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Soviet SDI Response Options: The Resource Dilemma

A Research Paper

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Soviet SDI Response Options: The Resource Dilemma

A Research Paper

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Office of Soviet Analysis, with
contributions from
SOVA and Office of
Scientific and Weapons Research
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SOV 87-10063X
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Soviet SDI Response Options: The Resource Dilemma

Summary

*Information available
as of 6 November 1987
was used in this report.*

When President Reagan announced the Strategic Defense Initiative (SDI) in March 1983, the Soviets already were pursuing a large number of strategic offensive and defensive force modernization programs and research in advanced technologies that could eventually contribute to a response. Concern over SDI has caused them to refocus some research and development (R&D) efforts and to increase funding for some research with potential application to advanced ballistic missile defense (BMD) or BMD countermeasures, but, to our knowledge, the Soviets have not yet initiated major new weapons procurement programs in response.

The Soviets apparently have proceeded on the assumption that they could delay responding to SDI with major new weapons procurement programs or the acceleration of ongoing programs until at least the early 1990s, when such responses could be incorporated in their 13th Five-Year Plan (1991-95). They will be making key decisions supporting this plan during 1988-90.

The time-frame within which we would begin to see Soviet force changes in response to SDI would depend on the degree to which the Soviets expanded production of existing weapon systems, modified and improved those systems, or developed new ones:

- Expanding production runs early in the 13th Five-Year Plan for systems that already exist or are currently under development could result in larger force deployments in the early to middle 1990s.
- Modifying existing weapons in response to SDI could result in some systems entering the force three to five years after the modification programs were initiated.
- Initiating major new weapons development programs during the 13th Five-Year Plan, however, would not result in production or deployment of those systems until after the year 2000.

To illustrate the resource commitments the Soviets could face in their planning, we have estimated procurement and operations and maintenance (O&M) costs, expressed in constant 1982 rubles, for systems the Soviets might deploy using existing or near-term technology. We have also considered the impact that responding to SDI might have on other high-priority military and civilian programs as they compete for scarce, high-technology resources. We lack the data to estimate the total amounts the

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Soviets are spending on BMD-relevant research, but the demands of the R&D phase of a weapons program for manpower, machinery, and raw materials are generally small in comparison with the procurement phase.

In examining the magnitude of the resource challenge Moscow is facing, we have examined four generic responses to SDI. We are not, however, projecting that the Soviets will actually respond to SDI with the specific types and levels of forces discussed nor are we judging that these force levels would be adequate or effective responses. The approaches we have considered are:

- **Saturation.** If the Soviets were to expand procurement of the SS-18 follow-on, the SS-X-24-class, and the SS-25-class ICBMs over a 10-year period to overwhelm a future US BMD system, we estimate that they could deploy **L** more reentry vehicles (RVs) on these systems than we project they will deploy by 1997 in the absence of a response to SDI. Such a response, however, would cost approximately 73 billion rubles—about twice as much as we would otherwise expect them to spend on these ICBM systems in the next 10 years.
- **Circumvention.** The cost of increasing deployment of air-breathing missiles to circumvent US BMD could vary greatly, depending on the delivery platforms chosen and the effectiveness of US air defenses. We estimate that, using current production capacity, the Soviets could produce over a 10-year period as many as 170 Bear H and 150 Blackjack aircraft, supporting Midas tankers, and 7,700 air-launched cruise missiles (ALCMs) at a cost of approximately 33 billion rubles, or about two and a half times as much as we expect them to spend on these systems by 1997 in the absence of a response to SDI.
- **Defense Suppression.** The cost of a defense-suppression response would vary greatly depending on the survivability and redundancy of the US BMD system and on the number and sophistication of the antisatellite (ASAT) weapons deployed. Procuring no more than a few hundred ground-based nuclear-armed ASAT interceptors and associated tracking and guidance radars would cost less than 10 billion rubles. Deploying as many as 1,200 ASAT interceptors and associated radars would raise procurement costs to about 25 billion rubles. We estimate that the Soviets could deploy about 60 space mines—orbiting satellites capable of

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destroying nearby space platforms on command—using existing ground control assets for about 6 billion rubles. Costs could escalate rapidly, however, if the Soviets were eventually to develop and deploy more sophisticated interceptors or space mines requiring dedicated ground control facilities.

• **Ballistic Missile Defense.** [

] projects that if the Soviets chose to expand their existing ABM defenses to cover key targets throughout the USSR, they could deploy a network of 3,200 ground-based, nuclear-armed exoatmospheric and endoatmospheric missiles, supported by Flat-Twin tracking radars and Pawn Shop guidance radars. We estimate that it would cost about 50 billion rubles to procure these systems—more than total Soviet procurement outlays on strategic defense, including both ABM and air defense systems, during the past 10 years. If the Soviets eventually attempted to deploy their own space-based BMD system, we believe space lift would be a potential bottleneck. Procuring enough SL-X-17 heavy-lift launch vehicles to meet lift requirements similar to those projected for US BMD systems could cost the Soviets about 40 to 75 percent more than we would otherwise expect them to spend on SL-X-17 procurement.

Whatever the costs of individual options, the Soviets' desire to minimize strategic and technological risk probably would lead them to adopt multiple approaches to countering SDI. A limited response entailing incremental increases in the procurement of ICBMs, ALCM carriers, direct-ascent ASAT weapons, and space mines, for example, would have only a modest impact on total defense spending or on the Soviet economy. A more robust, comprehensive response involving both extensive countermeasures and expanded Soviet BMD systems would lead to unprecedented expenditures and greatly increased military demand for a variety of scarce resources.

Thus, for anything beyond a quite limited response, the Soviets' public claims that they could counter SDI quickly and cheaply probably understate the severity of the trade-offs they would have to make in responding to SDI. Indeed, some Soviets have expressed concern that the cost of deploying advanced strategic defenses while modernizing and expanding offensive forces would be prohibitive. Even if General Secretary Gorbachev succeeds in raising productivity enough to sustain economic growth at an average annual rate of 2.5 percent during the 1990s, and if defense

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spending were kept at its current share of GNP, the Soviets would find it difficult to mount a large response to SDI during this period without curtailing other military programs. Significantly expanding procurement of weapon systems based on existing technologies would strain the Soviets' already taut component supply base. Reliance on more complex technologies would cause still greater strain because many Soviet weapons programs projected to reach initial operational capability in the late 1990s will compete for the same resources.

Additional demand for the critical products of advanced technology would hit the Soviet economy at a crucial juncture. Gorbachev is trying to reverse two decades of declining economic growth with a strategy that emphasizes industrial modernization through the acceleration of investment and the introduction of more technologically advanced capital equipment. His modernization plans call for many of the same scarce, high-technology resources—including microelectronics and flexible manufacturing systems—that would be required for advanced BMD systems and countermeasures. Initiating a response to SDI in the near term that depended on these advanced technologies would, in our view, require scaling back industrial modernization goals. If Gorbachev's industrial modernization program is substantially delayed, we believe Soviet economic growth would falter.

In an effort to both defer and reduce the costs and technological challenges involved in a major response to SDI, we believe the Soviets will continue to pursue arms control measures to gain US concessions on SDI. In the meantime, we expect that they will try to save money and time in SDI-related research by acquiring Western technology and by harnessing East European scientific expertise and manufacturing capabilities in areas where comparable Soviet capabilities are lacking or in short supply. Given Western controls on the export of critical defense-related technologies and the limited ability of East European countries to support Soviet efforts, outside help might ease, but will not solve, the challenges posed by SDI.

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Scope Note

This paper examines the resource implications of possible responses the Soviets might make to SDI. It begins by examining their concerns about SDI and the actions they have already taken in response to the initiative. It then estimates the cost of several potential responses to SDI and examines the technological challenges of formulating a response. Finally, the paper considers potential trade-offs among other important military and civilian objectives. *Because we lack specific information on the threat that the Soviets would perceive from US BMD deployment, however, we are not projecting the specific types and levels of forces they might employ in response to SDI, nor are we assessing the effectiveness of their potential responses*

[] It provides information on what the Soviets have already done in response to SDI and estimates the cost of a broader range of possible future responses. In addition, it expands the analysis of the impact that responding to SDI might have on other military and civilian programs.

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Soviet SDI Response Options: The Resource Dilemma

Soviet Strategic Defense Activities

Long before the United States announced the Strategic Defense Initiative (SDI), the Soviets had been investing heavily in strategic defense. They currently have the world's only operational antiballistic missile (ABM) system, which they have maintained around Moscow for two decades and are currently upgrading. They have deployed a large air defense network of surface-to-air missiles (SAMs) and interceptor aircraft, and they are now developing and deploying new air defense systems designed to improve their early warning and detection, tracking, command and control, and intercept capabilities against aerodynamic systems. They also have had an operational anti-satellite (ASAT) system since the 1970s.

In addition the Soviets conduct extensive research on advanced technologies with potential ballistic missile defense (BMD) and ASAT applications. For example, they have been working on military applications of directed energy for as long as the United States. There are important gaps in our understanding of the objectives and status of Soviet research in these areas. Nevertheless, because these research efforts predate the US SDI, we expect them to continue whether the United States proceeds with its program. (S/NF)

Why the Soviets Don't Like SDI

We believe the Soviets were surprised by and continue to be worried about the US SDI program (see inset). Their concern is reflected in the intensive campaign they have launched to undermine US and Allied support for SDI, which has combined diplomacy (particularly arms control initiatives) with extensive political influence activities.

¹ See DI Research Paper SOV-87-10045X, August 1987, *Soviet Political Influence Activities: Shifting Tactics To Counter SDI*.

The Soviets' reaction to SDI suggests that Moscow has three main concerns in considering potential responses. They involve the:

- *Strategic impact* of US deployment of BMD.
- *Opportunity costs* in the military and civilian sectors that could result from a major response.
- *Technological challenges* created by the US effort.

SDI has potentially far-reaching implications for Soviet strategy, force structure, and defense planning. If the United States decides to deploy a BMD system, the Soviets would face new uncertainty about the ability of their strategic forces to accomplish their targeting missions in war and their deterrence missions in times of crisis. Shifting technological competition from ballistic missiles and nuclear weapons, which the Soviets have acquired at great cost, to advanced defensive technologies in which the United States has many advantages would fundamentally change the dynamics of US-Soviet strategic competition. Restructuring Soviet force posture to counter US strategic defenses would be costly and time consuming and could disrupt plans for other important military and civilian programs. As the Soviets explore their options, the magnitude of the resources required and the availability of key technologies will weigh heavily in their response.

The Soviets fear that SDI will force an accelerated arms race in strategic offensive weapons. In both ² they have indicated that they would find it difficult to increase spending on strategic offensive forces sharply without affecting the availability of resources needed to modernize their conventional forces and industrial base. At the same time, despite public assertion that they will not attempt to emulate SDI, the Soviets are concerned that

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The US Strategic Defense Initiative

In March 1983 President Reagan called for an intensive and comprehensive effort to define a long-term research and development (R&D) program, based on emerging US technological capabilities, aimed at ultimately eliminating the threat posed by nuclear-armed ballistic missiles. Soon afterward, the United States established SDI as a broad-based R&D effort to determine the technical feasibility of developing ballistic missile defenses. In April 1984 the Strategic Defense Initiative Organization (SDIO) was established within the Department of Defense to manage the SDI effort. The SDIO was directed to place primary emphasis on nonnuclear technologies, while the US Department of Energy was tasked to conduct research on nuclear directed-energy weapons.

Decisions on when a US BMD system would be deployed were deferred pending preliminary research into the relative merits and feasibility of alternative technologies and system architectures. By June 1987 SDIO had endorsed a three-phase deployment strategy:

- The first phase—slated for 1992-95—would probably emphasize ground- and space-based kinetic energy weapons and sensors to intercept Soviet ballistic weapons in the boost-, postboost, and late midcourse phases of flight.*
- The second phase—slated for 1996-98—would improve US capabilities to intercept ballistic weapons in the midcourse and terminal phases by adding more space- and ground-based kinetic energy weapons, space surveillance sensors for interactive discrimination between RVs and decoys, and improved systems for battle management and command, control, and communications.*
- The third phase—slated for 1999-2000—would add advanced space- and air-based sensors, improved kinetic energy weapons, and space-based directed-energy weapons to attack Soviet ballistic missiles in all phases of flight.*

continued US commitment to strategic defense will eventually force them to accelerate the pace and expand the objectives of their own BMD programs. Soviet statements indicate that Moscow believes that the cost of deploying advanced strategic defenses while modernizing and expanding offensive forces would be prohibitive. Shifting resources from offensive to defensive forces, however, would impose potentially unacceptable constraints on the rate of improvement in the Soviets' strategic offensive forces. Technological stagnation of their forces in the face of continually improving US strategic defenses would upset the strategic balance and ultimately undermine their superpower status.

