Space Weapons or Space Arms Control?[1]

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Now is the time for nations to discuss and possibly to negotiate a ban on weapons in space and on antisatellite tests. The U.S. Congress should think more deeply than it has yet about the threats to the United States and the cost and effectiveness of various defenses. Since the resources for National Missile Defense could be used for competing military needs, as well as for other needs of the society that NMD is supposed to protect, major attention should be given to cheaper and more effective systems such as boost-phase intercept (BPI) for National Missile Defense. The summer 2000 decision President Clinton has promised to make regarding deployment of the National Missile Defense system under development should be "No," and the NMD development program should be scaled back in view of its inability to deal at all with bomblet payloads for BW agents, and with nuclear warheads in anti-simulation balloons accompanied by balloon decoys.

Introduction

MOST OF US in this room remember the sudden transition to the era of artificial Earth satellites, with the launch of the Soviet Sputnik on 4 October 1957. After almost fifty years, satellite services have become a part of daily life, providing services more cheaply or better than can otherwise be achieved. In the commercial or civilian field, there are satellites for weather observation, for communication, both fixed and mobile, for navigation, for distribution and broadcast of television, for commercial imaging, and the like. For the militaries of the world, and especially for the armed forces of the United States, we have benefited for thirty years from the Defense Support Program (DSP) satellites that see within a minute the launch of a

[1] This paper was delivered as part of the symposium "Ballistic Missile Defense, Space, and the Danger of Nuclear War," on 29 April 2000. It has also been made available on the Society's website, at www.aps-pub.com/star_wars/star_wars_toc.htm. This symposium also included papers by Roald Z. Sagdeev and John Steinbruner.

ballistic missile from almost anywhere on Earth. Beginning with the CORONA series of film return imaging satellites that had more than a hundred successful launches from 1960 to 1972, the U.S. has deployed an increasingly capable system on imaging satellites, which for the last twenty years or so have been electro-optical in nature, transmitting the images in near-real time.

Both civilian and military activities have been aided for the past decade by the Global Positioning System (GPS), for which hand-held receivers will give location to better than ten meters accuracy (or 100 meters for the ordinary user when "selective availability" is imposed to limit the accuracy of non-governmental users). In fact, GPS is routinely used for surveying to a relative accuracy better than one millimeter. It guides U.S. cruise missiles and can guide ballistic missiles to their targets with an accuracy of meters or less. In 1999, U.S. forces began to use bombs guided by GPS.

Thirty years ago I chaired for the President's Science Advisory Committee a Panel on Air Traffic Control, which in a 1971 report recommended the transition within the 1970s of the air traffic control system to one that depended entirely on satellites for communication with aircraft, independent monitoring of aircraft positions, and the provision of accurate navigation services. Both monitoring and navigation would depend upon time-difference of arrival, in just the way that GPS has evolved. This would still be a good approach, and ought to be the subject of an initiative by the G7 nations.

The U.S. no longer has a monopoly in space. Long-lived communication satellites to be placed in geosynchronous orbit are built by others as well, and many launches are carried out by the European Space Agency, with the Ariane booster, as well as by Russia and China. The evolving constellation of classified U.S. imaging satellites is now supplemented by commercial imagery with resolution as good as one meter. Iridium has come and gone, with more than sixty perfectly good satellites to be de-orbited over the next year or so.

Hundreds of satellites now present in space benefit the people of the world both economically and by their contribution to international security. Satellites range from those that broadcast television and radio, to voice and data communication, to GPS and GLONASS for precision navigation, to weather and commercial imagery satellites, to high-performance reconnaissance satellites. In addition, satellites routinely detect the launch of ballistic missiles, a capability that is increasingly being shared among nations. Scientific satellites for astronomy and for Earth observation are revolutionizing our understanding of the universe and of our planet.

Thus far, activities in space have proceeded without much conflict.

Means have been found for regulation and agreement to minimize interference in the radio spectrum, while making more efficient use of limited spectrum resources. The Outer Space Treaty bars the stationing of nuclear weapons in space, or "other weapons of mass destruction." And nations are responsible for damages that their space activities may cause to others, perhaps including destruction of the space assets of another nation.

The situation is complicated by the volume of private commercial activity in space, often in the form of international consortia in large complexes of communication satellites, in the production of commercial imagery, and the like.

Space Weapons

Ballistic missiles that arc through space are not classed as space weapons. Rockets that orbit and that can attack satellites or missiles are. The BAMBI system of orbiting interceptors to strike ballistic missiles in their boost phase was considered in the 1960s, and it has its counterpart in the miniature homing kill vehicles ("Brilliant Pebbles") advocated in the Star Wars era of the 1980s and by some even now.

The next speaker, Dr. David Finkleman, takes the other tack—that we have long had "weapons" in space (in the form of these military support systems), so we should have no inhibitions about deploying more (and ones that are unambiguous weapons such as space-based laser weapons and homing kill vehicles).

