17. Expansion of the Arms Race into Outer Space

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I. *The militarization of space*

When the Outer Space Treaty entered into force in October 1967, it was believed that outer space would be a 'zone of peace'. However, by the end of 1985, despite the ratification of the Treaty by 85 nations, this dream has remained an illusion. Militarization of this environment has continued.

This occurred in two stages. The first began with the launch of military satellites in 1958. The second phase began almost immediately with the development and testing of weapons which could damage or destroy these satellites. While anti-satellite (ASAT) weapons are not yet deployed in orbits around the Earth, we are on the verge of introducing such weapons into outer space under the guise of defensive systems.

The pace at which advances in the military use of space are made is accelerating. The first two and a half decades of the space age were dominated by the introduction and increasing use of military satellites orbiting the earth. These spacecraft, launched mainly by the USA and the USSR, are the essential eyes, ears and nerves of the fighting forces of today. Satellites orbiting close to the Earth identify potential military targets and determine their precise location. Spacecraft not only relay military messages over long (or short) distances but are also able to guide modern missiles, aircraft and naval vessels carrying lethal nuclear and conventional weapons to their targets with almost pin-point accuracies; and they can provide better centralized command and control of military forces. By the end of 1985, 2314 military satellites had been launched. This constitutes about 75 per cent of all satellites orbited.

There is no doubt that observations from outer space have been and are being usefully employed in verifying compliance with bilateral arms control agreements between the USA and the USSR. Both powers have also monitored from space many conflict areas of the world. Moreover, they may also be observing military manoeuvres in Europe as a confidence-building measure. However, the advances in space technology have added considerable impetus to the arms race. In addition, these advances are contributing significantly to the current change from policies of 'MAD' (Mutual Assured Destruction) to those which actually consider fighting a nuclear war.

The use of military reconnaissance, communications, navigation and meteorological satellites in orbit around the Earth continues to enhance the land-, sea- and air-based forces of both the Soviet Union and the United States.

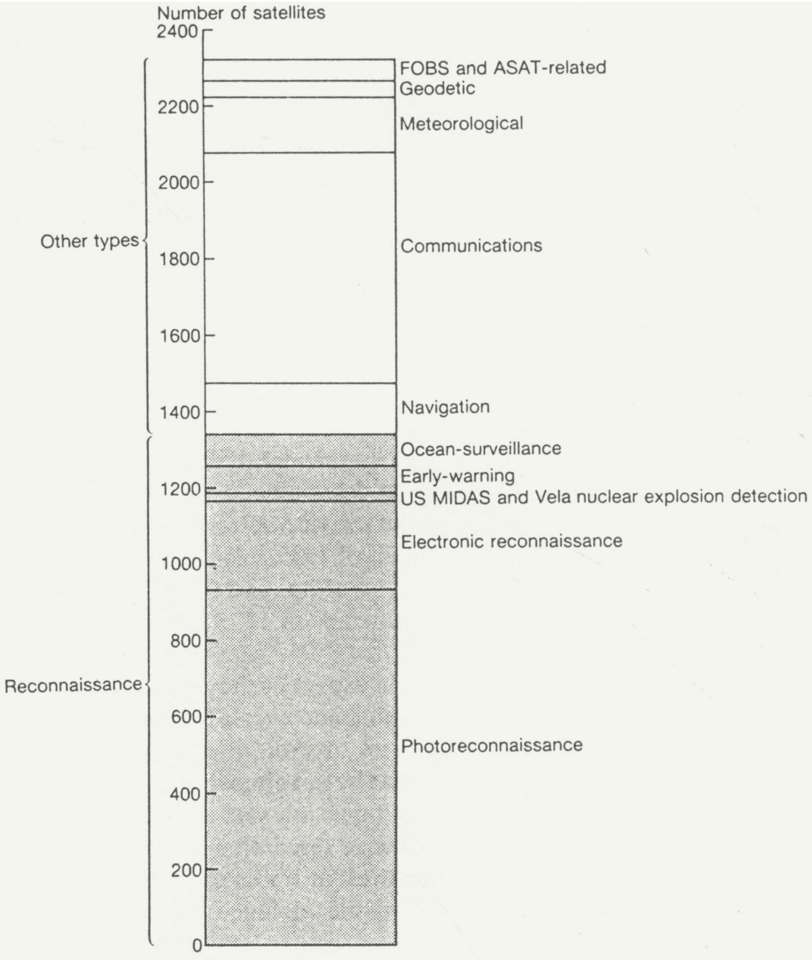
Two of the most significant advances in military space technology were made in 1982 when the US space shuttle made its first military-oriented operational flight, and when the Soviet Union apparently for the first time tested a re-usable satellite launcher.