These concerns are compounded by the Soviets' awareness that they may have to initiate a response to SDI at a time when they already face stiff competition for resources from other military programs and from Gorbachev's ambitious industrial modernization program. Diverting resources from these programs now to counter SDI would, in the long run, inhibit the Soviets' ability to compete effectively with the West in the development and deployment of advanced-technology weapon systems.

C I have expressed concern that SDI will force the pace of US-Soviet competition in the development and assimilation of key military-related technologies. Most Soviet weapons development programs emphasize proven and producible technology. SDI, however, involves many technologies that the Soviets have found difficult to develop and assimilate. They are therefore uncertain about their ability to keep up with US technological advances in strategic defense and are worried that other US military programs may benefit from technological spinoffs from SDI research. They have also voiced fears that diverting critically scarce resources to respond to SDI could retard technological progress elsewhere.

How the Soviets Have Responded So Far

Moscow's efforts to halt or slow the SDI program have been directed at eroding US public and Congressional support to achieve cutbacks in SDI funding,

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and at exploiting European doubts over the wisdom of pursuing what the Soviets have sought to characterize as a "new dimension of the arms race." Depending on the audience, the Soviets have taken different, even contrary, approaches in their attempts to undermine the SDI program. They have portrayed SDI as technically infeasible and prohibitively expensive, while at other times they have characterized the program as militarily destabilizing or relatively easy to counter. The Soviets have also brought pressure on the United States to negotiate constraints on SDI. Since the Geneva Nuclear and Space Talks opened in March 1985, the Soviets have sought to ban the development of space-related weapons, and have linked agreement on reductions of strategic offensive weapons to a resolution of space weapons issues.

Despite the hope that a new administration will abandon or deemphasize the SDI program, Soviet defense planners have not counted solely on propaganda and arms control efforts to block SDI. The Soviets have begun to assess possible future US BMD technologies and capabilities in light of their own strategic offensive and defensive systems.

Shortly after the President announced SDI, the Soviets initiated threat and technology assessments in the Academy of Sciences, the Ministry of Foreign Affairs, and probably in the Ministry of Defense.

These studies concluded that the Soviets' quickest, easiest, and least risky response would be to counter rather than to emulate SDI and to primarily emphasize proven technologies. At the same time, the studies identified technology areas related to SDI where Soviet research was considered inadequate and recommended that programs in these areas be given greater attention.

The Soviet Union has taken steps to better position its scientific and military institutions to respond to changes in US policy toward strategic defense. Reportedly, the Soviets have reallocated R&D resources to provide additional funding for some projects relevant to advanced BMD and have made

organizational changes at some research institutes to enable them to pursue such research more efficiently. For example:

- Feasibility studies of space-based BMD have brought about structural and managerial changes in some research institutes, resulting in an expansion and reorganization of military-related laser and space systems research.

- In 1984 a fivefold increase in funding for "space defense" research, while overall funding for science and technology (S&T) was left unchanged.

- In November 1985 that he had been given six times the amount of money he received in 1984 for SDI-related research.

- In 1986 claimed to control a multimillion-ruble budget for SDI-type research.

- Citing a statement made by a Soviet academician in mid-1986, said that the Soviet Government assigns the top graduating students from certain higher technical schools to military research programs in two key areas: countering SDI and developing a space shuttle and space station.

These adjustments to R&D programs probably are motivated by a Soviet desire to prevent the United States from achieving technological advantage in this critical strategic area. Because the US SDI program is itself still in the research phase, the Soviets probably have not yet felt compelled to go beyond R&D and political action in response. We do not have any evidence that they have initiated major new investment or acquisition programs either to counter or to emulate SDI.

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Besides mustering their own scientific resources, the Soviets have attempted to harness East European S&T assets to aid their counter-SDI research efforts. According to [] Gorbachev met with representatives from 10 Communist countries in December 1985 to gain their support to strengthen Soviet counter-SDI efforts. []

[] the Soviets requested still further scientific cooperation and additional funding from the other Warsaw Pact states to support R&D on SDI countermeasures.

Some East European countries have already responded to the Soviet appeal. []

[] Also, as of May 1986, the Czechoslovak Academy of Science was reportedly cooperating with the USSR on a Soviet program "corresponding to SDI."

Planning Horizon for a Larger Soviet Response

The threat and technology assessments the Soviets have already made suggest that they are probably incorporating potential SDI responses in their long-term military plans. These plans are developed on a case-by-case basis to weigh the implications of emerging military technological challenges over the next 15 to 25 years. On the basis of projected threat assessments and the estimated performance of Western systems, military planners derive key performance objectives for future Soviet systems. They then project the industrial and technology development and acquisitions needed to produce these systems and develop an R&D schedule for new systems or for major modifications of existing systems slated to enter production during the projection period. These plans do not, however, commit capital resources.

If the Soviets eventually decide to respond to SDI by procuring new or additional weapon systems, they will incorporate specific responses in their five-year national economic plans (FYPs). These FYPs commit

capital investment and resources to major programs that are ongoing or will be initiated during the plan periods. Because substantial shifts in resource allocation would disrupt the current FYP (1986-90), however, we do not expect major increases in procurement funding in response to SDI before the 13th FYP (1991-95)—barring a US commitment to go forward with deployment of advanced strategic defenses in the next year or two.

If the United States initiates deployment of BMD systems in the early 1990s, the 13th FYP will be a critical time for the Soviet Union to begin to respond with new or expanded strategic programs. The Soviets will make key decisions supporting this plan during 1988-90. By that time, they will have more information about potential SDI architectures and, in the wake of the US presidential election in 1988, will be better able to judge the future pace and direction of the SDI program. If, however, they still lack critical information about the deployment schedule and technical characteristics of possible US BMD systems at that time, they may choose to postpone commitment to specific countermeasures until midway through the 13th FYP—although any midcourse changes would be disruptive—or they could wait until they are planning for the 14th FYP. Such a delay, however, would place the Soviets at risk of conceding to the United States the strategic advantage. On the other hand, the Soviets could also settle for responses in the 13th FYP which, though possibly not optimal, could still complicate US strategic defense requirements. The Soviets could modify these responses over time as they acquired additional information. Pressure to initiate major procurement programs in response to SDI would diminish if they judged, based on their perception of domestic US support for SDI and on past US weapons procurement experience, that the United States is unlikely to meet the SDIO's schedule for phased BMD deployment.

The length of time the Soviets would require to respond to SDI would depend on the degree to which they expand production of existing weapon systems,

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modify and improve existing systems, or develop new ones. Larger than expected production runs or construction of new production capacity for weapons now in production or development could begin during the 13th FYP. If, on the other hand, the Soviets initiated early in the 13th FYP a full-scale development program to modify an existing system, they could begin production and deployment of the modified system by the 14th FYP (1996-2000).¹ Because the development cycle for new, complex weapons—albeit using existing technology—typically spans nine to 12 years, completely new weapons programs initiated early in the 13th FYP probably would not reach deployment until the early 2000s (see figure 1).

Soviet Response Options

This section examines the cost and feasibility of expanding production of systems the Soviets have already deployed, are developing, or could develop readily using largely proven technology. For response options incorporating more advanced weapons or support systems, we only identify technological and industrial constraints that might affect the timing and cost of production because we have difficulty estimating the cost of future systems whose technologies we do not yet fully understand. We are not predicting that the Soviets would actually respond to SDI with the specific types or levels of forces used in our estimates or that the options we have considered would be adequate or effective responses to SDI.

If the Soviets eventually respond to SDI by undertaking major procurement programs, they could choose from among four generic options:

- **Saturation**—Expanding or improving strategic offensive nuclear forces in an effort to overwhelm or penetrate US BMD.
- **Circumvention**—Increasing production and deployment of nonballistic systems, for example, long-range cruise missiles and delivery platforms, to circumvent US BMD.

- **Defense Suppression**—Deploying defense-suppression weapons such as ASAT interceptors or space mines capable of directly attacking the space-based elements of US strategic defenses.
- **BMD**—Expanding ballistic missile defenses.

If the Soviets decide that a major response to SDI is necessary, we think it is unlikely that they would pursue only a single option. Their desire to minimize strategic and technological risk would probably lead them to pursue multiple approaches to countering SDI. Ultimately, the Soviets' response would be shaped by their perception of US BMD objectives and capabilities and by their own strategic and technological requirements.

Many possible responses to SDI could be extensions of programs the Soviets are already pursuing or planning for the 1990s. For example, they are already developing and deploying new strategic offensive weapons—such as new ICBMs, cruise missiles, nuclear-powered ballistic missile submarines (SSBNs), and bombers—that could eventually contribute to their capabilities to saturate or circumvent US defenses. The Soviets could also build on their current programs to improve ABM and defense-suppression capabilities. Given their uncertainty about the future status of SDI and the performance characteristics of possible US BMD systems, they might consider an extension or expansion of ongoing or planned programs to be less risky in the near future than initiating costly new programs specifically in response to SDI.

To illustrate Soviet industrial capabilities to pursue the four generic response options and the resource implications these responses would entail, we have examined selected systems that could play an important role in a larger, integrated Soviet response. In each case, we have estimated the procurement costs for up to the maximum number of these systems the Soviets could produce over a 10-year period using existing production facilities operated at current utilization rates.⁴ When possible, we have also estimated

¹ For a detailed analysis, see D.I. Research Paper SOV 87-10037JX, 3 July 1987, *Preparation for Production of Soviet Weapons*.

⁴ See appendix A for a discussion of how the cost estimates were derived for this paper.

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the operations and maintenance (O&M) costs for these systems for 10 years.¹ The costs and probably the effectiveness of the individual options we have considered vary greatly. Some appear more affordable than others, but, because we have not analyzed the effectiveness of any of the forces considered, our estimates do not indicate which options would be most cost effective.

Saturation

The simplest of the active measures to overwhelm SDI would be a simple increase in the number of Soviet strategic missiles to a level assuring penetration of the American spaceshield.

*Maj.-Gen. Ivan I. Anureyev,
Former professor, Soviet General Staff
Academy
March 1987*

The response the Soviets have most often claimed that they would make to US BMD deployment is to expand their own offensive nuclear forces—especially ICBMs. They already have an extensive ICBM modernization program, and by the mid-1990s they will have replaced most of their current ICBMs with modernized missiles. 7

L we consider their deployment as replacements for older, less capable missile systems rather than as a response to SDI. The Soviets, however, might substantially increase the numbers deployed in an effort to saturate US defenses.

The number of additional ICBM RVs the Soviets would need to saturate US BMD would depend on the perceived effectiveness of the US defenses and their impact on Soviet strategic requirements and operational concepts. US BMD deployment could lead the Soviets to reassess their prioritization of US targets, change the damage expectancy required for various targets, add SDI-related targets, or substitute

¹ We have not estimated O&M costs for the systems considered under the defense-suppression or space-based BMD options because we lack historical data from which to extrapolate O&M procedures and costs. 7

submarine-launched ballistic missiles (SLBMs) or air-breathing weapons to cover targets currently allocated to ICBMs. Because we do not know which, if any, of these changes the Soviets would make in response to US BMD deployment, we cannot project how many warheads they would need to saturate those defenses. Nevertheless, as a baseline case, we can relate the Soviets' ability to pursue the saturation option to their basic ICBM RV requirements, assuming that their basic targeting approach remains unchanged. 7

L Our analysis of their current ICBM production facilities indicates, however, that they could produce ICBMs well beyond these levels. If the Soviets sought to saturate US defenses without changing their targeting requirements, they would have to deploy additional ICBM RVs to compensate for the attrition a US BMD system would impose. Our estimates indicate that if the Soviets produced the SS-X-24-class, and SS-25-class missiles using only existing capacity over 10 years, they could deploy about 11,500 RVs using these systems.

