MISSILE DEFENSE

Why America Has Almost No Protection From The Greatest Threat It Faces, And What To Do About It

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FINDINGS IN BRIEF

Nuclear war is the only foreseeable threat to America's survival in this century, and Russia is the most plausible nation from which a large-scale nuclear attack might originate. Other countries lack the means and/or the motivation to mount such aggression, but Russia has over 2,000 nuclear warheads capable of reaching the U.S., and tensions between the two countries are rising. The current U.S. strategic posture, which threatens massive retaliation to deter nuclear attack, probably cannot be sustained indefinitely. Some day, in some way, deterrence will break down.

Ten nuclear warheads could collapse the U.S. electric grid. Fifty could render every major city uninhabitable. Two hundred might well spell the end of American civilization. Most of the Russian warheads are mounted on long-range ballistic missiles, and Washington currently has no plan for intercepting such weapons if they are launched in large numbers. During the Cold War, U.S. leaders made a deliberate decision to forego strategic defenses of the homeland in order to stabilize the superpower arms race.

The current U.S. strategic posture, designed mainly to deter rational adversaries, cannot cope with a wide array of potential scenarios such as irrational leaders, accidental launches or breakdowns in the chain of command. To cope with the full spectrum of ballistic threats to America's homeland, a layered defense including interceptor missiles and/or beam weapons is required. The system would be costly, but not compared with the value of assets that could be destroyed in a nuclear war. However, current plans call for spending less than one-percent of the defense budget on relevant technologies.

The physics of countering large-scale nuclear attacks are daunting but doable. The logical place to begin is by expanding the current Ground-based Midcourse Defense deployed on the U.S. West Coast, which is oriented mainly to threats from North Korea but could be configured to intercept Russian warheads more effectively. Other assets already in the joint force such as the sea-based Aegis combat system could be upgraded to create a nascent layered architecture. A truly robust system would probably require a space-based layer too. If these steps are not taken, there will be no way of protecting America on the day deterrence fails.

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INTRODUCTION: THE MOST IMPORTANT PART OF AMERICA'S DEFENSE POSTURE IS MISSING

History records few examples of civilizations that chose not to defend themselves against the greatest threats to their survival. However, the United States is one such nation. Faced with the danger of a nuclear arms race during the Cold War, Washington entered into a pact with Moscow to prohibit construction of active defenses against attacks by long-range ballistic missiles. Such missiles had become the main method of delivering nuclear warheads over intercontinental distances. Thus, by foregoing the opportunity to build ballistic missile defenses of the U.S. homeland, policymakers consciously chose to leave their nation without active protection against the sole manmade threat to its existence.

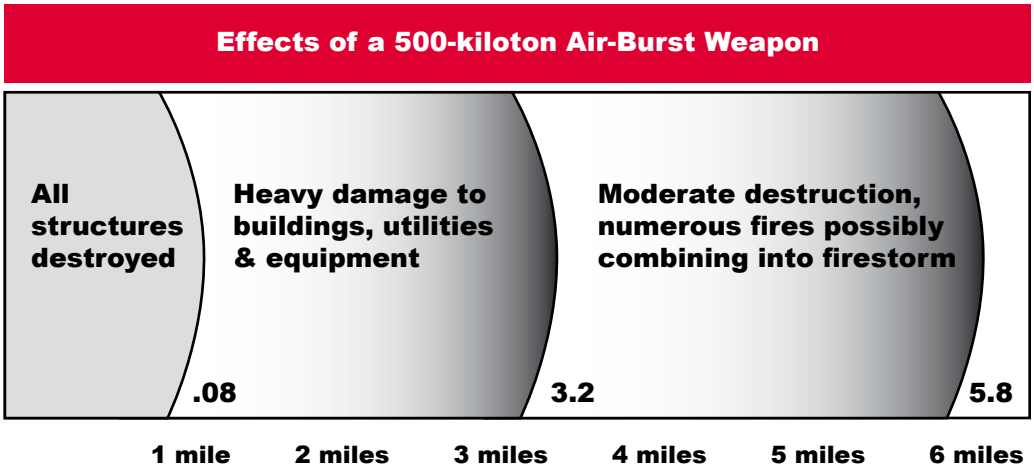
This decision was made after much analysis and reflection, which led policymakers to conclude that any effort to build effective missile defenses was doomed to failure because it was relatively inexpensive for the Russians to deploy more missiles and warheads that could overwhelm the defenses. The thinking was that if both sides relied on the threat of massive retaliation to deter nuclear attack rather than building active defenses, then the two countries could stop adding to their offensive forces and begin serious arms control. That is indeed what happened, however the subsequent reduction in nuclear arsenals probably had more to do with the collapse of the Soviet Union than America's willingness to eschew strategic defenses.

As a result of these decisions made several decades ago, Russia today has a nuclear arsenal capable of destroying the United States despite the fact that it has shrunk to a fraction of its Cold War size. The U.S. has a similar "assured destruction" capability that could wipe out Russia. Neither side has the kind of defenses that could significantly blunt such an attack, despite U.S. withdrawal from the treaty limiting strategic defenses in later years. But a great deal has changed since the nuclear arms race reshaped Washington's thinking about what security required in the modern world. New nuclear powers have emerged, new technologies with defensive potential have been developed, and Russia's geopolitical circumstances have been transformed.

Against that backdrop, the continued failure of the U.S. government to protect the American homeland against a large-scale nuclear attack needs to be rethought. Relying on offensively-based deterrence to prevent nuclear war is at best an incomplete solution to the nation's strategic dilemma, because adversaries are not always rational, accidents happen, and nobody can really prove deterrence is functioning until it fails. Said differently, the United States is running a great risk that its military posture might fail to prevent aggression leading to the destruction of American civilization. The purpose of this brief report is to explain why an alternative posture incorporating active defenses against nuclear attack is necessary and feasible.

