under unpredictable and potentially stressing conditions.

The testing program must, at a minimum, provide answers to these questions:

- How effective and reliable is the system in a predictable environment? How confident can we be in this assessment?
- How effective and reliable would the system be under operational conditions, which could be unpredictable and challenging? How confident can we be in this assessment?

A rigorous testing program provides the basis for answering these questions; without rigorous testing, there is no objective basis for making claims about the capability of any system.

The GMD system's testing program has a long way to go before it can provide credible answers. The GMD system has been tested a relatively small number of times. These have all been developmental tests, under strictly controlled, heavily scripted conditions rather than operational tests intended to reflect realistic operating conditions. (Despite this, the system has failed these tests more often than it has succeeded, indicating serious problems.) As tests that are set up for success, they provide very limited information about the effectiveness and reliability of the system under real-world conditions.

> { *Evaluating the BMDS [Ballistic Missile Defense System] is likely one of the most challenging endeavors ever attempted by the Department of Defense.*
>
> — Missile Defense Agency Director Lt. General Patrick O'Reilly at a 2009 House Armed Services Committee hearing on missile defense testing (O'Reilly 2009) }

Using a rigorous testing program to determine how the GMD system works under realistic, challenging conditions actually works at cross-purposes with another motivation for intercept tests. As the most visible marker of the capability of the system, a high value is placed on success. The MDA's fact sheet on testing states:

> *Testing also contributes to U.S. non-proliferation goals by sending a very credible message to the international community on our ability to defeat ballistic missiles in flight, thus reducing their value to potential adversaries* (Missile Defense Agency 2013).

Conducting challenging tests that may uncover problems—information needed to improve the system and increase confidence in its capabilities—is at odds with the goal of having tests succeed in order to send a message that the system works.

SYSTEM COMPONENTS KEEP CHANGING

Early in the Obama administration, the Pentagon undertook an effort to improve the missile defense testing program, and the fiscal year 2011 overview of the Missile Defense Agency budget laid out some of the challenges it needed to overcome:

> *Ideally, comprehensive and rigorous testing is enabled by a stable configuration of the system being tested; a clearly defined threat; a consistent and mature operational doctrine; sufficient resources to repeat tests under the most stressing conditions; and a well-defined set of criteria of acceptable performance. Unfortunately, none of these situations applies to the BMDS [ballistic missile defense system]. The hardware and software configurations of the BMDS frequently change since the system elements are still under development* (MDA 2010).

A fundamental difficulty with trying to quantify the capabilities of the GMD system today is that the components of the system continue to change. For example, the interceptors used in flight tests have not been built using the same components. The seven intercept tests of operationally configured interceptors (see the table) have used two different configurations of the kill vehicles, the CE-I and CE-II, with each configuration further divided into several sub-configurations. Moreover, the next intercept test, currently planned for late 2016, will use yet a third configuration, the CE-II Block 1, which will further compete for the limited number of future intercept test opportunities. In addition, in 2018 the MDA plans to begin testing the entirely new RKV.

The GAO back in 2010 warned specifically that changing the configuration of fielded interceptors gets in the way of accurately understanding the capabilities of what is fielded. Although the DOD agreed that this is a problem, it "stated that it remained committed to fielding new assets while performing testing and assessment activities in parallel despite the lower level of confidence associated with this approach" (GAO 2016a). Until the system converges on a fixed design, it will be difficult to use tests to determine the GMD system's effectiveness and reliability. This is an important reason that in a normal DOD5000 acquisitions process, operational testing happens after the system's production design is stable.

[*The Pentagon does not know the system's reliability very well at all and probably will not in the future either.*]

NOT ENOUGH TESTS

Assessing a system with a changing configuration is not the only challenge to using intercept tests to develop confidence in the GMD system. Even if the design were stable and each of the tests performed to date were testing the exact same system, the GMD system has not been tested enough times to provide a reliable assessment of its capability—and likely never will be. The slow pace and low success rate of testing has been a critical weakness of the approach to building the GMD system since construction began in 2002; fielding the system has always been a priority over testing it.

The MDA has conducted only nine GMD intercept tests since it declared an initial operating capability in 2004, and only three of the nine—one-third—were successes. Including pre-deployment tests of prototype systems in the count, the Pentagon has undertaken 17 GMD intercept tests in total, with only eight successes. Moreover, the test record has not improved over time, as might be expected for a system decades in development and supposedly getting better. Only three of seven intercept tests using operationally configured interceptors have been successful.

Earlier in the GMD program, the MDA intended to conduct intercept tests at a much higher rate. As of 2001, the MDA's predecessor agency, the Ballistic Missile Defense Organization, planned to conduct four intercept tests per year for the next five years; by 2006 the planned intercept testing rate had declined to three tests per year (see section 4 of

Appendix 7: Testing). Since operational testing began in 2006, the rate has declined to fewer than one intercept test per year. The long time between tests also contributes to the GMD system's concurrency problems.

Understanding the capabilities and limits of any system requires a significant number of tests (see *Appendix 8: Confidence Levels and Probability*), even if the system were meant to be used only in simple and predictable scenarios. A complex system such as the GMD will be susceptible to a range of problems, many of which will occur only with low probability, meaning they will not show up in every test. So a single successful test does little to ascertain what the true underlying success rate would be. Yet the current plan is for the RKV to proceed into initial production after a single intercept test.

The Institute for Defense Analyses, tasked with assessing the GMD system, pointed out that the Pentagon does not know the system's reliability very well at all and probably will not in the future either. It notes that due to the limited number of flight and ground tests there is "a significant degree of uncertainty in the estimates of current and projected GBI reliability" and that the tests planned for the future "are likely to be insufficient by themselves to reduce significantly this uncertainty" (IDA 2012).

It is difficult to overstate how important it is to understand the effectiveness of the GMD system well. Knowing the system's effectiveness is necessary not only for evaluating what missions—such as deterring or defeating an attack—it is suited for, but because the effectiveness directly impacts how the system would be used operationally. Planners need to know the intercept probability of the interceptors to determine the "shot doctrine"—how many interceptors to target on each attacking missile—to achieve a required level of defense.

For example, to get the same overall intercept probability, a GMD system would need to target twice as many interceptors with 50 percent effectiveness against each attacking missile than it would if the interceptors had 75 percent effectiveness (assuming the failure modes of the interceptors are independent of one another).