We estimate that if the Soviets produced all of these systems over a 10-year period using current capacity, procurement and construction costs would equal

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Figure 1
USSR: Developing New Systems and
Production Capacity

Preparation for production of weapons

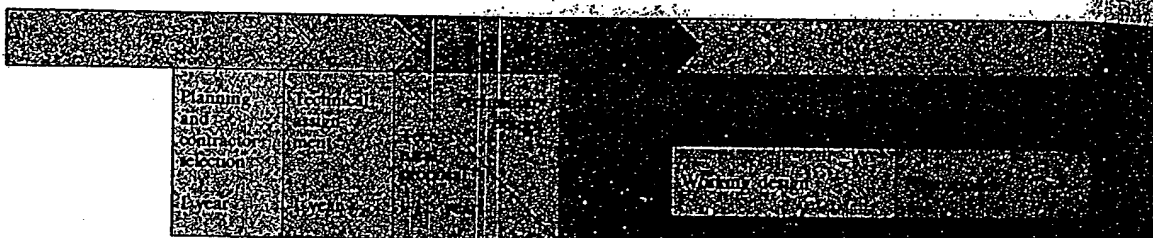
Phases:



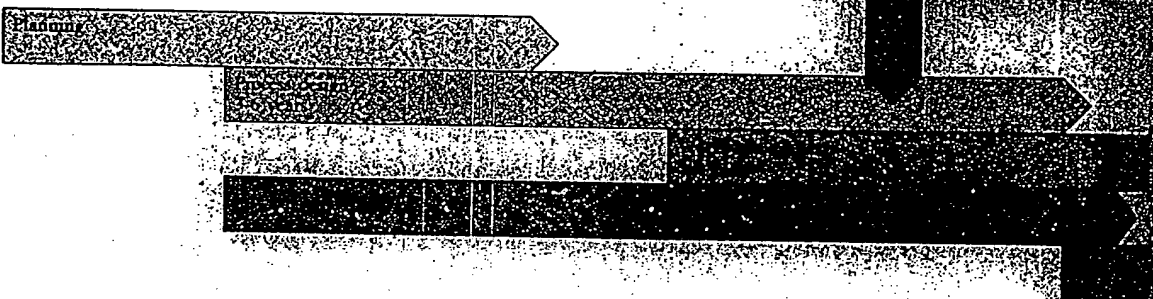
Major milestones:



At the design bureaus:



At the series production plants:



*Technical assignment: Requirements for the general performance and physical characteristics of the proposed system levied by the military on the intended lead design organization.

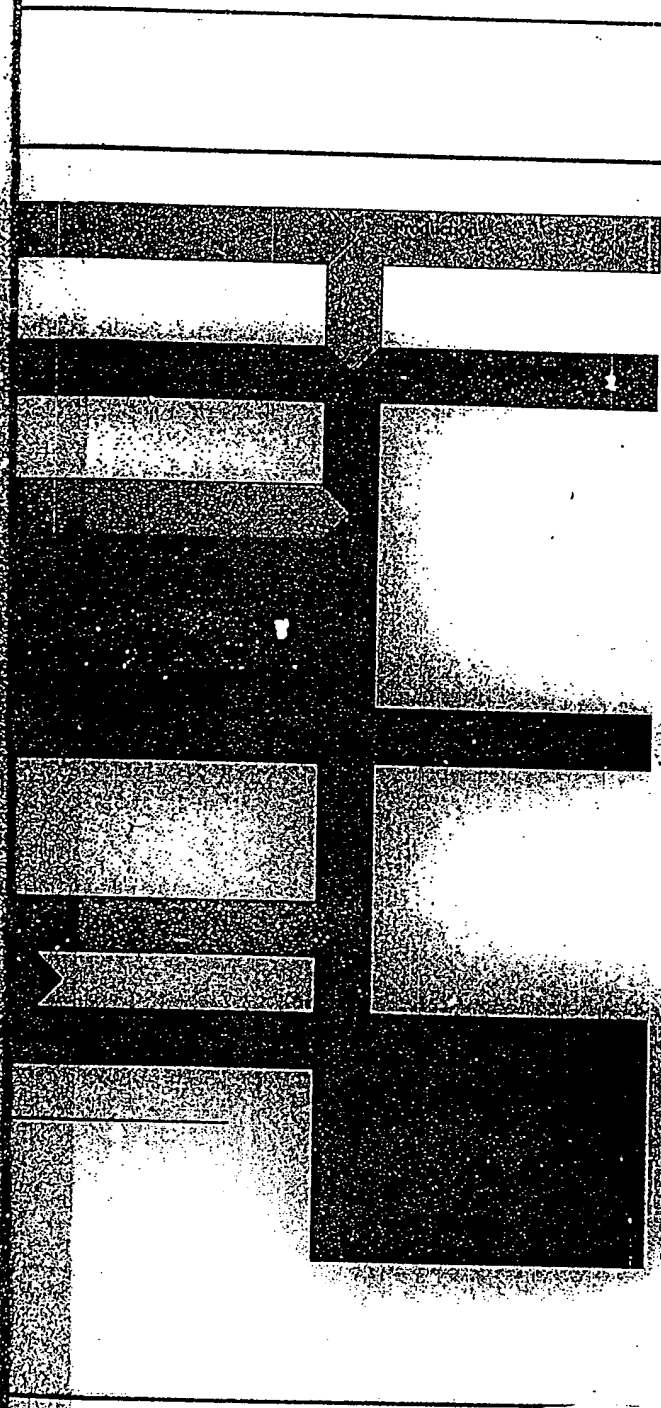
*Technical proposal: Design alternatives proposed by the integrating contractor in the responsible industry.

*Preliminary design: Preliminary design solutions (technology freeze) and subscale mockups.

*Technical design: Design solutions, full-scale mockup, review and approval of project status by technical authority.

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about 73 billion rubles. This is about 65 percent more than we estimate the Soviets spent on total procurement for the Strategic Rocket Forces (SRF) during 1977-86, and about twice what we project they will spend on these three systems between 1987 and 1996 in the absence of a response to SDI.

In addition to procurement costs, the Soviets would incur additional construction and O&M costs, although these would be small compared with procurement costs. Nevertheless, even if the Soviets were to pay the price for substantially increasing ICBM production, the SRF would have difficulty assimilating the expanded forces rapidly because of constraints on trained manpower and supporting infrastructure. The industrial facilities involved in producing large numbers of missiles and their subsystems and components might also experience shortages of raw materials and trained labor.

Generally, sustaining much higher levels of missile production for a long period of time would be feasible only if the Soviets were to forgo substantial modifications to the systems during their production runs. If the Soviets sought to maximize output by departing from their current practice of introducing incremental improvements to their missiles in the course of series production, they would have to refrain from introducing tailored BMD countermeasures—such as advanced penetration aids—to missiles already in production.

Besides expanding ICBM production, the Soviets have the option of responding to SDI by making qualitative changes to their ICBM forces to make them less vulnerable to US BMD systems. For example, they could deploy a larger number of warheads on existing missiles. In addition, they could deploy decoys along with RVs on their ICBMs to confuse US sensors and complicate targeting requirements for midcourse flight. The Intelligence Community estimates that, with a concerted effort, the Soviets could develop boosters with burn times of less than 100 to 125 seconds within five to seven years.⁷ Shorter burn

times would reduce the time available for BMD sensors to acquire the targets and associated weapons to destroy the booster before it deployed its RVs. Such a weapons development program would require the Soviets to develop a new rocket motor and a faster action postboost vehicle as well as to change the missile fuel type. Although we have no evidence that the Soviets are developing fast-burn boosters to counter SDI, their booster burn times are becoming shorter as they improve their rocket technology. Such countermeasures, which would require extensive missile design changes, would be costly and could reduce missile payload or accuracy.

Circumvention

SDI is not effective against cruise missiles or against aircraft... In the event of implementation of the SDI project, the arms race will shift from the sphere of ballistic missiles to other spheres.

Georgiy Arbatov,
Soviet academician
November 1986

The Soviets could attempt to circumvent a US BMD system by increasing their reliance on air-breathing missiles. To illustrate possible trade-offs associated with this option, we have examined the potential for expanded production of air-launched cruise missiles (ALCMs). The Soviets are already in the process of modernizing their heavy bomber forces by producing the Bear H and the Blackjack, which are equipped to deliver ALCMs. By the mid-1990s, these two aircraft will comprise the bulk of the Soviet intercontinental bomber force. The estimated accuracy and yield of Soviet strategic cruise missiles would allow them to destroy almost any target assigned to ballistic missiles. We believe, however, that the Soviets currently plan to use long-range cruise missiles in follow-on strikes, not for attacking the time-urgent targets against which many Soviet ICBMs would be employed. Moving counterforce targeting requirements from ballistic missiles to cruise missiles in response to SDI would heighten Soviet concerns over the survivability, penetrability, timeliness, and responsiveness of

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their attack forces. In considering the circumvention option, the Soviets would have to weigh the potential vulnerability of ICBMs and SLBMs to US BMD against the risks imposed by the slower flight times of cruise missiles and the potential vulnerability of their carriers to interdiction.

A major shift to ALCM would force the Soviets to build larger numbers of both ALCM carriers and supporting tankers. In addition, they would have to shift resources among cruise missile programs to allow increased production of the AS-15 ALCM. Because it takes much longer to build strategic aircraft than ICBMs and because each ALCM carrier can deliver only about as many warheads as a single large ICBM, it would take years and large resource outlays to deploy enough ALCMs to cover all the targets the Soviets currently assign to their ICBM forces.

In the absence of a response to SDI, we project that the Soviets will halt production of the Bear H and produce 90 Blackjacks during 1987-97, costing about 14 billion rubles. Existing capacity, however, would allow the Soviets, if they chose, to procure 7,700 ALCMs, 170 Bear H's, 150 Blackjacks, and associated tanker aircraft by 1997 at a cost of approximately 33 billion rubles. Greater reliance on the more sophisticated Blackjack would increase response costs and would require the Soviets to expand Blackjack production capacity beyond current expansion efforts.

they would require at least five years to bring a new plant on line.

O&M costs for strategic aircraft are considerably higher than for ICBMs, given the aircraft's greater requirements for routine maintenance and larger costs entailed in daily training and patrol operations. A large increase in strategic aircraft deployment would require the Soviets to expand basing facilities and to increase the number of maintenance personnel and flight crews, all of which would take several years to accomplish. For example, the deployment of 300 additional strategic bombers would require the

formation of approximately 20 new air regiments and construction of about 10 new bases, costing about 400 million rubles.

Defense Suppression

Laser stations in orbit for military purposes can be wrecked quite easily.

N. Zholkver,
Soviet writer
April 1986

Soviet military officials and scientists have often said publicly that space-based components would be the most vulnerable elements of a deployed US BMD system. Figure 2 shows that the Soviets have a variety of ASAT options that in the future could be capable of threatening US space-based BMD elements in a broad range of altitudes. For example, an ASAT interceptor based on the Galosh ABM missile could be used to threaten sensors and kinetic-kill vehicles deployed at altitudes below 1,000 kilometers (km). As figure 2 indicates, some of the Soviets' ASAT options are available now, some could be developed relatively quickly from existing technology, and still others—especially those requiring advanced sensors or space basing—probably could not be deployed before the late 1990s or beyond. Of course, ASAT missiles could themselves be vulnerable to US SDI system.

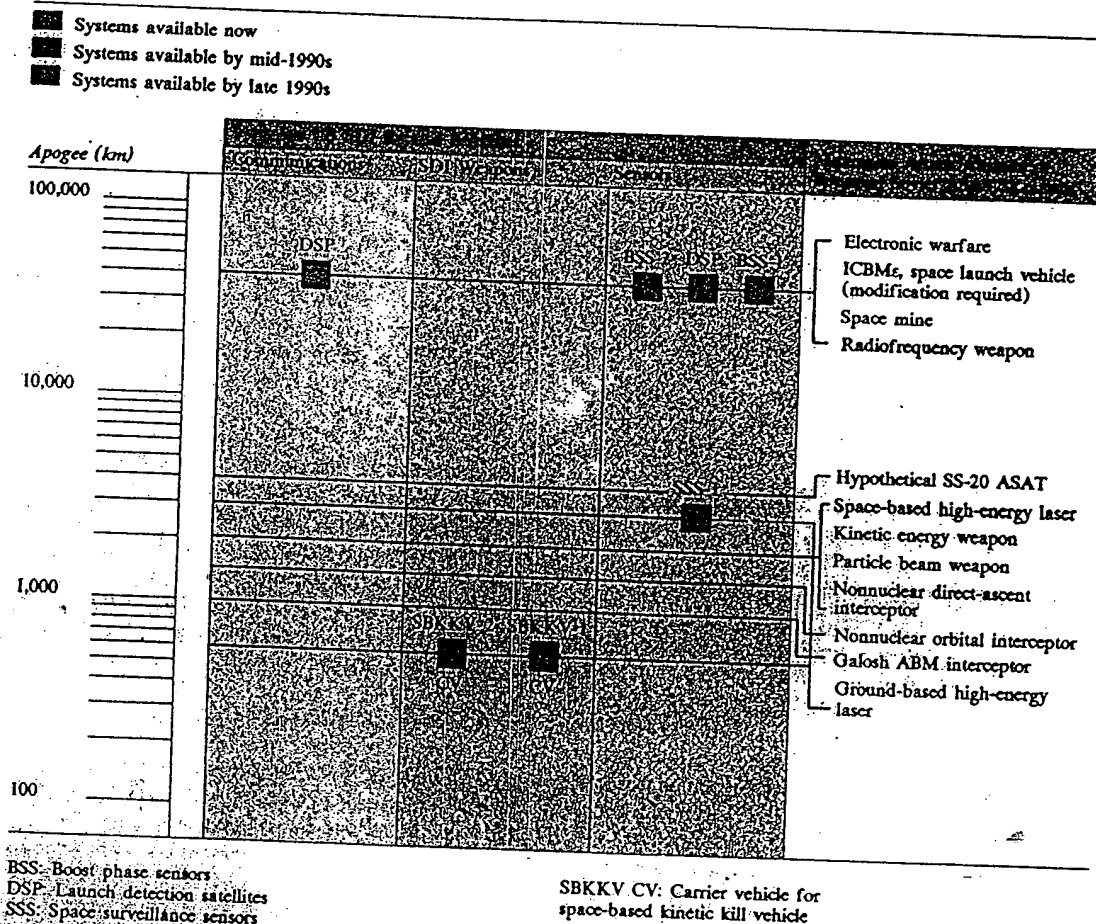
Of the Soviets' near-term ASAT options, the least effective would probably be the nonnuclear orbital ASAT interceptor. Its slow intercept capability would give US space-based defenses time to maneuver to safety or to attack the ASAT itself.