The report begins by examining the scope of the nuclear threat and the deficiencies in current U.S. nuclear strategy. It then explains why the reasons for abandoning active defense during the Cold War, while arguably valid at the time, no longer provide a credible basis for national security. The report goes on to describe the operational challenges associated with defense against large-scale nuclear attack, and argues that expanding the minimal missile defenses currently deployed on the U.S. West Coast would be an appropriate first step toward a better military posture. The report contends, though, that fielding resilient strategic defenses will require a sizable space-based component for tracking and intercepting hostile warheads in large numbers. It concludes by warning that deterrence cannot avert nuclear use indefinitely, and that real defenses are thus a moral imperative.

The mushroom cloud from a 21-kiloton blast over Nagasaki, Japan in 1945.
Strategic warheads in the current Russian arsenal typically have over 20 times the yield of the Nagasaki bomb.



The initial blast, radiation and heat damage caused by a one-mile-high air burst of a 500-kiloton weapon above a U.S. city would be followed by widespread fires, extensive scattering of radioactive debris, and electromagnetic pulse damage to electronics over hundreds of square miles.

NUCLEAR WAR IS THE ONLY REAL THREAT TO AMERICA'S SURVIVAL

Americans have largely ceased thinking about nuclear war since the Cold War ended a quarter-century ago. A small community of nuclear practitioners continues to maintain the U.S. strategic deterrent of long-range missiles and bombers, but for most politicians, pundits and members of the general public, other types of threats such as terrorism and cyber attack are a more common concern. The lack of worry about nuclear matters managed to persist through the Ukraine crisis of 2014, when Russian commentators repeatedly alluded to the destruction their strategic arsenal could cause in America and Moscow staged its most ambitious nuclear exercises in over a decade. Many commentators have noted that Russian leaders seem more concerned about war between the two countries than American leaders do.

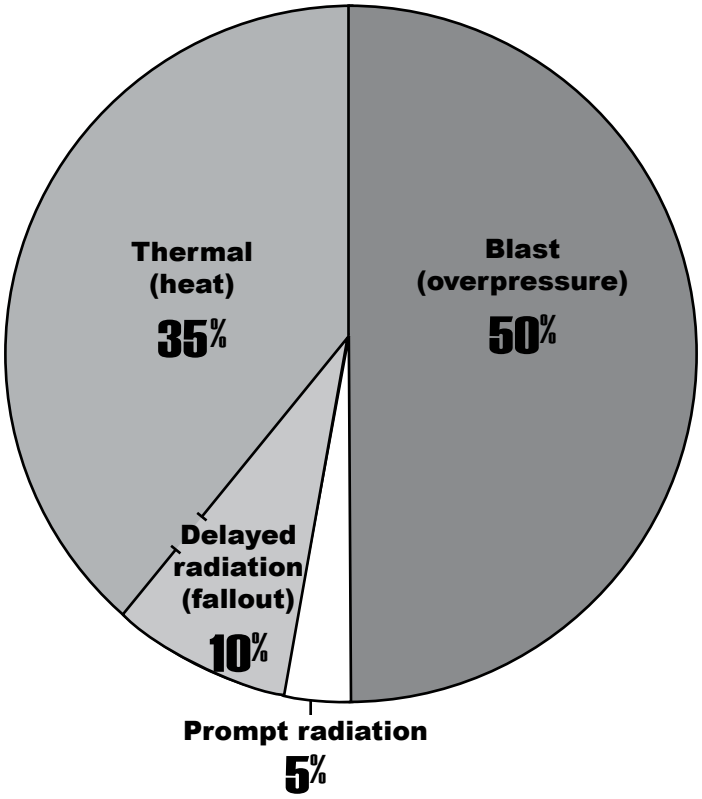
The relative detachment of Americans from the specter of nuclear war presumably reflects an assessment that any such conflict is very unlikely. However, by any reasonable measure nuclear weapons remain today -- as they were during the Cold War -- the single greatest manmade threat to America's survival. That threat is concentrated mainly in Russia, which along with America controls over 90% of the world's nuclear weapons. Other countries are gradually joining the nuclear fraternity, though, and some of them such as China and North Korea might one day contemplate nuclear use against the United States. The U.S. has deployed modest strategic defenses in Alaska and California that could intercept a small nuclear attack originating in either of those countries or Russia, but attacks of much more than a dozen warheads would overwhelm the U.S. network.

Russia at present has over 2,000 warheads in its nuclear arsenal capable of reaching the United States, most of which are carried on land-based or sea-based ballistic missiles. Moscow has been gradually modernizing its land-based deterrent by fielding a new long-range missile designated SS-27 in the West that is deployed both in hardened silos and on mobile launchers. The missile can be equipped with a single high-yield warhead or four independently-targetable warheads of lower yield. In addition to its land-based force of over 300 intercontinental ballistic missiles carrying approximately a thousand warheads, Russia also maintains a sea-based deterrent of ten strategic submarines, each carrying 16 long-range missiles, with a cumulative warhead count of about 600. The balance of Russia's strategic arsenal is carried on bombers.

