MILITARIZATION OF SPACE IMPLICATIONS FOR THE THIRD WORLD

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<u>CONTENTS</u>

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For errors, which still remain, I remain solely responsible.

Rani Shastri
4/1/89.

INTRODUCTION

With the launch of the Soviet Sputnik in October 1957 the search for the "new high ground" had begun. The military implications of space systems had in fact been speculated upon in the mid-1940s long before artificial earth satellites became a conceptual reality. The sixties and seventies witnessed a hectic build-up of artificial earth satellites by both the super powers to serve a variety of ends including photographic reconnaissance, electronic intelligence gathering, military communications, geodesy, etc. The array of uses to which artificial earth satellites have been put serve to negate the myth that outer space can in fact be used for peaceful purposes alone. As will be brought out in the course of this dissertation, it is impossible to differentiate between "peaceful" and "military" space systems. Therefore, while it may be rational to call for the de-weaponization of outer space, demilitarization is not a viable goal for advocates of disarmament in outer space.

The first three decades of military space presence was limited to 'passive' military systems in space, viz. those which did not play a directly offensive role in military conflict though they were extremely important in the military support structure such as C^3I (Command, Control and Communication Intelligence). President Ronald Reagan's March 1983 "Star Wars" speech injected a new element into the space militarization debate, viz. its weaponization. SDI (Strategic Defense Initiative) implied a ~~te~~ transition from passive to active military space systems with profound implications for arms control, nuclear deterrence and even economic/technological development.

This study is divided into four chapters including one concluding chapter. Chapter I deals with the historical development of military space technology with special reference to the super powers.The military space programmes of the US and the USSR are taken up in detail along with the motivations for military space presence. The impact of these systems on conventional and nuclear command and control is also analysed. At another level this Chapter studies the development of ASAT (Anti Satellite) weapons by the super powers and the impact of an ASAT arms race by the two sides.

The transition from 'passive' to 'active' military space systems is taken up in Chapter II. The technical aspects of the US SDI programme are studied in detail. Laser, Particle Beam and Kinetic Energy Weapon technologies have been taken up for analysis. It is felt that unless the technological aspects and viability of different ABM technologies is not understood a strategic analyses of SDI is not in order.

Chapter III deals with legal implications of the militarization of space. In particular the SDI Early Deployment issue has been analysed in the context of the ABM treaty. The debate over the broad interpretation of the ABM treaty is viewed primarily as an attempt to reconcile the treaty with Phase I deployment -- a tactic designed to keep the SDI programme alive after President Reagan's departure from the oval office in January 1989.

Chapter IV,also a concluding chapter, studies the implications of the militarization of outer space for the third world. The Missile Technology Control Regime instituted by seven Western industrialised nations recently is viewed primarily as an attempt to control the spread of civilian/ military space technology to the third world. In this context the development of space launch/missile systems by third world nations has also been analysed since the technological overlap. It has been argued that while attempts may be made by the major powers to control the spread of space technology to third world nations, military space systems are destined play an extremely important role in any future conflict and therefore the development of indigenous military space systems by third world nations that have the capability is a reality which cannot be ignored if they (these nations) wish to retain strategic independence and play a more assertive role in the international arena.

C H A P T E R - I

HISTORICAL DEVELOPMENT OF SPACE TECHNOLOGY

A CASE STUDY OF THE SUPER POWERS

(a) US in Space:

This section would take up the factors both internal and external which shaped the U.S. space programme from its inception. The evolution of American policy and doctrines towards the utilisation of space for military, quasi-military and/or peaceful purposes would be reviewed. With outer space promising to become the "battle-field of the future"[1] and U.S. policy playing a major role in accelerating that process, it is imperative to examine in detail the direction in which the American space effort has been evolving over the past few decades.

Most space-going nations refuse to acknowledge the fact that their primary goal in the exploitation of outer space is military. Nevertheless the indisputable fact remains that both the super powers have geared their space efforts primarily towards military purposes. For instance, the overwhelming majority of military satellites launched by the U.S., the USSR and China are for military purposes. Forty per cent of all satellites are military reconnaissance satellites.

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1. Title of a book, SIPRI, Outer Space Battlefield of the Future (Taylor and Francis, London, 1978).

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The technology involved in the few civilian satellites in orbit is such that it has "dual-use" capability. The French Spot earth resources satellite and the U.S. Landsat are two such examples. The Spot satellite in March this year published photographs of sensitive Soviet military facilities. Consequently, it could safely be concluded that almost all space activity has military connotations.

The US is one nation which acknowledges the military nature of its space programme. It also admits the fact that its primary interest in the exploitation of outer space is military. The National Aeronautics and Space Administration (NASA) is the apex body in charge of coordinating civilian space activity. NASA works closely with the U.S. Department of Defence (DoD) in formulating its space policy. The US Air Force has penetrated NASA management to a very large extent. Before NASA was established in 1958, space research and development was carried out mainly by the USAF. As a result many NASA technicians, administrators and scientists were recruited from the Air Force. NASA, therefore, is by no means a purely civilian agency as is often claimed.

The Kennedy and Johnson administrations regarded American pride and prestige as the motives for American

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space research. What cannot be forgotten, however, is that during these cold war years pride and prestige was essentially a derivative of power, particularly military power. Thus, while successive U.S. administratio s have cloaked the goals of the American space effort in varying degrees of idealistic jargon, the prime driving force has always been perceptions of national security.[2]

The Origin

The American space effort originated then with national security as its primary goal. A Rand Corporation study made public in 1946 states that the:

> ".... military importance of establishing vehicles in satellite orbits arises largely from the circumstances that defences against air arms attack are rapidly improving.... air offensive of the future would be carried out largely or altogether by high speed missiles... A satellite offers an observation aircraft (sic) which cannot be brought down by an enemy who has not mastered similar techniques".[3]

The report thus predicted accurately that future missions in outer space would involve ballistic missiles and satellite reconnaissance.

2. William H.Schaner, The Politics of Space (Holms and Mier, New Yerk, 1976). p.22.

3. Cited in Paul B.Stares, Space Weapons and US Strategy (Croom Helm, London, 1985), p.26.

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German scientist Werner von Braun in an interview in 1945 stated that "the whole of the Earth's surface could be observed from such a rocket (in Earth orbit). The crew could be equipped with very powerful telescopes and be able to observe even small objects such as ships, icebergs, troop movements, etc....".[4]

The US military space programme was in fact an extension of the German rocket programme. When the Soviets occupied Peneemunde, the centre of German rocket research, most scientists had left. In fact, about 150 such rocket scientists surrendered to the Americans under what was known as "Operation Paperclip". These German scientists made valuable contributions to the American space effort.

U.S.Space efforts in the early years thus involved both military and civilian programmes. The 1946 Rand report was buttressed by another report from Rand in 1950, which consisted of definitive recommendations to the USAF to conduct research in satellite reconnaissance. This report received a favourable response at the Pentagon and generated USA's first military reconnaissance satellite programme. The Pentagon had realised the growing importance of better strategic

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4. Cited in Paul B.Stares, Space Weapons and US Strategy (Croom Helm, London, 1984) p. 24.

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intelligence. The ballistic missile programme had also gathered momentum and America's first satellite launch vehicle was not too distant. While it was attempted in the mid-fifties to integrate the satellite and ballistic missile programmes this met with some resistance. Advocates of ICBMs and IRBMs were worried that satellite launch priorities would affect the design of the rocket boosters.

The American space effort - both the ballistic missile and reconnaissance satelliteprogramme — predated the launch of the Sputnik in 1957. Many in the space community attribute this event as the sole driving force behind the American military space effort. While the Sputnik launch may have resulted in an acceleration of American efforts to launch reconnaissance satellites and ballistic missiles it is evident that the intent to develop military space systems and ballistic missiles and the necessary research had been going on for quite some time before the historic Sputnik launch.

The launch of the Sputnik nevertheless created a crisis of a confidence in the U.S. lead in science and technology. While the U.S. scientific elite had anticipated a Soviet breakthrough and had been taking the necessary steps towards achieving an American presence in space

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it could not divulge this sensitive information to the outraged American public. Less than four months later the U.S. space community under heavy public pressure put the first U.S. satellite Explorer-I, into orbit on January 31, 1958. The race for military control of outer space -- the new high ground, had begun.

The shooting down of the U-2 reconnaissance aircraft with pilot Gary Powers aboard underscored the need to develop a satellite reconnaissance system. As a result of this incident President Eisenhower began taking personal interest in SAMOS (the Satellite and Missile Observation System). A National Reconnaissance Office (NRO) was created in 1960 to oversee development of U.S. reconnaissance satellites. NRO's existence remained secret until 1973 when its existence was inadvertently revealed.

Between 1957 and 1960 the United States developed a substantial satellite reconnaissance capability which was, of course, reciprocated by the Soviet Union. Apart from developing this system the Eisenhower era was also responsible for "legitimisation" of satellite reconnaissance. Khruschev, at a Paris Summit between the two leaders in 1960, stated that "any nation in the world in

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who wanted to photograph Soviet areas by satellite was free to do so". [5] This appeared to be an unguarded remarks by Khrushchev because the Soviets began a diplomatic offensive in 1962 to prohibit reconnaissance activity from space. However, it was after this that military space reconnaissance gradually gained legitimacy until it was enshrined in Articles V and XII of the SALT -I treaty of 1972 wherein parties to the treaty agreed not to interfere with each other's national technical means of verification.

Initial Soviet hostility to satellite reconnaissance was understandable. The Soviet Union stood more to lose by unrestricted reconnaissance activity. Satellite reconnaissance would open up the closed Soviet society. On the other hand there was not much extra information that the Soviets would glean from their reconnaissance overflights of the USA. It was understandable then that reconnaissance satellites would provide fertile ground for superpower polemics. The United States held that no nation could claim sovereignty over space. They compared outer space to the high seas from which reconnaissance was permitted. The Soviets on the other hand regarded satellite reconnaissance as a violation of their sovereignty.

5. Paul Stares, op. cit.

Apart from legitimisation of satellite reconnaissance the Kennedy era saw the budding of a programme to develop anti-satellite (ASAT) weapon systems. Although ASAT systems development reached its peak during the Johnson years; it was programmes such as SAINT (satellite intercepter) and MUDFLAP anti-satellite systems that were conceived of at this time.

While the Americans were talking about satellite interception, with another satellite, the Soviets in 1962 actually performed such a feat. A space rendezvous between spacecraft Vostok III and IV was reported. Even though the distance of separation between the two spacecraft was over 150 km -- too large for the mission to be of strategic value, it fuelled inevitable rumours in the US about satellite interception capabilities. As a result the SAINT programme was cancelled and a new ASAT programme was given new direction on very high priority. On July 6, 1963 a National Security Action Memorandum (NSAM 258) entitled "Assignment of Highest National Priority to Programme 437" or the Thor ASAT programme was issued.

In addition it was reported that on November 3, 1967 the Soviets had tested what Robert McNamara termed the "Fractional Orbital Bombardment System" (FOBS). The system was an ICBM with an orbital trajectory which would attack the United States from the South. Its trajectory constituted a partial orbit of the earth. The so-called FOBS threat also gave the United States an excuse to accelerate anti-satellite research. It was soon realised however that what FOBS could do could be accomplished more easily by ballistic missiles. The orbiting nuclear bomb question was put permanently into cold storage by the Outer Space Treaty of 1967.

<u>ASAT Weapon Development</u>

The early 1960s saw the birth of studies related to destroying or disabling satellites in orbit. While initial experiments were designed to study the survivability of U.S. satellite systems to ASAT attack, the experiments automatically resulted in minimal ASAT capability for the United States.

The first of such studies was the high altitude nuclear test programme or Project Argus.[6] It was contended that electrons and secondary radiation such as gamma rays and X-rays produced by a nuclear explosion could damage electronic equipment. It was found in a later series of tests that this electromagnetic pulse (EMP) did in fact produce X-rays which could damage satellites in space.

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6. See Samuel Glasstone and Philip Dotan, <u>The Effects of Nuclear Weapons</u>, (US DOD, Washington, DC, 1977,) p.45.

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In 1956 the role of satellite interceptor technology (SAINT) as an ASAT system was studied. Studies of satellite interceptors thus proceeded the first Soviet Vostok test of 1962. However, with the Vostok test ASAT systems acquired high priority. The SAINT programme was cancelled and the US Army and Air Force were directed to begin a study of the use of Nike Zeus and Thor missiles in the ASAT role. A number of such tests of both missiles were conducted. However, the concept of using these anti-ballistic missiles and intercontinental missiles in the ASAT role had inherent limitations. Both had nuclear warheads. Consequently they would generate an electromagnetic pulse which had the potential of destroying friendly satellites too. While some Thor missiles adapted for the ASAT role were deployed and maintained in a state of operational readiness, the concept of nuclear satellite kill did not catch on and was abandoned in the mid-seventies.

One ASAT project which deserves special mention is Project Dynasoar (Dynamic Soaring). It was projected to be a hypersonic guide vehicle which would be boosted into space, perform manoeuvees such as strategic reconnaissance satellite inspection and interception and intercontinental bombardment. The concept was remarkably

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similar to the Trans-Atmospheric Vehicles (TAVs) [7] being conceptualised today. However, technology at that time was not mature enough to permit the development of such a system.

The MHV System.

The current MHV (Miniature Homing Vehicle) programme [8] is an outgrowth of Project SPIKE designed to intercept and negate satellites prior to their overflight on the continental United States, which was proposed by the US Air Defence Command in 1971. However, work on this programme stalled and was resumed only in 1975 as the ALMHV (air-launch MHV) programme. First, public declaration of the MHV programme was made around this time. It was only under the Carter administration that the programme began to take shape.

President Carter had a two-track policy towards ASAT weapons. On the one hand he wished to fund ASAT weapon development to counter the perceived threat from Soviet RORSAT (Radar Ocean Reconnaissance Satellites),

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7. See Defense Daily, May 6 and May 11, 1987; see also New Scientists, May 7, 1987.

8. MHV is an acronym for Miniature Homing Vehicle, also known as ALMHV or Air Launched MHV.

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which provide the adversary with real time tracking capability of U.S. naval deployments, convoys and carrier battle groups as they move across the oceans.[9] On the other he wished to actively pursue ASAT arms control.

The ALMHV programme was inherited by President Reagan. In keeping with Reagan's overall policy of using outer space to further US strategic goals, the ASAT programme was accelerated and several tests against points in space and a satellite target have been conducted. While Carter wanted ASATs to threaten Soviet RORSAT and EORSAT satellites, Reagan claims ASATs must be developed to achieve parity with and thereby deter the USSR.

The current US ASAT weapon consists of a modified Short Range Attack Missile (SRAM) developed by Boeing Co. mounted on top of a Vought Corp. Altair III booster. At the top of the missile is the all important MHV which is a 12 by 13 inch cylinder with infrared sensors. The missile itself is mounted on an F-15 aircraft chosen because of its weapon carrying capability, high operational ceiling and rapid rate of climb besides being the

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9. Cited in <u>Defense Daily</u>, April 12, 1987.

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standard USAF air superiority fighter. Once airborne the F-15 launches the missile in the direction of the target satellite. LWIR [10] sensors on the MHV would lock onto the target which would be destroyed by direct kinetic impact. No explosions in outer space would be involved and no neighbouring satellites would be aff-ected in any way. Unlike the Soviet coorbital ASAT system which is confined to the Tyuratam launch, site the ALMHV can be launched from any ordinary airfield. Moreover, if mated with a modified F-14 aircraft the ASAT system could be deployed an an aircraft carrier with no way of knowing its location. Alternatively, by using air-to-air refuelling the range of the F-15s could be increased phenomenally.

It is often held that such an ASAT system would have limited capability against satellites in high orbits. What must be remembered is that most Soviet satellites are in highly elliptical "Moloniya" orbits with their perigees over the Sothern hemisphere. It is in this region that most Soviet communication and early warning satellites dip within range of the F-15 borne ASAT.[11] Consequently, American ASAT planners have considered basing ASAT weapons

10. LWIR is an acronym for Long Wave Infrared.

11. For details see Christopher Lee, War in Space (London, 1986) pp 110-115.

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at Diego Garcia in the Indian Ocean, at Ascension Island in the Atlantic and in Australia. If an aircraft carrier-borne ASAT weapon is developed it would probably be deployed in the southern Indian Ocean.

ASAT Weapons and Military Strategy.

The U.S. Congress in 1985 approved a moratorium on ASAT testing. The moratorium was extended this year. One of the major policy questions regarding ASAT as was debated in Congress is whether an ASAT race with the Soviet Union would further US security interests. It is a well-known fact that the US relies more heavily on its satellites for access to critical intelligence data, communications and command and control systems. Thus if an ASATrace were to begin, the US would be deprived of intelligence, communications, etc. to a higher extent than the Soviet Union. Moreover, US satellites tend to be multi-functional and have longer orbital lives thab Soviet satellites. Consequently the US has much fewer satellites in orbit. Because most Soviet satellites are short lived they have a much higher launch gate. It could therefore be concluded that in a war scenario involving anti-satellite attacks, the United States would emerge as the loser.

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C^3I and Space Systems

The U.S. Command, Control and Communications and Intelligence (C^3I) system is closely integrated with its military space programme. The United States requires assured and survivable communications, to transmit commands from the presidential command post downwards to its vast nuclear infrastructure.[12] Space systems are designed to play a vital role in this crucial chain of command. With the introduction of the doctrine of flexible response in the mid-1960s, the need for efficient and redundant C^3I assets grew. Space based elements of the command and control system were found to be extremely vulnerable to EMP (electro-magnetic pulse) effects as early research on the high altitude nuclear test programme had demonstrated. The doctrine of limited nuclear war enunciated by President Reagan in the early 1980s demanded even more of the space based C^3I system.

As a result of these doctrinal changes the United States has begun to place more emphasis on increasing the resistance of its space-based assets to the secondary effects of a nuclear exchange. The programme includes developing Gallium Arsenide (GaAs) technology to replace silicon in its space based and ground based satellite

12. Ravi Shastri, "C^3I Controlling the Uncontrollable", Strategic Analysis, 1987 pp. 1429-1446

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electronic systems. Gallium Arsenide is more resistant to the effects of EMP.

The cornerstone of the US C^3I modernisation programme is the Military Strategic/Tactical Relay (Milstar) system which would provide highly survivable jam resistant communications to users around the globe.[13] When deployed the system will include a constellation of spacecraft hardened against physical and electronic attack. Milstar is the highest priority C^3I programme in the US Defence Department. The Milstar space segment will consist of nine satellites -- three in elliptical orbits and six in geosynchronous orbits. Approximately 4,000 land, sea and airborne platforms of the US Army, Navy and Air Force will be equipped with Milstar terminals.

Milstar is, however, faced with a major problem as are other critical military space programmes --- the shortage of launch vehicles to carry the necessary hardware aloft. The Challenger disaster, the Titan failure which followed soon after and a series of similar incidents have left the US space programme grounded. The space community in the United States has been rife with arguments as to what direction the US space programme should take. The Challenger disaster placed a

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13. Defense Electronics, July 1986, p.97

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challenge before US dominance in space and how they would deal with this challenge remains to be seen. However, a number of new initiatives have been launched and efforts have been made to revamp existing structures and systems and develop new technologies.

The Challenger Disaster and its Implications

On January 28, 1986 the space shuttle Challenger blew up, killing the three astronauts on board and destroying its classified military payload.[14] The loss of the shuttle delivered a major blow to the US military space programme. President Reagan's Star Wars programme in particular suffered a setback. Leaving aside the military implications of the incident the US space programme has suffered commercially. With international launch competition growing, most nations aspiring to place satellites in orbit have chosen launch vehicles such as the European Ariane or the Chinese Long March to carry their payloads aloft. China in a particular has benefitted enormously. The USSR too has actively begun marketing its Proton booster.

