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Chapter 31

The U.S. and Soviet Space Systems Developments as Driven by the Cold War Competition*

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Introduction

A detailed study of the interactions between the U.S. and Soviet space programs during the Cold War poses not only historical interest, but also provides a teaching tool for the avoidance of provocative and unwise developments in the future. This paper discusses the histories of several space projects undertaken by both the United States and the Soviet Union in order to reveal typical scenarios for the development of space systems in the environment of the Cold War. To complement studies concentrated on more visible high-profile projects, like Man-in-Space or Man-to-the-Moon, this paper focuses on military space systems. This study identifies the basic modes of project evolution and outlines a balance between the predominant motivation behind a system's promotion, the status of its technical capabilities, and the response by the other side.

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Typical Modes For Space System Evolution

Mode A

In some cases an American space project stimulated a very similar response from the Soviet side, and that response continued far longer than the source itself. A *manned orbital station for reconnaissance purposes* is a classic example.

The U.S. Manned Orbital Laboratory (MOL) was initiated as an Air Force project in December 1963 in place of the abandoned Dyna-Soar program. The MOL was a trailer-sized orbital laboratory with an attached Gemini-B spaceship and a set of equipment for optical and/or electronic intelligence gathering. A go-ahead for its development was given by President Johnson on 25 August 1964.

This did not go unnoticed by the Soviet Union, so on 12 October 1964 General Designer Vladimir Chelomei started a draft design of the Almaz system.[1] The Almaz project used much of the MOL concept, with the exception of an Orbiting Piloting Station (OPS) with an integral Recovery Vehicle (VA); it also featured a separate Transport Supply Ship (TKS), based on the same framework as an Almaz OPS. The TKS also carried a Recovery Vehicle and was capable of delivering both cargo and crew to a base station. In 1967 a Draft Design of the Almaz was accepted by the State Commission and development started.

On 10 June 1969 the MOL program was cancelled without a single launch, as the USAF had failed to prove that the value of a human presence for the MOL reconnaissance mission was significant enough to compensate for an associated cost increase, estimated at 33%.

After 1969 the Almaz program also faced growing opposition. However, it was delayed rather than cancelled, and the order was given to use Soyuz spaceships, designed by Korolev's OKB-1, instead of the TKS for crew delivery.

Flight testing of the Almaz OPS began on 3 April 1973 and continued, with mixed results, until August 1977. Three stations were orbited, of which one depressurized before a crew arrived. Of the five crews sent to the other OPSs, only three were able to dock; they spent a total of 80 days working on the stations.

After OPS testing was completed, the Ministry of Defense refused to accept it for combat duty due to poor operational performance. A preference was given to automated reconnaissance spacecraft, which performed much more effectively. In 1978 the piloted Almaz program was cancelled.

Nevertheless, testing of another component of the Almaz system—the TKS transport ship—continued. The TKS was tested unmanned from 1977 to 1985, in conjunction with the Salyut 6 and Salyut 7 orbital stations, and then that program was also cancelled.

The core Almaz was later geared to an unmanned mode, very similar to the U.S. Hexagon (or Key Hole 9) reconnaissance spacecraft, which appeared as an unmanned backup to a manned MOL (which would have been Key Hole 10). TKS hardware was later used for the MIR modules. However, the continuation of the Almaz program had nothing to do with the manned orbiting laboratory for strategic reconnaissance. That way proved to be a dead end, and both sides had to accept that, though at different times.

Mode B

The history of the development of space systems for strategic reconnaissance also provides examples of quite a different mode of project evolution. Let us consider the development of the first *unmanned reconnaissance spacecraft*.

After feasibility studies going as far back as 1946, on 16 March 1955 the USAF and the Central Intelligence Agency (CIA) issued a Request For Proposal (RFP) for a Strategic Reconnaissance System, designated WS 117L. After year-long design studies, performed by three bidders, on 30 June 1956 a contract to develop a system, named PIED PIPER, was awarded to Lockheed. Its design called for a rocket upper stage which would carry several hundred pounds of camera equipment to be launched by an Atlas ICBM. The stage, integral with the camera section, would provide attitude control and stabilization, critically important for Earth imaging.

An original idea was to create a system for real-time global TV monitoring. However, it turned out that the resolution of available TV systems was too low to meet any reconnaissance purposes. Another problem with real-time monitoring was the tremendous volume of data to be sent from a spacecraft to Earth via communication links.

However, during June 1956 the RAND Corporation reported on the feasibility of film recovery from orbit. That proved to be the way for operational space reconnaissance for decades to come.

