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The Organization of Antimissile Defense

(According to foreign views) 50X1-HUM

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Under modern conditions, a wide variety of means can be used for the delivery of nuclear strikes against troops in a theater of military operations and against the objectives of a country's military potential: piloted aircraft, ballistic and cruise missiles, artificial earth satellites and spacecraft. This variety of attack weapons, which has a great range of speeds, and flight altitudes, and an enormous range of operation makes it necessary to examine the question of combatting them in a new way.

The ability of modern attack weapons to deliver strikes from low levels, from the stratosphere and, in the near future, from space, has produced a need for the broadening of the scope of antiair defense. Antiair defense is developing into antiair and antispace defense.

By contrast to the atmosphere (vozdushnoye prostranstvo), which has limits at a certain altitude, space (kosmicheskoye prostranstvo) is boundless. The limitless range of modern aerospace attack weapons, their freedom of maneuver (their strikes can be expected from any direction) and the possibility of their combined use both against troops and against the military objectives of a country, make it necessary to establish a single system for antiair and antispace defense.

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The tremendous progress in the development of aerospace attack weapons has made necessary a revision of views on defense.

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It is known that during the past few years the USA has spent about 35 billion dollars on the creation of a system of antiair defense for the North American continent. The "Sage" semiautomatic control system has been set up, depending upon three radar lines constructed in the northern part of the American continent and possessing the necessary means of communication and electronic computers. Active defense has been based on the employment of antiaircraft missiles and of interceptor fighters armed with guided "air-to-air" missiles.

The development of strategic missile weapons has thrown doubt upon the expediency of these huge expenditures. The USA has stopped the development of interceptor fighters and significantly reduced work on the creation of new classes of ground-to-air and air-to-air guided missiles, and has reviewed and reduced the original plans for the formation of squadrons of "Bomarc" antiaircraft missiles for the antiair defense of areas of the country.

At the same time, having proclaimed a doctrine of "terror" (ustrasheniye), the USA and its NATO allies had to ensure that there would be no possibility of the destruction of their own strategic aerospace weapons, which could occur as a result of the first enemy strike.

With the appearance of nuclear/missile weapons, the means of attack immediately and abruptly determined the means of defense. It has become necessary to create weapons and systems for defense against ballistic missiles, and in the near future against space weapons as well. Passive methods (dispersal, concealment underground of the launching mounts of one's own missiles, constant retention in the air of units of one's own bomber aviation) have not eliminated the need to establish effective systems

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of antimissile defense, despite the complexity of the problems which this has caused and their obviously enormous cost.

Work in the field of antimissile defense is being conducted in the USA, Great Britain, Canada and other countries. The leading role belongs to the USA.

The Americans have already been working for more than 10 years on the solution of the problem of antimissile defense (protivo-raketnaya oborona-PRO). The best scientific resources and a considerable number of the largest American industrial companies have been brought into work in this field.

The detection, recognition, interception and destruction of long-range missiles are problems that are hard to solve, because of the great speeds and altitudes at which missiles fly, and because of the small dimensions of the target (the nose cone of the missile). Moreover, the enemy can take various steps to make the detection and interception of the missile's warhead difficult, or measures to confuse the PRO system.

Three phases of a missile's flight trajectory are examined during theoretical investigations into the possibilities of combat with missiles. The first is the active phase, during which the engines and the equipment of the guidance mechanism of the missile are in operation. The missile moves through this phase in a comparatively short time, not more than 2 to 3 minutes.

The second is the middle or free-flight phase. The beginning of this phase of the trajectory is marked by the point in space at which the missile engines are cut off and its nose cone is released automatically. From this moment the nose cone of the missile moves along the trajectory of a freely thrown body (in the first approach to an ellipse).

The third phase is the final phase, during which the nose cone of the missile enters the dense layers of the atmosphere. Its duration is determined by the altitude of the active layer of the atmosphere, which is about 100 km. Methods for combatting missiles are being worked out in the USA in accordance with these features of the flight of missiles.