President Ronald Reagan, in his speech of 23 March 1983, asked the rhetorical question whether we might base our security not on the threat of retaliation against Soviet nuclear attack, but by living absolutely protected against nuclear weapons. The outpouring of funds in the ensuing Strategic Defense Initiative—SDI—energized a lot of technical work (and even more rhetoric) about space-based beam weapons—neutral particle (hydrogen atom) beams or space-based lasers.

The prospect of denial of peaceful use of space is what led the nations of the world to adopt the Outer Space Treaty. In reality, stationing a few nuclear weapons in space is far more costly than providing for their delivery against targets on Earth, as needed. Beyond nuclear weapons, there have been proposals for stationing thousands of small interceptor rockets in space, to destroy ballistic missiles in flight trajectory, and there is a good deal of enthusiasm in the U.S. Air Force for stationing powerful lasers in space for attack of targets in space, in the air, and on the ground.

If one had a single laser in space, it might take hours or days for the Earth to rotate and the laser to be at an appropriate point in its orbit to threaten a target on the ground or in the air. However, a substantial number of weapons in space might be able to destroy targets within minutes of the command to do so, if the targets were visible and not below clouds. The prospect of such weapons in space leads immediately to the consideration of counters to space weapons.

Antisatellite Weapons

Just because space weapons, unopposed, can have significant capability, both those contemplating the deployment of such weapons and those who might be on the receiving side have long considered how to counter them. In the Cold War era, it was perfectly clear that deployment of space weapons by the Soviet Union would have led to effective ASAT deployed by the United States; conversely, the Soviet Union was fully capable of providing the necessary ASAT to counter U.S. space weapons. This was true even in the case of what were supposed to be relatively low cost "brilliant pebbles," deployed by the many thousands in order to counter Soviet ICBMs and submarine-launched bal-

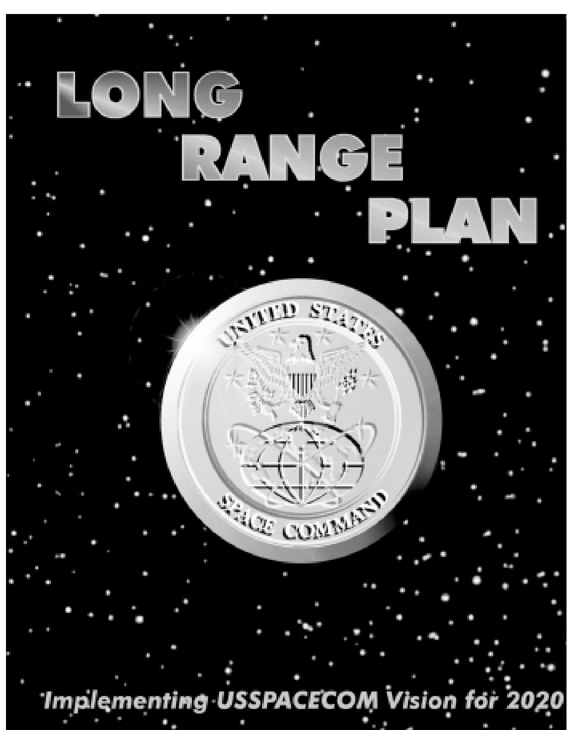

FIGURE 1. Cover of "Long Range Plan of SPACECOM" (March 1998)

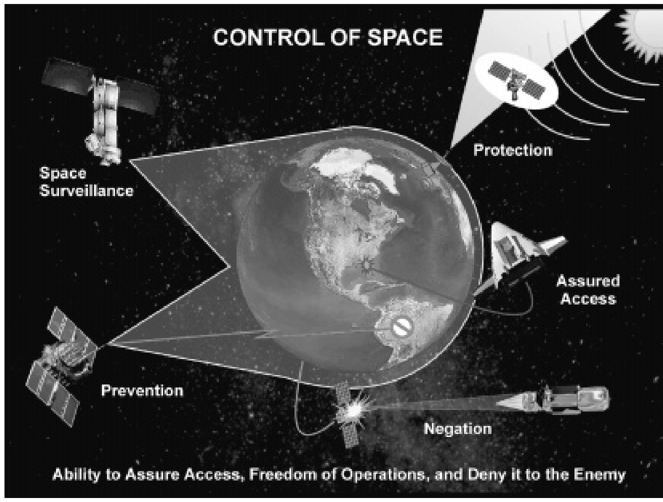

FIGURE 2. Figure 5-2 of "Long Range Plan of SPACECOM," "Concepts of Operations for Control of Space"

