Killer satellites

Farooq Hussain traces the history of the Soviet and US development of killer satellites

MILITARY operations depend heavily on satellites for intelligence gathering, navigation, weather information, command, control and communication. So their vulnerability to interference or destruction is a serious and legitimate concern of military planners. Satellites are delicate devices. To make one ineffective, it is necessary only to impair the performance of its sensitive equipment: its total destruction is unnecessary. As to means, radiation directed against a satellite can cause damage at much longer ranges than the effects of blast and flying debris from an explosion in the near-vacuum of space where shock waves have little effect. Nuclear warheads would be very effective against satellites—because of their lethal radiation. But the effects of nuclear anti-satellite weapons would be indiscriminate and would more than likely result in the destruction of friendly satellites as well as enemy ones. Killer satellites exploit the poor resistance of satellite components—particularly solar cells—to intense heating and radiation damage. High energy lasers can be easily directed at satellites, so their imagined use in killer satellites is extensive. Another possibility arises from the tendency satellites have to build up high electrostatic charges due to the higher electron density around the dark side of the planet. The use of ion beams directed at target satellites can cause arcing and discharge through the instrumentation either destroying or seriously damaging it. Precision guided missiles also offer the possibility of destroying satellites either by collision or by the use of a conventional warhead detonated close to the target.

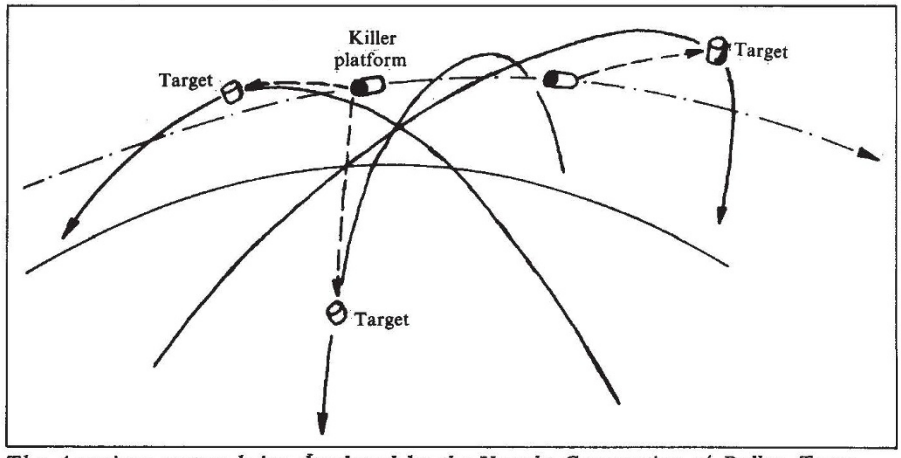
The United States and the Soviet Union have signed separate treaties in 1963 and 1967 first prohibiting testing and then deployment of nuclear weapons in space. But since 1968 the Soviet Union has been conducting tests within the general Cosmos series of satellites and these have been widely interpreted by western observers as an anti-satellite development programme. In these tests an orbiting interceptor is manoeuvred so as to make one or more close passes by a target satellite. Out of the 27 such Cosmos launches that have taken place to date only seven have ended with the explosion of the interceptor and these explosions have not always been in the general vicinity of the target satellite. The latest test in which the interceptor exploded in orbit occurred in December 1977. Other tests have taken place which have suggested that new manoeuvring techniques have been adopted for the interceptor satellites.

American concern over this satellite programme has arisen because of the sudden resumption of testing after a lapse of four years, and the accelerated rate at which testing has been taking place. One explanation for the Soviet tests is the development of reconaissance satellites by China. Soviet testing of the Cosmos series appears to have followed Chinese reconaissance satellite development since 1970. In addition the orbits followed by the Cosmos series seem more appropriate to interception of Chinese satellites than American ones.

American test

The only American test of an anti-satellite system took place in 1963 when a modified McDonnell Douglas Thor missile was fired against a missile booster in low earth orbit as the target. The Thor missile was brought within the range of the target for a simulated nuclear kill but the programme was dropped following the treaties banning nuclear weapons testing and weapons deployment in space. In a follow-on project the Vought Corporation built four infra-red homing guided missiles for use with conventional warheads. These missiles were to have been launched against satellites by a booster in a direct ascent trajectory towards the target without completing an orbit of the earth. Since the missiles were to have been armed with conventional warheads they needed a much smaller kill radius than for nuclear warheads and hence greater accuracy in guidance. But the first test launch suffered a booster failure and the second a mechanical malfunction in deploying the payload. The programme was finally abandoned because of anticipated difficulties in getting the interceptor close enough to the target for conventional warheads to be effective.

Recent advances in the available energy, frequency range, and compactness of military lasers have prompted ideas that killer satellites may be able to carry high energy continuous wave or pulsed lasers to destroy target satellites. Ground-based lasers have been in use for a few years to interrogate reconaissance satellites. The laser beam is used to illuminate the satellite, and the spectral pattern of the reflected laser radiation can be used to interpret various characteristics of the target. Using this technique it has been possible to determine the kind of equipment on the satellite and its sensitivity. Rumours that the Soviet use of lasers in this manner had temporarily blinded an American reconaissance satellite last year were persistent in spite of official US Department of Defense denials. However general concern within the US Department of Defense and Congress has resulted in substantial increases in the American space defence budget. $61 million was authorised for FY 1977 with $126 million requested for FY 1978 and an estimated $265 million being requested for FY 1979.