Following close on the heels of the Challenger tragedy, a U.S. Titan rocket exploded in May 1986; its payload was believed to be a sophisticated reconnaissance satellite.[15] The launch pad at Vandenburg was

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14. David Baker, "Why Challenger Failed", New Scientist, September 11, 1986, p.52.

15. Science, May 9, 1986 p.232.

severely damaged. The Titan disaster effectively sealed off launch of reconnaissance, communications and early warning satellites for some time. The US KH-11 reconnaissance satellite presently in orbit is not expected to remain live after 1988.

The implications of grounded launch vehicles are already being felt. The US military is taking precautions to prevent the breakdown of existing space systems vital for reconnaissance, communications and early warning against missile attack. Only one KH-11 photo reconnaissance satellite is currently in operation. KH 11s are supposed to operate in pairs. Further several of these satellites are operating in final backup systems.[16] John E. Pike, Head of Space Policy at the Washington based Federation of American Scientists, has identified reconnaissance, communication and early warning satellites as the "potential problem". Others, he says, used for electronic intelligence, ocean surveillance, weather monitoring and navigation, are in good condition.

16. William J. Broad, "Pentagon Nursing an Aging Network of Key Satellite", New York Times, July 20, 1987.

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In October 1988 the shuttle came back into operation. It is likely for the foreceable future to be reserved for these crucial military payloads. Most scientific and other civilian space missions are likely to be delayed indefinitely.[17] Some of the worst victims were the Halley probe, Ulysses which was to have observed the sun's poles, and Atlantis, the spacecraft which was to observe Jupiter. The optical telescope which was to be launched towards the end of 1986 to observe the stars without atmospheric distortion was also abandoned.

Perhaps the greatest challenge to the American commercial space effort would be other space-going nations filling in the demand for launch of Third World satellites. The Soviets have been offering their Proton booster in the commercial market. For instance, IRSIA, the first Indian remote sensing satellite is to be launched this year on a Soviet Proton.[18]. Several companies in the United States have been advertising Soviet launch service as an alternative to the space shuttle.[19] The US State Department recently issued a directive quoting

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17. C. Raja Mohan, "Beyond the Challenger Tragedy," Frontline, February 22-March 7, 1986.

18. Soviet Aerospace, May 11, 1987.

a US law which prohibits "the transfer of US space technology to the Soviet Union"[20] whereby they declared such activity illegal. The European Space Agency's (ESA) Ariane booster is to launch four Indian satellites.[21] The Chinese have also entered the market with their Long March -3 launch vehicle. A U.S. company Teresat has signed a launch reservation agreement with the Chinese who hope to launch the shuttle recovered Westar-6 spacecraft with the Long March-3.[22] Negotiations are in progress for Chinese launch of US satellites.

It is often held that the U.S. launch vehicle programme has been in such dire straits that they would never be able to get thousands of pounds of SDI-related hardware into orbit. These observers however fail to take into account the new concepts and technologies in space launch systems which are evolving in the developed world, viz. Trans-Atmospheric Vehicles or TAVs which would be designed to take off from an ordinary airfield, be boosted into orbit, conduct manoeuvres in space, re-enter the atmosphere and finally land at an ordinary airfield. The United States, some of its allies and the Soviet Union are believed to be working on such a system.

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20. International Herald Tribune, July 10, 1987.
21. Statesman, May 20, 1987.
22. Robert F.Brodsky, "Foreign Launch Competition Growing", Aerospace America, July 1986. p.86.

In the United States work on the spaceplane is concentrated at Rockwell International's Rocketdyne division in California. Rocketdyne Corp. has apparently produced a revolutionary design for America's NASP (National Aerospace Plane) which has impressed officialdom. As a result Rocketdyne has been granted a $500,000 contract for basic propulsion design work.[23] The project is expected to be worth as much as $3.3 billion over the next few years. All funding for the US NASP comes from the Air Force budget.

The British too seem to have faith in space planes. Work on designing Hotol (horizontal take off and landing) is well under way. The concept involved in Hotol is similar to the US NASP, viz. use of air-breathing and rocket engines in the atmosphere and in space respectively. It would be capable of placing 8 tonnes into a 500 km altitude orbit of the earth.[24] A model of the Hotol was displayed at the Paris Air Show in June 1987.[25]

Trans Atmospheric Vehicles offer a promising future for access to space. They would easily be able

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23. Defense News, July 27, 1987, p.7.
24. New Scientist, May 7, 1987.
25. Ibid., June 18, 1987.

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to launch, recover and repair military photo-reconnaissance and early warning satellites in low earth orbit. The U.S. military space programme then may not remain grounded for long.

The debate over what direction US launch vehicle strategy should take in the future has thrown up several new ideas like the one described above. Another innovative concept which can be viewed as a reaction to the launch of the Soviet Energia rocket in May this year is what has been termed as the Advanced Launch System (ALS)[26]. The US Air Force in May 1987 asked the Aerospace Industry to submit proposals for ways to design and build the advanced launch system. Others have suggested a return to the "big dumb booster" rocket relying on obsolete but reliable technology.[27] Still others have suggested abandoning heavy lift vehicles and have suggested smaller launch vehicles which would be able to launch small selective military payloads in a cost effective manner. In keeping with this suggestion the USAF has ordered 56 Titan II rockets to launch reconnaissance satellites into low earth orbit.

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26. International Herald Tribune, May 28, 1987.

27. Newsweek, August 17, 1987.

While a launch vehicle strategy for the United States future in space is being debated within the US space community, two projects are in balance whose future the outcome of the debate would determine. These are the US space station project and Ronald Reagan's Strategic Defence Initiative (SDI).

The Space Station

After almost a year of economic, political and technical problems, NASA has restored momentum to its space station effort.[28] The Senate space subcommittee and its corresponding committee in the House approved full funding -- $767 million for the space station in FY 1988.[29] The total cost is estimated at $31.3 billion, which includes $26.7 billion in R&D, $239 million in construction, $1.5 billion in shuttle launches and $2.9 billion in NASA personnel costs.[30] More recently Canada, Japan, UK and the US signed an agreement on cooperation in the space station effort.

NASA's Associate Administrator for the space station, Andrew Stofan, has stated that the space station

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28. See Theresa M.Foley "Space Station Back on Track After Year of Policy Disarray", Aviation Week & Space Technology, June 15, 1987, p.76.

29. Ibid.

30. Defense Daily, July 29, 1987.

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would result in a quantum leap for US space science and technology. James A.Van Allen, renowned space scientist in the journal Scientific American disputes this view.[31] The debate on the space station has eventually boiled down to a debate on the utility of manned vs. unmanned space flights. Van Allen is of the view that unmanned spacecraft can perform all important functions in space. Supporters of the space station argue that manned space flights could carry out activities such as recovery of sensitive satellites, repair of malfunctioning satellites, etc.-- with limitations. The space station would operate in low orbits and consequently astronauts on board would be able to carry out such extra vehicular activity only with low orbiting satellites.

President Reagan stated in January 1984 that "a space station will permit quantum leaps in science, communications, and in metals and life-saving medicines that can be manufactured only in space." [32] Three years later President Reagan's optimism is hard to share. Space commerce which included materials processing in space has disappointed enthusiasts. Satellite communications proved to be the only viable space related industry. Microgravity materials science is embryonic

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31. See James A Van Allen "Space Science, Space Technology and the Space Station", Scientific American, Vol 254, No.1 January 1986, p. 82.

32. Cited in Theresa M. Foley, n.28, p. 30.

and des not hold commercial promise. McDonnell Douglas, one of the few companies that opted to perform materials processing experiments in space, found the venture non-profitable and withdrew.

George Field, a researcher who served on the US National Commission on Space, holds that "Space manufacturing will remain a dubious enterprise until basic research in microgravity demonstrates its value."[33] As a result, the space station is likely to find itself highly dependent on the US Department of Defence (DOD).

The U.S. Defence Department has been singularly adamant in its demand for unrestricted access to the space station.[34] At stake is the international nature of the US space station effort. Dr. Robert Sims, Assistant Secretary of Defence for Public Affairs said in May that ".... we intend to use the space station for those national security purposes that we deem are appropriate."[35] The US DOD has reiterated, however, that American treaty obligations would be respected and it would not violate international law while performing experiments.

33. Cited in Theresa M. Foley, n.28, p. 30.

34. Aviation Week and Space Technology, June 15, 1987

35. Cited in Theresa M. Foley, n.28, p.76.

The Pentagon recently made public a list of possible experiments which would be carried out on the space station. Some of these include:

-- A space-borne direct view optical system

-- A Latitude/Longitude locator system

-- Maritime observations in space

-- The US Army Shuttle experiment

-- Space debris belt characterisation/mapping

-- Military geology from space

-- Battlefield surveillance from space

-- Launch detection from space

-- Experiments that would involve the use of an offer in space to perform weather observations

-- Designation from space

-- Free ion remote sensor technology.

The US Defence Department has begun to involve itself more closely with NASA in the space station programme. Military personnel are believed to be playing a prominent [36] role in the programme.

The U.S. military's demand for unrestricted access to the space station has sparked off a sharp

36. Cited in Theresa M. Foley, n.28, p. 76.

debate between NASA and its international partners. Canada in particular has vehement objections to the military use of the station. Canada will spend over $800 million on its programme which has evolved into an extremely well coordinated and organised effort.[37] Japan, too, which is developing a module to be attached to the space station, likely to have objections to its military nature. Despite their objections however both Canada and Japan will build modules for the station.

The European Space Agency (ESA) and China are also expected to be major participants in the effort. NASA officials feel that Chinese space technology is not advanced enough to make their participation fruitful. It has however been reported that a Chinese delegation held talks with NASA in January about the possibility of a Chinese role.[38] With the United States playing an increasingly important role in China's economic and military modernisation, some form of organised Chinese effort, however miniscule, cannot be ruled out if only for political benefits that the United States would gain out of the partnership.

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37. For details of Canadian participation in the space station effort see Aerospace Daily, July 27, 1987.

38. Aerospace Daily, June 18, 1987.

SDI and the US Space Programme

The American military space programme for the first four decades largely consisted of passive deployments in space. While active military space systems such as SAINT, Dynasoar, etc. had been considered these never got off the drawing board. Technology at that point in history was basically not mature enough to operationalise such exotic space based weapons.

Today, there is a qualitative shift in doctrines of space militarisation. There has been an obvious move towards space weaponisation, viz. deployment of active weapon systems such as lasers, particle beams and kinetic energy weapons in space.[39] The American Strategic Defence Initiative promises to bring about revolutionary changes in military space doctrines and is likely to have an adverse impact on deterrence, crisis stability and arms control.[40] Such details are beyond the scope of this chapter. It would suffice to

39. See Ravi Shastri, "Militarisation of Space and the Strategic Defence Initiative," Strategic Analysis, Aug, 1987., pp 585-604.

40. For details see Ravi Shastri, "BMD/Arms Control Debate", Strategic Analysis, November 1986 pp 927-942; See also Ravi Shastri, "SDI: Early Deployment and the ABM Treaty", Strategic Analysis, June 1987 pp 550-562.

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say here that SDI whether or not it results in the deployment of a viable Ballistic Missile Defence (BMD) system, would in any case result in a massive technological leap for the United States. The vast amount of R&D funds being channelled into Star Wars research are certain to produce some results. SDI research is likely to produce spinoffs for conventional defence and for industry.[41] The US military space programme is likely to benefit from advanced software, materials research, launch vehicle research and a host of other projects being conducted under the guise of strategic defence.

In order to establish a certain degree of homogeneity in the effort, the United States has attempted to induce its allies to participate in the effort. Most NATO nations and Japan have decided to formally participate in SDI for reasons which often have nothing to do with ballistic missile defences.[42] They wish to grab a share of the funds being doled out for research. The cooperative effort on the part of the West then will in all probability rejuvenate the pace of economic and technological development in the western world which had been tapering off of late. The Soviet Union could be expected to respond in kind.

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41. For details of SDI spinoffs, see Aviation Week and Space Technology, May 11, 1987 p. 89; see also Defense News, June 1, 1987.

42. Ravi Shastri "Japan's changing security perceptions and the SDI" Strategic analysis, May 1986 p. 452-465

Third World nations then would remain technologically dependent on and at the mercy of "Uncle Sam" and the Soviet Union for a lot more time to come.

(b) <u>USSR in Space</u>

While over the past two years the American space effort has been floundering the Soviets have gone ahead and overcome significant technical hurdles. The Mir space station, launch of Energiya HLV [43] and the consequent possible development of a space shuttle have been some Soviet achievements in conquering the final frontier. While their space programme may appear entirely peaceful with the Soviets repeatedly emphasising its peaceful intent, the dual-use nature of space-related technological developments makes it impossible to strictly separate the civilian and the military elements. Given the lack of adequate information in this regard it is a common practice among scholars particularly in the western world to attribute purely militaristic intentions to the Soviet space effort. But this is not the informed opinion in the West. A study carried out by the U.S.

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43. HLV is an acronym for Heavy Launch Vehicle.

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Congressional Research Service concluded that about 50 per cent of Soviet space activity was purely military in nature.[44] Many elements of the programme however, are used for scientific, civil and economic applications.

Motivations for Space Presence

The Soviet Union claims its space programme is entirely peaceful. However, as the following discussion would reveal, the primary motivation for Soviet space activity is military. Like the American programme national security assumes primacy over all other possible motivations.

The USSR has consistently advocated that its long-range goal in space is manned exploration and colonisation of the solar system. This is borne out by the fact that the Soviet space programme leads over that of the U.S. in man-in-space efforts and in human endurance in space records. The space station programme enabled Soviet cosmonauts to set a record of days in space. The presence of cosmonauts in space however cannot be dismissed off hand as an entirely peaceful enterprise as will be seen later.

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44 CIS (Congressional Information Service) report to the United States Congress on the Soviet Space Programme (Washington, D.C., 1986).

The furtherance of space science is seen by Soviet cosmonauts and others involved in the effort as a major goal of their space programme.[45] Planetary exploration, endurance in space, civilian TV communications, study of earth resources, etc. are outlined as areas where space science could play a major role. All these however also have military connotations.

Enhancement of national prestige and pride is another major motivation for the Soviets to invest in space. Space technology is one area where the Soviets have surpassed western nations. The United States and its allies have developed exotic technologies for use in space the results of which sometimes have proved disastrous. The Soviets on the other hand have maintained a consistent effort based on outdated but proved and reliable technology. For instance, the original ICBM developed in 1957 is still used as the main launch vehicle with improved upper stages. The reliability of Soviet systems has

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45. William Shelton, Soviet Space Exploration (New York) 1982 p. 205 .

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received a fillip with the recent Soviet space successes as compared to American and European failures. The West criticises the Soviet system for its lack of innovation and inventiveness. Their space programme however provides one field of technological development, based on which the Soviets can defend their system and hit back if necessary. Witness therefore, the race between the super powers for space firsts. The Soviets were the first in space (1957), they launched the first rocket to the moon (1959) the first man in space (1961), first woman (1963), etc.; if the Americans put the first man on the moon, the Soviets have the endurance record of man in space and a space station -- with the Americans struggling to follow suit. The prestige associated with being the first to achieve something in that vast nothingness is a major incentive for accelerated space activity.

The Soviets have attempted to gain maximum psychological advantage out of their space successes. By pursuing a policy of not announcing launch failures they have attempted to build up an aura of infallibility in their scientific and technical progress. They have then gone on to use this to influence other

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nations of the world through promises of co-operation in space technology, strengthen friendships and demoralise enemies. Cosmonauts from East European nations, and from India have flown on Soviet Soyuz missions. A Syrian and French cosmonaut are scheduled to visit the Mir space station soon.[46] While pride, prestige and exploitation of earth resources are viable goals for the Soviet space effort the primary motivation remains national security. In this respect both the Soviet motives as well as their actions appear to be no different from those of the Americans. Like the American space effort military components of space activity tend to dominate if not encompass civilian or peaceful uses. The inability to adequately differentiate between the two enables the Soviets to claim that their programme is entirely peaceful. A major policy difference appears to be that while the Americans are more open about their military space activity the Soviets refuse to acknowledge that they have a military space programme.

Another unique feature of the Soviet space programme is that it is cloaked in secrecy. While the U.S. Department of Defence (DoD) and the National

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46. <u>Flight International</u>, December 27, 1986.

Aeronautics and Space Administration (NASA) do not always immediately release the details of American military space flights they acknowledge the fact that a particular payload is to be used for military purposes. The Soviets on the other hand are highly secretive. They sometimes make references to the strategic value of scientific mission as was done during the Khruschev era. Since 1963 the Soviets have cloaked all space flights under the Kosmos label, leading to speculation that this was a cover for military-related missions.

Observers often attribute this Soviet secrecy to the inherently secretive nature of the Soviets political system at least until the dawn of the Gorbachev era. Gorbachev's glasnost and perestroika has not yet had time enough to penetrate the secrecy surrounding the Soviet space programme. However, two more rather compelling reasons for the Soviet penchant for secrecy can be cited off hand. The first is a corollary to the Soviets using their space successes to enhance national pride and their influence in the comity of nations as discussed earlier. Revelation of Soviet failures could undermine the confidence of smaller less developed nations of the world in the viability of Soviet science and technology and consequently their goal of using the space programme to increase national pride and prestige would suffer a setback. Further, since most Soviet launch vehicle technology is based on their ICBMs they would be reluctant to provide any detailed information which could compromise national security.

As a result of this penchant for secrecy independent observers find it difficult to obtain a clear picture of the Soviet military space effort. Researchers of the Kettering Group and those at SIPRI(Stockholm International Peace Research Institute) have done valuable work and have provided a good source of unbiased information regarding Soviet military activities in space. The nature of Soviet military missions is more often than not deduced from orbital parameters of satellites, the timing of their launch and recovery,etc.

While the Soviets have consistently denied any association with militarisation of space, the statements of certain Soviet leaders at different points of time tend to contradict this view. For instance, party Chairman Brezhnev said in 1966; "A host of all kinds of fabulous stories in the U.S. that it has most

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'all seeing' spy satellites...... authors of such stories do not realise what rockets, Sputniks, submarines and other technical equipment of the Soviet Union has".[47] Further, a 1970 article on intelligence services appeared to legitimise military uses of space particularly satellite reconnaissance. It stated:

> Let us repeat, the division of labour, within the intelligence services in no way signifies a desire on the part of its leaders to have clean hands; on the contrary, they use secret agents to fulfil the most serious and profound tasks which cannot be solved by satellites, reconnaissance aircraft or information centres using fast electronic equipment.[48]

The SALT-I treaty, to which the Soviets are a party, legitimises satellite reconnaissance. Article V of the treaty states that: "For the purpose of providing assurance of compliance with the provisions of this Interim Agreement, each Party shall use national technical means of verification at its disposal...."[49]

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47. Pravda, Moscow, July 2, 1966, cited in CIS report n 44 p. 24.
48. CIS Report, n. 2 p. 43.
49. For details SALT agreement, see US ACDA (Arms Control and Disarmament Agreement), Washington, D.C., 1982.

From the above quotations it is obvious that the Soviets have implicity accepted satellite reconnaissance as an integral component of their military strategic system. But rather than arguing that such military activity is not offensive, they continue to deny that they conduct any military satellite re-reconnaissance.

Having established that the Soviets indeed possess a military space programme one can go on to identify the specific military elements, which include photographic electronic and radar reconnaissance, early warning, military communications, navigation, weather geodesy and mapping. Before going into these details, however, the historical development of the Soviet space effort will be briefly reviewed.

