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Military Uses of Space

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Gregory H. Canavan

Los Alamos Los Alamos National Laboratory
Los Alamos,New Mexico 87545

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MILITARY USES OF SPACE

by

Gregory H. Canavan

ABSTRACT

This report reviews the information gathering, offensive, and defensive uses of space. The report concludes that, while all defensive uses are likely to grow, the most important ones are warning, verification, target relocation, and defense.

I. INTRODUCTION

There are currently three main military uses of space: information gathering, strategic offense, and strategic defense. This report gives a brief discussion of each, together with a rough indication of how their importance is likely to change over the next one to two decades. It concludes that all are likely to grow, but the most important uses are warning, verification, relocation of movable targets, and defense.

II. INFORMATION

Space is now the U.S.'s primary source of information about economic and military developments within the Soviet Union. Early information on the development of Soviet strategic and missile forces was obtained through overflight of the Soviet

Union by very high-flying U-2 aircraft, but when one was shot down by a Soviet defensive missile in 1960, it became necessary to shift most reconnaissance assets to space.

A. Reconnaissance Satellites

Photoreconnaissance and other satellite-borne sensors became the U.S.'s primary instruments for monitoring strategic developments and deployments. They have also evolved into the U.S.'s principal means of assuring compliance with treaties and agreements with the Soviet Union, in which role they are protected by treaty as "national means" of verification.

Reconnaissance and verification functions are likely to continue and grow, since a near-total opening of Soviet society would be required to make other monitoring means as productive. Maintaining even current levels of information on major developments is, however, likely to become increasingly difficult over the next few decades due to significant dispersal of Soviet facilities and forces.

B. Verifying Relocatable Targets

During the arms control discussions of the 1960s, the U.S. convinced the Soviet Union of the importance of survivable forces; during the SALT II discussions of the 1970s, it convinced the Soviets of the growing vulnerability of fixed missile silos and the advantages of making launchers mobile to avoid that vulnerability. Whether the U.S. will be able to take its own advice is problematical, but the Soviet Union is already deploying several hundred mobile launchers each year.[1] With current assets, the U.S. would be hard pressed to verify their number, let alone keep track of them for targeting.

It is argued that the Soviet mobile missiles could be eliminated through START negotiations, but it is not clear why the Soviets would surrender mobile concepts that are technically superior to the fixed alternatives they supplanted, as well as manifestly stabilizing, just because the U.S. is unable to deploy them for domestic political and budgetary reasons.[2] Moreover, the incentive to eliminate them is reduced with each additional mobile missile deployed during the delays in those negotiations. It is likely that their deployment will continue, and hence that the assets required to monitor them will grow proportionally.

C. Early Warning

Satellites can be used for early warning of missile launches, whose plumes are bright enough to be seen from space. Satellites that perform this function are also protected by treaty. Since they act to remove uncertainty and error, their operation is manifestly stabilizing. The need for early warning is likely to continue for the foreseeable future. Providing it will require continuing improvements of the satellites' sensitivity and the reduction of their susceptibility to direct or indirect interference. Those improvements can, however, be largely implemented with developed technology.

III. STRATEGIC OFFENSE

Space could arguably support strategic offensive missions: locating fixed targets, localizing mobile targets, and supporting space-based nuclear weapon concepts or space-strike applications of defensive satellites. Only the first, however, appears to have any significant military value.

A. Locating Targets

The basis of our current deterrent strategy is holding a set of strategic targets at risk, which requires that the targets be located precisely enough to be targeted. Satellites can do that extremely well. For the last two decades, space sensors have measured the location of fixed targets with ever increasing accuracy, making it possible for them to be targeted with ever decreasing error. That has forced some targets to super hardness and others to move out from under those highly accurate missiles, which can be accomplished by making them mobile. The Soviets are pursuing both actively.

