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The 'Militarization' of the Space Agency

Critics Complain That Pentagon Is Getting 'Free Ride' on Shuttle

By Thomas O'Toole
Washington Post Staff Writer

For the last 20 years the civiliar National Aeronautics and Space Ad ministration served itself and the scientific and technological communities almost exclusively.

No longer. NASA is about to begin serving a big new customer, a federal agency almost 40 times its size: the Department of Defense. When the space shuttle Columbia makes its fourth and last test flight next month, its cargo will be a secret Pentagon infrared laser whose invisible light can detect the rocket exhausts of missiles on their way to distant targets.

The trucking into space of the Pentagon's early warning laser spotlights what some observers of the civilian space agency say is a dangerous new trend.

In the years ahead, NASA will be dealing more and more with the Pentagon. More space agency business will be shrouded in secrecy, more of its missions will be classified and more of its research and development will have a military instead of a civilian application.

One sign that the space agency is being "militarized" is in the number of Air Force personnel now on active duty at NASA. There are eight Air Force officers assigned to NASA headquarters in Washington, 60 to the Kennedy Space Center at Cape Canaveral and 66, plus 22 Air Force civilian employes, at the Johnson Space Center in Houston.

NASA's top management has taken on a distinctive "blue-suit look." Head of the new Office of Space Transportation Systems is Air Force Maj. Gen. James A. Abrahamson. His executive assistant is Air Force Col. Joseph Rougeau. The head of external relations is retired Air Force general Frank Simokaitis. NASA deputy administrator is Dr. Hans Mark, a former secretary of the Air Force.

Of the first 44 shuttle flights NASA will make through 1986, 13 will be flown solely for the Pentagon. Of the 234 flights tentatively scheduled through 1994, according to a report released this week by the General Accounting Office, at least 114, or 48 percent, will be flown exclusively for the military.

In the past the Pentagon rarely flew even an experimental instrument on a space agency spacecraft and it was not supposed to be involved in more than 30 percent of the space agency's shuttle flights.

In a report prepared for Sen. William Proxmire (D-Wis.), senior Democrat on the Appropriations Committee, the GAO concluded that the space agency earmarked for the Pentagon almost 25 percent of the $3.47 billion it will spend on the shuttle in fiscal 1983. This includes two of 10 shuttle flights in fiscal 1984 and four of 13 flights in fiscal 1985.

"This is bad news for those who are concerned over cutbacks in NASA's space science activities," Proxmire said earlier this week. "Unless there is a dramatic change in current efforts to reduce federal spending, it means that more and more of each NASA budget will be spent on defense-related activities and less and less will be spent on civilian science."

What concerns Proxmire even more than the Pentagon's inroads into space agency business is the way the Pentagon has managed to avoid paying for it. The cost to the United States to develop and produce the first two space shuttles (Enterprise and Columbia) and test-fly Columbia four times is $9.9 billion. NASA will pick up the entire tab. The Pentagon's share of the shuttle development and test flight bill is zero.

Of the $15 billion it will cost to build and supply four flight models of the shuttle, the Pentagon's share is $2.4 billion. Most of that is for a shuttle launch facility at California's Vandenberg Air Force Base where 47 of the planned 70 flights at Vandenberg will be for the Air Force.

One of the major new improvements to be made to the shuttle is development of a lightweight casing for its two solid rocket engines that will let the shuttle carry 5,500 more pounds of payload into orbit. The $250 million improvement bill is being picked up by NASA even though the development will benefit the Pentagon, whose payloads are far heavier than anything NASA and the civilian shuttle users will fly.

Even when the Pentagon flies an instrument or satellite on the shuttle, it will do so at a bargain rate no other shuttle customer is being offered. Civilian shuttle users are being charged $18 million a flight through 1986 when shuttle user fees will be renegotiated. Not the Pentagon. Whenever the Pentagon flies on the shuttle through 1986, the use fee will be $12.2 million, a discount of 32 percent.

"It's clear to me that the Pentagon is getting a free ride on the space shuttle," Sen. Harrison H. (Jack) Schmitt (R-N.M.), chairman of the Senate subcommittee on space, said in an interview. "I think the time has come for the Defense Department to start paying for its share of that ride," the former astronaut added.

One thing the Pentagon is already paying for is security. The Pentagon is spending $26 million to modify the firing room (launch control center) at Cape Canaveral and $47 million to modify the Mission Control Center in Houston to safeguard the secrecy of its shuttle missions. The two-story Mission Control Center soon will have a third story with copper floors and copper ceilings to prevent any communications between the Air Force officers on the ground and astronauts in space from leaking to the air outside the building.

Even the routine air-to-ground chatter between shuttle astronauts and Mission Control will change when the Pentagon flies its payloads in space. More and more conversations will be private, fewer in-flight television broadcasts will be aired and the handling of Pentagon payloads will not be discussed over the public air-to-ground radio channel. Even the choice of astronauts will undergo a change.

"We will use astronauts on our shuttle missions from the regular NASA corps," Air Force Brig. Gen. Joseph Mirth said not long ago, "but only those with a military background."

The space agency has begun to involve itself with the Pentagon on more than just the space shuttle. NASA is turning over more time in its wind tunnels to the testing of military aircraft and is placing more emphasis on the military aspects of its aeronautical research at the expense of its civilian research.

The most controversial of NASA's plans to involve itself more with the military is its plan to seek more military contracts for the Jet Propulsion Laboratory, its Pasadena brainchild that designed, built and directed the Voyager spacecraft that explored the planets Jupiter and Saturn in the last four years.

There was a time when JPL did no military research. In the last year, it has negotiated contracts with the Air Force, Army and Navy and has made it a goal to do between one-fourth and one-third of its research for the Pentagon.

Among the projects JPL has taken on for the Pentagon are automated reconnaissance satellites that maintain themselves in orbit for years at a time, that communicate with Earth at unheard of speed and precision and that keep watch on the seven seas with radar the way cameras now do over land. JPL's first assignment from the Army is how to automate the battlefield. In a word, put robots into tanks instead of men.

"The trouble with this work is that a lot of it is classified, which means you can't tell your wife and kids what you're doing anymore," said one JPL official who insisted on being nameless. "The good thing is that it keeps the team sharp, it keeps the lab's skills intact while the space program slackens."

To hear NASA Administrator James M. Beggs tell it, the space agency must take on more work for the Pentagon if it is going to survive the rough seas of the Ronald Reagan budget years. Beggs also insists that NASA's expertise is essential if the United States is to maintain superiority over the Soviet Union.

"You don't just set an aircraft model in any wind tunnel and out comes a lot of numbers and somebody just crunches them," Beggs said in an interview. "The plain facts are, you need the NASA technical guys working our wind tunnels to solve the problems that come out of it, whether they be military or civilian aircraft."

As for the Pentagon paying more of its share for the ride it gets from NASA, Beggs responds a little differently.

"The other part of this has to do with the question of whether we're bending over too far backwards in accommodating the military on things like the shuttle," Beggs said.

"I guess I come out somewhere in the middle of the people who want to charge them for everything and those who want them to have a free ride." Pausing, Beggs said: "We have considered raising the price to the military and are in active discussion as to how that can be done."

Nuclear Star Wars: Yesterday's Fiction Is Today's Fact

By TAD SZULC

WASHINGTON—The entire U.S.-Soviet strategic balance may dramatically turn against the United States if some top Pentagon specialists are correct in their newly disclosed assessment that the Soviets are likely to deploy laser weapons aboard orbiting space satellites within the year. If such weapons are placed aloft, according to these experts, outer space may become a nuclear battlefield. The U.S. space shuttle, scheduled to blast off for the third time on Monday, is a key part of America's own space-based military strategy.

The disclosure in recent secret testimony before the House Armed Services Committee by Richard D. DeLauer, the Pentagon's research head, that the Soviets might be ready to deploy laser weapons in space next year serves to add the latest dimension to the unfolding scenarios of space wars, scenarios that are more and more realistic. Still, not all U.S. military experts agree with DeLauer's dire predictions. Two top Air Force generals recently testified to Congress that they were skeptical of Soviet technical prowess.

In testimony that was subsequently made public, DeLauer predicted that by 1990—in less than a decade—the Soviet Union will deploy "a large, permanent, manned orbital space complex . . . capable of effectively attacking . . . ground, sea and air targets from space." It is unclear, however, whether the United States will be in a position to do likewise. Meanwhile, both superpowers are engaged in developing and improving so-called satellite-killers, and the Soviets are believed to be well ahead in these weapons systems as well.

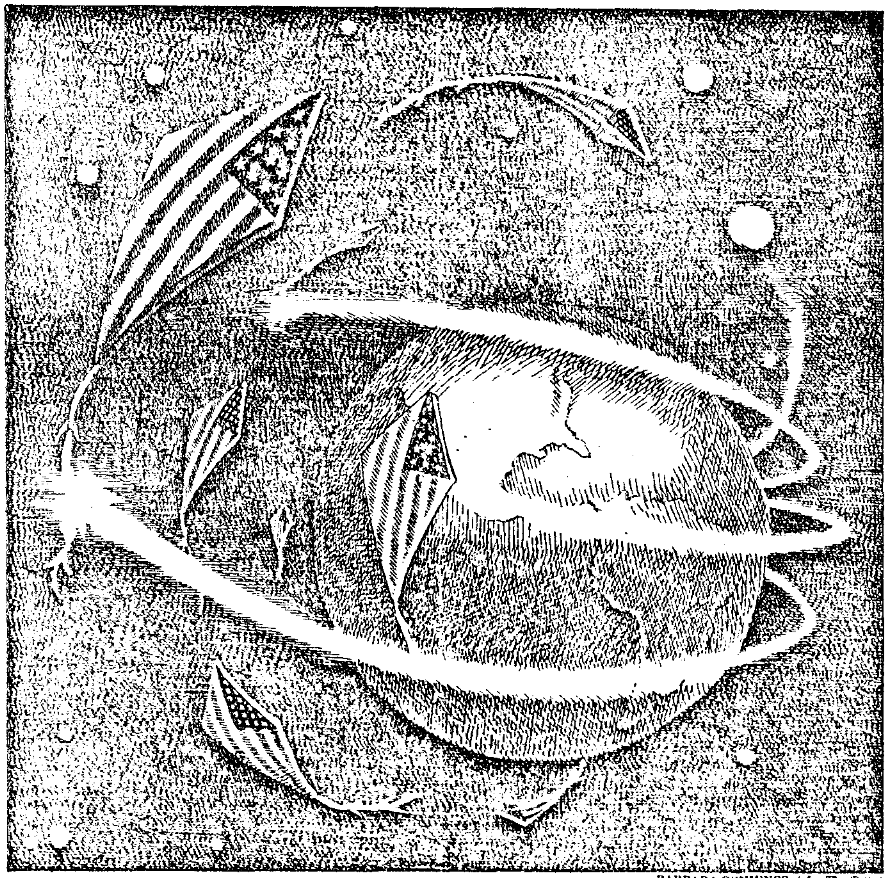
The Soviets have carried out numerous anti-satellite "killer" tests during 1981, the largest number of such tests within a single year. Most Pentagon specialists assume that Moscow has a deployed operational anti-satellite system—unlike the United States.

Until recently, America's basic strategic assumption had been that it would be the first to place laser weapons in space, thus acquiring a crucial superiority over the Soviet Union. But space-based lasers have never been a top Pentagon priority—notwithstanding congressional entreaties—and at this stage the United States appears unable to match the projected Soviet deployments.

"Laser" stands for Light Amplification by Stimulated Emission of Radiation, and it is a system in which atoms of energy molecules are unified to produce a cascading amplification of electromagnetic energy at a precise wavelength. By using highly polished mirrors, a pencil-thin beam of radiation can be made to escape in the form of light with greater intensity than any other radiation known to man.

In space warfare, high-energy laser weapons can be used against enemy satellites by directing the beams to "burn" through their metal skins, thus destroying their guidance mechanisms. Such beams travel at the speed of light, 186,000 miles per second.

Interviews with civilian and military specialists in Washington and a study of open literature on space warfare make it clear that spatial combat would not consist of duels between manned satellites hurtling through space and firing at each other with "death ray" laser beams. Such duels, experts say, would be fantasy. But attacks by Soviet lasers on U.S. satellites are a probability. Similarly, technology exists—within the U.S. space shuttle and the Soviet Salyut 6 space station in orbit since 1977—to place offensive nuclear weapons in space for attacks on enemy targets on earth, and such deployments are clearly being contemplated.



BARBARA CUMMINGS / for The Times

The greatest danger presented by lasers is their capability to destroy instantly U.S. detection satellites, which are designed to pick up unmistakable signals that huge Soviet SS-18 intercontinental ballistic missiles with multiple nuclear warheads are in final fueling and countdown stages before being launched against America. These detection satellites—along with strategic communications satellites—would be the first line of U.S. defense in a nuclear conflict.

Soviet lasers also could "burn" U.S. missiles launched as a counterstrike either as they rise from the ground or in mid-flight. The "smart" laser weapons can unerringly select U.S. missiles even in the midst of a nuclear exchange, distinguishing them from Soviet projectiles.

In high-energy laser weapons—ground or space-based—the Soviets are believed to have already developed a weapon prototype. On May 15, 1981, the Senate, increasingly concerned with possible delays in U.S. programs, added $50 million to the Pentagon's fiscal year 1982 budget for satellite laser-weapon development and $31.2 million for optical space probes to be launched if a Soviet nuclear attack was suspected. In all, the United States spent more than $500 million last year for laser-weapon research and development.

Also last May, Sens. Harrison Schmitt (R-N.M.) and William V. Roth Jr. (R-Del.) introduced legislation providing for the development of a satellite laser-weapons system against the Soviet ICBMs to take the place of the proposed MX missile system, on the theory that an effective laser defense development would protect the United States from a Soviet nuclear attack, obviating an immensely expensive new offensive system. In the fiscal 1983 budget, however, the Pentagon is asking for $433 million for laser research and development. But the discovery that the Soviets may be on the verge of deploying a laser-weapons system may push the United States into a crash program of its own—although nothing has been said about it so far. For space defense in general, the Pentagon has asked for an additional $218 million in the current budget.

However, the flights so far of the manned space shuttle Columbia also have opened a new age for the United States in the military uses of space. The shuttle, senior Pentagon officials say, may be employed to establish and supply space stations and platforms on which weapons could be installed; it may launch satellite killers against Soviet satellite systems; and it may carry laser weapons to destroy Soviet nuclear-tipped intercontinental ballistic missiles in flight and even before launch. The shuttle could match the Soviet manned complexes described by DeLauer.

Survivability of the U.S. satellite networks—defensive measures against Soviet killer satellites—may also be accomplished through new technology rendered possible by the space shuttle, although Soviet laser developments in space would create a new challenge.

Many military satellites are in low earth orbit—several hundred miles above the earth—and they are easily vulnerable to Soviet killer satellites. The newest American space satellites are in so-called geosynchronous orbit, about 23,000 miles in space. At present, they are probably out of the reach of Soviet ground-launched "killers." This, however, may change soon, especially if the Soviets try to launch their killer satellites from Salyut-type space stations, and if they try to use space lasers.

The planned U.S. response is to attempt to place satellites in orbit as high as 200,000 miles, making them safer from Soviet killer satellites, with inertial upper-stage rockets to be launched from the shuttle. Such rockets are one of the most revolutionary space developments, and one of the principal reasons for the Pentagon's participation in the funding of the space shuttle and support given it before the Congress.

What is emerging, then, in the 1980s—being planned for the 1990s—are space systems designed by the United States and the Soviet Union to destroy each other's surveillance, communications and killer satellite networks, and to shoot down each other's nuclear ballistic missiles. In the opinion of many scientists and defense experts, the nation with military supremacy in space is the most likely to win a nuclear conflict.

Nuclear warfare is being revolutionized by the emergence of the space dimension, and the outlook is on greater and greater concentration by the superpowers on the military uses of space. The potential is as endless as it is frightening.

Ted Szulc is a frequent contributor to The Times' Opinion section.