Early Years

The concept of rocket propulsion was first conceived of and later used in China in the 13th century AD. Christian monks who visited China learnt the basic principles and brought rocketry into Europe. However, it was not until the 17th century that rockets were used in Russia. Recorded history notes that Peter the Great set up a Rocket Works factory in Moscow in 1680 for the fabrication of military signal and illumination flares. Alexander Zauadho, an artillery

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officer, pioneered the Russian use of rockets as a weapon in the early 19th century. Another artillery officer applied mathematics to the scientific study of rocketry suggesting also that rocket propulsion could be used for travel.[50] Russian revolutionaries of the 19th century are also believed to have dabbled in rocketry. One such member of a revolutionary organisation, Nikolai Kilialchichbuilt the rocket bomb which mortally wounded Alexander II on March 13, 1881.[51]

Modern Russian rocketry was pioneered by Konstantin Tsiolkovskii (1857-1935) who was a deaf school teacher,. Among other things he was the first to visualise interplanetary travel, the laws of motion of cosmic bodies in space, the velocities required for earth orbit and escape, the use of multistage rockets, the use of liquid oxygen and liquid hydrogen as fuel, the need for heat shields during re-entry and the concept of space stations. His work in rocketry included establishing a comprehensive relationship between the velocity of a rocket and the velocity of its expelled gases, which later came to be known as the Tsiolkovskii formulae.

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In 1924 the Soviet government created and supported the Central Bureau for the Study of the Problems of Rockets (TSBIRP) with the objectives of bringing rocket researchers together and studying the interplanetary and military implications of rockets. Later in 1929 organisations such as TSBIRP and the Gas Dynamics Laboratory (GDC) were merged into the group for the Study of Reactive Motion (GRD). However, in the 1930s the pace of development slowed down. The political climate was not conducive for constructive research. It was not until after the war with the influx of German scientists that the Soviet spaceprogramme per se reached the take-off stage.

While space research, and particularly rocket research had been conducted in the USSR and by Robert Goddard in the U.S., both were far behind the Germans. When the Russians occupied Peenemunde, the German rocket research centre, most German scientists had already been rounded up under the American "Operation Paper Clip". The Soviets did manage to capture one scientist, Mikhail Iangel. The majority however went to the Americans. It is therefore logical to assume that the Americans benefitted far more from their German catch than did the Soviets.

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After the Second World War the Soviets rebuilt German facilities at Peenemunde and set a team of Germans and Russians working on it. Improvements were made on the German A-4 (V-2) -- its range and accuracy were enhanced. A new rocket called the T-1 or Pobeda with a range of 500-700 miles was developed.

According to Col Tokaty-Tokaw, who defected to the UK in 1984 the Soviets had plans in the early 1950s to develop rocket-boosted ICBMs. Tokaty-Tokaw revealed that he himself had suggested the construction of a three-stage rocket. His suggestion was not accepted. Had it been, the Sputnik might have come several years earlier, he said.

It is evident that by the mid-1950s Soviet ICBM design and development was well under way. In 1955 several articles appeared in the Soviet press on the uses of artificial earth satellites. In 1955 at the annual Congress of the International Astronautical Federation the Soviet delegate announced that it would be possible to launch a satellite within the next two years.[52] In May 1957, astronomer Bubhaiov disclosed that a Soviet satellite was around the corner. In June it was announced that all technical difficulties had been overcome and the necessary

52. William H.Schauer, The Politics of Space (New York, 1976).

apparatus created. In August the Soviet Government announced the completion of tests. On October 4, 1957, the world's first artificial satellite was launched.

The launch vehicle for the first Sputnik was the SS-6 ICBM, with a capacity of launching 1,360 kilograms into low-earth orbit. This is still the basic launch vehicle today. With improved upper stages (Proton), Soviet launch vehicles today use liquid oxygen/liquid h hydrogen as fuel. Kerosene derivatives are sometimes used for the first stage. Solid fuel is used in missiles but not in launch vehicles. The Soviets could also be working towards nuclear-propelled rockets as is the United States. The recent Soviet success with the Energiya heavy-lift vehicle (HLV) and reports about development of a space shuttle if valid would result in a quantum jump for Soviet space technology and potential for military exploitation of space. These successes and their implications will be dealt with later. What must be emphasised here however is that Soviet launch vehicles have relied on simple yet proven technology which has enabled them to retain their pre-eminence in space.

<u>Passive Military Space Systems</u>

The Kosmos label for space flights, the nature of which the Soviets did not wish to reveal, heralded the

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entry of Soviet military systems into outer space in 1962. Since then the Soviets have maintained a military space programme not unlike that of the Americans. A few major differences exist, however. One is the much higher launch rate of satellites in the Soviet Union. This is not due to any aggressive intent. The geographical location of the Soviet Union makes it necessary for them to launch satellites into orbits which have high rates of orbital decay. Hence most Soviet communication and early warning satellites have short lives requiring them to be replaced frequently. In contrast most US satellites are long lived and multifunctional requiring replacement after a longer period of time. The implication of satellite longevity will be discussed in connection with ASAT (anti-satellite) weapons later.

Reconnaissance Satellites

The Soviets have orbited both photo and electronic reconnaissance satellites. An additional reconnaissance satellites, the RORSAT or Radar Ocean Surveillance Satellite, which is believed to be nuclear powered has also been used extensively.

Almost 50 per cent of all Soviet satellite launches have been for photo-reconnaissance purposes. The most recent launch was on May 21 this year.[53] Photo-reconnaissance satellites that manoeuvre in orbit are believed to be close-look satellites. Early satellites had orbital lives of 4. 6 days. In the late seventies most Soviet reconnaissance satellites had lived of 12 days unless they were recovered earlier to observe a crisis situation. Today, advanced solar batteries enable them to stay in orbit for over a month. Flight altitudes are approximately, Perigee 147 km with apogees ranging from 200-450 km depending on the mission. Inclinations of approximately 52^{0} give good coverage of the northern hemisphere during daylight hours. Recoverable satellites retrofire and re-enter the atmosphere where they are recovered.

Soviet photo-reconnaissance satellites have covered the Iran-Iraq war (See Table 1), the Indo-Pak conflict and even observed South African and Chinese preparations for nuclear tests. Other activities that they have covered include:

- The American invasion of Grenada in 1983 (kosmos 1504 launched from Tyuratam on October 25 for the purpose);
- The 1983 crisis in Chad, when the city of Faya-Largeau fell to Libyan-backed rebels (Kosmos 1489);
- Events in El Salvador the same year (Kosmos 1471).

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53. Defense Daily, May 27, 1987.

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Kosmos 1504, 1489 and 1471 were manoeuvrable satellites implying thereby that they were used in the close-look mode.[54]

Table -1

Soviet coverage of the Gulf War

State	Designation	Particulars	Date of Lunch	Date of recovery
Kosmos	1210	82.3°	Sept.19, 1980	Oct. 3, 1980
Kosmos	1213	72.9°	Oct. 3, 1980	Oct. 17, 1980
Kosmos	1214	67 .2°	Oct. 10, 1980	-
Kosmos	1209 & 1212	(Launched as Earth Resources Satellites, could have covered the war)		

The Soviets orbited a series of reconnaissance satellites during the 1973 Arab-Israeli war. Kosmos 596, 597 and 598 were launched on October 3, 6 and 10 respectively and recovered after only six days in orbit even though the life of the satellites was 13 days.[55] The ground tracks of these satellites revealed that they could effect excellent area coverage of the region and then relay the information to ground stations in southern Soviet Union over which they would pass a few hours later.

54. For details see Nicholas L.Johnson "The Soviet Year in Space: 1983", Space World, October 1984.

55. SIPRI World Armaments and Disarmament Year Book 1974 (London 1974).

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Table 1 reveals that the Soviets had a great degree of interest in monitoring the early stages of the Gulf war. An interesting feature here is that Earth Resources Satellites could have been used for the purpose, serving to underline the dual civil/military nature of most space activity.

The Soviet Union launches its electronic reconnaissance satellites at orbital inclinations of 71° and 74° with orbital periods varying from 92 to 95 minutes. The London-based Kettering Group has not intercepted any communications from Soviet satellites which might indicate an ELINT role. Thus if any satellites are launched with the orbital parameters described above they are assumed to be fulfilling the electronic wavedropping role. Kosmos 1842 launched on April 27 this year is believed to be an ELINT satellite.[56]

A third category of Soviet reconnaissance satellites of which there is no counterpart in the West are believed to be the RORSATs. It is believed that the Soviets began orbiting these satellites in the late 1960s.[57]

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56. <u>Aerosapce Daily</u>, April 30, 1987.

57. Ibid.

Photo-reconnaissance satellites have an inherent disadvantage. They operate at frequencies which cannot penetrate cloud over. Radiation having wavelengths in the microwave region of the electromagnetic spectrum such as radar waves can penetrate clouds. Thus RORSATs enable the Soviets to track western naval movements across the oceans irrespective of whether they are obscured by clouds or not.

These radar surveillance satellites have perigees of 200-260 km. It is believed that the Soviets have conducted over 20 RORSAT launches since 1967.[58] The recent ones being on April 8, 1987 (Kosmos 1834)[59], March 21, 1986 (Kosmos 1736)[60], August 24, 1985 (Kosmos 1677) and August 1, 1985 (Kosmos 1670)[61].

RORSATs usually operate in pairs. Micromanoeuvres are used to compensate for atmospheric drag at low altitude. The satellites are believed to be powered by a nuclear reactor of the Romashka class. When the satellite has outlived its utility part of it is separated and moved into a higher circular orbit in which orbital decay is of the order of several hundred years.

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58. Aerospace Daily, April 30, 1987.

59. Defense Daily, April 15, 1987.

60. Aerospace Daily, March 24, 1986.

61. Ibid., August 6, 30, 1985.

The rest of the payload re-enters the atmosphere and is recovered. The part remaining in orbit is believed to be the nuclear power source. The half-life of the nuclear material aboard is believed to be shorter than the period of orbital decay of the orbit into which the satellite is launched. The uncontrolled re-entry of Kosmos 954 over Canada in January 1978 confirmed that a radioactive power source had been used. A nuclear power source has to be used because of the low altitude, where solar power would make it vulnerable to atmospheric drag.[62] It is believed that the Soviets have now introduced a new safety procedure, which ensures complete burn-up of the reactor core during re-entry.[63]

Communications Satellite

Most Soviet communications satellites are in highly elliptical Molniya orbits, with their perigees over the southern hemisphere. As a result they spend almost eight of their 12 hour orbital periods over the northern hemisphere, providing excellent coverage of the Soviet Union spaced at 45° intervals. The major problem with these satellites is their short orbital lives with results in a demand for frequent replacement.

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62. Soviet Aerospace, October 6, 1986.

63. Marcia C. Smith, Soviet Space Programme, CRS, (US Congressional Research Service (Report on the Soviet space programme).

The location of the Soviet Union at high altitudes in the northern hemisphere makes other longer lived orbits unsuitable for communications. Of late, the Soviet Union has begun orbiting communication satellites in the geo-synchronous belt at an altitude of 36,000 km. The bulk of Soviet communications however is provided for by Molnyia satellites which are also used to transmit space-related data to Soviet tracking ships.

Three series of Molinya satellites -- the Ekran, Gorizont and Raduga series -- are in operation. Though the Soviets claim that they are used exclusively for peaceful purposes, such as TV transmission, etc. it stands to reason that the Soviet military makes use of these satellites for both strategic and tactical communications. Very little is known about the Soviet strategic command, control and communication (C^3) network, but it is obvious that Molniya satellites are used to transmit commands from command posts to nuclear missile silos and ballistic missile submarines.

There are reports that the Soviets use satellites for tactical communications. Satellites in circular orbits of 1500 km would provide linkages between certain parts of the USSR. Tactical Communication Intelligence (COMINT) satellites are

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believed to be used by Soviet intelligence agencies. In April 1977 an Iranian, Ali Naghi Rabbani, was caught by the Shah's police SAVAK receiving coded instructions on a small transmitter via what was believed to be a COMINT satellite. Over 20 such satellites may have been orbited by the USSR.[64]

Early Warning Satellites

Soviet Early Warning Satellites have traditionally been placed in orbits similar to Molniya communitation satellites, but there are certain substantial differences in orbital parameters. Hence the Kettering Group has concluded that these Molniya satellites performed the role of early warning against nuclear attack. Equipped in all probability with SWIR (short save infra-red) detectors these satellites can peer into western United States and observe nuclear weapon bases. The information can then be relayed directly to the Soviet Union over which they would pass a little later.

Since 1975 the Soviets have begun placing early warning satellites in the geo-synchronous belt. The first such satellite launched on October 8, 1975 was placed over the Atlantic Ocean from where it would

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64. CIS Report n. 2 , p. 42.

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be able to monitor any signs of a nuclear attack.[65]

The Soviets like the U.S. use satellites for navigation. Only one Soviet satellite has been officially recognised asa navigation satellite, viz. Kosmos 1000 launched on March 31, 1978.[66] The Soviets have in orbit a total of 14 navigational satellites approximately eight of which are believed to be military satellites. The Soviets are also believed to be developing a global satellite positioning system known as GLONASS, which is similar to the proposed US Global Positioning System (GPS).

The Soviets admit to using satellites for weather forecasting, for geodesy and for mapping, but they claim that these activities are purely peaceful. But given the dual-use nature of these capabilities it is likely that the Soviet military makes use of the data recorded. A weather report for instance could be used merely for farming or it could picture cloud cover trends for use by naval ships. Defining the Earth's geoid is essential for accurate targeting of ICBMs. The USSR admits it performs geodesy from space.

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65. SIPRI, World Armaments and Disarmament Year book 1976 (London, 1976).

66. G.E. Perry, "Identification of Military Components within the Soviet Space Programme" in Bhupendra Jasani (ed.), Outer Space: A New Dimension of the Arms Race, SIPRI, (London, 1982) pp. 365-371.

To manage this vast network of satellites the Soviets rely on tracking facilities scattered all over their territory. A major tracking facility is located at Crimea. However, lacking the worldwide facilities that the US has the Soviets fill in the gaps by using tracking ships which are often named after famous personalities involved in their space effort. Their current fleet of tracking ships includes Akademick Sergey Korolov and Kosmonaut Yuri Gagarin. More recently Kosmonaut Kladestav Volkov entered service. Soviet Molniya satellites relay information between tracking ships and shore-based receivers.

One major proposed Soviet space tracking facility has been in the limelight for the past two years -- the Kerasmoyarsk radar in the eastern Soviet Union. The Reagan administration has over the past year repeatedly accused the Soviets of violating the ABM (Anti Ballistic Missile) Treaty in constructing the facility. In September this year Soviet authorities permitted a small U.S. Congressional delegation to visit the facility. The group found that although the location of the radar was such that it could warn of a trans-polar nuclear attack and it was not located at the periphery of Soviet territory as required under the ABM Treaty,[67] it nevertheless made no sense as an ABM radar.

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67. See US ACDA, n. 49.

The delegation concluded that the Soviets had not hardened the facility to withstand attack nor had they chosen a frequency that would suit nuclear battle management.[68]

Weapon Systems in Space.

Though weapon systems have never been deployed in space western sources indicate that the Soviets may have tested two kinds of weapon systems -- the Fractional Orbital Bombardment System (FOBS) and the Anti Satellite (ASAT) system. Statements made by Soviet leaders and the official media also appear to indicate that such systems were tested and developed. For instance, at a Soviet military parade in 1965 when Scrag SS-10 missiles were being viewed, Soviet radio declared: "Three-stage inter-continental missiles are passing by..... for these missiles there is no limit to range. The main property of this class is their ability to hit enemy objectives from any direction whichmakes them virtually invulnerable to anti-missile defence means.[69] At another parade in November the same year the radio said:"..... There are orbital rockets. Warheads of orbital rockets are able to inflict sudden blows upon an aggressor from the first or any orbit around the Earth".[70]

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68. News Week, September 21, 1987 p.23.
69. Moscow Radio, May 9, 1965, cited in Marcia C. Smith n. 63 p.50.
70. Moscow Radio, November 7, 1965 cited in Marcia C. Smith, n. 21, p.52.

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In 1966 debris was detected on two occasions from two unannounced flights by the Soviet Union suggesting that explosions could have occurred. The tests did not violate the outer space treaty because the satellite did not complete one orbit and did not carry a nuclear warhead. The launch vehicle used has been designated the F-1-r where r denotes a retrofiring stage which would bring the satellite back to earth.

The Soviets stopped testing FOBS in 1971, probably because they realised that it was counter-productive. The satellite carrying the warhead would travel on a precise path making it an inviting target of an enemy ASAT. It can attack its target only when it is directly overhead. The Soviets may have concluded therefore that ICBMs would fulfil the task much better and abandoned development of FOBS.

The Soviet Union has an anti-satellite weapon which American intelligence officials claim is fully operational. As early as 1962, Soviet Premier Nikita Khruschev claimed that the Soviets had a weapon that could "hit a fly in space." [71] Khruschev was probably exaggerating. But in 1968, it became evident that the Soviets did have a "hunter-killer" satellite programme. More recently in June 1985 Col. Gen. Nikolay Chervov,

71. Cited in Christopher. Lee n.11, p. 115.

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member of the Soviet general staff confirmed the existence of the Soviet ASAT weapon. He said however that the system consists of land-based weapons and not hunter-killer satellites as is generally believed. Several tests of the system have been carried out, according to Chervov, and they were "right on target." [72]

Chervov's disclaimer notwithstanding, the Soviet interceptor appears indeed to be a hunter-killer satellite launched on an SS-9 booster. Most launchings take place from Tyuratam, the targets being launched from the Plesetsk site. Approximately 20 tests have been carried out since 1968; less than half have been successful. The test involves the interceptor manoeuvring close to the target and then manoeuvring away onto to explode a while later.

Earlier the interceptor satellite required two orbits to manoeuvre close to its target. This made it vulnerable to attack. However, in later experiments conducted in the early eighties the Soviets appear to have perfected the technique of first-orbit intercept. Another drawback of the system is that it is launched only from the Tyuratam site and it can intercept the target only when it is directly overhead. It would be

72. Defense & Foreign Affairs Daily, June 11, 1985.

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able to attack only low orbiting US early warning and reconnaissance satellites. Geosynchronous satellites would be beyond its range.

There have been reports in intelligence circles in the West that the Soviets are developing an ASAT weapon system similar to the US F-15 borne ASAT[73] based on a MiG fighter airframe.[74] Reports of laser and particle beam ASAT have also made their rounds. Such reports however lack corroborative evidence.

ASAT weapons have been developed by both the superpowers. What then would be the impact of an ASAT competition between them ? The Soviets have a much higher launch rate and a much larger number of satellites in orbit; American satellites are multipurpose satellites and much longer lived. An unrestrained hypothetical ASAT war between the two would leave the US at a disadvantage. Their robust and reliable launch vehicle technology would enable the Soviets to recover much faster from an ASAT exchange.

New Technologies

The successful launch of the Energiya HLV on May 15 this year brought the Soviets into the heavy-lift

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73. For details see Ravi Shastri, "Space Technology and Military Strategy: A study of the US Space Effort", Strategic Analysis, October 1987. pp. 852-867.

74. Lee, n. 29 p. 111.

league. Energiya would give the Soviets the capability to launch 220,000 lb payloads. It would assist in their space shuttle, which was launched recently. Energiya gives the Soviets five times their earlier launch capability and four times the launch capability of the United States.[75]

The Soviet heavy-lift project was revived seven years ago,[76] after three previous attempts at launching an HLV in 1969, 1971 and 1972 proved unsuccessful. After a series of tests including stratic firing the Energiya finally lifted off on May 15 this year. In keeping with the new policy of glasnost the launch was announced in advance and the vehicle was even displayed on its launch pad on television. The vehicle had four large engines at its base and four large strap-on boosters. A cargo pod was mounted piggy-back on the main vehicle. On manned missions this cargo pod may be replaced by the space shuttle which the Soviets are reported to be testing.[77] The core of the vehicle is powered by liquid oxygen/hydrogen fuel. The strap-on boosters however use liquid oxygen/kerosene-derivative power plants.

