Harnessing the Heavens

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Soviet Space Power during the Cold War

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During the heyday of the Cold War space race in the 1960s, to most Western eyes, the Soviet space program represented an enigmatic mix of the spirit of exploration and the power of public relations. In the first decade of the space era, from 1957 to 1967, the Soviets achieved an unprecedented list of "firsts" that humbled the United States—the first Earth satellite, the first animal in space, the first lunar impact, the first human in space, the first woman in space, and the first extra-vehicular activity. Yet the public perception of Soviet space achievements as one of spectacular missions pushing the boundaries of exploration obscured a reality that only became clear to Western observers by the early 1970s: that Soviet space operations were overwhelmingly geared toward military goals. The military bent of the Soviet space program was most clearly evident in the sheer numbers of military satellites launched under the generic "Kosmos" designation. Since the end of the Cold War, with declassification of a large portion of the Soviet space effort, it has become abundantly clear that beyond numbers, the Soviet space program was largely a military space program: it institutionally emerged from the military services, it was funded by the military, driven by military imperatives, and its hardware was created by firms whose primary customers were the military. Of course, there was a civilian dimension to the Soviet space program—but even civilian spacecraft such as the Vostok, Soyuz, and Salyut grew out of requirements dictated by the military. As such, without an understanding of the military dimensions of the Soviet space program, it is almost impossible to understand the more visible and publicity-oriented space accomplishments of the other Cold War superpower.

The intent of this essay is to summarize the institutional, technological, and programmatic dimensions of the Soviet space power during the Cold War. In particular, it describes the origins of the Soviet military space program, the constituencies behind, how they developed strategy, and what technological choices drove their ambitions. It ends with a brief survey of the entire spectrum of Soviet military space operations, followed by some concluding thoughts on broader patterns of Soviet military space power past fifty years. By exploring these dimensions of Soviet military space power, this essay will provide benchmarks for comparison with equivalent American military space achievements. Its research is based on a wide array of Russian-language sources available since declassification began in the early 1990s. These include a set of major institutional histories of the Soviet space program, primary documents from government archives, and journalistic accounts in the Russian language.

Institutional History

Historians have devoted much attention to the technical and operational aspects of the Soviet military space program but relatively little to its institutional structure and decision-making process. Most have accepted overtly simplistic perspectives. During the Cold War, when writing on the Soviet space program, both space historians and popular writers in the West commonly attributed decision-making to either a singular leader such as Nikita Khrushchev (1894–1971) or invoked a generic "the Soviets." In the face of pervasive secrecy, the inner workings of the Soviet space program were as unknown as the secrets of the cosmos themselves. It was as if there was a monolithic structure located in some far away place, an almost mythological quantity, that ran a program of gargantuan proportions. This formulation, of course, bore no relation to reality. As has become increasingly clear, neither a single entity nor a single individual drove decision-making and policy formulation in the Soviet space program, although it is true that one man, Sergey Korolev (1907–66), the founding engineer of the Soviet space program, played an undeniably significant role.

Five institutional components determined Soviet space policy during the Cold War: the Communist Party, the defense industry, the military, the design bureaus, and the scientific community. Each had its own agenda for space policy, and more often than not, there was little unanimity among the major players.[1]

The Communist Party of the Soviet Union, the primary creator of Soviet space policy, administered the space program through a department in its Central Committee. A single individual, usually a Secretary of the Committee had final de facto say over long-range space policy. The most powerful of these secretaries was Dmitriy Ustinov (1908–84), perhaps the most influential personage in the rise of Soviet military power in the postwar era. Top national leaders of the country such as Joseph Stalin (1879–1953) and Leonid Brezhnev (1912–82) had varying degrees of interest in the space program, but usually relied on Ustinov's counsel. The Khrushchev era was somewhat of an anomaly. Unlike previous or later leaders of the Soviet Union, Khrushchev worked closely with the major engineering leaders of the space program such as Korolev, Mikhail Yangel' (1911–71), and Vladimir Chelomey (1914–84)—prompted in part by his keen interest in the development of nuclear-tipped intercontinental ballistic missiles (ICBMs) as the central tenet of Soviet military doctrine. His interest in space exploration as a means to further Soviet prestige all over the world is inarguable, but his actions in extracting the maximum propaganda effect of various missions appear to have been largely post-facto rather than preplanned. In most cases, the notion that Khrushchev recklessly ordered one-off space missions simply to usurp or preempt concurrent U.S. missions does not hold up to rigorous scrutiny.[2]

On paper, the role of the defense industry was to implement the policies of the Communist Party. The most powerful actor in this sector was the aptly titled Military-Industrial Commission (VPK), a body that coordinated the nine industrial ministries responsible for research, development, and production of all Soviet weapons systems. Because the VPK also had the responsibility of drafting official party and government decrees on weapons design, its purview, however, often extended to matters of policy. For most of the Cold War, this commission was headed by Leonid Smirnov (1916–2001), a man who worked largely in the shadows. American negotiators first identified Smirnov as an important player in the Soviet military-industrial complex during the SALT II negotiations in the early 1970s and found him to be a "tough and skillful negotiator" with a "technician's grasp of the issue superior to anyone [else] at the table."[3] Industrial managers constituted an extremely powerful lobby, a cohesive group whose members shared association through common educational experiences, regional backgrounds, and work during World War II. These men were the effective managers of the Soviet space program, the equivalent of a NASA administrator or deputy administrator.