The Soviets could try to overcome these deficiencies by developing a direct-ascent ASAT interceptor. Their ability to do so in the near term would probably be contingent on their willingness to arm their ASATs with nuclear warheads. Judging from the problems the Soviets have had in developing an advanced

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Figure 2
USSR: Potential ASAT Threat to
Proposed US SDI Systems



homing sensor for their orbital ASAT system, the US Intelligence Community estimates that they could not deploy an effective nonnuclear direct-ascent ASAT before the mid-1990s.¹ To illustrate the resource

implications of near-term Soviet defense-suppression options, we have estimated the cost of two different types of nuclear-armed, direct-ascent interceptors.

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The first direct-ascent ASAT option we have considered is the modification of existing SS-20 intermediate-range ballistic missiles (IRBMs) to fill an ASAT role. □

□ that an SS-20-class ASAT interceptor could threaten US satellites at altitudes of up to 4,000 km. This ASAT option is interesting in light of the Soviets' proposals to withdraw their SS-20s from Europe and Asia as part of an INF agreement, although they have indicated that they would be willing to destroy them as part of such an arms control agreement.

Modifying these existing missiles would be considerably cheaper than building entirely new interceptors. Moreover, the Soviets could hold down defense suppression-procurement costs by capitalizing on the defense system's "absentee problem"—that only a small fraction of the US orbiting defense satellites would be over the battle space at any given time. We estimate that the cost of modifying SS-20 IRBMs and procuring Try Add A tracking radars and Try Add B guidance radars to support deployment of 200 SS-20 ASATs would be approximately 3 billion rubles.

If the United States deployed large numbers of weapon platforms in space for boost-phase, post-boost-phase, and midcourse attack, the Soviets could perceive the need to deploy enough ASATs to attack a much larger number of space targets. They would also require larger numbers of ASATs if they sought to launch their ICBMs in several salvos, rather than in a single massed strike, since more US weapon platforms would be brought to bear. Finally, larger numbers of ASATs would be required if US platforms were highly redundant or equipped with a self-defense capability.

To illustrate the potential cost of pursuing a much larger ASAT response, we have considered a second direct-ascent ASAT option—producing large numbers of ASAT interceptors based on the Galosh ABM interceptor. We estimate that the Soviets have the capacity to deploy about 700 to 1,200 such interceptors over a 10-year period. Procuring missiles and associated tracking and guidance radars to support such a deployment would cost about 16 to 25 billion rubles.

To threaten US satellites at higher altitudes, the Soviets might choose to deploy "space mines," orbiting satellites capable of destroying nearby space platforms on command. The Soviets have stated publicly that they consider space mines an important defense-suppression option. They could deploy a few to threaten a relatively small number of critically important US SDI-related satellites either as a stand-alone, defense-suppression option or in conjunction with direct-ascent ASATs. We have examined a space mine approach that uses geosynchronous satellites armed with small nuclear warheads. We estimate that the cost of procuring and launching 60 such space mines would cost about 6 billion rubles. This estimate assumes that the Soviets could use SL-12 boosters to launch the space mines into geosynchronous orbit. If the space mines were too large or too heavy to be launched on the SL-12, however, the Soviets would have to use the more expensive SL-X-17 and a new, high-energy upper stage or a completely new launch vehicle.

The deployment of space mines could compete with other launch commitments, depending on how quickly the Soviets planned to deploy the mines and which launch vehicles they used. By 1990 they will have increased SL-12 launches to 15 to 20 per year, up from the early 1980s' rate of about 10 per year. Some of this additional launch capacity could be used to deploy space mines.

The Soviets would probably have to construct an extensive ground support network to provide command and control for a large direct-ascent ASAT or space mine force. We have not estimated the cost of such a command and control system. □

□ Nevertheless, we believe that a command and control system capable of attacking a large number of US space systems almost simultaneously on short notice would be costly to produce and operate.

The Soviets have worked on more advanced technologies that might be used to attack US BMD satellites. For example, they have one high-energy laser test

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facility at the Golovino Laser and Electro-Optical Test Center and two at the Saryshagan Missile Test Center. Because one of the test facilities at Saryshagan is equipped with a beam director, it could pose a threat to some US space systems. Turning these lasers into operational weapons, however, would require additional research and a large construction effort that would take years to complete. Although we cannot estimate with confidence the cost of building a network of ground-based, high-energy laser weapons, such a project would require large inputs of skilled labor, advanced materials, and sophisticated fabrication equipment.

Ballistic Missile Defense

Even if the Soviet Union were to develop a [space-based BMD] system of its own, the country's resources would be sufficient to finance it, with difficulty, but without the risk of economic ruin.

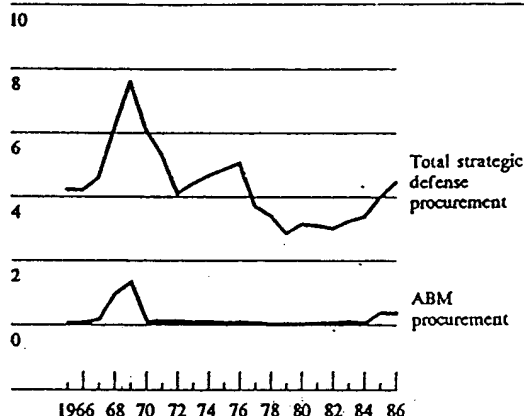
*Georgiy Arbatov
Soviet academician
November 1983*

If the United States proceeds with SDI, the Soviets will have to decide whether to give greater emphasis to BMD in their own strategic posture. CPSU Central Committee Secretary Anatoly Dobrynin has said that examination of the interdependence between offensive and defensive forces is among the most urgent tasks facing Soviet scientists and military planners. The Soviets would have a number of options from which to choose if they decided to expand their own BMD systems and capabilities in response to SDI.

One approach would be to expand existing ABM defenses to cover key targets throughout the USSR. The Intelligence Community has projected that the Soviets could deploy a nationwide network of up to 3,200 ground-based, nuclear-armed endoatmospheric and exoatmospheric interceptors, supported by Flat-Twin tracking and Pawn Shop guidance radars, over a 10-year period.¹ Procurement costs of such a system would total about 50 billion rubles. This is more than

Figure 3
USSR: Estimated Expenditures on
Procurement for Strategic Defense, 1965-86.

Billions 1982 rubles



total Soviet procurement outlays on strategic defense, including both ABM and air defense systems, during the past 10 years (see figure 3). Over and above these procurement costs, operating and maintaining large ABM forces would cost billions of rubles a year and would require a major expansion of Air Defense Forces manpower, support facilities, and training activities.

Deployment of a nationwide ABM system would be paced by radar production and launchsite construction. Rapid deployment of a nationwide, ground-based ABM system would place great strain on the Soviet Union's materials and electronics sectors. Moreover, the Soviets probably would not be able to produce adequate numbers of ABM interceptor missiles in this time frame unless they increased production capacity, either by converting production lines currently

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dedicated to air defense missile production or by constructing a new plant. Converting production lines would take two to three years, however, and could slow the pace of the Soviet Union's efforts to modernize its air defense forces. Construction of a new missile production plant would take longer—probably about five to seven years. In addition, the deployment rate of ABMs could be constrained by the availability of nuclear materials for ABM warheads, depending on the design of the warhead and the demands for nuclear materials from other force elements. If such constraints existed, deployment of large numbers of nuclear-armed ABM interceptors would take longer than 10 years.

The Soviets could also attempt to develop defensive systems based on more advanced technologies, analogous to those being considered in the US SDI program. They have been conducting research since the 1960s on directed and kinetic energy that may be applicable to BMD. We expect them to continue these efforts regardless of how far the United States proceeds with SDI. In most cases, Soviet projects on advanced BMD technologies are in the research or formative development stages, which require relatively little investment, but may preempt vital scientific skills. Because major technological deficiencies in such fields as sensors, battle management, electronics, and probably advanced nonnuclear weapon technologies would have to be overcome, the Soviets could not begin to deploy their own advanced BMD systems before the year 2000.¹⁰

Deploying a network of such advanced systems would be even more expensive than extensive deployment of ground-based ABM interceptors. Moreover, it would require the Soviets to undertake an ambitious industrial construction and tooling effort involving the installation of large amounts of often scarce advanced design, manufacturing, and test equipment. A BMD system with a large number of space-based elements would be more taxing for Soviet industry than a ground-based system, because of the additional requirements that it would impose for space lift, weight reduction, component miniaturization, and advanced materials processing.

The Soviets have publicly criticized space-based defensive systems as strategically destabilizing, vulnerable to enemy countermeasures, and enormously expensive. Moreover, ☐ Soviet technology studies have reportedly concluded that space-based defenses are less feasible than ground-based BMD. Indeed, most of the Soviets' advanced BMD research to date has concentrated on ground-based applications. If further research convinces them that space-based weapons are technologically feasible and militarily attractive, however, the USSR already has a strong, military-oriented space program on which to build such a response (see appendix B). Although we cannot estimate the complete cost of a Soviet space-based BMD system, providing adequate space-launch capacity alone would be very expensive, over and above the cost of procuring and operating the space-based weapons and sensors themselves.

The Soviets already have the production capacity to build a large number of SL-X-17 heavy-lift launch vehicles. We project that they will require about 100 of these boosters, costing about 23 billion rubles, during the 1990s to launch payloads not related to BMD ☐

☐ that they will have the capacity to produce only 20 to 50 additional SL-X-17s during this period.

If Soviet lift requirements to support BMD deployment were similar to those projected for the United States by SDIO—on the order of 5 to 10 million kilograms of payload to low-Earth orbit—the Soviets would require 40 to 100 SL-X-17 heavy-lift launch vehicles to meet those requirements. Consequently, if the Soviets chose to deploy their own space-based defensive system, they would probably have to increase SL-X-17 production capacity. Building a new production plant would probably take five to seven years. In addition, increasing SL-X-17 production to this level could strain component and materials supply and might force trade-offs with other space booster programs.

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The cost of procuring and launching an additional 40 to 100 SL-X-17s would be approximately 8 to 17 billion rubles, or about one-quarter to one-half as much as we estimate the Soviets spent on all military space procurement during 1977-86. The high cost of large-capacity boosters strongly suggests that, for the Soviets, as for the United States, space lift would be a major cost driver and potential bottleneck in any space-based BMD program. The Soviets' awareness of this challenge may reinforce their proclivity to concentrate their BMD R&D efforts primarily on ground-based systems, whether based on traditional or advanced technologies.

Potential Macroeconomic Impact

Gorbachev and other Soviet officials have stated publicly that the USSR's response to SDI would be quicker, cheaper, and more effective than SDI itself. Nevertheless, because the Soviets would probably pursue multiple approaches to countering SDI, the need to move on several fronts simultaneously could result in unprecedented costs compared with their past weapons programs. Moreover, the greater the change introduced in their strategic offensive and defensive planning in response to SDI, the greater the strategic mission and operational costs they will have to incur. Consequently, we believe that the Soviets are deliberately understating the difficulties they would encounter in pursuing even quantitative—let alone qualitative—responses to SDI.

The comprehensiveness of the Soviets' response to SDI and the technologies employed would be shaped by their perception of the effectiveness of US defensive systems. If the Soviets thought that US defensive systems were only marginally effective, they might be more willing to rely on countermeasures that used only existing technology. For example, they could deploy an additional 200 SS-X-24-class ICBMs (over and above what we expect them to deploy by 1997 in the absence of a response to SDI), 50 Bear H ALCM carriers and associated tankers, 200 direct-ascent ASAT weapons, and 30 space mines for under 35 billion rubles. Such outlays would have only a modest impact on the Soviet economy or total defense spending. While

affordable, limited responses based largely on off-the-shelf technology would entail uncertainty about the adequacy of the response and would run the risk of conceding to the United States superiority in advanced strategic defense technologies.