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75. Defense Daily, May 20, 1987.

76. Aviation Week & Space Technology, June 16, 1980 p. 26.

77. Ibid., December 3, 1980.

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After lift-off the vehicle reached speeds of Mach 4-6 using its core engines and strap-on boosters. The strap-on then separated and the core vehicle and its cargo pod continued their ascent. At this stage a complex manoeuvre took place. The main engine shut off and the payload separated out. The payload apparently was supposed to be carried further into orbit with its own rocket engines. But these failed to ignite and the payload fell to a fiery end in the Pacific Ocean.

The Energiya success is a major milestone in the Soviet development of its reusable space shuttle. Reports of testing of the shuttle have emerged off and on over the past three years. One such test is reported to have taken place on December 19, 1984.[78] The shuttle apparently orbited the Earth once; glided back into the atmosphere and splashed down in the Black Sea from where it was recovered.[79] In October 1988 a full shuttle was successfully flight tested.

Roald Sagdeyev, head of Soviet space research had confirmed that the Soviets had been testing a reusable space vehicle.[80] He added that Kosmos 1614

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78. International Herald Tribune, December 21, 1984.
79. Defense Daily, December 21, 1984.
80. International Herald Tribune, December 29-30, 1984.

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which Tass identified only as an artificial earth satellite was in fact a test of the model. The main problem at that time was the lack of a heavy-lift vehicle to get the shuttle aloft. With the Energiya success that problem seems to have been overcome. There are also reports of the runway at Baikanour Cosmodrome being extended.[81] Consequently, the launch of the Soviet shuttl in November 1988 came as no surprise.

The shuttle would provides the Soviets with cheap and easy access to near-space. Since almost all space activity is military in nature a Soviet shuttle would increase the rate of militarisation of outer space. Given the major role that the military played in the development of Energiya[82] HLV, it is unlikely that it would relinquish control over any space shuttle that may result from it.

Space Stations

Development of a shuttle vehicle would help accelerate the already robust Soviet space station programme. In the field of human endurance in space the West has not been able to match the Soviet programme. The Salyut series of spacecraft culminating in the

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81. Soviet Aerospace, October, 6, 1986.

82. Aviation Week & Space Technology, May 25, 1987 pp 25.

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Salyut 7 space station was a credible achievement. In February last year the Soviets launched the nucleus of their Mir space station which proved to be a major improvement over its earlier Salyut stations.[83] Mir has six docking ports where space-craft can link up. Two would take Soyuz ferries, carrying supplies and people to and fro between Mir and the Earth. The other four will take modules as the space station is expanded. Each module would have a specific function, including astro-physical research, biology, medical sciences, materials research, etc. Research conducted on Mir could be expected to have substantial spinoffs for defence.

The Soviets are using the Mir station to further their goals of inhancing national prestige and increasing their influence in the comity of nations. Several international ventures have been planned for Mir including joint experiments with Syrian, Bulgarian and even French astronauts.

In the wake of the American space disasters and the temporary grounding of US launch vehicles the Soviets are doing all they can to penetrate the market vacated

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83. New Scientist, February 27, 1986 p. 42

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by the United States. They are aggressively marketing their proton booster,[84] to launch Third World satellites. The Soviets have made overtures to Indonesia[85] and Thailand to launch their satellites with full respect for the secrecy involved. But so far, India is the only country to have signed a commercial launch contract with the Soviet Union.[86]

Conclusion

The Soviet space programme then appears, in contrast to America's floundering programme, to be in remarkably good shape. Although minor variations in emphasis may exist there appears to be little difference between the military space programme of the two nations -- except that the Soviets have not of late embarked on an aggressive programme of space weaponisation. Early weapon systems such as FOBS have in all probability been discarded as counter-productive. The Soviets have not, at least not yet embarked on a space-based strategic defence programme based on exotic

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84. Defense Daily, March 1, 1985.
85. Ibid., November 26, 1986.
86. Ibid., November 13, 1986.

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weapon systems such as lasers, particle beams and space-based kinetic energy weapons. Space weapons though not a viable option today may become increasingly legitimate in the eyes of the superpowers as technological hurdles are overcome. One can only hope that the Soviet Union and the United States would join together to prevent weaponisation of that final frontier in the years ahead. If the two nations realised the futility of nuclear weapons in Europe and agreed to eliminate their intermediate nuclear forces, they should realise the much greater danger and expense involved in the weaponisation of outer space.

CHAPTER - II

SDI TECHNOLOGY: THE TRANSITION FROM PASSIVE TO ACTIVE MILITARY SPACE SYSTEMS

President Reagan of the United States on March 23, 1983 made his famous Star Wars speech in which he urged the development of a system that "could intercept and destroy strategic ballistic missiles before they reached our own soil and that of our allies."[1] The U.S. President then aimed to spend $26 billion to develop such a shield. The President's speech was evidently provoking, inviting inevitable criticism from the Soviet Union. Yuri Andropov labelled it "irresponsible " and "insane". U.S. allies while refraining from public criticism initially expressed their reservations over the programme. Later they all fell in line however, not because they were convinced of the success of the effort but because of the potential financial, technological and other spin-offs which could result from such participation in the Strategic Defence Initiative (SDI).[2]

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1. Transcript of President Reagan's speech March 23, 1983 exerpts reproduced in Office of Technology Assessment (OTA) report to the U.S. Congress entitled Ballistic Missile Defense Technologies: A Summary . p.2.

2. See Manfred R.Hamim and W Bruce Weinerod, "The Trans-Atlantic Policies of Strategic Defence" Qr Winter 1986, Vol 29, No.4, p.723.

SDI has rightly received world-wide criticism. Apart from the fact that research into Star Wars weapon systems has not even approached the operational stage, implementation of the programme would result in the dismantling of three decades of arms control treaties including the Partial Test Ban Treaty - PTBT (prohibiting nuclear tests in outer space), the outer space treaty (banning nuclear weapons from orbit and the Anti-Ballistic Missiles -- ABM -- treaty). It is not surprising then that President Reagan's Star Wars speech was received apprehensively around the globe.

In the late 1960s and early 1970s when the U.S. and the U.S.S.R. began to discuss the problem of strategic weapons they both recognised the existence of a strategic parity and of a mutual overkill capacity. It was also recognised that neither side could win a nuclear war by striking first. Such a strategic situation has been given various names such as MAD(Mutual Assured Destruction) or the "Balance of Terror". This international strategic system has succeeded in maintaining peace in Europe -- the theatre for conflict in two world Wars. That it led to increasing tension in other parts of the globe is a subject beyond the scope of this chapter.

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What remains infallible, however, is the fact that the so called "nuclear stalemate" may have prevented the breakout of a third world war. The SDI programme can be viewed as an attempt to break this nuclear stalemate and therefore bears dangerous portents for the stability of the international political system.

During the ABM and SALT-I treaty negotiations, the futility of a large scale ABM system was realised. This was consequently incorporated into the ABM treaty, whereby either side would be allowed to defend either a ballistic missile site or a population center. The U.S. chose the former and the U.S.S.R. the latter. Later the U.S. dismantled its ABM system realizing its uselessness.

The resurgence of the importance of ballistic missile defences in the eighties is a classic example of the effects of technology on the arms race. Technological developments had made consideration of a large scale ABM system, which was unceremoniously discarded in the early seventies, possible.[3]

There is a fundamental difference between early ABM systems and the SDI, . While older ABM systems involved defence against ballistic missiles at the terminal phase only, SDI aims to destroy ICBMs (Intercontinental Ballistic Missiles) and SLBMs (Submarine Launched Ballistic Missiles) all along their trajectory.

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3. For an excellent study of the impact of technology development on Arms Control See Joseph Kruzel .. "From Rush Bagot to START; the Lessons of Arms contol" __Orbis__, Spring 1986, vol.30 No.1 pp. 80-95.

Ballistic Missile Trajectory

The elements of a ballistic missile trajectory are summarised in the diagram. Probable exotic weapons to be used to destroy the missile in different phases of its trajectory are summarised in Table I.

It is evident that destruction of missiles at the boost phase would prove to be most profitable for the defender. This necessitates the deployment of space based elements. At the boost phase the ABM system is confronted with a minimum

Table - I

Phase		Weapons used
1.	Boost Phase (within atmosphere)	Excruiser Lasers
2.	Post-Boost and Mid-Course Phase.	X-ray lasers, free electron lasers.
3.	Terminal Phase	KEWs.

number of targets since the warheads and decoys are not yet released. Second the boost phase is the most easily detectable due to the x intense heat and light produced by the launch. The missile itself is more

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vulnerable since its fuel tank walls are more difficult to protect than the warheads proper.

Further the boost phase period for ICBMs is 200-300 seconds. For IRBMs (Intermediate Range Ballistic Missiles) it is less and may be even less in future. The ABM system for a boost phase kill, must reach its state of readiness in this shortime period.

The short-time operation of thrusters during the separation of independently-targeted warheads from the "bus" at the post-boost phase enables the targeting system to identify the warheads themselves. This mid-course phase of the ICBM targeting is the longest (20-25 min.) and therefore allows for activation of the space-based ABM system. The trajectory can be accurately predicted. At this phase however the defensive system faces the largest number of targets - warheads and decoys. The dilemma before the system is whether to destroy all targets or first discriminate between true and false targets.

During the terminal phase when the warhead reenters the atmosphere, the terminal ABM system can offer only point defence. During this phase the number of

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targets decreases because the lighter decoys lag behind warheads in the atmosphere. The time period for this terminal phase is less than one minute.

The various exotic weapons that have been proposed for various "layers" of ballistic missile defence (BMD) are given in Table-I. Some of these include lasers and particle beams (directed energy weapons - DEWs), Kinetic Energy Weapons (KEWs) including electro magnetic railguns. While these weapon systems may seem very complicated the basic principles involved are actually quite simple.[4]

Directed Energy Weapons -- Lasers and Particle Beams

The idea that heat or light energy in a concentrated form could be used to inflict damage is not altogether new. The ancient Greeks recognized the potential of directed energy when they armed the king of their goods Zeus with thunderbolts, nature's form of beam weapon. The idea of focussing the sun's energy into a concentrated beam with the aid of mirrors also occurred to the Greeks. In one legend the defenders of the city of Syracuse used mirrors to focus sunlight on

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4 Jeff Hecht Beam Weapons : The Next Arms Race, (Plenum Press, New York, 1984), pp.20-54.

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the sails of Roman ships, heating the fabric to a point where it caught fire.

Directed energy technology in its present form is however, a comparatively recent phenomenon. Researchers during World War II recognized its potential when accelerator technology was refined for use in "atom-smashers". The idea of stimulated emission and laser technology date back even earlier. It was none other than Einstine who had predicted that a molecule could be stimulated to emit light of a particular wavelength, when light of that wavelength reached it.

Before the potential military applications of laser and particle beam weapons are analysed the basic underlying technology and scientific principles have to be understood. Only then will the problems and possibilities facing deployment of such weapons as a shield against nuclear missiles become apparent.

Military planners have always been in search of an ideal weapon -- guns, rockets and missiles, though more advanced than bows,, arrows and spears of Yester years do not exactly constitute todays's definition of ideal. Development of particle beam and laser weapons would in relative terms be a quantum leap towards developing an ideal weapons system.

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Mere generation of lasers and particle beams do not constitute a weapons system. They have to be "weaponised" i.e. adapted to battlefield conditions, whether in space or on earth. While lasers and particle beams have themselves been generated, their weaponisation is the problem facing researchers today.

High Energy Laser Technology (Simplified View)

The word LASER is an acronym for Light Amplification by Stimulated Emission of Radiation. SDIO (Strategic Defense Initiative Organization) spent $350 million on laser weapons research in 86-87.[5]

Laser physics is based on the quantum view of atoms and molecules.

Basic Structure of the Atom

It is a well-known fact that atoms consist of electrons, protons and neutrons. Protons and neutrons are concentrated in the nucleus while electrons are arranged around the nucleus in shells. Mutual attraction between the positively charged nucleus and the negatively charged electrons tend to draw the electrons into the nucleus while centrifugal forces associated with revolving electrons tend to push them outwards. A

5. Aviation Week & Space Technology, March 9, 1987, p.37.

balance is maintained between these two opposing tendencies and electrons tend to remain in fixed 'orbits' or "energy levels", dependent upon the charge/mass ratio of the nucleus of the atom and the distance of the electrons from this nucleus.[6]

Consequently, electrons closer to the nucleus are held more strongly and have lower energy. While those farther away have higher energy. When energy is supplied to the atom (whether in the form of heat or light), electrons jump to higher energy levels. Under such conditions the atom or molecule is said to be in an excited state.[7]

When the electron falls back to the lower energy level it emits this extra packet of energy in the form of radiation, whose wave length is inversely proportional to the energy of the transition. The packet of light energy emitted is known as a photon. The radiation thus emitted is known as spontaneously emitted incoherrent ratiation.[8]

Virtually all the light we see normally, such as from bulbs and from the sun is spontaneously emitted

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6. Hecht, n 4, pp.16-17.
7. Ibid., pp.80-85.
8. Ibid., p.82.

packets of light (Photons). Einstein however suggested that it might also be possible to <u>stimulate</u> the emission of light from atom/molecule in a higher energy level if it comes into contract with a photon. The exited atom would then fall back to the lower energy level after emitting an identical packet of light energy resulting in what is known as <u>amplification</u>.

In normal circumstances, laws of physics states that there are more atoms in lower energy levels.[9] The probability of transition from a particular energy level is proportional to the population of (nuclear or atoms in) that energy level, i.e. upward transitions would predominate. In other words, the chance of an externally induced photon venting its energy on an atom in the lower energy level is more probable resulting in the spontaneous emission of light. However, if by some means, the number of exited atoms could be made to predominate the incoming photons (light energy packets) would in all probability interact with exited atoms stimulating emission of more photons. Such an abnormal situation in scientific jargon is known as a population inversion. Only under such conditions would amplification via stimulation take place.

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9. Ibid., p.82.

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Population inversions can be created by supplying energy to the lasing medium via electric currents, intense light, chemical reaction, X-rays, etc.

In practice however, a mere propulation inversion is not enough to stimulate emission of light. A number of practical problems must be overcome.

Light travels in a straight line. Thus a photon travelling through an exited medium would stimulate emission of light equally in all directions. Without any preferred orientation. For a laser to be a viable weapon however light emission must be concentrated into a small area.

The further a photon travels through a medium, the higher the degree of amplification or "laser gain". However, since the photon travels at the speed of light (3×10^{10} cm/sec.) it would pass out of the medium very quickly.

These problems have been overcome by placing two mirrors on either side of the medium. These mirrors reflect light back and forth through the medium resulting in highly amplified laser gain. Some of this amplified light is allowed to leak out of one of the mirrors forming the highly coherrent laser beam. The rest continues to bounce back and forth stimulating more emission.

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The laser beam's power is essentially derived from its concentration. While a 1 KW room-heater will supply heat only if you are a few feet away from it, a 1 KW laser beam can be a powerful industrial cutting tool.

A laser beam will tend to spread out as the distance from its source increases. This is known as diffraction. Concentration of the beam using focusing mirrors is essential if the laser is to be weaponised. Further lasers generate vast amounts of waste heat which must be effectively dissipated under battle field conditions. The problem of heat dissipation is more apparent in solid, e.g. ruby lasers than in lasers where the medium is a gas. At high power levels the problem of heat dissipation limits the operation of the ruby laser to a few pulses per second. The now dissembled Shiva laser at the Lawrence Livermore Laboratory in the U.S. produced pulses that had a peak power of some 20 trillion walts but lasted only about .2 billionth of a second. Such lasers are fine for fusion research but have no weapons applications whatsoever.

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Types of High Power Lasers and Their Weapon Applications

The basic technology involved in producing a laser beam whether low or high power is basically the same, i.e Stimulated emission and gain in a non-equilibrium situation where the population of the energy levels has been "inverted". The methods used to bring about this inversion and the nature of the exited material however differ. Accordingly lasers are categorised as carbon dioxide or monoxide gas lasers, chemical lasers, oxygen iodine lasers, free electron lasers, excimer lasers, X-ray lasers, etc. X-ray lasers are receiving maximum attention today are the most controversial and will therefore be discussed in detail. However, a passing reference will also be made to the working of and problems with the other mentioned laser systems.

The Carbon-Dioxide CO_2 Laser was first demonstrated in 1964 by C.Kumar Patel. Patel produced a laser beam by passing an electric current through pure carbon dioxide. The electrons in the discharge passed their energy into CO_2 molecules producing a population inversion.

CO_2 lasers produce infrared radiation at wavelengths twenty times longer than visible light. Patel's laser systems due to over heating could not go beyond

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a power of 8,800 Watts, too low a power for applications in weaponary. Thus "flow systems" were developed where the gas was made to flow between electrodes to prevent overheating.

A major problem with gas lasers is a source of electrical power. The need to carry a power supply often much larger and more cumbersome than the laser system itself has been a major factor inhibiting battlefield applications of these gas dynamic lasers.

Chemical Lasers

The Pentagon on September 6, 1985 conducted a successful test of a MIRACL (Mid Infra Red Chemical Laser) against a fixed Titan II ICBM booster which resulted in the missile component being blown apart.[10]

Chemical lasers as their name indicates derive their energy from a chemical reaction. Hydrogen and Fluorine are used to trigger a chemical reaction. These gases are allowed to expand through narrow nozzles. Producing vibrationally exited hydrogen fluoride (HF). These exited molecules are passed in between a pair of

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10. Interavia Air Letter Sept. 16, 1987

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laser mirrors which extract their energy and stimulate the emission of a laser beam of wavelength 2.7 - 3.0 km (mcm).[11] However, radiation of this wavelength is strongly absorbed by water vapour in the atmosphere and therefore the atmosphere is opaque to it. To allow laser radiation to reach the earth's surface the DF (Deutarium Fluoride) laser may be used emitting in the range of 3.6 - 4mcm to which the atmosphere is practically transparent. Thus while hydrogen fluoride lasers are fine for use in space, deuterium fluoride lasers would be more suitable within the atmosphere. Space Based Laser (SBL) programme director at the SDIO Ltd. Col. Douglas Kline characterises both as potential candidates for space-based chemical lasers.[12]

The specific energy release of a chemical laser (i.e. the energy generated per unit mass of gas mixture) is a characteristic important for its weapons application. Soviet experts have estimated the maximum possible value of this energy release as in the Table given below:

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10. Report of the Committee of Soviet scientists for Peace against the Nuclear threat entitled <u>Space Strike Arms and International Security</u> Moscow October 1985 pp 83-85.

12 <u>Defense Daily</u>, December 6, 1985

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Soviet estimates of energy release of

Chemical Lasers

Energy	Wavelength	Type
380 J/g	3.6-4 mcm	DF
530 J/g	2.8 mcm	HF

Source: Committee of Soviet scientists for Peace Against the Nuclear Threat. Space Strike Arms and International Security. Moscow 1985

This power level is however several orders of magnitude lower than required for weapons applications.

This problem could be overcome by using serial systems in conjunction with one another. Synchronised operation would however require extremely accurate pointing and tracking systems.

The continuous chemical laser used the rapid pumping of a gas mixutre through the reasonator. In powerful chemical lasers the working mixture is pumped through with supersonic velocity. Such a system introduces strong pertubations and vibrations which are inadmissible in space based systems requiring accurate targeting.
At a distance of 1000 km. a chemical laser would produce a spot of 0.3 nucleus in diameter. Exposures of 4 seconds would be required to achieve an effective kill.