OPINION AND COMMENTARY

Laser weapon fairy tales

By Kosta Tsipis

Children delight in stories of magical devices that dispose ·ivially of a threatening presence: Aladdin's lamp or the ·ood Fairy's magic wand in early tales, the phaser of "Star rek" and the ray gun of "Buck Rogers" in contemporary :ience-fiction myths are all fantasy devices that relieve :elings of childlike helplessness. Very large laser weapons ı orbit around the Earth that would protect the United States ·om a Soviet missile attack have similar psychological ap- eal but are equally fictitious.

A laser is a device that produces a very intense stream of ght waves that arrive in step at a target, so their destructive ffect is the maximum possible. Each laser weapon would onsist of a powerful laser, a large, movable, precisely con- ·olled mirror to point the laser light beam at the target, ensors to detect the target, and energy stores and power- enerating facilities.

Missile-defense lasers would be deployed on satellites in rbits some 1,000 kilometers above the Earth. From this alti- ıde a satellite would be within striking distance of launching ites in the USSR for only a short period during each orbit. To nsure that at least one satellite would be within range at all ımes the total force would have to include about 50 satellites. ι single satellite would have to be capable of destroying an ntire flight or perhaps 1,000 missiles during their boost tage, which lasts for about eight minutes. Therefore the sat- llite could devote about half a second to each missile.

A laser weapon would damage its target by overheating, nelting, or cracking it. Damage is caused only by that frac- ion of the laser beam energy that is actually absorbed by the arget. In general much less than 10 percent of the energy arried by the laser beam to the target would be absorbed by t and cause damage. The rest is reflected and gets lost. So he laser must generate ten times more energy than what ·ould destroy the target.

Laser light has no trouble propagating in the vacuum of pace, but a laser beam would spread out due to diffraction, ın unavoidable consequence of the wave nature of light. So a ıeam that starts out one meter in diameter could spread to a 0-meter circle at the target 1,000 kilometers away. That ·preading thins out the light, so the beam at the target is a ıundred times less intense than it was at the laser.

In order, then, to tear the metal skin of an an ascending CBM with laser light (something that has been shown to be ·ossible in the laboratory), a laser weapon would have to ·enerate a series of rapid pulses of light some thousandths of ı second long, each equivalent to a million megawatts of ·ower. If, instead, the chosen destruction mechanism would ·e burning a hole in the side of the missile, a 100 megawatt aser would be needed with a continuous beam that would :ake a few seconds to accomplish its destructive task.

One such powerful laser would not be adequate, then, be- :ause it might have to shoot down up to a thousand enemy missiles in something under eight minutes if it were con- fronted by an all-out ICBM attack, since it could devote less than a half second per missile (which is not enough time even to locate and track a missile). How much fuel would a perfect laser require for such a task? Five tons of fuel and coolant per pulse would be required to crack the skin of a missile and about one ton of consumables would be required to burn a hole in it. So each laser weapon system in orbit would have to be provided with more than 1,000 tons of fuel to be able to attack all 1,000 enemy missiles that it would have to defeat in case of an all-out Soviet attack against the United States.

In all, then, 50,000 tons of fuel would have to be carried in orbit. If the US had four space shuttles and each made four trips a year to outer space loaded just with fuel for the lasers, it would take a hundred years and $100 billion in transport costs alone to move the needed 50,000 tons.

One way to lessen the amount of fuel needed by each laser weapon in space is to make its mirror much bigger and de- vise lasers that produce light of shorter wavelengths than what is available now. Neither of these developments is for- bidden by any physical law and so they are in principle possi- ble. It is conceivable then that at some distant future time a laser weapon suitable for deployment in space could be con- structed. Such a feat, however, is technologically extremely difficult and therefore improbable for the foreseeable future. The lasers that we have now are at least a thousand times less powerful than what would be needed for such a weapon, but, even if we ever were able to build lasers with the neces- sary power, the fuel requirement would obviate any practical antimissile system in space.

Neither the US nor any other country can build the mir- rors several meters in diameter with perfect surfaces, yet rugged and steerable, that a laser antimissile system would require. Finally, the sensors needed to detect and track a missile speeding at five kilometers per second a thousand kilometers away would have to be a thousand times more stable and speedy than what we have now. But even if by some miracle we could overcome these technical and eco- nomic hurdles, antimissile laser weapons would still be hope- lessly susceptible to enemy countermeasures: their sensors could be blinded, jammed, or fooled and enemy ballistic mis- siles could cheaply be made very resistant to laser light. Un- der these circumstances, proposals for the erection of a laser antiballistic missile defense in space sound like little more than childlike, wishful fantasies of omnipotence.

Kosta Tsipis is codirector of the Program in Science and Technology for International Security at the Massa- chusetts Institute of Technology.

GAO Pushing Accelerated Laser

Agency recommends early in-orbit feasibility demonstration for data required for integrated system of battle stations

By Clarence A. Robinson, Jr.

Washington—The U. S. should accelerate its laser development program to provide for an early feasibility demonstration in orbit of a space-based laser weapon, according to a General Accounting Office report to Congress.

The recommended feasibility demonstration, the GAO contends, is a necessary first step to obtain the data required for an integrated system of space-based laser battle stations with the capability to defend the country against a Soviet ballistic missile attack. The GAO wants Congress to increase funding to accelerate development and asks for a laser program with milestones to achieve the demonstration objective.

Because of the military potential of a space-based laser program, the GAO wants a well structured, funded and managed program from the outset, and the report questions whether such a program currently exists in the Defense Dept.

The report recommends that the Defense secretary establish a space-based laser program with clear and specific milestones and objectives recognizing "the relative priority of space-based lasers within the Defense Dept." The report calls for the commitment of necessary funds to meet objectives and to maintain the stability of the selected program.

The GAO study was completed in time to permit congressional action for the space-based laser development program in the Fiscal 1983 Defense Dept. budget request.

It said that directed-energy weapons—technology involving devices for generating power and controlling laser, particle and microwave beams—may revolutionize military strategy, tactics and doctrine.

Particle Fluxes

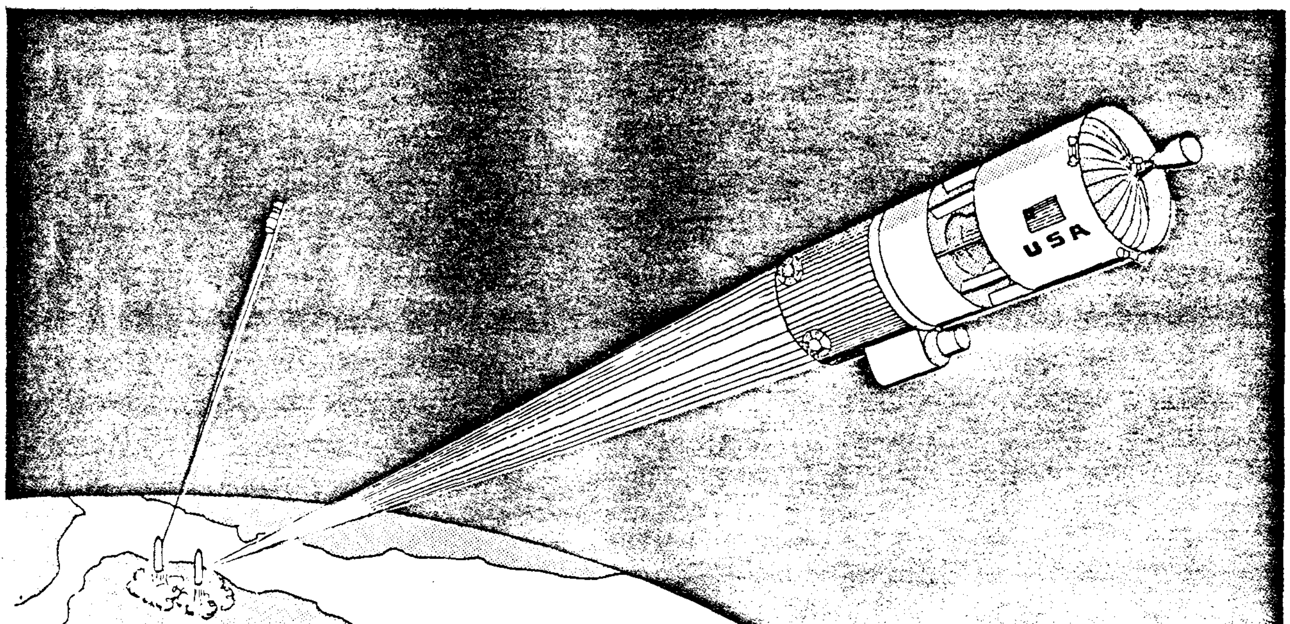
These weapons, which can destroy targets rapidly by means of intense electromagnetic radiation or particle fluxes, are expected to play an increasing role in the future, according to the report, and high-energy lasers are the most mature in technology and the best understood.

The detailed study by the GAO was conducted over a period of months, and it explains that if successful, space-based laser weapons could affect policy and help bring about a long-term solution enabling transition from offense-based nuclear weapons deterrence to defensive dominance.

The report centers on the concept of a constellation of laser battle stations in space with the potential for credible air and ballistic missile defense for the U. S., "where no defense currently exists," according to the GAO report. It was undertaken by the GAO because no other laser weapons concept is being developed with such profound implications, and the study assesses progress, issues and the existing management structure of space-based laser development.

The existing technology program managed by the Defense Advanced Research Projects Agency can support a feasibility demonstration of a space-based laser, the study shows. However, beyond the feasibility demonstration, advances will be needed in all areas of technology to begin developing a laser weapons program for damage-limiting ballistic missile defense.

The joint DARPA/USAF space-based laser program for Fiscal 1983 through Fiscal 1987 is continuing as a funding-limited effort, the GAO report said, and under this plan a technology-paced pro-



Space-based chemical laser battle stations are depicted in an artist's concept engaging Soviet ballistic missiles in the boost phase, when the nuclear-armed missiles are most vulnerable and before reentry vehicles can be deployed. Nuclear debris from destroyed ballistic missiles would fall back to Earth over the USSR. In this concept, 24 laser battle stations are placed in orbit in three polar rings of eight weapons each at an altitude of 1,200 km. (745 mi.). The battle stations would be used to engage ballistic missiles in the first 4 min. of flight before the engines burn out at maximum ranges of 5,000 km. (3,100 mi.). Optical equipment is used for surveillance, acquisition, pointing and tracking. Long-range, high-altitude aircraft also would be vulnerable in flight to the laser weapons. The battle stations would be shielded heavily against nuclear blasts and radiation and would use the laser weapons to defend themselves.

Program

gram appears bleak. If a technology-paced program is desired, Congress may be forced to create a new organization to manage the effort and carry out the program, the GAO study said.

The report offers some management possibilities that include:

- Establishing an Aerospace Force.
- Forming a secretary of Defense-managed and funded program.
- Forming a Defense Dept. laser task force.
- Starting a National Laser Institute.
- Creating a Space Force, a new branch of the military services.
- Establishing a Strategic Defense Agency.

The report calls for a management structure to exploit existing technology, adding that the DARPA triad laser technology program designed to develop and test the three main subsystems for a space-based laser weapon can support the feasibility demonstration in space of a laser weapon.

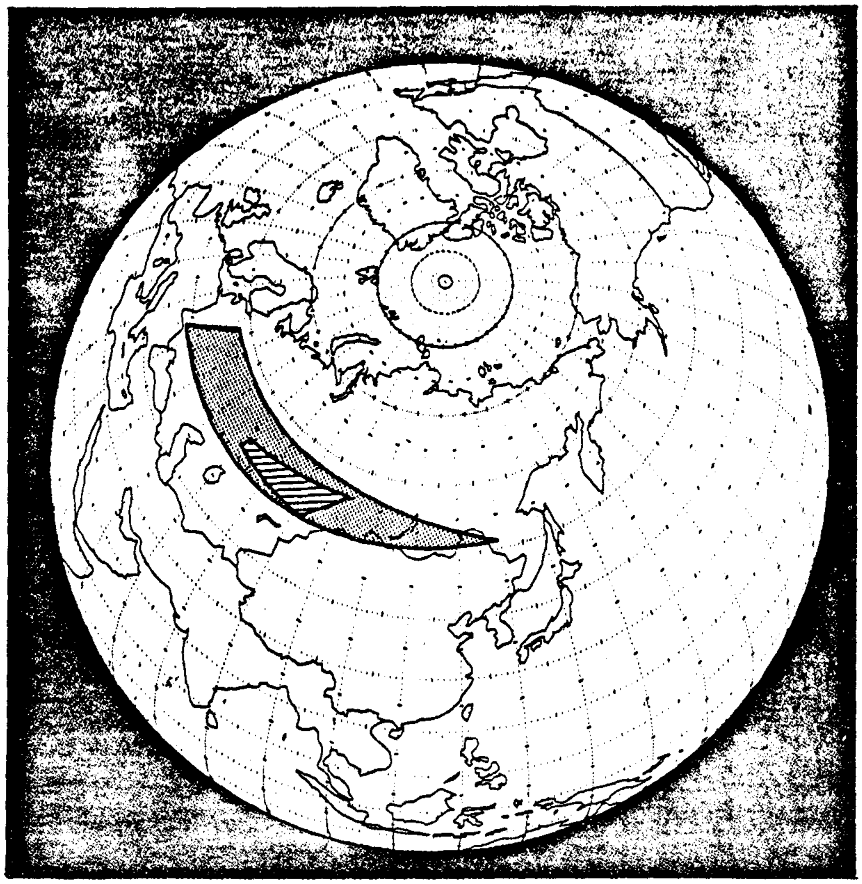
Conservative Funding

The present funding level of approximately $150 million per year for high-energy laser technology development is a conservative, funding-limited approach to space-based lasers, the GAO contends in the report.

Knowledgeable Defense Dept. and industry officials, along with documentation, suggest that a more prudent pace for demonstrating space-based lasers and weapons system feasibility would be a program limited by technology rather than funding, the report said.

The DARPA triad development effort includes:

- **Alpha**—Program to build a cylindrical 2-3-megawatt hydrogen fluoride chemical laser device to demonstrate the feasibility of directly extrapolating chemical laser technology to 5-10-megawatt levels. TRW is building the device under contract, and it is designed so that power can be expanded by adding generator modules. This device also may achieve 10-megawatt power levels at lower fuel efficiency. Ground tests are planned for the mid-1980s, and a space-based test is not now planned.
- **Large optics demonstration experiment (Lode)**—Demonstration of a 4-meter-dia. (13.1-ft.) primary mirror and associated beam control system for experimental use. The program as structured would enable a ground-based feasibility test with low power in the mid-1980s, and no space tests are planned. Lockheed and Hughes Aircraft are competing in the program.
- **Talon Gold**—Space-based demonstration of an advanced acquisition, tracking and precision pointing system scheduled for testing with the space shuttle in Fiscal 1987 to track targets at ranges up to 1,500 km. (931.5 mi.) with an accuracy of 0.2 microradians. Lockheed is the prime contractor for this program (AW&ST Mar. 8, p. 226), and recent brassboard measurements indicate that this technology may be scalable to 0.1-microradian pointing accuracy. The beam from a space-based laser not only must hit the target but dwell on it for the time necessary to destroy it.



Space-based chemical high-energy laser could alter the balance of power between the U. S. and USSR in favor of the defender. The inner area above the Earth depicted in hatching is the approximate engagement area where Soviet SS-18 heavy ICBMs would be destroyed in the boost phase of flight by laser weapons. The total Soviet ICBM force would fall within the outer shaded band for laser weapon engagement. The laser battle station system would concentrate on destruction of the 308 SS-18s permitted under the unratified SALT 2 agreement, which makes vulnerable to a first strike the USAF/Boeing Minuteman force. The laser battle stations at 1,200 km. (745 mi.) altitude have an orbital period of almost 2 hr. The altitude was selected to insure there are no holes in system coverage at the Equator where battle station separation is greatest. In an ICBM attack on the U. S., a fourth of the battle stations would take the brunt of the strike, but the remainder of the 24 stations would engage bomber, surveillance and early warning aircraft and SLBMs.

