What is Ballistic Missile Defense?

A ballistic missile defense system detects, tracks, intercepts and destroys incoming ballistic missiles or their warheads. A fully operational defense consists of sensors to detect a missile launch and to track the missile and warhead; an interceptor to disable or destroy the missile or warhead; and a command and control system. A missile can be destroyed by fragmentation warheads that explode in its vicinity or by more modern “hit-to-kill” technologies – i.e., by “hitting a bullet with a bullet.” Both types of intercept are known as “kinetic kill.” And work is also moving forward on directed energy technologies, which can destroy a missile and its deadly warhead at the speed of light.

Missile defense systems can be deployed on the ground, in the air, at sea, or in space. The United States currently operates missile defense systems such as the Ground-based Midcourse Defense (GMD) and the Theater High Altitude Defense (THAAD), together with the sea-based Aegis Ballistic Missile Defense System. Thus far, however, the United States has failed to deploy the most robust and effective kind of defense, a space-based missile defense system building upon earlier successes such as Brilliant Pebbles.

Why do we need missile defense?

Missile threats emanate from across the globe and in various forms. North Korea has hundreds of shorter-range ballistic missiles, is developing long-range ballistic missiles, and now has several nuclear weapons – and is building more. Iran has a large and growing ballistic missile inventory and is developing a nuclear weapons capability. Both are hostile to the United States. The willingness of North Korea, Iran, and even China and Russia to proliferate missile technologies raises further the likelihood that a nuclear weapon could fall into terrorist hands.

In fact, nuclear weapons are in the hands of unstable states that may be infiltrated by terrorist groups such as Al Qaeda. Pakistan, for example, was at the center of a vast proliferation network that was headed by A.Q. Khan, who was the architect of the Pakistani nuclear program and later sold nuclear weapons knowhow and hardware to terrorist sponsoring countries, including Libya, Iran, and North Korea.

Missile threats are not limited to intercontinental-range missiles. Short-range missiles, even SCUDs, can be launched on the United States from ships off our shores. Iran reportedly has launched a ballistic missile from a ship in a way that suggests they are working to achieve an EMP capability. Nuclear-armed terrorists who could purchase a SCUD for a few million dollars could also launch an EMP attack. Meanwhile, China and Russia, strategic competitors of the United States, continue to develop new and sophisticated strategic systems as part of their respective military modernization programs, even though our limited missile defenses are not designed to defend against a major nuclear attack.

There also is a potentially grave threat from an Electromagnetic Pulse (EMP) attack delivered by a ballistic missile. According to the 2004 congressionally-mandated EMP Commission, the United States faces an EMP threat that could have catastrophic consequences based on the detonation of even a single nuclear warhead. An EMP is generated by a nuclear weapon burst at any altitude above a few dozen kilometers, with the height of the burst determining the area exposed to EMP. Several potential enemies already have, or could soon acquire, an EMP capability. A weapon exploded over the center of the United States would produce catastrophic damage affecting the entire country. Without power, every aspect of the American economy would suffer, including food and water supply, transportation, finance, energy, emergency services, satellites, and national security. Our country would be reduced to a preindustrial level from which it might never recover. The devastating and irreversible consequences of an EMP attack are depicted in William Forstchen’s recent novel, One Second After (2009).
The United States does now have a very limited missile defense. It consists of 26 ground-based interceptor missiles (GBIs) deployed in Alaska and California which are designed to defend against certain kinds of long-range missile attacks from certain parts of the world, such as North Korea. The United States Navy also has 21 ships equipped with the Aegis Ballistic Missile Defense System, which currently is capable of intercepting short – and medium-range missiles – and in the future these and dozens more ships in the Aegis fleet of over 80 ships could be outfitted with missile defense interceptors improved to shoot down in their boost or ascent stage long-range ballistic missiles launched against the United States or its allies. The Aegis system could be given the technological capability to destroy missiles launched from ships off our shores. This would be an important step we could take in the near term to counter the EMP threat.

Furthermore, initial agreements were signed with the Czech Republic and Poland to deploy a new radar and interceptors, but whether these will actually be deployed remains to be seen.

