LA-11810-MS

National Security Uses of Space: Status, Prospects, and Issues

Los Alamos

Los Alamos National Laboratory is operated by the University of California for the United States Department of Energy under contract W-7405-ENG-36.

Prepared by Bo West, P-DO

Accession Number: 3470

Publication Date: Jan 01, 1992

Title: National Security Uses of Space: Status, Prospects, and Issues

Personal Author: Browne, J.C.; Garrity, P.J.; Canavan, G.H.

Corporate Author Or Publisher: Los Alamos National Laboratory, Los Alamos, NM 87545 Report Number: LA-11810-MS

Report Prepared for: U.S. Department of Energy, Washington, DC

Descriptors, Keywords: National Security Space Defense Requirement Constraint Asset Military Use Civil

Pages: 00015

Cataloged Date: Apr 29, 1992

Contract Number: W-7405-ENG-36

Document Type: HC

Number of Copies In Library: 000001

Record ID: 23744

Source of Document: DOE

LA-11810-MS

UC-700
Issued: January 1992

National Security Uses of Space: Status, Prospects, and Issues

John C. Browne
Patrick J. Garrity
Gregory H. Canavan

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

CONTENTS

NATIONAL SECURITY USES OF SPACE: STATUS, PROSPECTS, AND ISSUES

by

John C. Browne, Patrick J. Garrity, and Gregory H. Canavan

ABSTRACT

National security uses of space have grown rapidly in the last two decades because only space platforms can perform certain vital missions. Currently, space-based systems are used for information, communication, and early warning. The pressure for more, and more capable, space systems should grow as fast over the next two decades as it has in the last two in support of strategic deterrence, conventional military operations, and strategic defenses.

I. INTRODUCTION

Before the United States can safely expand its dependence on space systems, several technical, military, and political issues must be addressed. The cost of sensors, communications, and platforms must be significantly lowered to make expanded space missions affordable. Survivability is particularly important because satellites must survive if they are to support expanded military missions. If they could provide such support, however, space systems would no longer be viewed as unreliable instruments by the military and policy makers. This report discusses the steps required to make space systems a robust element of United States national policy.

II. DEFENSE IN SPACE

In discussing growth in the national security uses of space, it is useful to discuss the missions space platforms can perform well and the functions that have been or are being performed well. Currently, the main military applications of space are for information gathering, communication, and early warning.

Photoreconnaissance and other space sensors are now the primary means of monitoring developments and deployments inside the Soviet Union. They have also become the principal means by which the United States assures compliance with treaties and agreements with the Soviet Union, in which role they are protected by treaty as national means of verification. These information-gathering functions should continue to grow because no other means are likely to be as productive, but maintaining even current levels of information will become increasingly difficult if the Soviets continue to significantly disperse their facilities and forces. Space communication remains effective and could grow, although it faces nonspace competitors.

Satellites can give early warning of missile launches, whose plumes can be seen from geosynchronous orbits. Because they reduce uncertainty and error, warning satellites are also viewed as stabilizing and protected by treaty. The need for early warning will continue for the foreseeable future; providing it will require that satellites' sensitivity be improved and their susceptibility to direct or indirect interference reduced.

In addition to these current uses, technology has made several additional missions possible. Current United States deterrent strategy seeks to hold military targets at risk and requires that their positions be known precisely. The Soviets are now, however, convinced of the importance of survivable deterrent forces, the vulnerability of fixed silos, and the ability of mobile launchers to achieve survivability. Satellite sensors can determine the location of fixed targets, but mobile launchers are difficult to track.

The Soviet Union is now deploying several hundred mobile systems per year. With current space-based assets, it would be difficult to verify, let alone target, them. Verification requires that targets be observed every 2 to 4 weeks; targeting could require observation every day. The increase in the number of satellites required could be 10- to 30-fold; the increase in relative costs could be even greater because the cost of each satellite could rise with the more demanding requirements. Given the United States' limited access to the Soviet Union, however, space systems could be the only way to localize mobiles. Unless this capability is provided, mobile Soviet targets could essentially move out from under United States deterrent forces.

