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Russian Military and Dual-Purpose Spacecraft: Latest Status and Operational Overview

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Abstract

In this CNA Occasional Paper, Anatoly Zak, a noted expert on the Russian space program, examines Russia's military and dual-purpose spacecraft. He discusses the resurgence of the Russian space program in the past two decades, both the military and civilian components. The paper identifies different satellite classes operated by both the country's military and the civilian space agency, providing a detailed overview of radar imagery and early warning technologies in service today. Zak provides a detailed description of antisatellite capabilities in Russian service, and goes over some of the significant detriments to further progress, such as corruption and quality control issue in the Russian space service. He argues that the "growing pains" of the Russian space industry in the post-Soviet period could eventually be resolved or at least mitigated, allowing more effective use of available resources, cutting the development time, and producing more reliable systems in the future.

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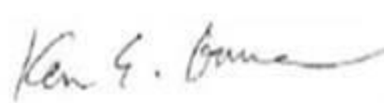

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Introduction

In the decade following the breakup of the Soviet Union, the Russian military faced dwindling budgets and decaying equipment, severe mismanagement, and rampant corruption. To a Western observer, the bloody conflict in Chechnya in the 1990s and the humiliating tragedy of the submarine *Kursk* in 2000 served as vivid illustrations of the Russian military in crisis.

Yet, during the first decade of the 21st century, the Kremlin, benefiting from a windfall in oil revenues, began investing increasingly large sums of money and effort into modernizing its military and reestablishing Russia as a significant military power on the world's stage. The process of Russia's military buildup started mostly under the radar of the general public in the West, until it exploded in the headlines with the Russian invasion of Georgia in 2008. Even then, there was a mixed picture of the Russian "victory," with reports of poor discipline, bad communications, and friendly fire within the Russian units.

Still, Moscow continued boosting military spending and the reform of its armed forces. In May 2012, Russian president Vladimir Putin signed a decree on the modernization of the Russian Army, which the Ministry of Defense began implementing as part of its Plan of Activities Through 2020.[1]

In 2014, the world saw the Russian Army's new face, when its special operations units launched the annexation of Crimea, followed by Russia's proxy war in Eastern Ukraine. In the following year, the Kremlin surprised the West again with its Syrian campaign, which was universally credited with turning the tide of the country's civil war in favor of the regime in Damascus, previously written off as dead.

For the Russian government, these unconventional conflicts were the first ones to take place in the new four-dimensional theater of action, where traditional battlefields on land, sea, and air were increasingly complemented by a space component. Satellites now played a major role in reconnaissance, communications, and navigation. And, in addition to their role in the "hot" ongoing conflicts, dedicated space assets were necessary for Russia's strategic military activities, such as building up its ICBM force, expanding into the Arctic, modernizing its navy, and rebuilding its early warning system to alert the leadership of impending missile attacks.

In turn, the growing importance of spacecraft in military operations triggered the renewed Russian interest in space-based weapons and potential orbital warfare, as more and more

[1] RedStar.ru, Mar. 13, 2019.

countries were entering or expanding their presence in the once-exclusive club of space nations capable of launching indigenously built rockets from their own territories and independently delivering their own satellites into orbit.

Obviously, Russia increasingly viewed the United States to be its biggest threat in space, as the overall relationship between the two countries was slowly deteriorating during the 2000s. Authors of a book on military space published in 2008 offered the following rationale for the Russian military space strategy:

> Taking into the account that the USA is partnering with Russia selectively, based exclusively on their own interests, it is possible to conclude that their actions in space exploration require adequate steps from the Russian Federation. The multi-year experience of the arms race teaches that the United States discuss agreements only with a strong partner, who can put up a respectable defense. For our country, there are only two ways: either to become a secondary space power or choose a strategy of retaining and building up of space potential (scientific, technical, defensive).[2]

Money is not everything when it comes to space

With the increasing role of space in modern warfare, a considerable portion of the Russian military budget had to be dedicated to the development of key space-related assets, including launch systems, such as rockets and their ground infrastructure, tracking and control stations, and the spacecraft itself. However, despite a decade-long growth of military and space budgets from the mid 2000s, the rebuilding of the Soviet space potential inherited by Russia turned out to be more difficult than modernizing any other aspect of the military.

As it did with the armed forces, Russia began actively restoring its space program, including its military component, after the industry had been severely starved financially for roughly 15 years. As it would be with any other high-tech field under the circumstances, the damage turned out to be irreversible in many respects. Even though most of the Soviet-era space prime contractors and their programs still existed on paper, in reality, they were now shadows of their former selves. Entire classes of previously operational or available technologies, such as large hydrogen rocket engines, space-based nuclear power sources, and orbital-based imaging radar, were no longer available. Even worse, most of the experienced personnel were lost to retirement, to more lucrative businesses, or to emigration. Much of development and testing infrastructure was in disrepair or in urgent need of upgrades.

[2] M. Getman, A. Raskin, *Voenny kosmos: bez grifa "sekretno"* (in Russian), Moscow, 2008, p. 34.

The breakup of the USSR and the following economic transition also severely disrupted a complex network of subcontractors that used to be spread across former Soviet republics, supplying everything from electronics to rocket fuel.

When the money began flowing into the space industry again in the mid 2000s, most of this funding had to be spent not on the development of the new spacecraft or the replenishment of existing satellite constellations, but on rebuilding the production infrastructure, rehiring and retraining the personnel, and building the new industrial base inside Russia. It would take years if not decades to do so. By that time, the space industry was no longer the best paying and most prestigious sector of the economy, as it had been during the Soviet times, and, therefore, it struggled to attract talent.

Facing the generation gap, the new leaders of the industry often had to learn from their mistakes. Moreover, fresh infusions of cash into space program also attracted corruption and nepotism, greatly facilitated by the gradual dismantlement of nascent democratic institutions in Russia, including a free press, an independent judiciary, and a sensible political opposition.

The new army of corrupt managers and middlemen populated the top echelon of all federal enterprises, bringing with them a heavy burden of wasteful spending, bureaucracy, incompetence, and even outright criminality. By some estimates, around $750 billion had been moved out of Russia since 1994.[3] Many corruption cases inside Roskosmos and the Ministry of Defense showed that the space program was not an exception from that destructive trend.

Inevitably, the technical expertise and the morale of the rank-and-file personnel within the space industry started lagging, paradoxically, exactly at the time that the budgets for Roskosmos and the Ministry of Defense were going up. Combined together, all these below-the-surface problems soon began manifesting themselves in the ever-increasing failure rate, long delays, and even complete stalling of projects (as will be shown below).

Russian space assets

Space had been critically important for military operations since the days of Sputnik, which the USSR launched in 1957.

During the Cold War, the Soviet Union was an absolute leader in the number of orbital launch attempts, with a vast majority of space missions serving the military. Even during the difficult decades of the post-Soviet transition, Russia was able to maintain a healthy leadership in annual launch rates, first of all thanks to the country's successful entrance into the global commercial launch market in the 1990s.

[3] Bloomberg, TheMoscowTimes.com, Mar. 12, 2019.