The US military expends significant time and resources to assess accurately the effectiveness of offensive strategic systems. For example, the Trident II submarine-launched ballistic missile, an important part of the US strategic arsenal, undergoes an average of six flight tests per year and has been successfully tested more than 150 times since its design was completed in 1989 (Lockheed Martin 2015). There is no compelling reason that a system intended to protect against nuclear weapons should not be held to standards at least as high as a system intended to deliver them. Given the relative complexity of the GMD system, one would expect it to need more testing than the Trident II.

> ***There is no reason that a system intended to protect against nuclear weapons should not be held to the same standards as a system intended to deliver them.***

However, cost and time are limiting factors to increasing the number of tests, even if testing were given a higher priority. While some in Congress have urged the MDA to accelerate the GMD testing program, the MDA has responded that it cannot appreciably speed things up. Each test is expensive—roughly $200 million—and requires significant preparation before and analysis afterward. The director of operational test and evaluation testified in 2015 that increasing the pace of testing "would require expanding MDA's staff of competent engineers and test infrastructure, both of which would require substantial resources and time to execute" (Gilmore 2015). The MDA also has reported that, "in order to meet fielding obligations of 44 interceptors by the end of 2017, all current interceptor production resources are devoted to manufacturing operational interceptors," leaving no resources for building interceptors that could be used for more tests (GAO 2016a). This is another case of the rush to field interceptors getting in the way of good development practices.

COMPUTER SIMULATIONS DON'T SOLVE THE PROBLEM

Because the tests are expensive and very involved to conduct and assess, the Pentagon is relying substantially on modeling and computer simulations to characterize the GMD system. While computer simulations have a role to play, they also have important limitations and cannot replace a robust flight test program.

The MDA argues that it can improve its estimate of the GMD system's capabilities by using computer models of the missile defense system and simulations of intercept tests. The parameters in the models are based on data collected in flight tests and by tests of subsystems and individual components.

Computer simulations can help characterize the system under known, tested conditions, but they have real limits in predicting how the system would work in the unpredictable real world of the battlefield. For example, simulations cannot uncover failure modes that are not already known, such as the track gate anomaly, or the quality control and design problems bedeviling the kill vehicle.

As Director of Operational Test and Evaluation Dr. Michael Gilmore testified in a spring 2014 missile defense hearing:

> *The other failures that have had to do with the IMU [inertial measurement unit], for example, it [sic] saturating, and the failure with the CE-1 [sic] to separate, those are failure modes that really can't be predicted by modeling and simulation. The modeling and simulation, although it's essential, basically assumes that the kill vehicles will function mechanically, for lack of a better way to put it, the way that they're supposed to* (Gilmore 2014).

[***The most critical testing weakness is the limited quality and scripted nature of the tests.***]

Additionally, computer models cannot be expected to reliably predict the GMD system's behavior under conditions that differ significantly from those used in real-world tests, including different intercept geometries, different lighting conditions, conflicting or incomplete information, or different behavior or appearance of the warhead.

The Navy does not, for example, rely on computer tests to simulate aging effects and ensure continued reliability of the Trident system. It instead uses frequent flight testing of the actual hardware. Extensive and continual flight testing under the range of possible conditions the system may confront is essential to understand the system's reliability and effectiveness.

TESTS ARE NOT OPERATIONALLY REALISTIC

But the most critical testing weakness is the limited quality and scripted nature of the tests. Standard acquisitions practice distinguishes between developmental tests, which provide information to improve a system's design, and operational tests, which show how well a system behaves in operationally realistic conditions. Nearly all the GMD tests planned for the next few years are developmental, geared to establishing that the current interceptor can work under limited conditions—a marked contrast to what might have been expected for a system 12 years after it was declared operational. Indeed, in 2015, the director of operational test and evaluation assessed that the GMD test program so far is "insufficient to demonstrate that an operationally useful defense capability exists" (DOT&E 2015).

The limited set of conditions under which the tests have been performed so far cannot be confused with operationally realistic conditions (see *Appendix 7: Testing*). The tests have been conducted under carefully constructed conditions.

Philip E. Coyle III, the Pentagon's director of operational testing and evaluation from 1994 to 2001 and a science advisor to the Obama administration, urged skepticism about the test program thus far: "The tests are scripted for success. What's amazing to me is that they still fail" (Willman 2014).

The metrics for an operationally realistic test, developed jointly by the director of operational test and evaluation and the MDA, include threat-representative targets, complex countermeasures, and unannounced target launch.[13] However, in all of the successful intercept tests, the timing was chosen so the target would be illuminated by the sun and would appear brightly lit against a dark background. Three of the four successful intercept tests using operationally configured interceptors used targets launched from Alaska rather than Kwajalein Atoll; that geography meant the distances were shorter and the crossing angle was large, thus the closing speeds were relatively low. Interceptors have yet to be tested against an ICBM-range target or with a long time of flight between interceptor launch and interception (see *Appendix 7: Testing*).

In reality, actual operational conditions can vary greatly: the target complex may be in shadow for significant parts of its flight, and the closing geometry and time of flight can be very different depending on the location of the interceptor site, the target of the attack, and how much time has elapsed between the launch of the threat and of the interceptor. As another example, a warhead from an emerging missile state's missile launch may well be tumbling, presenting a more difficult target to kill; however, as far as is publicly known, the GMD system has never been tested against a tumbling warhead.

And so far, the tests have rarely faced the stress of unpredictable conditions. Tests are delayed until inclement weather passes, and all the tests have been done with significant preparation and advance notice. In nearly all intercept tests, the interceptor has been cued by previously loaded information

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[13] *According to the director of operational test and evaluation, the nine metrics for an operationally realistic test are flight test use of: 1) operationally representative interceptors; 2) threat-representative targets; 3) complex countermeasures; 4) operational sensors; 5) operational fire control software; 6) warfighter-approved tactics, techniques, and procedures; 7) warfighter participation; 8) unannounced target launch; and 9) end-to-end test (DOT&E 2015).*

rather than by sensor observations.[14] As a result, the system has limited (if any) experience responding to unexpected trajectories, conflicting or incomplete sensor information, or a threat scene that looks different from expected.