Early United States space developments were stimulated by fears that the Soviets could deploy nuclear weapons in space and reenter them on United States targets. Such deployments are now prohibited by treaty, but they never had military significance. While in space the weapons would be more vulnerable, and at any time only a small fraction of them would be over useful targets. Furthermore, the propulsion and guidance required to reenter them could significantly reduce the number of weapons. A recent, related concern is that defensive platforms could damage targets on the earth's surface, but in addition to low availability, strategic defenses would be poorly suited to such roles because their flimsy structures, designed to fly in drag-free space, could not survive reentry, be guided, or deliver enough energy to produce significant damage.

The utility of space systems in locating mobile targets also applies to the theaters, where most forces are mobile. The most valuable mobile targets, tanks and command centers, are continually in motion, but space sensors could localize them to the precision required to direct effective attacks by smart weapons from air-, sea-, or ground-based launchers. The sensors required would be similar to those for locating strategic mobiles, so the two missions might be shared. In the theaters, gathering information and targeting mobiles appear to be the main high-leverage applications of space platforms.

Strategic defense is one response to offensive trends such as mobility. Defenses predeployed in space can take advantage of the high leverage gained by attacking missiles in the boost phase. The warning, tracking, and homing sensor technologies required are largely extensions of those needed for strategic offense, although they are simpler in important ways. Strategic offensive sensors must locate cold targets in intentionally cluttered environments; defensive sensors can use the missiles' plumes for acquisition, a tendency which makes them insensitive to relocatable targets--as well as intrinsically defensive in nature. Strategic defenses would be deployed in phases--developed kinetic energy first, more robust directed energy second, and advanced technologies third--to produce progressively higher levels of effectiveness. A common thread through all three phases is the need to discriminate the warheads from the numerous decoys possible. Lasers could play a useful transitional role, but particle beams, which can probe objects' interiors and measure their mass directly, would be needed soon.

There is relatively little disagreement between advocates and critics on the feasibility of strategic defense concepts; both feel that the technology can be made to work, although there are differing estimates of when and at what cost. Command and control are concerns, but the ability to integrate and process information efficiently and robustly has been established for strategic defenses' first phases, and their ability to protect their own critical nodes makes their command and control more tractable than those of offensive systems. Simple counter-measures can extract only modest prices; fundamental measures--fast missiles and compact launches--could extract a greater price but appear to be more expensive than the defenses. These offsetting, comparable offensive and defensive penalties leave the defense with a reduced but significant margin.

As capabilities of strategic defenses grew, they could address progressively more significant objectives. Initial defenses could negate a modest number of missiles, which would provide adequate defense of United States deterrent forces and some protection of population. Later, shifting from deterrence through retaliation toward defense, more capable defenses could address accidental launches, submarine-launched missiles, attacks on command and control, and attacks on population. Given the phases' different goals, it is not inappropriate for initial stages to defend some military forces, nor is it debilitating that their defense of population is imperfect. Effective defenses, deployed sensibly, would be crisis and arms control stabilizing. They should induce both sides to build defenses and reduce their offenses to obtain the resources required. If so, defenses should be more compatible with arms reductions than offenses have been in past decades.

III. REQUIREMENTS AND CONSTRAINTS

Increasing military access to space requires significantly increased payload at acceptable costs. The next generation of sensors and satellites could require both larger satellites to perform more demanding missions and more satellites to give the space-time coverage necessary for strategic and tactical missions.

Current military launch capacity should provide continuing access to space for satellites of modest masses. Current satellite constellations would require about 10 Shuttle launches per year, which would not require much increase over current capacity. Although reconnaissance and warning sensors could be reconfigured into smaller satellites for survivability, the number of satellites would increase, so this estimate of launch capacity would not be altered greatly.

The deployment of strategic defenses would require that tens to hundreds of satellites with 10- to 20-ton masses be launched into low orbits over the next few decades. Initially, about 300 space-based interceptor buses would be inserted into low orbits inclined over Soviet launch areas. With surveillance satellites, that insertion would require 10 to 20 Shuttle launches, a number which is at the margin of the launch capacity of planned fleets. Deploying a full constellation of about 1000 interceptor in 3 to 4 years would increase the launch rate to some 10 times the Shuttle's capacity, which would justify earlier development of the advanced launch system (ALS). Midterm deployments of additional kinetic interceptors and interim directed-energy weapons for fast missiles and compact launchers could exceed the Shuttle's capacity. The particle or laser beams needed to discriminate improved decoys would require the ALS. Current launch costs would contribute from 10% to 25% of the total cost of the first phase; for launch, volume is more of an issue than cost.