If, on the other hand, the Soviets felt compelled to emphasize advanced technologies in their response to SDI, costs would rise dramatically. Our analysis indicates that procuring and operating the more complex and comprehensive response systems could cost well over a hundred billion rubles. Such tremendous outlays would have a major impact on both the civilian and military sectors of the economy. In particular, constraints on machinery availability would force the Soviets not only to reduce production of consumer durables, but also to pull resources away from other military programs. Even with large reductions in other military programs, however, financing an SDI countermeasure effort that cost more than a hundred billion rubles over a 10-year period would probably force the Soviets to increase the share of GNP devoted to the defense sector.

The USSR's ability to bear the costs of responding to SDI would depend on how quickly it decided to respond, how well its economy performed, and how much it spent on military programs not related to SDI. If such an effort were mounted, we do not know when the Soviets might begin to procure the additional systems or how fast they would attempt to bring them on line. We can, however, make some assumptions about Soviet economic growth rates and defense allocation in the 1990s and illustrate how these might affect the availability of resources for countering SDI.

Even if Gorbachev succeeds in raising productivity enough to sustain economic growth at an average annual rate of 2.5 percent during the 1990s (the rate at which the economy grew during the mid-1970s and early 1980s), and if defense spending were held constant at the current estimated level of 15 percent of the GNP, the Soviets would find it difficult to mount a large response to SDI without sacrificing

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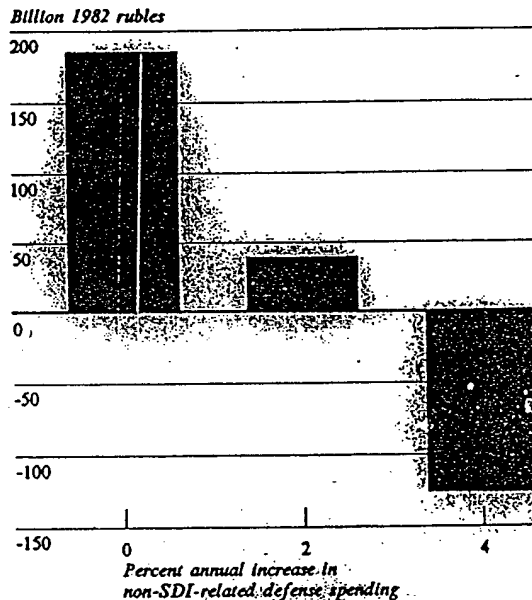
other military programs. If they did not increase spending on military programs unrelated to SDI during this time—thereby inhibiting their ability to meet force modernization requirements—they would accumulate during the 1990s about 185 billion rubles that they could use to counter SDI (see figure 4). If, however, the Soviets' expenditures on non-SDI-related military programs grew at an average annual rate of about 2 percent during the 1990s, they would be left with only about 40 billion rubles to spend specifically on countering SDI. Any increase in annual growth of non-SDI-related military expenditures above 2.5 percent would preempt outlays for countering SDI, unless the Soviets were willing to increase the share of GNP allocated to defense.

Resource Implications of Responding to SDI

Resource demands imposed by a major near-term SDI response would hit the Soviet economy at a critical juncture. Gorbachev is trying to reverse two decades of declining growth in the Soviet economy with a strategy that emphasizes industrial modernization through the acceleration of investment and the introduction of technologically advanced capital equipment. His objective is to match the productivity of major world industrial powers in both civilian and military production by replacing outdated plant and equipment and by accelerating the introduction of advanced technology into the production process. The extensive modernization of civilian industrial plants called for in the 12th Five-Year Plan will impose heavy demands on the machine-building and metal-working (MBMW) sector—which is also the primary source of military hardware.

As figure 5 shows, investment in the MBMW ministries that specialize in defense production exceeded that for MBMW ministries that specialize in civilian production during the 1970s and early 1980s. This high level of investment in the defense industrial sector enabled the Soviet Union to install the plant and equipment needed to produce almost all the weapons that we project for delivery through the early 1990s. The progress the Soviets have already made in modernizing their defense industrial base eased

Figure 4
USSR: Resources Potentially Available
To Counter SDI, 1991-2000^a



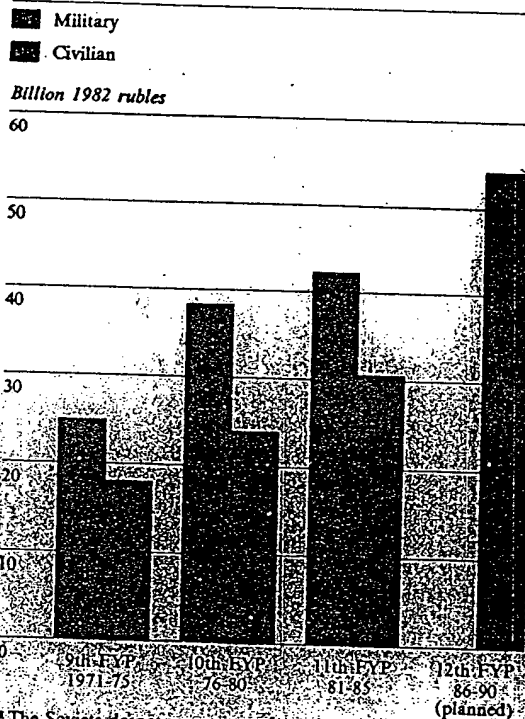
^a We assume that the Soviet defense burden will remain constant at 15 percent of GNP and annual economic growth will average 2.5 percent.

competition for investment resources between defense and civilian claimants during the early years of the 12th FYP

Civilian and military competition for machinery will probably intensify, however, in the late 1980s and early 1990s. During that time, the Soviets will need to retool their defense plants to produce the next generation of weapons. If the performance of the civilian machine-building sector has not improved sufficiently by that time, the Soviets will face tougher choices between the needs of the civilian and defense industries for scarce investment resources.

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Figure 5
USSR: Estimated Productive Investment in the
Machine-Building and Metalworking Sector,
1971-90 ^{a,b}



^a The Soviets do not report investment in military machine building.

^b Early last year, Soviet Premier Nikolay Ryzhkov publicly announced that 63 billion rubles would be invested in machine building during the 12th Five-Year Plan. An analysis of previous investment levels and other, more recent, public statements strongly suggests that the 63 billion figure embraces the planned value for the civilian sector only. We have adjusted this value to ensure comparability with the other data used to derive this series.

Competition for other resources—skilled labor, raw materials, and intermediate goods such as electronic components—is likely to be stiff even in the near term and could require the leadership to make difficult trade-offs among the three principle claimants to the USSR's machinery output—investment, consumer durables, and military equipment. The defense sector's direct and indirect consumption of metals, for example, rose from about 30 percent of total metals output in 1972 to nearly 40 percent in 1982. Unless Soviet industry significantly improves the efficiency with which it uses metals, competition for metal inputs will increase during the 12th FYP. Similarly, competition in the energy sector will be severe. Defense consumes about 20 percent of total Soviet energy output, primarily in the production of energy-intensive products such as machinery and nuclear materials. Gorbachev's effort to increase production of civilian MBMW output will increase energy demand and could intensify competition between the civilian and defense sectors.

The severity of the trade-offs that the Soviets might have to make to respond to SDI would be even greater if they not only procured large numbers of systems based on existing technology, but also developed and deployed completely new systems based on advanced technology. Countering, and especially emulating, SDI with advanced systems would require emphasizing technologies that the Soviets have found difficult to develop and assimilate. Figure 6 illustrates that they would have to make advances in a broad range of technologies, from information acquisition to production technologies, if they were to attempt to develop and deploy a multilayered BMD system similar to that being considered in the United States. To meet this broad-based challenge, they would have to diffuse their R&D and production resources over a wide range of technology areas.

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Figure 6
USSR: Technology Requirements for Deployment
of Advanced Ballistic Missile Defenses

Information acquisition/denial technologies	●	●	●	●			
Information processing/transmission technologies	●	●	●				●
Delivery platform technologies				●	●		●
Nonnuclear lethality technologies				●	●	●	
Production technologies	●	●	●	●	●	●	●

* SATKA: Surveillance, acquisition, tracking, and kill assessment

Competition Within the Military Sector

Responding to SDI in the near term with a large weapons procurement effort would strain the already taut Soviet component supply base. Production of advanced weapons is currently constrained by shortages of advanced materials and production equipment.¹¹

Soviet weapon systems increasingly incorporate sophisticated sensors, computers, microelectronics, signal processing, and advanced materials and structures. Producing an adequate supply of these high-technology components and materials in the years ahead will require increased output of computer-aided design and computer-aided manufacturing

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(CAD/CAM) equipment, precision machine tools, flexible manufacturing systems, automated assembly, and advanced testing and quality control equipment. Although responding to SDI might in the long run spur technological advances in these areas, in the short run it would primarily heighten the competition within the defense sector for these scarce resources.

Although it is too early to project what specific trade-offs the Soviets might have to make in responding to SDI, competition could be felt across a wide range of strategic, general purpose, and command, control, and communications programs. Figure 7 lists a number of Soviet weapons programs projected to reach initial operational capability in the late 1990s that will require technologies also likely to be important in countering or emulating SDI. Dotted cells in the table indicate weapons programs that might face increased competition for materials and components in given technology areas if the Soviets sought to counter or emulate SDI. An appreciation for the potential technological challenges the Soviets might encounter can be gained by looking closely at two specific technologies that are becoming increasingly important in the development, production, and operation of a wide variety of military as well as civilian systems: software and microelectronics.

Software. If the Soviets diverted their emerging software engineering capabilities to develop their own advanced strategic defense system, an array of other military and civilian programs could suffer. For example, they need new software packages to improve the terrain-following capability of their cruise missiles and to provide better control and selection of incoming information to yield improved battlefield management. On the civilian side, software is essential to introducing flexible manufacturing in industry.

Because the Soviets' efforts to develop an indigenous software industry began in earnest only in the early 1980s, they already have chronic shortages of qualified software engineers and development tools. Not surprisingly, these shortages have caused problems in meeting critical military needs for development and integration of software programs for command, control, and communications; multimode avionics; fire

control; electronic countermeasures; phased-array radars; missile guidance; ASW signal processing; advanced sensors; and digital communications.

Lack of experience and limited capabilities in the development of complex, real time interactive systems would severely inhibit the Soviets' ability to develop software to control sensor signal processing, target tracking, and battle management for a comprehensive BMD system comparable to that under consideration in the United States. According to US estimates, such software could require several million lines of computer code. At present, the Soviets' largest and most advanced military software systems—for example, those used for their most modern, large phased-array radars—are a few hundred thousand lines in size. Soviet industry is unlikely to be capable of developing such a BMD software system until it has significantly upgraded its software engineering base and indigenous production capability, probably not before the late 1990s.

Microelectronics. For more than two decades, the Soviet Union has made a concerted effort to develop an advanced microelectronics industry to satisfy primarily military objectives. It has followed a strategy of copying proven Western technology while creating its own massive research, development, and production program.

By relying primarily on Western technology rather than indigenous developments and by aggressively applying new technology to military systems, the USSR has reduced, but not overcome, the degree to which its microelectronics technology lags that of the United States in fielded military systems. Soviet designers incorporate new integrated circuits (ICs) into major weapons designs as soon as the ICs reach pilot production, while US system designers wait until new ICs reach full-volume production. The Soviet practice of placing priority on relatively low-volume military microelectronics production has enhanced applications to military systems but probably has delayed overall microelectronics industrial advance. Western manufacturers credit global competition and

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Figure 7
USSR: Illustrative Technology Trade-offs—
Impact of an Advanced Response to
Future Military Systems

	Electronic Warfare	Sensors	Command, control, & communications	Computing	Micro-electronics	Signal Processing	Guidance & navigation	Materials & structures	Routing & tracking	Power sources	Propulsion	Directed energy	Optics	CAD/CAM & assembly	Electronics production	Precision machining
Offensive																
New heavy ICBM							•									
Improved long-range, low observable peripheral attack aircraft	•				•		•			•				•		•
Improved long-range cruise missile		•		•	•	•	•	•								•
New SSBN						•				•						•
Defensive																
Ground-based laser (kilowatt class)									•			•	•			
Improved low-to-high altitude SAM	•	•		•		•	•									
New long-range air-to-air missile		•		•		•										
Support																
Main battle tank				•	•		•				•		•	•		•
Short-range ballistic missile		•		•	•		•				•					
Long-range medium artillery gun		•			•		•									
New ground mobile laser (50-km range)					•		•	•	•	•		•	•			

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Figure 7
USSR: Illustrative Technology Trade-offs—
Impact of an Advanced Response to
Future Military Systems (continued)

	Electronic warfare	Sensors	Command control & communications	Computing	Micro-electronics	Signal processing	Guidance & navigation	Materials & structures	Pointing & tracking	Power sources	Propulsion	Directed energy	Optics	CAD/CAM & assembly	Electronics production	Precision machining
New theater AWACS	•	•	•	•	•	•	•	•			•			•	•	•
New air superiority fighter	•	•		•	•			•			•			•	•	•
New long-range intermediate transport								•			•			•		•
New low-frequency active acoustic ASW system		•		•	•	•									•	
New point defensive SAM	•	•				•										•
New automated intelligence integration & dissemination system			•	•	•	•									•	
Improved SRF communications system			•	•	•	•									•	
New improved communication satellite		•	•		•	•				•					•	
New radar imaging satellite (synthetic aperture radar)		•	•	•	•	•									•	
New phased-array jamming system	•				•	•				•					•	

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high-volume commercial production for most advances in process technology and yield. Moreover, because yields grow large and stable only as quality-control problems are resolved in volume production, the Soviets risk reliability problems by introducing ICs into systems at pilot production.¹²

The Soviets have repeatedly experienced difficulties in volume production and have achieved only a fraction of the output similar plant and equipment would yield in the West. Consequently, despite massive investment and infusion of Western technology, the Soviet Union has an across-the-board shortage of all but the most basic ICs. Outdated and inefficient IC design, production, and test equipment, poor environmental and quality control, low-quality raw materials, shortages of skilled labor, and overemphasis on production quotas at the expense of quality result in low yields and uncertain availability.