The Russian Federation also operated a significant, though aging, fleet of its own spacecraft in orbit. According to the official data, as of January 31, 2018, Russia's civilian satellite constellation included 79 spacecraft, 31 of which were operating beyond their projected life span.[4] In 2018, the Ministry of Defense said that the Russian orbital assets had included 150 satellites, with nine military satellites launched that year.[5]

In 2017, ISS Reshetnev, the prime developer of major military and civilian spacecraft systems, reported that its satellites had made up a total of three constellations serving national security.[6]

Although primary users of most Russian orbital assets fall under the jurisdiction either of the Roskosmos State Corporation and its civilian partner agencies on one hand, or of the Ministry of Defense on the other, the real boundary between civilian and military applications of most satellites is often blurred. For example, such uses of space as communications, navigation, remote sensing, and weather forecasting are equally important for both military and civilian sectors. Because Russian satellites for these applications are used by government-controlled entities, all these assets should probably be qualified as dual use. (Among key federal organizations using the satellite data are the Ministry of Emergency Situations, MChS; the Hydro and Meteorological Agency, Rosgidromet; and the Ministry of Agriculture.)

The only two types of spacecraft that can be considered purely civilian are human (pilot-carrying) vehicles and scientific research satellites, such as astrophysics observatories and planetary probes. However, even those present some potential for military applications, as will be shown below.

It also worth noting that the Russian Academy of Sciences, RAN, which is the primary client for most scientific missions, has long-established ties to the Ministry of Defense and is well known for conducting research for the benefit of the military.

[4] A. Krasilnikov, "*Rossiiskaya grazhdanskaya orbitalnaya grupirovka*," *Novosti Kosmonavtiki*, No. 3, 2018, p. 68.

[5] Russian Ministry of Defense, https://itogi2018.mil.ru/.

[6] *Vestnik Rossiyskogo fonda fundamentalnykh issledovaniy*, No. 3, July-Sept. 2017, p. 72.

Optical Observation Systems

The Russian satellites performing imaging of the earth's surface and related remote-sensing observations fall under the jurisdiction of the Ministry of Defense and Roskosmos. Within the Ministry of Defense, the intelligence operations from space are managed by the Chief Reconnaissance Directorate, GRU.

In recent years, the Russian military has appeared to have finally completed a long-planned transition from film to digital photography of the earth's surface at high resolution. The final launch in the Kobalt-M series, designed to return exposed film to Earth in special reentry capsules, took place on June 5, 2015, and that particular spacecraft completed its mission the following September.[7] At that time, its manufacturer confirmed that no further production of Kobalt satellites had been planned.[8]

Since then, the Russian military has relied on imagery delivered remotely by such satellites as Persona. The first spacecraft in the Persona series was reported to overcome a number of problems in orbit,[9] following its launch in 2013 and the second satellite of the same type entered orbit in June 2015.

However, there are indications that the Persona satellite relied on a dead-end architecture and hardware fashioned from discontinued Soviet-era programs. Therefore, another new-generation imaging satellite is presumed to be in the works.

Civilian remote-sensing satellites

In recent years, Roskosmos launched three Resurs-P imaging satellites designed to provide high-resolution imagery of the earth's surface. These six-ton-class spacecraft were developed at RKTs Progress in Samara, and believed to be derived from previous military imaging spacecraft, such as Yantar and Orlets.

In 2018, Roskosmos was reported to be losing two out of three spacecraft in the Resurs-P family. It appears that both had stopped operating as early as 2017.[10] (In December 2018,

[7] http://www.russianspaceweb.com/kobalt_m.html.

[8] mzarsenal.spb.ru, 4, 2014.

[9] Kommersant, Aug. 8, 2014.

[10] RIA Novosti, Nov. 26, 2018.

Roskosmos released a photo from a Resurs-P satellite, proving that at least one of those spacecraft had remained operational.)

Two fresh satellites in the Resurs-P series are still slated for launch in the next two years. A new-generation Resurs-PM constellation of four satellites is also in development; launches are projected for 2022 and 2023, but these dates are highly likely to slip.

A pair of Kanopus spacecraft was listed as operational at the beginning of 2018. These are smaller, 500-kilogram-class satellites built at VNIIEM Corporation in Moscow, apparently with the extensive use of Western electronic components. The official purpose of the Kanopus series is to monitor natural and man-made disasters with the help of an imaging system reported capable of providing a resolution of 2.1 meters.

A fresh pair of Kanopus-V satellites (No. 5 and No. 6) was successfully launched from the Vostochny spaceport at the end of 2018. (See photo below.)

Figure 1. Photo from the Resurs-P satellite

Source: https://www.roscosmos.ru/25905/, a photo from the Resurs-P satellite shows the Soyuz-2-1a rocket with Kanopus-V5 and -V6 satellites shortly before liftoff from the Vostochny spaceport on Dec. 27, 2018.

Egyptsat-based design

In addition to the Resurs-P and Kanopus series, RKK Energia in Korolev also developed a unique small, high-resolution imaging satellite platform known as 559GK. It was funded at least partially under a commercial agreement with the Egyptian government within the EgyptSat-2 project. The first Egyptsat satellite was launched in April 2014 but failed in orbit soon thereafter.

RKK Energia later announced that it had committed to the development of the second version of the satellite, apparently as a compensation to the Egyptian government for the loss of the original satellite. The launch of the second 559K spacecraft, identified as EgyptSat-A, took place on February 21, 2019. "Self-portraits" of the satellite taken by an onboard camera were published after the launch, but no images of the earth's surface from EgyptSat-A has been made available at the time of this writing and the status of the spacecraft is not clear.

Other miniature imaging platforms

Several other programs demonstrate a continuous industry-wide effort in Russia to miniaturize imaging satellite platforms and their payloads. Obviously, the reduction in size and mass promises a greatly reduced cost for such programs.

In April 2016, RKTs Progress in Samara launched a semi-experimental imaging satellite, known as Aist-2D. Its liftoff mass was reported to be around 500 kilograms, and its Avrora imaging system was reported to be capable of producing panchromatic images with a resolution of 1.54 meters and multispectral images with a resolution of 4.6 meters. Aist-2D was believed to be operational at the beginning of 2018.

Also, ISS Reshetnev in Zheleznogorsk developed its own small remote-sensing platform known as MiR or Yubileiny. These satellites are reported to be less than 70 kilograms in mass.[11]

At least one variant of the MiR/Yubileiny satellite, launched in July 2012, remained operational as of beginning of 2018.

[11] *Vestnik Rossiyskogo fonda fundamentalnykh issledovaniy*, No. 3, July-Sept. 2017, p. 71.

VNIIEM Corporation, based in Moscow, is known not only for its civilian Kanopus and Meteor remote-sensing satellites, but also for having developed the EMKA small satellite designed specifically for observations of the earth's surface under a contract with the Ministry of Defense. The first EMKA was launched on March 29, 2018; however, its orbit appeared to be decaying despite small correction maneuvers and the spacecraft is predicted to reenter the atmosphere in May 2019.[12]

Finally, PO Polyot, based in the city of Omsk, developed the Kanopus-ST spacecraft, which was equipped with a radiometer and reportedly designed to track submarines; however, its launch on December 5, 2015, resulted in its loss and it is unclear whether this program continues.[13]