The Obama administration’s 2010 defense budget reduced missile defense investment by almost 15 percent, from $10.92 billion in 2009 to $9.3 billion. This significant cutback has already resulted in funding reductions or the elimination of a number of potentially important missile defense systems previously under various stages of development. Programs severely cut include the Airborne Laser (ABL) program, the Multiple Kill Vehicle (MKV), and Kinetic Energy Interceptor (KEI) programs.

On the positive side, however, the 2010 budget has proposed to increase funding for the sea-based Aegis Ballistic Missile Defense System by more than 60 percent to about $2 billion. Notably, a land-based version of the Navy’s Standard Missile-3 (SM-3) is being considered for deployment in Turkey to defend against Iranian ballistic missiles. A new emphasis on short range threats has also led to funding increases for the short-range Terminal High Altitude Area Defense (THAAD) – from $104.8 million in 2009 to $420.3 million in 2010 – and the SM-3 sea-based interceptor programs – from $56.8 million in 2009 to $168.7 million in 2010.

These programs still fall far short of the robust and layered defense America needs to defend itself against the ballistic missile threat.

Developed twenty years ago, Brilliant Pebbles is a highly maneuverable space-based missile defense system, designed to consist of about 1,000 small satellites, or “pebbles,” in orbit several hundred kilometers above the Earth’s surface, capable of destroying as many as 200 nuclear warheads. Other versions designed to defend against heavier attacks were proposed that would have had several thousand “pebbles.” Weighing only 45 kg and no larger than a large watermelon, each Brilliant Pebble would detect, track and intercept hostile missiles within its field of view. In the event that such a missile was launched, sensors on each Pebble would detect and locate the origin of the launch and immediately begin tracking the missile as it thrustted towards space, the missile rising slowly and vulnerably toward the Pebbles. Each Pebble knew the location of all Pebbles, and would calculate which was in the optimal position to intercept a given missile – and that Pebble would “take the shot” and inform the rest of the constellation of its decision. Thus, no potentially vulnerable central command post was needed in order to attain high defensive effectiveness.

The Pebbles would follow the entire path of attacking missiles, employing this battle management approach, and possible intercepts could occur early while the attacking missile was rising from its launch pad, or later in its flight outside of the Earth’s atmosphere, or even later as it was re-entering the atmosphere and approaching its target. Thus, Brilliant Pebbles was actually a layered defense with multiple engagement opportunities.

It was rigorously determined in thorough reviews, both inside and out of government, in 1989 and 1990 that the Brilliant Pebbles concept was the most efficient and reliable method of intercepting ballistic missiles. Utilizing off-the-shelf commercial technology, the production, launch, and operational costs of a Brilliant Pebbles constellation would be comparatively low compared to alternative means of defense against ballistic missile attacks.

The 1989 formal DoD cost estimate to develop, test, deploy, and operate a constellation of 1,000 Brilliant Pebbles (replacing each Pebble once during a 20-years operational lifetime with 1,000 in reserve) was $11 billion – or $19 billion in 2009 dollars. This figure should be compared to the total expenditure of $30.7 billion for the Ground-based Midcourse Defense (GMD) system now being deployed, which has an intercept capability limited to only a few hostile missiles.

That the Brilliant Pebbles operational concept is sound and affordable was demonstrated by the development and deployment (for about $5 billion) of the Iridium communications system, over a 5-year interval in the early 1990s, and its continuous operation ever since. This system of some 66 medium-sized satellites, operated by a handful of personnel – unlike the standing army involved in managing space operations of most military (and civil) space systems – employed many of the concepts conceived during the 1980s by the Brilliant Pebbles team.
In 2004, a report by the American Physical Society (APS) argued that a Brilliant Pebbles-like defense would be impractical to deploy because it would require huge increases America’s current space launch capacity. Is this true?

The Brilliant Pebbles analysis in the APS report was far removed from reality, relying upon assumptions which are simply incorrect. As the saying goes, “Garbage in, garbage out.”

First, the APS wrongly claimed that each Brilliant Pebble would be some twenty times heavier than the correct weight of 45 kg. This led to excessive launch cost estimates as noted below. The APS also asserted that 1,600 Brilliant Pebbles would need to be deployed in order to intercept as many as 200 nuclear warheads. In contrast, the far more extensive and expert reviews completed in 1989 and 1990 concluded that 1,000 Brilliant Pebbles would provide coverage sufficient to destroy up to 200 nuclear warheads with high confidence. Again, the APS study relied on incorrect data and flawed assumptions to produce incorrect conclusions.