In addition, no tests have been conducted against targets that have been created specifically to be difficult to intercept. While including credible decoys to confuse or overwhelm the defense is a well-known strategy for improving the effectiveness of a missile attack, only one successful intercept test using an operationally configured interceptor—the last one, in 2014—has included any decoys at all. Moreover, it is implausible that any of the countermeasures used in that particular test posed any significant discrimination challenge; according to a 2015 testing report, that test did not include complex countermeasures (DOT&E 2015). The concentration of responsibility in the MDA itself likely contributes to this lack of operational realism in test targets; the MDA designs the targets and countermeasures, rather than an adversarial team charged with trying to challenge the system using the most recent intelligence about the missile threat.

Many operationally realistic conditions will not be included in tests for many years. The next intercept test, scheduled for late 2016, is planned to be the first-ever test against an ICBM-range target. While aiming multiple interceptors at a target is an important strategy for improving the capability of a defense using interceptors with low effectiveness, this strategy has never been tested. No GMD intercept tests have aimed more than one interceptor at a target, and this will not be attempted until late 2017 at the earliest. In addition, a test against more than one simultaneous target (two) is not scheduled until 2021 (Syring 2016a; Butler 2014b).

Walking before running or, as MDA Director Syring says, “Build a little, test a little, learn a lot” (Syring 2014a) is a reasonable strategy, and it is also true that developmental tests should precede operational tests. Yet it is critically important to understand how very limited the information is that the testing program has provided so far—and could provide in the future—about the real-world capabilities of the GMD system.

Whether the limited nature of the testing program so far is understood at all levels of policy making is unclear. The 2010 Ballistic Missile Defense Review, the official assessment of the system, states, “The United States is currently protected against limited ICBM attacks” and further, “The United States now possesses a capacity to counter the projected threats from North Korea and Iran for the foreseeable future” (DOD 2010). This is echoed by frequent descriptions by government officials of the GMD system as providing an effective defense now against a North Korean missile (see *Appendix 8: Quotes about Effectiveness*). As is clear from this discussion, such claims are not supported by evidence.

> ***Tests are delayed until inclement weather passes, and all the tests have been done with significant preparation and advance notice.***

The reality is that the number of tests required to accurately understand the reliability and effectiveness of the GMD system against real-world threats is significant, and the resulting cost would be great. Realistically, because the pace of testing and of including operationally realistic conditions is slow, knowledge of the system’s capabilities will be limited, which in turn limits the ability of the United States to rely on it to provide an effective defense. That lack of information has important consequences, which are discussed in the following section.

The GMD System Is Unable to Keep Up with Evolving Threats

One concern raised both by missile defense advocates and skeptics is whether the GMD system will be able to keep up with an evolving missile threat. Currently, it is meant to defend against a few unsophisticated missiles, but moving beyond this will require that the system be able to effectively discriminate warheads from debris, decoys, and other countermeasures.

Such discrimination is critical, in fact, even to defend against a simple threat, since objects may be traveling with the warhead that confuse the defense, even if they are not included intentionally by the adversary. For example, in the January 2010 intercept test, stray bits of unburned solid rocket fuel that were ejected from the missile that launched the

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[14] *The director of operational test and evaluation’s 2011 report on BMD sensors states that the 2010 intercept test FTG-06a was the first time a GMD interceptor was launched on data provided by an AN/TPY-2 forward-based radar. It further stated that Aegis BMD radars had yet to be used for this task, and that the Cobra Dane and Upgraded Early Warning Radars don’t participate in intercept tests in an operationally realistic manner because of their locations and fields of view. The SBX was the primary midcourse sensor for the first time in the FTG-06 test, though it “exhibited undesirable performances that contributed to the failure to intercept” (DOT&E 2011).*

target unintentionally confused the SBX radar, contributing to the test's failure (see *Appendix 2: Sea Based X-band Radar*).

The importance of the capability to discriminate the warhead from other objects is underscored in the 2012 National Academy report, which stated:

> *There is no practical missile defense concept or system operating before terminal phase for either the U.S. homeland or allies that does not depend on some level of midcourse discrimination, even in the absence of deliberate decoys or other countermeasures. The only alternative is to engage all credible threat objects* (NRC 2012, 3–26).

Similarly, Director of Operational Test and Evaluation Michael Gilmore testified to Congress on May 9, 2013:

> *If we can't discriminate what the real threatening objects are, it doesn't matter how many Ground Based Interceptors we have. We won't be able to hit what needs to be hit* (Gilmore 2013).

Intentional countermeasures range from the relatively simple to the more sophisticated. An example of a relatively simple countermeasure is to break the upper stage of the missile into pieces similar in size to the warhead; North Korea reportedly demonstrated such a fragmentation capability by breaking up its booster during its February 2016 satellite launch (Ap and Kwon 2016).

As an adversary's capabilities evolve, any defense system must expect somewhat more advanced countermeasures, such as lightweight decoys designed to confuse the defense sensors,[15] combined with measures to disguise the warhead itself (see Chapter 1). According to the US intelligence community and others, building lightweight, credible decoys does not require technology more sophisticated than that available to a country capable of building a long-range missile in the first place.[16] The 1999 National Intelligence Estimate of Foreign Missile Developments stated that Iran and North Korea could develop penetration aids and countermeasures by the time they flight test their missiles (National Intelligence Council 1999).

Yet the GMD system has very little ability to discriminate the target from decoys or other objects. While the NAS report emphasizes the importance of discrimination and discusses technology and techniques that might yield an improved capability to do so, it notes that such technologies and techniques "have yet to be included in the existing or planned GMD architecture" (NRC 2012, 135). Since the time that report was issued, the MDA has initiated an effort called Discrimination Improvements for Homeland Defense; in the mid-term (through 2020), it will "use available technology to improve sensors, kill weapons, and battle management/fire control capabilities needed to better address countermeasures" (Syring 2014b). A January 2016 flight (non-intercept) test reportedly provided an "early evaluation" of these improvements (Syring 2016a).

However, the GMD system's current sensors provide little data that would be useful for the discrimination mission. The infrared sensor on board the kill vehicle can see the threat cloud only around a minute before impact, and with poor resolution: it sees individual objects as single pixels until a few seconds before impact (see *Appendix 10: Sensors*). In addition, the GMD system has only a single high-resolution radar that can observe the threat cloud mid-journey, the SBX, which has important limits to its ability to contribute to the discrimination mission. It is based in Hawaii, not an optimum location to view the trajectory of a missile taking off from North Korea on its way to the continental United States. And the SBX's limited field of view precludes it from providing high-resolution radar data on missiles launched sequentially. Additionally, the current design of the GMD system restricts it from concurrently collecting and analyzing radar and infrared data (data the National Academy sees as most useful for discrimination), due in part to the limited ability of the kill vehicle to communicate with the rest of the system once it has been launched (see *Appendix 7: Testing* and A*ppendix 2: Sea Based X-band Radar*).