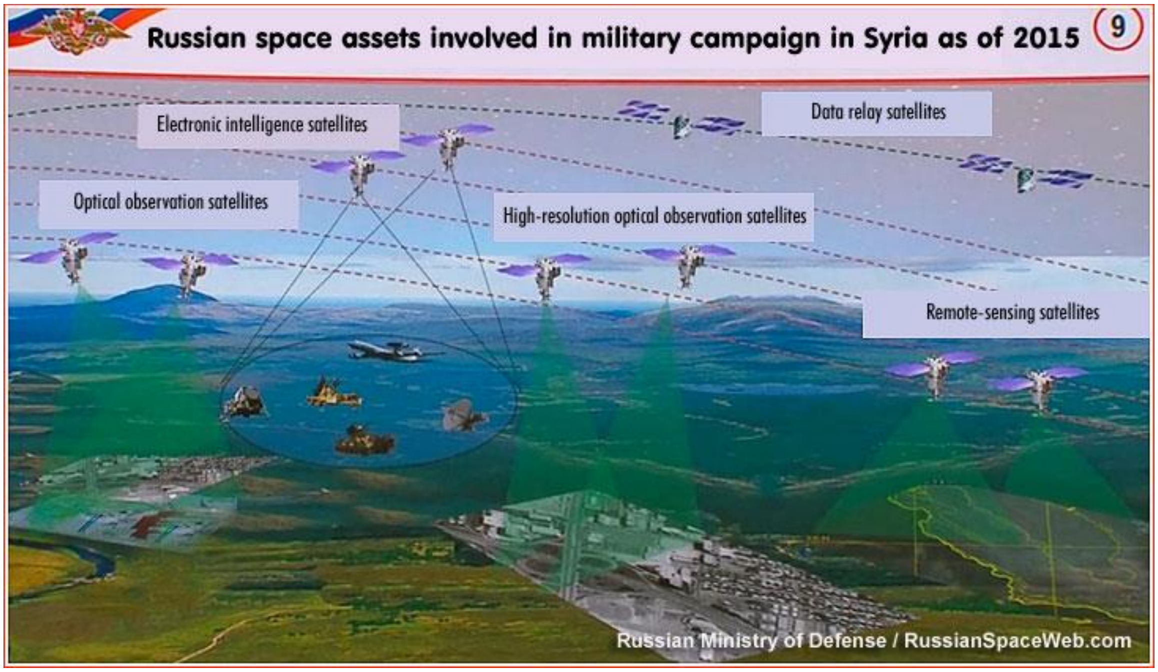
How the Russian military uses reconnaissance satellites

In 2015, the Russian Ministry of Defense provided a rare glimpse into its use of space assets during Moscow's military campaign in Syria, which began in September of that year. (See the following figure.) According to Chief of General Staff Valery Gerasimov, a total of 10 spacecraft had been involved in the support of Syrian operations, including civilian remote-sensing satellites. The latter category probably included Resurs-P and Kanopus spacecraft. According to the Russian military, orbits of some satellites had to be adjusted to facilitate their coverage of the conflict zone. Gerasimov said that the orbital assets were used to identify targets more quickly and determine their coordinates more accurately.

[12] *Interfax*, Mar. 22, 2019, https://www.interfax.ru/world/655326.

[13] http://russianspaceweb.com/kanopus-st.html.

Figure 2. Space assets used by Russia in military campaign in Syria, 2015



Source: a screenshot from RT (Russia Today) TV channel broadcast on Nov. 17, 2015, and from the Ministry of Defense briefing: http://syria.mil.ru/files/morf/2015-12-02_brief_Rudskoy_RU.ppt, and http://syria.mil.ru/news/more.htm?id=12070708@cmsArticle

On December 3, 2015, the Russian Ministry of Defense released aerial and satellite imagery, to prove the involvement of the Turkish government in the illicit oil trade with Islamic terrorist groups in Syria and Iraq. (See the following image.) Officials did not identify the satellites that had produced the imagery, but quoted October 18 and November 14, 2015, as the dates when the space-based photos had been taken.

Figure 3. Aerial and satellite imagery showing Turkish government in illicit oil trade

Source: http://syria.mil.ru/files/morf/2015-12-02_brief_Rudskoy_RU.ppt Aerial and satellite imagery, released Dec. 3, 2015, by the Russian Ministry of Defense, to prove involvement of Turkish government in illicit oil trade with Islamic terrorist groups in Syria and Iraq

Russian military officials specifically stated that space reconnaissance provided evidence that oil trucks from terrorist-controlled areas had been heading to Turkish ports for the subsequent shipment overseas. Satellites also helped detect as many as 1,720 oil trucks stationed primarily off road in improvised parking areas, Russian military officials said. A satellite was also credited for obtaining images of 3,200 trucks heading from terrorist-controlled areas in Iraq to an oil refinery in Turkey.

Radar Imaging

Although Russia is making considerable progress in rebuilding its observation capabilities from space, one crucial subsection of space-based surveillance remains elusive: all-weather, day-and-night radar imaging of the earth's surface. Practically, all Russia's geo-political rivals—including the US, Europe, Israel, China, and India—either have mastered that sophisticated capability or are actively worked toward acquiring it.

It is another example of technology that was available in the USSR, at least in some form, but has yet to be revived in the post-Soviet Russia.

Kondor series

NPO Mashinostroeniya, based in the town of Reutov, built Soviet Almaz space stations, including their radar-carrying versions. It has recently made two attempts to orbit compact radar-carrying Kondor-E and Kondor satellites. After years of delays, they were built under contracts with the South African government and the Russian Ministry of Defense, respectively. Interestingly, the company apparently relied on its old network of subcontractors, such as the Vega company, which had previously supplied space-based radar systems for the Almaz series.

Both Kondor missions were cut short by in-orbit failures soon after the satellites reached orbit in 2013 and 2014.

Budget documents indicate that Roskosmos took over at least some part of the Kondor program with the goal of launching civilian incarnations of the series, currently planned for 2019 and 2020. A more advanced version of the satellite, called "Kondor-FKA-M," was promised in 2025.[14]

Obzor-R series

In parallel, TsSKB Progress in Samara is now developing the Obzor-R radar-carrying spacecraft, but its launch is continually being delayed. The first Obzor-R it is not expected to fly until 2020 at the earliest—several years behind the originally advertised launch dates.

[14] RIA Novosti, Nov. 12, 2018.

Neitron system

In 2018, the official publication of NPO Lavochkin identified a planned launch of the Neitron satellite on a Soyuz rocket before the end of the year,[15] but the mission evidently has had to be postponed into 2019. There are speculations that Neitron might be a new-generation radar-imaging satellite developed at NPO Mashinostroeniya to succeed the Kondor series.

[15] The *Novator*, No. 2, Feb. 2018, p. 2.

Military Cartography

Bars-M satellites

From 2008 to 2013, Russia developed a series of Bars-M (14F148) satellites designed to provide high-resolution stereo images of the earth's surface, specifically for military cartography. As many as six satellites of this type were known to be under construction as of 2014, but only two were launched in 2015 and 2016. At least one more Bars-M mission is expected to lift off in 2019.

The Bars-M's main payload consists of a dual telescope called "OEK Karat," where "OEK" stands for the Optical Electronic Complex. The triple-lens instrument was developed at the LOMO company in St. Petersburg, which also built the main imaging system for the Persona reconnaissance satellite.[16]

According to procurement contracts, it appears that in 2018, the Russian Ministry of Defense allocated 379 million rubles ($5.7 million) for the development of digital maps that might have been based on the remote-sensing data delivered by the Bars-M system.[17]

The ongoing effort to independently produce and update detailed maps of the entire globe is another example of Moscow's steady work at rebuilding its Soviet-era capabilities.

In his assessment of Russia's Syrian operation, Minister of Defense Sergei Shoigu admitted that experience in Syria—and, in particular, the use of high-precision weapons—dictated the necessity to revamp Russian military orbital assets, especially for the delivery of detailed reconnaissance and cartographic information.[18]

[16] F.D. Molev, *Issledovanie optiko-eletronnoi sistemy opredeleniya vzaimnogo rassoglasovaniya elementov kosmicheskogo teleskopa* (in Russian), St. Petersburg, 2014.

[17] Zakupki.ru.