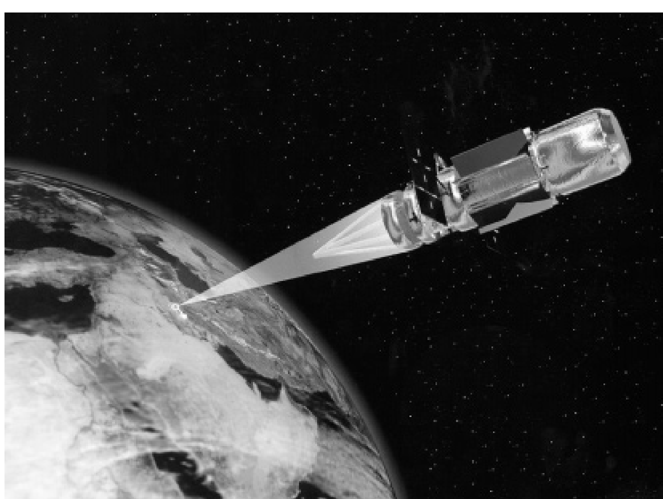

FIGURE 3. Inside of back page of U.S. SPACECOM "Vision for 2020" (February 1987)

listic missiles (SLBMs). But a simple analysis shows that it is far easier and cheaper to destroy such satellites by ground-based ASAT, as their population is being built up in space.[2]

[2] R. L. Garwin, "Brilliant pebbles won't do," *Nature* 345 (5 July 1990), 21.

Neither the motivation nor the capability is so clear in a world in which Russia no longer is an enemy of the United States, and vice versa. Therefore, no individual nation has so strong a motivation as previously to counter the deployment of space weapons. To the extent that space weaponry would be seen to confer hegemony, nations or consortia of nations would oppose them.

In the absence of adequate international agreements to protect its activities in space (and the United States government is not at present apparently seeking such agreements), the United States Department of Defense has launched a Space Control Technology Program that will include elements of "protection, prevention, negation, and surveillance" of various space activities. The goal is often stated as "space control," which conjures up the vision of antisatellite weapons (ASAT) that could destroy satellites at will. Publications of the U.S. Space Command illustrate this point, as shown in Figures 1–3.

In 1999 Bob Bell of the U.S. National Security Council spoke about space control as follows: "We need not be victim to 'old think.' The old-think Cold War mentality was that we envision space control as ASAT, and we equate ASAT with a dedicated system that went up and destroyed something."[3]

Apparently Bell emphasizes options such as destroying or jamming the link between an adversary's satellite and the Earth. Unfortunately, many satellites are extremely vulnerable to destruction by weapons launched from the ground—ASAT or antisatellite weapons. The Soviet Union tested many times a so-called co-orbital ASAT, which was launched into an orbit similar to that of the quarry satellite, and after an orbit or so moved close enough so that an explosion could propel pellets of the ASAT warhead to destroy the quarry satellite.

The United States has had development programs for ASAT weapons. It had deployed two nuclear-armed ASAT systems but destroyed them long ago. More recently it developed the miniature homing vehicle (MHV) technology, for a weapon that could be launched from an F-15 or other aircraft, that would not enter orbit but that would simply arrive at the right time to meet a satellite in low-Earth orbit (LEO) and collide with it. This is the same technology that is being deployed with the Patriot short-range Theater Missile Defense (TMD) system, and has been chosen for longer-range TMD and for the interceptor for the proposed National Missile Defense (NMD) system. Destroying a satellite is far

[3] Stewart M. Powell, "Bell at the White House," *Air Force Magazine*, February 1999, pp. 41–42.

simpler than destroying a warhead carried on a reentry vehicle for several reasons:

- The satellite is far more fragile than is a nuclear warhead equipped with reentry vehicle.
- The satellite follows a highly predictable trajectory.
- The satellite is considerably larger than a warhead.
- The intercept time can be chosen, for the most part, at the convenience of the attacker, and the attack can take place within a short range of ground-based radars or laser systems to aid the attack.

The optimum ASAT system would be a ground-launched rocket carrying an MHV—capable simply of rising to an altitude of 500 km or so, to be able to reach the satellite that would be under attack.

It is not so easy to destroy a satellite in geosynchronous orbit, such as are most of the TV broadcast satellites and some weather satellites, or even in intermediate Earth orbit (MEO) such as the navigation satellites—GPS. But many valuable systems are in LEO, and some of them in small numbers and of the greatest importance to international security. These include the systems long known as National Technical Means (NTM) that are protected against bilateral attack by the ABM Treaty of 1972 and the SALT Agreements.

In 1983, I testified to the Senate Foreign Relations Committee in support of a draft treaty limiting antisatellite weapons, presented to that same committee in May 1983 by the Union of Concerned Scientists. I had played a role in drafting the proposed treaty.[4]

The first two articles of the draft read

Article I

Each Party undertakes not to destroy, damage, render inoperable or change the flight trajectory of space objects of other States.