The APS also claimed that deployment would require the United States to increase its annual space launch capacity by five or ten times in order to deploy the system over a three-year period. Today – as was the case in 1989-93, when the total Brilliant Pebbles launch costs were estimated to be about $1 billion in 1989 dollars – the United States has the space launch capacity to deploy the 1,000 required Brilliant Pebbles by using medium-launch or heavy-lift rockets within the existing Delta-or Atlas-series. Each of these commercial space-launch vehicles is capable of lifting well over a hundred 45 kg Brilliant Pebbles into orbit, and deployment would pose no major issues with regards to launch capabilities.

The robust and cost-effective Brilliant Pebbles system of the 1989-1990 period has become even more desirable given the considerable technological advances of the last two decades that would be available in a twenty-first-century version of Brilliant Pebbles.

We learn from our test failures as well as our successes, improving as we move forward with development, testing, and deployment. There now exists a substantial track record of success with a variety of missile interceptors under a variety of circumstances. While no weapon system in history has been perfect – and missile defense is no exception, the vast majority of missile defense tests have been successful. Still, since no one missile defense system can succeed perfectly, a layered defense should be deployed to provide redundancy and compensate for any technical difficulties.

As discussed above, we had developed by the late 1980s all the technologies necessary for an advanced space-based missile defense called Brilliant Pebbles that would have given us several opportunities for intercepting a missile or its warhead during the several phases of its flight to its target. At that time the technology was clearly established as a result of thorough in-and-out-of-government reviews in 1989 leading to a March 1990 decision to proceed with the Brilliant Pebbles program.

Brilliant Pebbles survived numerous scientific and engineering peer reviews in the 1989-90 time period, including analyses by some groups hostile to space-based missile defenses and intensive “red team” analyses against advanced offensive countermeasures. The JASON, an elite advisory group not noted for its advocacy of missile defense programs, concluded that there were “no show shoppers” to developing and deploying Brilliant Pebbles.

Despite the technical feasibility of proceeding with Brilliant Pebbles, opponents gained the upper hand politically. After the Pentagon’s acquisition authorities formally approved proceeding with the Brilliant Pebbles development program, it was curtailed by Congress in 1991-92 and finally cancelled by the Clinton Administration after it came to office in 1993 and before the defensive concept could be fully demonstrated by comprehensive testing. However, all of the key Brilliant Pebbles technologies were extensively demonstrated in the Clementine lunar mission in 1994, DoD’s first-and-thus-far-only mission into deep space.

The issue is not whether missile defense technologies will work. That missile defenses can work has long been established, and technologies continue to advance. The key issue is which defensive systems should be further developed and deployed.
Missile defense represents a relatively small part of the U.S. defense budget: in 2009 just about $10 billion out of a defense budget of more than $700 billion before the Administration announced cuts in missile defense. This means that missile defense comprises less than one seventieth of what the nation is spending each year for defense. This amount pales in comparison to the devastating consequences of even a single nuclear missile against an American city. Even during the Reagan Strategic Defense Initiative emphasizing defenses against missile attacks, the fraction of the DoD budget devoted to missile defense never rose even as high as 2 percent. The present investment level in defenses against missile attacks is also miniscule compared with the nearly $800 billion appropriated in the economic stimulus. Congress has rushed to spend at least $2 billion for the Cash for Clunkers program, while reducing the missile defense budget by nearly that amount. In addition to protecting people and jobs, missile defense itself creates jobs.

It is impossible to calculate the cost of a devastating attack on one or more of our major cities that could have been prevented by missile defense. As in the case of 9/11, we would never know precisely how much lost talent, earning power, and the overall contribution to our society there would have been if so many highly productive people had not died. But in place of the 3,000 fatalities resulting from the 9/11 attacks, we could face losses in the hundreds of thousands. Unlike the 9/11 tragedy, the deaths would be complemented by massive numbers of injuries, such as burns, radiation sickness, cancers, and other untold horrors. One may ask whether the cost of an insurance policy is worth the amount we are called on to pay, contrasted with other ways that finite financial resources could be spent or invested. Missile defense can also be regarded as form of catastrophic insurance policy.