Weather, camouflage, and cover are fundamental limits to sensors in space. Much of the electromagnetic spectrum is available, but the infrared and visible portions are often obscured by clouds over strategic and theater targets. Radars reduce, but do not eliminate, weather limitations, which are fundamental and would not be changed by improved technology. The main barrier, however, is developing and producing the sensors. Sensor technology has been pursued for several decades, but process yields remain low and costs high. Current technology could produce enough sensors for current military missions but appears marginal for the larger sensors planned for strategic defense. Recent developments could support higher yields and lower costs but have not been demonstrated at volume. The large laser and particle beams must also be developed and produced, but their costs must be greatly reduced from those of current, one-of-a-kind platforms.

IV. DEFENDING SPACE ASSETS

Survivability is not required for verification, but it is essential for warning sensors and satellites that perform more demanding missions. Nonsurvivable satellites could be destabilizing because they would be seen as useful only in support of preemptive strikes.

The development of techniques to incorporate survivability will take time, but if they are implemented correctly, the penalties need not be large. In the near term, developed technologies for hardening and maneuver should suffice; in the midterm, deception and self-defense are required; and in the long term, active defense and thicker shielding are indicated. The satellites of initial concern are those for warning, communications, theater and strategic surveillance, and defensive interceptors. Warning satellites can operate at high altitudes, where they are relatively safe from direct attack. Low-earth-orbit satellites could be dispersed over a volume so large that each one would encounter another by chance about every few years, and the deflections needed to avoid contact are predictable and small, so satellites could last a century for random encounters.

Surveillance and defensive satellites must fly over the Soviet Union at altitudes of a few hundred kilometers to achieve useful resolution with practical sensors and obtain effective attrition with initial interceptors. That altitude puts them within range of direct attacks by conventional and nuclear anti-satellite weapons. Defensive satellites do not have to reenter, however, so they can be hardened far beyond current levels with thick shielding. With some ability to maneuver, such satellites could be very hard to attack--particularly small satellites, which have small value to the attacker and low penalties for maneuver. Kinetic-energy carrier vehicles could break even against near-term antisatellites; individual satellites could have significant margin.

The Soviets could also deploy nuclear antisatellites in orbit. That deployment would violate treaties, but the means to detect the violations might not be available. Such anti-satellites could be interspersed with the United States satellites, but because of the great distances and large deflections required to attack United States satellites from such orbits, interspersed antisatellites would be considerably less effective than ground-based ones. Space mines, or co-orbiting antisatellites, could, without treaty violation, keep station within the satellites' keep-out distances, where the mines would be in position at all times to disarm all defenses at the outset of hostilities. Space mines would be difficult to evade; large defensive satellites would exhaust themselves trying to move away. A satellite could destroy a mine if the mine tried to come closer than the satellite's lethal radius, but the right to do so and the dimensions of its excluded zone would have to be defined clearly in advance, or such incidents could produce crises.

It would be more difficult to defend against decoyed space mines because the satellite would not know what to defend against. Defensive maneuver could be effective, as the decoys would be eliminated by each maneuver, but the best counter would be discrimination. Passive means could discriminate in the near term; lasers could perform an interim role in the midterm; and particle beams could provide fundamental discrimination in the midterm to long term. Space mines would thus drive the defense to maneuver, decoys, and discrimination, but all should be available when needed for the satellites' primary mission.

Large directed-energy platforms could defend themselves; those that were not large enough could make effective use of hardening, maneuver, and decoys. By cooperating with each other, directed- and kinetic-energy satellites could compensate for each other's limitations and achieve adequate survivability. Geosynchronous satellites tend to be large, and the Soviets could probably determine their positions before attack. During their approach, however, direct-ascent antisatellites would be far from supporting sensors, so defensive satellites could use deception to evade the simpler attackers.

Ground-based lasers could pose more of a threat to low-altitude satellites than would direct-ascent antisatellites in the midterm. Such lasers address targets serially, so they would take hours to sweep space, during which they would be vulnerable. Thus, they would be most effective in attriting satellites and decoys in peacetime, when they could operate unopposed for long periods of time. Lasers costing about half a billion dollars could destroy hardened satellites in a few seconds. Their beams would, however, have to be corrected for atmospheric distortion to deliver lethal powers even at the altitudes of low earth constellation. Because those corrections are difficult, laser antisatellites are described as midterm threats. Hardening would provide temporary protection. Shielding a satellite for a month, which would roughly double its cost, could buy weeks or months during which the threat presented by the laser's attrition of satellites could be addressed deliberately.