[18] https://tass.ru/armiya-i-opk/6186664.

Early Warning Systems

During the 2010s, Russia continued a steady effort to rebuild its early warning system, which would warn the leadership of a ballistic missile launch, and which had a major space-based component. Ironically, the strategic importance of the early warning system had grown after the Cold War, because of the significant proliferation of missile technology across the globe.

The new Russian early warning constellation was to be the first line of defense in a two-layered virtual barrier around Russian borders intended to warn the Kremlin of an impending missile attack. The system also included ground-based radar installations across Russia and ground control infrastructure.

EKS OiBU Tundra

The latest early warning system is apparently known in Russian as *Edinaya Kosmicheskaya Sistema Obnaruzheniya i Boevogo Upravleniya*, EKS OiBU (code name 14K032) which can be translated as the "integrated space system for detection, battle command and control." In 2012, reports surfaced that the type of satellites forming the constellation had been named "Tundra" (14F142).

The overall development of the EKS OiBU network was centered at Moscow-based TsNII Kometa, which had overseen early warning and antisatellite projects since 1973. (In 2012, the center was renamed the OAO Kometa Corporation).[19] The development of the new-generation spacecraft for the network was delegated to RKK Energia in Korolev.

Unlike previous early warning satellites, the Tundra was reported to be capable not just of detecting and locating a launch but also of tracking a missile to its target. The available information about the design of the satellite (which reportedly was equipped with one primary telescope and one side-looking scanning sensor), seemed to confirm that claim.

With this new capability, the space-based component of the EKS OiBU network would be fully autonomous in its early warning capacity (i.e., it no longer had to be supported by a ground radar), thus cutting a precious minute or so in warning the leadership of a potential surprise attack. Still, the system was to be closely integrated with new-generation ground-based radar systems. Working in tandem, radar and satellites would be less prone to false alarms and other errors.

[19] M. Pervov, *Sistemy Raketno-Kosmicheskoi Oborony Sozdavailis Tak* (in Russian), Aviarus-XXI, Moscow, 2004.

According to one claim from the Russian Ministry of Defense quoted by *TASS* in 2015, one Tundra satellite could replace five or even six old-generation satellites. The report did not explain how such a drastic jump in efficiency could have been achieved, but it probably referred to a wider-view angle of the tracking telescopes on each individual satellite.

At least one Russian source downplayed the revolutionary qualities of the new-generation early warning satellites, describing the latest developments in the field as an effort to make incremental improvements in the capabilities of the observation sensors to track missiles flying along complex non-ballistic trajectories.[20]

Apparently, the EKS OiBU network would also perform some communications functions, such as the transmission of information to the antimissile batteries or the commands for a responsive nuclear strike by the Russian strategic missile forces. According to TsNII Kometa, the capabilities of early warning satellites allow them to be converted into an informational system for Russia's strategic weapons.[21]

Multiple sources said that the EKS OiBU constellation would include slightly different satellites in two types of orbits. The constellation would comprise at least eight satellites. As of 2014, a total of 10 satellites were reported as planned for deployment by 2018, probably counting all backup spacecraft in orbit.

Deployment of the EKS system

Following the launch of the first satellite in the EKS constellation at the end of 2015, the Russian Ministry of Defense promised that the second satellite would fly in 2016. But in October 2017, the official *TASS* news agency quoted a defense industry source as saying that two early warning satellites would be launched annually beginning in 2018. By 2022, the space segment of the early warning network was expected to include 10 spacecraft, *TASS* said at the time.

As with many other programs, these forecasts turned out to be wildly unrealistic, indicating major development problems with the system. The second EKS/Tundra satellite was launched in May 2017, and no launches took place in 2018 or at the beginning of 2019.

[20] E.M. Makarenko, A. Yu. Potyupkin, *Na Orbitalnykh Rubezhakh* (in Russian) Academia, Moscow, 2008.

[21] V.P.. Misnik, ed., *Tsentralny nauchno-issledovatelsky institut "Kometa"* (in Russian) , Oruzhie i Tekhnologii, Moscow, 2003.

Final constellation arrangement

Based on the 12-hour orbit flown by the first EKS satellite (named Kosmos-2510 after launch), it appears that four such spacecraft would be enough to monitor the North American continent practically 24 hours a day. In addition, two or three satellites deployed in the geostationary orbit would be enough to provide global coverage of the planet and two such spacecraft would be enough to track launches of ballistic missiles from the Pacific and Atlantic Oceans, from where these weapons could target the Russian territory. Additional satellites could provide reliable backup operations.

According to some reports, possibly based on the operation of the previous-generation US-KMO network, each satellite could use its apogee path over North America for observation of missile launches and then, during the following apogee over the opposite side of the earth, the spacecraft could change attitude to provide ideal conditions for the illumination of its solar panels by the sun in order to recharge its batteries. Potentially, the reverse sequence could be used to monitor the situation over Asia.

Geostationary version of the Tundra early warning satellite

In its annual report published in June 2018, RKK Energia announced that during 2017, it had been working on determining the design concept of a spacecraft for the geostationary orbit. Although it was identified in the text of the document as a "communications" satellite, the accompanying text mentioned launches of other such vehicles in May 2017 and at the end of 2015 (exactly when the previous Tundra missions had lifted off). That left no doubt that the information actually pertained to the Tundra project.

The wording in the report seemed to confirm that the geostationary version of the Tundra satellite had still been in the early stages of development.

In the meantime, in June 2017, ISS Reshetnev announced that it had manufactured mechanical hardware for the solar panel rotation mechanism for the spacecraft built by RKK Energia. Reshetnev said that it had been the fifth copy of the system designed to point solar panels toward the sun. Because the host spacecraft had not been identified, the announcement likely referred to the EKS/Tundra satellite as well.

Electronic Intelligence

Liana constellation

In addition to the imaging reconnaissance from space, Russia was upgrading its capabilities in the space-based electronic intelligence, which is also managed by the GRU.[22] In 2009, the Russian military launched the first version of the Lotos-S satellite for the new Liana network. Lotos-S built at MZ Arsenal in St. Petersburg was designed to replace the Soviet-era Tselina-2 satellites, developed in Ukraine and launched for the last time in June 2007. Lotos was apparently based on the standard spacecraft bus originally developed at RKTs Progress in Samara for optical reconnaissance satellites and serially produced at MZ Arsenal.

Like its predecessors, Lotos-S was capable of intercepting radio signals, thereby helping locate, identify, and target various military vehicles and installations.

Three more Lotos-S spacecraft were launched in 2014, 2017, and 2018. However, unofficial sources indicated that, despite their high cost, the initial Lotos satellites in the series reportedly provided no advantages over Tselina-2. Due to the complexity of the spacecraft, its development had to be split into several phases.

In 2017, the Russian Ministry of Defense also awarded MZ Arsenal a contract for a modified version of the satellite, dubbed “Lotos-M.”

Naval Pion-NKS subsystem

Originally, the Russian military planned to have the Liana network take over electronic intelligence for the Russian Navy. The navy had been using two types of satellites, US-A and US-P, to locate targets at sea. The US-A (or “active”) spacecraft used a radar instrument to bounce radio waves off the target’s surface, and the US-P (“passive”) satellite “listened” for radio emissions from potential targets. Special terminals installed on Russian battleships were reported to be capable of downlinking real-time data directly from the Liana network for the purpose of weapon guidance.[23]

[22] Argumenti.ru, No. 47 (185) Nov. 26, 2009.

[23] RIA Novosti, Sept. 2, 2014.