The cost of missile defense also depends on the type of system and the threat against which it is deployed. During the Cold War, an effective missile defense would have had to destroy large numbers of Soviet warheads. With the end of the Cold War, the threat has been drastically reduced. The more modest missile defense now being pursued is not designed to intercept even the reduced numbers of Russian missiles and warheads or the nuclear force being deployed by China, and is instead configured only against a few missiles and warheads such as might be launched by North Korea or Iran. Whether the United States should not also defend against, for example, the growing Chinese missile arsenal, is a serious strategic question that needs to be considered. Secretary of State Hillary Clinton has declared that the United States will need to offer a “defense umbrella” to allies especially in the Middle East if Iran acquires nuclear weapons. This will require more, not less, investment in missile defense. The most effective way to do this would be to deploy space-based kinetic interceptors, along the lines of Brilliant Pebbles, building on the Brilliant Pebbles design of a generation ago and benefiting from improvements since that time.
Missile defense will weaponize space, which should remain free of weapons.

Since 1967 we have had an Outer Space Treaty that prohibits stationing weapons of mass destruction in space. Such weapons are considered to be offensive weapons. The purpose of missile defense, by contrast, is to defend against weapons of mass destruction.

The 1967 Outer Space Treaty already limits the use of outer space to “peaceful purposes.” It has long been established that “peaceful purposes” means “non-aggressive purposes,” and the right to self defense is expressly recognized by Article 51 of the UN Charter. Almost identical language appears in the Law of the Sea Convention, yet no serious person has argued that warships are banned from the high seas. Indeed, just as the Law of the Sea Convention includes several references to military activities at sea, the Outer Space Treaty includes references to military activities in outer space.

Ballistic missiles spend much of their trajectory in space as they move from Earth to their designated target. It is for this reason that space-based defenses like Brilliant Pebbles (pre-orbited and pre-accelerated closer to the path of an enemy missile) would be so effective. Destroying a missile by colliding with it, Brilliant Pebbles would not employ nuclear weapons (or any explosive for that matter) and thus would not violate the 1967 Outer Space Treaty. Indeed, it would employ non-nuclear means to destroy nuclear weapons aimed at the United States or our allies and friends, making Brilliant Pebbles clearly a defensive instrument.

We should conclude a treaty that bans space-based missile defense because space weapons can also destroy satellites.

This is tantamount to asserting that an automobile driven recklessly can kill people and therefore that automobiles should be banned. Like automobiles, how technologies are used depends upon those who use them. Many other examples of dual use technologies and instruments could be offered. For example, think of kitchen knives and the lethal uses to which they could be put.

Furthermore, it is difficult, and probably impossible, to define what is a space weapon. For example, ground-based systems can also be used to destroy satellites in space, as seen by China’s unanticipated destruction of a weather satellite in January 2007 using a ballistic missile launched from within China. Because objects in space can be targeted either from the ground or from space by satellites that appear benign, our ability to define a “space weapon” in a treaty is highly doubtful – as demonstrated by previous arms control negotiations that dealt with these issues. And if one cannot satisfactorily define a space weapon, one cannot ban it in a treaty. Extensive discussions and negotiations over time have shown this to be true.

Space treaty proposals which would ban space-based interceptors while allowing ground-based anti-satellite weapons would do little to protect satellites but much to keep the United States vulnerable to hostile missiles aimed at targets here on Earth. Furthermore, any medium – or long-range ballistic missile is potentially capable of shooting down low-Earth-orbit satellites.

Some are urging that the United States sign on to a draft treaty currently being circulated by Russia and China. The only possible result of doing so would be to tie our hands while leaving our potential adversaries to continue existing space programs and commence new ones. Recognizing that verification – which President Reagan (“Trust but verify”) recognized was essential to any meaningful arms control agreement – in this area will be virtually impossible, Article VI of the draft treaty simply provides that verification measures may be agreed upon at some future date. The treaty provides no limitations on ground-based anti-satellite systems, or space-based systems that arguably have a “dual use.” Any effort to strengthen such a treaty to prohibit space-based systems that have a military purpose might arguably require us to destroy our GPS, communications, and weather satellites – which provide tremendous assistance to our military in wartime – without getting anything of value back in return. This would decrease our ability to predict deadly hurricanes and impede emergency response vehicles that now find their way to fires and medical emergencies by GPS satellites.