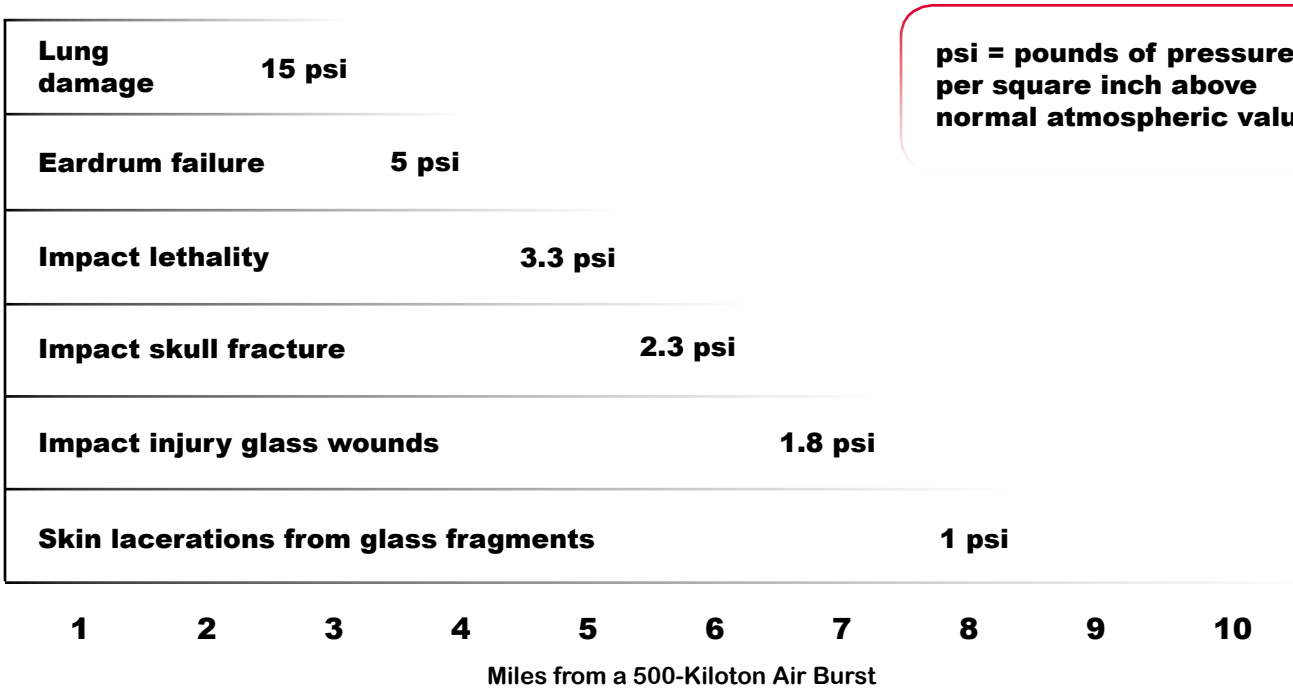
Optimally targeted, ten of the warheads in Russia's strategic arsenal would be sufficient to collapse the U.S. electric grid. Fifty would be sufficient to render uninhabitable every U.S. city with a population exceeding half a million. Two hundred warheads impacting on U.S. soil would effectively wipe out the U.S. economy, destroying all major transportation, communication, financial and medical networks. It is by no means certain that America as we know it today would ever recover. A single 500-kiloton warhead typical of the weapons in the Russian strategic arsenal, detonated in an airburst above a major city, would destroy virtually every structure within a one-mile radius, cause extensive fires and damage within a five-mile radius, and lead to widespread suffering in a far larger area.

The human consequences of such an explosion would be fearsome and multi-faceted. In addition to the blast wave leveling thousands of structures, there would likely be a wind-spread firestorm spreading faster than people could escape, prompt and delayed doses of lethal radiation, and electromagnetic effects sufficient to shut down most digital devices over hundreds of square miles. Hundreds of thousands of casualties would result, many involving horrible injuries that could not be remedied due to the collapse of medical services. And that is just the damage caused by a single 500-kiloton warhead. Russia has over 2,000 nuclear warheads capable of reaching America. So in the absence of strategic defenses, Moscow has the ability to obliterate America, perhaps forever.

Effects of a Nuclear Explosion



Injuries from Nuclear Blast Effects



psi = pounds of pressure per square inch above normal atmospheric value

CURRENT U.S. NUCLEAR STRATEGY DOESN'T ADDRESS ALL THE WAYS WAR COULD OCCUR

When the Nixon Administration signed the Anti-Ballistic Missile Treaty in 1972, it largely abandoned work on how to intercept such weapons. Although the U.S. briefly activated a limited defense of U.S. missile fields in the upper Midwest, administration officials were skeptical that defense of "soft" targets such as cities was feasible given the size of the Soviet offensive arsenal and the relative ease with which additional warheads could be added to overcome any defensive network. At the time, Russia had over 40,000 nuclear warheads in its inventory, and the prevailing view in Washington was that there was no practical way of preventing a large-scale, deliberate attack from destroying the United States.

The U.S. therefore concentrated its strategic spending on deterring such a deliberate attack, deploying a "triad" of offensive forces that could retaliate after a surprise attack by laying waste to the Soviet Union. The assumption was that if Moscow could not devise a credible way of disarming America in a first strike, then it would recognize that launching a nuclear attack was suicidal. However, U.S. official thinking went beyond that: it accepted the need for America to be similarly vulnerable -- i.e., defenseless -- so that neither side would perceive the need to engage in a destabilizing arms race. The theory was that if Moscow knew it could destroy America no matter how destructive a U.S. surprise attack might be, then it would feel secure enough to limit the size of its nuclear arsenal and begin engaging in meaningful arms control.

Unusual though this arrangement was, U.S. policymakers felt they had little alternative because there were few options for building resilient strategic defenses at the time. The Russian nuclear force was simply too big and too destructive. However, from the beginning there were critics who warned that any strategy based on deterrence rather than real defense was a catastrophe waiting to happen. The most glaring deficiency in the "mutual assured destruction" posture, as it came to be known, was that it assumed leaders on both sides would be rational in their approach to the use of nuclear weapons. Having only recently defeated fascist powers in Europe and Asia whose leaders at times appeared to be quite irrational, the assumption of Soviet rationality for the indefinite future seemed optimistic at best.

A second line of criticism was that even if leaders on both sides were rational in the clinical sense of that term, they might make miscalculations during crises leading to a nuclear exchange. Information available to leaders during events such as the Cuban missile crisis in 1962 is always incomplete, and subject to contradictory interpretations. Divergent cultural norms and the psychological stresses associated with crisis bargaining might lead to rash acts -- a problem exacerbated by the fact that the two sides were defenseless against an all-out nuclear attack and might fear losing their deterrents in a surprise attack. History provided many examples of crises that degenerated into war because of miscommunication.

In addition, there was the danger that nuclear weapons might be used as the result of a purely mechanical or operational error, or as the result of a breakdown in the chain of command during a period of instability. As with the case of irrationality and miscommunication, offensively-based security offered no real answer to these dangers. A partial solution pursued by every U.S. administration over the last four decades has been to encourage reductions in the size of nuclear arsenals so there are fewer weapons to launch in the first place. But strategic arms control has intrinsic limitations because the two countries are still committed to giving each other an assured-destruction retaliatory capability and once arsenals shrink below a certain level cheating is incentivized by the possibility of gaining advantage in a future nuclear exchange.