However, various conflicting requirements of the land-based and naval systems prompted developers to propose two variations of future satellites—Lotos and Pion, which would make up the Liana constellation.

Pion-NKS (14F139), carrying a pair of large deployable radar antennas and the radio-intercept system, was thus expected to combine functions of the US-A and US-P satellites, providing all-weather target guidance and electronic intelligence for the Russian Navy.[24] As of 2009, Pions were expected to operate in a 500-kilometer orbit with an inclination of 72 degrees toward the equator.[25] Later, official sources cited an orbital inclination of 67 degrees for both Lotos and Pion-NKS.

Despite the inevitable need for at least two different spacecraft in the Liana network, the developers still hoped to minimize the range of hardware needed for the two subsystems and give Lotos and Pion the capability to back up each other while still pursuing their specific tasks. Such an approach, which had failed during the development of the previous-generation systems in the USSR, promised to cut cost and shorten development time. However, in reality, Pion-NKS ended up a decade behind its land-focused sibling Lotos-S.

According to multiple Russian sources, the launch of the first Pion-NKS spacecraft had been continually delayed. By 2009, the program had already run into trouble, and the first launch of Pion-NKS was not expected before 2012.[26]

In the following years, there were reports that, Pion-NKS, like a number of other military programs, had stalled around 2014, as a result of Western sanctions and the loss of Ukrainian suppliers.[27]

According to unofficial sources, the first spacecraft bus for the Pion-NKS was fully assembled at the KB Arsenal plant in St. Petersburg by 2015, but the spacecraft then sat there for several years, waiting for its payload from the TsNIRTI Berg Institute.[28] In 2016, the corporate newspaper of MZ Arsenal confirmed that the lack of payload from a subcontractor had prevented the final assembly and integrated testing of the (first) Pion-NKS satellite.[29]

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[24] A posting on the web forum of the *Novosti Kosmonavtiki* magazine, July 13, 2017.

[25] A posting on the web forum of the *Novosti Kosmonavtiki* magazine, July 21, 2009.

[26] A posting on the web forum of the *Novosti Kosmonavtiki* magazine, July 4, 2009.

[27] MK.ru, Sept. 4, 2018.

[28] A posting on the web forum of the *Novosti Kosmonavtiki* magazine, July 13, 2017.

[29] M. Sinitsin, *Arsenal* newspaper, No. 4, Apr. 22, 2016.

In September 2018, Minister of Defense Sergei Shoigu said that the production and testing schedule for the long-delayed Pion-NKS spacecraft would finally be approved at the end of October 2018.[30] The fully deployed Liana constellation was expected to include at least two Lotos and two Pion satellites.

In any case, as of the end of 2018, the Russian Ministry of Defense was still lacking an all-weather, day-and-night radar imaging capability from space.

Repei system

In addition to the Liana electronic intelligence system, Russia disclosed the existence of the yet-to-be-launched Repei-V and Repei-S satellites, intended to enter elliptical and geostationary orbits, respectively. These satellites were apparently also designed for detecting sources of radio emissions.

It was not exactly clear whether the Repei system, developed at ISS Reshetnev, was meant to replace or complement the Liana network. However, there were some hints that a capability for intercepting satellite communications was in the works, which might explain a specific task for the Repei project.[31]

In a potentially related development, in 2015, Radio-electronics Technologies Concern, KRET, announced the development of a payload for a prospective electronic warfare spacecraft.[32] Also, in May 2014, Russia launched an Olymp satellite into geostationary orbit; it was suspected of intercepting communications from other geostationary satellites, while there were also indications that it could be a data-relay spacecraft.[33]

[30] Zvezda TV channel, Sept. 04, 2018.

[31] Bart Hendrickx, a posting on the web forum of the *Novosti Kosmonavtiki* magazine, Nov. 23, 2018.

[32] *Interfax-AVN*, Feb. 20, 2015.

[33] http://russianspaceweb.com/olymp.html.

Weather Forecasting

The Russian weather-forecasting orbital assets include the Elektro-L No. 2 satellite, launched in 2015 into the geostationary orbit, and a pair of Meteor-M satellites launched in 2009 and 2014 into low polar orbits. One follow-on Meteor spacecraft was lost in the launch accident in November 2017, along with the Bauments-2 imaging micro-satellite, but a replacement is now scheduled for launch in the middle of 2019.

In the meantime, the launch of Elektro-L No. 3 has been continually delayed due to technical problems.

Efficiency of Russian remote-sensing systems

Despite a nominal revival of the Russian orbital remote-sensing assets during the 2010s, their actual usefulness for federal civilian and military agencies is difficult to assess. In fact, there are clear signs that the new-generation remote-sensing systems deployed by Russia are afflicted by the same problems that had been known since the Soviet period. In addition to the high failure rate of the satellites, the products and services they do provide often fail to meet the requirements of end users and are not competitive with equivalent foreign capabilities.

The recent experience of the Russian civilian meteorological agency with remote-sensing satellites reveals the inefficiency of the national remote-sensing system. In a recent interview with the Russian website Gazeta.ru, officials at Rosgidromet described failing or poorly performing instruments, which render officially functioning satellites practically useless.

According to the head of Rosgidromet, Maksim Yakovenko, only 30 percent of the instruments aboard Elektro-L and Meteor-M satellites were working.[34]

Furthermore, the payloads aboard those satellites that do work often provide low-quality data, far below their official specifications, or information inferior to that delivered by foreign satellites and/or information openly available on the internet, Rosgidromet officials said.

Finally, Roskosmos is accused of being too slow to respond to requests for urgent data. Badly needed information often arrives after deadlines or even when it is no longer needed. In response to complaints, Roskosmos cited work overload due to having too many clients.

The story in Gazeta.ru also quoted Rosgidromet officials as saying that the Ministry of Emergency Situations, MChS, was sending requests for remote-sensing data delivered by

[34] RIA Novosti, Mar. 26, 2019, https://ria.ru/20190326/1552105318.html.

Resurs-P satellites, despite claims by Roskosmos that it had been directly feeding MChS and the Ministry of Defense that very information.[35] Rosgidromet apparently grew so frustrated with the service provided by Roskosmos that it made plans to develop its own satellites.[36]

Because the Ministry of Defense already launches and operates its own satellites, it might be less affected by interagency bureaucracy and mismanagement; however, the Russian military is likely to suffer from the same or similar problems with the overall incompetence of the management and the low quality of the Russian satellite systems. Known years-long delays and multiple failed launches and in-orbit failures of Russian military satellites, as well as known cases of litigation between the Ministry of Defense and its contractors within the Russian space industry, point toward the same conclusion.

[35] Gazeta.ru, Dec. 26, 2018.

[36] RIA Novosti, Mar. 26, 2019, https://ria.ru/20190326/1552105318.html.

Communications Satellites

The communications satellites are known to provide significant support to command and control operations of all types of armed forces. In particular, secure satellite communications are critical for battlefield control of the surface ships, submarines, and aircraft of the Russian Navy, which largely depend on satellites for maintaining contact with their command centers on shore.

In 2018, the Russian Ministry of Defense disclosed the role of satellite communications in command and control of the Russian unmanned aerial vehicles (UAVs) operating in Syria. Based on the graphic released by the military (see below), it appeared that unidentified satellites had been used to link the Control Group of the Chief of Staff in Moscow with the main command post of the Russian Army in Syria and with forward mobile ground stations responsible for the field deployment of UAVs.