The major space design entities, called "design bureaus," designed the spacecraft, launch vehicles, ground facilities, and all their subsystems. Almost all the prime contractor design bureaus originally began their existence by producing missiles or aircraft. By the early 1960s, several of these organizations had diversified into the emerging space industry. The most prominent of these design bureaus, the Experimental Design Bureau No. 1 (OKB-1) headed by Korolev, essentially founded the Soviet space program. In the early 1950s, OKB-1's primary bread and butter was the design and development of long-range ballistic missiles. By the late 1950s, however, Korolev diverted funds to develop early Soviet space satellites.[4] OKB-1 created the Sputnik, Luna, and Vostok spacecraft, and by the early 1960s enjoyed a dominant position within the emerging space program. Most of OKB-1's resources were devoted to missile development, but Korolev's primary interest was space exploration. Weaned on the ideas of the early twentieth-century theoretician Konstantin Tsiolkovskiy (1857–1935), Korolev's vision of the Soviet space program was one which expanded progressively from Earth orbit to the Moon and eventually to the inner planets. This vision, however, had to deal with more earthly concerns. By the time of the pioneering first piloted spaceflight of Yuri Gagarin (1935–68) in 1961, other chief designers, such as Chelomey, Yangel', and Valentin Glushko (1908–89), challenged Korolev's monopoly and influence in the space arena. Through the 1960s and 1970s, these chief designers gained an enormous amount of influence and essentially began to dominate Soviet space policy by submitting a flood of proposals up to the political structure that the politicians were unable to properly evaluate for efficacy. In this flood, many ambitious projects with little or no effective economic or military value were approved only to be cancelled after spending millions of rubles. The byproduct of such managerial waste was a cacophony of conflicting voices that did immense damage to effective decision-making on long-range priorities.

Of the remaining two players, the USSR Academy of Sciences, representing the scientific community, was the weakest voice in the Soviet space program. The Academy's institutional connections with the space industry were strained in the early 1960s when many of its applied science institutes were moved out to the defense industrial structure in a restructuring designed to foster closer ties between science and production.[5] The Academy's most important connection to the space program was via academician Mstislav Keldysh (1911–78), one of its top scientists who played a key role in determining Soviet space policy by dint of his actions as an arbitrator of major technical disputes.

The last and certainly not the least major player was the Soviet military. In terms of operational aspects, the Soviet space program emerged as an off-shoot of their ballistic missile effort. Unlike the United States, neither the Air Force nor the intelligence agencies had much to do with the beginnings of the Soviet space program. The operator of ballistic missiles, the Soviet Strategic Rocket Forces, served two important roles in the Soviet space program—first, as the primary customer for almost all systems, and second, as the primary funding agent for almost all systems. The Rocket Forces was established as a separate military service in December 1959 by combining troops and administrative units originally under artillery command which had been responsible for procuring and operating long-range ballistic missiles. Because the primary goal of the Rocket Forces was to develop a credible nuclear deterrent against the United States in the 1960s, their leadership had little interest in funding or sponsoring expensive manned space projects, such as a human lunar-landing project competitive with Apollo. Instead, they poured an enormous amount of money into developing systems that could support a robust military presence in space.

Organizational Evolution of the Soviet Military Space Program

By the late 1950s, when the Soviet space program was still in its infancy, the Rocket Forces essentially inherited management of the burgeoning space operations infrastructure—they owned and operated the launch vehicles, the launch sites, and the ground communications segment. Recognizing that space operations would require a different set of institutional imperatives than missile operations, the commanders of the Rocket Forces created a subdivision in September 1960, the 3rd Directorate, to manage orders, delivery, and operation of all space-related elements.[6] Military officers of the "space directorate" developed the "tactical-technical requirements," that is, the specifications for all early generations of Soviet military and intelligence space-based vehicles. In October 1964, the "space directorate" was subordinated directly to the commander-in-chief of the Rocket Forces.[7] By this time, the space directorate had its own operations center (Center 156) and continued to oversee the entire ground communications segment for the Soviet space program through a control center (Center 153).

Control of Soviet space assets was a contentious issue in the 1960s. Many opposed the monopoly of the Rocket Forces over military space operations, a monopoly that they basically inherited by an accident of institutional history. At various points, the Soviet Air Force tried to wrench control of the military space program from the Rocket Forces, but without success. At other points, as the officers of the "space directorate" gained more and more experience, they resented being beholden to the command structure of the Rocket Forces. As the Soviet military space program grew into gargantuan proportions in the 1970s, the Rocket Forces leadership finally and reluctantly relinquished control over space operations. In November 1981, the Soviet government formalized the duties of the Main Directorate of Space Assets (GUKOS) as being on par with the other major services of the armed forces; its head would now report directly to the minister of defense, the Soviet equivalent of the American secretary of defense. A list of the assets under GUKOS provides a sense of the scope of the Soviet military space program in the 1980s. They included the staff and infrastructure at two launch ranges at Baykonur and Plesetsk; the entire ground- and sea-based communications segment for the Soviet space program; an "arsenal" for space weapons; a leading R&D institute where hundreds of military engineers developed requirements for future military and intelligence systems; a military academy for training engineers who would go on to lead GUKOS; and a cadre of military representatives who monitored the production of military space satellites at the various design bureaus.[8] Through most of the Cold War, GUKOS was headed by two senior generals, Andrey Karas' (1918–79) and Aleksandr Maksimov (1923–90), both artillery battle veterans from World War II. Former cosmonaut German Titov (1935–2000), second in orbit after Gagarin, served as a deputy in the space directorate during the 1980s.

GUKOS did not oversee all Soviet space assets. From the early 1960s, the Soviet Air Defense Forces and the Navy insisted on operational control of a number of military space assets. The Air Defense Forces, whose mandate was to deny foreign incursions into Soviet airspace, retained control over four major systems whose profile overlapped with the space program: the missile early warning system, the anti-ballistic missile system, the anti-satellite system, and the space objects tracking network. In March 1967, the Soviet military established a separate organization, the Directorate of the Commander of Anti-Missile and Anti-Space Forces to oversee all of these systems.[9] The Navy similarly retained control over those assets that served naval operations—in particular, ocean reconnaissance and naval communications satellites.