II. *Reconnaissance satellites*

These can be divided into four types – photographic, electronic, ocean surveil-

* From Bhupendra Jasani, 'The military use of outer space', *SIPRI Yearbook 1986;* 'Outer space being turned into a battlefield', *Bulletin of Peace Proposals*, vol. 17, no. 1, 1986; *Outer Space – A New Dimension of the Arms Race*, SIPRI 1982; chapters on the military use of outer space, *SIPRI Yearbooks 1983, 1984, 1985*.

Figure 1. Number of military satellites of different types launched between 1958 and 1985.



lance and early warning satellites. The orbits of each of these types of satellite are optimized for the specific mission of the satellite.

Photographic reconnaissance satellites detect, identify and pinpoint military targets. In addition to photographic cameras, sensors include television cameras, multispectral scanners and microwave radars. Some of these instruments can spot objects at least 30 cm in size. Both the Soviet Union and the United States launch such satellites regularly, and the People's Republic of China has launched at least seven such satellites.

In 1985, the Soviet Union launched 34 photographic reconnaissance satellites. While the USA did not manage to launch such spacecraft in 1985, there were two satellites in orbit, one launched in 1982 and the other in 1984. The former decayed in the middle of August 1985. This difference in number is only because the life times of all the US satellites are much longer than those for the Soviet ones. One reason for the short life times of the Soviet satellites is that they probably carry less fuel on board their spacecraft in order to keep them up in orbit. This is because of the lack of availability of advanced micro-electronics and micro-sensors. But the Soviet Union is beginning to launch long-lived satellites.

Electronic reconnaissance satellites, often called electronic intelligence (ELINT) satellites, carry equipment designed to monitor and detect radio signals generated by the opponent's military activities. Such satellites not only locate systems producing military-related electronic signals but they also measure the characteristics of the signals so as to be able to plan penetration of defences.

Ocean-surveillance and oceanographic satellites detect and track naval ships and determine sea conditions which can, for instance, help in forecasting the weather or, less innocently, in detecting submarines. Space-based sensors include radars that can 'see' through clouds and detect even small pleasure boats. The radars on Soviet spacecraft are powered by small nuclear reactors fuelled with highly enriched uranium 235 fuel and have power output of about 40 kWe. Two such satellites, Cosmos 954 and Cosmos 1402, dropped out of their orbits as a result of loss of control over them in January 1978 and in February 1983 respectively. Reactors from both these satellites contaminated the atmosphere.

In the USA, two projects, code named White Cloud and Clipper Bow, emerged. Satellites under the Clipper Bow programme are supposed to carry active radars to locate ships. The latter are yet to be launched.

Knowledge of what is happening in the oceans – for example, the height of waves, the strength and direction of ocean currents, and salinity of the sea water – can help in the design of sensors to determine whether submarines are lurking beneath the surface. Also these factors contribute to improving the accuracies of missiles launched from submarines.

Early-warning satellites have partially replaced the radars that were originally deployed to give warning of a surprise attack by ballistic missiles. The radars provided about 15 minutes during which a response could be worked out. The use of early-warning satellites has extended this warning time to some 30 minutes. Some of the early-warning satellites carried additional sensors to detect nuclear explosions conducted above ground, in the atmosphere and in outer space.

Communications satellites are beginning to fulfil the need of the military for rapid and efficient communications needed as a result of highly complex and sophisticated weapons. Moreover, space-based sensors for surveillance of the Earth, together with land-based surveillance systems, generate a considerable amount of data. The transmission of this and other data for military purposes needs reliable and secure communications systems. Space has become an area of vital interest as some 80 per cent of military communications are carried out using artifical Earth satellites. Satellites also play a vital role in the command and control functions for the military forces of the big powers. Even communications between mobile forces such as aircraft, naval ships and soldiers on foot and their commanders are being conducted via satellites.