It was the very same year, 1956, when the Soviet OKB-1 also started design studies for a recoverable reconnaissance satellite. Note that in addition to a photographic camera with recoverable film, the spacecraft was supposed to carry photo-television equipment with the intention to provide near-real-time imagery.[2]

In January 1958 President Eisenhower approved the development of the CORONA reconnaissance satellite, which would be launched by the Thor IRBM and carry a camera with a recoverable film canister.

The original Soviet design looked much like the CORONA. It featured a large cylindrical equipment section and a small conical recovery vehicle. However, in 1958, when CORONA development went ahead in the U.S., the Soviet Union also started design studies for a manned spaceship. Unlike the U.S., the OKB-1 was the sole lead contractor for all spacecraft development. Being unable to conduct two such big projects simultaneously, and unwilling to lose either of them, the OKB-1 drastically revised the design of the reconnaissance satellite to make it as similar to the manned spaceship as possible. The resulting spacecraft, known as Zenit, adopted a large (2.3 meters in diameter) spherical recovery vehicle, where not only the film but also all intelligence-gathering equipment was located.

Despite this unification, the pace of development of an automated reconnaissance spacecraft apparently suffered from a higher priority given to the manned spaceship (which was considered more beneficial for the country's global image).

While CORONA was ready for a flight a year after the formal go-ahead, it took Zenit more than three years to reach that stage. The CORONA test flights began on 28 February 1959 and the system achieved operational status in August 1960. The first launch of the Zenit 2 occurred as late as 11 December 1961, seven months after Gagarin's flight. Testing of the Zenit 2 was completed in October 1963 and after that the system was put into routine operation—three years later than CORONA.

At the very first stage of Zenit 2 flight testing it turned out that the phototelevision apparatus did not meet the requirements, and it was abandoned in favor of additional photographic cameras.

The original Zenit 2 remained in operation until 1970. CORONA was used until 1972. They were both replaced with more advanced photoreconnaissance spacecraft. That history goes beyond the scope of this paper.

The bottom line in this part of the discussion is that when there is a strong operational demand for a system, it appears as soon as technology and a commitment to proceed are available.

To emphasize the role of technology available, recall that original attempts to build systems for *real-time* reconnaissance monitoring proved fruitless both in the United States and in the Soviet Union, and that idea had to wait for about two decades until the technology got ripe. It was not until charge coupled devices (CCDs) were developed and matured in the 1970s, when optical electronic reconnaissance spacecraft, capable of high quality real time imaging, appeared. The first American optical electronic reconnaissance satellite was launched on 19 December 1976, while its Soviet counterpart followed six years later on 27 December 1982.

For a more specific discussion of a case of developing an urgently demanded system against yet under-developed technology, below we consider a history of *systems for early warning about a missile attack.*

Mode C

The idea of detecting ballistic missile launches from space emerged as soon as the Soviet Union and the United States developed ballistic missiles with an intercontinental range.

The United States started the development of the Missile Defense Alarm System (MIDAS) as early as 1958, as one of the three outlets of the WS 117L program. The MIDAS spacecraft had to detect launches of Soviet ICBMs during their boost phase, looking for intense radiation from hot exhaust plumes. Eight spacecraft, equipped with scanning heat-seeking sensors and placed into polar orbits with heights of 3,000 kilometers, were supposed to provide a continuous monitoring of Soviet territory.

A perceived (and greatly overstated) Soviet ICBM threat caused a rush to develop an operational system and put it into service as soon as possible. When MIDAS launches started in 1960, it was expected that the system would become operational by the end of 1963. However, major technical problems surfaced during testing. An assured and error-proof detection and discrimination of a missile plume was complicated by the effects of background radiation from the Earth and reflections of sunlight from clouds.

After November 1963, further MIDAS launches were dropped and the program was scaled back to an R&D effort. That step reflected both technical challenges to be overcome before proceeding to an operational system development, as well as the diminished urgency of that development. By then the CORONA reconnaissance satellites had discovered that the Soviet ICBM force was not nearly as impressive as was originally suspected.

In the Soviet Union space-based missile detection systems were also considered, starting in from the early 1960s. Basic features of such a system had been identified, including an understanding that the operational location for an early warning spacecraft would be a geostationary Earth orbit (GEO). At the same time, it was realized that the technology available was not mature yet, and a space-based early warning system remained at a research level.

Meanwhile, early in 1966, after several years of research and advances in sensor technologies, the United States issued a request for proposals for an early warning system with satellites in geosynchronous orbit. Contracts for the development, known as Program 949, were awarded in late 1966, and after test launches between 6 August 1968 and 1 September 1970, early warning sensor operations in geosynchronous orbit were successfully tested. In 1970, Program 949 was renamed Program 647, and in 1972 the space-based early warning system was commissioned into regular operations.