Quality-control deficiencies are making it increasingly difficult for the Soviets to assimilate Western design and process technologies at and above the very-large-scale integration (VLSI) level. VLSI is critical to the advanced sensor and computer hardware that US industry experts believe will pace development of SDI or any Soviet counterpart.

Competition With the Civilian Sector

Soviet civilian industry competes with defense industries for supplies of skilled labor, high-quality components and equipment, and high-technology materials. For example, civilian industry requires increasing numbers of the ICs (especially microprocessors) that are critical components in modern factory automation systems—robots, numerically controlled machine tools, and computers—and that are helping to fuel economic growth in the West. Improvements that the Soviets are planning for their domestic telecommunications networks will also require large inputs of advanced electronic components, communications equipment, computers, and possibly fiber-optics, all of which are currently in short supply.

¹² For a detailed analysis of Soviet microelectronics technology and production capabilities, see DI Intelligence Assessment *SW-86-100816*, December 1986, *Soviet Microelectronics: Impact of Western Technology Acquisitions*.

The primary civilian ministry responsible for production of computers, instrumentation control systems, and other electronic equipment—the Ministry of Instrument Making, Automation Equipment, and Control Systems—is unable to meet the high demand for these products. Consequently, the defense industries that produce communications equipment, electronic components, computers, and radars for the military—the Ministry of the Communications Equipment Industry, Ministry of the Electronics Industry, and Ministry of the Radio Industry—also produce a significant share of electronic components and equipment for civilian industry. Similarly, ministries that produce major weapon systems and perform weapon system integration, such as the Ministry of Aviation Industry and the Ministry of Defense industry, also produce machine tools, metallurgical equipment, and other manufacturing equipment for civilian industrial plants.

Judging from official Soviet statements, however, the support defense industries have given to the civilian sector has often lagged requirements, probably because such support detracts from their ability to meet the needs of their defense customers. Nevertheless, as part of the industrial modernization program, defense industries are not only being tasked to do more for the civilian sector but are also being held more accountable for their performance in this area. In June 1986, Chairman of the Council of Ministers Nikolai Ryzhkov called on the defense industries to provide the most modern manufacturing equipment to light industry. That same month, the CPSU Central Committee criticized four defense industrial ministries—the Ministry of the Communications Equipment Industry, Ministry of the Electronics Industry, Ministry of General Machine Building, and Ministry of the Radio Industry—for insufficient attention to the production of electronics products for the civilian sector and ordered them to improve the quality of their output for civilian consumption.

Soviet planning for long-term economic growth and weapons modernization will be complicated by uncertainties about the outcome of the industrial

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modernization program and its effect on the country's ability to meet future military requirements. SDI exacerbates these uncertainties. Gorbachev's modernization plans call for many of the same scarce, high-technology resources—such as microelectronics, telecommunications equipment, and flexible manufacturing systems—that would be required for advanced SDI countermeasures. In weighing their options, therefore, Soviet planners face a dilemma. Initiating a rapid and major response to SDI could force the Soviets to scale back their industrial modernization goals. Diverting resources away from industrial modernization, however, could leave them less capable of responding to SDI or other US military challenges in the long run.

Implications of Resource Constraints for Soviet Policy Toward SDI

The Soviets undoubtedly would prefer to postpone the initiation of costly new weapons programs in response to SDI until they have time to prepare their industrial base to facilitate a response. By focusing on R&D now and deferring procurement programs, they could eventually benefit from productivity improvements resulting from Gorbachev's industrial modernization program. In addition, pursuing basic and applied research on a number of advanced technologies—especially the microelectronics, computing, and software skills that support advanced materials processing and manufacturing capabilities—would give the Soviets an opportunity to apply the resulting technological advances to a wide variety of products, both military and civilian. By deferring their response, the Soviets could also employ new technological capabilities that are expected to result from ongoing military R&D in air defense, ASAT, and BMD. For example, building on their work on a new low-to-high altitude SAM, the Soviets could develop technologies that could be applicable to defense against ballistic missiles. Soviet research on laser air defense and ASAT weapons could also yield results applicable to advanced BMD.

Near-term responses to SDI would be more likely to disrupt ongoing research and production plans because many critical human skills and hardware

resources are already in scarce supply and are almost certainly committed to other programs. Because R&D relating to near term responses must be program specific and more narrowly focused, developments applicable to other programs are less likely to result. In addition, the initiation of new, ambitious R&D projects with short deadlines would pull scientists and engineers away from other priority projects.

The prospect of near term resource trade-offs provides the Soviets a strong incentive to use arms control to try to stop or delay US development and especially deployment of BMD systems. Their desire to postpone the need to respond to SDI will make them reluctant to agree to arms limitations that would facilitate a US transition to greater reliance on strategic defenses. Consequently, we believe they will continue to seek constraints on SDI as the price for reductions in strategic offensive nuclear weapons. In addition, the Soviets will continue to play on West European fears that SDI may eventually weaken the US commitment to Europe. Such political efforts offer by far the cheapest—yet potentially very effective—means of countering SDI.

At the same time, as a hedge against the possibility that their arms control initiatives could fail and that the United States would continue to make progress in SDI, the Soviets could ease the economic and technological challenges of responding by drawing on technology inputs from other countries. We expect them to continue to try to enlist East European scientific expertise and manufacturing capabilities to supplement their own SDI-related research. Except for a few select technologies, however, the East Europeans have little to contribute. Legal and illegal acquisition of Western technologies—especially in the software, microelectronics, optics, and directed-energy fields—will provide the Soviets greater opportunities to save money and time in developing the necessary technologies. Yet, even if they are relatively successful in circumventing Western controls on SDI-related technologies, the savings they would realize in R&D would only marginally offset the costs of procuring and operating forces to match or counter advanced US defenses.

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Ultimately, therefore, the Soviets will have to rely on their own resources to respond to the SDI challenge. To do so successfully, they will have to overcome a number of industrial and technological limitations. Although the Soviets have given every indication that they will bear these costs if necessary, they probably will do so only after they have exhausted all other options.

Even if the United States opts for continued research rather than near-term BMD deployment, the progress it has already made in SDI research has probably caused the Soviets to reassess the role BMD may eventually play in US defense policy. Consequently, we believe that whatever the fate of SDI, the Soviets will place increased emphasis on advanced BMD countermeasures and technologies in their own R&D planning.

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Appendix A

The Costing Methodology

We have estimated the procurement and, where possible, O&M costs of selected systems that could be part of a larger, integrated Soviet response to SDI. We have not estimated the cost of any fully integrated response because we lack information on the specific mission and force requirements that the Soviets might deem necessary if the United States proceeds with SDI. Moreover, because we cannot estimate the cost of systems whose technical characteristics we do not understand, we have provided cost estimates only for systems that currently exist or could be developed based on existing or near term technology.

We use a direct-costing method to estimate procurement costs. First, we break down overall weapon systems into their constituent elements, in building-block fashion. A missile, for example, is broken down into its propulsion system, guidance package, reentry vehicle, warhead, launcher, and associated ground equipment. We then estimate the cost, expressed in constant US dollars, of each element using a variety of costing methods. Next we convert the dollar costs to constant costs expressed in 1982 rubles using empirically derived ruble-dollar ratios that are specific to the particular type of equipment being considered. We then sum the results to obtain our ruble estimate of total system costs.

The cumulative cost of producing a given number of weapon systems takes into account cost reduction over time as the plant learns to produce the system more efficiently. Our estimates illustrate the cost of producing selected systems, up to the maximum number we estimate the Soviets could produce if they operated existing production facilities over a 10-year production cycle at current utilization rates. There is uncertainty in these estimates. We cannot quantify this uncertainty, but the costs presented here are our best estimates and are unbiased. We compare these cost estimates with what we project the Soviets will spend on the same systems in the absence of a response to

SDI.¹¹ The Soviets could add production capacity to increase their capability to respond to SDI. However, we have no evidence that they have initiated plant expansion specifically for this purpose.

In addition to estimating procurement costs, we have estimated O&M expenditures over a 10-year period for most of the systems we considered. O&M costs include our estimates of requirements for personnel, equipment maintenance, and logistics for the routine functioning of the system.

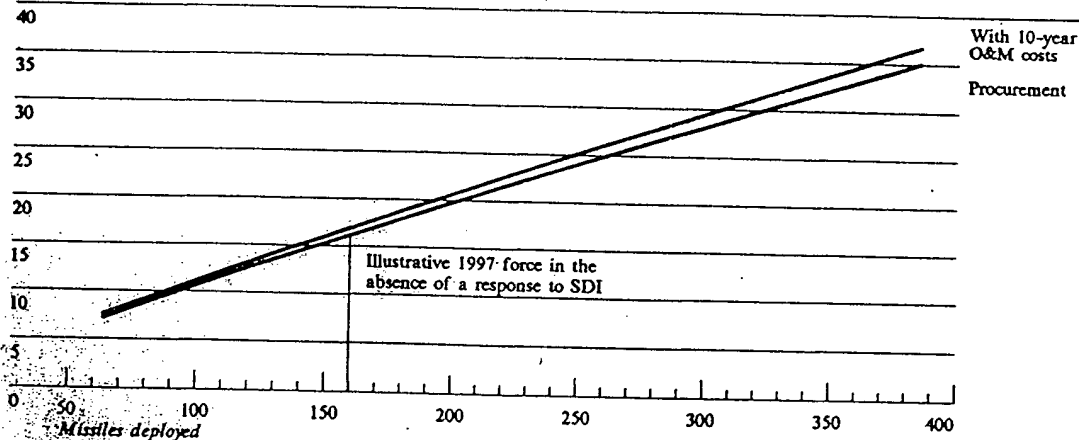
Saturation

Figure 8 shows how the procurement and O&M costs increase as additional missiles are deployed. We project that the Soviets will deploy about 160 of these missiles by 1997 in the absence of a response to SDI, at a cost of approximately 16 billion rubles. Current production capacity, however, would support a larger deployment. On the basis of the historical production experience of the SS-18 ICBM, we estimate that the Dnepropetrovsk

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Figure 8
USSR: Estimated Production and Cost
of SS-18 Follow-On*

Billion 1982 rubles



* Cost includes missile, warheads, and launcher.

plant can produce as many as 580 ICBMs over a 10-year period. Using the ratio of production to deployed launchers observed in the SS-18 program (1:56), this level of production would be consistent with deployment of about 370 launchers, the remainder being required for testing, training, and spares. Even if the Soviets replaced all SS-18 launchers with launchers, deployment of missiles would require the construction of an additional 62 new silos and associated launch control centers, costing about 400 million rubles. Procurement and construction costs of such a deployment—including the missiles, warheads, launchers, and additional silos—would total 34 billion rubles. In addition, O&M for 10 years would cost about 4 million rubles per

in silos currently housing the SS-19. We assess that this class of missiles could carry 10 RVs, and thus could also potentially help saturate US defenses in the midcourse and terminal phases of flight.