B. Localizing Mobile Targets

Satellite-borne sensors can also be used to determine the location of mobile targets, a task that is rapidly increasing in difficulty as a larger fraction of the Soviet's forces become unobservable or rail or road mobile. Mobility makes it difficult to keep track of the locations of targets, particularly those that can move more frequently than they are observed. The technical difficulty of monitoring them is formidable. For verification it might be necessary to photograph a target every week or month; for targeting it could be necessary to observe mobile targets every day or so, or at least on the time scale for them to move and reestablish readiness to launch. That 10- to 30-fold increase in the number of satellites required would be expensive, given the cost of each.

Given the U.S.'s limited access to the Soviet Union, space appears to be the only vehicle for localizing such targets on a time scale commensurate with their movement and with a policy of holding them at risk. Thus, on a 10-20 year time scale it may be necessary to either provide the assets required for localization, or to change that strategy. The space assets required would have to grow both in numbers and capability to continue to support the current deterrent strategy. Moreover, those assets would not be in sanctuary, so they would have to be configured to survive attacks as well.

Should mobiles require localization by space sensors and mobile targets be deployed more rapidly than sensors, the satellites' ability to localize them would initially drop. Over time, however, improving those sensors could restore something like the offense's current ability to negate them. If so, the net result would be a return to approximately the current, unsatisfactory situation in which deterrence is maintained through fixed launchers of eroding survivability. The improved sensors would then have relocated the strategic targets, so the expenses for relocatable targets and sensors, which are significant, would have essentially paid for a one to two decade extension of offensive deterrence.

C. Weapons in Space

Some earlier strategic offensive concepts called for deploying nuclear weapons in space to provide an ability to rapidly deorbit them onto one's adversary. Such deployments are now prohibited by the Outer Space Treaty, but they never had much military significance. Ignoring the vulnerabilities of the orbiting weapons, sensors, and command elements themselves, the fundamental problem is that at any given time only a fraction of a percent of the weapons would be in position to reenter over useful targets. Most would be elsewhere in their orbits, from which they could be brought to bear only over a period of hours or days, which is much larger than the duration of an intercontinental attack. Even then they could be delivered only at a large price in propulsion and guidance, with a corresponding reduction in the number of weapons delivered.

Orbiting a weapon and then deorbiting it to attack essentially pays the price of entry into space twice. For a given launch capacity, that would reduce the number of weapons deployed by over an order of magnitude, producing a larger, unilateral reduction in strategic offensive weapons than that sought in current arms control negotiations. Fractional orbital concepts pay roughly the same penalty; they otherwise resemble standard ballistic trajectories. Thus, the only effective use of space by standard nuclear weapons appears to be their brief, ballistic passage through it on the way from their silos to to their targets.

D. Space Strike

A more recent concern is the use of kinetic energy interceptors, particle, or lasers beams to cause damage to targets on the surface of the earth.[3] Strategic Defense Initiative (SDI) concepts are, however, poorly suited to such roles.[4] Kinetic energy interceptors are flimsy structures weighing a few tens of kilograms that are only designed to fly through drag-free space. They could not survive reentry, and whatever fragments did would be unlikely to strike populated areas. Even those that did by accident could cause only limited, local damage, since the energy they contain is closer to that of a grenade than a bomb. Particle beams cannot penetrate into the earth's atmosphere at all, and laser beams could at worst, and at great expense, set fires in flammable materials, which could be extinguished, or insulated in advance.[5] None of the defensive concepts could have any significant impact on strategic systems prior to launch. Thus, defensive platforms would not appear to have any useful offensive roles.

E. Related Applications

The discussion above stressed the difficulty of, and the utility of space assets for, localizing strategic super-hard and relocatable targets. Much the same problem is already faced in theater reconnaissance, where many of the forces faced are mobile, and many of the most valuable targets such as tanks are almost continuously in motion. It is clear that the sensors discussed above could have a fundamental role in localizing such targets and bringing indirect fire to bear on them.