Article II

1. Each Party undertakes not to place in orbit around the Earth weapons for destroying, damaging, rendering inoperable, or changing the flight trajectory of space objects, or for damaging objects in the atmosphere or on the ground.
2. Each Party undertakes not to install such weapons on celestial bodies, or station such weapons in outer space in any other manner.
3. Each Party undertakes not to test such weapons in space or against space objects.

[4] "Space Weapons," joint articles—"History and current debate," by R. L. Garwin and J. E. Pike, "Effect on strategic stability," by Y. P. Velikhov, and "A treaty limiting anti-satellite weapons," draft treaty (pp. 10S–11S), *Bulletin of the Atomic Scientists*, May 1984, 2S–15S.

Although some participants in the CD argue that there is at present no arms race in space and no reason to negotiate or even to discuss space arms control, I believe that the best time to introduce such treaties and regulations is when there is not active conflict or even an approach to conflict in space. To this end, I quote the final paragraph in my testimony of 18 May 1983:

> . . . we can urgently negotiate a treaty along the lines of the Draft presented here, or we can see the wealth and security of our nation imperiled by a needless conflict in space, brought about by a greater desire for advantage than for mutual benefit, and fostered by emerging doctrine and organizations which regard space as an opportunity for conflict rather than the marvelous tool and environment which it is. We can try to make space safe for all non-weapon activities, or we can risk our own continued military and civil use of space.

I believe that a consensus has evolved since 1984 to the effect that military uses of space are permitted, but that weapons in space are problematical and could be very destabilizing. My own view is that if there are weapons in space, then there will be extensive development and deployment of ASAT, in order to negate those weapons. Furthermore, it is relatively easy, as I indicated in my previous writings, to deploy "space mines," which could be very small and relatively crude satellites that could provide a rapid capability of destroying valuable space assets. I believe that the time is now for the nations capable of developing ASAT or of putting weapons into space to discuss such matters and to draft agreements with the aim of preventing deployment of space weapons and of preventing tests of antisatellite weapons.

If we deploy space-based lasers (hydrogen fluoride or deuterium fluoride "chemical lasers"—megawatt class, with mirrors ten meters or more in diameter) is there any doubt that France and Russia will do the same? And that we will build ASATs and space mines to counter these, and that many nations will build ground-based interceptors to counter them AND to counter our vital imaging, communications, and navigation satellites? Even if weaponization of space is ultimately inevitable, like our own deaths, why should we rush to embrace it?

Defense against Ballistic Missiles

Although the Soviet Union built, and Russia continues to operate, a substantial nuclear-armed defense of the Moscow area against strategic ballistic missiles, the current focus of attention in missile defense is the system in development by the United States and scheduled for deployment decision in July 2000. This "National Missile Defense" is nominally now described as having a capability to deny access to any portion of the fifty states by long-range missiles carrying strategic warheads (biological weapons or nuclear weapons) and launched by one of a few "rogue nations." The system is proposed to handle with high effectiveness four or five or "a few tens" of warheads. It is always said that it would have also a subsidiary capability to guard against accidental or unauthorized launches by China or Russia.

The proposed NMD system would consist of upgraded early warning radars, additional BMD x-band radars, ground-based interceptors initially based in Alaska and North Dakota, and augmented space observation capabilities in high Earth orbit and low Earth orbit.

I have written and spoken extensively recently and over the last decades to explain my judgment that this system will be ineffective even against the stated threat. The reason is simple—any nation that can build an ICBM can readily arrange that a payload of biological warfare agent would be dispensed in bomblet form just after the powered flight phase of the rocket. Bomblets weighing a kilogram or less would be so numerous that they could not possibly be intercepted by the proposed system. A nuclear warhead could be surrounded by an enclosing balloon, making it easy to deploy dozens of similar empty balloons to serve as effective decoys. A U.S. government document of September 1999[5] summarizes a classified National Intelligence Estimate regarding countermeasures. It notes:

- Russia and China each have developed numerous countermeasures and probably are willing to sell the requisite technologies.
- Many countries, such as North Korea, Iran, and Iraq probably would rely initially on readily available technology—including separating RVs, spin-stabilized RVs, RV reorientation, radar absorbing material (RAM), booster fragmentation, low-power jammers, chaff, and simple (balloon) decoys—to develop penetration aids and countermeasures.
- These countries could develop countermeasures based on these technologies by the time they flight test their missiles.