Navigation satellites are another family of military craft which send out coded signals with which armed forces can plot their own positions with a high degree of accuracy. For example, the planned US 18-satellite navigation system, the Global Positioning System (GPS) or the NAVSTAR, will determine the position, in three dimensions, to within about 20 m of an aircraft, missile, naval craft or a soldier on the ground. Efforts are being made to even eliminate the need for terrain contour mapping used in cruise missiles and replace it with the GPS.

Both the USA and the USSR have developed satellite navigation systems. In the USA, an added mission is planned for such satellites. Although the USA has launched satellites specifically to detect nuclear explosions in the atmosphere and in outer space, it is now planned that US navigation satellites will carry sensors for this purpose under the Integrated Operational Nuclear Detection System (IONDS). This is intended also to provide damage assessment both within the USA and within enemy territories during and after a nuclear attack. This effort is in support of the nuclear war doctrines which require early warning of attack, information for assessing the size of the attack, and data on the attacked target so that an appropriate response can be made.

Meteorological and geodetic satellites form the final members of the military spacecraft armoury. The former can gather information about the weather along a missile's proposed route, so it can be buided accurately. The latter satellites obtain data about, for example, the shape of the Earth or its gravitational field to achieve the same result.

The amount of data collected by meteorological satellites is considerably more than just to know whether an area of interest is covered by clouds in order to plan photographic reconnaissance missions or bombing missions. For example, there are sensors on board such satellites which measure the oxygen and nitrogen density of the thermosphere, and which determine the temperature and water vapour at various altitudes. One reason for such detailed measurements of the properties of the atmosphere could be that once man has understood the mechanics of weather and climate formation, his military genius may be able to control these for hostile purposes.

However, an immediate contribution of such data is to improving the accuracy of missiles. Among the factors influencing accuracy are the water vapour content in the atmosphere and the wind velocity along the missile's possible trajectory. Not only do the meteorological conditions determine the corrections made to missile trajectories but these conditions are also taken into account when predicting satellite orbital tracks.

This brief review of the military encroachment on outer space indicates the extent to which the military satellites of the two major powers are becoming part of the world-wide nuclear and conventional weapon systems and war-fighting strategies.

With the increasing use of satellites to improve the fighting efficiency of military forces on Earth, the two superpowers have naturally come to regard satellites as important military targets. They have therefore now developed, tested and even deployed some anti-satellite (ASAT) weapons. They range from ground- or air-based anti-satellite missiles and orbiting hunter-killer satellites to more futuristic ground- or space-based high-energy lasers. Thus began the second phase of the militarization of outer space.

On 23 March 1983, President Reagan called on US scientists and engineers to find 'the means of rendering nuclear weapons impotent and obsolete'. This has added a new dimension to the ASAT weapon arms race because some ASAT weapons are envisaged not only for space warfare but also for ballistic missile defence (BMD) systems based in outer space. In January 1984 the President in fact gave the go-ahead to research and development of space-based BMD systems. There is not only an ASAT-BMD overlap, but the technological base is also common to many other applications.

III. *ASAT weapons*

In October 1957 the first artificial earth satellite, Sputnik 1, was launched by the USSR. Exactly two years later, the USA successfully tested an aircraft-launched anti-satellite missile that would carry a nuclear warhead. These early tests were carried out using B-42 aircraft. However, they were discontinued, and missiles with nuclear warheads for ASAT use were eventually deployed on the ground, until about 1975, when they were dismantled. Around 1972 interest in air-launched ASAT weapons was rekindled. The current US F-15 ASAT weapon is a revival of the old B-42 weapon resulting from improvements in guidance technology so that a non-nuclear warhead can be used. Such a non-nuclear device is called a kinetic-energy weapon (KEW) or impact weapon.

ASAT kinetic-energy weapons can be propelled either by chemical rockets or by electromagnetic forces. The F-15 ASAT weapon is an example of the former. It consists of a two-stage short-range attack missile (SRAM), with an Altair booster, mounted with an infra-red heat-seeking warhead. The aircraft and missile part of the system was flight-tested on 21 January 1984: no target was involved, but the missile was aimed at a point in space to demonstrate the ability of the SRAM to get the warhead to its target. The second flight of the warhead was conducted on 13 November 1984: while the warhead was not aimed at a specific target, its infra-red guidance system was tested against a star.