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Excimer Lasers

According to Lt.Col. Kline Excimer lasers are the leading ground based laser candidates for SDI. An Excimer molecule is one where the atoms consistuting the molecule are bound together only in the higher energy state. When the molecule comes down to the ground state (lower energy stall) it falls apart implying thereby that a population inversion exists as long as there are excimer molecules to be found in the medium.

Typical exaimer molecules are those formed between the "rare" or "inert" gases such as Xenon and Krypton and halogens. Excimer molecules are formed when a mixture of gases is subject to an electrical discharge or with a laser beam. A pair of mirrors stimulates emission of a concentrated and amplified beam of ultraviolet light at a comparatively short wavelength of .25 to .35mcm. The efficiency of the system defined as the percentage of absorbed energy emerging in the laser beam is up to 10 percent. The most important lasers for use in weaponary are the Krypton fluoride and Kenon fluoride lasers.

Initially the Pentagon's interest in excimer lasers was for use in outer space. However, these lasers would require hundreds of giga walts of power for each

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battle station. Therefore, the idea of space based excimer lasers was given up.

Of late the possibility of basing the laser system on the ground probably on a high mountain with a stable atmosphere and bouncing the beam off space-based orbiting reflectors has generated interest. Successful sub-scale experiments in the U.S. have demonstrated their potential. Due to the short wavelengths of excimes lasers space based mirrors would not require a very large diameter.

On June 21, 1985 U.S. Air Force technicians conducted a successful test of an argon low power laser. The test was conducted on a mountain on the island of Maui, 10,023 feet above sea level, as the space shuttle flew overhead.[14] The target of the laser was a mirror which bounced the beam back to Mawi. In order to compensate for atmospheric distoration a technique known as "adaptative optices" is being developed. A pilot laser beam sent from the space mirror would be detected at the ground based laser. It would reveal distorations caused by the atmosphere. As a result corrections could be applied by the ground-based laser.

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14 International Herald Tribune, June 22-23, 1985

X-ray Laser

Several other short wavelength laser systems have been considered for use as weapons, but of late "Project Excalibur" or the X-ray laser programme at Lawrence Livermore Laboratory in the U.S. has been gathering momentum. The programme has generated as much controversy as it has made progress. Edward Teller, Senior Research Fellow, at Livermore considers it the most promising ABM technology proposed so far. U.S. Department of Energy has allocated $100 million for research into X-ray lasers of a total of $350 million for laser research.[15] In addition Edward Teller reportedly convinced President Reagan of the X-ray lasers' potential, resulting in a reprogramming of $100 million in funds from other SDI programmes to the X-ray laser programme.

On December 28, 1985 the U.S. Department of Energy (DOE) detonated a hydrogen bomb 1,800 ft below the ground at the Nevada test site, to evaluate the concept of a nuclear powered X-ray laser which could be used to destroy Soviet missiles in flight. The test codenamed "Goldstone" had an explosive force of 20-150 kilotons and measured 5.3 to 5.6 on the Richter Scale. Though DOE

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15. Defense Daily, October 1, 1985

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officials were characteristically tight-lipped about the test, it was apparently a success.[16]

Technologically X-ray lasers differ somewhat from the systems described so far, represent a futuristic technology and are therefore worthy of special mention.

X-Ray Laser Technology

X-rays have very short wave lengths -- generally 1-100Å (1Å=10^{-8} cm). Electronic transitions that emit X-rays are therefore extremely energetic involving an energy level close to the nucleus where electrons are firmly held and one much farther away. Exitation of X-ray lasers therefore requires a large amount of energy. In addition the exited state lifetime is very short, i.e. the medium would be exited for a very short time. The probability of stimulated emission declines as wave length decreases, further compounding the problem.

The intense pumping energy required a to excite X-ray lasers, would result in the vapourisation of the X-ray laser material. However, X-ray photons (packets of energy) would speed through the medium causing amplification and gain along the way and leave the medium long before the pumping energy is transferred directly to the atoms causing vapourisation. Consequently an X-ray laser would invertibly self-destruct and can

16 Defense Daily, January 2, 1986

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therefore be used only once. Mirror optics would not work because the X-ray laser energy would vapourise the mirrors if the nuclear pumping energy had not done so already. X-rays are strongly absorbed by the atmosphere and therefore any future battle station would have to be based in space treating problems with pumping X-ray lasers.

Mirrors cannot be used for amplification as they are in other lasers. The energy of the X-ray pulse would vapourise them if the laser pumping energy had not done so already.

Therefore instead of a resonator, X-ray lasers would rely on "amplified spontaneous emission", . Spontaneously emitted photons would stimulate the emission of other photons as they passed through the exited laser material. With no mirror at the end of the material the amplified beam would emerge in the direction of the laser rod.

Achieving electronic transitions of the extremely high energies required for X-ray emissions proved to be no easy task. In 1981 however it was reported that researchers at Lawrence Livermore Laboratory in the U.S.

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had used X-rays from a small nuclear explosion to pump an X-ray laser. The more recent test at Nevada whose outcome is classified proves that the technology has now been refined.

The basic concept of an X-ray laser battle station involves a ring of about 50 laser rods surrounding of a low yield nuclear warhead. Each rod would be pointed at a target, therefore, requiring its own pointing and tracking system, a formidable requirement. The bomb would be detonated and the X-rays generated would pump the laser rods, resulting in a population inversion at extremely high energy levels. Stimulation would take place spontaneously as X-ray photons travelled through the exited laser medium. The amplified highly directional laser beam would emerge from the end of the rod, its width being dependent on the dimensions of the rod. The narrower the rod the more directional the beam would be. X-rays from the nucle r explosion would diffuse in space but the energy in the X-ray laser beam would remain tightly focused, far from the battle-station where it could disable its target.

X-ray lasers have posed a vast array of problems to researchers. One of the most potent remains the large number of pointing and tracking systems required for

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individual laser rods in a battle-station composed of, say 50 independent rods. The hardware required is not easy to come by.

In fiscal 1983 the U.S. Defence Advanced Research and Projects Agency (DARPA) invested $35 million in Talon Gold pointing and tracking experiment.[17] A shuttle test, verified its ability to track and point lasers at satellites, aircraft and ground targets.

Long thin laser rods required for high power X-ray lasers would be subject to vibrations and bending. They must all be pointed at their targets when the bomb goes off. Practical requirements call for the relative positions of the two ends of the rod to be controlled within one part in a thousand. Slight mechanical vibrations could knock the lasers off target.

The nuclear explosion itself would not affect the alignment of the laser beams because X-rays travelling at the speed of light would leave the rods before the force of the explosion hit them. The problem however lies with the conventional explosive generally used to trigger a nuclear blast by forcing two sub-critical masses of fissionable material together. The vibrations produced by this conventional explosive would have time

17. See OTA report n 1 p.82
See also Defense Daily March 4, 1985.

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to travel through the rods before the nuclear explosion is produced. Details are being researched and are believed to be classified.

To be a viable defence against boost-phase attack the system must either be based in space, or it must be launched upon warning of an attack (pop-up laser). Orbiting X-ray laser battle-stations, on the other hand would be extremely vulnerable to an enemy ASAT attack. Even the advocates of X-ray laser battle stations admit that the weapon could be foiled by launching an attack slowly enough, that there would be targets only for a few of the lasers on each battle station.

There are natural limits on the distance to which X-rays can propagate within the atmosphere (short wavelengths are strongly absorbed). The X-ray laser must therefore wait for the booster to climb higher than atmospheric altitude for it to be effective.

Pop-up X-ray lasers could be countered by develop ing fast burn boosters. The boost phase time period for an ICBM is 200 - 300 seconds. A pop-up system must therefore be deployed in less than that time frame. The boosters on the laser would have to be faster and

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more rapidly accelerating than ICBM boosters. The enemy could counter this defence by building faster burn boosters.

The X-ray laser situation is not all that dreary however. They have other potential uses apart from use in weaponary. X-ray lasers could be effectively used to distinguish between warheads and decoys during mid-course flight, which lasts about 25 minutes and therefore permits popping up of the laser system. They could also be used in medicine since they provide exceptionally clear three dimensional portraits of human tissue and crystalline molecules.

Many scientists believe that the X-ray laser will make an extremely effective anti-satellite weapon but doubts persist over its utility for missile defence. It has even been postulated that lasers could trigger urban fires.

Particles Beam Weapons

The Pentagon in May 1985 initiated studies on conceptual design for a flight of a neutral particle beam (NPB) system.[18] The study included the conceptual design of a system configuration consisting of a space qualified NPB source, a target acquisition system and a detector system. The integration and operation of the system will also be studied and relevant experiments proposed.

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18 *Defense Daily*, May 13, 1985

While studies on space deployment of NPB's are recent in origin, the technology itself dates back to World War II when accelerator technology was refined for use in fission research.

One can get a simplified understanding of how a particle beam weapon works by a brief look at nature's version of a particle beam -- lightening. Lightening occurs when natural processes in the atmosphere separate electrons from atoms and build up a high static voltage between the clouds and the ground. If this voltage is high enough to cause a breakdown of air (which acts as an insulator), a powerful electric current will flow between the clouds and the ground. The carriers of this current are charged particles for example electrons.

Unlike the massless photons which direct energy in lasers the particles which constitute particle beams have mass. Thus while a laser destroys its target by heating the surface. Charged Particle Beams(CPBs) would deposit their energy deep within the target, where they are likely to cause more lethal damage than the laser beam. Deployment problems of CPB weapon systems can only be understood after a brief look at the underlying technology.

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Particle Beam Technology

The Pentagon holds that "particle beam technology is in the very early research and exploratory development phases with fundamental issues of feasibility to be resolved. There is an enormous gulf between the technology required for fulfillment of the conceptual payoffs and the "state of the art".

Particle beam technology broadly encompasses four sub-technical aspects. These are:

(1) Beam generation

(2) Particle acceleration

(3) Propagation

(4) Beam Control (Pointing and tracking).

Beam Generation

Generation of a beam of energetic particles starts with the generation of the particles themselves. These particles may be electrons, protons (hydrogen atoms which have lost one electron) or negative ions (atoms with one or more extra electrons). Generation of these particles requires large amounts of electrical power and switching systems which regulate power output in intervals of billionths of a second.

The first stage of a particle beam generator is a source of the particle. The simplest source is a potential

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(voltage) applied across a pair of conducting electrodes in vacume, what a high school student would call a "diode" in electrical terminology. Negatively charged particles (electrons) are emitted from the negatively charged electrode(Cathode) and polar forces carry them towards the positively charged electrode the anode. Instead of being collected at the anode the electrons pass through it into the accelerator. [19]

A pulse of ions starts in the same way, with a short, high voltage pulse applied to a pair of electrodes. Positively charged ions (atoms that have lost one or more electrons) come from the positive electrode, produced either from the electrode material or a discharge in a gas. If the goal is negatively charged, ions, electrons are injected into the positive electrode, so that they are likely to attach themselves to gas atoms coming to that electrode from the negative electrode(cathode) producing negatively charged ions which can be drawn into the accelerator.

Electron or particle beams powerful enough to be of interest for weaponary are not produced continuously but rather in short bursts or pulses (analogous to bolts of lightening). The simpliest way to provide this power is to store electrical energy in large capacitors.

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19 Hecht n. 4 p. 42

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Accelerator Technology

Accelerator technology is being researched at Lawrence Livermore Laboratory in the U.S. So far two leniar electron accelerators have been built. The experimental test accelerator began operation in 1979 as an outgrowth of the Navy's "Chair Heritage" programme.[20] was intended only as a testbed for the Advanced Test Accelerator (ATA) which generates pulses of 50 million electron-volt electrons.

Both ETA and ATA are linear induction accelerators in which a series of accelerating arrangements are arranged in a straight line. In operation a pulsed alternating electrical voltage swiftly changes the electric field applied to the beam thus accelerating the particles. The process is repeated with the voltage increasing as the beam of particles pass down the accelerator tunnel accelerating it further at each step.

Sandia National Laboratories NM, USA, developed a similar system RADLAC-1 (Radical Line Accelerator). RADLAC-1 zaps targets to produce X-rays which stimulate the effects of nuclear explosions. In addition RADLAC-II, became operational in August 1985 and produced its first beam.[21] The goal of the programme is to develop

20 Defense Daily, Oct 5, 1985

21 Aerospace Daily, Aug 28, 1985.

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high current, high energy leniar accelerator technology to investigate the physics of producing and propagating potentially lethal beams of electrons. Sandia National Laboratories, Air Force Weapons Laboratory and DARPA took part in the programme. Sandia said that RADLAC-II is the highest power induction leniar accelerator in the U.S. and will help address key issues in research of potential directed -- energy weapons, using electron beams. "If successful this accelerator technology would be capable of producing multi-mega watt electron beam pulses of about 100 nano second duration. If a significant fraction of the energy in a single such pulse can be delivered to any military target, the beam would cause castrophic destruction of that target" a Sandia scientist said.[22]

Beam Propagation

A charged particle beam is subject to two conflicting effects caused by the electrical charge carried by the particles. Like charges repel each other, but the flow of so many like charges in the same direction generates a magnetic field surrounding the beam that tends to pinch it together. This self-pinching effect would occur when the beam is travelling through air.

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22 Cited in Aerospace Daily, August 28, 1985

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Air tends to absorb some of the energy particle beams carry; under normal circumstances an electron beam could make its way through 200 meters of air before half its energy had been absorbed by the atmosphere.

For single pulses this would limit the range of the weapon. However the first pulse would have heated the air around it causing it to expand and consequently clearing out a path for the second beam. Theoretically this "hole-pinching" effect should make it possible to transmit electron beams for a few kilometers.

In addition recent research has revealed that charged particle beams electron beams for instance can be propagated through the atmosphere by creating a conductor path from the source to the target along with the charged particle beams will travel. This is done by using a laser to create an ionised channel through the upper atmosphere, through which the electron beam is pumped. Such experiments have been conducted but results are classified. The project has been designated Antigone, after the daughter of Oedepus in Greek mythology.

Neutral Particle Beams (NPBs)

Charged particle beams cannot be sent thousands

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of kilometers through space to destroy enemy missiles. Not only would mutual repulsion cause the beams to break up, but the earth's magnetic field would bend the beam in complex unpredictable ways. These problems can be avoided by using beams of neutral particles, a concept being tested by DARPA's White Horse programme at Los Almos National Laboratory.[23]

Particle accelerators work only on charged particles. Neutral particles therefore cannot themselves be accelerated. The approach being researched at Los Almos is to start with negatively charged hydrogen atoms (hydride ions H^-), hydrogen atoms with two electrons instead of one),. After being accelerated to high energies in a Radio Frequency Quadrapole (RFQ) and a conventional leniar accelerator, the particles are passed through a gas or some other medium focuses that would strip off the extra electrons to leave a beam of neutral particles.

The RFQ, incidentally, is a Soviet invention, which has four poles instead of two. The RFQ accelerates the beam as well as focusses it. Neutral particle beams are not held together by the same cohesive effects that come into play in charged particle beams. Fortunately

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23 For a summary of NPB technology. See Harold Brown, "Is SDI technically feasiable" Foreign Affairs Vol. 64, No.3, 1986 pp 435- 454.

in outer space there is nothing to get in the way and the uncharged particles would not be affected by the earth's magnetic field. Though gravitational effects would come into play (due to the comparatively large masses of the particles), these would be negligible at high speeds.

The NPB would travel at velocities 100,000 times faster than prospective targets. In addition the energy would be deposited deep within the target thus destroying it (unlike lasers which deposit their energy on the surface). Dr. Burick, who heads the White Horse project at Los Almos says that the beam "converted a super-cooled copper stop instantly into green plasma". [24]

White Horse scientists have recognized the importance of the ion source in particle beam weapons research and also the UK's expertise in this field. Los Almos has placed a major contract totalling E 1.5m for the ion source with Culham Laboratories, U.K. [25]

Neutral Particle Beam technology has its problems however. Stripping of the extra electrons scatters the particles and harms beam quality. Such scattering could

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24 For US, NPB Prog See <u>Aerospace Daily</u>, Mar 29, 1985

25 <u>Financial Times,</u> Feb, 17, 1985.

disperse the beam causing it to spread out and thus reduce its intensity to a point where it would not be lethal. It could also be deflected causing it to miss its target altogether.

Particle Beam Technology is currently in the development stage. Its feasibility for weapons applications has not been firmly established. However, neutral particle beam technology is showing considerable promise for strategic defense applications like target designation. The total budget for the technology is expected to leap from $18 million in FY 85-86 to $120 million in FY 86-87.[26]

Kinetic Energy Weapons

The Third category of weapon systems which had been proposed for SDI are Kinetic Energy Weapons. Though attempts have been made to portray these as exotic Kinetic Energy Weapons (KEWs) are in no way different (in terms of physical principles involved) from the early ABM systems -- Safeguard, Galosh etc. which also employed the principle of Kinetic kill.

Kinetic energy weapons as their name suggests involve the use of pellets accelerated to high speeds, to destroy incoming warheads. The mode of imparting

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26 For SDI budgeting trends see Aviation Week and Space Technology, March 9, 1987.

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kinetic energy may however differ. For instance early ABM projectiles employed chemical energy - burning fuels (liquid or solid) to impart kinetic energy to their projectiles. Exotic KEWs being proposed may use electro-magnetic propulsion accelerate projectiles to high speeds. Electro magnetic propulsion involves accelerating a conducting projectiles to a high speed along a long rail along which a steadily increasing electro magnetic field is applied - hence the name electro magnetic railgun.

Over the years research into exotic weapon systems such as lasers and particle beams have revealed that such technologies though fine in principle are decades away from being weaponised (see earlier section). With support for SDI beginning to dwindle in the US Congress and with Reagan who was see as the driving force behind the programme on his way out supporters of SDI began in1986 a desperate struggle to keep the programme alive. Early deployment or Phase 1 deployment became the key to SDI's future. Today ardent opponents of Kinetic Energy Weapons like Edward Teller have begin supporting a limited SDI involving kinetic energy weapons and not exotic technologies like lasers or particle beams. Under the new concept SDI

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is to involve three phases. Phase I would be a limited SDI system involving Kinetic Energy Weapons both ground and space based. Phase II would expand on Phase I to cover not only missile sites but population centers. Phase III, would be a full fledged SDI system involving exotic weapons systems which by the time this phase is implemented would have come on stream.

SDI in 87-88

The first phase of SDI would employ conventional rockets based on rocket propulsion, very similar to ABM systems that existed in the seventies. The system would probably be a set of guided rocket interceptors which would "home in" [27] on the target and destroy it by force of impact. In other words, these defensive weapons would use kinetic energy to destroy their targets as against beams and explosive weapons. They would also use a network of yet-to-be-developed sensors, communication software and battle management systems. As will be seen in the next chapter these factors are crucial to the so-called broad interpretation of the ABM treaty.

The first time of an early missile defence would probably be a series of space-based kinetic kill vehicles

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27 David E. Sanger, "Many experts Doubt 'Star Wars 'could be effective by the mid 90's, New York Times, February 11, 1987.

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(SBKKVs) (5,000-10,000) mounted on 200-400 orbiting "garrages" which would knock out enemy missiles within minutes of launching by colliding with them. The large flaming tail of the booster rocket would enable short wave infrared (SWIR) [28] identification of the missile. The second line of defence would involve a series of ground-based missiles launched from the United States.