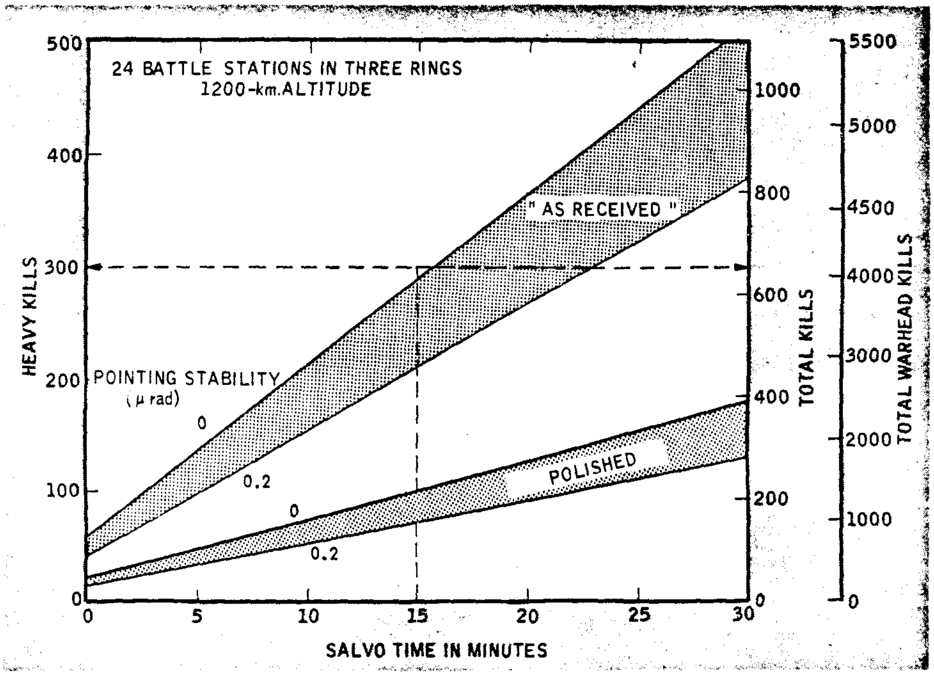
Defense Dept.'s study of space-based lasers completed last summer asked that approximately $50 million a year be added to the development program. However, the study advised against any integrated space demonstration for military missions.

The Defense Dept.'s 5-megawatt, 4-meter-dia. (13.1-ft.) and 10-megawatt, 10-meter-dia. (32.8-ft.) class laser systems are supported in development by DARPA programs that provide technology demonstration in Fiscal 1986-88, the GAO told Congress. But the report adds that technology already demonstrated is available to begin developing a 2-megawatt, 2.4-meter-dia. (7.9-ft.) system if required and that this Air Force technology is sufficient for a space-based laser feasibility demonstration.

Hardness Levels

Because of postulated levels of hardness that a laser countermeasures program might provide for the USSR, the Defense Dept. emphasizes the use of 25-megawatt, 15-meter-dia. (49.3-ft.) lasers in large numbers. This tends to drive development toward shorter wavelength pulsed lasers, or serves to increase development and deployment costs for a battle station system in orbit for ballistic missile defense.

The Soviet Union, however, does not have these levels of laser hardening on its



Interaction of laser battle stations in space against ICBM targets in the boost phase depends on launcher location, reflectivity of missile booster skin, salvo time and pointing stability. The capability against booster skin is depicted in this graph, which represents the performance of 24 battle stations in orbit. The upper curve represents an absorbtion of laser energy of normally bright aluminum as received when shipped to a factory. The lower curve, labeled Polished, assumes the use of very refined polishing techniques. Laser energy must be absorbed to heat the structure of the ballistic missile to cause it to fail. If the surface is polished so brightly as to reflect laser energy, the missile would survive. Polished surfaces are difficult to maintain in an operating environment when contaminated by reflective exhaust gases and traversing the atmosphere. Missiles are covered with camouflage paint or are anodized, making them absorptive and lasers highly effective against them. Current Soviet ICBMs are hardened only from 0.5-1.0 kj./cm.², with a hardness of 25 kj./cm.² anticipated.

present generation of deployed intercontinental ballistic missiles. It would not be an easy task for an enemy to remove the missiles from silos to harden them, and measures taken for countering laser weapons would reduce the payload of nuclear warheads, the missile range or both, according to a Pentagon study.

"Deployment of moderate numbers of platforms of 5-megawatt, 4-meter-dia. performance level would place at risk large numbers of ballistic missiles and aircraft in the current strategic inventory due to their approximately 1 kj./cm.² vulnerability," according to the study.

ICBM Launch

The study adds that a laser battle station system would have to cope with a simultaneous launch of 1,000 ICBMs hardened to levels of 10-20 kj./cm.².

A USAF study completed in July, 1981, reveals that a 10-megawatt, 10-meter-dia. laser weapon could provide a significant capability for several military missions, the GAO report said. The report calls for a long-term commitment to invest in the future, adding that incentives exist for investigating research toward realizing such a potential to defend the U.S. against ballistic missile attack.

The Defense Dept. has invested approximately $2 billion for high-energy laser technology for military applications. In the current fiscal year, DARPA has $108.1 million for space-based laser technology, USAF has $20 million, the Army $22.9 million, the Navy $60.9 million and USAF another $88.7 million for non-space-related development. It is difficult to break out funding since non-space development also can be adapted to space applications.

In Fiscal 1983 the funding being sought in Congress for DARPA is $115.7 million, USAF $40.6 million, Army $64.4 million, Navy $69.2 million and USAF non-space-related laser technology is $109.4 million.

While the DARPA development program is oriented toward an antisatellite or defensive satellite capability for space-based lasers, the devices can be used against aerial targets in flight, according to the GAO report. A 10-megawatt, 10-meter-dia. weapon could provide rapid global projection of U.S. power against aircraft targets.

The laser weapon could provide simultaneous U.S. air defense and attack enemy airlift lines of supply and airborne early warning aircraft. This laser weapons system also would have an antisatellite capability and a limited ballistic missile defense capability.

The GAO report explains to Congress that by engaging ballistic missiles in their boost phase, lasers have targets that are easily tracked, are at their more vulnerable stage and also are not located over U.S. territory.

Effective damage limiting space-based lasers for ballistic missile defense may be required to neutralize as many as 1,000 boosters in 4 min. This would require a large number of platforms—25 megawatt, 15-meter dia.—still beyond the technology horizon.

A key issue is survivability, since a space-based laser system placed in orbit by the U.S. would provide a threat to the strategic posture of the USSR and would likely promote countermeasures development. Each Soviet countermeasure would have to be analyzed for the lasers to survive in wartime, making it a complex issue.

Technology Advances

Advances are needed in power, efficiency and quality of laser devices. They also are needed in size and weight of large optics and in the manufacturing of them, and in precise pointing and tracking as well as in battle management.

Space-based lasers function best in mixed forces with other more conventional ballistic missile defense alternatives—terminal and non-nuclear midcourse defenses—because of the stress involved in a damaging limited mission, according to the GAO report. A multilayer ballistic missile defense system has the capability of very low leakage, even with some leakage through one of the layers. Each layer does not have to neutralize the entire threat, and the size and cost of each layer can be reduced.

The GAO report stresses the importance of a first-generation 10-megawatt, 10-meter-dia. space-based laser against Tupolev Backfire bombers armed with cruise missiles for fleet air defense, Soviet SS-20 intermediate-range ballistic missiles, low-altitude spacecraft and limited numbers of ballistic missiles.

The GAO stresses that under the pace of the DARPA triad program and the Air Force responsibility for space-based laser weapon development, a decision to conduct an orbital demonstration in space to establish feasibility will not be made until mid-1987, unless funding levels are sharply increased.

Present funding for the DARPA triad program and the Air Force effort are, according to the GAO, the minimum required to keep the program moving, and Defense Dept. officials involved in the program believe the funding should be doubled, according to the study.

"The decision to deploy laser battle stations cannot be made until the feasibility demonstration is accomplished, and the USAF program office is expected to receive an average of approximately $40 million per year through Fiscal 1987," the GAO said. The agency added that USAF interest in space-based lasers to date means that prospects above $40 million a year are bleak within the existing program structure.

Space Div. Priority

The report adds that in the USAF draft program objective memorandum (POM) for the Fiscal 1984 budget request the Space Div.'s priority is shown with no funding allocated for the space-based laser program because of higher priorities.

DARPA and USAF are developing a plan for the joint space-based laser program to augment the effort by approximately $50 million per year, but that amount is insufficient to address fully issues for decisions of future prospects of space-based laser weapons, the GAO said. The study adds that more funding could reduce program risks and provide confidence that technology is ready to enter weapon system acquisition process.

The DARPA triad laser technology program as now structured will not support a space-based laser weapon system initial operational capability before the year 2000.

The demonstration of the total system in orbit will not be conducted until the triad program is completed, so that the actual launch of a space-based laser for feasibility demonstration would not take place until 1985 or later under the present plan, the GAO said.

Larger Soviet Effort

The study explains that the Soviet Union's high-energy laser program is three to five times larger than the U.S. effort, including research, development, test and evaluation of a space-based laser weapon.

Defense Dept. officials have testified in secret sessions with Congress (AW&ST Mar. 8, p. 272) that the USSR could achieve an initial operational capability with a space-based laser as early as 1983. That information was based on a recent intelligence community assessment that concluded such a Soviet device in space could be capable of destroying U.S. surveillance, communications or early warning spacecraft.

By the early 1990s, the Pentagon officials explained to Congress, the Soviets could have a large space complex in orbit capable of attacking a variety of targets within the Earth's atmosphere from space.

The GAO study reveals that the U.S. leads the USSR in many areas related to space-based lasers by 5-10 years. These areas include the optical systems critical to developing advanced weapons, early warning and electro-optical sensors, miniaturization, computers and lightweight spacecraft. The USSR is believed to lag behind the U.S. from two to seven years in microelectronics and computer technology.

The on-board computational requirement for ballistic missile defense with a space-based laser is enormous, and this is one area in which the U.S. has a big advantage, according to the GAO.

The high-energy space-based laser system is being referred to by the U.S. scientific community as representing truly credible missile defense alternative for the country in the foreseeable future, according to the report.

Technology in chemical high-energy lasers has reached the point, the study continues, where military application is relatively clear. But the present program's funding-limited approach to space-based laser technology runs the risk of keeping potentially revolutionary technology in component development for the foreseeable future.

The GAO report adds that, because of the bleak future in augmenting the program above the Defense Dept. recommended level, feasibility issues will not be addressed fully before a demonstration decision is made in 1987.

Funding constraints have forced performance reductions and schedule delays in the DARPA triad program. The delays in turn will affect future program efforts, which will require data from the DARPA program.

Calling the space-based laser battle stations valuable for strategic applications, the GAO study refers to the technology as important as the invention of the wheel, computers and nuclear weapons.

The GAO study proposes options to accelerate the space-based laser program. These include:

- Resolution of the key technology uncertainties at an early date. This option also includes development of shorter wavelength advanced technology devices in a parallel program in critical technology areas to provide a backup capability.
- Acceleration of technology to provide for a sub-scale orbital feasibility demonstration of a space-based laser as an integral part of the program.
- Aggressive effort to advance the state of the art for space-based lasers with flight tests by 1993, at an additional cost of $250-300 million each year through the next 4-5 years.
- Orbital test in 1990, which would commit technology early that can be used to demonstrate the feasibility. Engineering design to accomplish this goal would be started in Fiscal 1983, with vehicle fabrication as early as Fiscal 1985 based on results of the triad program. This approach would cost approximately $400 million more a year through Fiscal 1985, and $600 million per year from Fiscal 1986 through flight demonstration for a total of approximately $5 billion.

Incentives exist for investing in research toward realizing the potential to defend the U.S. against ballistic missile attack. "Realistically, early generations of space-based laser weapons will not provide the important military capability needed to achieve defensive dominance, but would represent steps toward developing such a system," according to the report. □

Short-Wavelength Laser Effort Urged

Washington—High-energy laser research should be reoriented away from emphasis on long-wavelength chemical lasers and replaced by accelerated research on short-wavelength high-energy lasers, the House Armed Services Committee has recommended. The recommendation was made in the House Fiscal 1983 Defense Authorization Bill and will be included in the committee's report, now in preparation.

Robert S. Cooper, director of the Defense Advanced Research Projects Agency, told the House and Senate Armed Services committees prior to their completion of the 1983 authorization bill that the laws of physics favor short-wavelength lasers (AW&ST Mar. 15, p. 13).

Cooper told Sen. John W. Warner (R.-Va.) that he did not intend his remarks to indicate that the U.S. should bypass chemical laser research. Cooper said current levels of funding, much of which supports chemical laser research conducted by DARPA, are adequate.

Sen. Malcolm Wallop (R.-Wyo.) took issue with Cooper's statement that the current laser program is adequately funded.

"Perhaps the Defense Dept. would do well to hire new managers in this field," Wallop said, noting that the Soviet Union has little trouble spending more funds than the U.S. provides for laser research.

Wallop said DARPA has testified in previous years, before Cooper became its head, that the three main components of a laser system should be tested in space. Cooper said two of the subsystems could be tested on the ground.

Wallop criticized Cooper for stating that full-system testing in space is an imprudent use of funds.

Obstacles to a more aggressive space laser program lie in management, not technology, Wallop said.

Do We Need Space Weapons?

Many defense experts urge that the US develop orbital lasers, particle-beam weapons, and "killer satellites." They say the country will need these weapons for the next decade. Critics call such exotic devices a dangerous waste of money.

Celestial Call to Arms Sounded

..."It is an unpalatable truth, but we must face it: Before the end of this century—probably in this decade—space weapons will end the balance of terror that has made nuclear war all but unthinkable for the last 36 years. They will make possible a global conflict whose undamaged victor could dictate terms to a disarmed and helpless loser. The Soviet Union is preparing for this decisive war. The US is not.... Laser weapons have already been used to shoot down aircraft and have been operated from airplanes. Other space weapons include charged-particle beams. Russian scientists did much of the pioneer work in such beams and are believed to be far ahead of us in their development. A single space station armed with laser weapons could be deployed before 1990. It could burn down every missile launched by one side during an all-out nuclear war, then leisurely burn down all the enemy's bombers for an encore."

Jerry Pournelle in *Omni*
4(2):30, 138-9, Nov 81 [**CY-12**]

..." 'Laser battle stations are not something out of "Star Wars,"' Wyoming Sen. Malcolm Wallop, who favors speedy development, recently told his colleagues. 'Actual physical pieces of the system already exist. Only the money and the will to put them together is lacking.' Wallop is convinced that the first pieces of an effective space-weapons system could be orbiting in five years.... The Dept. of Defense has not made any commitment to put weapons in space, either during the 1980's or any time later. Nevertheless, it has spent an average of $200 million a year for the past decade on high-energy-laser and particle-beam research."

Jim Schefter in *Popular Science*
219(5):75-7, 138, Nov 81 [**CY-13**]

..."Being denied the use of surface observation posts in places like Iran and Ethiopia has helped spark the military's interest in space.... But the potential Soviet threat is probably the most compelling reason for the military leaders' desires to get into space. Treaties ban weapons in space, yet it is known that the Soviets have been developing an anti-satellite [ASAT] system. 'In the absence of an effective ASAT agreement, the US must continue to improve the survivability of its satellites and to develop an ASAT capability of its own,' submits Air Force Brig. Gen. Donald A. Vogt...."