In his prepared speech, Dr. Finkleman criticizes such objections to NMD as uninformed, and argues that many who doubt that we have the technology for effective defense doubted that we had the technology to go to the Moon. No doubt he can find someone who fits this description, but public programs need to stand up to informed criti-

[5] "Foreign Missile Developments and the Ballistic Missile Threat to the United States Through 2015," National Intelligence Council (September 1999) available at http://www.fas.org/irp/threat/missile/nie99msl.htm

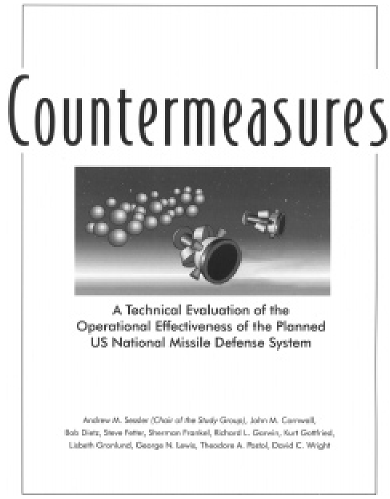

FIGURE 4. Front cover of "Countermeasures"

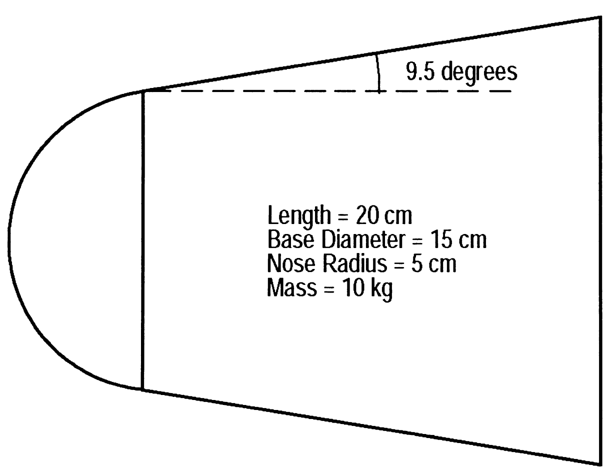

Figure 7-1. The configuration used for calculating the heating of a conical bomblet. *It has a nose radius of 5 cm, a base diameter of 15 cm, a length of 20 cm, a cone half-angle of 9.5 degrees, a mass of 10 kg, and a ballistic coefficient of 12,000 N/m² (250 lb/ft²).*

FIGURE 5. Figure 7-1 of "Countermeasures," "Large Bomblets (10 kg)." (Small bomblets are about 1 kg.)

FIGURE 6. Figure 8-1 of "Countermeasures," photograph of NASA Air Density Explorer balloons, first launched in 1961

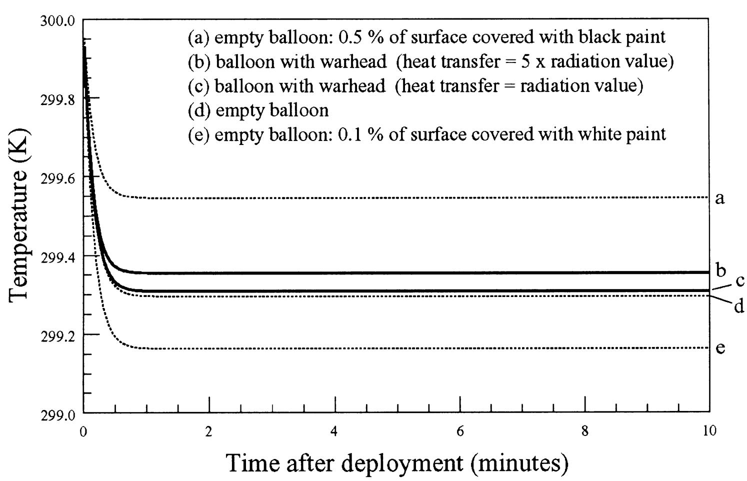

Figure H-2. Temperature variation after deployment of painted balloons with and without warheads, near room temperature.

This figure shows the daytime temperature variation after release of lightweight (0.5 kg) balloons with an outer surface covered with a thin layer of aluminum-silicone paint. The balloons are at a temperature of 300 K when released. One balloon is empty and two contain warheads with a surface emissivity of 0.036. For the balloons containing warheads, in one case the heat transfer between warhead and balloon is taken to be that due to radiation, in the other the heat transfer is taken to be five times that due to radiation (the inside surfaces of the balloons are assumed to be blackbodies). Also shown are two empty balloons with small fractions of their outer surfaces covered with another type of paint: in one case 0.1 percent by white enamel paint, and in the other 0.5 percent by black paint.

FIGURE 7. Figure H-2 of "Countermeasures." Within less than a minute of deployment of the balloon, temperature of the antisimulation balloon and of the empty balloon has stabilized to within 0.01 deg. Note that the entire range of temperatures covers a band of 0.4 deg—a difference totally unobservable by any seeker involved in the National Missile Defense system.

cism, and that is what I try to supply here and have tried to provide as a co-author of the “Countermeasures” report.