There is in fact almost a continuum of such targets ranging from mobile theater targets to those essential for strategic survivability. All use mixes of hardness, mobility, and deception; naturally, similar sensor technologies apply to all. While the applicability of the sensors is clear, the magnitude of the resources required for the numbers and recycle times involved is less clear.[6] For theater applications as well as strategic, information gathering appears to be the only application with significant military impact; the concepts could have little impact on tactical units in the field.[7]

A second connection is to civil applications. Resource monitoring--agriculture, extraction, distribution--requires significant resolution and timeliness. Ideally the sensors developed for strategic and theater force monitoring could be used when away from their primary targets for resource monitoring as well. That synergism is, however, currently inhibited by Soviet policy, which regards the inspection of its territory with such means and resolution for other than verification or warning to be the grounds for actions such as those taken against the U-2 and KAL-007. Thus, broadening the release of information from strategic sensors for civil applications would require a significant relaxation of current understandings. Given the high cost of those sensors and the uncertain value of the information to the civil sector, there is at present little incentive to seek such relaxation.

F. Summary of Strategic Offense

Overall, it appears that the only effective offensive use of space is obtaining information on Soviet forces, their numbers, and dispositions in support of current deterrent strategy. In that role, space sensors could be quite capable; they appear to be the only developed sensors that could reestablish the locations of mobile targets on the time scales required. Deploying nuclear weapons in space would reduce their number and effectiveness by about an order of magnitude for a modest decrease in delivery time, and defensive satellites cannot deliver militarily significant strikes from space.

IV. STRATEGIC DEFENSE

Strategic defense is in part a response to the offensive trends discussed above and in part an attempt to shift from deterrence through retaliation to deterrence based on the ability to defend oneself.

A. Common Technologies

Some strategic defense technologies are extensions of those required for offense. The sensors for strategic defense must be able to acquire and track targets shortly after their launch. That makes them complementary to the sensors required for the localization of relocatable targets, which must locate their targets prior to launch. Thus, today's sensors for warning strategic forces of missile launch could evolve into the sensors needed to alert strategic defenses in the future. Given the current trends in Soviet offenses, as the various measures and countermeasures are implemented, the requirements for the two sets of sensors could converge to one.

B. Relocatable Targets

Strategic defenses are relatively insensitive to the shift to relocatable targets, apart from the greater difficulty of negating launches from concentrated areas. Since the defenses do not operate until after the missiles' launch, that provides an unambiguous signal of attack as well as precise information on the locations of the missiles. Because the defenses are not effective until the missiles rise above most of the earth's atmosphere, and because they produce no significant collateral damage, they are primarily defensive in nature.

C. Four Questions

The questions generally asked about strategic defense can be reduced to roughly four general questions: Will the concepts work? Would the system work? What is it for? Would we be better off if we had it?

Detailed answers have been attempted elsewhere;[8] the paragraphs below summarize the answers, indicating the main lines of the arguments and the weaknesses in the current arguments. In the process, the following sections give a brief introduction to the interactions between the main defensive concepts.

1. Will the Concepts Work?

Given the large volume of heated discussion that has surrounded strategic defense,[9] it is surprising that there is relatively little disagreement within the pro or con technical communities with the position that its individual sensors, interceptors, lasers, and particle beams can probably be made to work.[10] Concerns remain over how soon, how well, and at what cost, but it is no longer credibly argued that the individual concepts simply could not perform effectively.[11] The questions have now shifted instead to the level of systems and countermeasures.

2. Would the System Work?

The concepts could work and the defense still fail if their command and control systems were susceptible to overloading or countermeasures. There has been extensive discussion[12] of the defense's ability to integrate the information from all of the sensors and interceptors that must be processed in an effective, timely, and robust manner to achieve the optimal allocation of assets required for effective defense.[13] In the absence of more detailed simulations and tests, which will only occur over the next few years, it is not possible to give a definitive answer. The current understanding appears to be that the command and control issues are demanding, but arguably within the state of the art.[14]

These problems are somewhat generic. Although command and control issues have been debated for decades, it cannot be said that strategic systems deployed to date have reached the level now required of strategic defenses.[15] In part that is because it is difficult and expensive to build networks that are robust against precursor attacks, which could sever key links in a well-known net. Thus, it is interesting that strategic defenses, which are capable of protecting their own critical nodes, are in some ways more tractable than the command and control of existing strategic systems.