Lad Kuzela in *Industry Week*
15 Jun 81, p. 107-8

Opponents List Costs, Dangers

...The push for space weapons "started in 1967, paradoxically, with the signing by the Soviet Union, the US, and 72 other nations of the UN Outer Space Treaty, which banned the deployment of weapons in space. No treaty in history has been so abrogated.... Ninety-five per cent of all Russian space launchings since 1957 have been military. The American proportion, despite such civilian triumphs as the moon landing, has been 86%.... The space race continues, largely in secret.... One plan being mooted by America is to launch a satellite command station into orbit 132,000 miles from Earth—halfway to the moon—and out of the reach of killer satellites and beams.... The stakes are rising by the day. As Marvin Goldberger [California Inst. of Technology] has remarked grimly, 'We are going through the valley of the shadow of death.' "

Robert Darroch in *World Press Review*
29(1):32-3, Jan 82 (From *Bulletin*, Sydney, Australia, 27 Oct 81) [**CY-14**]

..."Some analysts believe that either the US or the Soviet Union could wake up one day and discover that its opponent had deployed a workable space-based antiballistic missile [ABM] system or even an ASAT system. Such an event would wipe out all advances of the past 30 years in intercontinental nuclear delivery systems, satellite data gathering techniques, and space-based military communications. It would, so this theory goes, be the ultimate in strategic blackmail.... This apocalyptic vision misrepresents the real dangers posed by these new weapon systems. Although it may be possible to conceal early testing and development, the amount of time and the number of tests needed to perfect any sort of weapon system, let alone one as complex and prone to failure as a beam weapon, would make eventual detection inevitable.... So early deployment of a space weapon by the US would result in Soviet response. Moscow would inevitably accelerate its ASAT and ABM programs."

David A. Andelman in *Foreign Policy*
(44):94-106, Fall 81 [**CY-15**]

..."Aerospace companies...are spending tens of millions of dollars to design laser weapons to fit in the payload bay of the Space Shuttle. Hawkish Republican Senators led by Malcolm Wallop of Wyoming, Jake Garn of Utah, and ex-astronaut Harrison Schmitt of New Mexico favor plans to ring the Earth with 18 five-megawatt carbon dioxide chemical fueled laser ABM satellites. This plan would require some 50 Space Shuttle flights, requiring cancellation of quite a few 'frivolous' scientific space missions."

Jim Heaphy in *Science for the People*
13(4):35-9, Jul-Aug 81

..."While relatively unsophisticated systems may be technically feasible for both the US and the Soviet Union, the costs of deploying effective systems make them impractical for the foreseeable future. Despite these stumbling blocks, the US and (according to some reports) the Soviet Union are spending large sums on research and development in these areas.... Such competition is reminiscent of the 'nuclear airplane' project of the late 1950s and early 1960s, on which billions of dollars were spent despite widespread belief that such a system would never get off the ground."

Gerald Steinberg in *Technology Review*
84(1):57-63, Oct 81 [**CY-16**]

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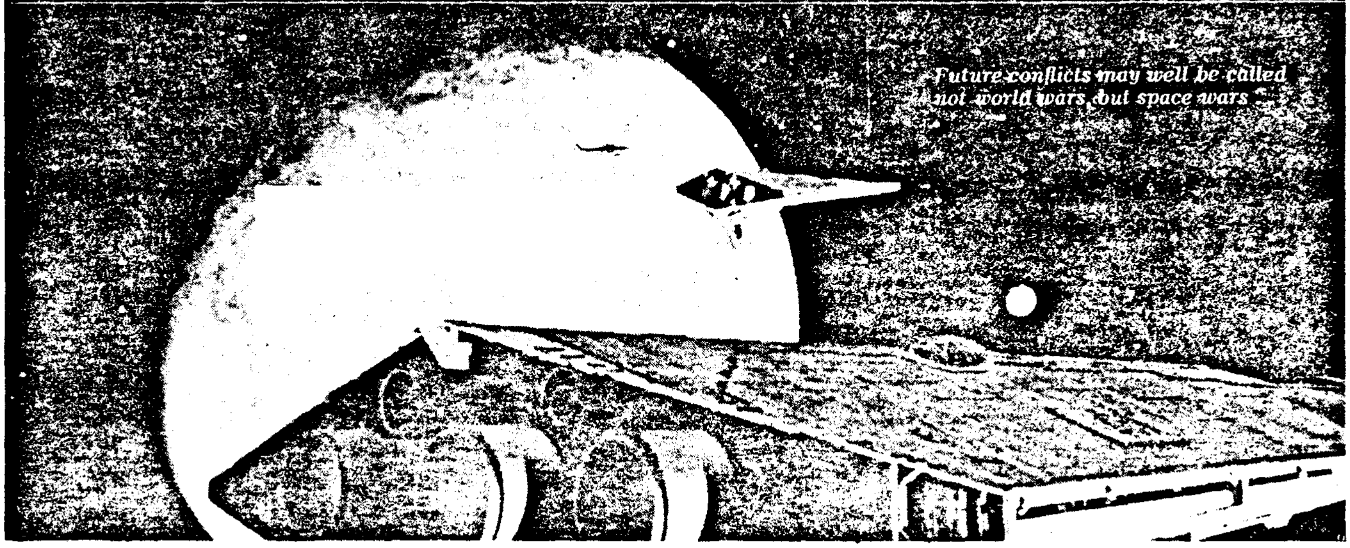
STAFF:
Publishers: Eugene Garfield (ISI) & Alan McGowan (SIPI)
Editors: Thomas G. DiRenzo, Thomas Marcinko & Fred Jerome
Research: Patricia Heller, J. Henry Haggerty & Michael Jacobs
Production: Ellen Weinstein & Madeline Herninko
Graphics: Robert Ewing & David Rokita

Satellites show their warlike face

Most of the satellites put into space have been for the world's military forces. The superpowers are keeping track of each other's movements with an ever more advanced battery of spies in the sky



Future conflicts may well be called not world wars but space wars

Lucas Film

Mark Hewish

Space has been described as the battlefield of the future. This is not strictly true: war is already being waged in space, in a cat-and-mouse game played by the superpowers. The era of space battleships armed with lasers and particle-beam weapons is many years in the future. But military chiefs are surprisingly well practised in using a more prosaic kind of spacecraft—satellites—mainly for surveillance. Of the 3000 or so satellites launched so far, about two-thirds have either been entirely military or have fed information into defence projects. Last year alone, the USSR placed in orbit at least 85 military satellites.

As far back as the late 1940s, the US thought about using satellites as high-flying robot spies to complement or even replace manned aircraft. In the 1950s, engineers from both the US and the USSR developed ballistic missiles that flew in space on their way to targets. The engineers quickly gained expertise in the technology of large rockets, guidance electronics and re-entry vehicles—the latter to protect warheads as they plummet into the atmosphere at many thousand kilometres per hour. Replace the warhead with a spacecraft, use miniature re-entry vehicles to carry film back to Earth, and you have a "spy satellite."

The very technology that made spies in the sky possible also provided the reason for developing more of them. Both superpowers wanted to know the exact locations of the targets for their missiles. And they were desperate to find out about the other side's rocketry developments: satellites could provide both types of information.

The skies are now criss-crossed with a web of surveillance satellites operated by military forces. The vehicles carry film and televison cameras, infrared sensors that can see at night, radars to penetrate cloud and bad weather, and listening devices to intercept "enemy" radar and radio transmissions. The space vehicles are also used in other areas of warfare. In the 1960s, when the US Navy launched its first submarines carrying Polaris ballistic missiles, naval engineers needed to tell the vessels' commanders where their targets were. The original guidance information would become outdated after many weeks at sea. The answer was the network of Transit navigation satellites that is still widely used today.

At about the same time, the commanders of air bases and aircraft carriers wanted to know what the weather would be like over targets to be attacked by their aircraft—so a new breed of military meteorological satellites was born. A large part of the radio traffic between NATO commanders and their forces is now routed via specialised communications satellites. Other spacecraft watch for a nuclear attacks, monitor enemy missile tests and measure the effectiveness of new weapons.

Before the 1980s are out, American soldiers in their foxholes in Europe will be able to find out where they are (to within a few metres) by tuning in to a web of 18 NavStar navigation satellites that fly in shoals more than 16 000 km above their heads. They will be able to communicate directly from a bunker in Germany to their headquarters in Washington DC—simply by unstrapping a satellite terminal that is small enough to be carried on a man's back. Surveillance spacecraft hovering in geostationary orbit at a height of 36 000 km will stare at the Earth with perhaps a million or more individual infrared detectors, looking for the slight rise in temperature that shows up a cruise missile's jet-engine exhaust.

In the days of the Cold War, the Americans in particular had good reason to develop spy satellites. To find out about the US's ballistic missiles, the Soviet Union had only to peruse government documents freely available in Washington, buy good maps of the US and instruct spies to look out for major earthworks. For the US, it was not so easy. No Westerners were allowed anywhere near Russian missile bases, and Soviet maps deliberately showed big towns and other potential targets up to 15 km away from their true positions.

A significant event took place in August 1960—though at the time it seemed prosaic enough. A US Air Force satellite called Discoverer 13 ejected a capsule containing photographic film; the capsule re-entered the atmosphere and was picked up from the sea. This exercise showed that pictures could be taken in space and returned to Earth for analysis. This method is still used today when military officials need high-quality photographs from satellites.

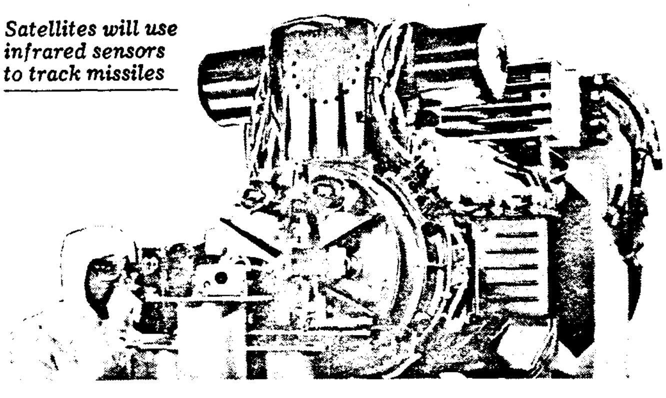
In parallel, American scientists developed a way of obtaining photos more quickly. The film is automatically processed inside the spacecraft and the prints scanned by a narrow light beam passing back and forth across it. The various shades of grey are converted to radio signals and transmitted to Earth, where a similar arrangement in reverse builds up prints with the characteristic lined appearance of wire photos.

In January 1961, the US launched Samos 2, its first operational surveillance satellite that relied on radio transmission. The craft orbited the globe for a month. By mid-1972, a total of 109 US spacecraft had systematically mapped most areas of military interest on the Earth's surface. They have since been succeeded by the aptly named Big Birds—huge 13-tonne reconnaissance satellites—and by the KH-11 craft. The latter are operated by the Central Intelligence Agency rather than the US Air Force.

The KH-11 has a life in orbit of two years or more, compared with five or six months for Big Bird. It sends its pictures back to Earth via a digital data link rather than in film capsules. Engineers can manoeuvre their satellite out of its normal orbit to take a more detailed look at areas in which they are particularly interested—the war zone in the recent fighting between Iran and Iraq for instance.

The US Air Force still has a small number of its earlier close-look satellites, known as low-altitude surveillance platforms, which it keeps in reserve for emergencies. The most recent one was launched on 28 February, when the build-up of Russian forces near the Polish border was reaching its peak. These craft fly relatively close to the Earth—as near as 130 km. So they fall into the planet's atmosphere and burn up after the short time of 50 to 80 days. The cameras on these space vehicles can distinguish objects only 15 cm in diameter. The film is ejected in capsules and snatched in mid-air by C-130 Hercules aircraft.

The space shuttle will play a big part in military surveillance. The US Air Force has only three of the low-altitude surveillance satellites in reserve and will run out of Big Birds in 1983. A new version of the KH-11 providing better-quality pictures will be launched in 1984, but in the future the only way of getting high-resolution pictures back to Earth will be to carry cameras in the shuttle. By placing their faith in manned space vehicles for spying from the sky, the US's military chiefs are returning to a concept which their country once abandoned: Big Bird was

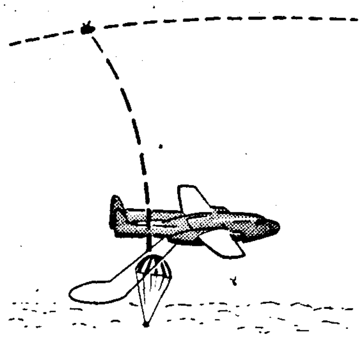


Satellites will use infrared sensors to track missiles

assigned high priority only because the Air Force's planned manned orbiting laboratory (MOL), was cancelled in 1969. The laboratory, based on the two-man Gemini capsules that NASA placed in orbit during the 1960s, would have been used for surveillance missions.

Targets will obviously have to be extremely important to risk flying a manned (and very expensive) shuttle over them to take photographs in times of tension. This is especially true once the Soviet Union has perfected its killer satellites—unmanned craft that manoeuvre alongside orbiting vehicles and blow them up with explosives.

In the late 1980s, American armed forces will concentrate on radar rather than cameras for space surveillance. One type of satellite will track the movements of Warsaw Pact tanks and other armoured vehicles, while the US Navy will use another to watch for warships. The Navy already has its own ocean-surveillance system: this comprises sets of three satellites which fly in clusters on parallel paths. The craft use interferometry techniques: they compute ships' positions from data provided by several antennas which measure the direction from which vessels' radar or radio signals arrive.



A quick film service: military aircraft routinely pluck from the sky film capsules which are ejected from orbiting spy satellites. In another technique, the satellite transmits data to the ground while it is zooming over the Earth and taking pictures

In its space surveillance activities, the USSR concentrates on satellites that return film to Earth. Last year the Soviet Union launched 35 such craft, of which 7 provided pictures of the Earth for peaceful uses—to find out information about geology or the growth of crops for instance. The rest had military applications. Four of the vehicles were of a recent design. Bigger than most satellites, they are similar to the Soyuz vehicles that ferry crew to and from the Salyut space stations. The Soyuz-type reconnaissance satellites carry solar cells to provide electrical power, giving them twice the two-week life of earlier battery-powered types. At least three Russian satellites of different types observed the early days of the Iran-Iraq war last September.

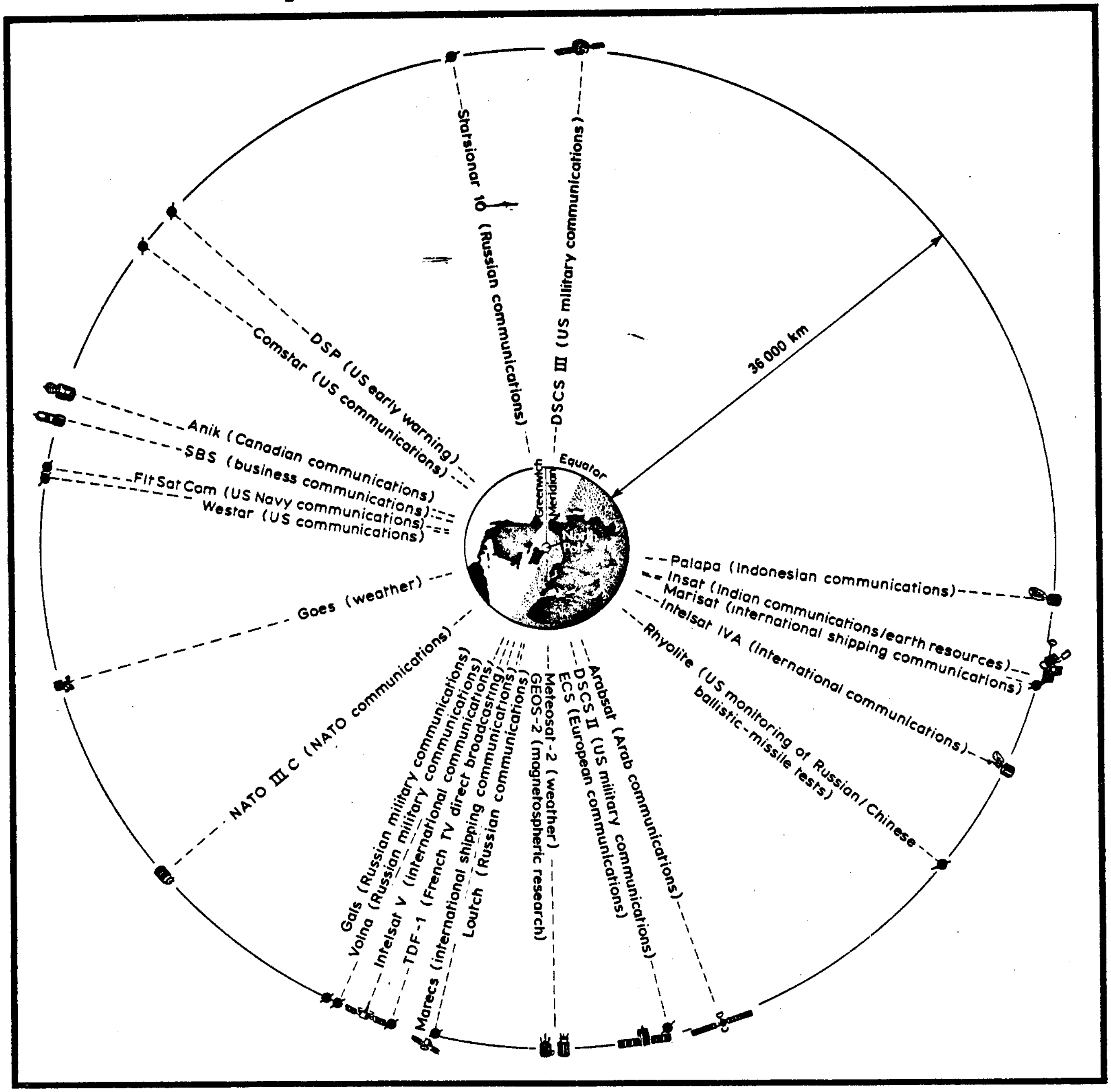
A military base in space

Military crews aboard NASA spacecraft have brought back information useful for defence purposes, but Russia has pioneered manned missions devoted specifically to military operations. The third and fifth Salyut space stations, launched in 1974 and 1976, carried high-resolution cameras in place of scientific instruments and flew slightly lower than their civilian counterparts. There have been no purely military Salyuts recently, however, so their role may have been taken over by unmanned craft. Both the US and Russia are looking at permanent space stations carrying up to 12 men at a time, and these will have obvious military applications.