Nuclear Weapons Inventories (2014)

	Deployed Strategic	Non-Strategic	Non-Deployed	Total Warheads
United States	1,922	200	5,384	7,506
Russia	2,484	2,000	4,000	8,484
China	--	--	250	250
France	290	--	10	300
United Kingdom	160	--	65	225
India	80-100	--	--	80-100
Pakistan	--	--	90-100	90-100

Source: armscontrolcenter.org

China and Pakistan do not deploy warheads with launchers under normal peacetime conditions.

Russia is gradually replacing its Cold War strategic arsenal with a new generation of land- and sea-based nuclear systems. Many of the land-based systems will be deployed on mobile launchers and carry multiple independently targetable warheads.

WASHINGTON ABANDONED ROBUST DEFENSES FOR REASONS THAT MAY NO LONGER BE VALID

The United States today lacks active defenses of its homeland against a large-scale ballistic missile attack, and the government has no plans to pursue such a system. The Ground-based Midcourse Defense system currently deployed in Alaska and California is designed mainly to counter small attacks from second-tier nuclear aggressors such as North Korea, in keeping with the longstanding official view that any defensive system capable of impeding a major Russian nuclear attack would undermine the foundations of offensively-based deterrence. However, geopolitical and technological circumstances have changed considerably since the U.S. elected to forego extensive national missile defenses in the 1970s, and much of the reasoning underpinning that decision now looks suspect.

At the time the Anti-Ballistic Missile Treaty was signed in 1972, the United States faced only one nuclear-equipped adversary of any consequence -- the Soviet Union. China possessed only a minimal nuclear deterrent, and other potential aggressors that have since joined the nuclear "club" had no weapons of mass destruction at all. Moscow was not only viewed as having a deep ideological commitment to competing militarily with the West, but its strategic rocket forces were growing rapidly. By the late 1980s, Russia would have over 40,000 strategic and tactical nuclear warheads in its arsenal. Although the United States had invested heavily in missile-defense systems such as Nike-Zeus, Sentinel and Safeguard, the prevailing view among experts was that Russia's offensive arsenal could easily overwhelm any defensive scheme constructed from the technologies then available.

The U.S. approach to homeland defenses was thus focused primarily on how its superpower rival might react, and within the framework of deterrence theory, it was easy to imagine that a major defensive effort might prove "destabilizing." If Russia felt pressured to further expand its offensive deterrent every time America added another increment of defense, then the resulting arms race could continue indefinitely. Nonetheless, within a few years after the ABM Treaty was ratified, U.S. policymakers began to have misgivings about the limits it imposed on U.S. defenses. In 1983, President Reagan questioned the efficacy and morality of offensively-based deterrence in a national address announcing the Strategic Defense Initiative. That initiative proposed using defensive technologies outside the scope of the ABM Treaty such as lasers to escape from the mutual-hostage relationship in which the two superpowers found themselves.

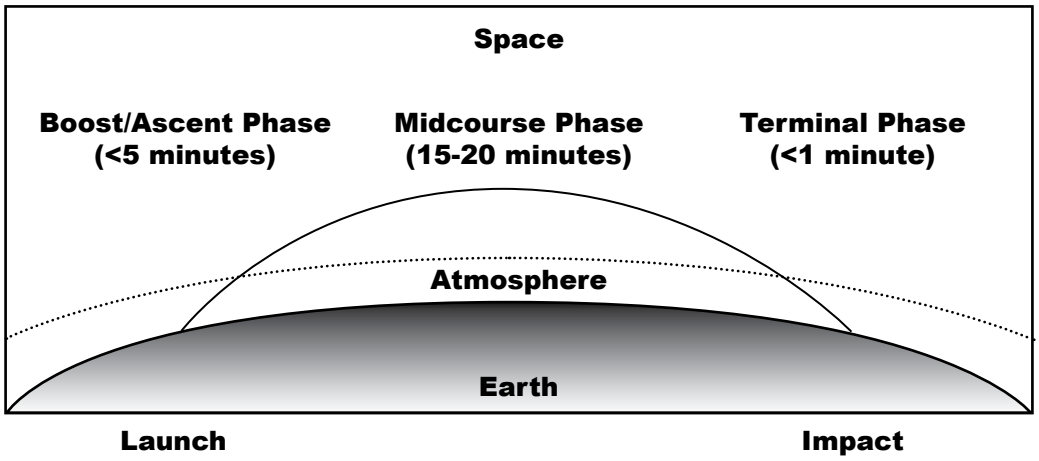
Despite significant technological advances during the Reagan years, the momentum behind missile-defense efforts waned when the Cold War ended. Many observers assumed that with the collapse of the Soviet Union, the threat of nuclear war would gradually recede. However, the demise of America's Cold War rival was soon followed by the emergence of new nuclear aspirants such as Iran and North Korea whose susceptibility to traditional concepts of deterrence was by no means clear. The danger posed by new nuclear players was officially recognized during the Clinton Administration as North Korea began testing the means for delivering warheads over long distances. U.S. concerns were further stoked in later years by Moscow's drift back to authoritarianism, a trend that was accompanied by slow but steady modernization of all three legs in the Russian strategic triad.

In 2001 the Bush Administration withdrew from the ABM Treaty and began planning for the deployment of a thin missile defense against the kind of limited nuclear attacks that countries like North Korea might one day be capable of mounting. The centerpiece of this plan was the Ground-based Midcourse Defense system now deployed in Alaska and California, which has the ability to defend the entire U.S. against small-scale ballistic missile attacks. However, plans to expand this system to Europe and the U.S. East Coast were deferred by the incoming Obama Administration; it focused most of the nation's missile-defense spending on protection of overseas allies and forces against theater-range ballistic missiles. Because the new administration subscribed to Cold War assumptions about the destabilizing potential of national missile defenses, little was done on its watch to investigate how emerging technologies might be applied to protecting the U.S. homeland.