Indeed, the 2012 National Academy report concludes that:

> *The current GMD system has been developed in an environment of limited objectives (e.g., dealing with an early-generation North Korean threat of very limited numbers and capability) and under conditions where a high value was placed on getting some defense fielded as quickly as possible, even if its capability was limited and the system less than fully tested. As a result, the GMD interceptors, architecture, and doctrine have shortcomings that limit their effectiveness against even modestly improved threats and threats from countries other than North Korea* (NRC 2012).

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[15] *If the decoys are lightweight, multiple decoys can be carried along with the warhead on the launching missile, which has a limited amount of mass it can carry.*

[16] *For a detailed technical account of possible midcourse countermeasures and their expected performance against a sensor system such as the one planned for the NMD system during the Bill Clinton administration, see Sessler et al. 2000.*

Although the report said, “The current GMD system architecture must be and can be fixed,” its “fix” looks essentially like an entirely new system. The NAS-proposed system would include:

- a new interceptor with a higher-acceleration booster and more capable kill vehicle than those used in the current GMD system;
- a new interceptor deployment site in the eastern United States;
- five new X-band radars; and
- a different concept of operations (NRC 2012, 17–18).

Those recommendations indicate the large scope of work necessary to evolve the current system into one that has some capability to address the problem of discriminating the target warhead from other objects. To improve the GMD system’s discrimination capabilities, the MDA plans by 2020 to add a single Long Range Discrimination Radar in Alaska and to include communication improvements in the new kill vehicle.

Assessment of the Current System: Summary

This analysis shows that nearly 15 years after its deployment was fast-tracked, the GMD system has not demonstrated an operationally useful capability to defend even against the limited threat it was designed to engage.

While 30 interceptors have now been fielded, most use a version of the kill vehicle that has had only two successful intercept tests, and the rest use a kill vehicle that has had only a single successful intercept. Both types of kill vehicles are known to have additional problems. The intercept test record since deployment began is poor: just three successful intercepts in nine tests (33 percent).[17] And since these have been development tests conducted under controlled and scripted conditions, they therefore tell very little about the system’s behavior against a real-world attack.

This dire state is the result of rushing a system into the field to meet a timeline imposed by considerations other than technical maturity, while exempting it from the usual rules that provide oversight and accountability for the development of major military systems.

And the system remains on a path to failure. While the Pentagon has made some changes in recent years to fix problems in the missile defense development process, evidence indicates that these changes are inadequate to ensure that future development will avoid problems that have plagued the system.

Despite more than a decade of development and a bill of $40 billion, the GMD system is simply unable to protect the US public, and it is not on a credible path to be able to do so.

> ***This dire state is the result of rushing a system into the field to meet a timeline imposed by considerations other than technical maturity, while exempting it from the usual oversight and accountability for the development of major military systems.***

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[17] *Including earlier tests using prototype interceptors, the record is eight successful intercepts out of 17 tests (47 percent).*

[CHAPTER 5]

Strategic Consequences, Diplomatic Implications

As the preceeding discussion makes clear, more than 10 years after its initial deployment in 2004, the GMD system is fraught with problems arising in part from the Bush administration's decision to exempt it from standard Pentagon practices for developing complex military systems, a lack of rigorous oversight, and the Obama administration's failure to change course.

The test record demonstrates that the GMD system's effectiveness is low—even against a single launched missile with simple or no countermeasures. Moreover, the GMD system is unlikely ever to undergo enough testing under a broad enough set of conditions to provide high confidence that it could reliably stop even a limited attack, due in part to the enormous resources comprehensive testing would require.

As a result, the unknown effectiveness of the GMD system places fundamental limitations on its ability to contribute meaningfully to US security and military planning. These limitations are not often a part of the debate about what resources should be dedicated to a strategic missile defense system. Instead the assumption is that any capability is better than none, and that any missile defense will always be a useful adjunct to other military capabilities and diplomacy.

However, as we discuss below, it is not as simple as that. It is critical to understand how effective the system is, and how that effectiveness—or lack thereof—affects the roles it can play in US defense plans.

Because of the visibility of intercept tests and the open nature of American society, the GMD system's lack of capability is impossible to hide from US adversaries. US policy makers and military leaders must similarly have a realistic understanding of the limited capabilities of the system and the implications of those limitations.

Can the GMD System Achieve the Strategic Goals of US Missile Defense?

What level of technical performance can the GMD system realistically achieve, and what role can it therefore play in strategic planning and in diplomacy? In other words, what are its benefits and risks, and are those benefits worth the risks? Under what conditions is some strategic missile defense better than none?

The Obama administration's 2010 Ballistic Missile Defense Review listed the policy priorities for homeland missile defense: it should "dissuade [Iran and North Korea] from developing an intercontinental ballistic missile (ICBM), deter them from using an ICBM if they develop or acquire such a capability, and defeat an ICBM attack by such states should deterrence fail" (DOD 2010, 11).

Missile defense is also intended to reassure international allies and partners that the United States will stand by its security commitments to them (DOD 2010, 12). And it is meant to reassure the US public that political and military leaders are addressing and reducing the threat of missile attack.

The demonstrated effectiveness required of the GMD system will differ depending on the strategic goal it is meant to support: to dissuade, deter, defeat, or reassure. Here, we assess the suitability of the GMD system to support each of these goals.

DISSUADE COUNTRIES FROM BUILDING ICBMS

Many factors go into a country's decision-making about whether to develop ICBM technology and at what cost. These may include the country's desire for international prestige or for space launch capability, its perception of its adversaries and its security challenges, and its assessment of what other options exist for addressing these challenges and achieving its aims.

Dissuasion assumes that the prospect of facing a missile defense reduces an adversary's assessed value of ballistic missiles and shifts its cost/benefit calculation enough to convince it to forego developing missiles.

This logic suggests that a missile defense system would be most likely to dissuade if it were highly effective—enough to make an adversary's attack very unlikely to succeed. In contrast, a modestly effective or ineffective defense system or one of unknown effectiveness may equally well spur an adversary to build more, or more sophisticated, missiles than it otherwise would. For example, the GMD system (and other elements of US missile defense) appears to be a factor in Chinese decisions about expanding and improving its strategic missile force (OSD 2015).