On 13 September 1985 the F-15 ASAT system was tested against a real target, the Solewind P78-1 satellite (launched in February 1979). It was chosen as the test target because it was still functioning and could therefore aid in determining whether the interception was successful: on interception, at about 500 km, the miniature homing vehicle (MHV) ceased to transmit, and the Solewind stopped sending its telemetry to the ground receiving station. It has been reported that the satellite broke up into over 100 pieces.

The Soviet ASAT system could be categorized as a rocket-propelled KEW. In October 1967 the USSR signed the Outer Space Treaty; a year later, the first of 20 tests was conducted. Rather than using a rocket-propelled warhead, orbiting satellites destroyed the target either by direct impact or by exploding nearby. The ASAT satellite need not be in the same orbit as the target spacecraft and is guided to the target either by a radar or by an infra-red sensor. The tests carried out so far have used a modified SS-9 intercontinental ballistic missile (ICBM) to reach their targets. The important deficiency of such a system is the long time needed for interception: it takes up to three hours from the time of launch until the interception of a target. The Soviet Union has not conducted any ASAT tests since June 1982. In its 1983 Draft Treaty proposal to the United Nations, the USSR seems to have offered an ASAT test moratorium.

Other ASAT technologies being considered are space mines, high-power radio-frequency weapons and high-energy laser weapons. The last two fall in the category of directed-energy weapons (DEW). Space mines would be orbited within lethal range of target satellites and would be commanded from the ground to explode and destroy the target. While space mines are considered only as ASAT weapons, the two DEWs are also thought to be useful as defensive weapons and are being investigated under the US Strategic Defense Initiative (SDI) programme. The fact of similar technology is not the only link between offensive ASAT and defensive BMD weapons: the other link is that, once defensive weapons are deployed, the opponent may develop or already have developed ASAT weapons to destroy them. Moreover, defensive platforms may also carry ASAT weapons as a defence against the opponent's space-based ASAT weapons.

IV. *BMD weapons*

After President Reagan's SDI speech in 1983, much of the early debate on defensive weapons focused on defence against ICBMs. The problems of defence against cruise missiles, bombers, submarine-launched ballistic missiles (particularly from short ranges) and tactical missiles have not been addressed in any depth. Thus, we are a long way from making nuclear weapons 'impotent and obsolete'.

The defensive system would have to cope with some 8000 wearheads among as many as 300 000 light decoys such as balloons, chaff and aerosols, and up to some 150 000 heavy decoys which might even include pieces of the bus.

The US SDI programme is basically divided into four areas: Surveillance, Acquisition, Tracking and Kill Assessment (SATKA); defensive weapons; systems concepts/battle management; and survivability, lethality and key technologies.

SATKA involves upgrading existing sensor technologies as well as new developments. The aim is to develop BMD technologies for boost-phase surveillance, mid-course tracking, and terminal-phase tracking and discrimination. While, for the boost phase, surveillance sensors would be mainly space based, mid-course and terminal-phase surveillance and tracking would be accomplished by ground-based radars together with air- and space-borne radars and optical sensors. Active sensors such as radars and lasers and passive optical sensors such as infra-red devices are therefore being investigated. Another device being investigated is based on a laser tracking system.

Among the optical devices, passive infra-red sensors and active laser radars are being investigated to perform essentially three tasks: collection of data on the infrared exo-atmospheric and high endo-atmospheric signatures of both ballistic missile components and re-entry vehicles; development of laser imaging devices; and infra-red studies of the natural background radiation.

The objective of the survivability, lethality and key technologies programme is to determine initially the effects of lasers on a wide variety of targets. On 6 September 1985 the high-energy mid-infrared chemical laser (MIRACL), based at the White Sands Missile Range in New Mexico, was used to destroy the second stage of a fixed Titan I missile placed on the ground about 1 km away from the laser. Such tests are of course conducted in a controlled environment and are therefore not in any sense tests of the actual capabilities of *directed-energy weapons (DEWs).*

The SAKTA programme also includes boost surveillance and tracking systems, and space surveillance and tracking experiments.

V. *Space weapons*

Space weapons can be divided into two basic groups: kinetic-energy and directed-energy weapons. Kinetic-energy weapons derive their destructive energy from the momentum of a propelled object, that is, from its speed. Some of these weapons may even carry chemical explosives. In directed-energy weapons, energy in the form of beams propagated with the speed of light is itself used to destroy a target. These weapons can in principle be Earth-based, space-based or, as in the case of an Earth-based laser, can have mirrors in space to reflect the destructive energy to the target.