Core Features of a Layered Missile Defense

- Early warning sensors to detect launches
- Tracking sensors to discriminate warheads from other objects
- Highly responsive hit-to-kill interceptors or beam weapons
- Battle management centers to coordinate engagements
- Communications networks to tie the defense architecture together

Typical Ballistic Missile Flight Trajectory



Intercontinental ballistic missiles have arcing trajectories that begin with an initial boost into space, after which they release warheads that coast to intended targets. Each missile may carry multiple independently targetable reentry vehicles containing one warhead each plus penetration aids to defeat defenses.

THE BASIC PHYSICS OF MISSILE DEFENSE ARE DAUNTING BUT DOABLE

The U.S. Department of Defense has been researching and developing missile-defense technologies for nearly 60 years -- ever since Russia demonstrated the ability to build long-range ballistic missiles with its launch of the Sputnik satellite in 1957. Although the level of effort has varied considerably from decade to decade depending on perceived threat levels and prevailing strategic concepts, a great deal has been learned. For instance, early plans to use nuclear-armed interceptors against incoming warheads were abandoned as scientists came to better understand how the effects of a nuclear explosion might impede tracking and engagement of later-arriving warheads. On the other hand, technological breakthroughs enabled development of highly accurate "hit-to-kill" mechanisms that could reliably disable attacking warheads with nothing more than the kinetic force of impact.

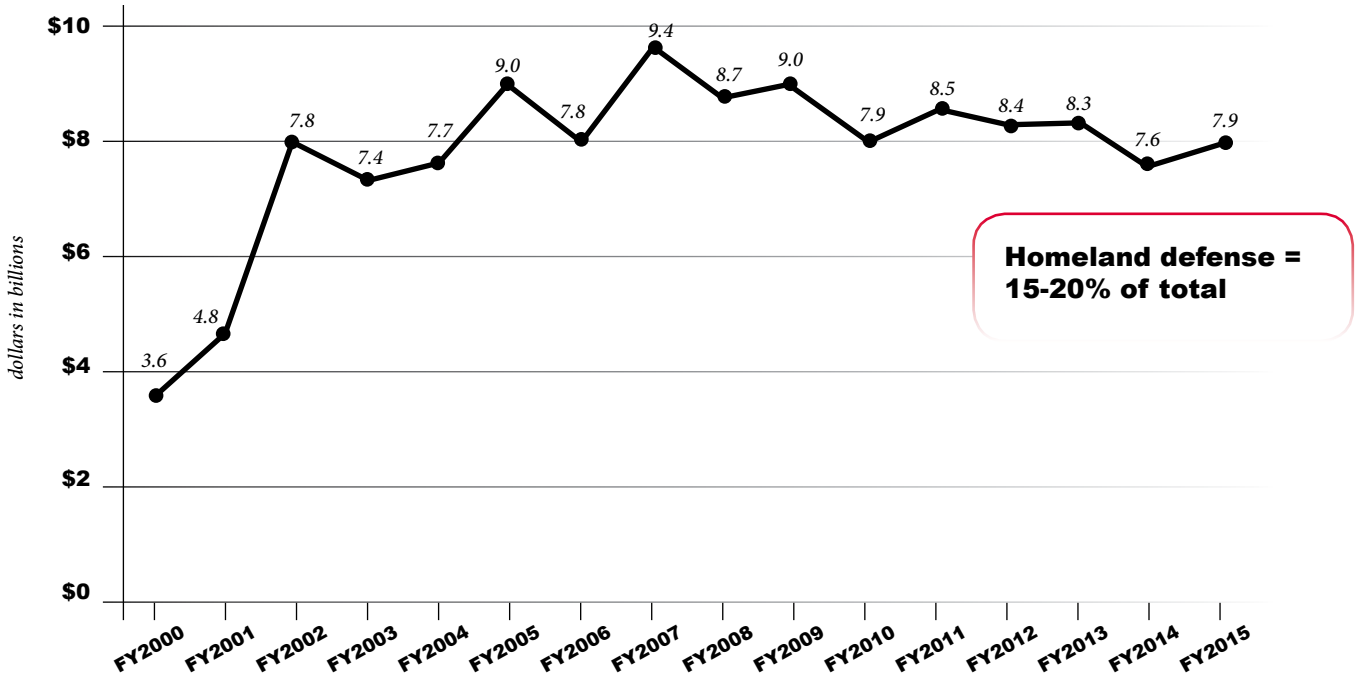
The basic physics of missile defense are driven by the ballistic trajectory of attacking weapons and the characteristics of those weapons that make them resistant to successful interception, such as speed and hardening. With regard to the trajectory, every long-range ballistic missile traverses three operating regimes once launched: an initial "boost" phase of 1-5 minutes in which rockets expend their fuel putting warheads onto a course toward their intended targets; a "midcourse" phase lasting up to 20 minutes during which warheads coast through space; and a "terminal" phase of less than a minute during which warheads re-enter the atmosphere and detonate on targets.

Boost phase, also known as ascent phase, is the most attractive regime in which to attempt intercept because lofting rockets are relatively easy to track and vulnerable to a variety of kill mechanisms. If a missile is carrying multiple warheads, they can all be destroyed with a single shot in boost phase before they are released and become separate targets later in the trajectory. However, boost-phase interception requires defensive forces to deploy near the point of origin for attacking missiles, and most potential aggressors have sited their launch complexes in locations that afford defenders minimal time to react -- typically deep within the defended interior of the attacking nation. Such locations also minimize the likelihood that missiles can be destroyed in a preemptive attack before launching.

Midcourse affords defenders more time in which to react, but once boosters burn out and warheads are released from the missile's "bus," they are much harder to track. Tracking is impeded not only by their small size and faint signatures, but also by debris and decoys accompanying the warheads through space, creating a cloud of objects that defenders must sort out. The debris and decoys will be quickly filtered out once warheads re-enter the atmosphere, but at that point there is little time left to attempt interception and the warheads will be moving at a speed of several miles per second. An effective defense must track each threatening target and engage it with kill mechanisms -- interceptors or energy beams -- powerful enough to destroy the attacker. Given the compressed timelines, this will require an automated response in which the overall defensive effort is managed using sophisticated algorithms and highly reliable software.