In February 2008, the United States also destroyed a decaying U.S. satellite with a shot from the cruiser USS Lake Erie, based in the Pacific Ocean – here, too, the launch came from the surface of the Earth. The U.S. launch demonstrated how an existing defense against short and medium range ballistic missiles could quickly be modified to shoot down a satellite moving slightly faster than an intercontinental ballistic missile, with only several weeks of preparation – primarily by software modifications. Clearly, advanced technology now enables us to disable or destroy a target moving at high speed – not only to hit a bullet with a bullet, but to strike even a part of the bullet with a bullet.
The United States should set an example for the world by foregoing the use of space for military purposes, including space-based missile defenses.

Space is already weaponized. Ballistic missiles fly much of their total flight trajectory to their targets through space. In a sense, space became weaponized when the first German V-2 rocket was launched against targets in England in 1944 and in the months that followed before the war in Europe ended in May 1945. Orbiting satellites also serve many military functions for the owners, including early warning and surveillance systems, command and control, and communications. And they are the equivalent to “gunsights in space” because of their utility in helping various operators to direct their fire at enemy targets on the ground. As such space capabilities become more extensive and commonplace, it is even less likely that space can be expected to remain the sanctuary free of military operations that many idealists desire. They have become critical for keeping casualties and costs low and effectivenesses high for U.S. air, land, and sea military operations. We are highly dependent on satellite-based systems for our daily lives and our military – our enemies recognize that this is our Achilles Heel and we need the ability to protect our satellites from attack.

Space is a place, not a sanctuary. Space technologies, like technology in general, are dual-use – they can be employed for civilian or military purposes – and for offensive and defensive purposes. More and more countries are gaining access to space technologies, which increasingly are available for civilian or military use. For the United States to restrict itself in the use of space would impose a huge handicap with ever more severe adverse commercial and military consequences.

Missile defense has evolved through administrations of both parties even though President Reagan made a decisive breakthrough in accelerating missile defense research and development. Like the cell phone, which incorporates latest and best available technologies, missile defense should be based on a commitment to use optimal means to defend against missile attack. Democrats and Republicans are equally vulnerable to the effects of a missile launch against the United States. An EMP attack would have catastrophic consequences for all Americans. Ballistic missiles and EMP do not distinguish between people according to political party affiliation. Missile defense would protect Democrats and Republicans as well as Independents. Therefore, missile defense should not be seen as a partisan issue.

Isn’t Missile defense more a Republican than a Democratic party issue?

This argument is based on outmoded Cold War thinking associated with the strategy of Mutual Assured Destruction (MAD). During the Cold War, the United States held its own population hostage to the intentions of its adversary. If the Soviet Union attacked the United States with nuclear-armed ballistic missiles, the United States would retaliate in kind. This mutual vulnerability was also known as the “balance of terror.”

We then assumed that both we and the Soviet Union so valued our survival that neither would initiate a nuclear war. But today we face enemies who threaten mass murder and who may not be deterred by the threat of retaliation leading to their destruction. Suicide bombers and the 9/11 hijackers have demonstrated a willingness to sacrifice their own lives to attack the United States, and that they believe such attacks make them martyrs, justifying rewards in the hereafter.

The first obligation of the U.S. government is to provide for the common defense of our population. It would be of little consolation to the millions of dead Americans that we could inflict similar carnage on another country’s population. We should ask our political leaders why we should not defend our population if we have the means to do so.

Our ability to retaliate with nuclear weapons will be sufficient to deter an attack on the United States or its allies.
The threat of missile attack is less likely than a suitcase bomb smuggled into the country and exploded in a city.

The United States must work to defend against any weapon of mass destruction, whether delivered by missile or non-missile means. Of course, homeland defense and security planning must have as a major focus countering the potential smuggling of a nuclear weapon into the United States or the terrorist use of a “dirty bomb,” which uses an explosive charge to scatter radioactive materials and can be built using materials already here without the need therefore to smuggle them into the country.