Figure 4. Russian satellites link Control Group of Chief of Staff with Russian Army units and forward mobile ground stations in Syria responsible for field deployment of UAVs

Source: https://i.imgur.com/3xP3v6D.jpg, a graphic released by the Russian military, showing unidentified satellites appearing to link Control Group of Chief of Staff with main command post of Russian Army in Syria and forward mobile ground stations responsible for field deployment of UAVs.

Due to large volume and high sensitivity of defense-related information, Russia operates a fleet of communications satellites dedicated exclusively to the military. Their technical specifications and, in many cases, their overall appearance are classified.

Meridian and Sfera-V constellations

Traditionally, Russia maintained two main types of military communications satellites: those operating in the highly elliptical orbits with their apogees over Russian territory and more traditional spacecraft in the 24-hour equatorial (or geostationary) orbit, which allows the satellite to appear fixed in the sky to an observer on Earth.

Around 2006, the Russian military began launching Soyuz rockets to deploy Meridian (14F112) satellites into the elliptical orbits. The Meridians served as a communications segment for the Russian command and control system of the armed forces—particularly, the Russian aircraft and ships operating in the Arctic Ocean, where Meridians would be a better option (and, farther north, the only option) for satellite communications, because in the polar regions, the geostationary satellites would be too low in the sky or even below the horizon.

Geostationary communications satellites

At the same time, Russia operates several geostationary communications constellations deployed with the help of Proton rockets. The newest generation includes the Raduga-1M spacecraft, launched in 2007, 2010, and 2013, and the Potok-M data relay system, deployed between 2011 and 2015.

According to its manufacturer, ISS Reshetnev, Raduga-1M (aka Globus-1M or 17F15M) is equipped with the "advanced multi-channel repeaters operating in centimeter- and decimeter-wave bands, thus ensuring stable communications with mobile stations including some hard-to-reach mountainous regions."[37] It is capable of broadcasting in four frequency bands: L-, C-, X- and Ka-band. It is also known that the onboard electronics complex known as Tsitadel was developed for the satellite at NII KP in Moscow. Globus-1M is considered to be the third-

[37] *ISS Reshetnev,* corporate newspaper (in Russian) No. 5, 2008.

generation military communications satellite, which is part of the second-generation integrated satellite communications system, or ESSS-2 for short.[38]

As of 2018, Russia was also actively planning the deployment of the third-generation integrated satellite communications system, ESSS-3. That network was expected to include geostationary satellites, called "Sfera-S," and satellites in elliptical orbits, dubbed "Sfera-V."[39]

However, the delivery of foreign avionics for the first Sfera-V spacecraft in 2015 was hampered by a newly imposed ban on the supply of sensitive technologies to Russia in the wake of the Crimean events of 2014.

The replacement of sanctioned components with Russian equivalents reportedly delayed the start of the assembly of the first new satellite until at least 2019 and may have pushed the liftoff mass of the spacecraft beyond the capabilities of the Proton and Angara rockets. As a result, by the beginning of 2016, the first launch of Sfera-V had slipped until at least 2021.

In the spring of 2016, the situation prompted the Russian military to order four current-generation Meridian satellites at a price tag of 14 billion rubles, plus 8 billion for Soyuz rockets to launch them.[40] At the time, the launch of the first satellite from the new Meridian batch was scheduled for 2018.[41] As of December 2018, the mission had apparently slipped to the first quarter of 2019.[42]

Around the same time, the Yaroslavl Radio Plant, YaRZ, announced that it had inaugurated the new 3.5-billion-ruble facility for the assembly of payload modules for new-generation communications satellites in August 2018. The assembly of each module was expected to take up to six months. At the time, the development (of the host satellite) was reported to be in the process of issuing working documentation, and would soon be setting up the production line.[43] Industry sources hinted that this announcement had referred to the Sfera-V project.[44] It indicated that the problem with the supply of foreign components for the Sfera project was approaching a resolution.

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38 RIA Novosti, Nov. 2013.

39 "V" in the Sfera-V stood for "*vysoko-ellipticheskу*" or "highly elliptic," to denote a type of its operational orbit, as opposed to Sfera-S, which means "stationary" (i.e., the geostationary orbit-based version).

40 The newspaper *Kommersant*, http://www.kommersant.ru/doc/2913130, accessed June 2016.

41 *TASS*, June 21, 2016, http://tass.ru/kosmos/3386718.

42 RIA Novosti, Dec. 15, 2018.

43 *TASS*, Oct. 30, 2018.

44 A posting on the web forum of the magazine *Novosti Kosmonavtiki*, Oct. 30, 2018.

Blagovest constellation

To provide an additional broadband capacity for the Russian military, ISS Reshetnev developed the Blagovest network.[45] According to official information, Blagovest satellites were designed to receive and transmit signals in three bands and to provide modern communications, including broadband internet access.[46] However, the real capabilities of the deployed Blagovest network are a subject for debate in the unofficial circles.

By the end of 2018, Russia had successfully launched three out of four satellites in the Blagovest constellation. According to ISS Reshetnev, the Blagovests were the last spacecraft designed to launch on the Proton rocket and all subsequent satellites would be built for Soyuz-2 and Angara rockets.[47]

Strela-3/Rodnik low-orbital communications systems

Russia also inherited from the Soviet period a low-orbital communications system, known as Rodnik or Strela-3M. The system was designed for the so-called "store-and-dump" communications, when the spacecraft records a fax, a telex, or an e-mail in its onboard recorder as it overflies a sender and then downlinks the message when it reaches the range of receiving antennas of an addressee. The method was intended primarily for communications in very remote areas that lack more traditional ground-based communications channels. The Rodniks are also believed to be used by military and civilian intelligence services and other government agencies. Russia began deploying the Rodnik network in 2005 and launched its 10th member in November 2018.[48]

SSKMS

The Ministry of Defense also planned to deploy satellite systems known as SSKMS for confidential mobile communications. The network was expected to include four satellites,

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45 *Vestnik Rossiyskogo fonda fundamentalnykh issledovaniy*, No. 3, July-Sept. 2017, p. 71.

46 *ISS Reshetnev,* corporate newspaper, No. 457, Dec. 2018.

47 Statement by Nikolai Testoedov, head of ISS Reshetnev, quoted by the official Russian media, Apr. 2018.

48 http://russianspaceweb.com/rodnik.html.

launched in 2021, 2023, and 2025. However, the program, which was to cost 2 trillion rubles, was reportedly cancelled in 2016 due to budget cuts.[49]

Data-relay satellites

One important subcategory of communications satellites is data-relay spacecraft, which provide contact between mission control and low-orbiting satellites when they fly out of direct view of ground stations. A pair of the newest-generation Russian military data-relay satellites called "Garpun" ("harpoon") were launched in 2011 and at the end of 2015. They made up a network known as "Potok-M."[50]

Garpun (14F136) was developed at ISS Reshetnev, likely as a replacement to a previous-generation Geyzer/Potok spacecraft for the nation's Command and Relay System, GKKRS, apparently also known as "Rassvet" ("dawn"). With an estimated mass of 2.4 tons, Garpun enables the transmission of strategically important information from low orbits to its government and military users in the near-real time.

Various Russian new-generation military satellites performing electronic intelligence and reconnaissance functions in low orbit might use Garpun's capabilities to communicate with their ground stations.