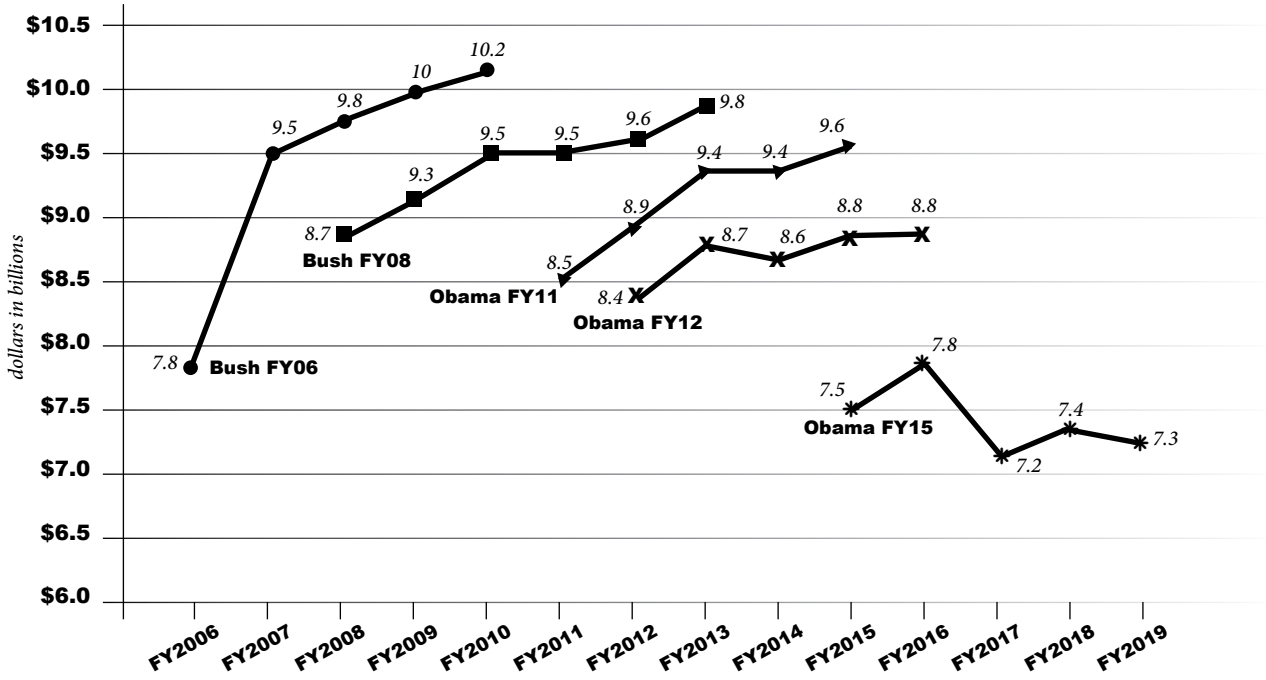
The U.S. Missile Defense Agency has repeatedly demonstrated all of the technology needed to track and intercept fast-moving ballistic warheads, such as target-discrimination sensors and hit-to-kill interceptors. However, no defense is perfect and even a handful of nuclear weapons exploding on U.S. territory would be a catastrophe of unprecedented proportions. Therefore, military planners stress the importance of constructing a layered defense in which defenders will have more than one opportunity to down each incoming warhead. Layered systems provide what experts call "multiplicative" defense: if each layer in a two-layer architecture is 90% effective, than the overall effectiveness of the architecture is 99% -- any attackers that get through the first line of defense will likely be intercepted by the second. In this manner, even large-scale attacks can be repulsed using technology that is already in hand.

Funding for the Missile Defense Agency Averages 1-2% of the Pentagon's Budget



Source: Missile Defense Agency

Missile Defense Spending Plans Have Drifted Downward



Source: Missile Defense Agency

BUILDING OUT THE EXISTING DEFENSIVE NETWORK WOULD BE A GOOD START

The United States today possesses a limited missile defense of its homeland that was deployed after Washington withdrew from the ABM Treaty in 2002. Called the Ground-based Midcourse Defense (GMD), it consists of radars, interceptor missiles and a battle management network capable of destroying hostile warheads as they coast through space en route to U.S. territory. Although the Pentagon's Missile Defense Agency manages a diverse array of defensive efforts, GMD is the only system currently being funded that was designed from its inception to protect the U.S. against attacks by intercontinental ballistic missiles. Thus, if a decision were made to provide the U.S. homeland with more comprehensive missile defenses, it would probably begin by expanding the existing GMD system.

