The Continuing Impact of the Nuclear Revolution

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The advent of nuclear weapons with their tremendous increase in destructive force decisively shifted the balance between offensive and defensive forces. This change has profound implications in judging the wisdom of any plans to deploy defenses against ballistic missiles carrying nuclear warheads.

The history of warfare is replete with competition between offense and defense, from the sword and the shield to the struggle between assault troops and fortifications. World War II provides lessons on the relative effectiveness of offense and defense. The French attempted to erect an impenetrable defense in the form of the Maginot Line against Germany, only to have Adolf Hitler's mobile armored forces circumvent the defenses by taking a more northerly route. An innovative offense defeated a static defense. In the Battle of Britain, Hitler's Luftwaffe carried out repeated massive attacks against Britain. However, each mission suffered losses on the order of 10 percent, inflicted by the Royal Air Force, which was assisted by radar, a newly introduced technology, and cryptography, which together yielded warning of such attacks. As a consequence, the attacking forces were reduced by a third for each 10 sorties flown, a level of attrition that proved unacceptable. History contains many such examples of both successes and failures of defenses against conventional attacks.

Nuclear weapons, however, profoundly changed the relationship between offense and defense because they increased the explosive power of a payload of a given weight and size by a factor of one million—a very profound change indeed. The demands on the performance and reliability of defenses against an attack by even a single missile carrying a nuclear weapon must therefore be extremely high for the defense to be considered effective. When the Germans attacked Britain during World War II with primitive ballistic missiles, none were intercepted, but the damage was limited because the missiles carried conventional explosives. Had they carried nuclear warheads, a single missile would have devastated London. Defense against ballistic missiles is therefore a totally different problem depending on whether such missiles carry conventional or nuclear payloads.

Against this background, national missile defense has re-entered the national and international political agenda. The Anti-Ballistic Missile (ABM) Treaty, signed in 1972, explicitly forbids deployments of defenses that protect the entire territory of signatory nations against strategic ballistic missiles. The basis of this treaty was the mutual recognition during the Cold War that the United States and the Soviet Union had attained a strategic balance based on deterrence: neither side could launch a nuclear attack against the other without incurring the risk of a retaliatory strike that would produce unacceptable damage. To appreciate the extent of the potential destruction, it should be remembered that the combined yield of the two nuclear weapons that killed 250,000 people in Hiroshima and Nagasaki would equal only about one-tenth the yield of a single nuclear weapon in today's arsenal.

At the height of the Cold War, the United States and Soviet Union deployed more than 60,000 nuclear weapons in aggregate. Today the number of nuclear weapons in the world has shrunk by about one-half, with the overwhelming majority in the hands of Russia and the United States. At the same time, the so-called rogue states still have no nuclear weapons, although North Korea may have enough plutonium for one or two.

Nuclear weapons can be delivered to the U.S. homeland in many ways, of which the intercontinental ballistic missile is only one and the one requiring the most technological prowess. Nuclear weapons can be dropped from airplanes of almost any size, delivered by cruise missiles traveling in the earth's atmosphere, detonated on ships in US harbors, or even smuggled across land borders. The United States has no significant homeland air defense, and its borders are notoriously porous, as witnessed by the largely ineffective "war on drugs." Thus, a ballistic missile defense, even if it succeeded, would address only one avenue for the delivery of nuclear weapons. Moreover, rogue states are unlikely to adopt long-range missiles as their choice for nuclear weapons delivery because of cost and because the origin of the missiles is unambiguously traceable.

This was the situation during the Cold War, and this is the situation that remains today. The argument that deployment of a national missile defense could decrease US security is not a "relic of the Cold War" and does not reflect "Cold War thinking." The United States' vulnerability to delivery of nuclear explosives remains a fact that is difficult, if not impossible, to remedy by technical measures as long as nuclear weapons remain in the arsenals of the world.

The debate over missile defenses is complicated by the fact that ballistic missiles vary in range and can be used to attack military facilities and troop concentrations with conventional warheads. Theater missile defense (TMD), intended to defend smaller areas against short- to medium-range missile attacks, could be useful in defending US troops or military facilities against conventional attacks, whose impact could be significantly blunted by even partially effective defenses. This situation contrasts sharply with the use of defenses against nuclear warheads, where leakage of even a single nuclear warhead would have disastrous effects.

The ABM Treaty does not deal with TMD because the treaty's intention is to preserve strategic stability, and it is expected that TMD would be used chiefly in battlefield situations against missiles armed with conventional warheads. (The situation is complicated by the fact that in the case of defense of small nations, such as Taiwan, Israel, or even Japan, TMD could be perceived as providing a defense for the entire territory.) In 1997 the United States and Russia negotiated a demarcation agreement that defined the boundary between permitted and forbidden anti-missile deployments as measured by the character of the interceptor and the speed of the target to be intercepted. The demarcation agreement, however, has not as yet been formally submitted to the Senate for ratification, and it remains mired in congressional politics around the future of the ABM Treaty.