With information about that available, the task of acquiring a similar system got a top priority in the view of the Soviet leadership. During 1972, a draft design of an integrated missile attack warning system, combining ground-based and space-borne segments, was completed and approved. The very same year the first hardware demonstration satellite was launched, despite the fact that optical equipment was not available yet.

During 1974-1976 several engineering test satellites were launched into highly elliptical orbits, which allowed the monitoring of launch sites from an apogee, and one into geostationary orbit, which allowed for constant monitoring.

Testing of detection equipment and algorithms continued until 1978. In 1978, the system was accepted into a "limited operation," despite the fact that its space segment consisted of only two satellites in highly elliptical orbits which could not provide permanent coverage. Moreover, a system software had not been perfected yet. To ensure precise identification of signals observed, mathematical processing of signals from heat-seeking sensors was duplicated by monitoring a scene by operators through a visual monitoring channel.

Improvements and further deployments continued constantly. In 1980, the system of four operational spacecraft, capable of the continuous monitoring of US continental ICBM sites, was deployed for the first time. In 1982, the system was commissioned into full operation. Nevertheless, it had still not been completely worked out.

One specific problem with the system was caused by an eccentric orbit employed by the Soviet early warning spacecraft. At every rotation their orbit passed through Earth's radiation belts and subjected the spacecraft to intense bombardment by high energy particles. As a result of charging, spacecraft quickly went out of order. That problem was overcome in the mid-1980s by the introduction of specific changes in spacecraft design.

The use of a geostationary orbit, which would provide better coverage with less spacecraft and would avoid charging problems, posed significant difficulties for the Soviet Union. The distant location of the Soviet launch facilities from the Equator resulted in a significant loss of payload during insertion into GEO. It was not until early 1984 that launches of operational early warning satellites to geostationary orbit began.

By the mid-1980s, the Soviet early warning system had been perfected and currently serves in a full capacity, with spacecraft deployed both in highly elliptical and in geosynchronous orbits.

After the original task of detecting ICBM launches of each other was solved, both the American and Soviet systems are being modified to extend their capabilities on the basis of new advances in technology.

A major direction is sensor upgrades, namely to replace lead sulfur detectors with those using cadmium-mercury-tellur. New sensors allow the extension of the operational range of the system to longer wavelengths and, thus, to detect colder objects, like plumes of tactical ballistic missiles. In perspective, early warning systems could enable the detection of cruise missiles and jet planes.

The history of early warning systems development shows that until a technology is ripe, politically driven attempts to speed up development result only in early hardware manufacturing and longer and more expensive development until the technology will mature.

Mode D

The most complicated scenario includes not only the actions of one side, stimulated by a perception of a threat or information about an adversary's development, but a chain reaction of developments and counter-developments. The most spectacular case of that kind is the history of anti-satellite weapons.

Preliminary studies of countermeasures against Earth-orbiting satellites originated in the US by the mid-1950s. A variety of options had been studied in the late 1950s, including ground-, sea-, and air-launched interceptors, as well as manned and unmanned orbital spacecraft for satellite inspection. Of all those early studies, the SAINT project was the most remarkable, as it was that project which stimulated a chain reaction of further developments.

The 6-month contract to study satellite interception techniques was awarded by the US DoD Advanced Research Projects Agency to the RCA Corporation on 11 June 1959. Information about that was available via a DoD press release, so that the Russians would learn about it in close to real time.

Early in 1960, a project concept was singled out for a co-orbital unmanned interceptor, and the contract was submitted for approval by the Secretary of Defense. The final approval for project SAINT (for Satellite Inspection Technique) came on 25 August 1960. At all official levels it was constantly repeated that this is a system for *inspection*, rather than for *interception*. A delicacy of this matter was associated, first, with the primary mission of SAINT, which was supposed to be an inspection of orbiting nuclear bombs, expected to be deployed by the Russians.

Secondly, the US did not want to provoke the Russians into developing satellite negation systems, which could infringe on the freedom of the operation of American reconnaissance satellites.

However, official statements that the SAINT would carry no armaments and pose no threat to any nation, were not believed by the Soviets. The Soviet side considered the SAINT as a dangerous offensive space weapon and decided not to be left behind.

Following their perception of the "true" goals of the SAINT, the Soviets from the very beginning chose a "kill" option. The system, the design of which started in the middle of 1960, got the name "IS," for "*Istrebitel' sputnikov*" ("a destroyer of satellites").