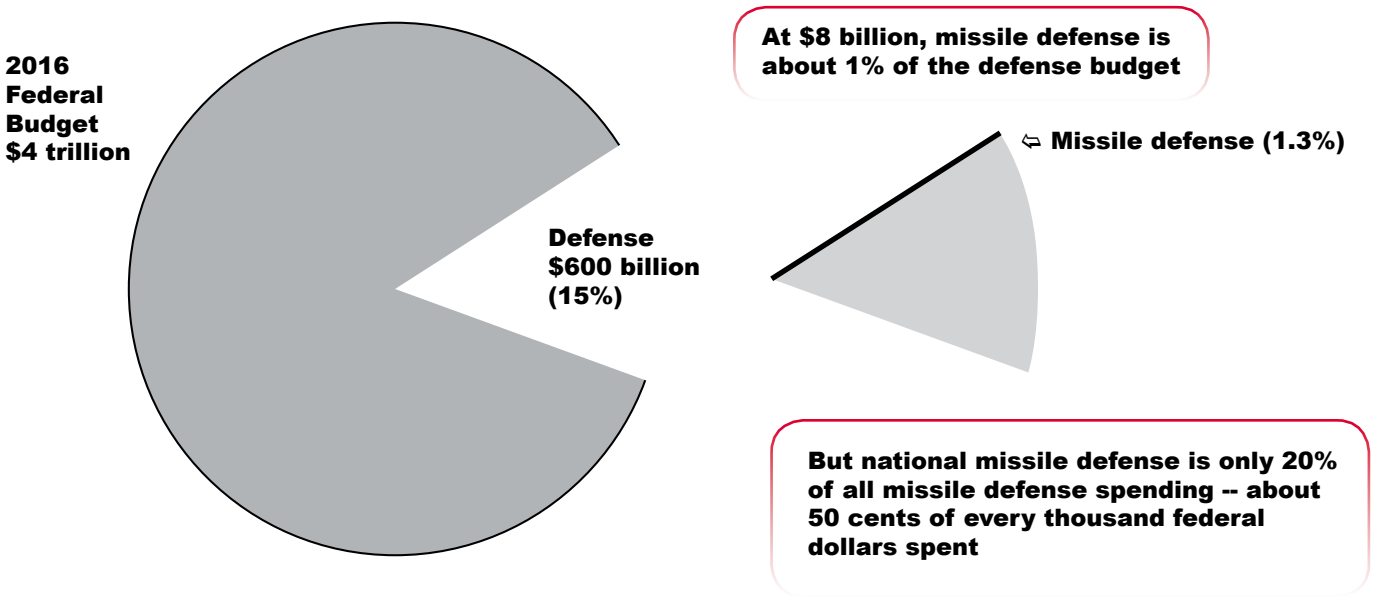
The Ground-based Midcourse Defense system is postured to defeat small nuclear attacks originating in North Korea or Iran. Neither of those countries today has the capacity to launch such attacks over intercontinental distances, but U.S. intelligence has repeatedly judged them to be seeking such a capability and making rapid progress. The GMD program relies upon land-based, sea-based and space-based sensors to detect and track hostile missiles, with the information from the various sensors -- mainly radars -- merged in a battle management system that computes appropriate engagement vectors for interceptor missiles located at Fort Greely in Alaska and Vandenberg Air Force Base in California. The entire defensive architecture is tied together with a redundant communications network utilizing orbital transponders and buried fiber cables.

The GMD system is capable of defending the entire United States against intercontinental ballistic missiles originating in any country. However, in order to be effective against more than a handful of warheads, it would need a larger number of interceptors located at more sites. Planners have considered deploying a third interceptor site and associated radars in the northeastern region of the U.S. This not only would provide additional interception capacity, but would enable defenders to respond in more timely fashion to attacks -- perhaps enabling a "shoot-look-shoot" capability in which warheads missed on the first try could be targeted a second time. Even in its present, modest configuration, GMD is a useful insurance policy against certain types of attacks from Russia or China, such as those that result from accidents or a breakdown in the chain of command.

For large-scale attacks, though, the GMD system would need to be expanded to many more sites and augmented with at least one additional layer of defense. The most likely candidate to provide that second layer is the sea-based Aegis defense system, which consists of long-range radars and Standard Missile interceptors on naval surface combatants. Aegis is already integral to the national missile-defense system in that its sea-based radars are part of the detection and tracking architecture that feeds information into GMD. However, Aegis at present does not have the capability to intercept intercontinental ballistic missiles, despite its demonstrated capacity to destroy intermediate-range missiles and its potential ability to deal with strategic missiles launched from submarines while they are still in boost phase.

By upgrading the Aegis architecture, including development of a more robust interceptor system, it would be feasible to field a second, mobile layer of midcourse defenses against long-range warheads attacking the U.S. to bolster the protection provided by the Ground-based Midcourse Defense. Combining GMD and Aegis in a layered defense of the homeland would present potential aggressors with a significant targeting challenge, because the two systems would intercept warheads at different points in their trajectory, with one layer thinning out the threat the next one must negate. Such an architecture would be more resilient than stand-alone GMD, because Aegis can be continuously maneuvering at sea and reduce the threat attackers pose to fixed GMD sites on land. At the very least, this architecture would force attackers to think long and hard about their prospects for achieving the goals of an attack -- thereby strengthening deterrence.

Missile Defense of the Homeland is Under-Funded



Examples of Military Crises U.S. Policymakers Failed to Anticipate

1941	Japan attacks U.S. base at Pearl Harbor
1950	North Korea attacks South Korea
1957	Sputnik; Russia demonstrates ICBM technology
1962	Russia deploys nuclear weapons in Cuba
1968	Tet Offensive in South Vietnam
1973	Yom Kippur War in Middle East
1979	Russia invades Afghanistan
1990	Iraq invades Kuwait
2001	9-11 attacks in New York and Washington
2014	Russia invades Ukraine

SPACE-BASED SYSTEMS ARE CRUCIAL TO AN EFFECTIVE HOMELAND DEFENSE

Any missile-defense architecture aimed at defending the U.S. homeland against large-scale nuclear attacks would necessarily rely heavily on orbital systems. Even today's very limited network of ground-based interceptors relies on overhead early-warning satellites and communications links to function effectively. But the real key to developing resilient, reliable missile defenses is to devise some method of evening up the "cost-exchange" relationship between the offense and the defense, so that it is no longer cheaper to deploy additional offensive warheads than it is to add defensive interceptors. Resolving that asymmetry between offense and defense almost certainly would require adding a robust layer of space-based protection to whatever surface-based systems have been built.

There are several reasons why space-based systems have an advantage over surface-based defenses in coping with large-scale attacks. First of all, orbital sensors and interceptors can directly overfly the missile sites of hostile nations, thereby gaining much greater proximity to the source of an attack than any terrestrial system could; boost-phase interception, in which missiles are destroyed before they can release multiple warheads and countermeasures, would thus potentially become possible. Second, space offers a unique and unfettered vantage point from which to view nuclear attacks, enabling defenders to coordinate their engagements for optimum effect. Third, the trajectories of warheads carried on intercontinental ballistic missiles unfold almost entirely in space, so it is there that defenders have the most options for defeating them; interceptor systems already in orbit would not incur the time and cost penalties associated with having to be launched from the surface before they could engage incoming warheads.