Because all these systems were developed in a roughly same timeframe, the spacecraft in the low orbit could be equipped with specialized antennas designed to track Garpun in the geostationary orbit in order to relay a large amount of data to ground antennas located out of their direct view. Theoretically, with a constellation of three Garpun satellites evenly spread in the geostationary orbit, low-orbiting satellites could maintain uninterrupted communications with ground control. For example, Russian satellites could gather intelligence data over North America while simultaneously downlinking information and receiving commands from mission control in Russia. Garpuns were expected to be deployed in the same three orbital positions in the geostationary orbit that had been registered by the USSR in mid 1980s for a previous-generation Potok military data relay constellation: 13.5 degrees west, 79.8 degrees east, and 168 degrees east longitude over the equator. There were reports that a new-generation military data-relay satellite would be dubbed "Gerakl-KV."

[49] *TASS*, Jan. 14, 2016, http://tass.ru/kosmos/2586264.

[50] *Vestnik Rossiyskogo fonda fundamentalnykh issledovaniy*, No. 3, July-Sept. 2017, p. 71.

Navigation Satellites

After many years in development and testing, the GLONASS global navigation network was finally brought to its full operational capacity around 2011. The GLONASS constellation is often advertised as a civilian system, but, according to ISS Reshetnev (its prime developer), "The reliable operation of the GLONASS constellation and stability of its navigational field allows [us to] successfully achieve strategically important national and international goals, including tasks of a direct concern for the highest levels of the Russian government, including maintaining battle readiness of the armed forces...."[51]

In addition to a regular GLONASS constellation, the Russian government apparently plans to deploy a six-satellite GLONASS-V network from 2023 until the end of 2025. The system was apparently designed to increase the accuracy of the network in the Eastern Hemisphere. The satellites, with a mass of less than one ton each, will be launched in pairs on the Angara rockets.[52]

[51] *Vestnik Rossiyskogo fonda fundamentalnykh issledovaniy*, No. 3, July-Sept. 2017, p. 71.

[52] GLONASS-iac.ru, retrieved on Dec. 14, 2018.

Antisatellite Capabilities

In recent years, Russia has also made considerable (and often public) efforts to develop and deploy new antisatellite systems. Speaking to the personnel of the Military Academy of the Chief of Staff, Yuri Borisov, the newly appointed deputy prime minister for the military industrial complex, listed the Nudol mobile antisatellite complex and the Tirada-2S mobile satellite communications suppression complex among the slew of military hardware planned for fielding during a period from 2018 to 2027.[53] There are also indications that orbital maneuvering satellites for inspection and intercept purposes are in development. In addition, there were rumors that a series of military maneuvering satellites orbited during the 2010s might be used to test inspection and intercept systems.

The first antisatellite spacecraft was launched on December 25, 2013, along with a routine three-spacecraft cluster of the Rodnik communications satellites. The mysterious object was later identified as Kosmos-2491 and was detected doing orbital maneuvers and transmitting signals. On May 23, 2014, another spacecraft of this type was launched and was identified as Kosmos-2499. It maneuvered extensively in the following months and made a close proximity flyby of a Briz-K stage, which had previously delivered it into orbit.[54] In 2015, Kosmos-2499 maneuvered in orbit in parallel with yet another vehicle of the same type launched on March 31, 2015. The latter spacecraft was designated "Kosmos-2504," and it was seen conducting maneuvers as late as 2017.[55]

The rationale behind the active development of antisatellite weapons might include not only the desire to destroy existing reconnaissance and communications and other unarmed satellites but also a new fear that space is on the verge of being weaponized. In a preface to a 2008 Russian book on military space, Lt. General Stanislav Yermak wrote: "With the beginning of the new century… [a] real threat has emerged for an armed standoff in space…. It is likely that in the near future not only spacecraft for gathering, processing and transmission of information would be delivered into space, but also those carrying various types of weapons: kinetic, particle-based and lasers."[56] According to Yermak, the all-but-inevitable deployment of weapons in space will have a goal of targeting both orbital and land-based objects.

[53] vpk-news.ru, retrieved on July 4, 2018.

[54] http://russianspaceweb.com/Cosmos-2499.html.

[55] http://russianspaceweb.com/Cosmos-2504.html.

[56] M. Getman, A. Raskin, *Voenny kosmos: bez grifa "sekretno"* (in Russian), Moscow, 2008.

Prospective Technologies

In addition to early antisatellite experiments, various reports pointed at possible ongoing research in several other advanced spacecraft technologies.

Between December 2017 and December 2018, KB Arsenal in St. Petersburg, a major contractor in military space systems, conducted a study code named NIR Yadro (core). The project looked at architectures of spacecraft based on the Transport and Power Module, TEM, equipped with a high-output nuclear power source. Among the applications considered for the TEM-based satellites were remote sensing of the earth's surface, radio-electronic warfare, transmission of energy via laser, and communications.[57] Essentially, it appeared that the project was considering the feasibility of replacing the traditional solar power supply systems with nuclear sources aboard all types of high-powered application satellites.

In July 2016, Shvabe Holdings, a developer of military optics, reported that it had been working on an orbital-based lens that would be capable of concentrating solar energy for propelling the spacecraft.[58]

[57] RIA Novosti, Dec. 22, 2018.

[58] RIA Novosti, July 6, 2018.

Human Space Flight

From the dawn of the space era, human spacecraft have been considered well suited for testing prospective space technologies, including military systems.

Russia is currently operating the five-module segment of the International Space Station, ISS, as well as the expendable Soyuz crew vehicles and the Progress cargo ships for transport operations to and from the outpost. (The Soyuz spacecraft has been the only way to deliver crews to the ISS during much of this decade.)

Although the ISS is considered a civilian project, RKK Energia, the prime contractor on the Russian segment, conducted a program for using the station for military experiments and research, known in Russian as "VPEI" («Военно-Прикладные Исследования и Эксперименты, ВПЭИ»).

The VPEI program included the following fields of research:

- Monitoring and early warning:
    - Support of active operations:
        - Experiments: Portret, Nablyudatel-FTsO, Signatura-KA, Platan, Dvornik
    - Parameters of ionosphere and navigation accuracy:
        - Experiments: Gidroksil; Tsirkach, Vsplesk, Kurs, Monitor-GFO, Diagnostika
    - Identification of sources of radio emissions:
        - Experiments: Seyatel, Pustynnik, Koks
    - Anti-mission defense and antisatellite systems:
        - Experiments: Zerkalo, Fantom, Otklik
- Radio-electronic warfare:
    - Monitoring and radio-location technologies
        - Experiments: Kanal, Pustynnik, Napor-mini, RSA, Duo-RSA
- High-speed telecommunications:
    - Experiments: SLS, KOLS (EKOLINS)
- Monitoring of targets (on the ground):
    - Target condition monitoring:
        - Experiments: Ekon-M; Ekon-L, Uragan
    - Targets and backgrounds:
        - Experiments: Ekon-Napor; Svinets-MKS

- Optical electronics:
  - Experiment: Matritsa-S
- Defense of space assets:
  - Experiments: Khlopushka, Farengeit, Zashita-P, Pelena, Gitara-KE, Istok-M, Lepton
- Life-span extension:
  - Experiments: Prima, Biek-RS, Stoikost

There are strong indications that one such experiment was conducted during the flight of the Progress MS-07 cargo ship to the station in 2017.[59]

In May 2018, RKK Energia reported successfully conducting a total of 14 experiments for the Russian Ministry of Defense, which included monitoring military targets on the ground, and detection and research into the anomalies on the sea surface, in the upper atmosphere, and in the ionosphere. The work also included testing of calibration techniques for ground-based radar systems.[60]

Based on that work, RKK Energia proposed a forward-looking list of future "scientific and application research and experiments for implementation aboard the Russian ISS Segment." It was based on the VPEI program and was prepared under a special directive of the Russian government. RKK Energia hoped that it would be a basis for the interaction between the Roskosmos State Corporation and the Russian Ministry of Defense in the development and testing of the dual-use technologies aboard the ISS.[61]

However, the further development of the VPEI project stalled in 2016 due to lack of funds. To resume the project, RKK Energia proposed to resume the preliminary research project known as Ruslo-2020 and expand it into a wider program. It was to be funded through the 10-year armaments budget, which was expected to fund the Russian military from 2018 to 2027.