The detection of missiles in flight. Timely detection of missiles in flight is one of the most important elements in a PRO system. For warning of a surprise attack using missiles, means for the early detection of the latter were required first of all. Using the newest achievements in the field of electronics, the Americans devised powerful radar sets with a range of operation of several thousand kilometers.

The increase in the range of operation of radar sets was achieved by increasing the power of the transmitters and the sensitivity of the receivers, by setting up improved antennas, and by using the technical and scientific achievements attained in the field of radar in the last few years. Great successes were achieved in this respect, thanks particularly to the application of methods of a new science - the theory of information.

Experimental models of the American PRO radar sets had a power of from 2 megawatts (the AN/FPS-17 set) to 10 megawatts (the AN/FPS-35 set). The vacuum tubes which are being developed at present allow the power of the transmitters to be increased to 20 to 50 megawatts. Thanks to the use of molecular amplifiers, the sensitivity of the receivers is increased tenfold and a hundredfold . This also permitted an increase in the range of action of the sets.

The use of huge directional antennas and of new methods for the separation of reflected signals made it possible to increase the range of action of a set without significantly increasing its power, both by concentrating the energy emitted in the required direction and by improving conditions for the reception by the antenna of reflected signals. Based on the use of new antenna devices, the AN/FPS-49 and AN/FPS-50 radar sets were devised in the USA, with a range of action of up to 5400 km against a target as small as that which is represented by the nose cone of an intercontinental ballistic missile.

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Besides such sets, whose range of operation is still limited by the zone of line-of-sight (zona pryamoy vidimosti) the possibility of using "Tepee" sets employing the back-scatter probing (vozvratno-naklonnoye zondirovaniye) method. In principle, this method permits the detection of missiles while they are still in the active phase of their trajectory. But such sets can only determine the azimuth and, with little accuracy, the distance to the target. It is therefore proposed to use the "Tepee" set to supplement detection systems using AN/FPS-49 and AN/FPS-50 sets.

As well as radar sets, infrared equipment may be used to detect missiles. By locating such equipment on the ground it is very hard to provide the great range required. When it is located in space the situation changes fundamentally. First of all, the great obstacle of atmospheric absorption of the infrared radiation disappears. Secondly, the missile can be detected in the active phase of its trajectory, when it is a powerful source of infrared radiation.

Already in 1957 experiments were conducted in Canada which showed the possibility of detecting missiles with infrared equipment, at a range of up to 1600 km. In 1958 the Americans were able to track the flight of the third Soviet artificial earth satellite,

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flying at an altitude of about 400 km above the earth, with an infrared tracking device of the firm "Aerojet". Later, models of infrared devices with even greater ranges of operation were produced, For example, the range of operation of a multipurpose gyroscopic head, built by the "Martin" firm in 1959, is estimated as several thousand kilometers when the launch of a missile is detected from space and several hundred kilometers when using the head to aim at artificial earth satellites.

In this way, thanks to the enormous progress in the field of radio-electronics, the problem of detecting missiles in flight is being successfully resolved.

Recognition of missiles. In the development of a system of antimissile defense, a great deal of attention is devoted to solution of the problem of recognition of the missile's nose cone from among the various types of interference and of dummy targets.

There are many methods which make it possible to hamper the destruction of the missile in flight and to disorganize the PRO system. These methods include: covering the missile nose cones with a protective layer which sharply reduces the reflection of electromagnetic energy;--the use of dummy targets which camouflage the flight of the actual nose cone;--the use of active jamming of the radar sets of the antimissile defense system.

One of the simplest ways of creating dummy targets is to break up the missile airframe as soon as the nose cone is separated in the middle section of its flight trajectory. All of this presents complex problems for the PRO in finding methods of combatting equipment which creates radio-electronic interference and in developing methods of identifying targets, i.e., of determining their true nature. The general problem of recognition of dummy targets in the middle phase of a trajectory has not yet been solved by the Americans, even theoretically.

One opportunity for recognition occurs during the flight of the nose cone and of its accompanying complex of dummy targets in the final phase of the trajectory--in the atmosphere. During reentry into the atmosphere the movements of the dummy targets and of the missile warhead change in different ways, their infrared radiation varies in intensity and spectral characteristics, and other phenomena appear which simplify the solution of the problem of recognition.