This technical report[6] on Countermeasures describes in detail BW bomblets that would be released on ascent, antisimulation balloons and similar decoy balloons for nuclear warheads, and a shroud cooled with liquid nitrogen that can hide a nuclear warhead from the infrared seeker of the NMD interceptor. Of course, a nation wishing to kill tens of thousands or hundreds of thousands of U.S. residents could do this far more simply, cheaply, and sooner by the use of short-range missiles (either cruise or ballistic) launched from cargo ships near U.S. shores. The nine-person Rumsfeld Commission identified this threat as available earlier and sooner than would be intercontinental ballistic missiles.[7]

To illustrate, I show some figures from reference 5, Figures 4 through 7.

Nevertheless, if the United States wished to build defenses against the stated threat (ignoring the more important approaches) this could likely be better done by boost-phase intercept while the rocket is still burning. It poses a much more evident and fragile target, and it turns out that the location and size of North Korea and Iraq are such that boost-phase intercept is quite possible at much lower cost than the proposed National Missile Defense.

A joint program between the United States and Russia could be quite effective, and a Protocol to the ABM Treaty could be used to allow such activities and other limited activities that would handle the stated threat better than the proposed NMD system and would not violate the spirit of the ABM Treaty, because they would be totally ineffective against even a single ICBM launched from the interior of Russia or the United States, or, incidentally, against Chinese ICBMs.[8] More recently I presented a concrete version of this approach.[9]

A joint Ballistic Missile Defense site on Russian territory south of Vladivostok could house ground-based interceptors that would reach

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[6] “Countermeasures,” A Technical Evaluation of the Operational Effectiveness of the Planned U.S. National Missile Defense System, UCS-MIT Study, A. M. Sessler (Chair of the Study Group), J. M. Cornwall, R. Dietz, S. A. Fetter, S. Frankel, R. L. Garwin, K. Gottfried, L. Gronlund, G. N. Lewis, T. A. Postol, and D. C. Wright, April 2000.

[7] “Executive Summary of the Report of the Commission to Assess the Ballistic Missile Threat to the United States,” by B. M. Blechman, Lee Butler, R. L. Garwin, W. R. Graham, W. Schneider, Jr., L. D. Welch, P. D. Wolfowitz, R. J. Woolsey, and D. H. Rumsfeld (Chairman), 15 July 1998. The 307-page Report is Secret. One Secret Appendix and one unclassified Appendix. http://www.fas/org/irp/threat/bm-threat.htm

[8] http://www.fas.org/rlg/990317-nmd.htm (17 March 1999).

[9] “Cooperative Ballistic Missile Defense,” by R. L. Garwin, presented at the State Department Secretary’s Open Forum on National Missile Defense Against Biological and Nuclear Weapons, 18 November 1999 (available at http://www.fas.org/rlg).

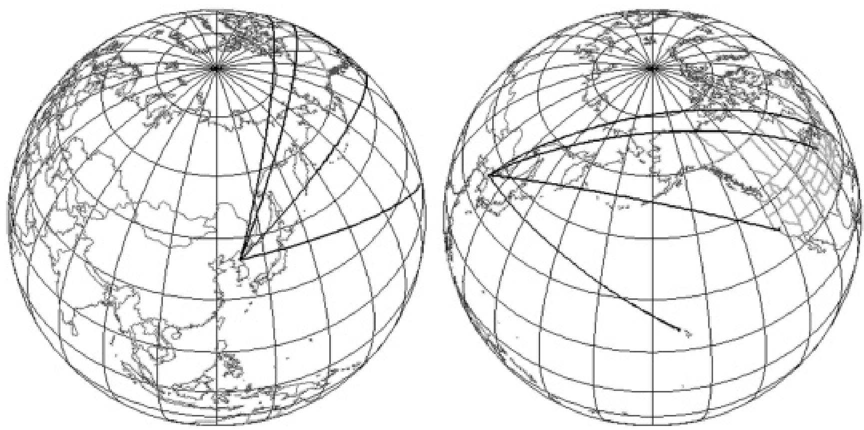

FIGURE 8. Ground-Trace of North Korean ICBM for Attacks on Washington, Chicago, San Francisco, and Honolulu

Constraints of 1972 ABM Treaty

- ABMT bans "…ABM systems (against strategic ballistic missiles) for a defense of the territory …" and also sea-based, space-based, or mobile ABM systems…
- It is a myth that the 1972 ABM Treaty inhibits U.S. defenses against short-range missile threats to coastal cities. These are not strategic ballistic missiles.

FIGURE 9. "Constraints of 1972 ABM Treaty," from author's presentation of 26 August 1999

What to do?

- NMD, as proposed, will not handle even the NK ICBM threat--early release of BW submunitions; enclosing balloon for RV.
- Start over:
    - Hit-to-kill on ICBM booster from 1000 km E, W, or N of NK (military cargo ships, or US-Russian joint test range).
    - Launch and vector on DSP data. Home on booster flame (plus hard-body lead-ahead).
    - HTK interceptor 7-8 km/s, 10-g average.