The American system being developed by the Vought Corporation of Dallas, Texas

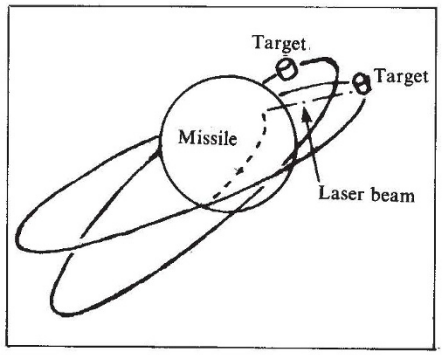
In September the United States Air Force announced the award of a $58.7 million contract to the Vought Corporation of Dallas, Texas for the development of a killer satellite. The project developed out of a competition begun in 1975 between General Dynamics/Pomona and Vought to produce an unarmed miniature homing missile designed to destroy satellites by force of impact on collision. The

missile, about twenty centimetres in diameter and thirty centimetres long, is guided either by active radar or by far-infra-red seekers. Infra-red has special advantages because satellites give distinct thermal 'fingerprints'. More than ten homing missiles are carried into orbit by a highly manoeuvrable platform whose orbit is directed so as to provide the opportunity to fire missiles at the maximum number of target satellites within a minimum number of orbits. Free-fall tests of the infra-red guidance system have demonstrated mid-air activation, target acquisition and guidance to impact with a target. Electronic countermeasures against infra-red seekers (which are passive detectors, emitting no signal of their own) are more difficult than for active radar; and it is difficult for satellites to make rapid evasive manoeuvres in orbit. A similar system involving missiles armed with conventional warheads has also been under investigation.

Interpreting Soviet tests

By comparison, Soviet tests have only obliquely suggested a preference for destruction by large explosions in the vicinity of the target satellite. Since Soviet tests have never resulted in the physical destruction of a target, the explosion of the interceptor could be explained as a test of the vulnerability of the target to attack—rather than demonstrating the potential of the interceptor to destroy target satellites. The difficulty in interpreting properly the explosions in the Cosmos series also lends support to the idea that Soviet killer satellites may soon carry laser or ion-beam weapons. In any case the Soviet and American hunter–killer satellite developments should not be directly compared because each Super Power has very different approaches to the development of major weapon systems.

Presently US space defence research is concentrated upon problems of hardening satellites against attack and increasing the resistance of communication, command, and control transmissions to jamming. These battlefield transmissions now rely almost completely on satellites. The third generation of American military communications satellites now being developed employ a technique of using multiple directional beams for transmission, and of shifting frequencies in the ultra and super high frequency bands (7 to 8 GHz) to avoid the effects of jamming. Satellite antennae are being developed that use electronic counter-measures to eliminate the effect of a directional jamming beam fixed on the satellite. Solar cells are being designed and built to withstand the effects of intense heating and radiation, by using filter coatings which do not absorb energy at typical laser wavelengths, and by using construction techniques with materials with high resistance to heat and radiation damage. The vulnerability of solar cells has led to an increased interest in nuclear power sources for satellites which until now have always had the disadvantage of being much heavier and considerably more costly to operate. Three designs are currently under consideration all of which use P^{236} isotopes as the power source. With the considerable improvements in performance that are being achieved for satellites military dependence on them can be expected to increase throughout the 1970s and early 1980s. During the first half of the 1970s military missions accounted for about half of the American satellite launches and both the number of military satellites and their relative size and payload will increase further as the NASA Space Shuttle begins operation.



The Soviet system can only knock out one satellite at a time making it ineffective against the US global positioning array of 36 satellites

The development of killer satellites is unlikely to provide any significant strategic advantage for either Super Power and the race to develop them is likely to be very costly. A surprise attack is hard to achieve with killer satellites because the preliminary manoeuvres are easily detected by other satellites. It is also possible to place in distant orbits satellites which are ready to replace ones destroyed by an attack. These so-called 'dark' satellites have characteristics such as very small radar cross-sections and low reflectivity which make them very difficult to detect and track. Because of their distant orbits they are relatively safe from attack in the first instance. The real advantage of destroying military satellites in a strategic nuclear conflict would appear only if one side destroyed a significant number of the opponent's satellites while retaining its own. A rapid destruction of all satellites would yield no advantage to either side.

It is perhaps to avoid a costly arms race that both the Soviet Union and the United States are anxious to reach an agreement limiting the development of killer satellites. The United States was reported to have requested Soviet consideration of such an agreement last March. The Soviet response was favourable and the United States National Security Council are presently considering a formal policy based on reports by various departmental agencies on the implications and verification problems of a hunter–killer satellite limitation or ban. The intention is to provide for an agreement separate to SALT and talks on a possible agreement over limiting killer satellite development may begin this Spring. Meanwhile US Defense Department officials are concerned that present programmes should not be effected by the agreement and it is unlikely that the incentive given to US space defence research by the recent Soviet testing of the Cosmos satellites will be abated by a limitation—unless the form of the agreement is radically different to those which have been made in other areas of strategic arms control. □

1979 looks like a good year for US science

CLIMATOLOGY, reproductive and developmental biology, and military-related basic research are three areas of science likely to receive a major boost from President Carter's Budget for the fiscal year 1979, which was submitted to Congress on Monday.

Other areas to benefit from a budget that proposes an overall increase of 10.9%—about 5% above expected inflation levels—for basic science include solar studies, which is given the green light for two major projects, and earthquake research. Potential casualties include one of the five planned space shuttles, and the Clinch River liquid metal fast breeder reactor demonstration project. The proposed termination of the Clinch River project would save about $150 million, and would result in virtually no increase in the energy research and development budget overall.

In general, the budget carries an optimistic message for basic science, in line with the results of a broad-ranging survey of the nation's resarch activities carried out at the President's request by the Office of Science and Technology Policy (OSTP). The projected