Following the collapse of the Soviet Union, the Russians reorganized military space operations into the Russian Space Forces (VKS) in August 1992. Five years later, it was folded into the Strategic Rocket Forces but became independent once again in March 2001 and is currently known simply as the "Space Forces," headed by Colonel-General Vladimir Popovkin (1957–).

The least illuminated aspect of the Soviet military space program remains the users of information. From the little bits and pieces of information, it is clear that the Ministry of Defense General Staff had at least three directorates which served as consumers of information collected by space assets. These were an operations directorate (for military support systems), a reconnaissance directorate (for imagery analysis), and a military topography directorate (for ICBM targeting).[10] A separate division also handled communications issues.

Early Military Space Systems

Soviet military officers had been interested in the military applications of space travel from the time that they first conceived of artificial satellites. The earliest satellite studies in the Soviet Union were conducted in the early 1950s at the Scientific-Research Institute No. 4 (NII-4), a top secret R&D institute embedded deep within the Soviet Ministry of Defense. Here, Mikhail Tikhonravov (1900–74), the man who in the early 1930s designed the first Soviet rocket to use liquid propellants, headed a talented team exploring various satellite ideas. Some of these studies have been declassified and suggest ambitious plans. For example, one study under Tikhonravov issued in 1955, indicates that his team was interested in at least two military goals: photo-reconnaissance and destroying targets from orbit, both of which they believed would be feasible with a satellite launched in the near future.[11]

As in the United States, the Soviets considered space-based photo-reconnaissance the most important priority in the early years of the space program. What were the requirements driving the first Soviet reconnaissance satellite? A secret RAND study issued in 1958 speculated that the Soviets would have no real need to spy on the American landmass unless it was for bomb damage assessment, but that they would need to spy on other areas of the world and certainly need ocean reconnaissance capabilities.[12] In reality, the Soviets were motivated to develop reconnaissance systems for three reasons: to obtain first-hand intelligence on American military capabilities, to verify information obtained through conventional sources, and for ICBM targeting.

The development of the first Soviet photo-reconnaissance satellite established two major precedents in the Soviet military space program, patterns that would cut across almost all other programs in the following thirty years. These were, first, the repeated conversion of military spacecraft for civilian purposes; and second, the use of modular designs that were incrementally modified over decades to create a proliferation of subvariants.

The first government decision in favor of space activities, issued in January 1956, approved work on a scientific satellite (D1), a biological satellite (D2), and a reconnaissance satellite (D3). The latter eventually evolved into two three-axis stabilized photo-reconnaissance satellites; one for radio transmission of images with passive orientation (OD-1) and the other with a return capsule and active orientation (OD-2).[13] Already in the earliest days of the Soviet space program, military requirements began to dominate "civilian" goals. For example, the first Soviet piloted spacecraft, the Vostok that carried Gagarin into orbit, was less a singular and dedicated crewed vehicle than simply an outgrowth of the first Soviet reconnaissance satellite. In 1958, when Korolev was trying to interest the Soviet leadership in a project to launch a human into space, he used his OD-2 reconnaissance satellite project as a "trojan horse." In May 1959, the Soviet government formally approved development of the OD-2 film-return photo-reconnaissance satellite. Korolev convinced a couple of senior defense industry managers to insert an additional line at the end of the written request that added: "and also a satellite designed for human flight."[14] Korolev understood that both a film-return reconnaissance satellite and a piloted spacecraft shared one requirement, the need to return a heavy payload from orbit. As such, Korolev simply used the OD-2 vehicle as a common platform from which to design both the crewed vehicle and the reconnaissance satellite. The former became the Vostok spacecraft and the latter became the Zenit-2 spy satellite; they shared the exact same outer design.[15]

Zenit-2, the early model, was an area survey satellite with a resolution of about 7–10 meters. Each spacecraft returned a large spherical reentry module to Earth with exposed film and cameras, the same reentry capsule that returned Gagarin from orbit. The Soviet military Space Forces launched Zenit-2 models at least eighty-one times between 1961 and 1970. To complement the area survey version, Korolev's design bureau developed a high-resolution model in parallel, known as Zenit-4, which used the same basic bus but had improved cameras allowing a ground resolution of up to one meter. These satellites, which spent about a week in orbit, were launched seventy-six times between 1963 and 1970.

The early Zenit satellites were conceived prior to any long-term plan for Soviet military space systems. The first major government decision in support of military space systems was issued in October 1961 as a result of early research done by the procurement division of the Strategic Rocket Forces and carried out, according to the official history of the Russian Space Forces, as a response to the U.S. militarization of space. Signed by Khrushchev, this decree called for "the wide expansion of work on the creation of military space systems up to the period of 1965" and responded to requirements issued by the Rocket Forces, the Navy, and the General Staff. The decree defined the first generation of Soviet military space systems as including the following nine goals: photographic observation and cartography (for ICBM targeting); signals intelligence; real-time TV reconnaissance; military communications; ocean reconnaissance; navigation; meteorology; calibration of ground radars for ABMs and early warning; and geodesy.[16] The categories defined in the 1961 government decision largely determined the types of systems developed by the Soviets during the early years of the space program. The expectation was that in the period 1961–65, the Soviets would launch about 130 to 140 satellites for military purposes, a dramatic increase in launch rates that testified to the enormous expansion in projected military capabilities in the early 1960s.