Seeking out independent warheads in space would be a more difficult matter. There would be no flaming "tail" for identification. Warheads and decoys would cruise through space together and at the same speed, not allowing for discrimination. Tracking would therefore prove a difficult task. Fortunately, however, all objects in space are long wave infrared (LWIR) emitters. They could therefore be detected, though with some difficulty. The problem lies in the fact that the earth too is a LWIR emitter and therefore sensors designed to detect and track warheads in space would have to face away from the earth to prevent the warhead signal from being drowned in LWIR radiation being emitted from the earth. There are no indications of these formidable tracking problems being solved soon enough to allow early deployment by 1993, as Carpor Weinberger former US Defence Secretary, has asserted.

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28 SWIR, LWIR and MWIR are acronyms for Short, Long and Medium Wave Infra Red Radiation.

The terminal layer of the ED (Early Deployed) SDI would find warhead tracking and discrimination an easier task. Warheads when they re-enter the atmosphere heat up and become SWIR and MWIR emitters. The lighter decoys either burn up as a result of re-entry or fall back, being much lighter than the warheads themselves. Homing interceptor missiles with sensitive MWIR sensors based on the ground would track and destroy these warheads by force of impact.

The SDI programme, with early deployment in mind, has thus acquired a dual thrust, i.e. space based kinetic kill vehicles (SBKKVs) and ground based interceptors (HEDI and ERIS). SDIO confidence with regard to SBKKVs is high because of the success of the SDI Delta 180 experiment conducted on September 5, 1986, when a kill vehicle equipped with a Hughes Phoenix air-to-air missile radar tracker successfully acquired, tracked and then actively manoeuvred to intercept and destroy another satellite.

SDIO's ground-based kinetic interceptor programme consists of two major technolgies being perfected for ABM defence -- the High Endo-atmospheric Defence Interceptor (HEDI) and the Exoatmospheric Re-entry vehicle Interceptor System(ERIS).

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Mid-Course Interception - ERIS

The weaponry being developed for mid-course intercept is the Exoatmospheric Re-entry Interceptor System (ERIS). It is an outgrowth of the 1984 Homing Overlay Experiment (HOE) in which a rocket launched from Kwajalein test range in the South Pacific destroyed a dummy warhead fired from Vandenberg Air Force Base, about 3000 miles away in California (USA).[29] The manoeuvrable stage of the rocket used in the experiment contained sensors and an umbrella like "kill device" and weighed more than a ton. Lockheed Company officials who are involved with the ERIS programme told the US House Armed Services subcommittee recently that Lockheed can deliver a workable ERIS system "within four to five years of the go-ahead."[30] The cost of an ERIS system was estimated to be 1 million per intercept. The first flight test for ERIS is planned some time in 1989.

HEDI Technology

While ERIS is a mid-course intercept system, HEDI is designed primarily for terminal defence. McDonnell Douglas, the prime contractor for HEDI systems development, claims that HEDI could reach Initial Operational

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29 *Defense Daily*, July 7, 1985

30 *Defense Daily*, Jan 13, 1987

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Capability (IOC) by 1994. HEDI forms the terminal phase of the early deployed SDI system with SBKKVs and ERIS. Constituting the mid-course defence, McDonnell Douglas claims that a HEDI system with an overall effectiveness of 93% would cost $110 billion. The George C. Marshall Institute in its report on missile defence in the 1990s put the cost of a single HEDI interceptor at $3 million.[31] The total cost of a deployed HEDI system, consisting of 30 radars, launch facilities for 30 sites, 3,000 interceptors and one year's operation and maintenance, adds up to $18 billion.[32]

HEDI does not face the discrimination problem that ERIS does. Being a terminal defence system HEDI needs to destroy only incoming warheads since most decoys, being lighter, have either fallen back in the atmosphere or have burned up due to the heat of re-entry. The Medium Wave Infra Red radiation generated as a result of the heat of re-entry enables the sensitive MWIR detectors at the tip of the interceptor missile to track and home in on the target. However, the tip of the interceptor rocket also gets heated as it rushes through the atmosphere, thereby interfering with the guidance system. This had proved to be a major

31 Defense Daily Jan 13, 1987

32 Ibid.

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shortcoming of HEDI technology. McDonnell Douglas officials, however, claim that one of their major accomplishments with regard to HEDI technology has been the introduction of a system which cools the IR sensor with gaseous nitrogen to allow it to detect its target.

Budgeting Trends

The emphasis SDIO has begun placing on early deployment of SDI is evident from the budgeting trends for various segments of the SDI programme in the FY 1987 budget (see Table 1). Total allocations for Kinetic Energy Weapons (KEWs) are budgeted to increase from $545.8 million in FY 1986 to $1,199.7 million in FY 1989, while Directed Energy Weapons (DEWs) show a more modest increase from $803.4 million to $1,245.8 million. The budget for SBKKVs scheduled to increase from $226 million in FY 1986 to $357 million in FY 1989. The Pentagon wants to increase sepending on ground KKVs from $107.6 million in FY 1987 to $307.6 million in FY 1989.[33]

TABLE - I

Budget for	Fiscal 1986	Fiscal 1987	Fiscal 1988	Fiscal 1989
	(Dollars in Millions)			
Directed Energy weapons	803.4	843.6	1,103.7	1,245.8
Kinetic Energy	545.8	729.6	1,074.7	1,199.7

Source: Aviation Week and Space Technology, March 9, 1987, p.38.

33 For KEW budgets See Aviation Week and Space Technology, March 9, 1987, p.38.

Many scientists have criticised the early deployment decision contending that it would have an adverse impact on the overall SDI programme. Early research had concentrated on directed energy weapons, specificially Project Excalibur or the X-ray laser programme, and White Horse, a neutral particle beam experiment. Lasers and particle beams have fallen behind and Kinetic Kill Vehicles have taken their place.[34] Scientists at Lawrence Livermore Laboratory, the main centre of research on advanced high power lasers, have been specially critical of this shift in priorities.[35] They say that such shifts would not bode well for the development of a comprehensive ballistic missile defence in the long term.

Despite the claims to the contrary of contractors such as McDonnell Douglas and Lockheed Co., a shrewd observer would easily identify the problems with an early deployed system. Critical battle-management and software problems would remain. Orbiting space based kinetic kill vehicles would be vulnerable to ASAT (anti-satellite) attack. There has been considerable speculation in the United States

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34 See, William J. Broad, "Early Deployment Said to Harm SDI Goal" in <u>International Herald Tribune</u>, March 10, 1987

35 Ibid.

on whether they have the launch capacity to get the system into orbit. Conservative estimates indicate that at least six to eight million pounds of gear -- including space "garages," sensors and battle management stations that would coordinate the defence would have to go into orbit. Others say the figure is twice the above.

Getting eight million pounds into orbit would require about 125 space shuttle flights. With the space shuttle on hold and the American space programme slowly recovering, it is doubtful whether this launch capacity could be achieved by 1992, when, as Weinberger claims, the system can be deployed. A failure of any one layer of the system would put an additional burden on the follow-up system. A 90% defence does not appear feasible with an advanced BMD system, leave alone with the rudimentary system that SDIO officials are taking about.

What then has motivated the Reagan administration to opt for early deployment? One reasonable explanation could be that having walked out of SALT the United States wishes to violate the ABM treaty while the Reagan administrationis in office and the political will to violate the ABM treaty exists.

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The SDI programme has already developed its own "constituencies" [36] and has established an economic momentum of its own. The ABM treaty remains the only hindrance. Witness, therefore, the shift towards the "broad interpretation" of the ABM treaty.

It will prove rewarding therefore to analyse the ABM treaty in the context of the early deployment decision. Only then will it be clear how the Reagan administration has twisted its interpretation of the treaty to serve its own ends. This will be taken up in the next chapter.

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36 Kruzel n. 3 p. 86.

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CHAPTER - III

LEGAL ISSUES

The debate over Early Deployment and the ABM treaty has overshadowed other legal issues related to SDI. SDI development, testing and final deployment would violate the Partial Test Ban Treaty (PTBT, 1963) which bans the testing of nuclear at devices in outer space and the Outer Space Treaty (OST) which prohibits the deployment of nuclear weapons in outer space. Third generation nuclear weapon systems such as the X-ray laser which would utilize a nuclear explosion to energise the laser rods which produce the laser beam would if and when deployed violate both these treaties. The X-ray laser beam would have to be generated in space because the very short waive length X-rays do not penetrate the atmosphere. However possible ABM treaty violation has generated. the most controversary and the ABM treaty shall therefore be analysed in detail in the context of the Early Deployment Issue.

ABM Treaty

The ABM (Anti-Ballistic Missile) treaty was signed by the United States and the Soviet Union in

Moscow on May 26, 1972. Instruments of ratification were exchanged on October 3 the same year. Recognising the technological constraints on then existing ABM systems and realising also that a defensive arms race would be futile, the superpowers agreed to place certain limits on ballistic missile defences. The ABM treaty in effect gave credence to nuclear doctrines such as mutual assured destruction (MAD) and reinforced the structure of deterrence. Mutual vulnerability was deemed as stabilising, nearly eliminating the possibility of high intensity conflict on areas of prime interest to the superpowers such as continental United States, Europe and the Soviet Union.

Due to the non availability of appropriate technology, ABM systems of that time, such as the American Safeguard and the Soviet Galosh, could not provide an effective defence against ballistic missile attack. Both parties to the treaty then decided that by concluding the ABM treaty they would reduce to a large extent the uncertainties involved in the game of nuclear brinkmanship.

Today, however, almost fifteen years after the agreement was signed, things seem to have changed. While a comprehensive defence against ballistic missiles may be decades away[1] no physical laws would prevent

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1 Cited in <u>Defense Daily</u>, January 2, 1985

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the construction of an BMD system. Technology has developed to an extent that any further development or testing would come into conflict with the "traditional" view of the ABM treaty. The Reagan administration therefore requires the "broad interpretation" to carry on with SDI research.

Let us begin the analysis by stating the controversial articles of the ABM treaty.[2]

Article I

1. Each party undertakes to limit anti-ballistic missile (ABM) systems and to adopt other measures in accordance with the provisions of this treaty.

2. Each party undertakes not to deploy ABM systems for a defence of the territory of its country and not to provide a base for such a defence, and not to deploy ABM systems for defence of an individual region except as provided for by Article III of this treaty.

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2 For further details of the ABM treaty see US Arms Control and Disarmament Agency (ACDA), Arms Control and Disarmament Agreements; Texts and Histories of Negotiations, Washington D.C., 20451, pp 139-47.

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Article II

1. For the purpose of this treaty an ABM system is a system to counter strategic missiles or their elements in flighting trajectory, currently consisting of:

(a) ABM interceptor missiles, which are interceptor missiles constructed and deploy -ed for an ABM role, or of a type tested in an ABM mode.

(b) ABM launchers, which are launchers constructed and deployed for launching ABM interceptor missiles, and

(c) ABM radars, which are radars constructed and deployed for an ABM role or of a type tested in an ABM mode.

2. The ABM system components listed in paragraph one of this Article include those which are:

(a) operational

(b) under testing

(c) undergoing testing

(d) undergoing, overhaul, repair or conversion or

(e) mothballed.

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Article III and IV lay down specific rules for deployment of ABM rockets, launchers and radars.

Article V

1. Each party undertakes not to develop, test or deploy ABM systems or components which are sea-based, air-based, space-based or mobile land-based.

Article VI

1. To enhance the effectiveness of the limitations on ABM systems and their components provided by the treaty, each party undertakes not to deploy in the future radars for early warning of strategic ballistic missile attack except at locations along the periphery of its national territory and oriented outward.
Article XIII provides for a standing consultative commission which would consider questions concerning compliance with the obligations assumed and related situations which may be considered ambiguous.

Agreed Statement D

In order to ensure fulfilment of the obligation not to deploy ABM systems and their components except as provided for in Article III of the treaty, the parties agree that in the event ABM systems based on

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other physical principles and including componets capable of substituting for ABM interceptor missiles, ABM launchers or ABM radars are created in the future, specific limitations on such systems would be subject to discussion in accordance with Article XIII and agreement in accordance with Article XIV of the treaty. (Article XIV provides for amendment procedures).

The Debate

The largest bone of contention in Washington of late has been the traditional view of the ABM treaty pitted against the so-called broad interpretation. The US administration announced that it had seriously considered adopting the broad interpretation ostensibly because SDI research, particularly that related to the early deployment scenarious discussed earlier, would be severely constrained by the traditional view. Sam Nunn, a Democrat from Georgia, chairman of the US Senate Armed Services Committee (SASC) has said that the formal adoption of the broad interpretation would create a "constitutional crisis of broad dimensions."[3]

The broad interpretation which the Soviets have categorised as new was put forward in February by Abraham D. Sofair, now the chief legal advisor at the

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3 Cited in New York Times, March 11, 1987.

US State Department, and vociferously supported by administration officials including Richard Perle and Caspar Weinberger. The ABM debate has in fact ricocheted back and forth between Richard Perle and Sam Nunn. Nunn has charged Sofair with presenting a "complete and total misrepresentation" of the negotiating record of the treaty.[4] In his address Sam Nunn admitted ambiguities in the negotiating record which have been cited by proponents of the broad interpretation in support of their view. However, he asserted that the "negotiating record is the least persuasive evidence of a treaty's meaning... It does not have the same standing as ratification proceedings whereby the Senate takes a formal testimony and has a formal debate and has formal presentation of matter by administration witnesses."[5] Richard Perle on the other hand has asserted that the Soviets have stated and demonstrated that they do not consider themselves bound by the US ratification process.[6]

The debate between Perle and Nunn has thus boiled down to a situation where the negotiating record is projected to challenge Senate ratification proceedings.

4 Cited in <u>Washington Post</u>, March 13, 1987
5 Cited in <u>Defense Daily</u>, March 18, 1987
6 <u>Defense Daily</u>, March 16, 1987.

The Two Interpretations

The US administration, following the broad interpretation of the ABM treaty, contends the development, testing and deployment of space-based and other mobile ABM systems and components is banned for those systems that existed at the time that the treaty was signed, i.e. missiles launchers and radars. This is done by Article V. This ban applies only to these types of ABM systems because the treaty defines ABM systems and components in terms of technology that existed at the time. This is done in Article II which lists the components of an ABM system.

Finally, the broad interpretation contends that as a consequence there are no limits at all on the testing and development of futuristic systems. In other words futuristic systems, i.e. those based on other physical principles, can be tested in space. This would not violate Article V. However, the deployment of futuristic systems is banned under Agreement Statement D.

The traditional interpretation which was also the Soviet interpretation contends that the development, testing and deployment of space based and other mobile ABM systems and components is banned by Article V,

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regardless of whether these systems existed when the treaty was signed or are futuristic systems based on other physical principles such as lasers or particle beams. This ban applies to both traditional and futuristic ABM systems because Article II defines an ABM system as a "system to counter strategic ballistic missiles or their elements in flight trajectory." The lists of ABM systems cited in the treaty -- as rockets, launchers and radars -- is not intended to be exhaustive since new systems could come into being in future which would be subject to discussion (Agreed Statement D) by a Standing Consultative Commission set up by Article XIII. Thus the traditional interpretation allows the development and testing of fixed land based ABM systems including systems in existence when the treaty was signed and futuristic systems. Thus the development and testing of futuristic systems can be done at agreed test ranges. Their deployment is banned by Article II and Agreed Statement D taken together.

Under the traditional interpretation, therefore, Article V bans the deployment of space based ABM systems whether they be traditional or futuristic. The broad interpretation contends that Article V does not apply to futuristic systems and they can therefore be tested and developed in any mode. Agreed Statement D, however, bans deployment of these systems.

The Negotiating Record

The present controversy is apparently an outgrowth of the Nixon directive which instructed negotiators of the treaty to protect the right of the United States to develop futuristic lasers on which US scientists were already working secretly but to ban deployment. American negotiators apparently put forward two suggestions in this regard.[7] One was to ban the development, testing and deployment of all mobile ABM devices including interceptor missiles, missile launchers and radars. This would also cover "other devices to perform these functions" implying thereby that any systems developed in the future would also be covered. The second major proposal was to ban the deployment of new types of stationary ABM systems such as those using lasers. Former US negotiators state that they made headway on the first proposed but not on the second.

On September 15, 1971, the US accepted the Soviet suggestion that Article V refer to "components"

7 Michael R. Gordon "Arms Debate Now Centers on ABM Pact", New York Times, February 17, 1987.

instead of "devices." The suggestion that reference to a "ban on other devices substituting for existing components" was dropped. American negotiators, however, said that the Soviets agreed that the terms of the article should be taken as implying that future systems were covered by the treaty.

However, when negotiators reconvened at Vienna some time later, Soviet officials apparently questioned whether limits should be set on futuristic systems. Some experts believe that the Soviets were merely trying to learn more about what "futuristic systems" the United States was developing. Sofair has contended that this section of the negotiating record shows that the Soviets had no intention of placing any limits on futuristic systems.

One of the American negotiators, Raymond L. Garthoff, says that while Article II was being drafted an important step was taken to see that futuristic systems were covered. The word "currently" was introduced in defining ABM technology. This would imply that other systems could come into being in future.

In this context Article V and Agreed Statement D all put together would tend to ban space based development and testing of futuristic systems, the Soviets agreed to the use of the world "currently" on December 21, 1974.

The question of stationary, land based ABM systems was taken up in Agreed Statement D. Garthoff contends that Agreed Statement D allowed development and testing but banned deployment of stationary futuristic systems.

The use of the word "created" in Agreed Statement D tends to bear out this view. Creation of new ABM systems would require development and testing. Deployment would, however, be subject to joint review under the Standing Consultative Commission set up by Article XIII.

Sofair disputes this view. He says that the Americans sought to get the Soviets to agree to ban on development and testing of new types of systems but succeeded in getting the Soviets to ban only deployment. He goes on to say that Agreed Statement D cannot have been included to ban deployment futuristic systems because the deployment of such systems is banned by Articles II and III. Therefore, Agreed Statement D must have had another purpose. He suggests that the Americans, having tried and failed to negotiate a ban on development and testing of futuristic systems, settled only for a ban on deployment of these systems.

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Negotiators refute Sofair's argument. They say that Agreed Statement D was completed before work on Article III was finished.

Ratification Proceedings

The Senate, when it was conducting hearings on the treaty, was told that Article II encompassed all ABM systems, be they current or futuristic. This would tend to support the traditional view of the treaty. Further, since the time the treaty was negotiated four consecutive administrations have subscribed to the narrow interpretation. Thus the "subsequent practice" too showed that the traditional view holds good.

The philosophy of the ABM treaty articulated in the Preamble is to set limits on anti-ballistic missile systems so that the pace of development of offensive weapons slows down. It specifically states that:

..... Considering that effective measures to limit anti-ballistic missile systems would be a substantial factor in curbing the race in strategic offensive arms and would lead to a decrease in the risk of the outbreak of war involving nuclear weapons. Proceeding from the premise that the limitation of anti-ballistic missile systems, as well as certain agreed measures with respect

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to the limitation of strategic offensive arms would contribute to the creation of more favourable conditions for further negotiations on limiting strategic arms.

Mindful of their obligations under Article VI of the NPT.

Declaring their intention to achieve at the earliest possible date the cessation of the arms race and to take effective measures towards reductions in strategic arms, nuclear disarmament and general and complete disarmament, agree as follows[8].... etc.

The broad interpretation of the ABM treaty not only would not help serve any of these ideals but in fact specifically violates the spirit (and letter) of the treaty. The move towards early deployment, the driving force behind the ABM treaty, would lead to an intensification of the strategic offensive arms race, the very thing the ABM treaty sought to avoid. As a counter to any defensive system the United States would set up, the Soviets would choose the cheapest countermeasure, viz. proliferation of offensive weapons; and

8 See US ACDA , op. cit., p. 139.

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they have reportedly so stated. The broad interpretation then would violate the very purpose for which the ABM treaty was negotiated, i.e. to curb the offensive arms race through limits on defences.