In the long term, the United States and the Soviets could deploy comparable constellations of large, capable satellites, lasers, and ground- and space-based antisatellites. The concern then becomes the possibility of the constellations' attacking one another in peacetime by error or direction. For properly shielded platforms, however, the constellations would have little effectiveness in attacking one another, and little incentive to do so; they could interact without degradation for months. Thus, the Soviets' deployment of antisatellites in space would present little challenge--and possibly some advantage--to the defenses. Space-based antisatellites forfeit the advantage in availability ground-based antisatellites hold, a loss which puts them at a great cost and performance disadvantage. If the United States and the Soviet Union deployed comparable defensive constellations, they should be able to coexist with little incentive for either to attack the other in peacetime or crisis. The presence of the other's platforms should not significantly affect either side's ability to execute defensive missions.

V. RELATIONSHIP OF MILITARY TO CIVIL USES OF SPACE

Early civil applications were by-products of military space programs, which provided the boosters and support systems needed for scientific missions. After reaching the moon, civil programs turned to unmanned planetary probes and to the Shuttle, which was seen as a way of reducing the costs of manned, near-earth military and civilian missions. Commercial booster programs were started, and space experiments were performed, but neither endeavor has yet resulted in commercial applications, in part because of the high costs of fabrication and launch. If military and civil payloads could be integrated, reduced launch costs could induce the comparable reductions in payload fabrication costs needed to induce increased civil-sector volume.

Currently, commercial applications largely amount to developers' attempting to sell simple boosters to the civil sector in competition with the Shuttle. It is not clear these boosters are economically viable, given the Shuttle's recovery, and the government is the only buyer of launch capacity. If interest grew in near-earth manned and unmanned sensors, however, a commercial niche could evolve. Military and civil sensors are now fabricated by private industry. If those industries were allowed to sell similar packages to commercial efforts, remote sensing and scientific packages could be commercialized rapidly. More sensors and spares are required for both sectors. Civil assets could be used to augment military assets in crises. If civil assets were integrated into those of the military, they could provide useful protection against losses, essentially serving as on-orbit spares. The two issues that require resolution are planning for integration and providing for survivability. The former awaits assessment that the contributions from civil assets could be important, but adequate survivability could be provided to civil assets without degrading their primary missions.

Civil applications have shifted toward the monitoring of energy, resources, agriculture, and extraction, all of which require timely information with high resolution. Military sensors are capable but expensive, but much of that complexity and cost derives from the difficulty of the measurements they seek. Thus, civil sensors covering the same spatial, temporal, and spectral bands might not be less expensive. Sensors for monitoring strategic and theater force could be used for resource monitoring when away from their primary targets. That use is now inhibited by Soviet policy, which regards inspection of its territory with such resolution for reasons other than verification to be hostile. Current trends might make it possible to modify those attitudes, and given the cost of the sensors and the value of their information to the civil sector, there is an incentive to seek such relaxation. Less direct uses would involve applying civil or military assets to monitor international drug traffic and terrorism, which could become so pressing in the next few decades that they could prove to be as critical as the sensors' primary missions.

Civil space budgets will probably grow, but not rapidly enough to cover the Shuttle, ALS, space station, and planetary science. Funds for science are likely to be used to cover problems in hardware and launchers, a tendency which could further decrease popular support for the civil program. Recognition of this tendency has stimulated proposals to put the launch and station programs into a separate department. That approach has, however, in the past produced unexpected and untoward consequences. The preferred approach would be to keep all elements of the civil program together but do a better job of protecting research funds from overruns.

A number of nations have developed launchers. Some are small and specialized; others, like the Soviets', are larger than United States launchers. Some are cheaper than United States facilities, more available, and not necessarily less reliable. Thus, the United States could use that capability, particularly if easing international tensions made it possible to lower the barrier between military and civil platforms and to launch military assets, still the dominant cargos, on civil or other launchers. Over the next few decades, it might become possible to jointly develop, launch, and use such assets.