The Russians, like the Americans, have specialised in satellites that look solely at the oceans. One of these, Cosmos 954, crashed in Canada in January 1978 and scattered radioactive debris from its nuclear power generator. One of the three Russian sea-surveillance satellites launched last year had similar characteristics to Cosmos 954, but the other two were "ferrets" that listen to radio transmissions. If photo-reconnaissance satellites are the eyes of a modern intelligence service, then the ferrets are its ears. The craft eavesdrop on enemy communications, record them on tape and then replay the messages as the satellites pass over their own ground stations. The US Air Force normally orbits ferrets in piggyback fashion, using the same booster rocket as a Big Bird or KH-11. Last year the Russians launched six of these craft.

One of the US's earliest military space projects was Midas, a network of satellites in low orbits (a few hundred kilometres above the Earth) which were designed to give 30 minutes' warning of a Russian missile attack. This would double the warning time provided by a chain of three

Satellites speed the world's information flow . . . .



Satellites are jostling for space in geostationary orbit, particularly in the most sought-after positions over the Atlantic

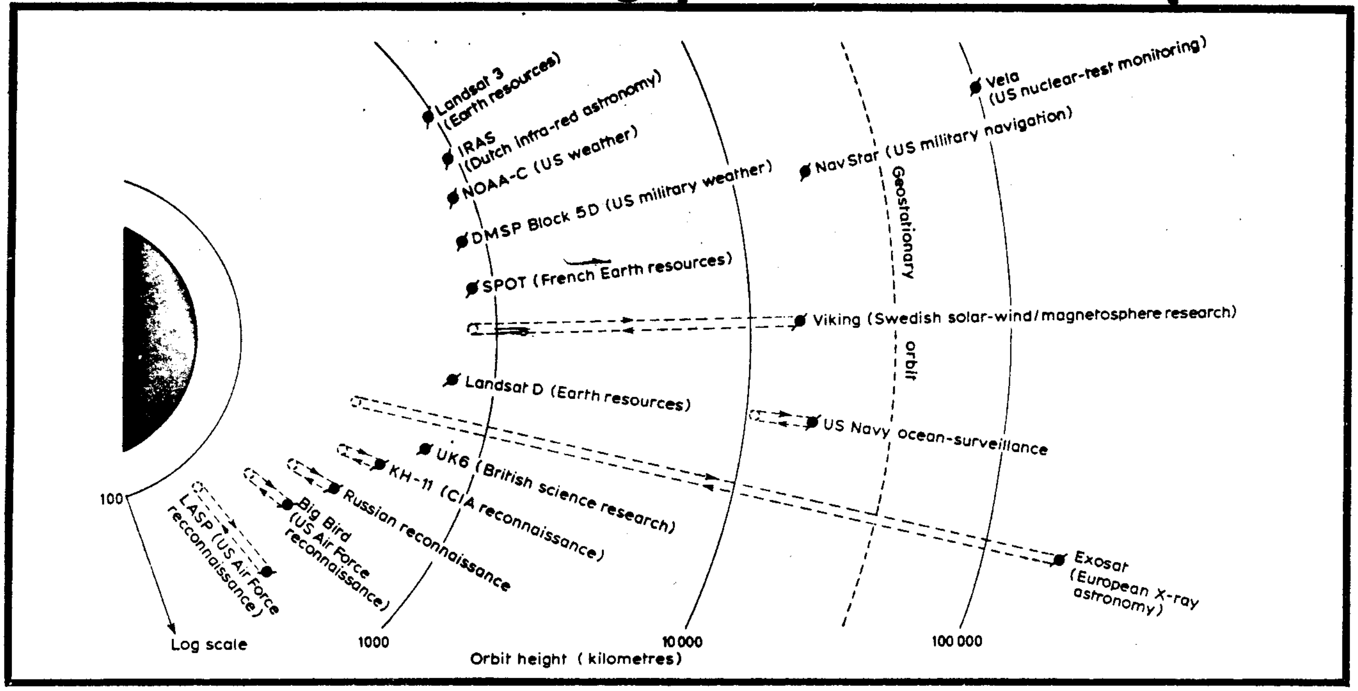
ground-based radars, one of which is at Fylingdales in Yorkshire. (The others are in Alaska and Greenland.) Midas satellites carried infrared sensors to detect the heat given off by the engines of Soviet missiles—but unfortunately they have failed to work. In 1972, therefore, the US Air Force switched its emphasis to satellites in geostationary orbit with what it calls the Defence Support Program.

One of the satellites in the project is positioned over the Indian Ocean, where it can monitor missile tests in China and the Soviet Union and also warn of an attack on the US by land-based missiles. Another hovers over central America, alerting the US if submarines fire missiles. Replacement satellites are launched as the old ones wear out.

The satellites each carry about 2000 infrared sensors that detect radiation with wavelengths between 3 and 5 micrometres—the type of electromagnetic waves given off by very hot objects such as missile engines. The next generation of early-warning satellites will probably operate between 8 and 13 micrometres. They will be able to detect cooler objects, the jet engines of aircraft for instance.

In 1984, in an experiment code-named Teal Ruby, the US Air Force plans to launch its P80-1 research satellite with an unusual passenger on board—an array of 150 000 infrared detectors. If the experiment is successful, the US may launch another satellite called HALO (high altitude, large optics) which will carry up to 10 million detectors. In

. . . . but are turning space into a rubbish tip



Low-Earth orbits are primarily the domain of military and scientific satellites

The lumps of metal that make up the satellite world

Satellites can be broadly divided into two types. The first travels in a geostationary orbit around the equator at a height of 36 000 km; the second type takes up other available orbits. In a geostationary position, a space vehicle completes one sweep around the Earth in the same time that the planet makes one rotation. It thus appears to hover motionless in the sky. A satellite in geostationary orbit can "see" about one-third of the Earth's surface, so it can relay radio and data messages and TV programmes between any two points in that area.

Most communication satellites, such as those in the Intelsat series used by more than 100 countries, are in geostationary orbit—as is a network of weather satellites provided by agencies in the United States, Europe, USSR and Japan. The US has several military satellites in this orbit, in what it calls the Defence Support Program. These craft should warn of attacks by ballistic missiles. With its Rhyolite craft, America also monitors tests of these weapons by Russia and China.

More than 170 communications satellites are already in the geostationary position or are planned. Add all the military satellites, together with those now planned for direct broadcasting of television programmes, and the space left for more satellites in this orbit becomes very limited. International agreements ensure that the signals from satellites near each other are modified so that they do not cause interference.

Space nearer the Earth is also very crowded, with 3000 or so satellites jostling for position alongside bits of old rockets and other debris. The vastness of space makes collisions unlikely, but one day the shuttle may have to act as a garbage truck to retrieve space junk or nudge it into a different orbit so that it re-enters the atmosphere and burns up. The band of space from the top of the Earth's atmosphere (70 or so km high) to a height of several hundred kilometres is occupied by satellites that have to get as close a view as possible of what is going on beneath them. Several types of spy satellite fly very low, brushing through the highest point of the atmosphere, as their instruments strain to pick out the smallest details. As a result, their orbits "decay" very quickly and they may have lives of only a few weeks. Further up are the longer-lived civilian Earth-resources satellites, doing a similar job but accepting a correspondingly inferior picture quality. At roughly the same heights are the civilian and military low-orbit weather satellites, which have orbits that take them over the poles.

Scientific research satellites frequently have orbits that bring them near the Earth at their perigee but fling them out into the depths of space at apogee. This shape of orbit may be adopted for various reasons; it helps, for instance, in the examination of the magnetosphere. □

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conventional early-warning satellites, the view of the Earth is scanned across the array of detectors to build up a picture. In Teal Ruby, however, the detectors "stare" continuously at the scene, just like a frog's eye. This change is expected to improve the sensitivity by a factor of five and allows information from the sensors to be updated several times a second. As the rocket engines of an intermediate-range ballistic missile burn for only 30 to 50 seconds, the staring array gives a much better chance of detection.

Satellites also play a part in military communications. The US, Soviet Union, NATO and Britain have all launched this kind of craft. The vehicles operate similarly to satellites such as the Intelsat series used for ordinary international telephone calls. The military vehicles transmit to and from terminals on land, ships and aircraft. The US Air Force, which needs to link people who operate nuclear bombers, missile control centres and early-warning networks, has an unusual approach: it puts its transponders on other people's satellites. The Air Force's AFSatCom system includes 12 channels on each of the US Navy's FltSatCom satellites, with other transponders on commercial spacecraft. AFSatCom may use up to 30 transponders on host satellites by the late 1980s.

A new generation of military satellites is on the way, however, which incorporates technology substantially different from that in its commercial counterparts. General Electric is building a satellite called DSCS III. The electronic circuitry in the craft is shielded to withstand nuclear radiation, and jamming its communications links is much more difficult. If a ground-based jammer locks on to one of the radio channels, the channel shuts down and is replaced by another one with different characteristics.

A major problem with radio links is their limited capacity. And the "footprint" on the ground—the area over which the radio energy is spread—may approach 500 km in diameter for a geostationary satellite, giving weak signals. So military engineers in the US are experimenting with laser communications. A laser could send information between ground stations via a satellite at the rate of 1000 million bits per second—equivalent to transmitting the contents of the Encyclopedia Britannica every second—yet produce a footprint only a few hundred metres across. Such transmissions would be almost impossible to intercept or jam. Last December, the Air Force completed Earth-bound trials with an experimental laser system and will launch it on the P80-1 satellite in about 1984.

Military commanders also need to know where they are: hence the reason for navigation satellites. The Transit network of navigation satellites operated by the US Navy since the mid-1960s continues to be used by mariners throughout the world, and has recently been updated by the introduction of three new satellites known as Novas. The satellites transmit radio signals on a precise schedule that is corrected as they fly over timing stations on the ground. Receivers on board ships detect the doppler shift—the slight change in frequency of the radio signals as the relative positions and speeds of the vessels and satellites alter—and a computer works out the ship's position to within 200 m or so.

In the mid-1980s this arrangement will be replaced by the Global Positioning System, using 18 NavStar satellites orbiting in belts at a height of more than 16 000 km. Each spacecraft will carry three atomic clocks accurate to one second in 30 years. Receivers in land vehicles, backpacks, ships, aircraft and even missiles will measure the time that radio signals arrive from different satellites. As the transmission times of the signals are coordinated, the receiver can calculate its own position and speed. The network has been reduced from 24 satellites to 18 to save money, but it will still be accurate to within about 16 m. With the system, missiles will be able to fly to unseen distant targets (so long as the exact location of that target is known). Landing craft will be able to approach strange beaches in complete darkness. Even squads of soldiers out on patrol will be able to work out their precise position. If there is another World War, satellites—normally thought of as perfectly benign examples of spacecraft—will play a big part in influencing its course. □

Walt Disney

11 August 1982

Department of Defense (DoD)
Fact Sheet
DoD Space Policy

The Secretary of Defense has recently approved a classified statement of policy designed to guide the space-related activities of the Department. The policy is a result of an internal Department of Defense study of the space environment and its relation to national security. The purpose of the study was to produce a space policy that is consistent with international law and national policy, and that would provide focused and coherent broad policy guidance for future DoD space-related activities. While the DoD Space Policy contains details which require the statement to be classified, its fundamental thrust is unclassified.

The DoD Space Policy is in furtherance of the National Space Policy announced by the President on July 4th, and is fully consistent with and supports the principles underlying the conduct of the United States Space Program, including the use of space for peaceful purposes and support of the inherent right, recognized in the UN Charter, of all nations to self defense. As does the national policy, the DoD policy recognizes those uses of space that have thus far proven sound while providing the focused direction required to guide future DoD space activities in a changing world environment.

The DoD Space Policy directs the continued maintenance of a strong technology base, as authorized in the National Aeronautics and Space Act of 1958, with leadership in those areas necessary for effective provision for the defense of the United States. In so doing, the policy recognizes that since a number of military missions can be very effectively supported by space systems, future use of space should have an operational orientation.

Those responsible for DoD space activities are, therefore, directed to provide effective operational support to US forces in peacetime and in conflict. These activities include such functions as command and control, communications, navigation, environmental monitoring, warning, surveillance and space defense.

Soviet development of an operational anti-satellite (ASAT) capability presents the potential for space to become a hostile environment. Therefore, the DoD Space Policy directs that military space systems, including all essential ground elements as well as orbiting spacecraft, be designed, developed and operated to enhance the survivability and endurance of critical mission functions.

Within such limits imposed by international law, the DoD Space Policy directs the continued development of an operational anti-satellite (ASAT) capability. The purpose of the ASAT capability is to deter threats to space systems of the United States and its allies, and threats from space systems supporting hostile military forces.

DoD planning emphasizes continued adherence to the existing international legal regime which pertains to space. The DoD Space Policy also provides guidance to the Department to consider verifiable and equitable arms control measures that would ban or otherwise limit the deployment of specific weapons systems should those measures be compatible with United States national security.

The Department of Defense conducts research and planning efforts to support the national security interests of the United States by developing those military capabilities required to respond to threats to the national security. The DoD Space Policy contains no new directions in space weaponry, but provides for continued research and planning.

Space launch is critical to any space capability. The DoD Space Policy, therefore, requires the availability of an adequate launch capability to provide flexible and responsive access to space to meet national security requirements. In so doing, the DoD Space Policy recognizes the Shuttle as the primary space launch system and the need for the DoD to continue to cooperate with NASA efforts to develop a fully operational Space Transportation System.

The relationship between the DoD and NASA, as specified in the current DoD-NASA Memorandum of Understanding, will continue to be the basis for the management and operation of the Space Transportation System. In accordance with this memorandum, DoD will plan and conduct all activities necessary to control and manage national security Shuttle missions.

Background

In August 1981, the Secretary of Defense directed the Under Secretary of Defense for Policy (Dr. Fred Ikle), to take the lead in conducting a study to review the military use of space. The study was prepared in collaboration with the Under Secretary of Defense for Research and Engineering (Dr. Richard DeLauer) and the Chairman of the Joint Chiefs of Staff (then Gen David C. Jones), with the involvement and participation of all the Military Departments. The study was to formulate a space policy for the Department of Defense that would guide all future space-related activities of the Department.