> ***A defense system of poor or unknown effectiveness may equally well spur an adversary to build more, or more sophisticated, missiles than it otherwise would.***

It is important to note that to dissuade, a missile defense system would not only need to be very effective, but that this effectiveness needs to be understood by the potential adversaries. How can the defensive capabilities of the GMD be communicated? A set of successful intercept tests would provide visible markers of an effective defense. However, the GMD's poor test record is clearly unconvincing. The United States has other means to signal to potential adversaries that it has faith in the GMD's effectiveness: for example, by consistently spending significant amounts of money on it and by making official statements that exaggerate the GMD system's capability (see *Appendix 9: Quotes about Effectiveness*).

Just as a scarecrow is only effective when the crows believe it's real, the GMD system can only affect an adversary's decisions to the extent its capability is believable. The evidence suggests that the missile defense "scarecrow" does not work. Neither Iran nor North Korea has been dissuaded from developing long-range missile technology.

Consider North Korea. As a result of intensive diplomatic engagement by the Clinton administration, in 1998 North Korea instituted a moratorium on flight testing its missiles; this moratorium was significant because flight tests are critical for developing longer-range missiles and can be monitored by satellites and radars. However, following a period of increased tension with the United States, North Korea ended the moratorium and conducted an unsuccessful flight test of a long-range rocket in July 2006—nearly two years after the GMD was declared operational. Since then, North Korea has conducted five additional launches of long-range rockets, including successful launches of satellites into orbit in December 2012 and February 2016 (Spaceflight101 2016; Harlan 2012). These launchers use the same technology North Korea could use in a long-range ballistic missile.

Similarly, Iran continued to develop its rocket technology after the GMD system was fielded. It launched four small satellites into orbit between 2009 and 2015 and is reportedly preparing to launch its more capable Simorgh booster in the near future. While Simorgh development appears to have been delayed for several years, possibly by sanctions (Grego 2016), there is no evidence that development of the GMD system has dissuaded Iran from pursuing missile development.

DETER MISSILE ATTACKS

The GMD system cannot meaningfully increase deterrence—to make a missile attack from a country like North Korea less likely—for several reasons.

The primary way a missile defense system helps deter an attack is by creating uncertainty about whether an adversary's attack would succeed. A low chance of success may make the adversary less likely to launch the attack. This uncertainty argument dates to the Cold War, and was applicable to a peer adversary like the Soviet Union (or Russia), which might have contemplated a carefully planned and coordinated "counterforce" strike against hardened US military targets, including nuclear missile silos. Successfully destroying these targets would reduce the ability of the United States to retaliate. In such a peer scenario, missile defense could create uncertainty about how much of the US retaliatory force the attack might leave intact. That uncertainty could therefore increase deterrence of a nuclear first strike.

The same logic does not apply to an attack that a country such as North Korea, Iran, or even China might consider. These countries' missile arsenals are too small and inaccurate to mount an effective counterforce strike on hardened US military targets. (Currently, neither North Korea nor Iran has missiles that could reach the United States, and Iran has not tested a nuclear weapon.) Instead, they would target US cities or other large, unhardened sites. US missile defenses would be irrelevant to deterrence because the United States would retain a retaliatory capability in any scenario.

The primary factor in deterring North Korea from launching nuclear weapons against the United States is the certainty of a devastating US response. The presence or absence of US missile defense makes no meaningful difference compared with the deterrence afforded by US offensive nuclear and conventional forces.

Some argue that homeland missile defense offers a different kind of deterrence, by taking the option of a "cheap shot"—launching just a few missiles—off the table for North Korea, and forcing it to either stay its hand or escalate to a larger attack (Roberts 2014). The implication is that North Korea knows with certainty the United States would retaliate if it were to attack with a large number of missiles, but might believe the US may refrain from retaliation if the number of missiles were small. By taking the option of a small attack off the table, the argument goes, missile defense would serve to deter a small attack. However, because North Korean missiles would necessarily target cities or other soft targets, it is not credible to imagine the United States retaliating differently depending on whether North Korea launched a few or many nuclear weapons against US cities.

Further, if North Korean leadership was not making rational decisions, or was considering a last-ditch vengeance attack on the United States as its regime collapsed, neither offensive nor defensive forces would act as a deterrent.

DEFEAT AN ATTACK AND AVOID "NUCLEAR BLACKMAIL"

Should deterrence fail to prevent a North Korean attack, then the missile defense is intended to "defeat" the attack. However, reliably defeating an attack is a highly demanding task. So it's important to ask what protection the GMD system can potentially offer. Can it work well enough to affect military planning?

Suppose it were possible to build a system that demonstrated—through extensive, rigorous testing—that strategic missile defense was highly reliable in all the relevant attack scenarios. Such a defense could have an important impact on US military planning. In particular, by neutralizing the threat of North Korean nuclear attack on the US homeland, such a defense could help prevent the US military from being deterred from taking actions it found to be in its interest but knew might increase the risk of a missile launch against the United States.

The desire to have freedom of action by having a credible capability to defeat an attack, and therefore neutralize the missile threat from North Korea or other countries, is an important motivation for many missile defense proponents. This is sometimes referred to as avoiding the "nuclear blackmail" problem.

A 1999 RAND report described the situation this way: "Ballistic missile defense is not simply a *shield* but an *enabler* of U.S. action" (Gompert and Isaacson 1999). Similarly, Bush administration officials argued that with a missile shield, "A president will be free to intervene in regional conflicts against heavily armed foes such as North Korea, Iran, or Iraq without worrying about losing an American city" (Diamond 2001). But to act as such a shield, the missile defense system would need to demonstrate that it is highly effective, through thorough, rigorous testing that provides high confidence in this capability. Otherwise it is too risky to rely on.

Reliably protecting US cities from a nuclear attack, however, is so difficult and uncertain that the United States will never realistically be able to eliminate nuclear blackmail. For example, even if US officials knew the GMD system had an improbably high 95 percent effectiveness against one missile, an attack by just five missiles still has a one-in-four chance of at least one nuclear warhead penetrating the defense and destroying a city[18]—a more likely outcome than correctly predicting the roll of a die.

Using multiple interceptors to target each warhead is a strategy that only works well when the interceptors are already reliable; using four interceptors to target each warhead yields the same one-in-four chance of a warhead getting through if each interceptor were 50 percent reliable, and if the failure modes were independent. If the failure modes are not independent, shooting additional interceptors does not help; for example, decoys that fool one interceptor would likely fool them all (see *Appendix 8: Confidence Levels and Probability*).