VI. SUMMARY

Military uses of space for information, warning, communication, and verification will probably continue to grow. However much United States/Soviet Union relations might improve, it is likely that agreements will have to be verified for several decades to build confidence. In many cases, the United States has no practical means of verification other than space sensors, so there is little doubt those assets will continue to grow in capability and significance. Strategic offensive uses of space are modest and are likely to remain so. Although there is little incentive to put offensive weapons in space, it is incumbent on the United States to verify that emplacement does not occur. The technical means exist; the issue is developing hardware.

For the United States to continue its present deterrent policy, the means of detecting and tracking strategic and theater mobile targets will be needed, tasks which will require sensors with higher spatial and temporal resolution and greater survivability. Space sensors are the only way to locate moving targets on the timelines required to support current deterrent strategy. Although the technical challenge is significant, such sensors could probably be available when needed if development were started soon. Such an effort has not been undertaken, in part because of concerns about survivability, but the sensors could be provided with existing technology. Near-term satellites could be made survivable with a combination of shielding, maneuver, and deception; midterm satellites could add self-defense. Adequate means exist for detecting nearby space mines; other space deployments of antisatellites act to the defense's advantage.

Strategic defense is a large issue; only modest components have been approved for development. A more ambitious program would require major increases in fabrication and launch capacity. Strategic defenses could address a range of applications. Initially, such defenses would be imperfect but could still deny militarily significant missions to Soviet missiles and provide some protection of population. The Soviet air-breathing threat could also be addressed, given increased emphasis on the detection of bombers and cruise missiles.

For current cost and performance estimates, defenses should be stabilizing, a circumstance which would provide new incentives for arms reductions. Required expansions in sensor capability and survivability could be accompanied by increases in satellite mass and cost. The need for more and larger sensors would make current limitations on United States launch capacity restrictive. A very large increase in launch capacity could be needed over the next decade, especially if the deployment of strategic defense proceeded rapidly. Planned threefold to fivefold reductions in launch costs could make that expansion less difficult.

There is no fundamental need to differentiate between military and civilian payloads, so the timely development of the advanced launch system could satisfy the military requirements and provide the appropriate civil expansion as well. The ultimate contribution of space systems to military missions depends on sensor and survivability technologies that are common to information, offensive, and defensive strategic sensors. If space platforms can overcome current technical and political limitations, they could perform essential stabilizing functions.

Military and civilian space applications have evolved in different directions in recent decades, but the military's need for greater capacity and the civil sector's need for detail have brought their requirements together again. Economic, ecological, and energy needs are likely to require the level of detail available only from military sensors, a level which would be difficult and expensive for civil users to duplicate. The improving international environment could make the spin-off of civil information from military sensors possible. Because there is arguably significant payoff for dual use and the risk of military missions can be controlled, developing such sensors jointly and with commercial and international cooperation, where appropriate, could greatly expand the capabilities of all at modestly increased costs.

Stressing military and civilian applications that only space systems could meet has caused their rapid development over the last two decades. At present, plans for further growth are tempered by concerns about performance, cost, and survivability. Improved components and integration could cause the first two concerns to offset each other, and the technology exists to make satellites adequately survivable. Thus, there are no fundamental barriers to expanding the use of space under a policy that integrates military and civil space goals in a framework of commercial and international cooperation. Continued development is required, but the tools could be developed to permit the greatly expanded exploitation of space in the next decade.

VII. ISSUES

From the discussion above, the main space issues for the next decades are as follow:

1. The rate of growth of resources for information and verification.
2. Whether significantly improved sensors and increased assets should be devoted to locating and targeting mobiles.
3. Whether strategic defense should be deployed, over what period of time, and to what end.
4. The growth of the launch capacity required for items 2 and 3 and its integration with military and international capacity.
5. Whether military assets should be used for civil monitoring and vice versa and whether civil assets should have dual uses to replenish military assets in crises.
6. The relative priority of the space station, advanced launch system, and space science.

The first issue is not whether resources for information and verification should increase, but how fast they must do so. It is a budgetary issue, but so large that it approaches a policy issue. The second issue shapes national policy, which would be undercut by ongoing Soviet actions without such improvements. The third issue, which is 5 to 10 years off, questions whether strategic defenses, however difficult, may not prove to be the best answer to the problems raised in the second issue. The fourth issue flows from the requirements that would be generated by defensive deployments. The fifth issue could determine whether a meaningful civil monitoring program or a sustainable military program is affordable. The sixth issue addresses the rationalization of the missions and focus of the civil space program.