By the early 1960s, military strategists recognized the need to devote dedicated resources to studying the entire spectrum of military applications, studies which were centered at the secret NII-4 military institute belonging to the Strategic Rocket Forces. In June 1960, the NII-4 leadership established a division, the 6th Specialty, comprising 190 officers and 40 servicemen to study the future of military space. They engaged in three major research projects, on space weapons, space-based reconnaissance, and ground communications for military space systems.[17] Little is known about the contents of their research, particularly on questions of how much they relied on public or intelligence data from the United States. Their research work, ordered by the

Space Forces, was finished in 1964, and explored the possible military uses of space from the years 1966 to 1975 and also analyzed the contours of modern war in space. Their recommendations fed into a second major government decision on the development of military space systems issued in July 1967. This was the first government decision enshrining the Soviet ideology of using modular space systems and incremental development of variants—a philosophy very different from the American approach of large technological leaps.[18]

Long-range planning for Soviet military systems typically followed a similar pattern. Usually, teams from the NII-4 institute (or their newly formed "space branch") were assigned to conduct R&D study projects under top-secret codenames.[19] For example, in 1967, the NII-4 space branch began two study projects named *Prognoz* (Prognosis) and *Sirius* that were to be completed in 1970. The goal of these studies was to project future military systems from 1971 to 1980. As part of these projects, military engineers generated several requirements: the need to develop systems that could carry out multiple goals with the same spacecraft, to continue the trend of using military systems for later civilian use, to modernize payloads, to reduce the mass and size of spacecraft, and to use the latest micro-electronics on satellites. Overall, the study recommended developing twenty-seven military space systems (including twenty-two automated and five piloted). These recommendations were eventually passed on to the commander-in-chief of the Rocket Forces who approved them.[20] Most of the recommendations of these two studies were eventually adopted for the second generation of Soviet military space systems introduced in the 1970s. The final result of such R&D studies carried out by the NII-4 space branch was the issuance of top-level government decrees signed by the reigning Soviet leader, be it Brezhnev, Andropov, or Gorbachev. For example, the major decree on Soviet military space systems in the 1970s was issued in February 1976 and signed by Brezhnev. Its contents followed closely the recommendations produced by the NII-4 institute's space branch.

Expansion of Military Space Systems in the 1960s

In the early 1960s, Korolev's OKB-1 design bureau found itself overloaded with an enormous amount of work in developing missiles and spacecraft. As a result, Korolev actively sought to "seed" a number of important profiles in other up-and-coming design bureaus. To ensure at least indirect control, he made sure that these satellite design bureaus were headed by men who owed their careers to his patronage. For example, in 1964, he farmed out all further work on photo-reconnaissance satellites to a branch of OKB-1 based in the city of Kuybyshev, which was co-located with a large production factory. Here, under the tutelage of Korolev protégé Dmitriy Kozlov (1919–), almost all Soviet photo-reconnaissance satellites were developed for the next forty years. Korolev handed over communications and geodesic satellite development to OKB-10, a new design bureau based in the Siberian town of Krasnoyarsk. Under Mikhail Reshetnev (1924–96), another Korolev protégé, this design bureau became the leading Soviet developer of communications satellites. In fact, in terms of sheer numbers, Reshetnev's organization has manufactured more satellites than any other organization in the world.

Korolev did not always get his way. Managers in the defense industry, particularly the powerful Dmitriy Ustinov, successfully ensured that there were separate sources of power in the military space program that were completely independent of Korolev. Mikhail Yangel's OKB-586, based in the Ukrainian city of Dnepropetrovsk, claimed the development of signals intelligence and radar calibration satellites. The giant KB-1 conglomerate under Aleksandr Raspletin (1908—67)—the developer of Soviet anti-ballistic missiles—was tasked with development of extremely sensitive military systems. Although relatively unknown in the West, KB-1 and its offshoots such as the Kometa organization have been collectively responsible for Soviet anti-satellite, ocean reconnaissance, and early warning systems. Unlike many other Russian space organizations, the Kometa firm, headed for decades by Anatoliy Savin (1920–), still remains largely behind a veil of secrecy. Finally, in the 1960s, weather satellites were assigned to Andronik Iosif'yan's (1905–93) NII-627, an institute which had hitherto developed electrical systems for ballistic missiles.

One of the hallmarks of Soviet military space operations became evident to Western observers by the late 1960s, namely that the identity and missions of all military spacecraft were obscured under the catch-all designation of "Kosmos." This was not an accident on the part of Soviet military authorities, but part of a deliberate policy of disinformation. Originally, the Kosmos series had been inaugurated in March 1962 as part of a series of small satellites for minor scientific experiments. But once the Soviets began launching Zenit-2 reconnaissance satellites a month later, military authorities decided that it would be better to group these vehicles also under the Kosmos label. Recently declassified documents show that the Soviet government wanted to use the Kosmos name to "mask satellites," especially "military satellites, experimental satellites . . . and also objects which did not achieve their goals owing to failures of on-board systems."[21] Officially, however, the Soviets consistently claimed that the entire Kosmos series was for scientific goals. Aware that Western observers were fully cognizant of the lazy obfuscation of military satellites, in the mid-1960s, the Soviet military tried to introduce a second catch-all series under the name "Zarya" to confuse Westerners even more. The idea was to randomly distribute different military satellites under both the Zarya and Kosmos names.[22] Although the Soviet government never approved the Zarya plan, it underscores the levels to which the Soviets sought to reconcile their public claim to have never launched a single military satellite with the reality that almost all of their satellites were military in nature. Up to the present time, over 2,400 satellites have been launched under the Kosmos label. The "true" names and missions of most of these vehicles came to light only in the 1990s.