By studying the nature of changes in speed it is possible to distinguish the missile nose cone from the dummy targets. The missile warhead will brake more slowly than the dummy targets and will have a higher speed. However, since it passes through the dense layers of the atmosphere in a very short period of time (10 to 12 seconds) this method of recognition is not acceptable. Recognition of a target by this method will occur too late and the defense system will have no time to destroy the nose cone which has been picked out.

During entry into the atmosphere, both the nose cone and the dummy targets accompanying it heat up and give off infrared rays, a shock wave builds up in front of them, and an ionized gaseous trail behind them. However, the use of these phenomena for recognition of the nose cone is unacceptable for the same reason.

The most effective method for recognition, used by the Americans in the "Nike-Zeus" system, consists of the use of special radar sets with very high discrimination, capable of receiving data on the whole group of targets during flight while it is still in the middle phase of its trajectory. The signal reflected from a flying object makes it possible to obtain some idea of the change in its reflecting surface during flight, of its dimensions, and even of its shape.

If signals from flying nose cones and from various dummy targets are studied in advance, the knowledge of their "signatures" can be used to solve the problems of recognition.

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In order to put this method to practical use, the Americans registered the signals reflected from the nose cones of their own missiles while these were being tested at firing ranges. Signals from the nose cones of Soviet missiles launched into the central part of the Pacific Ocean were also registered. In 1961 launchings of "Titan" missiles with devices for the creation of interference and of dummy targets began.

A recognition radar set is used in conjunction with an electronic computer, into whose memory are fed the characteristic signals which correspond to the flight of actual nose cones. This same machine receives data on the signals of all objectives observed from the recognition set. Comparison of these data in the machine permits recognition of the missile nose cone in a group of dummy targets.

Means of detection and recognition. At the present time the basic means for the detection of missiles in flight are ground radar posts with ultra-long-range detection sets, which make up the Ballistic Missile Early Warning System.

The BMEWS system includes three radar posts, located in Thule (Greenland), Clear (Alaska), and Fylingdales Moor (Britain). The range of operation of the radar sets installed at these posts exceeds 5000 km.

In addition to the detection of missiles in flight, the BMEWS system permits the approximate determination of the probable objective of an attack. The performance of the second task is simplified by the fact that, after the engines stop working, the warhead of a missile follows a ballistic trajectory, to determine which it is enough to make several fixes and to determine the impact point of the missile by extrapolation of the trajectory.

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The total warning time--i.e., the time from the moment the alarm is given until the missiles strike their targets--provided by the BMEWS system is from 15 to 17 minutes.

The shortcomings of the BMEWS are that it does not cover all the probable missile launching areas and that it can be neutralized with the aid of special equipment or disorganized by the creation of dummy targets. In addition, the system is expensive, cumbersome, stationary, and could be destroyed before missiles are launched against objectives on the territory of the USA.

The realistic way toward an increase in warning time lies in the use of special earth satellites with infrared or radar equipment which permit detection of missiles in the active phase of their trajectory.

Satellites with infrared equipment for the detection of missiles launchings are being developed in the USA under the "Midas" project. As is known, in October 1961, the "Midas-4" satellite recorded the launch of an American "Titan" ballistic missile from Cape Canaveral. The satellite passed over Florida at an altitude of more than 3000 km. The launching was detected within 90 seconds of the launch of the missile, but the detection signal was transmitted within 90 minutes, when the satellite passed over California, where there is a station for the reception of signals from such satellites.

In the experimental satellites, detection signals are to be recorded, together with time details, and transmitted to the earth on the commands of the tracking stations which have so far been built. In a future satellite operational system, the signals must be transmitted immediately as the launchings are detected. A network of interconnected earth satellites will be used for this purpose.

Besides detecting launchings of missiles, "Midas" satellites can probably determine, at least approximately,

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the direction of their flight, in order to provide plots for the sets of the BMEWS system.