The Reagan-era Strategic Defense Initiative aimed at providing robust defenses of the U.S. homeland developed two generic options for how space-based interceptors might be implemented. One option was high-powered beam weapons, probably lasers, which could engage attacking warheads with great accuracy and lethality in the vacuum of space due to the absence of distorting influences. A second option was hundreds or thousands of low-cost kinetic interceptors that could be deployed in low-earth orbit so that some were directly above enemy missile sites at all times. The latter concept came to be known as Brilliant Pebbles, and was briefly the centerpiece of the national missile-defense program during the administration of George H.W. Bush. In either case, these novel interception systems would have been integrated with overhead sensors capable of precisely discriminating hostile warheads against the cold background of space.

Contrary to what some critics alleged, the main drawback of such systems was not their high cost. Their cost would have been modest relative to the value of the overall defense budget and the national assets being protected. The real problems were operational and technological. Planners needed to think through how they would protect orbital defense against preemption by an attacking nation, and how an attacker might time its launches to minimize the effectiveness of space-based interceptors. For instance, kinetic interceptors deployed in low orbits move quickly across the Earth's surface, and thus hundreds of spacecraft might be needed to assure a handful are within range of boosting missiles at the time of launch. However, there has been huge progress in all of the relevant technologies since the Cold War ended while ballistic-missile technologies have changed only modestly, so the options for deploying effective space-based defenses are far greater today.

If Washington had invested continuously in developing space-based defenses over the last two decades, it today would have a potent capacity to degrade even large-scale nuclear attacks against the U.S. homeland. When combined with systems such as the Ground-based Midcourse Defense and Aegis warships in an integrated architecture, the resulting layered defense would have been able to deny any potential aggressor a plausible motive for attacking while fully negating accidental or unauthorized launches. It is not likely that Russia or other prospective adversaries would have had the resources to counter U.S. defensive moves with new offensive capabilities, and the U.S. might have found the technology needed to overcome the cost-exchange advantage enjoyed by the attacker. However, U.S. leaders chose not to make that investment, and as a result America's survival today depends on the goodwill of other nuclear-armed nations.

The extensive damage caused to the Japanese city of Hiroshima by a relatively low-yield (15 kiloton) airburst puts in perspective why the cost of acquiring a robust national missile-defense system would be modest compared with the value of assets potentially destroyed in the absence of defenses.

History of Homeland Missile Defense Since 9-11

2002-2004	**"DEPLOY LIMITED CAPABILITY" – Bush Administration withdrew from ABM Treaty to deploy modest Ground-based Missile Defense (GMD) oriented mainly to North Korean threat.**
2005-2008	**"IMPROVE CAPABILITY & CAPACITY" – Prototype GMD deployment achieved with aim of later enhancing homeland-defense capability.**
2009-2012	**"SUSTAIN & CURTAIL DEVELOPMENT" – Missile defense emphasis shifted to theater defense of allies by Obama Administration while GMD funding scaled back.**
2013-2015	**"ADDRESS GROWING HOMELAND THREAT" – Renewed concern about North Korean threat leads to incremental expansion of GMD with no provision for countering bigger ballistic threats.**

CONCLUSION: AMERICA MUST BE READY ON THE DAY DETERRENCE FAILS

The United States currently spends about one-percent of its military budget on missile defense -- roughly $8 billion in a posture costing $600 billion annually. Small as that amount may sound, it overstates the share of resources allocated to national missile defense, because less than a fifth of the Missile Defense Agency's budget is expended on programs designed to defend the homeland. The actual amount spent each year on homeland missile defenses is $1-2 billion -- less than one in every thousand dollars dispersed annually by the federal government. The obvious implication is that national missile defense is not a federal priority, even though a large-scale nuclear attack is the only man-made threat that could wipe out the Republic in a brief amount of time.

The two fundamental reasons why national missile defense has been assigned such a low priority is that policymakers believe the current nuclear balance can be sustained indefinitely, and that effective defense against a determined attack by a major nuclear power such as Russia isn't practical. The first belief is faith-based, and over the long run probably untrue. There are too many ways in which offensively-based deterrence might fail, and the danger of such a failure grows as additional nations join the roster of nuclear-armed powers. Rationally or irrationally, deliberately or accidentally, nuclear deterrence will one day fail. If it fails on a large scale, that may be the day that American civilization goes the way of all previous civilizations. The question of whether effective defense of the homeland is feasible thus is a matter of national survival.

The notion that defense against large-scale missile attacks isn't practical tends to be self-fulfilling. If policymakers doubt a program can succeed then they won't fund it vigorously or consistently, nearly guaranteeing its failure. That is part of what has gone wrong with national missile defense in the quarter-century since the Cold War ended. The goals of missile-defense research and development have changed with each presidential administration, providing too little time for new concepts to be tested and deployed. While the current goal of defending the homeland against small attacks launched by North Korea or Iran is certainly worthwhile, it leaves much of the nuclear threat spectrum unaddressed -- at least by active defenses. The bigger threats are consigned to the category of "too hard to do," depriving Americans of any hope on the day deterrence fails.

In a purely logical sense, it is impossible to say effective missile defense is not feasible because there is no way of knowing how deterrence will fail. The traditional approach of missile-defense doubters has been to postulate the most stressing threat, and then describe the many ways in which active defenses might be circumvented or suppressed. But just as there are many ways in which deterrence might fail, so there are many kinds of nuclear attacks that might result. Some will be very challenging to defeat, while others might be negated by no more than the Ground-based Midcourse Defense system that the U.S. already has deployed. The simplest way to address a wider array of nuclear threats is to scale up existing programs like GMD and Aegis, increasing the number of sensors and interceptors while gradually improving the quality of hardware and software.

The Missile Defense Agency has several such initiatives under way today, such as the plan to replace the existing "exoatmospheric kill vehicle" on ground-based interceptors with a more reliable system. On the other hand, the agency has recently canceled programs that could be crucial to a resilient homeland defense, such as the Space-based Tracking and Surveillance System designed to enable precise "birth-to-death" tracking of incoming warheads. The latter decision was made mainly for budgetary reasons, and reflects how under-resourced national missile defense is. The level of funding is so low that budgets could be increased tenfold without materially impacting the government's fiscal health. What tends to get lost in budget deliberations is that failing to give missile defense of the homeland the priority it deserves could have catastrophic consequences for everything else the government does. Congress needs to give this critical mission more resources while there still is time.

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