FIGURE 10. "What to do?" from author's presentation of 26 August 1999

ICBM speed in about 100 seconds. The system would consist of the existing U.S. defense support program (DSP) satellites in geosynchronous orbit, that have seen every ballistic missile launch on Earth for several decades (including every Scud launched during the 1991 Gulf War), together with large interceptors similar to the ground-based interceptor (GBI) proposed for the National Missile Defense System.

The same interceptor would also be housed on U.S. military cargo ships in the Japan Basin. For boost-phase intercept, the complex seeker would be replaced by a much simpler one, and the interceptor would be self-guided as soon as it left the atmosphere, heading toward the bright flame of the ICBM to which it was directed by the DSP satellite observation.

A DSP satellite scans the entire visible face of the Earth every ten seconds, and two DSP satellites provide a stereo view of the boosting ICBM's trajectory, adequate to direct the seeker of the ground-based interceptor. Rather than a deeply cooled multi-band infrared seeker, as is necessary for mid-course intercept in the proposed NMS system, this interceptor for boost-phase would have an uncooled mid-infrared seeker that from 1,000-km distance gathers 1,600 times the light available to DSP. This would be supplemented by a low-resolution thermal-infrared imager to see the missile body within the propellant cloud.

I illustrate here with a few graphics from the referenced papers. These were all provided by Professor Ted Postol of MIT.

DSP detection of ICBM launch and characterization of its trajectory would be adequate if the interceptor seeker could track the ICBM flame despite the acceleration and vibration of the interceptor after it left the atmosphere. Alternatively, for the North Korean case, a modest radar in South Korea or on the launch ship would serve.

The 1972 ABM Treaty between the United States and the Soviet Union bans a defense of the national territory against strategic ballistic missiles. The Boost-Phase Intercept system could be accommodated by a simpler process than amending the individual articles of the ABM Treaty; instead one could have a protocol to the Treaty that would permit, in addition to the deployments specified in the 1972 ABM Treaty,

1. ABM systems of any type deployed at a site jointly operated by the United States and Russia, or by those two parties plus Belarus, Kazakhstan, or Ukraine.
2. On ships unsupported by ABM radars and deployed in the Japan Basin (off North Korea), the Gulf of Oman, or the Caspian Sea.
3. Or as specifically agreed among the parties.

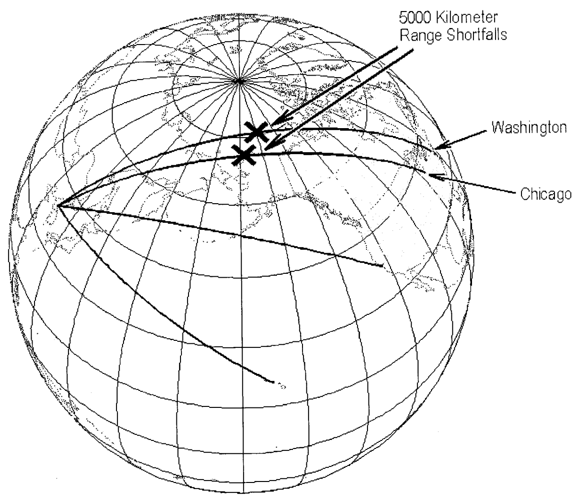

FIGURE 11. Range Shortfall of Intercepted North Korean ICBM Ten Seconds Prior to Burnout

It has been proposed that fleets of hundreds or thousands of homing kill vehicles be orbited for boost-phase defense. I judge that for the task of countering ICBMs from North Korea, Iraq, or Iran, this is both a more expensive and inferior system. Ninety-nine percent of the interceptors are useless against any particular missile launch, since they are on the other side of the Earth. Furthermore, it takes the same rocket speed to put an interceptor into orbit as is considered for our surface-

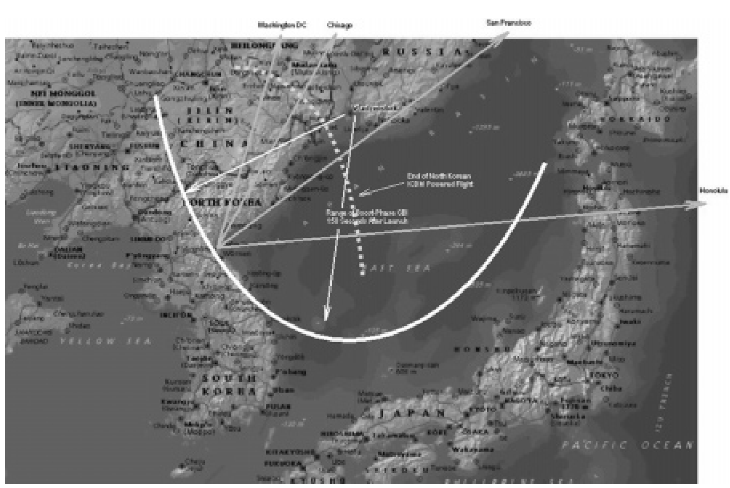

FIGURE 12. Engagement Region of Russian–U.S. 100-Second Burn-Time Ground-Based Interceptor Against North Korean 250-Second Burn-Time ICBM