And as the discussion in Chapter 4 indicates, the reality is that the limited testing program means officials will not know the reliability of the defense system with high confidence, especially against a real-world attack that it has not faced before. With unknown capability, the defense system cannot support a freedom-of-action doctrine. US officials will simply never have high enough confidence in the GMD system's capability to take actions as though US cities were invulnerable to nuclear attack.

While the GMD system will not meet the goal of defeating an attack, what about building a GMD system—even one with largely unknown effectiveness and reliability—to provide

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[18] *A 95 percent reliability would mean each missile would have a 1/20 chance of getting through the shield. For five missiles, the probability that one would get through is 5 x 1/20 = 5/20 or 1/4 (one in four).*

whatever defense it can against a nuclear missile attack on US cities.

The simplistic argument that "any defense is better than no defense" is not credible—the Pentagon has criteria for deciding when to invest resources in military systems, and missile defense should be no exception. The benefits must outweigh the costs, which are discussed below.

But it is also important to recognize that the GMD system has not been developed and built over the last decade in the way one would build a system whose goal was to protect US cities. If it had been, the emphasis would have been on producing a system with demonstrated capability rather than continuing to rush minimally tested hardware into the field. If developing an effective missile defense is a goal of the GMD system, then this deeply flawed development process is not the right path.

REASSURE THE PUBLIC AND US ALLIES

As discussed in the preceeding sections, the GMD system is not useful in dissuading, increasing deterrence, or reliably protecting cities—and has no realistic prospect of doing so in the future. What about reassurance?

American leaders confronted with the possibility of a long-range nuclear missile threat by a country such as North Korea have strong motivations to assure the US public they are effectively dealing with the threat and protecting the populace from a nuclear strike. Supporting missile defense is a way to signal this, regardless of whether the defense is actually effective.

And once the United States has begun to build a missile defense system, leaders have an incentive to overstate the system's defensive capabilities, for several reasons. For example, they may believe the scarecrow is effective and that exaggerating the capabilities of the defense adds to its ability to dissuade or deter an adversary.

Moreover, creating the perception that the GMD system can defend cities from a missile strike reduces public concerns that might otherwise deter decision makers from taking risky military or political actions. This false perception of capability also helps US officials reassure allies that the United States will not be deterred from acting on its security guarantees because it fears a North Korean missile strike. However, since these perceptions are not backed up by actual defense capability, any reassurance they give is unjustified.

In the same way that a scarecrow is a metaphor for using the perceived capability of the defense for dissuasion or deterrence, attempting to reassure the public and US allies by claiming the defense system has capabilities it does not in fact have is similar to using it as a placebo. Political and military officials may see the current value of the GMD system as stemming from its perceived capability rather than its actual, demonstrated capability. This view is consistent with the repeated claims by government officials that the system is effective, despite a preponderance of technical evidence that it is not. It is also consistent with policy makers favoring more missile defense over better missile defense, such as the preference for deploying more untested interceptors rather than making the painstaking effort to build interceptors that work reliably.

BOX 2.

How the United States and Israel Used the Placebo Effect in the Gulf War

An example of the placebo effect was seen during the 1991 Gulf War. When Iraq started firing Scud missiles at Israel, it led to intense domestic pressure for the Israeli military to respond. The United States was concerned that if Israel joined the conflict, it would split the coalition of Arab states the United States had put together to fight Iraq. The public perception—fueled by repeated US claims of successful intercepts—was that the US Patriot anti-missile system was highly effective in countering the Scuds. However, it wasn't (Lewis & Postol 1994).

By reassuring the Israeli public that it was being protected, even though the Israeli military knew the Patriot system was not effective,[19] the Israeli government was able to reduce public pressure for a military response and kept Israel from actively joining the conflict. In this case, the attacking Iraqi missiles were both inaccurate and equipped with small conventional warheads, and caused so little damage that it was possible to portray the damage as due to falling debris rather than intact missile impacts (Fetter 1993, 293–296). It would not be possible to maintain such an illusion about an attack with nuclear-armed missiles.

This tension is reflected in the dogged congressional support of an East Coast missile defense site despite repeated statements by the MDA and the Pentagon that it needs to

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[19] *On February 11, 1991, Israeli Defense Minister Moshe Arens told President George H.W. Bush that, as a rough estimate, the Patriot system only had "about a twenty percent rate of success" and that "We're very close to having to take action" (Atkinson 1994, 289–290).*

spend resources on improving what it has, not adding a new site that would drain billions of dollars from the budget.

Ironically, in addition to drawing resources away from development and testing, prioritizing the perceived capability of the system can work against efforts to improve the system's actual capability in another important way. While better oversight and rigorous testing are critical for building an improved system, in the short term they are likely to expose the GMD system's shortcomings and undermine its capability as reassurance. As a result, prioritizing the perceived value of the system may lead to opposition to better oversight and testing, thereby undermining more effective development efforts.

So while the Bush and Obama administrations exempted the GMD system from standard accountability requirements to field some capability quickly, that exemption now helps shield the GMD system from scrutiny. It helps maintain the illusion of an effective system at the cost of actually building one.

But in addition to hamstringing development of the system, prioritizing the illusion of capability over actual capability is dangerous and counterproductive, as discussed next.

Costs and Risks of Deploying the GMD System

The preceding discussion illustrates that the GMD system has serious limits in how much it can contribute to the goals of dissuading countries from building missiles, deterring those countries from using them, or reliably protecting the cities those missiles might target. Reassuring the public and allies relies on exaggerations about the capabilities of the defense.

Continuing to develop and deploy the GMD system and exaggerate its capabilities can, paradoxically, create risks that outweigh the potential benefits of an unreliable defense. If US political and military leaders overestimate the capability of the defense, it can lead them to take actions that can actually *increase* the risk of a missile attack against the United States.

First, while technical experts may understand the actual limitations of the GMD system, political and military leaders may not. Overestimating the ability of the GMD system to defend against ballistic missiles may lead these officials to pursue more aggressive policies in a crisis—which could increase the risk that an adversary would launch missiles at the United States—in the mistaken belief that the defense could counter such an attack. However, the largely untested GMD system cannot reliably defend against such an attack. As a result, an unrealistic belief in the capability of the defense could lead to actions that escalate a crisis and increase the risk of nuclear warheads exploding on US territory.