In formulating the DoD Space Policy, the study gave comprehensive consideration to the National Space Policy being drafted concurrently, and to Soviet space activities, US and foreign civil space activities, US law and policy, international law impacting the use of outer space, applicable technology opportunities, and military missions able to be performed by space systems. Careful review of these areas resulted in a DoD space policy that, consistent with technological and budgetary practicalities, will guide the US military in space-related approaches to meeting our national security obligations.

Defense Dept. Backs Space-Based

Weinberger endorses a U.S. space-based defense system against ICBMs; requests rapid pursuit of new technology

By Clarence A. Robinson, Jr.

Washington—Defense Secretary Caspar W. Weinberger has endorsed a U.S. space-based ballistic missile defense system for protection against intercontinental ballistic missiles. The system would be designed to intercept hostile nuclear-armed ballistic missiles prior to mid-course trajectory.

The secretary met with Sen. Malcolm Wallop (R.-Wyo.) and Defense Dept. officials earlier this month (AW&ST Sept. 20, p. 15). Weinberger said he had directed the department to pursue the technology for a space-based defense as rapidly as possible.

Meeting Participants

Richard D. DeLauer, under secretary of Defense for research and engineering; Fred C. Ikle, under secretary for policy; H. Alan Pike, acting director, directed energy office, Defense Advanced Research Projects Agency, and Senate staff member Angelo Codevilla attended the Weinberger-Wallop meeting planned to discuss directed energy weapons development with emphasis on the chemical mid-infrared laser, the most near-term application of the technology.

DeLauer said the Defense Dept. is pursuing a dual track approach to develop the chemical laser system embodied in the DARPA triad program to develop and test the technology for the three major components and to develop short wavelength laser technology.

Chemical Laser

The chemical laser device, according to DeLauer, will initially operate at approximately 5 megawatts but would be scalable to approximately 10 megawatts. The under secretary added that the pointing and tracking accuracy technology is understood.

That is the Lockheed Talon Gold element of the triad program. The company also is developing the primary mirror system under the large optics demonstration experiment (Lode). The laser device, known as Alpha, is being developed under contract by TRW.

Wallop said last week he is impressed with Weinberger's position on active defense, "and I was impressed with his questions concerning space-based lasers. He asked all of the right questions, the ones you would hope that a Defense secretary would ask."

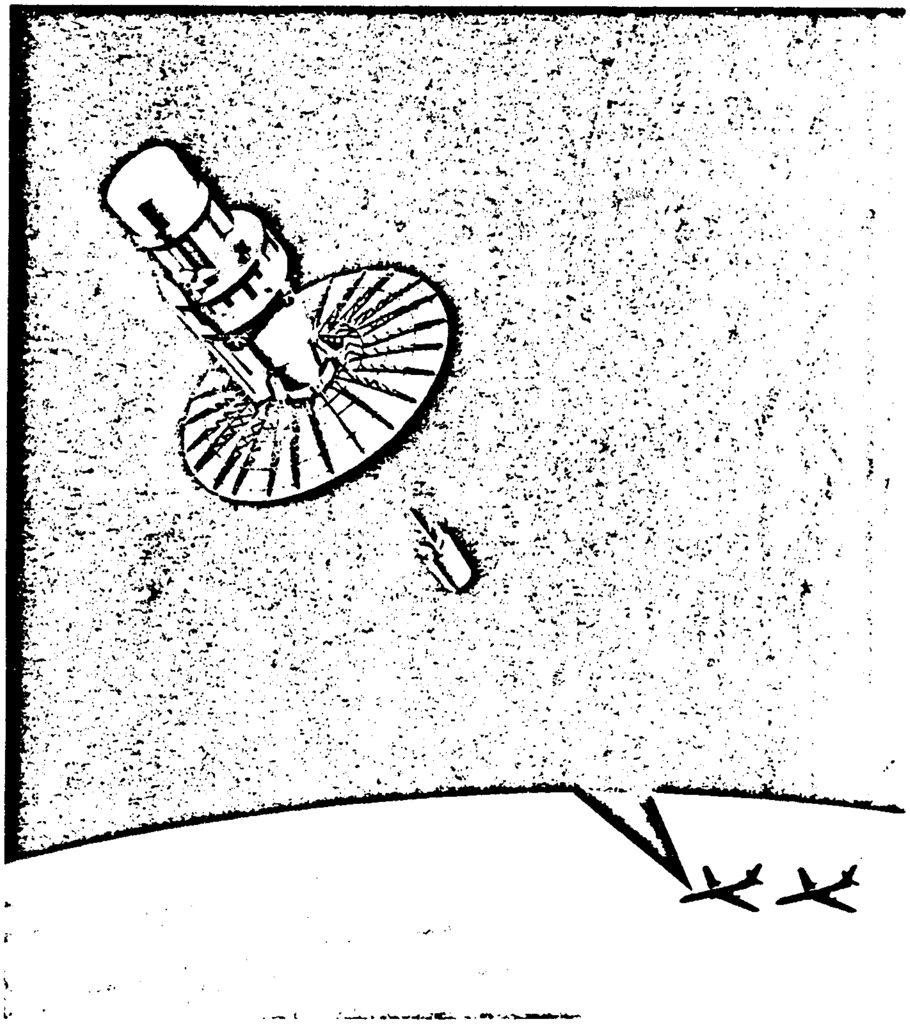
Pike provided technical information on the Defense Dept.'s laser technology programs, "and no one in the room challenged what he said ... that the technology capability separately exists for a chemical laser system, and that in each case the technology in each area has exceeded the original design requirements," Wallop said. "The elements of a space-based laser system could be integrated into a system that would work in space in some fashion."

Pike did not state that the components would work 100% as demanded, but again no one in the meeting countered, challenged or corrected this assessment, according to Wallop.

"In response to a question from Weinberger, Pike explained that a space-based chemical laser would be a rugged, survivable platform capable of self-defense against attacks," the senator added.

"The Defense secretary clearly showed from his questions and statements that he is seeking to resolve the strategic nuclear weapons predicament for the nation vis-a-vis the Soviet Union," Wallop continued. Weinberger also showed that while it is essential to modernize strategic offensive forces, in the longer term, the strategic needs of the nation will require a shift from offensive to a defensive strategy, "and therefore to building a space-based antimissile weapons system," Wallop said.

"By his insightful questions on the technology of chemical laser development, and the articulation of the strategy on the defense he plans to implement, Weinberger showed that his statements are not rhetoric, rather that he is trying to understand



Design of a 10-megawatt, 10-meter-dia. space-based chemical high energy laser system is depicted in an artist's concept (above left) by Lockheed Missiles & Space Co. The laser device is mounted directly behind the primary mirror for the beam control/director system. Note the segmented mirror with actuators on the reverse side of the mirror to control wavefront adaptive optics. The system is the problems involved in building space-based laser weapons stations."

Weinberger stated the Defense Dept.'s commitment to deploying space-based defensive systems as quickly as possible, according to those at the session. The senator also stressed that he is not seeking to press for development of chemical lasers at the expense of other laser technology, and that he supports all of the laser development programs.

Wallop said there is no argument that the U. S. could deploy within the next five years a 5-megawatt, 4-meter-dia. chemical laser weapon in space that is capable of defeating the current inventory of Soviet weapons systems—ballistic missiles, hostile spacecraft and bombers at high altitude.

He added that Weinberger was told by his advisers that there is no longer any controversy that the capability exists to build a 10-megawatt laser with a 10-meter-dia. beam director that could be used to overcome Soviet targets, including those equipped with countermeasures or hardened against laser radiation.

The Pentagon assessment is that existing arsenals of Soviet strategic weapons are vulnerable to space laser weapons that are based on technology being developed in the current DARPA program.

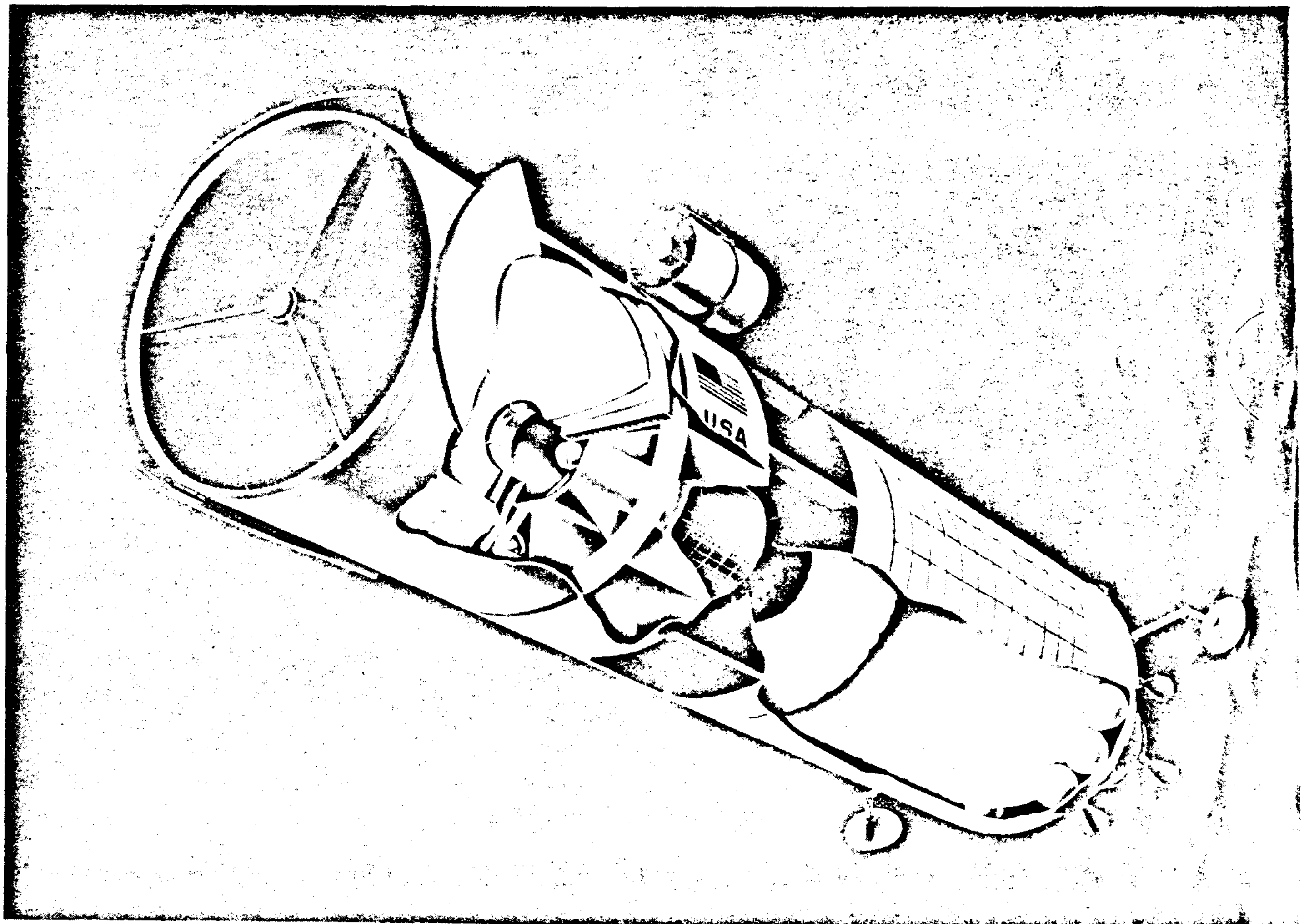
The assessment adds that deployment of a modest number at the 5-megawatt, 4-meter-dia. performance level would place at risk large numbers of ballistic missiles and aircraft in the Soviet inventory because of their approximately 1 kj./cm.^{2} vulnerability. Hostile weapons systems hardened to 10-20 kilojoules/cm.^{2} levels could be overcome by scaling to a 10-megawatt, 10-meter-dia. laser system.

Several aerospace companies are offering to accelerate feasibility demonstration of a space-based chemical laser system by conducting the program on a fixed-price contract. Wallop said Kodak has offered to provide mirrors for laser battle stations on that basis.

Lockheed Missiles & Space Co. is building a 65-cm. Lode mirror that can be used with visible lasers as well as with infrared devices, so that the technology applies to both medium and short wavelength devices.

The Lode program calls for the company, which also is building the Talon Gold pointing and tracking laser radar system, to develop the concept and design the beam control for a high-energy space laser system.

Lockheed, according to Defense Dept. officials, is operating under a $20.7-million contract for the initial phase of the program to fabricate, test and demon-



shown engaging high-altitude aircraft targets. A conceptual design of a typical 5-megawatt, 4-meter-dia. high-energy laser device is depicted in a cutaway drawing revealing the primary mirror for beam control. The chemical tanks for laser power are at the right of the design, and the Talon Gold pointing and tracking system is mounted atop the cylindrical laser. The 5-megawatt laser device resembles the larger laser mounted aft of the 10-meter-dia. mirror (illustration above left). This 5-megawatt concept employs the technology components in the Defense Advanced Research Projects Agency triad program.

Bendix/Allied Merger Complicates Takeover

The takeover maneuvers involving Bendix, Martin Marietta and United Technologies became more complicated last week when Bendix agreed to merge into Allied Corp., formerly Allied Chemical Corp., to forestall its acquisition by Martin Marietta (AW&ST Sept. 20, p. 22). The acquisition fight was triggered last month by Bendix's initial effort to acquire Martin Marietta (AW&ST Sept. 6, p. 45).

The proposed Bendix merger with Allied was announced Sept. 22, hours before Martin Marietta began to buy previously tendered shares of Bendix stock. The next day, Martin Marietta said it had bought 44% of the potentially outstanding Bendix shares and would seek to buy more to give it clear majority control.

But following Martin Marietta's disclosure that it had acquired 44% of the Bendix shares, Allied said it will delay its attempt to buy Bendix stock.

Earlier last week Bendix said it had purchased more than 70 of Martin's shares.

Bendix was unable to call a special Martin Marietta stockholders' meeting to take control for 30 days because of a change in Martin's bylaws made on Sept. 16. Bendix last week twice delayed its own special stockholders meeting called to seek changes in its own charter to delay Martin Marietta from taking control if it obtained more than 50% of Bendix shares.

The Allied Corp. offer for a majority of Bendix shares is $85 a share, with a securities swap for the balance estimated to be worth approximately $75 a share. Earlier, United Technologies had raised its per-share cash offer from $75 to $85 for Bendix, while the current Martin Marietta offering price is $75 a share.

strate critical beam control technology in a ground-based experiment. The DARPA contract is being managed by the Air Force Weapons Laboratory as the agent.

The work on this element of the triad program began in August and is scheduled to be completed by November, 1984. Competing contractors were told to design the Lode technology program to cost approximately $60 million and to resolve beam control issues. Lockheed was selected in June, the Pentagon officials said.

The company will design in the second phase of the Lode effort a 4-meter system with a maximum jitter of 0.2 microradians. The system is designed to compensate for wavefront errors in the laser beam. Critical design review will be in late 1984, when fabrication of the 4-meter beam director/expander and associated equipment is planned to begin.

Mirror Competition

The primary mirror for the Lode system, according to Defense Dept. officials, will be government-furnished equipment to Lockheed and will come from the large active mirror program (Lamp) with a competition now in progress between Perkin-Elmer and a team of Itek/Eastman Kodak. The competition is expected to end in February, 1983, with selection of a contractor.

The Lamp effort is aimed at providing a segmented, active primary mirror and is anticipated to cost between $30-50 million. Corning Glass Works will provide the ultra-low expansion glass for the mirror to the Lamp contractor.

Despite assurances by DARPA and Defense Dept. officials that the triad program is designed to provide adequate funding to complete demonstrations of the major components of a laser weapon system, the Talon Gold element with its laser radar, laser illuminator and passive infrared tracking system will now accomplish only visible tracking without infrared tracking. But the element will be used in the space-based test of the component system to track spacecraft and aircraft as well as ballistic missiles, Pentagon officials said.