An operational system of "Midas" satellites should be set up by the Americans before 1965.

Satellites with radar sets are still in the stage of scientific and experimental development, and their establishment, probably as multipurpose spacecraft, is possible after 1965. Thus, one of the projects, proposed by the "Ryan" firm, envisages the creation of a space system of early warning with satellites, on which a whole system of radar sets for the detection and tracking of the ballistic missiles and spacecraft of the enemy is installed.

The employment of artificial reconnaissance satellites in a PRO system increases the possibility of detecting missiles. With the help of satellites a missile can be detected within 1 to 2 minutes of its launch.

Interception and destruction of missiles. The task of intercepting and destroying missiles consists of preventing them from exploding in the area of defended objectives. The interception and destruction of a missile is considered most effective during the active phase of its flight trajectory (during the acceleration stage), when the missile presents a large target and is flying at a comparatively low speed. Interception during the middle phase of the trajectory may lead to the destruction of the missile at a great distance from the defended objective. However, in both the first and second cases, means of interception with a great range of operation and highly accurate guidance are required. The development of such means involves great technical difficulties. In the USA means for intercepting the nose cone of a missile in the final phase of its trajectory, when it enters the atmosphere, have been brought, in practice, to the stage of flight tests. Interception at this phase of the trajectory

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permits the use of weapons with a comparatively short range of operation.

Because of their great approach speeds, the interception of missiles is only considered possible on collision or collision-intersection courses. A nuclear warhead is used to destroy the nose cone of the missile.

Taking into consideration the comparatively small radius of destruction of even a nuclear warhead when it explodes outside the dense layers of the atmosphere, other probable methods of destruction are being studied in the USA. Special project "Glipar" was devoted to this question, having as its goal the study of the possibilities of destroying missiles or of rendering them harmless, including those which, at today's level of technology, appear highly problematical, but which may prove effective in the future, when our knowledge of these questions has increased considerably.

The "Glipar" project studied the possibility of destroying missile nose cones with small fragments or particles of hard substances, with gases, plasmas, electrical charges, radiation and with the action of various fields. The use of hard particles, which, when they hit a nose cone which is moving at high speed, may inflict considerable damage upon it, proved to be the most effective means.

One of the experiments to study the impacts of hard bodies, flying at great speeds was conducted in 1961 in the ballistics laboratory at the Aberdeen Proving Grounds, and in this, metal balls 7 mm in diameter brought about the almost complete destruction of the wall of a 105 mm artillery shell.

Evidently in connection with this, the Advanced Research Projects Agency of the U. S. Defense Department advertised for bids for the development of a PRO system (Project ARPAT) in which the warhead of a missile would be destroyed with "shrapnel" shells when it enters the atmosphere.

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As for the other methods of destruction studied, their realization at the existing level of technology was found to be in practice impossible, although research in this direction is still continuing. As an example, one can mention the method based on the use of so-called "lasers" --powerful sources of monochromatic infrared or light radiation. Such lasers already make it possible to obtain a narrow beam of radiation which has an impulse power of tens of megawatts, although it is true that this is of very short duration, measured in microseconds.

The use of similar means from the ground is hardly possible, even taking into account their future development and a future manifold increase in the energy of their destructive impulse. The basic obstacle here is the absorption of energy by the atmosphere. This obstacle can only be overcome by installing improved lasers on spacecraft with a high coefficient of effectiveness and great power. While impulses of modern lasers can lead to the heating of material to a surface temperature of several thousand degrees, in the future one can foresee the possibility of burning through the structure of the nose cone of a missile or satellite, which can prevent the explosion of the missile's charge or can lead to its destruction during reentry into the atmosphere.

Means for the interception and destruction of missiles in the active and middle phases of their flight trajectory are in the stage of theoretical development. Earth satellites are considered the most promising means for the performance of these tasks.

The development of a space antimissile system is being conducted in the USA under the "Bambi" program. Such a system could provide defense on a global scale, but requires the use of several thousand satellites. In order to bring this system into use it is necessary to reduce significantly the cost of orbiting a kilogram of payload and to bring this down to several dollars or, at the most, tens of dollars. The destruction of missiles can be carried out by homing satellites (the RBS project) or by satellites armed with homing antimissile .