Second, a mistaken belief by policy makers and the public that the GMD system is an effective response to the spread of ballistic missiles could reduce the incentive to vigorously pursue other, potentially more effective approaches to the problem. For example, if policy makers believe the GMD system can defend against a North Korean missile attack, they may have less incentive to support diplomatic approaches that are likely needed to ultimately reduce the probability of such an attack.

Third, US development of a national missile defense system can affect Chinese and Russian actions in ways that reduce US security. For example, while Chinese analysts are understandably skeptical of the capabilities of the GMD system, they remain concerned that US investments in missile defense, and US cooperation on missile defense with countries on China's periphery, could pose a potential long-term challenge to China's own security.

Moreover, the US focus on missile defense and technologies that could target Chinese missiles suggests to Chinese analysts that US leaders may want to deny China a nuclear retaliatory capability so the United States could exert nuclear coercion (Kulacki 2014). These actions sow distrust and resentment that undermine efforts to reduce nuclear threats. They also create pressure for China to take steps to improve its retaliatory ability, for example, by increasing the size of its arsenal and putting its missiles on alert status (Kulacki 2016). Indeed, China's decision to put multiple warheads on its missiles, which the Pentagon sees partly as a reaction to US defenses, actually increases the number of nuclear warheads aimed at the United States (OSD 2015).

Similarly, Russia's consistently negative reaction to US missile defenses contributes to deterioration in relations and a deadlock in further arms cuts. The lack of progress in nuclear arms reduction leaves a larger number of missiles pointed at the United States than there might otherwise be.

A strategic missile defense system that increases the number of warheads aimed at the United States and increases the risk of an attack—while at the same time not providing an effective defense against such an attack—makes us less safe.

Finally, the enormous expense of the missile defense enterprise effectively prioritizes it out of proportion to its actual potential to contribute to security. That high cost diverts resources from where they may be better spent, especially under the constrained budget environment that is expected for the foreseeable future.

The costs discussed here are significant—not only the $40 billion price tag, but also the increased risks that come with pursuing strategic missile defense. And they certainly outweigh the benefits of an ineffective and unreliable defense system. It is crucial that Congress, the administration, and the American people appraise with clear eyes what role the GMD system can play and at what cost, rather than simply supporting missile defense uncritically.

[CHAPTER 6]

Findings, Conclusions, and Recommendations

[***Critical equipment continues to be fielded on timelines set by imposed deadlines rather than technical readiness.***]

Nearly 15 years have passed since the MDA accelerated the development of the GMD system. Today a broad consensus has formed—among critics and supporters alike—that the system suffers from serious deficiencies resulting in uncertain effectiveness and low reliability.

These deficiencies did not result from a lack of funding for the program. Rather they are the result of systemic problems that date to the beginning of the development process: a presidentially imposed breakneck pace to field the system starting in 2002, and a lack of oversight and accountability dating to the Bush administration's decision to exempt the system from standard Pentagon practices that impose rigor and scrutiny when developing major military systems.

Exempting the GMD system from normal acquisition requirements, independent oversight, and testing milestones was a recipe for disaster. It established a culture under which building the system must be "done right now" rather than "done right." The Pentagon pursued concurrent fielding and development, which resulted in engineering and design shortcuts and a fielded system with significant quality-control problems and design flaws. And because missile defense was not being built under normal acquisitions rules—which require a system be developed in response to clear requirements and after considering cost, risk, and effectiveness trade-offs—the MDA pursued numerous false starts and dead ends.

It is important to recognize that these issues are not simply historical problems that have now been fixed. Improvements to the missile defense acquisition process at the end of the Bush administration and by the Obama administration do not provide the rigor of established processes and are insufficient to prevent reoccurrence of many of the problems that have plagued the development of the GMD system for nearly 15 years. Critical equipment continues to be fielded on timelines set by imposed deadlines rather than technical readiness, tests are conducted under controlled and heavily scripted conditions and do not rigorously evaluate the system, and poorly vetted projects are added to the missile defense program, wasting time and money.

As a result, the United States continues to spend billions of dollars on a system that cannot effectively defend the US public and is not on a credible path to being able to do so.

Ballistic missile defense is one of the costliest and most complex military systems ever built, yet is the only major defense program that is not subject to DOD5000 acquisitions oversight. Exempting missile defense from standard Pentagon acquisition and oversight policies did not create a working system quickly. Instead, it has led to higher costs and produced little capability.

Key Findings

- The Bush administration exempted missile defense from the normal oversight and accountability processes required of other major military systems, with the goal of quickly fielding the GMD system. This decision allowed the Pentagon to field missile defense systems without undergoing operational testing. Nearly 15 years of this approach has led to an expensive and poorly performing system.

> ***The pursuit of a strategic missile defense system can make the United States less safe by encouraging a riskier foreign policy.***

- Obama administration attempts to improve oversight and accountability without bringing missile defense under the normal processes have led to ongoing problems. These include projects that have been started without sufficient vetting and later canceled, and components that are being fielded based on imposed deadlines rather than technical maturity—in some cases with known flaws.
- The MDA has conducted intercept tests of the GMD system at a rate of fewer than one per year since the end of 2002. Moreover, the tests have been conducted under simplified, scripted conditions. Even with the limited objectives of those tests, only a third have been successful since deployment began, and the record is not improving over time. Pentagon testing officials assess that the GMD system has not demonstrated an operationally useful capability.
- The GMD system currently includes 30 fielded interceptors. The majority use a type of kill vehicle (CE-I) that has had only two successful intercept tests in four tries. The last successful intercept test was in 2008; the most recent one failed. Other interceptors are equipped with the CE-II kill vehicle, which has had only a single successful intercept test in three tries. None of the tests have been operationally realistic.
- The MDA began fielding both the CE-I and CE-II kill vehicles before they underwent any intercept tests.
- The MDA will not be able to test the GMD system often enough and under a broad enough range of conditions to develop a high degree of confidence in its effectiveness under operational conditions and against real-world threats, which may have unknown characteristics. This lack of confidence limits the system's military utility. While computer simulations can help characterize its effectiveness under known, tested conditions, they cannot substitute for actual tests. For example, they cannot reliably predict the system's behavior under conditions or against targets that differ significantly from those used in real-world tests, and cannot uncover weaknesses that are not already known, including quality control and design problems.
- The GMD system was designed to defend against a very limited threat. Modifying it to engage more sophisticated threats would require substantial changes and additions. Even a modified system would face fundamental problems in dealing with countermeasures that an adversarial ballistic-missile state would be expected to field.
- The continued development of the GMD system without adequate oversight and accountability, and the continued fielding of interceptors without adequate testing, means the system is not even on a path to achieving a useful ability to intercept ballistic missiles.
- US officials have strong incentives to exaggerate the capability of the GMD system to reassure the public and international allies—and have done so, despite its poor test record.