Soviet Military Space Systems during the Cold War

Numerically, the largest Soviet military programs have undoubtedly been for optical reconnaissance, dedicated to spying on American assets as well as global hotspots all over the world. The Russians divided their reconnaissance programs into three very broad generations of satellites: Zenit, Yantar, and Orlets. Each generation was defined by an entirely different bus, with qualitative changes in systems. Yet within each generation there were literally dozens of variants, incorporating the stated philosophy of incremental improvement. By changing a camera here, adding a second return capsule there, Soviet engineers were able to squeeze maximum returns from basic bus modules developed decades before. The early Zenit class of satellites, first launched in 1961, were modified well into the 1990s, including marginally modified vehicles such as Zenit-2M (Gektor), Zenit-4M (Rotor), Zenit-4MK (Germes), Zenit-4MKM (Gerakl), Zenit-6 (Argon), topographic models such as Zenit-4MT (Orion), and dual high-resolution and area survey variants such as Zenit-8 (Oblik). The last Zenit, a Zenit-8, was launched in 1994.[23]

Early second generation satellites such as Yantar-2K, launched during 1974–83, had two small film return capsules and longer lifetimes than the Zenits. Later models, such as Yantar-4K1 (Oktan) and Yantar-4K2 (Kobal't) flown during 1979–83 and 1981–96, respectively, had improved high-resolution capabilities.[24] A significantly improved and current version of the latter, Kobal't-1 was first flown in 2004. The Soviets introduced digital imaging in 1982 with Yantar-4KS1 (Terilen), a vehicle that might be considered a counterpart to the American KH-11 KENNAN reconnaissance satellites introduced in 1976. A newer version of Terilen known as Neman was put into service in 1989. In addition, topographic mapping duties (for targeting) were performed by the Yantar-1KFT (Kometa), whose photographs were marketed commercially in the post-Communist era.

The third generation photo-reconnaissance satellite Orlets-1 (Don), launched beginning 1989, combined the benefits of wide area survey and detailed photography via return capsules, of which as many as twenty-two were used on advanced models of the spacecraft such as Orlets-2 (Yenisey). A new fourth generation reconnaissance satellite known as Araks, capable of digital photography and transmission, has been launched only twice since 1997. In the early 2000s, Russia continues to operate five types of reconnaissance satellites—Kometa, Kobal't-1, Yenisey, Neman, and Araks—with possible new systems such as Kobal't-M, Kondor, and Persona scheduled to come on line in the next few years.

Signals intelligence (SIGINT) constituted a major goal of Soviet intelligence operations in space. Their first dedicated electronic intelligence (ELINT) satellites were the Tselina-O and Tselina–D series of satellites for area and detailed surveillance, respectively, declared operational in the early 1970s. These were succeeded by a much more capable and unified second generation system known as Tselina-2.[23] A very high-security program was the ocean reconnaissance satellite program known as Legenda, whose goal was both to monitor U.S. naval operations and provide targeting data for Soviet tactical and strategic cruise missiles. The system included an "active" portion (using radar) known as US-A and a "passive" portion (using ELINT equipment) known as US-P. The former—known in the West as radar ocean reconnaissance satellite (RORSAT)—was notable for being the only operational Soviet spacecraft to use a nuclear reactor as a power source. The two systems were nominally declared operational in 1975 and 1971, respectively, and although the Russians still continue to fly modernized US-P satellites, they discontinued the nuclear-powered US-A missions after several catastrophic accidents.[25]

A key aspect of space-based military intelligence during the Cold War involved early warning of enemy missile launches. The Soviets were late in the game in deploying a space-based early warning system, partly due to years of disagreement over the specifications of a first-generation system. Beginning 1972, the Soviets tested the US-K and US-KS (Oko) systems; despite many serious problems, the system was placed on active duty ten years later. A newer system known as US-KMO (Oko-1) was designed to have a "look-down" capability from geostationary orbit to detect launches against the background of the Earth's surface. The system was put in service in 1996 but its operational capability is rather limited.[26]

Besides intelligence, the Soviets also experimented with several military programs including an operational co-orbital anti-satellite (ASAT) project using an interceptor known as IS and small targets (known as DS-P1-M and Lira). The first successful interception of a target was performed in 1968, and by the late 1970s the system was declared fully operational. It was stood down in 1983 after nearly two dozen Earth orbital tests although ground testing continued well into the 1990s. An updated system (IS-MU), apparently capable of interceptions at high altitudes, was declared operational in 1991 but was decommissioned in 1993 on orders from new Russian President Boris Yeltsin.[27] Another parallel ASAT system known as Naryad was tested in the early 1990s but abandoned before service duty.

One of the more unusual systems tested was the Fractional Orbital Bombardment System (FOBS), a space bombing system designed to put nuclear bombs in partial Earth orbit for de-orbit at any given point to strike ground targets. After two dozen tests of the system during 1965–71, FOBS was declared operational, with the full knowledge that deploying nuclear weapons in space violated the Outer Space Treaty signed by the United States, the USSR, and the United Kingdom in 1967. FOBS was fully decommissioned in 1983.[28]

Besides ASAT and orbital bomb systems, the Soviets invested an enormous amount of resources in developing a wide spectrum of space-based weapons systems. In 1976, seven years before President Ronald Reagan committed to the Strategic Defense Initiative (SDI), the Soviet government approved a landmark decree on the development of experimental space-based defensive and offensive systems, similar to the American SDI. This was evidently part of a broader space-based defense research program under the code name Fon. The basic idea was to develop a single large bus, based on the piloted Salyut space station, that could be equipped with either a 1-megawatt laser or a set of rocket weapons; these two weapons systems, known as Skif and Kaskad, respectively, were intended to introduce a set of ambitious weapons systems into space. After a torturous series of decisions and delays, a modified and simplified version of the Skif known as Skif-DM was launched on the first flight of the Energiya superbooster in 1987. At the time, the Soviets avoided any mention that Energiya's payload was a prototype of a space-based laser system.[29]