Early Deployment Technology Vs. the ABM treaty

Having analysed the ABM treaty in both its "forms" and also having reviewed technologies for early deployment of SDI it would prove interesting to study the impact of early deployment of SDI on the ABM treaty. Only then will it become clear why the treaty has been so blatantly distorted.

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The broad interpretation of the treaty is at pains to show that development and space based testing of ABM systems based on "other physical principles" is permitted since these systems did not exist at the time when the treaty was signed. Here lies the major contradiction.

As is evident from the discussion on early deployment technologies, any rudimentary BMD system would consist only of kinetic energy weapons such as SBKKVs, ERIS and HEDI. The physical principle involved here is kinetic kill, i.e. destruction by force of impact.

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This physical principle is by no means new. Cavemen who used slings to hurl rocks at one another also used the principle, the only difference being the way in which kinetic energy (energy of motion) is imparted to the projectile in question. The rudimentary ABM systems of the seventies -- the US safeguard and the Soviet Galosh -- also used the principle of kinetic kill. Rocket, propulsion, i.e. chemical combustion energy, was used to impart the required kinetic energy of motion. SBKKVs of today may use electromagnetic energy to propel a projectile but the physeical principle remains essentially the same kinetic kill. Lasers, if they can be successfully weaponised, would constitute a "new physical principle" based as they are on light energy consisting of photons. Kinetic energy weapons, be they SBKKVs, ERIS or HEDI are based on the same physical principle that has been used in weapons since the stone age i.e. kinetic kill.

Supporters of the broad interpretation then find themselves in a quandary. To fall under the broad interpretation they must portray early deployment technology as exotic, new and based on "other physical principles." The physical principle, however, remains essentially the same. To get around this dilemma

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Richard Perle has presented some interesting arguments. First of all, he contends that ABM systems in existence in the seventies destroyed their targets by exploding near them, some using nuclear explosives while systems such as SBKKVs, HEDI and ERIS destroy these target by direct impact -- a naive suggestion as shall be discussed. Second, he says that systems in existence today use advanced guidance systems which did not exist in 1972.

Any individual with a high school knowledge of physics will see the naivete in the argument. The ABM devices of yesteryear which exploded near their target threw debris in its path. The target was destroyed by kinetic impact although heat energy would also play a major role in the kill. Thus the principle of kinetic kill existed even then. The advanced guidance systems could be advanced technological systems but they do not negate the fact the physical principle involved in actual destruction of the target remains kinetic energy. KEWs then are not based on other physical principles. The new interpretation of the ABM treaty should also ban their development and testing in the mobile mode

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or in space in accordance with Article V. Under these circumstances the whole exercise of twisting the ABM treaty and indulging in "legalistic gymnastics", as Sam Nunn aptly put, it would appear futile.

If one was to accept the broad interpretation of the treaty and also hypothecise for a moment that kinetic energy weapons are based on other physical principles, what then? Then, as SDIO officials claim, they would have wide leeway to perform a range of SDI tests which would otherwise be constrained. The Heritage Foundation, a conservative Washington think-tank, contends that SDI tests could be performed "much more realistically under the broad interpretation."[10] In particular, the Delta 181 experiment planned for November this year would receive a boost. Delta 181 is designed to test spacebased sensor capabilities for kinetic and directed energy weapons. Going by the narrow interpretation Article V would place severe limits on the test. It would only allow observation of targets orbiting inspace. The broad view, however, would allow space based sensors to "actually track and intercept ballistic missiles."[11]

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10 Defense Daily, March 16, 1987

11 Ibid.

In other areas the broad interpretation would permit more realistic experiments for discriminating between warheads and decoys in space, better testing of space based kinetic kill vehicles under real conditions and full power testing of ground based lasers along with their relay mirrors in space. On the whole, the broad interpretation would permit a more rapid development of SDI technologies, particularly those related to early deployment. The broad interpretation is therefore imperative if Weinberger's utopian goal of deployment of an BMD system by 1993[12] is to go forward.

US allies have in general expressed scepticism about the broad interpretation of the ABM treaty. This followed Soviet allegation in February this year that the United States had moved into the permissive interpretation at the Geneva talks.[13] There have also been press leaks in Washington that a presidential directive has been issued instructing US megotiators not to discuss limits under the narrow interpretation with their Soviet counterparts. Most bluntly, West German Chancellor Helmut Kohl said in an interview to Osnabrucker Zaitung recently that both the United States and the Soviet Union "must clarify together how one should interpret the ABM treaty."[14] It was clear that

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12 International Henald Tribune, February 9, 1987

13 Christian Science Monitor, February, 27, 1987

14 Ibid.

he felt that the US could not change its interpretation unilaterally.

The United States has over the past year or so succeeded in overcoming allied resistance to SDI and roped them into the programme with promises of generous research funds and R&D spinoffs.[15] A rudimentary SDI as envisaged by early deployment scenarios would provide a population defence of US cities, leave aside Europe which faces medium and short range Soviet missiles. This could topedo, the whole exercise of involving US allies in the research programme.

More recently, the INF treaty has been negotiated which eliminates US cruise and Pershing missiles from Western Europe in exchange for Soviet SS-20s. All the IRBMs with a range of 500-5000 km would be dismant-led. US allies however have interests other than the purely strategic aspects of the SDI programme. US allies such as the UK, FRG, Japan and Israil are keen to gain access to the vast funds being doled out by the SDIO. Therefore, most US allies which initially had reservation about Phase I deployment and its impact on arms control treaties later fell in tune. However President Reagan remains the only effective driving force behind the early deployment plan. Once the administration changes in Washington SDI funding may receive a substantial cutback.

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15 See Ravi Shastri "BMD/Arms Control Debate" <u>Strategic Analysis</u> Vol.X, No.8 November 1986 pp 925-942

CHAPTER IV

IMPLICATIONS FOR THE THIRD WORLD

Space systems have from their inception been used by space going nations to enhance national security. At the same time nation states have jealously guarded space technology from falling into the hands of their adversaries.[1] Along with nuclear weapons access to space technologies -- launch vehicles, satellites, etc. helped the superpowers perpetuate global hegemony in the post-Second World War era. Super power monopoly over outer space was, however, short-lived and European nations under the banner of the European Space Agency (ESA) and France, independently were soon in a position to challenge super power monopoly. Subsequently Japan and China emerged as major space going nations with India tagging along. Today, the Chinese commercial space business is viable enough to challenge Europe and the United States.[2] In fact, with the U.S. launch vehicle business in dire straits U.S. companies even started negotiating with China to launch U.S. satellites on their Long March Vehicles.[3]

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1. Ann M. Florini, "The Opening Skies: Third Party Imaging Satellites and U.S. Security", International Security, Vol.13, No.2, Fall 1988, pp.91-121.
2. Richard DeMier "China's Springboard to Space", Aerospace America, March, 1988, pp.16-20.
3. For US-Chinese Satellite launch negotiations, see Defense and Foreign Affairs Weekly, October 24-30, 1988; Aviation Week and Space Technology, October 3, 1988, p.21 and October 24, 1988, p.36; Flight International, Oct.15, 1988, pp.19-12.

Today renewed attempts are being made to restrict access of third world nations to space and missile technology both of which go hand in hand. The Missile Technology Control Regime (MTCR) is one such example.[4] At the same time SDI R&D promises to re-establish American technological hegemony. The impact of the MTCR on the security of third world states needs to be examined in detail.

I

The MTCR

Seven industrialised nations on April 16, 1987 initiated an agreement to limit the transfer of ballistic missiles and related technology to developing nations. The agreement, now christened the "Missile Technology Control Regime", took four years of negotiations conducted in total secrecy.[5] Officials in Washington involved with the negotiations were contratulating themselves on their success in maintaining its secrecy. Had word of the negotiations leaked out all kinds of "complications" would have resulted, including pressures from private companies engaged in the export of related technology and from recipient governments.

The missile technology regime is remarkably similar to the nuclear proliferation regime of the sixties. The latter

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4. Aviation Week and Space Technology, April 20, 1987, p.28.

5. Ibid.

did not succeed in controlling the spread of nuclear weapons since threshold nations, i.e. nations with the capability to build their own nuclear weapons, kept out of the treaty. The missile technology regime on the other hand is an attempt to exercise unilateral control. It would have an adverse impact on nations trying to capitalise on peaceful uses of space for their own advancement. Of the nations that are pursuing space launch programmes, India's is the most advanced. The impact of this new "arms control" initiative on India warrants detailed attention.

In the sixties, when the Nuclear Non-Proliferation regime was instituted, delivery systems were not the problem. Of more immediate concern to the major powers was to see that nuclear weapons and related technology did not find its way into the hands of nations of Third World. Nuclear weapons seen at the time as one step towards acquiring international power and prestige would endanger the status quo and introduce incalculable complications into the delicate balance of terror established by the major powers. The NPT therefore was designed to restrain membership of the nuclear club and to retain hegemony over the rest of mankind. Mutual deterrence prevented the super powers from using nuclear weapons against each other. However, nuclear powers have on several occasions indulged in nuclear blackmail by threatening to use nuclear weapons against Third World states which lack the ability to retaliate. The doctrine of the threat of use of force without war and coercive diplomacy have become credible and useful doctrines of national policy of some nations.

The nuclear non-proliferation regime was not successful in curbing the spread of nuclear weapons. Most "threshold nations" kept out. In comparison to the nuclear technology regime the missile technology regime is somewhat different. First, it is a unilateral attempt to control the spread of ballistic missiles. There has been a realisation on the part of the major powers that most Third World nations, unlike in the fifties and sixties when they had first emerged from the colonial embrace and were still in a high state of dependence, have begun to strike out an independent path. They have become more cognisant of their national interests. Any attempt to draw them into the fold of a missile technology regime would meet with stiff resistance. Second, the grey area besween civilian space programmes and ballistic missiles programmes is far more fuzzy than the difference between civilian and military oriented nuclear programmes. For instance, the developed world aids nuclear programmes of several developing nations under strict controls established and implemented by the International Atomic Energy Agency (IAEA). The IAEA controls the diversion of fissile materials such as plutonium and generally keeps a watch on the orientation of the nuclear programme. On the other hand, there exists, at least in theory, virtually no difference between a ballistic missile programme and a space launch programme. An attempt to extend the regime to cover ballistic missiles therefore would be far more difficult.

A study carried out by the United States Congressional Research Service (CRS) in April 1986 identified two major ways in which Third World states can acquire ballistic missiles.[6] One is the indigenous development of missiles or satellite launch vehicles and the other is export of short range missile systems by the superpowers themselves. There exist, however, other methods by which Third World nations acquire ballistic missiles. As outlined by Aron Karp, developing nations could import satellite launch vehicles and modify them.[7] They could also hire foreign expertise to help them develop ballistic missiles. Before going into details of the attempts of various nations to achieved ballistic missile capability the fundamental characteristics of ballistic and space launch vehicles and the differences between them must be thoroughly understood.

The Technology

Third World nations seeking to acquire space launch vehicles

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6. See CRS (Congressional Research Service) report Ballistic Missile Proliferation Potential in the Third World, April 24, 1986

7. Aron Karp "Ballistic Missiles in the Third World" International Security Vol.9, No.3 Winter 1984/85, pp 166-195; See Also Aron Karp "Controlling the Spread of Ballistic Missile to the Third World" Arms Control Vol.7, No. 1, May 1986, pp 30-36

(SLV) technology must overcome two major technological problems. The first is propulsion. Any rocket requires propulsive force. This propulsive force is imparted to the rocket using chemical energy. In essence this is similar to a chemical explosion, the difference being that energy is released in a controlled manner. The fuels used to impart this energy can be solid or liquid. Solid fuel rockets are easier to develop and provide fewer engineering problems than liquid fuelled rockets. The latter are, however, more efficient i.e. they have a higher energy release per unit mass of propellent. Most Third World nations therefore, pursue the solid fuel option.

The second requirement of SLV is a guidance system. Radio guidance systems, though available to some developing nations, have inherent problems. Radio waves do not propagate beyond the horizon. They are in addition vulnerable to jamming and other forms of interference. Inertial guidance systems are preferred. However, precision machining and advanced minaturised computers are part of the intertial guidance package and these technologies are hard to come by.

If an SLV must be used in the ballistic missile mode, additional technical requirements must be overcome. For instance, inertial guidance is a must if the missile is to have an adequate range and accuracy. Second advanced ablative materials that can withstand and dissipate the heat of re-entry must be fabricated.

Third World rockets have an extremely limited payload capability. For instance, the Indian SLV can deliver 40 kg into low earth (300 km) orbit. The Argentine rocket can deliver a 50 kg payload to a height of 500 km. Few if any Third World nations have this capability to minaturise nuclear warheads. It is widely believed that an SLV would require a 500 kg payload capability and a range of 700 km to be an effective weapon. Initial American warheads weighed 4,500 kg.

Third World nations have forty years of experience to learn from. They also have access to computer aided design and manufacture (CADM). They might therefore succeed in building a 1,000 kg warhead which takes over five years to miniaturise. Third World ballistic missiles with a deliverable nuclear weapon is therefore not a near term, have alone an immediate possibility.

The inevitable question arises. Could a ballistic missile be used in the conventional mode, i.e., could it be armed with conventional chemical or biological (CB) warheads in a cost effective manner? The answer to the first question is yes and the second, no. It is to be expected that a Third World ballistic missile will lack advanced guidance systems. Consequently, it would have a large Circular Error of Probability (CEP). Lacking accuracy, a ballistic missile armed with conventional or CB weapons would not be an attractive proposition. Witness the relative ineffectiveness of German V-2 rockets armed with conventional warheads.

Ballistic missile and nuclear warheads therefore go hand in hand. Many of the nations aspiring for nuclear weapons have also shown an interest in ballistic missiles.

It is often contended that bombers and other multi-role aircraft would suit Third World needs as a delivery system for nuclear weapons. This is largely correct under the existing force structures of Third World adversaries. Aircraft delivery offers several advantages. A combat air-craft in the air to ground role can carry weapon payloads in the range of 7000 kg with the capability of a single weapon weighing over 1000 kg -- the likely weight of a crude nuclear weapon. Aircraft delivery would have a quicker response time than ballistic missile systems which would require elaborate countdown procedures. Lacking effective range. Third World nuclear missiles would have to be forward-based making them vulnerable to surprise attack and increasing the temptation for preemption.

Strategic distances in the theatre of the developing world vary from 300-1,200 km. Modern combat aircraft often provide this range. Range constraints can be overcome by using mid-air refuelling, as Israel did while bombing Iraq's Osirak reactor, or by sending the aircraft on a one-way mission. Aircraft carriers and friendly territory could also be used for launching an attack, multiplying effective range.

Currently, the air defences of Third World nations are not sophisticated enough to warrant missile delivery capability. These are likely to improve however with the transfer of sophisticated weapons and early warning systems. Under these circumstances the probability that a nuclear armed aircraft would penetrate more sophisticated enemy air defences would decrease. Consequently the pressures for acquiring ballistic missile capability could increase.

As is evident from the earlier discussion, any country capable of launching a satellite could develop a ballistic missile provided certain technology constraints are overcome. Missiles could also be augmented by other means. So far, India is the only nation in the Third World (besides China) to have launched a satellite. It is also the only nation whose space launch programme has been oriented solely towards peaceful purposes. Military benefits have not evolved as a spin-off the civilian programme, except perhaps, only in improving communications to some extent. In most other cases, including the United States, the Soviet Union, China and France, SLVs were developed from ICBM boosters. In the United States, for instance, Atlas and Titan ICBM boosters were used to launch Gemini and Mercury spacecraft. Until recently, the Soviet SS-6 ICBM booster was used as the country's main launch vehicle. In contrast, the developed nations India's space programme is remarkably peaceful.

Aron Karp has outlined four ways in which a Third World nation could aspire for missile capability.[8] The foremost and most attractive, of course, remains indigenous development. By developing a missile based on indigenous technology, a nation may avoid the difficulties associated with dependency. Indigenous development may result in unforeseen technical spinoffs. However, no missile programme can be considered totally indigenous. They are dependent for components and dual-use technology which is often available commercially. It is this form of transfer that the missile technology regime seeks to regulate. The impact of such controls on the Indian programme will be discussed later.

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8. Aron Karp, n. 7 p. 33.

Short range ballistic missiles have been transferred to Third World nations once they have outlived their utility for the superpowers. For instance, the Soviet Union has exported SCUD-8 (300 km range) and Frog-7 (70 km ranges) SSMs to Syria, Iraq and Egypt. SCUD and Frog SSMs are believe to have been used by Egypt in 1973 and by Iraq in 1982-83. The US transferred its Lance SSM to Israel. Recent reports have indicated that Syria may have received SS-21 SRBMS from the Soviet Union. As the United States replaces the older Pershing IAs with Pershing IBs and the Soviet Union deploys more SS-21s, 22s, and 23s, the older SRBMS may find their way into Third World arsenals.

A country may also modify a SAM missile for the ground to ground role. For instance, South Korea with alleged Taiwanese assistance adapted the Nike Hercules surface to surface missile supplied to Korea by the United States. South Korea is also reported to have modified US supplied Honest John rockets to improve their accuracy. Israel too has developed SSMs modifying the US supplied Lance.

The most controversial Israeli weapon, however, remains the Jericho IRBM. Reports surfaced in 1985 that Israel had deployed an unspecified number of Jericho II missiles in the Negev desert and in the Golan Heights. Jericho II is believed to be a follow-on of Jericho which is said to have co-developed with the French firm Marcel Dassault, before the 1967 war. Jericho features a two-stage solid propellant system and is capable of carrying a nuclear warhead.

Jericho II is said to have an estimated range of 500-700 km. It is believed that Jericho II was test-fired in Iran in the mid-1970s when a close relationship existed between the Shah and the Israeli government. Iranian mullahs have revealed documents pertaining to a certain "Operation Flower" which dealt with increasing the range of Israeli surface-to-surface missiles.

Similarly, Taiwan has been accused of modifying the American supplied Lance with Israeli help for use in ballistic mode. The outcome of this collaboration was the Ching Feng or Green-Bee missile.

The Commercial Aspect

Aron Karp talks of what he calls the "commercial connection".[9] The commercialisation of space, i.e. the entry of private companies with profit as their sole motive into the space launch business, would have an effect on space launch technology and consequently ballistic missile technology. He specifically mentions three firms trying to establish commercial control. General Dynamics has attempted to privatise the Atlas Centaur rocket which it manufactures. Matin-Marietta has made a bid for the Titan series and a Washington

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9. *Ibid.*, p. 33

company is hoping to operate the McDonnell Douglas Delta. In addition, smaller space companies such as Star-Struck have offered exotic proposals such as space burial of human ashes!

In this context the West German Company OTRAG (Orbital Transport and Rakaten AG) deserves special mention. Otrag gained to international fame in the 1970s when it offered its launch activities to Zaire and Libya. Otrag, using commercially available technology, developed a rocket designed to lift large payloads in clusters. Zaire leased a tract of barren territory for Otrag to test its SLVs. It is believed that Libya offered Otrag a test range and facilities as well as financial inducements. As a result of diplomatic pressures Otrag left Zaire in 1979 and Libya in 1981.

What Aron Krap emphasises is that once commercialisation becomes a viable option and takes hold, companies like Otrag might offer launch services and developments for Third World states for commercial benefits.

SLV Programmes

Among Third World nations some, namely Brazil, Argentina, Pakistan, South Africa and India, are believed to have indigenous space launch vehicle programmes. Of these, the Indian programme is believed to be the most advanced.

Brazil has developed the Sonda series of sounding rockets. A large number of successful launches has enabled Brazil to reach an altitude of 650 km with a 500 kg payload. Before the end of this decade Brazil plans its satellite launch vehicle designated VLS. Its ambitious target is to launch a 150-200 kg satellite to a 500 km polar or 700 km circular orbit.[10]

Pakistan has developed a miniscule sounding rocket programme. There have been a few reports of a Pakistani desire to develop an SLV. However, the likelihood of such a possibility materialising in the near future appears dim.