Unlike the SAINT, it was unequivocally designated to fight the American spysats, which were at that time considered as an intolerable intervention into the internal affairs of the Soviet Union, the same as spy planes before them. (Note that the development of the IS started basically simultaneously with shooting down of F. Gary Powers' U-2 on May 1, 1960, and the following decision of the US administration to switch overflights of the Soviet Union to spy satellites).

The reasoning behind SAINT failed, as it proved technically difficult to get anything valuable from in-orbit inspection, that couldn't be done otherwise. Moreover, Russian orbiting bombs failed to appear. So the SAINT program was doomed as unable to solve a task, which itself failed to appear. On 3 December 1962 the SAINT program was cancelled. Yet that was too late to stop the development of the Soviet IS system.[4]

Moreover, continued American programs to develop an anti-satellite weapon using directly ascending nuclear missiles provided additional reasons for the Soviet side to keep its ASAT development going. Program 505, employing the upgraded Nike-Zeus surface-to-air missile, was operational from 1 August 1963 until 1967, and Program 437 demonstrated test launches of Thor IRBMs from February 1964 until September 1970. Yet before either of those systems became operational, it was clear that their use was hardly feasible at all, as explosions of their nuclear warheads would not only destroy targets, but damage US satellites as well. However, the systems were kept operational for a fairly long time, and their testing provided an additional push to the Soviet desire to develop an ASAT capability of their own.

Unlike the SAINT, which was unarmed, and the US direct-ascent ASATs, which were nuclear-tipped, the Russian system used a kinetic kill. The IS showered a target with a flux of pellets to put it out of order.

A non-nuclear kill option was chosen, in all probability, not because of a perceived collateral damage from a nuclear explosion in outer space, but rather because of a lack of data about the negating capabilities of such an explosion (Note that the anti-ballistic missiles developed in the early 1960s, and first successfully tested on 4 March 1961 against an IRBM warhead, also used a non-nuclear kill mechanism).

Eleven months after the SAINT was cancelled, the first launch to prove the design of the IS occurred. On 1 November 1963 the spacecraft, called the Polyot-1 was orbited and tested a mainframe, attitude control, and in-orbit maneuvering systems.

Full scale testing of the IS complex began in October 1967 and the first interception occurred on 20 October 1968. After two phases of testing were completed (in 1968-70 and in 1971), the IS system was commissioned for "pilot operations" with the Soviet Air Defense Forces.

It was during the second phase of the IS testing when the American Air Defense Command proposed the development of an air-launched missile, capable of intercepting and negating satellites by using terminal homing and kinetic kill rather than a nuclear charge.

In March 1975, *Aviation Week & Space Technology* reported about the development of the so-called Miniature Homing Vehicle (MHV), which was supposed to be launched by a two-stage rocket carried underneath an F-15 fighter, and use long-wave infra-red homing to collide with a target.

A year afterwards, in March 1976, the Soviet Union began a new series of ASAT testing after a 5-year interval. A new series was to demonstrate the extended operational flexibility and range of the system. In the first round of testing the IS was tested against targets in orbits varying from 250 km to 1,000 km in height. This series demonstrated an operational interception range of 150 km to 1,600 km. The new phase of testing ended in May 1978, just days before negotiations between the US and the USSR on an ASAT ban started in Helsinki. After that the system was commissioned for full combat operations and its operational launches were suspended for the time of the talks.

However, the completed series of tests no doubt gave a major push to US efforts in non-nuclear ASAT development. The contract for MHV development was awarded to Vought in September 1977, and in 1978, the system, although plagued by numerous technical problems, got the status of a "major weapons system."[5]

Operational testing of the Soviet ASAT resumed in April 1980 after the negotiations on an ASAT ban stumbled and the United States withdrew from them. New Soviet testing helped to keep the MHV development on course despite cost overruns and schedule slippage (Originally expected to cost $500 million, the system by 1986 was estimated to cost $5.3 billion to complete).[6]

The first flight test of the MHV occurred as late as 24 January 1984. By that time, the Soviet Union had already introduced a self-imposed moratorium on ASAT testing in August 1983, following President Reagan's announcement of the Strategic Defense Initiative in March 1983. The Soviets continued to abstain from the launches of their ASATs, and under pressure from the Congress the US cancelled the program in 1988. By that time only 5 out of 14 scheduled tests had been performed.[7]

However, Soviet military officials, including top authorities in the Missile and Space Defense Forces, continue to believe that the American system is operational. References to the allegedly superior American ASAT capabilities might be even used as an argument in favor of further upgrades to the Soviet system, which is less capable and versatile than the MHV would be.