For our cost estimates we have assumed that all SS-X-24-class missiles are deployed in the rail-mobile mode. Mobile deployment might be advantageous in overcoming some types of US BMD systems by making it harder to predict the missiles' launch points or by allowing the Soviets to exacerbate the defense's "absence problem" by concentrating ICBMs in a small zone prior to launch. Furthermore, because the saturation option assumes that the Soviets are trying to increase significantly the number of ICBM RVs deployed, they might retain SS-19s for a longer time than we would otherwise expect. If they used SS-X-24-class missiles to augment rather than to

SS-X-24-Class Rail-Mobile Missile

The SS-X-24-class ICBMs, including the SS-X-24 and its follow-on, are solid-propellant missiles designed for deployment both in a rail-mobile mode and

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replace SS-19 forces, however, they would gradually incur increasing maintenance costs and reliability problems with the aging SS-19 force

SS-X-24-class missiles are produced at the Pavlograd Missile Assembly Plant. We project that the Soviets will deploy about 220 SS-X-24-class ICBMs by 1997 in the absence of US BMD deployment, at a cost of about 11 billion rubles

Using the ratio of production to deployed launchers observed in the SS-19 program (1.66), this would be consistent with the deployment of about 440 launchers, or twice what we expect in the absence of a response to SDI. As figure 9 shows, such a maximum procurement effort for this missile system—including missiles, warheads, and launcher trains—would increase costs to about 21 billion rubles. In addition, 10 years of O&M costs would equal about 5 million rubles per SS-X-24-class mobile missile deployed.

SS-25-Class ICBM

The SS-25-class ICBMs include the single RV SS-25 currently being deployed and the SS-25 follow-on, which may carry either one or three RVs and which we project will be deployed by the early-to-middle 1990s. Both are solid-propellant missiles designed for road-mobile deployment. Production of large numbers of these relatively small missiles could enhance the Soviets' ability to saturate future US boost-phase defense.

We project that, by 1997, in the absence of a response to SDI, the Soviets will deploy about 270 SS-25-class missiles at a cost of about 9 billion rubles

Using the ratio of production to deployed launchers observed in the

SS-20 program (1.86), this would be consistent with the deployment of about 540 to 630 launchers.

As figure 10 shows, such a maximum procurement effort for SS-25-class missile systems—including missiles, warheads, and launchers—would cost about 19 billion rubles. O&M costs over a 10-year period would add about 4 million rubles per missile deployed

Circumvention: The Cost Estimates

Bear H ALCM Carrier

The Bear H is a long-range strategic bomber that travels at subsonic speeds and can carry as many as 12 AS-15 cruise missiles. These long-range, subsonic, low-altitude, land-attack ALCMs could be used to "underfly the umbrella" of strategic defenses. The Soviets have already deployed 70 Bear H aircraft. We have indications that production of this aircraft is nearing an end

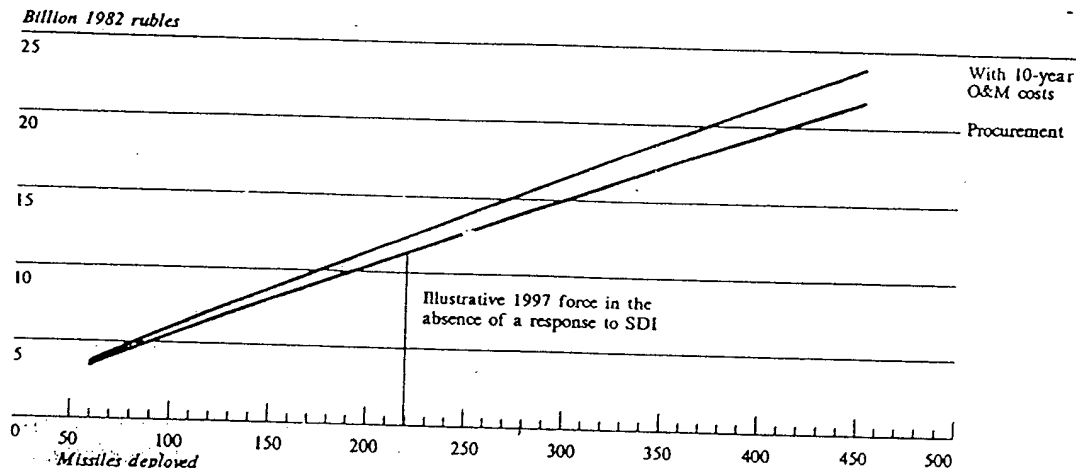
In response to SDI, the Soviets might extend production of the Bear H. The Kuybyshev Airframe Plant 18 has the capacity to produce up to about 170 Bear H's over a 10-year period. Figure 11 shows what it would cost to add these aircraft (including 24 ALCMs per Bear H) to the 1986 force and to procure a comparable number of Midas tankers, which would be required to accompany the Bear H on its long-range missions. As the figure indicates, producing these forces for 10 years using existing capacity would cost about 11 billion rubles. In addition, O&M over a 10-year period would cost about 7 million rubles for each Bear H deployed and about 15 million rubles per Midas tanker

Extending production of the Bear H over another 10 years, however, would interfere with the Soviets' ability to introduce new aircraft production at the Kuybyshev Plant. In addition, increasing deployment significantly would strain the support infrastructure, especially that associated with basing and O&M.

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Figure 9
Estimated Production and Cost of
SS-24-Class Rail-Mobile ICBM *



*Cost includes missile, warheads, and launcher.

Blackjack ALCM Carrier

The Blackjack is a strategic bomber that has probably been designed for long-range subsonic cruise with supersonic high-altitude dash. This aircraft has been designed to carry bombs, short-range attack missiles, and AS-15 ALCMs. If used as an ALCM carrier, it could carry 12 AS-15 ALCMs. We assess that the Soviets had produced nine of these aircraft as of November 1987. (One of these aircraft crashed.)

We project that, in the absence of a response to SDI, the Soviets will deploy 90 Blackjacks by 1997. Assuming that they also procure 24 ALCMs per Blackjack and 90 Midas tankers, the procurement costs would be about 14 billion rubles. Figure 12 shows the cost of procuring and operating additional Blackjacks (including 24 AS-15 ALCMs per Blackjack) and Midas tankers over 10 years, and our best estimate of associated O&M costs. Floorspace analysis indicates that current capacity at the Kazan Plant could support production of approximately 150 of these aircraft

over a 10-year period. Such a procurement effort would cost about 22 billion rubles. O&M costs would add an additional 25 million rubles per Blackjack and 15 million rubles per Midas.

The Kazan Plant is currently undergoing expansion that we project will be completed in the early 1990s.

The Kazan Plant will have the capacity to produce a few more Blackjack bombers each year than existing capacity allows.

Defense Suppression

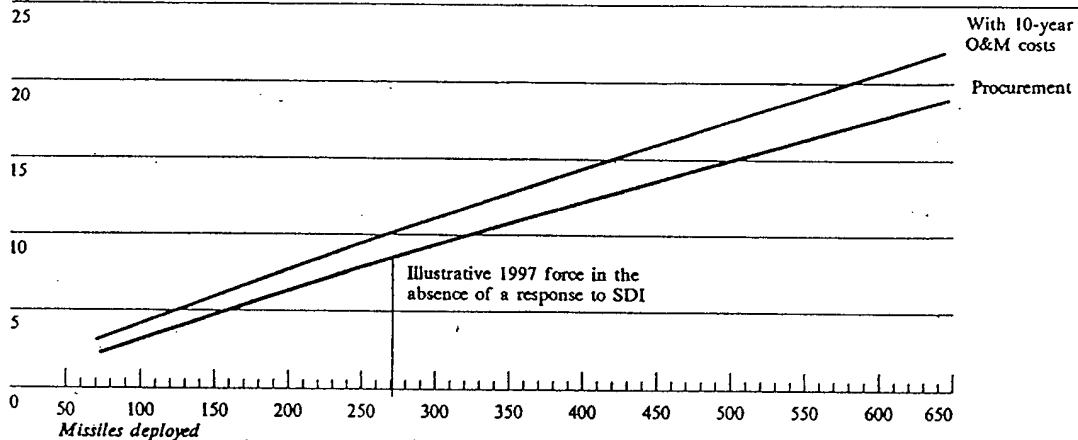
We have estimated the procurement cost of three very different systems that could be used for defense suppression: two potential direct-ascent ASAT

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Figure 10
USSR: Estimated Production and Cost of
SS-25-Class ICBM ^a

Billion 1982 rubles



^a Cost includes missile, warheads, and launcher.

systems and a space mine option. We have not estimated the additional O&M costs or the cost of constructing ground control networks that might be required to support ASAT operations because of our uncertainty about how the Soviets might operate ASAT systems. If the ASAT systems were operated at a high state of readiness, these costs would probably be substantial.

SS-20-ASATs

The Soviets would need to modify their SS-20s extensively to convert them into ASAT weapons. Because many of these missiles are now nearing the end of their operational lifetimes, the Soviets would probably be required to refurbish the missile casings and replace the propellant. They would also probably replace the SS-20's postboost vehicle and three warheads with a single nuclear warhead. The Soviets might consider using a smaller nuclear warhead for ASAT purposes to minimize the impact that nuclear bursts in space could have on their own satellites and

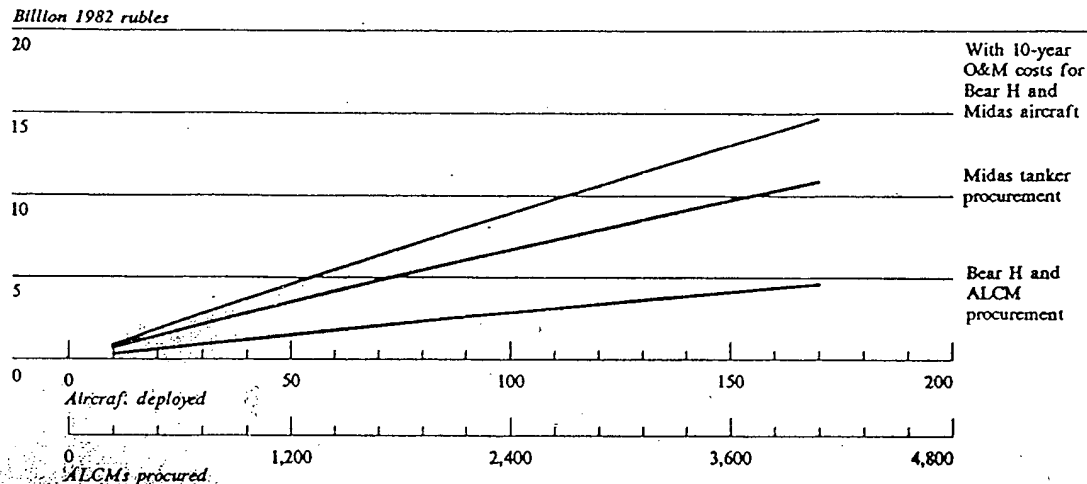
ground-based electronics systems. For example, they might reengineer the front end of the missile to accept a 10-kiloton warhead. The Soviets would have to replace the missile's guidance and control system and refurbish the launcher electronics as well. Finally, to use these missiles in an ASAT role, the Soviets would need to procure tracking and guidance radars. We have assumed that they would buy one Try Add A tracking radar for every 16 ASAT launchers and one Try Add B guidance radar for every eight ASAT launchers.

Although many modifications would be required to convert this missile, this option would still be relatively inexpensive. Figure 13 shows the costs associated with converting up to about 370 SS-20 IRBMs. Assuming the same ratio of missile production to deployed launchers observed in the SS-20 IRBM

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Figure 11
USSR: Estimated Production and Cost of Bear H and Tanker
Aircraft in Excess of 1987 Force Levels ^{a,b}



^a Cost includes aircraft and AS-15 ALCMs.

^b An estimated 70 Bear H's had been produced by November 1987.

program, this level of production would be consistent with a deployment of 200 ASATs. Deploying 200 converted SS-20 ASATs would cost the Soviets roughly 3 billion rubles.

Galosh-Class ASAT

To adapt the Galosh ABM missile to the ASAT mission, the Soviets might modify it to carry a smaller—10-kiloton—nuclear warhead. Figure 14 shows the costs of producing a large number of Galosh-class ASAT missiles. We estimate that the Soviets could produce approximately 1,200 to 2,000 such interceptors over a 10-year period using existing capacity at Moscow Plant 41. Given a typical production-to-deployment ratio for ICBMs (1:7), this production level would support deployment of between 700 and 1,200 ASATs. As in the SS-20 ASAT case, we assume the Soviets would procure one Try Add A tracking radar for every 16 ASAT launchers and one Try Add B guidance radar for every eight ASATs deployed. We estimate that procuring these large

numbers of Galosh-class ASAT missiles and associated radars would cost roughly 16 to 25 billion rubles. The Soviets would incur additional costs in constructing the large number of ASAT launchpads that would be necessary to support ASAT deployment.