To support military communications, the Soviets flew several generations of Molniya satellites, including Molniya-1, -2, -3, and -3K, in highly elliptical orbits around the Earth ensuring that the satellites would maximize their stay over the Soviet landmass.[30] A separate communications system known as Tsiklon (later replaced by the Tsiklon-B) served naval communications needs. Modern versions are publicly known as Parus. Numerically, the Strela series, used for store-dump type military communications, was probably the most extensive Soviet communications system. Since 1964, hundreds of small Strela satellites in many different versions (such as Strela-1M, Strela-2M, and Strela-3), have been launched into orbit to form constellations in medium orbits. In the late 1970s, the Soviets introduced several new classes of large communications satellite systems such as Raduga, Ekran, and Gorizont to provide services to both military and civilian users from geostationary orbit. Additional systems include Luch (or Altair) to support communications between manned spacecraft and the ground, and Geyzer to serve as relay points for reconnaissance satellites.

The Meteor weather satellites (including Meteor-1, -2, and -3) provided meteorological information for both civilian and military users.[31] The construction of a dedicated navigation satellite system—similar to the American Global Positioning System (GPS)—was begun in 1982 using Uragan satellites. The system, now known as Glonass, continues to operate using modernized satellites although the system has never reached its optimal 24-satellite coverage. Minor support satellites included Sfera and Musson (for geodesy), Tsikada (for navigation), and Tayfun, Vektor, Yug, and Romb (for radar calibration). The extensive DS series of satellites produced by the Yuzhnoye design bureau based in Dnepropetrovsk (in present-day Ukraine) represented the largest group of small satellites. These modular satellites, launched between 1962 and 1977, executed a host of scientific and technological experiments to support both civilian and military objectives.[32]

Almost all Soviet military satellite buses were later converted for civilian use and given entirely different names. In fact, Westerners unwittingly obtained their first views of military systems when pictures of the civilian versions were first published. These civilian versions included the remote sensing Resurs-F series which essentially used Zenit-type reconnaissance satellite buses, and the Meteor-Priroda, Resurs-O, Fram, and Okean programs, all dedicated to remote sensing or meteorological operations and all of which use buses originally developed for reconnaissance programs. Similarly, scientific space projects such as Bion (for biomedical experiments), Foton (for microgravity research), Proton, Energia, Astrofizika, and Efir (to study high-energy particles), and Prognoz and Astron (for astronomy) were all derived from military buses.

Piloted Military Systems

The Soviets devoted an enormous amount of resources on piloted military systems. Most of these also followed the pattern of civilian-military connections. For example, in the early 1960s, the main OKB-1 and its Kuybyshev branch worked on the development of several military variants of the Soyuz, including the Soyuz-R (for reconnaissance), the Soyuz-P (for orbital attack), the 7K-VI (for military experiments), and the Soyuz-VI (a small military space station).

The most famous piloted military system was the Almaz space station project, approved by the Soviet government in 1967 and tasked to the OKB-52 design bureau of Korolev's competitor, Vladimir Chelomey. Almaz included two large station elements, a station proper, and a large transport ship. The system was similar in capability, size, and design to the U.S. Air Force's Manned Orbiting Laboratory (MOL). Military officers would spend weeks and months aboard Almaz spying on high-priority military targets using a massive camera known as Agat; the idea was to verify the efficacy of near real-time reconnaissance. Almaz was also equipped with a "space cannon" to ward off potential attackers in orbit. Three crews spent time on two different Almaz stations in the mid-1970s, but the Soviet Space Forces eventually abandoned the idea of piloted reconnaissance in 1978, believing that it was a poor substitute for robotic reconnaissance, a decision the Americans had come to much earlier with MOL. Although the original Almaz idea was abandoned, it has a rich legacy in the current Russian space program. The civilian Salyut and Mir space stations were derived from Almaz as was the core of the International Space Station (ISS). In addition, some of the Russian modules for the ISS are derived from the large transport ship originally slated for Almaz.[33]

A second thrust in the development of piloted military systems was the Soviet Air Force's interest in a reusable spaceplane. Beginning in the late 1950s, the Air Force tried to push through the development of several spaceplane projects, all of which were aborted before the flight-testing stage. In each case, the spaceplane projects were advanced on the initiative of chief designers such as Vladimir Chelomey or Artem Mikoyan (1905–70) or the Air Force, but were cancelled due to a distinct lack of interest from the military Space Forces who strongly favored automated systems for space combat. The closest the Soviets got to a spaceplane program was a project known as Spiral, initiated in 1966, which involved the development of an air-launched one-man spaceplane for missions involving photographic reconnaissance, orbital bombing, and anti-satellite goals. All work on the project was cancelled in 1978 after a series of drop tests designed to test the vehicle's aerodynamic capabilities at subsonic speeds.