The pursuit of a strategic missile defense system can make the United States less safe by encouraging a riskier foreign policy, by encouraging potential adversaries to modernize and increase their arsenals, by short-circuiting creative thinking about solving strategic problems diplomatically, and by interfering in US efforts to cooperate with other nuclear powers on nuclear threat reduction. The United States may incur these costs whether or not the system provides an effective defense.

A Better Path Forward

In response to the problems of the GMD system, the National Academy study (NRC 2012) calls for essentially starting over, with new interceptors, new sensors, and a different concept of operations. The MDA is taking a different tack, redesigning the kill vehicle and interceptor booster, and adding a single large discrimination radar. But without rigor and accountability as bedrock principles in the development process, neither approach is likely to provide the intended benefits.

Clearly a fundamental change is needed in the US approach to strategic missile defense. The administration should bring the GMD system under rigorous accountability and oversight.

In particular, the GMD system must have clearly defined objectives as well as specified benchmarks against which the Pentagon and Congress can measure the program's progress independently of the MDA's assessment. The GMD system must undergo rigorous testing and evaluation so the Pentagon and Congress can make a realistic assessment of its true capabilities.

Both missile defense proponents and critics should welcome and support such a rededication to rigor. Proponents should support it as a necessary, although not sufficient, step to develop working technology. Critics should welcome it as a process that keeps untested equipment out of the field and provides credible information about strategic missile defense's capabilities and potential, which is essential to any debate about its value. If fielded equipment cannot be demonstrated to be effective and reliable, then the system should not be considered operational, and instead viewed as solely a research and development effort.

The ongoing failure of Congress and the Pentagon to require rigor, and instead make unsubstantiated claims about the system's effectiveness while continuing to provide billions of dollars in funding, is both cynical and a disservice to the public. The idea of protecting the United States from ballistic missiles with a national missile defense shield is a compelling one, but policy must be made sensibly, with a clear vision. Strategic missile defense must be evaluated on the merits of what strategic goals it may contribute to, how well it might do so, and at what cost.

Congress and the Obama administration (and future Congresses and administrations) must use the results of rigorous testing and evaluation to provide meaningful oversight of the GMD program and to decide what to invest in and what to do without. They must use it to give strategic missile defense appropriate priority compared to other technological and diplomatic approaches to mitigating the ballistic missile threat, as well as other needs of the nation.

The political climate after the events of September 11, 2001, made it difficult for Congress to question executive decisions about defense and security matters, including the wisdom of accelerating strategic missile defense by exempting it from normal rigorous oversight procedures. Since then, however, little effort has been made to engage in substantive debate about the role of missile defense in national and international security. That discussion needs to be a priority for policy makers and the engaged public.

Recommendations

- The secretary of defense should bring the GMD system under oversight at least as rigorous as that required of other major military systems. We recommend that missile defense systems be returned to the standard, time-tested DOD5000 acquisition process rather than continuing to modify the current, alternate acquisition process.

  A rigorous acquisition process should include:

  - Requiring a rigorous interagency process, including the intelligence community and the State Department, that characterizes the current and projected ballistic missile threat.
  - Specifying the particular missile threats the GMD system is intended to counter and over what timeline, and assessing the system's efficacy, risks, and costs (financial and strategic) compared with alternate methods of countering the threat.
  - Specifying what capability the system must demonstrate against that particular threat in order to merit deployment.
  - Assigning the task of developing operationally realistic and challenging test targets and conditions to an adversarial outside the MDA itself.
  - Requiring the GMD system to undergo extensive and rigorous testing to evaluate its real-world effectiveness, with the highest priority on operational realism. The test program must be certified by the director of operational test and evaluation.
  - Analyzing new missile defense initiatives rigorously on the basis of costs, risks, benefits, and alternatives before funding can be granted. Neither Congress nor the administration should be able to create programs, such as a third interceptor site or a space-based missile defense element, that have not undergone appropriate scrutiny.

> [***The GMD must undergo rigorous testing and oversight as least as rigorous as that required of other major military systems.***]

[***The United States must fundamentally change its approach to strategic missile defense.***]

- Missile defense development must not be schedule-driven. Congress and the administration must refrain from imposing deadlines that are not based on technical maturity.
- Fielding of the system should not continue to be funded from research and development budgets.
- Congress and the administration should halt the deployment of additional interceptors until all known flaws have been eliminated from those additional interceptors and a testing program shows they are effective and reliable.
- Congressional oversight should involve hearings that include the perspectives of independent experts as well as government experts, as it has in the past.
- The current and future US administrations should work with China and Russia to ensure that development of a strategic missile defense system does not interfere with progress on strategic issues important to all three countries.

In short, the United States must fundamentally change its approach to strategic missile defense. If the GMD system is to be part of addressing the ballistic missile threat, the United States must make its development and deployment a process with clear goals, rigorous testing, and effective oversight and accountability. Components must not be fielded on timetables set by imposed deadlines but by technical maturity. It is time to treat strategic missile defense like the serious military system it is supposed to be. Congress and the president should ensure that taxpayers' dollars are spent in ways that actually make us safer.

[APPENDICES]

Appendices

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Shielded from Oversight

The Disastrous US Approach to Strategic Missile Defense

> ***The George W. Bush administration rushed the GMD system into the field, exempting it from standard military oversight and accountability. Congress and the president should bring the system under rigorous oversight to ensure taxpayers' dollars are spent to actually make us safer.***

When the George W. Bush administration decided in 2002 to field the US Ground-based Midcourse Defense (GMD) missile defense system, it exempted the system from the military's rigorous "fly before you buy" performance standards that guide the development of virtually all other major weapons systems. This change allowed the administration to rush the GMD system into the field without the oversight and accountability that the United States through years of experience had learned were necessary for ensuring success.

The price tag is more than $40 billion (and counting) for a system with a poor test record and no demonstrated ability to stop an incoming enemy missile under real-world conditions. Congress and the president should bring the GMD system under rigorous oversight to ensure taxpayers' dollars are spent to actually make us safer.

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