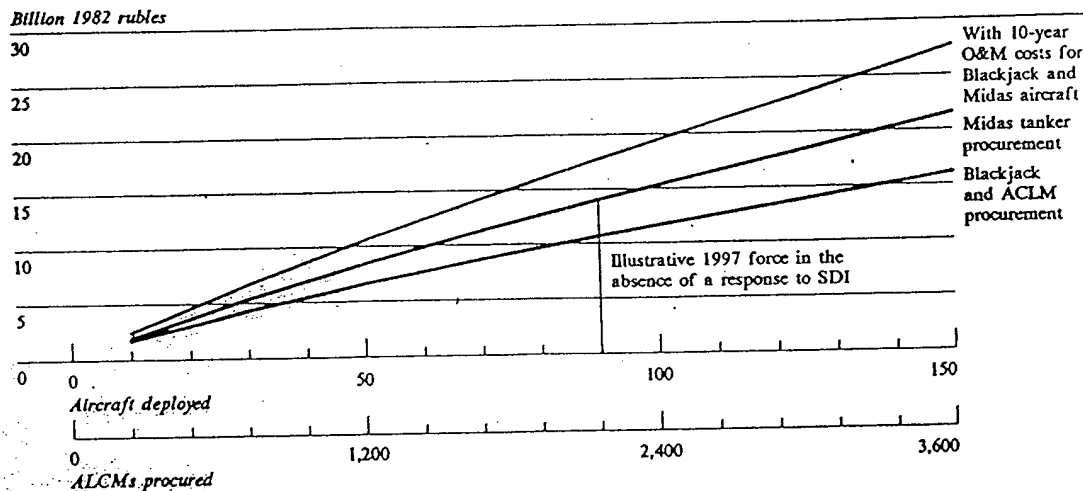
Space Mines

As a cost analog to a small space mine, we have estimated the cost of deploying a Soviet communications satellite equipped with a homing sensor and armed with a 10-kiloton nuclear warhead. Such a space mine would be launched on an SL-12 booster. Figure 15 shows that procuring and launching 60 of these hypothetical space mines could cost the Soviets about 6 billion rubles.

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Figure 12
USSR: Estimated Production and Cost of
Blackjack and Tanker Aircraft *



* Cost includes aircraft and AS-15 ALCMs.

Ballistic Missile Defense

Ground-Based ABM

To illustrate the potential cost of deploying a large, nationwide ABM system, we have estimated the cost of the ABM Breakout force []

[] This hypothetical ABM Breakout force in 1997 consists of 350 endoatmospheric and 150 exoatmospheric interceptor missiles deployed around Moscow and 2,325 endoatmospheric and 375 exoatmospheric interceptor missiles deployed outside of Moscow. We have also estimated the cost of producing 500 Flat-Twin and 1,000 Pawn-Shop radars for target tracking and engagement. Total procurement costs for these interceptors and radars would be about 50 billion rubles.

Space Lift in Support of BMD

Our efforts to estimate the potential cost of a nationwide ballistic missile defense system are hampered by our large uncertainty about Soviet BMD objectives

(limited or comprehensive) and technology choices (traditional nuclear weapons or advanced nonnuclear weapons). All BMD options would be very expensive, but development and deployment of space-based defenses similar to those being considered by the United States would be particularly challenging. Because of a lack of information about what systems a Soviet space-based BMD system might comprise, we have only estimated the cost of providing space launch capacity to support a range of possible lift requirements.

We think that, if the Soviets deployed a BMD system with a large number of space-based elements, they would rely heavily on the SL-X-17 heavy-lift launch vehicle that they are currently developing. This booster, which made its maiden flight in May 1987, is the only one in the current Soviet inventory capable of lifting many of the heavy payloads that would be required for space weapons. Each booster has an

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Figure 13
USSR: Estimated Cost of Converting SS-20
IRBMs to ASAT Role *

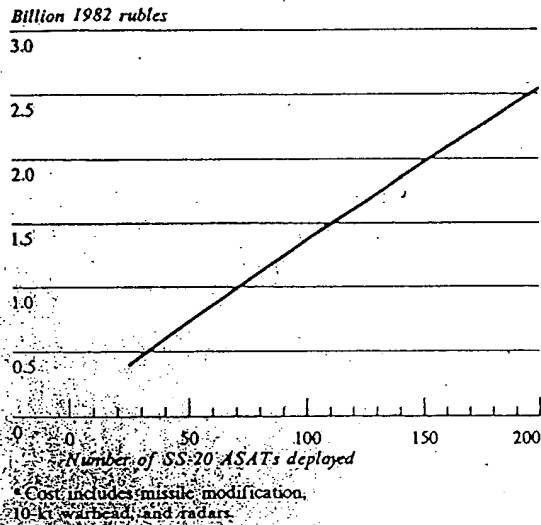


Figure 14
USSR: Hypothetical Production and Cost
of Galosh ASAT Interceptor *

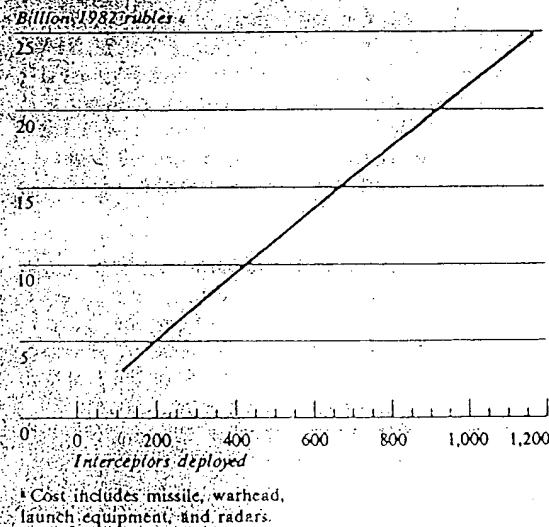


Figure 15
USSR: Estimated Cost of Deploying
Hypothetical Space Mine *

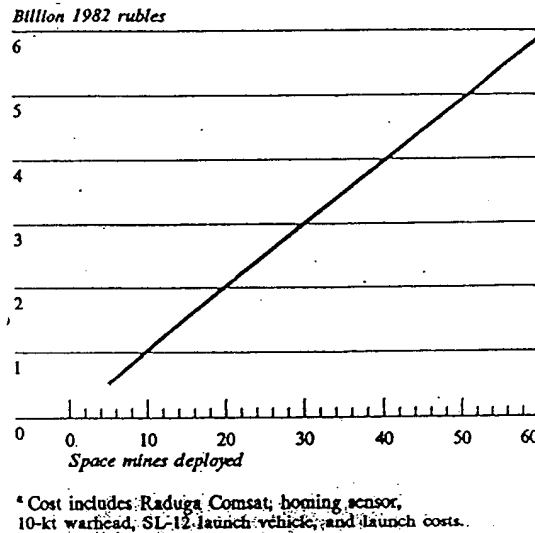
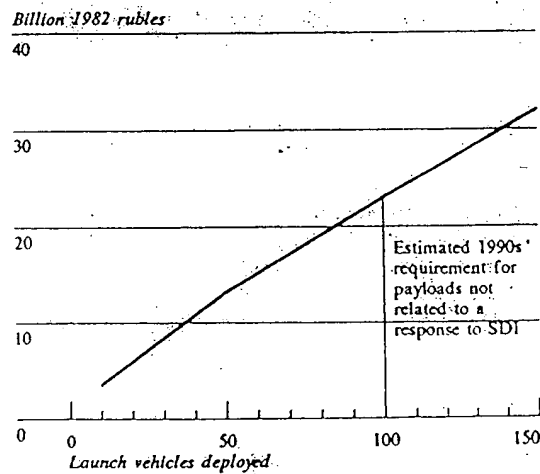


Figure 16
USSR: Estimated Production and Launch Costs
of SL-X-17 Heavy-Lift Launch Vehicle



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estimated lift capability of 100,000 to 126,000 kilograms. Lift requirements estimated by SDIO in 1987 for a possible US BMD system were approximately 5 to 10 million kilograms. If the Soviets were to deploy a similar BMD system, they would need between 40 and 100 SL-X-17 heavy-lift boosters.

Increasing SL-X-17 production from the 100 boosters we project the Soviets will use in the 1990s to launch payloads not related to SDI to 150 boosters—the maximum level possible using existing capacity—would raise SL-X-17 procurement and launch costs from 23 billion rubles to 32 billion rubles (see figure 16). If the Soviets required as many as 100 SL-X-17s to launch space-based BMD systems, they would have to increase production capacity, and costs would rise to about 40 billion rubles.

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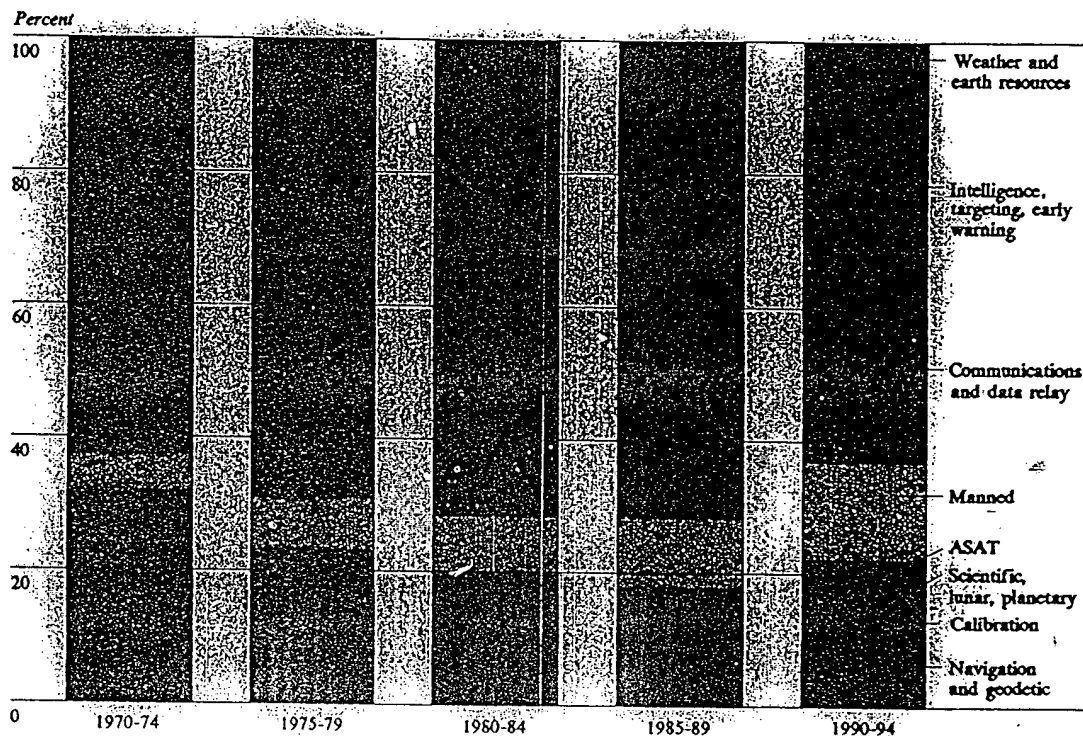
Appendix B

The Soviet Space Program

The Soviets view their space program as an integral part of their political, military, and scientific competition with the United States. Since the mid-1960s, they have sought to maintain a continuous presence in space. Indeed with the deployment of the MIR space station in 1987, they may be close to achieving that goal.

In the early years of the Soviet space program, expensive civilian lunar and planetary projects comprised a large share of total space expenditures. As the Soviets' space program matured, and after the cancellation of their lunar program in 1974, they

Figure 17
Trends in Soviet Space Launches, 1970-94



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increasingly shifted their space program toward military applications and manned space stations in near-Earth orbit. We estimate that, in the late 1970s and early 1980s, the Soviets spent at least two-thirds of their space procurement and operating costs and three-fourths of their space R&D costs on military or military-related missions. They currently dedicate about 70 percent of their space launches to support traditional military missions of communications, targeting, reconnaissance and surveillance, navigation, meteorology, and geodesy. Another 25 percent of their launches support dual military/civilian functions, and the remaining 5 percent support purely civilian scientific missions (see figure 17).

Projected increases in both military and civilian space procurement for the late 1980s and 1990s reflect the introduction of new, rather than modified, satellite systems and the proliferation of geosynchronous communications satellites that will require the use of the more expensive SL-12 and SL-X-17 launch vehicles. The projected increase in space procurement also reflects expected growth in the Soviets' vigorous manned space program.

The Soviets appear to be planning a resurgence in their civilian planetary and astronomical programs for the late 1980s and 1990s. They have already planned five missions through the late 1990s to study Mars

and its moons and may also be planning a mission to study Mercury. These planetary missions would occur after the Soviets have deployed most of their new, major military spacecraft, thereby lessening competition with the military over funding for space systems. We expect some important military space programs to be undertaken concurrently with these civilian space projects, however, so that some resource competition between the two is still likely.

The Soviets could use their interplanetary missions to test new military technology, some of which could support SDI-related research. For example,

a small laser experiment planned for the Soviet Phobos mission to Mars could have application in space-based BMD research. If, however, the Soviets moved beyond research into the deployment of countermeasures or strategic defense systems that included a large number of space-based elements, demand for space lift and associated funding pressures might force them to delay and possibly eliminate many scientific and planetary missions.

That a Soviet attempt to replicate the US SDI effort would cause everything else to come to a halt, certainly the Soviet planetary research program.

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