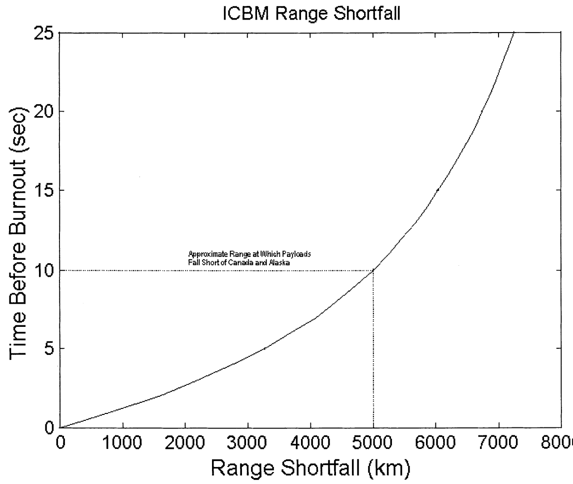

FIGURE 13. Range Shortfall of Intercepted North Korean ICBM for Various Intercept Times Prior to Burnout

based boost-phase intercept, and the homing kill vehicle needs to endure an orbit for years instead of for a couple of minutes before intercept. Finally, these orbiting interceptors would also have a capability against Russian ICBMs, despite a potential commitment to launch them only into low-inclination orbits. Such a system operated by the United Nations might be more acceptable to Russia, but surely not to those who advocate a U.S. National Missile Defense.

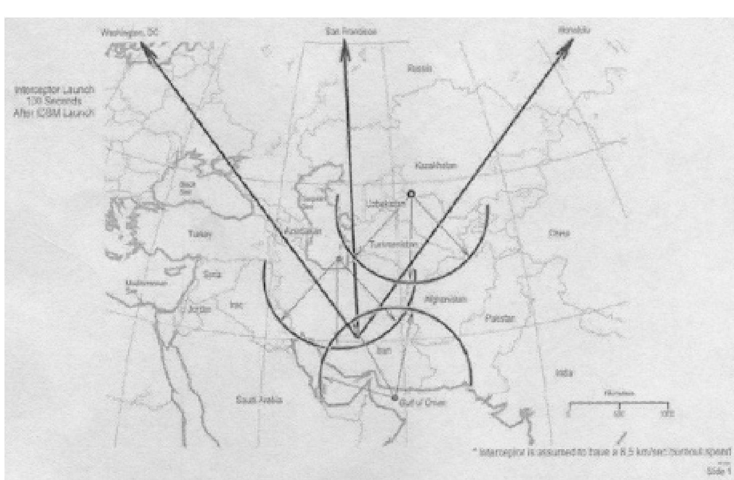

FIGURE 14. Engagement Region of Russian–U.S. 70-Second Burn-Time Ground-Based Interceptor Against Iranian 250-Second Burn-Time ICBM

I firmly believe that the 18,000 Russian nuclear warheads pose a most substantial threat to the United States and to Russia, and that it is far more important to reduce these warheads, for which there is no purpose, than it is to maintain a possible advantage in deployed U.S. warheads over those fielded by Russia. Russia, the U.S., and the rest of the world would all benefit if Russian and U.S. warheads were to be immediately reduced to 2,000 deployed strategic warheads, with the rest being immediately and irrevocably committed to civil nuclear power. They can be rapidly demilitarized so that they can never be used as nuclear weapons, long before they can be disassembled. I believe equally firmly that abandonment of the ABM Treaty will prevent future reductions in the offensive threat and will have serious political consequences. Furthermore, there is no high-level military enthusiasm in the United States for the proposed National Missile Defense system, since it does not address the major threats to the United States. Furthermore, it is unlikely to work even against the threat posed by emerging missile powers.

Conclusion

Now is the time for nations to discuss and possibly to negotiate a ban on weapons in space and on antisatellite tests. The U.S. Congress should think more deeply than it has yet about the threats to the United States and the cost and effectiveness of various defenses. Since the resources expended for National Missile Defense could have been used for competing military needs, as well as for other needs of the society that NMD is supposed to protect, major attention should be given to cheaper and more effective systems such as boost-phase intercept (BPI) for National Missile Defense.

The Summer 2000 decision President Clinton has promised to make regarding deployment of the National Missile Defense system under development should be "No," and the NMD development program should be scaled back in view of its inability to deal at all with bomblet payloads for BW agents, and with nuclear warheads in anti-simulation balloons accompanied by balloon decoys.