Probably the most important piloted military system brought to fruition was the Buran reusable space shuttle. The origins of the Buran shuttle remain obscured in anecdotal accounts complicated by competing and often contradictory memoirs. It is clear that a major reusable space transportation system was conceived in the 1972–73 period by Soviet defense industrial leaders. In the mid-1970s, the design of such a system went through several different iterations, influenced significantly by perceptions of the military prowess of the American Space Shuttle. In February 1976, the Soviet government approved the development of an integrated space transportation system that included the Energiya superbooster and the Buran space shuttle, the latter remarkably similar to the American Shuttle. The similarity between the two had as much to do with fundamentally identical aerodynamic requirements as it did the Soviets' efficient use of knowledge from the American original. Unlike the American Shuttle system, the Energiya superbooster operated as an independent super-heavy launch vehicle. The Buran space shuttle, probably the most expensive space project in the history of the Soviet space program, was launched only once, in 1988, on a robotic test flight. The project was effectively terminated by 1993 as a result of the financial collapse in Russia after the fall of the Communist government.[34]

Some Broad Patterns

The declassification of the inner details of the Soviet space program in the 1990s confirmed that the Soviet space program was by and large synonymous with the Soviet military space program. The evidence points to five broad historical patterns. First, almost all "civilian" systems were derived from "military" counterparts. The Soviets developed dedicated civilian satellite buses only in rare cases, such as for deep space and interplanetary missions.

Second, the Soviets defined generations by the particular satellite bus. Each generation typically lasted about ten to fifteen years. Within generations, designers introduced a plethora of incremental improvements that generated a proliferation of subvariants. Western analysis of Soviet achievements in space were hampered partly because the enormous amount of subvariants obscured or clouded accurate evaluation of designations and capabilities.

Third, more often than not, the Soviet military declared systems operational prematurely. These premature certifications occurred due to a combination of long delays in system development and anxiety about the political leadership's censure over failure to meet "official" deadlines. In many cases, de facto system operation did not occur until two to three years after issuance of the document declaring operational status.

Fourth, almost all Soviet military projects had American equivalents. Soviet designers pushing one or another ambitious military project frequently invoked parallel American projects to justify their own proposals, although it is clear that American commitment to a particular type of system was never a sufficient factor in Soviet decision-making, but usually a necessary one. Long-range military requirements and domestic politics, particularly the vicissitudes of professional advancement, played an equally important role in the development of Soviet military systems. In most, but not all cases, the Soviets were behind the curve by about five to ten years in comparison to U.S. systems. There were exceptions, particularly in the development of antisatellite and piloted military systems. In terms of technology, the Soviets were very

innovative with subsystems, but less so when subsystems were integrated into a single system. Large-scale technological systems were prone to failure because of weak links in integration rather than innovation.

Finally, the Soviets invested enormous resources in unrealized military projects. In fact, unrealized projects vastly outnumbered realized ones. Such projects were typically competitive proposals between design bureaus which reached the mockup and/or ground testing stage before being cancelled. Any full accounting of the Soviet military space program has to account for these projects.

Based on numbers alone, the Soviet military space program was the largest of its kind during the Cold War. The Soviets invested vast amounts of funding into both automated and piloted military systems and fielded an array of space assets, covering every need and requirement. They had every intention of competing in full force with U.S. space-based military and intelligence systems. Defined by narrow technological measures, most (but not all) Soviet systems were inferior to their American counterparts. Yet, with less sophisticated technology, they often managed to accomplish their intended goals at far less cost and often more effectively than comparable U.S. systems. Their commitment to a vibrant military presence in space also enabled them to establish a vast infrastructure (command, control, communications, production facilities, launch centers, research institutes, educational institutions, space troops, and so on) that represented a significant element of Soviet military power during the Cold War. In the immediate post–Cold War years, this supporting infrastructure faced the threat of permanent degradation. Now, with the recent oil and gas boom that has pumped new blood into the Russian economy, Russia's military space program is regrouping, modernizing, and even expanding. In looking to the future, they can benefit from a half-century of sustained experience in military and intelligence operations in space that represented one of the most capable efforts in the history of military spaceflight.

Notes

1. For an in-depth discussion on the organization of the Soviet space program, see my "Soviet Space Programme Part 1, Organisational Structure 1940s–1950s," *Spaceflight* 36 (1994), 283–86; and "Soviet Space Programme Part 2, Organisational Structure in the 1960s," ibid., 317–20.

2. I make this claim in my *Challenge to Apollo: The Soviet Union and the Space Race, 1945–1974* (Washington, D.C.: NASA, 2000).

3. Arthur J. Alexander, "Decision-making in Soviet Weapons Procurement," *Adelphi Paper* 147/8 (Winter 1978/9), 20.

4. Asif A. Siddiqi, "Korolev, Sputnik, and the International Geophysical Year," in Roger D. Launius, John M. Logsdon, and Robert Smith, eds., *Reconsidering Sputnik: Forty Years Since the Soviet Satellite* (Amsterdam: Harwood Academic, 2000).

5. *Soviet Space Programs, 1962–65; Goals and Purposes, Achievements, Plans, and International Implications,* Prepared for the Committee on Aeronautical and Space Sciences, U.S. Senate, 89th Cong., 2d sess. (Washington, D.C.: GPO, 1966), 154–59.

6. V. V. Favorskiy and I. V. Meshcheryakov, eds., *Voyenno-kosmicheskiye sily (voyenno-istoricheskiy trud): kniga I: kosmonavtika I vooruzhennyye sily* (Moscow: Izdatel'stvo

Sankt-Peterburgskoy tipografii No. 1 VO "Nauka," 1997), 56–57; the full title was 3rd Directorate of the Main Directorate of Reactive Armaments (GURVO).

7. The 3rd Directorate was basically moved out of GURVO, renamed the Central Directorate of Space Assets (TsUKOS), and subordinated to the commander-in-chief of the Rocket Forces.

8. Favorskiy and Meshcheryakov, 71–73.

9. V. N. Yakovlev, ed., *Raketnyy shchit otechestva* (Moscow: TsIPK RVSN, 1999), 168–69.

10. The reconnaissance directorate was headed by Lieutenant General Petr Kostin from 1961 to 1973. See Petr Shmyrev, "Radiorazvedka na zarye kosmicheskoy ery," *Aerokosmicheskii kur'yer* (January 2006).