They added that Lode is the key element that will pull together the Talon Gold and Alpha laser technology. Lode was reoriented last year and the technology is being upgraded to expand from a 5-megawatt, 4-meter-dia. system to a 10-megawatt, 10-meter-dia. system for engagement of ballistic missiles and aircraft as well as for antisatellite and satellite defense missions. The 5-megawatt, 4-meter-dia. system would be able to propagate a beam with 500 w./cm.^{2} out to a range in excess of 1,000 km. The submicroradian laser beam with active wavefront control would provide a beam brightness of 400×10^{16} w./steradian. This produces a beam with sufficient intensity to destroy a target with a dwell time of approximately 1 sec. at 1,000 km. That energy is 400 joules/cm.^{2} for a 1-sec. burn time on the target.

The Lode system is being designed to employ a phase control of the wavefront with adaptive optics—a system of actuators to warp the segmented beam control mirror to null out beam anomalies. Wavefront sensing will be employed to detect thermal distortions in the optical train. The system requires onboard computers and data processing to analyze and correct distortions by moving the actuators to solve the problem. The computational requirements are state of the art, Defense Dept. officials said.

The Defense Dept. officials added that the Lode system will be tested in the Lockheed 30 × 90-ft. vacuum chamber. Lode ties in closely with the Talon Gold pointer and tracker and the two must be boresighted so that the Talon Gold system points with the primary mirror with precise accuracy.

Lode Fabrication

The last two phases of the Lode program would cost approximately $57 million for fabrication and test. The Lode system has common features for both a 5- and 10-meter-dia. beam control system, and also could be used with shorter wavelength visible lasers.

The Alpha laser device element of the triad program is being limited now because of funding to 2-2.5 megawatts, even though it is scalable to 10 megawatts. The Alpha element has completed preliminary design review and is in detailed design review, working toward critical design review. Any plan to take the Alpha laser to above 5 megawatts is unfunded.

The Defense Dept. will require an integrated ground-based experiment of the total system before a space-based feasibility experiment. Under the program funding levels planned, that could not happen before 1990, according to Defense Dept. officials. With increased funding, the program could be accelerated by several years to accomplish a space-based demonstration. Using existing technology hardware—the Alpha laser device and the 2.4-meter mirror in the backup space telescope—a subscale feasibility demonstration could be carried out within several years, the officials said.

"There is no dispute that the technology is at hand to accomplish systems integration with a high-energy laser weapon, and there is no dispute that the technology can be scaled to levels adequate to be effective in multimission performance, and this was pointed out to Weinberger," an official who attended the meeting said. □

Laser Funding

Washington—The Defense Dept. has awarded high-energy laser contracts to three aerospace companies totaling approximately $20 million. The funding is to develop technology for a supersonic oxygen iodine chemical laser.

The oxygen iodine laser would operate at a shorter wavelength than the deuterium fluoride or hydrogen fluoride chemical lasers already in development.

These medium wavelength devices operate with hydrogen fluoride at 2.7 microns and deuterium fluoride at 3.8 microns. The oxygen iodine laser operates at 1.3 microns and will be a shorter wavelength chemically pumped laser.

The companies winning the laser development contracts are Rockwell International, TRW and Bell Aerospace Textron. The Air Force Weapons Laboratory, Kirtland AFB, N. M., will manage the contract.

In consonance with the Administration's conviction that space is emerging as a fourth medium for military operations of various kinds—co-equal with, and as important as land, sea, and air—the Air Force has announced the planned formation of a special . . .

SPACE COMMAND

SETTING THE COURSE FOR THE FUTURE

BY EDGAR ULSAMER, SENIOR EDITOR (POLICY & TECHNOLOGY)

ON June 21, 1982, the Air Force announced the planned formation of a special command broadly responsible for all military space activities. The new Space Command will be formed on September 1, 1982. Headquarters will be in Colorado Springs, Colo. Space Command will be built around the existing Aerospace Defense Center staff. According to then-Air Force Chief of Staff Gen. Lew Allen, Jr., Space Command is to become a unified command within about a year.

Creation of Space Command will consolidate USAF operational space activities, provide a link between the space-related research and development process and operational users, and retain North American Aerospace Defense Command authority and responsibilities as currently organized, according to General Allen. Approximately 200 manpower authorizations will be transferred from Offutt AFB, Neb., to Colorado Springs to augment space personnel in the Aerospace Defense Center.

In a separate but related action, the Air Force also announced a decision to create within Air Force Systems Command (AFSC) a Space Technology Center at Kirtland AFB, N. M., during the first half of FY '83.

Under the realignment, three AFSC laboratories—the Air Force Geophysics Laboratory (Hanscom AFB, Mass.), the Air Force Rocket Propulsion Laboratory (Edwards AFB, Calif.), and the Air Force Weapons Laboratory (Kirtland AFB, N. M.)—will report to the Space Technology Center Commander, under the AFSC Space Division Commander, rather than to the Director of Laboratories at Hq. AFSC, Andrews AFB, Md. The laboratories will remain at their present locations.

The new Center will focus on the major scientific disciplines for launch vehicle and spacecraft technology. It will emphasize space technology to develop qualitatively superior space systems as the Air Force moves into the twenty-first century.

Coordinating the Space Effort

Formation of the new command at this time is consonant with the Administration's—especially Secretary of the Air Force Verne Orr's—views that space is emerging as a fourth medium for military operations of various kinds, coequal with and as important as land, sea, and air. The decision to set up the new command clearly represents a logical extension of a series of recent actions by the White House, Congress, the Defense Department, and the Air Force that underscore the importance of a coordinated military space effort. Of special importance is the fact that the Air Force is to be designated as the DoD Executive Agent in space.

Other recent measures that helped set the stage for a dedicated space command include:

- Formation and coordination by DoD of a Space Operations Committee, chaired by the Secretary of the Air Force, to deal with all space operations issues within the Department of Defense.
- Elevation of CINCNORAD to a four-star level in line with his broadening responsibilities for space, missiles, and aircraft defense.
- Separation of the space and ballistic missile activities within the old

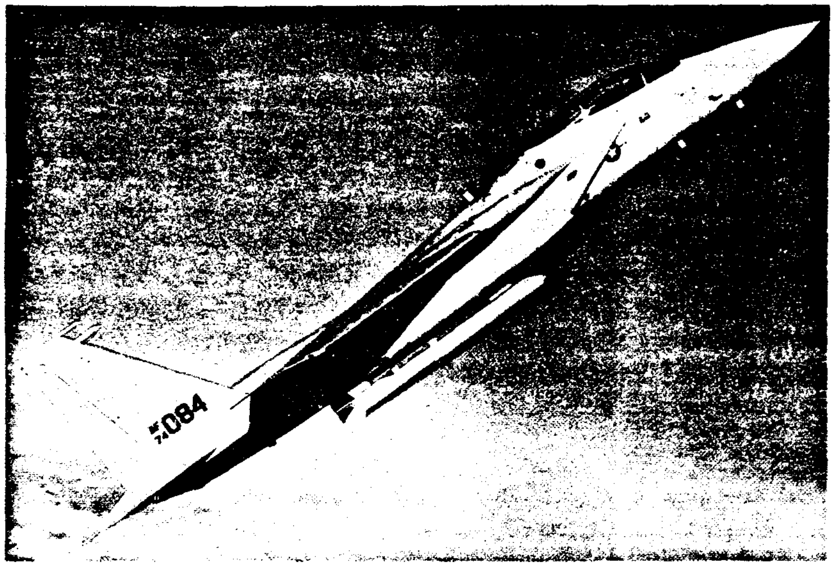
AND:

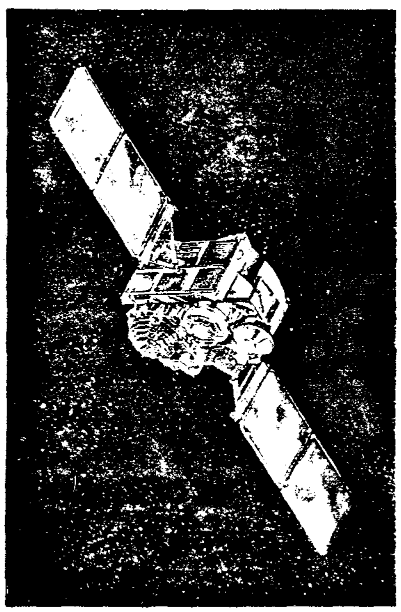
Space and Missile Systems Organization (SAMSO) and the formation of a separate Space Division.

• Establishment of a Deputy Commander for Space Operations within the new Space Division.

• Construction of an Air Force Consolidated Space Operations Center (CSOC) near the existing NORAD complex. This facility will bring together Air Force space and launch operations.

• Formation of a Directorate for Space Operations within the Office of the Deputy Chief of Staff/Plans and Operations to complement relevant R&D activities.





FAR LEFT: The Space Shuttle lifts off on its maiden flight.
ABOVE: An ASAT mated to an F-15 is shown in artist's conception.
LEFT: DSCS III will provide SHF satellite communications for worldwide command and control.

• Establishment of a General Officer Space Operations Steering Committee (SOSC) with responsibility for reviewing space policy, space operations, and space-related activities.

• Establishment of the Air Force Manned Space Flight Support Group at the Johnson Space Center to develop the expertise necessary to transition to the Shuttle and to serve as the initial cadre at the new CSOC facility.

• Establishment of a course in space operations at the Air Force Institute of Technology to train officers for future management roles in space.

• Providing NASA with a select group of Air Force people to serve as astronauts and formation of a joint program with NASA for training spaceflight engineers.

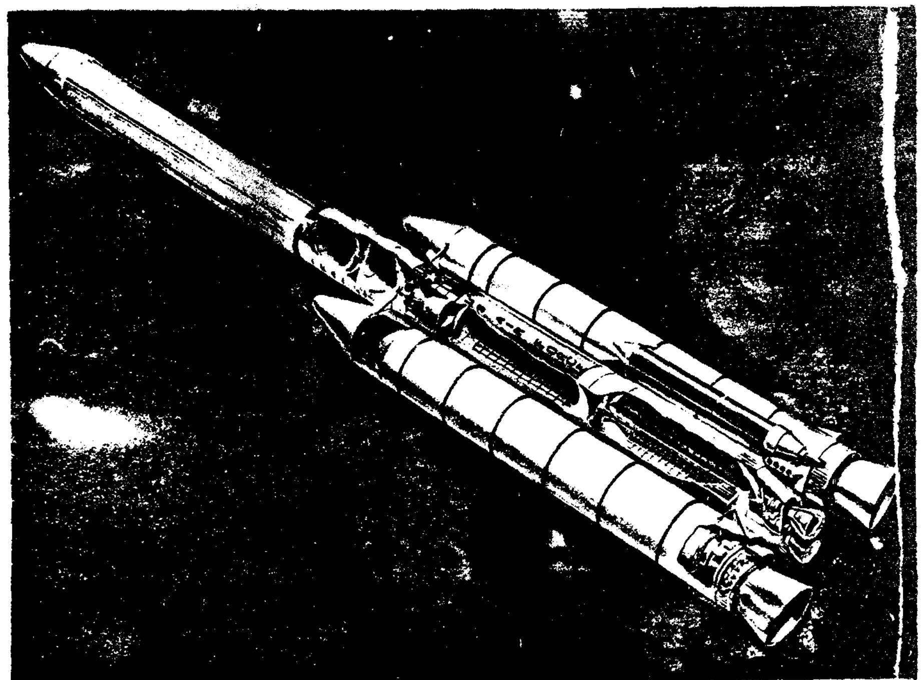
The Deputy Chief of Staff for Research, Development and Acquisition, (DCS/RD&A), Lt. Gen. Kelly Burke; Assistant DCS/RD&A Maj. Gen. Jasper Welch; and their special assistant, Col. Augie Caponecchi, in concert with other experts, recently completed a unique stem-to-stern analysis of the Air Force's changing role in space. The central conclusion is that space, in military terms, is big, important business, and getting more so.

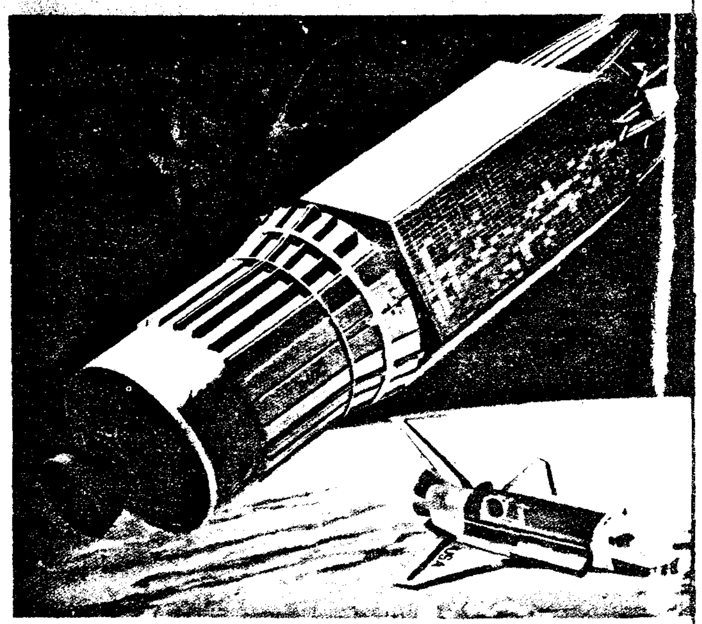
The Air Force currently spends more than $7.2 billion a year on space programs, or about nine percent of its total budget. Since the Air Force placed its first primitive satellite—known as SCORE for Signal Communications by Orbital Relay Equipment—into orbit on December 18, 1958, USAF's space budget has grown in real terms, on the average, by some seven percent a year.

As General Welch points out, the progress of the Air Force's space program over the intervening twenty-three years "has been truly outstanding." The latest DSCS (Defense Satellite Communications System) III spacecraft to be launched next month is a far cry from the heavy and clumsy SCORE "Sputnik catch-up" satellite that beamed President Eisenhower's prerecorded Christmas message around the world during its twelve-day life span.

DSCS III features 108 wideband transmission links, provides access to 132 ships and other terminal locations, offers 536 channels for mobile ground force use, as well as highly secure, jam-resistant communications for the strategic bomber forces. Moreover, this versatile satellite is highly resistant to the effects of nuclear detonations in space and has a calculated life span of at least ten years.

The evolution from short-lived experiments in space of marginal military value (phase I of USAF's space effort) to devices offering a high degree of utility (phase II) and finally to the current phase III that is marked by systems that not only are of pivotal, military importance, but are long-lived and highly efficient—and therefore offer levels of cost-effectiveness and operational economy unthinkable and unattainable previously—germinates a doctrinal revolution. As both the US and the USSR become dependent on space systems in a categoric sense for essential communications, surveillance, targeting, navigation, weather prediction, intelligence, verification, and warning functions, space, at least under wartime conditions, ceases to be a sanctuary.





ABOVE: Titan III 34D expendable boosters will remain in the inventory until the Shuttle achieves mature status. RIGHT: An Inertial Upper Stage (IUS) and its payload, NASA's Tracking and Data Relay Satellite, soon after they separate from the Space Shuttle Orbiter in low earth orbit.

Growth of Soviet Space Efforts

As the Air Force analysis brings out, the pervasive military importance of space is being exploited by the Soviets at a dizzying rate. The tempo of the Soviet military space effort denotes "aggressive expansion," entailing a program "significantly greater than that of the US," according to General Welch. Over the past ten years the Soviets have averaged more than seventy-five launches a year, or four to five times the number of US launches; moreover, they have placed an aggregate of 660,000 pounds into orbit, or about ten times what the US lofted into space during the same period.

Some seventy percent of all Soviet space activity is purely military, with an additional fifteen percent sharing a dual role with the nonmilitary sector—leaving only fifteen percent of their space activity as purely civil or scientific in nature.

The Soviets possess a range of booster systems and have the means to replenish or fortify their space assets on short notice. In addition, they maintain a massive overlapping and redundant ground control network.

Also, the Soviets have exhibited particular interest in manned systems. Their large Salyut-6 manned space station is in its fifth year of operation. They recently placed into orbit Salyut-7, which is apparently intended to replace or supplement Salyut-6 with a system resembling NASA's Skylab. Additionally, they have in development a new and more powerful launch vehicle, similar to NASA's Saturn V, that will have the capability of putting much larger manned space stations into orbit.