Some of these weapons are thought to be useful as defensive weapons against intercontinental ballistic missiles carrying nuclear warheads. While ballistic missile defence (BMD) systems are claimed to be defensive in nature, they could in fact easily become ASAT weapons against an opponent's satellites. Thus space weapons have become the subject of considerable heated public debate.

DEWs are basically of three types: high-energy laser, particle-beam and radio-frequency weapons. DEW developments have focused on high-energy laser (HEL) weapons. Four major types of high-energy laser are being investigated: *(a)* chemical lasers powered by, for example, a chemical reaction between hydrogen and fluorine, operating in the mid-infra-red, or chemical reactions between oxygen and iodine; *(b)* excimer lasers using krypton fluoride; *(c)* free-electron lasers; and *(d)* X-ray lasers.

Among the laser weapon developments, the X-ray laser has perhaps been the most controversial because it depends on the use of a nuclear explosion to power it. If X-ray or gamma-ray lasers are deployed, this may jeopardize the 1963 Partial Test Ban Treaty (PTBT), which bans nuclear weapon tests in the atmosphere, in outer space and under water. Certainly the deployment of such systems will violate the 1967 Outer Space Treaty, which prohibits orbiting nuclear weapons and other weapons of mass destruction. In any case, the Outer Space Treaty will be violated in spirit since orbiting any BMD system cannot be regarded as a peaceful activity and the Treaty requires parties to use outer space for peaceful purposes only. It was reported that on 28 December 1985 an X-ray laser was tested in an underground explosion named Goldstone. The yield of the weapon was reported to be between 20 and 150 kt.

VI. *Soviet space research programmes*

Since the announcement by President Reagan in March 1983 of the US intention to begin a vigorous research programme on strategic defence, this issue has become the central topic in arms control debate. It is not surprising since this, the so-called Strategic Defense Initiative (SDI), has far-reaching consequences; it is controversial in nature and US-Soviet negotiations depend on the US attitude towards it. The President's speech resulted in the establishment of the SDI Office, the organization of the US research efforts on strategic defence technologies giving it a direction and the appointment of a single man – General Abrahamson – to direct the programme. It must be realized, however, that the USA as well as the USSR have been engaged in research on defensive systems since the ABM Treaty of 1972. Most probably the Soviet Union also has its own SDI, but few details have emerged.

In the US-Soviet negotiations on nuclear and space arms in Geneva, the USSR has declared that, 'As a first step ... the sides should, for the entire duration of the negotiations, set a moratorium on the development (including research), testing and deployment of space strike weapons...' 'Space strike weapons' have been defined as 'weapons to destroy objects in space and to launch attacks from space against objects in the atmosphere and on Earth, including the creation of a large-scale anti-missile system with space-based components'.

Concerning conventional BMD, a set of 11 large ballistic missile early-warning radars called Hen House radars are deployed on the periphery of the Soviet Union. During the ABM Treaty negotiations, it was recognized that ballistic missile early-warning radars can detect and track warheads, thus adding considerably to the ABM capability of the nation possessing them. Therefore, the two sides agreed that such radars must be placed on a nation's periphery and looking outwards only. This would mean that early-warning radars would not be able to track incoming warheads once they have passed the radars. However, the USSR is constructing six more Hen House-type phased-array radars with improved accuracy for tracking ballistic missiles. Five of these either duplicate or supplement the coverage of the Hen House system. The sixth, under construction at Abalakova near Krasnoyarsk in central Siberia, has recently raised considerable debate because the radar is situated some 750 km away from the nearest border and is facing away from the border towards the mainland mass of the USSR. It appears to close the gap that is left by the existing radars. Such a radar would violate the terms of the ABM

Treaty. The Soviet Union has explained the radar by saying that it is a satellite tracking system. However, its technical characteristics and appearance resemble other Pechora-type radars. The latter types have been acknowledged by the Soviet Union as being early-warning radars.