Countermeasures are also only partially resolved. It is now clear that flares, reflectors, jammers, and other "simple" countermeasures extract only modest prices from the defense, but it is also clear that fundamental measures such as fast boosters and buses and compact launch areas can extract significant penalties from some concepts.[16] Those countermeasures, plus others such as hardening boosters, ultimately extract roughly proportional penalties from the offense and defense, leaving the defense with a significant, but reduced, margin.[17] Survivability of space assets against precursor or attrition attacks also follows that pattern, although it appears that the satellites of greatest concern in the near to midterm could arguably be made survivable through existing techniques.[18]

Overall, whether it could work as a system is unproven, although it can now be argued plausibly on the basis of some data. Resolving the issue will require significant development and testing. The sensor and survivability parts are in common with the developments required for information gathering applications.

3. What Is It For?

Missions for military systems generally track their evolving capabilities. Initially, when their capability is slight, their missions are modest. As defenses become more capable, they are able to address an increasing range of applications. Small deployments of initial defenses would be able to negate an attack by only a few, simple missiles, although they could do that with significant confidence.

It can be argued that there is little value in handling third-country missile attacks as long as national or subnational groups could deliver weapons in aircraft, ships, or contraband; the converse argument is that there is little point in closing those lesser delivery means as long as missile attacks remain an attainable option. Given the availability of design information, carriers, and the lack of progress on proliferation, serious efforts will apparently be needed over the next decade to close off all of these other delivery means.

As the capabilities of the defenses grew, a succession of missions--submarine-launched missile attacks, accidental launch, attacks on command and control, military targets, and ultimately value targets--could be addressed progressively. The question of strategic defense's ultimate goal would thereby be settled by what it could do, which is how that determination is made for any military system, rather than by debate. While popular discussion typically concentrates on just one application at a time, so long as a moderately demanding application is addressed, the technologies for lesser attacks would have to be be developed as well to support it, and the component technologies for more stressing applications would also evolve.

4. Would We Be Better Off If We Had It?

Even if given strategic defenses could reduce the damage from exchanges, they would also have to reduce the likelihood of such exchanges to be fully stabilizing. There are two dimensions to that reduction: crisis and arms stability. Improved capabilities against attack are crisis stabilizing, so long as the defenses are not introduced in such a manner as to threaten or eliminate the strategic reserves of the other, which would result in only irrational options in a crisis. Those conditions can be met through modest constraints on joint offensive-defensive deployments and arms reductions.[19]

Defenses are arms control stabilizing so long as they induce the other side to build defenses rather than offenses. If defenses are effective for both sides, they induce successive rounds of defensive increases and offensive reductions, which could reduce them to offensive levels that even limited defenses were capable of handling--at ever-decreasing levels of possible destruction.[20] This feedback loop is stabilizing so long as the defenses are cost effective. Thus, defenses and arms reduction appear to be compatible in a way that offensive forces and arms control have not been.[21] This conjecture on the internal dynamics of combined crisis and arms control stability is largely theoretical, but it is obviously consistent with the initiation and evolution of the current strategic arms discussions linking defenses and deep offensive reductions.

V. ASSESSMENT

The military uses of space for gathering and communicating warning and verification information are growing. Strategic offensive uses of space are modest, and likely to remain so. Space sensors appear to be the only way to locate moving targets on the timelines required to support current deterrent strategy; other offensive uses appear limited.

Strategic defense concepts appear to be adequate for a useful range of applications, although the robustness of their supporting systems is not fully established. With current estimates of cost and performance, strategic defenses appear to be crisis and arms control stabilizing. If so, they could provide the incentive needed for significant arms reductions.

Space's ultimate contribution to military missions depends on sensor and survivability technologies that are largely common between information and strategic defense sensors. If space platforms can overcome their current technical and political limitations and vulnerabilities, they could perform essential strategic functions and serve as a stabilizing role consistent with and conducive to the goals of arms reduction.

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