Clearly, the demands on the performance of missile defenses against nuclear weapons are extremely high. The question therefore becomes, do we have the technology needed to achieve this level of effectiveness? The table below illustrates the alternative means by which interceptors can destroy ballistic missiles. Each one of these approaches has its strengths and weaknesses. The table is divided into columns that delineate when the intercept of the incoming ICBM is to occur: during the boost phase, the time during which the missile booster is still burning; in midcourse, when the attacking missile is traveling outside the atmosphere; and after re-entry, once the offensive missile is approaching its target within the atmosphere.

In addition to the different locations of intercept, missile defenses can employ a variety of technologies. The interceptor can be guided by sensors employing radar or using infrared detectors registering thermal emissions from the target warheads. Sensors can be based on land, placed on aircraft, or deployed on orbiting satellites. The interceptor can destroy the incoming ICBM in a number of ways: by direct impact (hit-to-kill), by fragmentation of an explosive warhead, or through a nuclear detonation.

Boost Phase

Boost-phase intercept defenses have never been developed but are now apparently under serious consideration. During the boost phase, an ascending missile emits extremely intense infrared radiation, and therefore no decoy other than another booster can simulate a missile during this period of its trajectory. However the boost phase is very short, no longer than three minutes, and takes place near the launch site. A boost-phase interceptor must therefore be forward-based on a ship or aircraft or on friendly territory. Alternatively, coverage could be provided from space, but a

large number of satellites would be required for such coverage to be continuous.

Boost-phase intercept faces several problems. A decision to intercept on receipt of a putative signal indicating an ICBM launch has to be made in an exceedingly short time and may be subject to error. Additionally, the forward-basing requirement means that either the ships or aircraft that launch the interceptor are vulnerable to attack themselves. Moreover, most potential inland launch sites cannot be covered at all from sea or air. This disadvantage could, of course, be considered an advantage if the United States wanted to signal that the ABM system is intended solely to neutralize a rogue state, like North Korea, and is not capable of defending against inland launch from either Russia or China. Because boost-phase defenses intercept the ICBM before it can disperse a fragmented payload, they would also be effective against a missile that carried small multiple payloads, such as “bomblets,” which, although too small for nuclear weapons, might carry biological warfare agents.

Midcourse Intercept

Intercept while an enemy’s ICBM travels in the vacuum of outer space permits more decision time to commit an interceptor. However, its weakness is that, because light and heavy objects follow identical trajectories in the vacuum of outer space, the offensive ICBM could employ a number of techniques to deceive the intercept vehicle. For example, a substantial number of lightweight decoys could be deployed in parallel with the real warhead, making it difficult for the interceptor to discriminate between them. Such lightweight decoys can be designed to simulate the thermal emissions from the real warhead and even the fluctuation in such emissions or variations in reflected light caused by the warhead’s motion. Alternatively, the offense could employ “anti-simulation” countermeasures, in which the real warhead is enclosed in a light balloon, making it indistinguishable from a number of accompanying decoy balloons. Also, should the offense employ many small bomblets, the defense would have to attack each of the bomblets, which in practice would be impossible.

Terminal, or Reentry, Defense

Once the offensive missile’s payload is re-entering the atmosphere, it faces drag, which would distinguish lightweight decoys from the heavy warhead. Thus, the principal countermeasure available to the entering warhead would be to maneuver, hoping that the interceptor cannot keep up with such motions. However, terminal defense can only defend a limited area, and it would be ineffective against bomblets that could result in a very large number of identical entering targets.

The Clinton administration pursued plans for midcourse intercepts with the interceptors initially based at a single location. The initial ICBM trajectory was to be tracked by infrared sensors placed on orbiting satellites, followed by tracking by ground-based radars. Final hit-to-kill guidance was to be provided by infrared seekers located on the intercept vehicle itself. Ideally, the Clinton defense sought to cover the entire United States but would have left US allies unprotected. During the presidential campaign, the Clinton defense was opposed—and rightfully so—because of its vulnerability to decoys and fragmented warheads.

Moreover, since the Clinton defense was designed to defend only the United States, US allies heavily criticized the plans because they would have been left exposed as potential hostages to enemy attack and because they were concerned with the anticipated highly negative reaction of Russia and China. President Bill Clinton decided not to deploy the system after determining that, of his four criteria for deployment—technical readiness, a demonstrated threat, cost, and impact on relations with other states—neither adequate technical readiness nor acceptance by other nations had been achieved.

President George W. Bush reaffirmed his campaign commitment to the concept of a national missile defense in his speech on May 1, but he remained silent on how this goal is to be accomplished technically. The words the administration often uses are “multilayered defense,” meaning that the system would combine several of the basic options given in the table on the previous page, with emphasis given to boost-phase intercept. The cost of a multilayered defense would be much larger

than the estimated $60 billion the Clinton defense would have cost. Accepted designs for the architecture of such a defense do not exist, and the wisdom of going forward with such a defense hopefully will be critically examined during the strategic review that the administration is now conducting.