Furthermore, Soviet interest in DEWs and particularly in laser weapons dates back at least to 1962. In 1967 a weapon application of a carbon dioxide laser was described. It has recently been reported that the Soviet Union has admitted to conducting laser 'experiments and tests' against satellites in orbit. One of the important elements of such weapons is the power supply. The Soviet Union is supposed to have developed a magneto-hydrodynamic power generator producing some 15 MW of electric power in short bursts. Moreover, a so-called Pavlovskii generator has been installed at Sary-Shagan: this device uses thermonuclear explosions conducted underground. It is at Sary-Shagan that Soviet laser and particle beam weapon research is being carried out. In fact most of the Soviet ABM-related R&D takes place at this site. It has been reported that in the 1960s the USSR developed an experimental gun that could propel heavy metal particles at speeds of some 25 km/s in air and over 60 km/s in vacuum.

It is clear from the above that both the USA and the USSR have been engaged in research in defensive weapons since signing the ABM Treaty in 1972.

VII. *Implications*

Technological momentum is being generated in the USA and in the USSR for defensive weapons based both on the ground and in outer space. After over two years of intense debate on the implications of SDI a number of questions remain unanswered. Any defensive development and deployment of space-based weapons would jeopardize a number of existing arms control agreements. For example, ASAT weapons in their crude form already exist. If the decision is taken to go ahead and develop a BMD system, more effective and sophisticated ASAT weapons will emerge.

There are a number of other consequences of the development and deployment of BMD systems. Some have argued that if one side embarks upon an effort to achieve an effective defence (not necessarily a perfect one) supported by a strong national will, then the opponent may give up the development of more offensive weapons and begin to develop their own defensive system. On the other hand, if one side acquired such a weapon, it might then be tempted to strike first against the other, probably using tactical nuclear weapons, believing that it could still defend itself against the opponent's ICBMs, the release of which might result in escalation from tactical to strategic nuclear weapons. This is to be viewed particularly in the light of the availability of such small-yield, highly accurate nuclear weapons.

Moreover, a very important consequence would be for both the USA and the USSR to embark on yet another round of arms competition. Not only may there be a laser BMD race, but the two sides would multiply manyfold their offensive nuclear arsenals to ensure that despite the opponent's BMD systems some nuclear weapons would reach their targets. This would accelerate the nuclear arms race rather than check it. Perhaps a more serious implication of such a development lies in the fact that it violates the spirit of the 1972 ABM Treaty.

There are other consequences of such 'defensive' policies also. For example, how would a BMD system that substantially reduces the number of Soviet nuclear missiles reaching the USA in a potential attack affect the security situation in Western Europe?

It is argued that if both the powers built an effective defensive system, they would no longer live in fear of nuclear retaliation, making a conventional or even a nuclear war in Europe more likely. Another concern is that the small French and British nuclear deterrents would no longer be very effective 1 against Soviet defence. With regard to this it has been argued that an anti-tactical missile (ATM) defence, if made practical, would make the Europeans feel safer living without the fear of nuclear weapons being used against them, thus shifting the reliance on conventional weapons. This would again make a conventional war likely in Europe, an idea not cherished by Europeans.

In any case, there are, unfortunately, over 2700 nuclear delivery vehicles with about 4800 warheads deployed in East and West Germany alone and these include nuclear bombs for tactical aircraft, short- and medium-range ballistic missiles, artillery, surface-to-air missiles and nuclear land mines. The ranges of some of these weapons could be as short as 15 km (for artillery). How could one defend against such weapons?

The SDI as it exists now is a research programme. However, research may trigger a race for deployment that may outstrip arms control processes to prevent production and installation of new and potentially destabilizing weapons. In this connection it must be mentioned that France has recently proposed a European research programme called EUREKA, European Research Co-ordination Agency. It has been reported that the French Foreign Minister Roland Dumas said that the programme is not directly related to the SDI which he called 'a vast military program with civilian implications'; Eureka, he said, is 'a vast, long-range civilian program with military implications'. This needs to be viewed in connection with the French nuclear forces.

The concern about the British and French nuclear forces would also apply to the People's Republic of China. Some of the European arguments would also apply to Japan and many other non-nuclear weapon states.

Moreover, since the defensive anti-missile weapons could also be used against orbiting satellites, and in fact the defensive platforms will have ASAT capabilities if only to defend against enemy attack, deployment of defensive weapons may pose a threat to satellites of other nations. Thus, what appeared, at first, a problem between USA and USSR and perhaps Europe, is now a more global issue with far-reaching implications.