Perhaps most troubling has been the Soviet drive to steal a march on the US in the space weapons area. Although the US has no operational antisatellite capability, the Soviets have deployed and are repeatedly testing a space weapon, the ASAT, whose sole purpose is to deny this country use of space. There is evidence that they are deeply involved in the development and testing of an improved ASAT.

Lastly, the Soviets, since the 1950s, have devoted substantial resources to high technology developments applicable to directed energy weapons that could eventually prove to have high military value in space. As a result, the Soviets can be expected to score steady gains in the reliability, sophistication, and operational capability of their space systems and their space weapons.

Stepping Up the Technology Program

The US response to the growing Soviet space threat, the Air Staff analysis suggests, should center on technological advances, especially as they relate to the Space Transportation System, or "Shuttle," as well as other such high-payoff areas as Very Large Scale Integration (VLSI) circuitry. In anticipation of the Space Shuttle's seminal influence on military space utilization, the Air Force is already committed to the construction of a Consolidated Space Operations Center.

Scheduled to become operational in Colorado Springs, Colo., by 1986, CSOC will provide on-orbit command and control of satellites as well as operational control of the Shuttle. Linked to the Aerospace Defense Command's facilities in the Cheyenne Mountain complex, CSOC thus leads to a comprehensive and integrated operational space command and control capability. The prospect of longer lived satellites, an operationally mature Shuttle, the Vandenberg AFB launch facility, CSOC, and the opportunity for on-orbit service, repair, modification, and augmentation of satellites places the Air Force's approach to space in a state of evolution, according to the RD&A analysis.

The next logical step in this evolution could be a manned space station assembled in orbit. NASA is evaluating such a development, but so far has not been given specific commitments by the White House for budgetary reasons. In addition to providing a permanent human presence in space, such a station could serve both as a scientific laboratory and as a space operations facility for assembling, resupplying, and servicing satellites and for launching spacecraft to higher orbit, according to the Air Staff analysis.

Additionally, the Shuttle could be used during the construction phase to carry men and building materials into orbit and during the operational phase to reman and restock the station periodically.

In this context, General Welch suggests that "we as a nation should go ahead with procurement of the fifth Shuttle Orbiter and . . . we should study the possibility of a new, more capable Block II Shuttle." At the same time, given the critical importance of military space requirements, there appears to be a categoric need to back up the current Shuttle with Expendable Launch Vehicles until the Shuttle has matured into a "high-confidence" system. The Air Force, therefore, will continue to acquire some Titan III 34D and Atlas boosters, at least through 1984. In addition, there appears to be a clear requirement for special launch vehicles for limited contingency war missions, even after the Shuttle becomes fully operational. Key here is the reconstitution of critical space systems following hostile attacks, which would require rapid launch by survivably based boosters, possibly specially configured MX missiles.

Follow-on Upper Stage Vehicle

A second issue related to the Shuttle involves selection of a follow-on upper stage vehicle that can deliver payloads into high-energy orbits—such as required by a variety of defense and other national security spacecraft—after being placed in low earth orbit by the Shuttle.

The Air Force, as part of the Defense Department's contribution to the Space Transportation System, is building the Inertial Upper Stage (IUS) to meet DoD and NASA requirements. The Administration, after several reviews, has rejected sole source procurement of the Centaur in favor of competitive development of a Higher Energy Upper Stage (HEUS) as the follow-on to the IUS. The Congress, however, appears to be on the verge of directing the Administration to proceed with a "sole-source" program confined to Centaur.

The IUS, assuming normal evolutionary improvements, is expected to meet all foreseeable defense needs at least until the late 1980s. DoD, however, anticipates major growth in military spacecraft, primarily to meet increased survivability requirements, in the late 1980s and beyond. Although the Centaur has more than twice the payload lift capability of the IUS, it is not otherwise well suited for defense missions. The number and variety of USAF's missions place severe demands on the upper stage, and extensive modifications would be needed to make Centaur usable, according to General Welch. Further, all of the national security spacecraft are now configured for the IUS, and significant spacecraft modifications would be required to make them compatible with Centaur.

The bottom line, therefore, would be large hidden costs to DoD if congressional direction to have NASA build the Centaur is not reversed. These costs range between $400 million and $800 million for Centaur and DoD spacecraft modifications—over and above the NASA development costs for Centaur, according to the Air Staff analysis.

The Air Force, according to General Welch, has "what we consider to be a better plan—we prefer to proceed with the joint Air Force/NASA development of a new HEUS." The HEUS will be designed to meet both Air Force and NASA requirements, and timed to allow transition of national security spacecraft with minimum effect on cost and schedule. Further, General Welch pointed out, "we believe we can structure a program using preplanned product improvement [P^3I] concepts; this could enable the HEUS to grow logically to meet NASA Orbital Transfer Vehicle requirements and thus completely avoid a second major development program. We have already directed the Air Force Systems Command to begin concept work on the HEUS, and NASA is participating actively in that process."

Setting the Course for the Future

Aggressive Soviet space efforts, combined with widening technological opportunities in the area of space weaponry and space warfare, suggest that military contests in space are a real possibility. The concomitant problem confronting the Air Force is charting a course that steers its space program in a way that avoids the escalation of war into another medium for as long as possible, yet prepares for the inevitability—given the dynamics of technology and the lessons of military history—of weapons going into space. These divergent objectives obviously militate against the US tolerating for long dangerous asymmetries in space, epitomized by the troublesome and growing Soviet ASAT capabilities.

Yet there is concern in the Air Force, the Defense Department, and other agencies that the zest for correcting this dangerous deficiency might lead to an overreaction, especially if the Soviets succeed in putting a first generation laser weapon in space within the next five years. As General Welch warns, "such a weapon would have much greater political than military value. In fact, I would expect its military effectiveness to be marginal." The Soviets already have placed a laser system in orbit that US intelligence describes as a rangefinder system of less than startling competence.

The US, the Air Staff analysis points out, must not allow an impending Soviet space laser extravaganza to "dictate the pace of the course we have set for ourselves." As General Welch, who over the past two decades has been intimately involved with USAF's laser program, stresses, "I firmly believe we should proceed with prudent and measured speed down the general path we are on, meaning a balanced program consisting of near-term efforts directed at a more conventional ASAT vehicle to be launched from a high-speed fighter and longer term efforts on a range of other promising possibilities."

ASAT Flight Test Near

As he points out, the Air Force is firmly committed to develop, test, and deploy an air-launched ASAT capability. "The program was recently reviewed by both the Air Force and OSD and found to be in excellent health [and] received strong support," according to General Welch. Additional funding to reduce technical risks and to expand the flight test program has been included in this year's budget and should permit a first flight test of ASAT in the very near future.

In addition, the Air Force, the Defense Advanced Research Projects Agency (DARPA), and the Army have been working since September 1981 to develop a joint program to resolve known uncertainties associated with the feasibility and utility of space-based laser weapons.

But as the Air Staff analysis points out, "unfortunately, our efforts to date have resulted in a lack of unanimity within the technical community about the full capabilities of the space-based laser." It is imperative, therefore, that the risks and uncertainties be identified and resolved before a national commitment is made, in the Pentagon's view.

DARPA's triad of laser programs—currently in limbo because of congressional wrangling over whether long-wave length systems should be scrapped in favor of new, largely untried short-wave length approaches—is designed to do precisely that. The first program, ALPHA, consists of a large chemical laser development program. The second program is TALON GOLD, and consists of a laser acquisition, precision pointing, and tracking project. The third program is LODE—Large Optics Demonstration Experiment.

The current turmoil over the direction, feasibility, and utility of space-based laser weapons has triggered significant organizational adjustments to focus management attention on DoD space technology development. Under Secretary of Defense for Research and Engineering Richard D. DeLauer has designated Dr. Robert S. Cooper, Acting Assistant Secretary of Defense for Research and Technology and the new Director of DARPA, as the focal point for space activity within the DoD R&D community. Further, Maj. Gen. Donald Lamberson, USAF, who has years of unique experience in directing high energy laser technology, was recently named Assistant for Directed Energy Programs and reports directly to Dr. Cooper. Finally, the Air Force established a space laser program management office at AFSC's Space Division in Los Angeles, Calif.

The Air Staff analysis concludes that, in the laser weapons program, "we are making progress and our current funding levels are about right. We simply must not allow ourselves to be hurried as we enter the technology confirmation period confronting us."

Survivability and Endurance

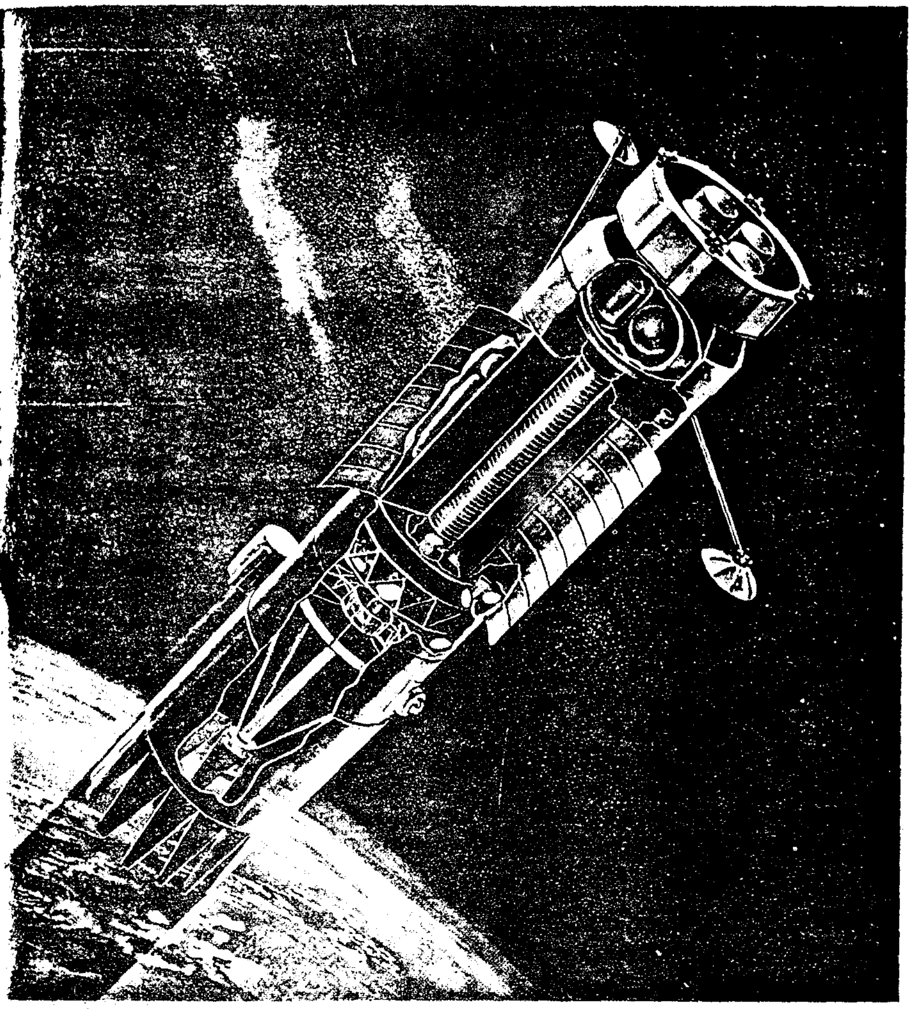
Another cardinal requirement that is related to ASAT centers on the survivability and endurance of space-related assets. As military dependence on these systems continues to grow, so do concerns over their survivability and endurance.

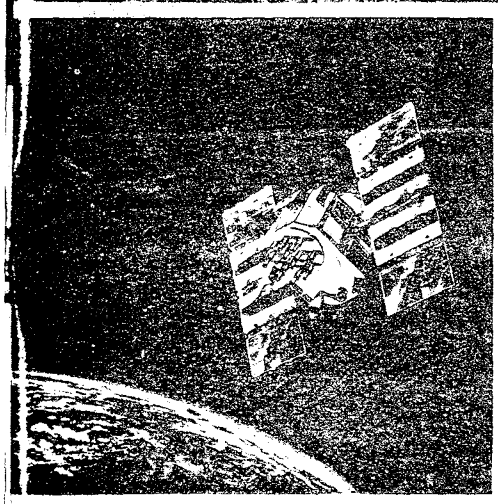
Space systems generally consist of three principal elements: ground control and terminal facilities, a launcher replenishment component, and the satellites themselves. Theoretically, a determined foe could destroy single components within an element of a particular space-based system in a rather straightforward manner, just as any individual tank, ship, or aircraft could be destroyed if sufficient resources are applied.

Conversely, when the problem is looked at comprehensively, it becomes clear that the complexity of trying to reduce or eliminate the performance of an entire space system—which very likely includes at least minimal survivability measures, multiple satellites on orbit, and inherent component redundancies—is enormous. As a corollary, putting a modern space-based system out of commission, at the very least, appears to be extremely costly, difficult, and would take a lot of time to accomplish. The latter trait would provide a considerable amount of valuable warning information for the defender to initiate appropriate recovery or retaliatory measures.

As a result, General Welch suggests that "our systems as they exist today are survivable, but future systems can and should be made even more survivable on a selective basis." With space systems' survivability and enhanced surveillance and command capabilities singled out as key elements in the Administration's strategic modernization program, the Air Force is devoting some eighteen percent of the FY '83 space hardware budget for survivability; this is scheduled to increase to thirty percent by 1987.

Planned new capabilities, in addition to the DSCS III improved communications system, include: The Navstar Global Positioning System (GPS), which offers significantly enhanced navigation and weapon system targeting capabilities; IONDS (Integrated Operational NUDET





ABOVE: Artist's conception of space-based laser system, currently under study for technical feasibility and military utility. LEFT: Navstar provides accurate positioning and velocity information.

Detection System), which makes it possible to pinpoint the location of nuclear weapon explosions; and MILSTAR, which enhances communications capability in a nuclear environment while reducing susceptibility to jamming. Finally, the Air Force is improving the responsiveness of the space system command and control network by removing critical single nodes, procuring back-up satellites, providing mobile ground terminals, and reducing dependence on overseas ground stations.

The central element of USAF's efforts in this area, according to the Air Staff analysis, "is to develop space systems and a support structure that are reliable and efficient in peacetime and are more survivable in conflict, thus increasing the confidence of our operational commanders in their continued availability and permitting them to place greater reliance on their use."

The Defense Department and the Air Force, in concert with a government-wide review of America's space policy under the aegis of the White House Office of Science and Technology Policy, are drafting a coherent guide for the future military use of space. Of obvious and overriding importance to the Pentagon are the criteria for acquiring and operating the launch vehicles required to ensure reliable access to space, as well as the doctrines and means for maintaining free access to space over the long pull.

The Air Force's short-term goals that ensue from this postulate, as the Air Staff analysis spells out, are fairly clear cut: "First, we recognize that change is inevitable due to the military and economic advantages of space surveillance, communication, and navigation, and that therefore we need to expand our military capabilities in space.

"Second, we believe it is imperative that the US have confident and free access to space in order to exploit its unique military potential.

"Third, we consider it essential that we pursue a vigorous R&D program to ensure the availability of adequate options to ensure our ability to meet our inherent right of self-defense. That is, we must posture ourselves to assure continued and full access to space in the interests of national security."

The outlook over the longer term, by contrast, is hazy owing to various imponderable factors. Fundamental are the pace of technological progress, the nature and capacity of future launch vehicles, the survivability of military space-related assets, and the control and use of national space assets—military and civilian—in time of crisis.

As the Air Force stands at the crossroads of formulating its doctrinal and organizational approach to the high ground of space over the decades ahead, it is fitting to evoke Theodore von Kármán's sage recommendation to General "Hap" Arnold in 1944:

"The men in charge of the future Air Force should always remember that problems never have final or universal solutions, and only a constant inquisitive attitude toward science and a ceaseless and swift adaptation to new developments can maintain the security of this nation. . . ."

The Air Force's formation of a space command would seem to fit this prescription acutely. ■

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Bonnie Mangan
Science Bibliographer
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