Research and development on missile defenses has been pursued for decades at an accumulated cost of some $100 billion in today's dollars. Nevertheless, the technical status of such defenses is such that the plans outlined by the president in his speech could not become reality during the next two presidential terms.
All ballistic missile defenses against nuclear weapons delivery result in an unfavorable exchange ratio relative to the offense. In other words, should the United States decide to deploy such defenses to reduce the vulnerability of this country, an adversary could increase or modify its offensive forces at a drastically lower cost and in a way that would leave the United States just as vulnerable. Thus, deployment of a US national missile defense, should a capable adversary nation such as China or Russia decide to respond by enhancing its strategic nuclear force, would simply escalate arms competition to higher levels of potential violence without actually protecting the United States.

Such an unfavorable exchange ratio may not be a sufficient argument against deploying missile defenses against rogue states, such as North Korea, which might not be able to afford to counteract such defenses even at moderate cost. It has therefore been difficult for some national leaders to reject proposals to defend their countries against possible threats from potential adversaries "of concern" or from unintended releases of a small number of nuclear-tipped missiles from any country.

For instance, under congressional pressure, President Lyndon Johnson proposed the Sentinel system to defend US cities against then-rogue-state China. But President Richard Nixon, recognizing the escalatory nature of the Sentinel system and a comparable Soviet system, negotiated the ABM Treaty and converted the Sentinel hardware to the terminal defense of US Minuteman missile sites. This system, called Safeguard, was eventually deployed at one site as permitted by the ABM Treaty, but operation was discontinued after less than one year once its limited effectiveness in relation to its operational cost was recognized.

The Clinton defense was designed to "walk the tightrope" by defending the nation against the ballistic missiles from today's rogue states—North Korea, Iran, and Iraq—and stopping accidental launches from Russia and China, while ostensibly not being sufficiently robust to blunt the deterrent forces of Moscow and Beijing. But China, Russia, and US allies did not find this limited objective credible.

In view of all the basic facts, the financial, political, and strategic costs outweigh the benefits of the limited protection a national missile defense could offer. An honest acknowledgment by the US leadership that technical means to prevent hostile nuclear detonation on US soil do not exist and are not in the offing would go a long way toward providing a realistic and honest basis for discussion on a national missile defense.

All the technical and economic facts concerning ballistic missile defense, combined with the availability of delivering nuclear weapons by means other than ballistic missiles, lead to an inescapable conclusion: In the nuclear weapons age, the world is condemned to live in an offense-dominated condition. That means that defenses cannot protect the United States from nuclear weapons. That goal has to be attained by dissuasion, where dissuasion means a combination of diplomacy and deterrence. Diplomacy must convince a potential adversary that its security will decrease rather than increase by acquisition and delivery of nuclear weapons, while deterrence implies that the US response would be unacceptable to the adversary if it crossed the nuclear threshold by actually using such weapons. Dissuasion has been effective for 55 years—notwithstanding the eruption of roughly 100 armed conflicts in that time, a tradition of "non-use" of nuclear weapons has prevailed since they were first employed against Japan.

Should this administration now decide to deploy missile defenses to protect the United States? Today there is nothing to deploy, and no system can be in place before the Bush administration leaves office. Thus, the current debate over missile defenses is a house of cards built on a nonexistent technical foundation. Other nations should not immediately feel militarily threatened by a

deployment decision, but such a decision would de facto abrogate the ABM Treaty and would place the entire arms control structure in jeopardy. Such a decision would profoundly and negatively affect political relations with Russia and China, as well as with NATO and the rest of the world. In particular, should China respond to US deployment plans by augmenting its now limited long-range missile force, both qualitatively and quantitatively, first India and then Pakistan are likely to respond in kind. US security would be diminished.

The revolution in warfare caused by the advent of nuclear weapons cannot be reversed. Scientific and technical facts cannot be coerced by policy. Defense of the nation, however well-intentioned, cannot be achieved by scientifically unsound means. President Bush should reconsider his approach to national missile defense and await the outcome of a balanced and thorough analysis of the fundamental issues.

Intercept Options			
	Stage at which ICBM is intercepted		
	Boost Phase	**Midcourse**	**Re-Entry**
Coverage	Large	Large	Small
Countermeasures	Very difficult	Easy decoys	Maneuvering target
Interceptor launch location	Forward presence or space	Flexible, depends on range	Near defended area
Vulnerability of interceptor launcher	Generally large	Generally small	Small
Decision time to commit to intercept	Less than three minutes	15-30 minutes	About 30 minutes
Effectiveness against fragmenting warhead	Good	Nil	Very limited
Economic exchange ratio of defense if ICBM carries nuclear warhead	Poor	Poor	Poor

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