Equally important is the need to defend against ballistic missiles, which remain a preeminent weapon of terror with potentially far greater consequences. Our enemies know well that a chemical, biological, or nuclear warhead delivered above a city can be far more devastating than one at ground level. We need a comprehensive homeland security strategy that addresses these and other threats that could have catastrophic consequences. Rogue states such as North Korea are quite willing to export ballistic missiles. Missiles have also been made increasingly available to terrorist organizations by Iran, as seen with Hezbollah’s launching hundreds of short-range missiles against Israel in 2006.

While guarding against other threats with potentially devastating consequences, we cannot ignore the fact that missiles are very attractive weapons which would not need to be smuggled into a country. They can be launched at an American city from a ship off the coast. Indeed, the US conducted a launch of a SCUD-like missile as long ago as 1947 from the deck of a surface ship off of the East Coast to examine the feasibility of such capabilities.

Missile defense must become a fundamental part of homeland security. The failure to develop a homeland security strategy that prominently features ballistic missile defense represents a grave error in strategic judgment.

This objection defies the experience of history. Repeatedly, we have been surprised by events that could not have been easily anticipated: Pearl Harbor, the various Cold War crises, including the Cuban Missile Crisis, and more recently 9/11. Although we cannot fully predict the next crisis, we can take prudent steps to protect the American people. In fact it is the fundamental duty of our government to guard against the most catastrophic threats.

It is possible to launch short-range missiles against the United States from ships off our coasts. These could come in the form of an attack against our coastal cities or from an EMP attack. (See Question 2.) The technologies needed for a short-range nuclear ballistic missile attack or an EMP launch against the United States are widely available. (See Question 2). Iran has already test-launched a ballistic missile from a ship in the Caspian Sea. A missile fired into the atmosphere off our East Coast could destroy much if not all of our entire electrical and electronic infrastructure. A nuclear missile launched against New York or Washington, D.C., would multiply by many times the devastation of the 9/11 attacks.

Iranian President Mahmoud Ahmadinejad has orated that a “world without America” is both possible and desirable. Missile defense can play a crucially important part in preventing an attack that would bring to fruition Ahmadinejad’s dire vision for the United States. This is why we need not only sea-based, but also space-based missile defenses. We simply cannot wish away the EMP threat or the threat of a nuclear strike against one or more of our cities. Instead, we can and must protect ourselves from such a catastrophe.

The ballistic missile threat to the United States is not imminent and, therefore, we have sufficient time before it fully materializes to develop necessary defenses against it.
Missile defenses will provoke a destabilizing arms race.

Arms races arise from political differences. States or individuals arm when they want to threaten others or to defend themselves. As political differences subside, so do arms races. Furthermore, the absence of missile defense has invited and encouraged the proliferation of ballistic missiles worldwide since the Cold War. During the Cold War, the 1972 ABM treaty prohibiting a national missile defense was followed by a huge build-up of missiles targeting the United States and its allies. In the absence of U.S. missile defense, the Soviet Union made large-scale investments in ballistic missiles and nuclear warheads.

As a notable aside, when the Soviets focused on building ballistic missiles capable of striking the United States in the 1950s, we had an extensive air defense system and no missile defense. Once we dismantled our air defenses in the 1960s, the Soviets increased their investment in long-range bombers as well. Therefore, it could be argued that having no or limited defenses is in fact provocative and leads to an increase of offensive threats to take advantage of the weakness.

Furthermore, the largest Soviet ICBM build-up occurred after the ABM Treaty was signed, after the US stopped deploying its Minuteman missiles, and after the single permitted US missile defense site in North Dakota was decommissioned. Harold Brown, President Carter's Secretary of Defense and a former member of the U.S. SALT/ABM Treaty Delegation, noted this ironic denial of the linkage argument in stating, "We build, they build; we stop, they build."

Indeed, many believe that the U.S. deployment of the Pershing II and Ground Launched Cruise Missiles in Europe, the Strategic Modernization Program, and especially the Strategic Defense Initiative under President Reagan led to the first major reductions in nuclear weapons in history. Actions speak louder than words.

Building a missile defense would not create any new threat to even our adversaries, but would simply enable us to protect our population from those who may not be deterred by the threat of retaliation. We and our allies have both the duty and the right to defend our populations and armed forces against such attacks. Among its benefits, missile defense would discourage our enemies and potential adversaries from spending money on programs to kill countless numbers of innocent Americans and permitting us to protect those people if deterrence fails.