South Africa is believed to have developed a missile programme in cooperation with Israel.[11] In 1979 an American satellite detected a flash off Marion Island in the South Atlantic. Speculation about cooperation in the nuclear field between Israel and South African increased following revelations made by Mordechi Vanunu, the Israeli nuclear technician, in Britain. In addition, Frank Barnaby, a former director of the Stockholm International Peace Research Institute, believes that Marian Island could provide a site for testing missiles. These are being developed

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10. See CRS report, p. 20-21.
11. Observer, December 28, 1986.

probably in collaboration with Israel for use in the nuclear mode.[12] Plans for the construction of an airfield on the island tend to bear out this view. Environmentalists who protested were told that the airstrip would facilitate evacuation in case of medical emergency. This argument does not appear convincing because construction of a hospital on the island would be a cheaper alternative. The island will in all likelihood be used to perfect short range ballistic missiles and may also be used to augment South Africa's ongoing nuclear programme.

The Indian space programme is believed to be the most advanced in the Third World.[13] India began working on an indigenous space programme in 1967 and has been launching sounding rockets ever since. The Rohini series of sounding rockets have improved with time. The SLV programme began in 1973 and India put its first satellite in orbit using largely indigenous technology in 1980. Since 1983 it has been working on an indigenous ASLV (Augmented Satellite Launch Vehicle). While the SLV-3 launched in 1980 had a payload capability of 40 kg, the ASLV, an SLV rocket with two strap-on boosters is projected to place a payload of 150 kg in low earth orbit. The first launch of ASLV

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12. Observer (London), December 28, 1986.
13. For details of the Indian Space Programme, See Department of Space Annual Report for various years.

failed. While the strap-on boosters functioned normally the first stage did not ignite. As a result the mission was abortive.

However, considering the launch failures of major space powers such as the United States and France of late, the ASLV failure is nothing to be disheartened about. India also plans a Polar Satellite Launch Vehicle (PSLV) with four strap-ons. PSLV would launch a 1,000 kg payload into Polar orbit. Finally, the geosynchronous satellite launch vehicle would have a payload of more than 1,000 kg and would place its payload into geosynchronous orbit. ASLV and PSLV are projected to have an inertial guidance system.

PSLV could, theoretically, give India an IRBM capability provided guidance and re-entry vehicle problems are overcome. However, there is no substantial evidence to suggest that India intends to convert its SLV into a ballistic missile. In fact, the Indian programme is one of the few where a launch vehicle programme has developed independent of military concerns. In the United States, Soviet Union, China and in France, space launch programmes were a spinoff from ICBM booster development programmes as discussed earlier. In the United States, Atlas and Titan ICBM boosters were used to launch Mercury and Gemini spacecraft and the Soviet Union relied on the SS-6 ICBM booster as its main launch vehicle until recently. The Indian programme, in contrast, is only for peaceful and civilian uses.

India needs access to space to facilitate peaceful economic development. Meterological and remote sensing satellites would help in this task. It is correctly argued that remote sensing satellites would provide military reconnaissance capability. However, the point that needs to be stressed is that Indian space research is not directed towards military purposes. The Indian Space Research Organisation (ISRO) and Defence Research and Development Organisation (DRDO) are independent entities under the departments of Space and Ministry of Defence respectively. While reports of collaboration between the two agencies may have resulted in the creation of the Balasore missile testing range[14] where 'Prithvi' was test fired, the point remains that the Indian space. programme grew into a missile programme and not vice versa.

In 1986, India opened its missile testing range at Balasore in Orissa.[15] The event raked up a political storm with various political parties taking up the issue for displaced tribals. India plans to use the range to test surface-to-surface and surface-to-air missiles. The range is, however, not yet in operation. In the interim period the Ministry of Defence has decided to use the Chandipur range in Orissa. DRDO scientists have developed (indigenously)

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14. Times of India, May 11, 1987
15. Ibid.

a long range surface to air missiles "Agni".[16] Agni is to be flight tested soon. In addition, the Minister of State for Defence, Arun Singh, announced in Parliament recently that the surface to air missile "Trishul" had been successfully test-fired.[17] DRDO scientists are believed to be developing a long range SAM missile designated "Akash," [illegible] surface missile [illegible] and an advanced anti-tank missile "Nag". None of these missiles is nuclear capable.

It is obvious from the above discussion, that of the Third World nations with viable space programmes, the Indian programme is the most advanced. Consequently, in Western thinking India would be farthest on its way to achieving ballistic missile capability. Though guidance and re-entry vehicle problems remain, the Indian PSLV if and when it comes on stream -- probably by the late 1990s provided the necessary reorientation of the programme takes place -- would give India an IRBM capability and capacity to strike strategic targets in its neighbourhood with indigenously developed warheads. The PSLV is slated to deliver a 1,000 kg payload. It is argued that India in a time frame of five years could miniaturise its nuclear warhead to weigh 500 kg, what with CADM and other state-of-the-art manufacturing technique at its disposal.

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16. Times of India, May 11, 1987.

17. Ibid.

Most of these allegations, on the face of it, must appear to be true. India has a demonstrated capability to make nuclear weapons, and has been testing short range missiles. Combining the two efforts to develop a nuclear capable IRBM requires a political decision and India has consistently maintained that it has no programme to manufacture nuclear weapons and that its space programme, like the nuclear programme is only meant for peaceful purposes. However, in view of the overall global nuclear proliferation and the closer regional dimensions of it, India has maintained that it would keep its option open.

Viewed in this context, however, the seven nation proposal to set up a missile technology regime would appear to be targeted mainly at India. India is the only Third World nation that has a space programme worth its name. It has also demonstrated that if it so desires it could produce a deliverable nuclear warhead at short notice, though the option has not been exercised. Let us examine the proposals made under the regime and specifically see what impact it would have on an Indian space programme, whether civilian or military.

The Missile Technology Control Regime - Controlling Space Technology

The missile technology regime initiated by the United

States, Canada, Britain, France, West Germany, Italy and Japan on April 16, 1987 is the outgrowth of four years of negotiations which began when President Reagan authorised the secret negotiations in 1982.[18] The talks resulted in informal controls on some of the technologies. Senator John Glenn (D-Ohio) is believed to have been deeply involved with the negotiations. Most of the technologies on the control list have been de facto banned for export since 1985.

The regime aims to ban the export of missiles with a range of more than 300 km and a payload of 500 kg. These specifications were chosen because 500 kg happens to be the minimum weight of a miniaturised warhead. 300 km is the minimum distance at which a nuclear warhead would be militarily useful. The list of items banned for export are divided into two categories.

<u>The Commodity Control List</u>

- Machines for military equipment manufacture
- Propellant production equipment
- Pumps (specified for propulsion system)
- Valves (specified for propulsion system)
- Pyrolytic deposition and densification equipment
- Filament winding and tape laying machinery
- Wind tunnels (specified)
- Vibration test equipment

18. International Herald Tribune, April 18-19, 1987.

- Production equipment for inertial systems
- Jet engines
- Integrated flight instrument systems and inertial navigation equipment
- Radar and airborne communications and electronic navigation equipment
- Telemetering and telecontrol systems
- Transmission equipment, single/multi channel (specified)
- Lasers and las er systems (specified)
- Electronic measuring equipment (specified)
- Radio receivers (digital, including airborne) and frequency synthesisers
- Electronic assemblies and integrated circuits (specified)
- Computers for airborn applications and specially designed analog or analog/digital (bybrid) computers
- Analog to digital and reverse converter
- Gravity meters
- High density fuels
- Polymeric products usable as fuels

The first category includes rockets and rocket engines. The second category includes sub-components for these systems such as rocket fuel technologies, missile computers, light weight turbojet engines and certain composite materials used for warheads and heat shields, tracking and guidance systems and avionics equipment. Controls would be imposed on those nations where the US and other suppliers "suspect missile projects are in progress".[1]

19. Wall Street Journal, August 17, 1987.

The guidelines to be used on whether or not to supply technology include nuclear proliferation concerns, capabilities and objectives of the missile and space programme of the recipient states, significance of the transfer in termsof the potential development of nuclear weapon delivery systems, other than manned aircraft. Assessment of the end use of the transfers, and applicability or relevant multilateral agreements.

It is obvious, therefore, that the restrictions are meant to control the export of missile and related technology and thereby hinder the Indian space programme, whether it be for peaceful or military purposes. The controls would operate selectively. In fact, the word selectivity is emphasised in the agreement. Countries such as Israel, Pakistan and South Africa which fall in line with US security interests may be exempted on the ground that they do not harbour "malafide intentions". In fact, US officials have already named India as the major country at whom the controls are aimed.[20] On the other hand, the US has been cooperating with Israel in developing the Israeli Arrow ATBM (Anti-Tactical Ballistic Missile)[21]. Eighty per cent of the developmental cost is to be borne by the US.[22] The technologies involved in the

20. Ibid.

21. Aerospace Daily, October 25, 1988.

22. Ibid.

joint programme involves many of those technologies which are controlled by the MTCR.[23]

Having concluded that India is one nation which could achieve IRBM capability in the near future and that these controls are therefore aimed at India (Israel having been exempted), one would wonder what threat an Indian IRBM would pose to Western nations. An Indian IRBM would not be able to target Western military facilities in the region, leave alone the nation's territories. One would expect the Soviet Union to be far more concerned since it is within striking range of several missile proliferators including India, Pakistan and Israel. However, the new control regime would deny India a capacity to develop an IRBM which could pose a threat only to parts of China.

Consequently, it appears that the regime is geared more towards controlling civilian space technology. Aron Karp suggests that following the conclusion of an agreement controlling missile proliferation, Western nations should offer concessional launch services to Third World nations. Such an agreement would of course condemn that latter to a perpetual state of dependency, an arrangement which must be avoided at all costs.

Some of the controlled items include navigational equipment, computers to aid design and manufacture, testing equipment, pumps and valves, etc. Many of these items are

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23. <u>Ibid</u>.

available on the open market today. Once the regime comes into effect, however, the situation may change. India's peaceful space effort too will be adversely affected.

Nations trying to acquire composite and ceramic materials used on warheads to withstand heat of re-entry are often branded as aiming for ballistic missile capability. These advanced materials, incidentally, are also needed for satellite recovery and other such programmes. Banning their export would constrain peaceful space programmes of several nations, particularly India.

While the Missile Technology Control Regime seeks to prevent the sale of ballistic missiles and related technology to selected Third World nations an authoratative report appears a few months later which calls for the proliferation of'highly accurate long range smart' missile systems in developing regions of the world. The report entitled 'Discriminate Deterrence'[24] was prepared by the Commission on Long Term Strategy, comprised of a group of influential individuals within and outside the US government. On page 50-51, the report states that

> "Long Range is likely to be increasingly necessary for our weapons particularly in the Asian Pacific theatre. Given the growing importance of that theatre, the Pentagon should look ahead by choosing systems with ranges significantly beyond those needed in the European theatre"25.

24. Report of the US Commission on Long Term Strategy, Chaired by Fred C. Ikle and Henry Kissinger entitled <u>Descriminate Deterrence</u>, Washington, 1988.

25. <u>Ibid</u>, pp.50-51.

The U.S. DOD (Department of Defense) recently accepted these recommendations when the Pentagon called for long range missile systems to be integrated into its naval systems.[26] Realizing the importance of missile systems for their security several third world nations besides India have begun planning to acquire missile deterrents. The Saudis recently purchased an IRBM with a 3000 km range from China.[27] Reports have emerged to the effect that Syria has been negotiating with China to acquire the 800 km M-9 missile.[28] Iraq has been believed to be finding the Argentine Condor missile effect,[29] while a joint Brazilian-Libyan missile development project is believed to be under way.[30] Third World nations have thus been working hard to circumvent MTCR controls.

II

While at one level the development of Space technologies would have repurcussions at the level of third world missile development which is a field closely related to space technology, at another the MTCR would curtail development of

26. Tony Capaccio "Eying Third World DOD Changes Munitions Plan", Defense Week, September 26, 1988

27. AAS Milavnews, April 1988.

28. Defense and Foreign Affairs Weekly, July 4-10, 1988.

29. Financial Times, December 21, 1987.

30. Jane's Defence Weekly, February 6, 1988

independent space based photo reconnaissance, electronic reconnaissance, military communications systems by third world nations. As long as independent capabilities in these fields are not obtained no state can claim strategic independence. The case of Iran and Iraq where the US selectively supplied satellite intelligence data to both sides serves to underline the disadvantages of dependence. Israel despite its special relationship with the US was not willing to receive 'edited' satellite reconnaissance data and cited the dependence argument to justify its launch of Offeq-1 recently.[31] Europe and China too desire to reduce their dependence on the super powers. France has developed a civilian remote sensing satellite SPOT which however revealed images of Soviet military facilities at Sereormonsk and Murmansk.[32] SPOT technology would be used as a basis for the French Helios military reconnaissance satellite with a higher resolution to be developed in the 90s.[33]

India's IRS-IA remote sensing satellite launched on the Soviet Proton booster recently would give India limited photoreconnaissance capability. The resolution of IRS-IA however is 72 meters too low at present.[34] However, with

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31. Flight International, October 1, 1988; Aviation Week and Space Technology, September 26, 1988.
32. Ann M. Florini, n .1, p.101.
33. Ibid., p.90.
34. Ibid., p.113.

indigenous launch vehicles being developed launch into a lower orbit would provide higher resolution. Two 36 m resolution satellites are also planned. Higher resolution and lower orbits together would provide India with photographic reconnaissance capability in the not too distant future.

Strategic thinkers in the US have already begin to view independent military space systems of third world and European nations with disdam. Some feel that independent European Space Capabilities would drive a wedge between the US and its NATO allies making the latter more strategically independent.[35] It would enable the latter to independently guage Soviet military capabilities making them use likely to accept US perceptions. Similarly third world satellites would make them more independent of the super powers and at the same time allow the former to peer into the latter's military installations. One can therefore expect a tightening of MTCR controls in the future allowing of course for 'allied proliferation' a la Israel.

International Space Co-operation and the Third World

As early as May 1978 France proposed the setting up of an International Satellite Monitoring Agency (ISMA) at the UN General Assembly.[36] The UN Secretary General appointed

35. Ibid., no.1, p.113.

36. M. Abdel Hady, "Verification Using Satellites, Feasibility of an International or Multinational Agency", in Bhupendra Jasani (ed.) Outer Space: A New Dimension of the Arms Race SIPRI, Taylor and Frances, London 1982, pp.275-95.

an expert group which dealt with the technical, legal and financial implications of establishing such an agency. The group recommended that the objective of ISMA could include arms control, verification and crises monitoring. The major issue of course remained and shall remain how to provide a free and unbiased flow of information.[37] In this context the establishmentISMA was to be an evolutionary process. In the initial stages, it would consist only of ground receiving stations and depend on nations which operate reconnaissance satellites. In the second phase an independent satellite monitoring network was to be established. The agency was to provide raw "data" and not "information" obtained from analysing raw data.

Both the super powers opposed the setting up of an ISMA. Presumably because it would adversely affect their monopoly over international space activity which has military connotations.[38]

Peaceful space cooperation has been attempted in the past. Such international cooperation however has its limitations. An offer was made to India by the Soviet Union in 1986 to set up a space center in Southern India.[39] The merits and demerits of international space cooperation with particular reference to India and the Soviet offer will be briefly considered.

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37. Ibid., p.279.

38. Ibid., p.280.

39. Amrit Bazar Patrika, November 28, 1986.

President Gorbachev on November 27, 1986 proposed to both houses of the Indian Parliament during his last visit to this country the setting up of an international space center in Southern India. Details of the now abandoned proposal are not publicly available but from Gorbachev's earlier statements the agreement would seen to include a school for training of space specialists, cosmonauts and facilities for launching space craft. If the agreement were to include construction of space launch facilities, details of the agreement need to be scrutinized. What rockets would be used for launching satellites? Would India benefit from the agreement? The Soviet Union already launches Indian Satellites (IRS-1A was launched on the Proton Booster from Bikanour). Would transfer to an Indian launch site be better?

It must be remembered in this context that the Soviets are negotiating with the seven nation western group (the Missile Technology Control Regime), Whether or not they would be a party to the regime. It could well be that given the close relationship between super powers in the wake of the INF treaty the Soviets would be drawn into the regime. Their desire to transfer space launch technology to India may wane.

Possible advantages for the Soviets :-

At the outset it must be mentioned that almost all space systems are dual use in nature. It is extremely difficult to distinguish between peaceful and military space systems, particularly in the case of the space programmes of the superpowers.

i) First, if the space center involves launch of satellites using Soviet vehicles such as the Proton booster, they may be able to preassurize India into reducing the momentum of development of its indegeneous space launch vehicle and missile programme in keeping with their possible unspoken commitments to the MTCR. They may then be able to delay the emergence of a new IRBM power on their southern flank.

ii) Second, a space center situated South of the tropic of Cancer in South India would provide the Soviets with an equitorial launch of platform. The U.S. launches most of its equitorial satellites from Cape Carnival. The USSR, with its landmass located at northern latitudes lacks access to equitorial launch platforms.

iii) Third, due to the fact that the Soviet landmass is situated at extreme northern latitudes the Soviets must rely on a fleet of tracking ships to fulfill ground communication network requirements. The U.S. overcomes this problem with a number of tracking facilities located around the globe. The Soviets lack such facilities and have attempted to fill the gaps with their tracking ships. Their current fleet of tracking ships named after famous space personalities include Akademick Sergei Korolov, Kosmonaut Yuri Gagarin and Kosmonaut Kladestav Volkov. A space center in Southern India may help overcome home problems with the Soviet ground communication network.

Advantages for India

Benefits that would accrue to India include:

i) India may gain access to cheap satellite launch. Again it must be kept in mind that if launch vehicle technology is not transferred the indigeneous SLV and missile programme may suffer. Also the Soviet Union launches Indian satellites on a commercial basis already.

ii) Indian scientific manpower would receive advanced scientific and technical training which could be utilised for our indigeneous space programme.

Disadvantages for India

i) Dependence on the super powers in a crucial technological field with important military applications would increase. Considering the fact that strategic independence in scientific/technological fields with important military applications has been a cornerstone of our policy since independence such a path of dependence may not be a wise course to follow.

ii) As a result of increased dependence one super power would gain increased leverage over the Indian military space and missile programme. Given the future possibility of the Soviets joining the Missile Technology Control Regime, such dependence may not be in India's interest. The Soviets may at the instance of western nations (given improved relations) preassurize India to abandon or curtail its military missile programme in which rapid studies have been made of late.

<u>International Space Cooperation</u> has been attempted in the past. History has shown that it has its limitations. The tortorous negotiations held over the past few years with regard to international participation in the US space station effort is a case in point. The controversy centerd around US DOD (Department of Defence) instance to use the station to further US national security interests. Canada and Japan vehemently opposed military use of the station. Recently however, they reconciled themselves to military use. The US space station may end up being a western alliance military space effort.

Given the dual use nature of most space systems, it is almost impossible to separate military and peaceful uses of outer space. The military advantages that would accrue to the Soviets from a space center in India must be kept in mind.

<u>Conclusion</u>

Military space systems are likely to play a decisive role in any future conflict between Third World states or between major powers and third world states. No matter to what level Third World states build up their military capabilities. Their military punch will be limited by lack of access to space reconnaissance, communication, etc. Dependence on one or other super power would thus remain. This would lead to the conclusion that it is imperative for those Third World nations who wish to obtain strategic independence to spare no effort to develop independent military space capabilities.

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xxxxxx