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missiles of the "space-to-space" class (the SPAD project). Both these projects are still in the initial stage of development. In both cases an infrared guidance system is considered to be the most suitable for homing.

Besides automatic interceptor-satellites, for anti-missile and antispace defense, it is also proposed to use piloted interceptor-satellites with a man on board. For the present the development of such satellites is being pioneered by some American firms.

In the USA it is considered possible to create PRO space weapons in 1966-1967.

For the interception and destruction of missiles in the final phase of their trajectory (during reentry into the atmosphere), the Americans, starting in 1955, have developed several PRO systems. The "Nike-Zeus" system, which permits the interception and destruction of missiles at altitudes of up to 150 km and at ranges of up to 320 km, has received the greatest development.

Up to the present day, experimental models of the radar set for this system, of the electronic computer, and of experimental models of the "Nike-Zeus" antimissile missiles have been constructed.

Although the "Nike-Zeus" PRO system has been under development for many years, and although some of its elements could be put into mass production, adoption of the system as armament is being delayed. In the U.S. Defense Department there are doubts of the reliability and effectiveness of the system, particularly in its ability to distinguish missile nose cones from dummy targets.

Moreover, the cost of setting up such a system, even for the defense of only the most important cities and objectives on United States territory, is calculated in billions of dollars (according to some data it may reach 4 to 15 billion dollars).

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Taking these circumstances into consideration, the U.S. Defense Department and the President of the USA have reacted to the proposals of the army to begin production of the components of the system before the completion of its comprehensive tests, including firings against "Atlas" type combat missiles, with a certain caution.

Flight tests of the experimental model of the missile began in 1959 at the White Sands proving ground. The second step in the tests, including the launching of a complete three-stage missile with a guidance system, but without a nuclear warhead, is being completed at present at Point Mugu on the west coast of the USA (the state of California). The third step, during which live firings of "Nike-Zeus" missiles will be carried out against "Jupiter" and "Atlas" missiles, is planned for the middle of 1962. The "Atlas" missiles will be launched from Vandenberg Air Force Base and the "Nike-Zeus" missiles from Kwajalein Island in the Marshall Islands in the Pacific Ocean. A complete complex of components for the system is being built on this island, including underground launching mounts for the missiles, for radar sets (target acquisition, target recognition, and tracking of the target and of the missile), and the necessary computers, launching and auxiliary equipment.

After the speech of the Minister of Defense of the USSR, Marshal of the Soviet Union Comrade R. Ya. Malinovskiy, who reported to the XXII Congress of the CPSU on the successful solution in the USSR of the problem of destroying missiles in flight, the American command decided to speed up the tests and the beginning of production of the components of the "Nike-Zeus" system. The time limits for conducting live firings of "Atlas" intercontinental ballistic missiles for interception by "Nike-Zeus" missiles are connected with the decision of the President of the USA on the resumption of nuclear weapon tests in the atmosphere. The first tests, with the detonation of nuclear warheads on "Nike-Zeus" missiles with a yield of from 2 to 5 thousand tons are planned for the end of December 1961 or January 1962. The first firings against "Atlas" missiles, in which both the "Nike-Zeus" missile and the target missile will be fitted with nuclear warheads, are planned for February 1962. Without waiting for the conclusion of the tests, the Defense Department and the President of the USA decided to ask for appropriations to begin production of components of the "Nike-Zeus" system in 1962. It is planned to arm the first PRO batteries with them in 1963.

The organization and conduct of PRO. All means of antimissile defense will be subordinate to the Air Defense Command of the USA. It is planned to use the units and subunits of the PRO in the first place for coverage of missile bases and strategic aviation bases. The use of the "Nike-Zeus" system in combat is carried out in approximately the following manner. A target (missile), crossing the fan-like beam of a BMEWS system radar set, reflects electromagnetic energy which is picked up by the receiving apparatus of the set.

Information on the target, contained in the reflected signal, enters the target selection system and is then transformed into numerical form and fed into a computer.