In 1992, a proposal was revealed from the ASAT system contractor, TsNPO Kometa, suggesting a "System for the Ecological Safety of Outer Space." The proposal clearly relied upon earlier ASAT developments, but capabilities outlined there go beyond those of the earlier tested system. This may mean that a chain of ASAT developments, jointly coined by Soviet and American decisions, may get longer.

Conclusive Summary

The spirit of confrontation and worst-case interpretations of the observed developments of an adversary had a major impact on the development of space systems in the United States and the Soviet Union, the two key participants in the space race.

A majority of the US and Soviet space developments, especially in the defense-related area, were in some ways motivated by the moves of the adversary. In the American case, a typical path for such a project would be to originate as a response to some perceived threat from the Soviet Union. In the Soviet Union, in addition to a similar motivation, a major role was also played by the information available to the public about American projects.

Initiated projects would be pursued through a set of determined design and development phases. Depending on the technical feasibility, availability of appropriate technology, funding, and resources, as well as political backing or opposition, a project would proceed step by step through those stages until it would be either cancelled at some phase, or an operational system would be eventually developed and commissioned. In theory, that development review process must assure the selection and support of feasible and essential projects, and cut off those which are unrealistic, cost-ineffective, or simply useless.

In most cases, when a real practical demand was present, appropriate systems were eventually developed and deployed by both sides, with a time lag of the Soviet counterpart determined primarily by a technological gap. A set of such examples includes not only reconnaissance satellites, discussed above, but also space systems for navigation, communication, meteorology, etc.

Technical problems might deter development, but if a demand was assured, technical problems were eventually overcome and a system appeared in place (like early warning satellite systems or real-time optical reconnaissance spacecraft).

Perceived threat-driven projects usually revealed their inconsistency during the development process (mainly because original threat estimates were subjected to worst-case exaggerations in the Cold War environment). In the American case, such projects were usually cancelled relatively early in the development process. In the case of the USSR, a mechanism of program reviews proved less effective than in the US because of the general arrangement of the Soviet management system, which did not allow independent assessment capabilities. As a result, in the USSR the project, once started, typically continued throughout development until at least the testing phase (like the Almaz or the Buran shuttle) or even all the way down to an operation (like the ASAT system).

In the latter cases, the second round of provocation could occur, when Americans would initiate a counter-development against a new Russian capability, which, as a matter of fact, originated as a response to an earlier abandoned American project. Such "Catch-22" scenarios were facilitated by the differences in project staging and commitment procedures and by the different approach to secrecy and information availability.

Since program development stages begun in each country did not match perfectly, it was not easy for one side to judge correctly about the real status of a program of the other side. Similarly, with a tradition of keeping all details of the national space program in secrecy, the Soviet leadership interpreted public discussions of space projects in the United States as a demonstration of an ultimate commitment to their development. On the other side, a popular Soviet tradition of building flight demonstration hardware as soon as possible resulted in American overestimates of Soviet project progress, as the US themselves would build flight-rated hardware at a much later phase of development.

Those misunderstandings and misinterpretations of each other's intentions and capabilities complicated a balanced analysis of space projects and, at a minimum, resulted in the unreasonable spending of funds and resources.

The lessons summarized in this paper, are those which we ought to learn from the Cold War space race experience in order to prevent any unwise or provocative developments in the future.

Reference Notes

[1]The Almaz program has been recently described in Russian sources: Igor Afanasiev, "Neizvestnye korabli," *Kosmonautika, Astronomia Series*, Moscow, Znanie #12, 1991; Vladimir Poliachenko, "Izyuminka Almaza," *Krylia Rodiny*, nos. 1 & 4, 1992; V. A. Poliachenko, and A. V. Tumanov, "Upravliayemyi Almaz," *Aviatsiya i Kosmonautika*, no. 8, 1993.

[2]Yuri Frumkin, "Pervyi sputnik-razvedchik," *Aviatsiya i Kosmonautika*, no. 4, 1993, pp. 41-42.

[3]Originally, the whole program was called "Vostok" with the designations "Vostok 1" and "Vostok 3" assigned to manned spaceships and "Vostok 2" and "Vostok 4" to automated spacecraft. When the name "Vostok" was revealed after the flight of Gagarin, the name of the reconnaissance spacecraft was changed from "Vostok" to "Zenit," with the numbers left intact.

[4]A kind of orbiting bomb did appear in the USSR later for a while. So-called "orbital warheads" were tested by the Strategic Rocket Forces from 1965 until 1971, but were abandoned due to operational uselessness.

[5]Paul Stares, *The Militarization of Space: U.S. Policy 1945-1982.*

[6]John Pike, and Eric Stambler, "Arms Control and Anti-Satellite Weapons," The Federation of American Scientists, 1993.

[7]*Ibid.*