11. M. K. Tikhonravov et al., "Preliminary Report on Theme No. 72, Research on the Question of Creating an Artificial Satellite of the Earth, Report No. 571," NII-4, 2 Apr. 1955, abstract and table of contents in possession of the author.

12. Amrom H. Katz, *Soviet Requirements for a Reconnaissance Satellite*, Report D-4883, (Santa Barbara, Calif.: RAND, 1958).

13. V. V. Molodtsov, "Pervyye kosmicheskiye proyekty (k 40-letiyu zapuska 1 ISZ)," *Zemlya i vselennaya* no. 4 (1997).

14. B. Ye. Chertok, *Rakety i lyudi: Fili Podlipki Tyuratam* (Moscow: Mashinostroyeniye, 1996), 424.

15. Peter A. Gorin, "ZENIT: Corona's Soviet Counterpart," in Robert A. McDonald, ed., *Corona: Between the Sun & the Earth: The First NRO Reconnaissance Eye in Space* (Bethesda, Md.: American Society for Photogrammetry and Remote Sensing, 1997).

16. Favorskiy and Meshcheryakov, 76–77.

17. Ibid., 64–65.

18. Ibid., 89–90, 118.

19. The NII-4 "space branch" was established in March 1968. It separated from its parent institute in April 1972 and was designated TsNII-50.

20. Favorskiy and Meshcheryakov, 189–90.

21. Russian State Archive of the Economy (RGAE), fond 4372, opis' 81, delo 1239, list 44–46.

22. Ibid.

23. Peter A. Gorin, "Black 'Amber': Russian Yantar-Class Optical Reconnaissance Satellites," *Journal of the British Interplanetary Society* 51 (1998).

24. Bart Hendrickx, "Snooping on Radars: A History of Soviet/Russian Global Signals Intelligence Satellites," ibid., 58, Supplement 2 (2005).

25. Asif Siddiqi, "Staring at the Sea: The Soviet RORSAT and EORSAT Programmes," ibid., 52 (1999).

26. Pavel Podvig, "History and the Current Status of the Russian Early-Warning System," *Science and Global Security* 10 (2002).

27. Asif A. Siddiqi, "The Soviet Co-Orbital Anti-Satellite System: A Synopsis," *Journal of the British Interplanetary Society* 50 (1997).

28. Asif A. Siddiqi, "The Soviet Fractional Orbiting Bombardment System (FOBS): A Short Technical History," *Quest* 7 (Spring 2000).

29. "The 'Star Wars' That Never Happened: The True Story of the Soviet Union's Polyus (Skif-DM) Space-Based Laser Battle Stations" (in two parts), *Quest* 14 (nos. 1 and 2, 2007).

30. Bart Hendrickx, "The Early Years of the *Molniya* Program," *Quest* 6 (Fall 1998).

31. Bart Hendrickx, "A History of Soviet/Russian Meteorological Satellites," *Space Chronicles (Supplement to Journal of the British Interplanetary Society*) 57, Suppl. 1 (2004).

32. V. Agapov, "K zapuski pervogo ISZ serii 'DS,'" *Novosti Kosmonavtiki* no. 6 (1997).

33. Asif A. Siddiqi, "The Almaz Space Station Complex: A History, 1964–1992," *Journal of the British Interplanetary Society* 54 (2001) and 55 (2002).

34. Bart Hendrickx and Bert Vis, *Energiya-Buran: The Soviet Space Shuttle* (Chichester, UK: Springer-Praxis, 2007).

The Long March Upward: A Review of China's Space Program

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In examining the history of the Chinese space program, it is clear that the People's Liberation Army (PLA) of the People's Republic of China (PRC) has been an important element in its development. Many of the PLA's senior leaders, especially in the years immediately after the founding of the PRC in 1949, were intent upon promoting the development of China's scientific and technological base. This interest, however, has not always been sufficient to insulate the Chinese space program from either the objective conditions of the Chinese economy, or the political turmoil that has regularly roiled the Chinese Communist Party (CCP) took power.

The space program is also characterized as emblematic of Chinese indigenous development. Reference to the "two bombs, one satellite" program, which generally refers to Chinese development of nuclear and thermonuclear weapons (sometimes nuclear weapons and guided missiles), as well as satellites usually is in the context of China's self-reliance.

When the People's Republic of China was founded in 1949, China had been at war almost continuously, either internally or externally, since the early 1930s. This near-continuous state of war had not only wrought massive devastation over much of China, but had stunted economic growth and technological development. China's military industries, indeed, its overall technological and industrial base, were extremely weak. To remedy this, CCP Chairman Mao Zedong and the rest of the top Chinese leadership expressed an interest in developing China's arms industries. Moreover, the intent was to develop not just conventional arms industries, but the ability to manufacture the accoutrements of a superpower: nuclear weapons, missiles, and satellites. Mao himself declared that it was essential to develop such systems because "in today's world, if we don't want to be bullied, we must have these things."[1]

One key personality in this effort to establish China's arms industries was Dr. Qian Xuesen. Qian, an American-trained physicist who had worked at the Jet Propulsion Laboratory and with Theodore von Karman, had returned to China in 1955. In early 1956, Qian tabled "A Proposal to Establish China's Defense Aviation Industry," which called for the creation of an aerospace industry, including provisions not only for the design and manufacture of aircraft, but of rockets and missiles as well. This proposal was incorporated into the "National Long-Term Plan for the Development of Science and Technology, 1956–1967," which called for developing nuclear energy, jet and rocket technology, and broadly promoting science and technology.[2] As part of the plan, a Fifth Research Academy of the Ministry of National Defense, responsible for missile development, was established, with Qian at its head. Chinese histories of