The selection device enables the missile to be picked out among the numerous reflections which result from atmospheric phenomena, the Northern Lights, meteorites, artificial satellites, etc.

The computer calculates the approximate trajectory of the missile's flight and determines the objective which is probably under attack, for target acquisition by subsequent elements of the defense system. In addition, the computer formulates a message on the detected target, which is fed into the communications line in numerical (coded) form, and arrives at the US Continental Air Defense Control Center. The report shows the calculated trajectory and the probable impact point of the missile.

A special warning system has been set up to transmit data on the appearance of missiles. At each post of the BMEWS system there are data units (datchik) and means of communication which provide instantaneous transmission of data.

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In the antiair defense control center the message which has been received is decoded and evaluated and the data received are compared with information which has arrived from other sources.

In accordance with the indications received from BMEWS posts or at the command of the antiair defense control center, the antimissile subunits are put in a state of combat readiness.

The "Nike-Zeus" system consists of a series of defensive centers, which provide protection for particular objectives with the aid of several batteries of antimissile missiles. The fire of these batteries is controlled from the defense center, which has an acquisition radar set and a computer for processing both the data arriving from BMEWS posts and those from this set.

The acquisition set has an operating range of about 1600 km and carries out a repeat (povtornyy) detection of the missiles approaching the defense objective. For this it is necessary for the nose cone of the approaching missile to be in motion within the operating sector of the set for about 20 seconds. Information on the targets goes from this set to the computer of the defense center and is used for target acquisition and for the distribution of targets among the antimissile missile batteries.

The battery is the basic subunit of the system. It has a target recognition set, a target tracking set and several sets for tracking the antimissile missiles. Apparently a battery will consist of 24 antimissile missiles with the necessary launching and auxiliary equipment. All the equipment of a battery is stationary.

The target recognition set picks out the missile nose cone from among the dummy targets. Recognition of the target is based on a comparison of the signal characteristics reflected from the target with the known characteristics of various objects which have been fed into the memory of the computer. As a result of such a comparison, the

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data on the real target are singled out by the exclusion of false information. Approximately 30 seconds is taken for target recognition, after which the missile nose cone is taken over by the target tracking set.

When the target is being tracked, its trajectory is defined with greater precision and the requisite data are fed into the device for controlling the launch and guidance of the antimissile missiles. The guidance computer calculates the flight trajectory of the antimissile missile and determines the point at which it will meet the target. At the necessary moment the command for the launch is given and this ignites the engine of the first stage of the antimissile missile.

After the missile is launched, data on the flight of the target and of the missile continue to be continuously fed into the computer of the tracking system, and on the basis of these, commands are evolved for the guidance of the antimissile missile to its target. This device is a digital computer capable of performing 200,000 arithmetical operations per second.

The intercept computer also determines the moment for the detonation of the antimissile missile and generates the command for the explosion, which is then transmitted to the missile by the set which is tracking it.

It is considered that about 100 seconds are needed to prepare the antimissile missile for launching, to launch it, and for it to enter the interception area. To carry out the series of operations in intercepting and destroying a missile warhead with a speed of 8 km/sec., approximately 2 min. and 40 sec. are taken by the "Nike-Zeus" system. During this time the missile warhead will travel approximately 1300 km. The interception and destruction of the missile warhead is effected in the final phase of the trajectory at an altitude of about 150 km.

From all that has been said one can conclude that so far the USA does not have an organized PRO system or

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effective means for combatting missiles. Many problems connected with recognition, interception, and destruction of the missile in flight still must be settled.

The establishment of antimissile defense involves huge expenditures of materiel which can only be afforded by states with a developed industrial-economic base and a large network of scientific-research institutions. The widest development of work on antimissile defense has therefore been achieved only by the USA. Meanwhile, in connection with the great expenditure on these tasks and the difficulty of resolving the technical problems of antimissile defense, some American military specialists are calling for the development, above all, of strategic attack weapons -- long- and intermediate-range missiles, strategic aviation and an atomic fleet -- as a means of "deterrence".

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