RKK Energia also reported obstacles in developing procedures for licensing agreements on the use of intellectual property generated aboard the ISS in the course of dual-use experiments owned by the Ministry of Defense. RKK Energia reported the lack of a practical mechanism for using military assets and personnel to support dual-use experiments aboard the Russian ISS segment.

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59 "Why Does Russia Have a Secret ISS Experiment?" https://www.popularmechanics.com/space/satellites/news/a28584/russia-experiment-secret/.

60 A report by Evgeny Mikrin, designer general at RKK Energia at the meeting of the Scientific and Technical Council, NTS, of the Military Industrial Commission, VPK, May 28, 2018.

61 Ibid.

According to RKK Energia, the Russian ISS segment also lacked the necessary technical capabilities required for conducting planned military research. Because a number of experiments have been relying on the use of the Progress cargo ships, RKK Energia identified a list of upgrades necessary for future military operations:

- Increasing the autonomous flight duration (of Progress ships) up to three or five months (from the current one month)
- Increasing the available propellant load up to 500 kilograms at the end of the mission, to provide up to 220 meters per second in delta V (for maneuvering)
- Improving the accuracy of the attitude control system up to five or 10 minutes
- Adding a high-speed digital downlink system for experiments operating at 4 or 6 megabits per second
- Developing various small spacecraft up to 250 kilograms in mass, which could be automatically deployed from the Progress cargo ships and could enter orbits with an altitude of up to 750 kilometers and have a life span of up to five years[62]

In March 2019, the head of Roskosmos, Dmitry Rogozin, said that the ISS is not well suited for military experiments due to its international nature and claimed that the Roskosmos State Corporation had not planned any military experiments aboard the station. However, Rogozin did not specify whether he included the Progress cargo missions to the ISS in that statement.[63]

[62] E.A. Mikrin, *Nauchno-tekhnicheskie problemy realizatsii proekta "Pilotiruemye kosmicheskie sistemy i kompleksy,"* Oct. 17, 2018, RKK Energia.

[63] RIA Novosti, Mar. 25, 2019. https://ria.ru/20190325/1552075559.

Failures of Modernization due to Corruption and Quality Control Issues

During his address to the Federal Assembly on February 20, 2019, Russian president Vladimir Putin said that radical changes in communications, navigation, and remote sensing demand an increase by orders of magnitude in the capabilities of the Russian orbital assets.

In an apparent response, on March 5, Minister of Defense Sergei Shoigu said that in this context, several ongoing research and development programs aim to build modern satellites for providing more accurate reconnaissance and cartographic information.[64]

During the expanded meeting of the Defense Committee at the Duma (parliament) on March 13, 2019, Shoigu said that after a six-year modernization program (launched in 2012), Russia had gotten essentially a different army than the one it had prior to 2013.

In particular, Shoigu said that the Russian armed forces had received 57 new spacecraft; however, he provided no breakdown of the types of spacecraft included in this total and no details on their latest status, which makes this number largely meaningless.[65]

The same goes for his claim that the percentage of modern technology in the Russian armed forces rose from 16 to 61.5 percent in six years. According to Shoigu, that percentage increased to 74 percent for the Russian Air and Space Forces.

One hint about the accuracy of Shoigu's statistics is provided by his accompanying claim that the new-generation Angara rocket had been developed and that the Unified Detection and Battlefield Control System, EKS OiBU, was in the process of being deployed. In reality, after two decades of development, just two test launches of the Angara rockets had been conducted in 2014, with dummy payloads, and the family has remained grounded ever since due to the inability of Roskosmos to organize its serial production. It is still unclear when the vehicle will become operational. As for the EKS system, it is also years behind schedule and nowhere near its promised level. The two satellites currently in orbit have reportedly experienced various "coming of age" problems, essentially stalling the deployment of the constellation.

The bottom line is that all of Shoigu's statistics, like any numbers provided by the Russian military and Roskosmos, should be taken with a grain of salt.

[64] https://tass.ru/armiya-i-opk/6186664.

[65] RedStar.ru, Mar. 13, 2019.

It is obvious that the country's defense and space industry continues to suffer from the same chronic problems, such as mismanagement, corruption and brain drain, so typical for other high-tech sectors in Russia.

According to the Kremlin's own Chief Military Prosecutor Valery Petrov, in 2018, the corruption in Russia's military quadrupled to seven billion rubles ($110 million) and was not going down.[66]

Not better was the situation at the Roskosmos State Corporation, which builds practically all spacecraft for the Ministry of Defense. At the end of November 2018, the head of the Kremlin's own accounting agency (*Schetnaya Palata*) Aleksei Kudrin said that Roskosmos had broken all records in financial malfeasance. The total amount of uncovered financial violations reached an astronomical 1,865 trillion rubles (US $28.9 billion), including 760 billion (US $11.7 billion) in accounting, according to Kudrin. The State Prosecutor's Office also reported multiple and continual violations at Roskosmos as late as the middle of 2018, resulting in a failure to complete defense contracts, deliveries of low-quality hardware, a lack of control over budget spending, and poor management of research and development and handling of intellectual property. A total of 1,700 violations of the law were registered, producing 302 prosecutorial actions. More than 200 officials were under administrative sanctions, 44 cases were sent for further investigation, and 16 criminal cases were launched.[67]

The recent history of the Russian space program is overloaded with reports about severely delayed schedules, lack of sophisticated components and, especially, quality control issues.

Tackling quality-control issues

The lack of quality control is undoubtedly the most pressing problem for the Russian space program, including its military component.

In his March 13 presentation, the Minister of Defense Shoigu referred to ongoing attempts to tackle the quality control situation when citing the reconstitution of the Soviet-era military acceptance service ("*voennaya priemka*"), which used to be responsible for certification of all projects and hardware under development or in testing across the defense sector.

According to Shoigu, this measure helped reduce the number of failures by 2.7 times for the new equipment and weaponry manufactured by the defense industry. As with other statistics,

[66] The *Moscow Times* via *TASS*, March 21, 2019

[67] http://www.newsru.com/russia/22mar2019/rogozin.html

Shoigu did not provide any details on the methodology behind that number or any background information, such as the number of actual failures over time.[68]

Based on the available history of recent missions, it seems that quality control problems within the Russian space industry stem from three main culprits:

- The low quality of critical components such as avionics, power supply systems, and communications
- The unqualified or unmotivated personnel responsible for human errors
- The inadequate testing of hardware due to lack of funding or availability of necessary checkout facilities and diagnostic equipment

The problem of low-quality electronics is the most serious. It traces its roots all the way back to Stalinism and its denunciation of “cybernetics,” which prevented the Soviet Union from building a solid foundation for an electronics industry.

According to one popular Russian anecdote, a Sony executive who visited the USSR in the 1970s was asked by how many years the Soviet electronics industry was lagging behind Japan, and replied “forever.”

Whether or not this is true, the history of the Russian space program is littered with spacecraft lost to unreliable avionics. A proverbial “heavy particle” from space (destroying sensitive electronics aboard satellites) became the most popular excuse cited in official reports about failures of Russian spacecraft.

The problem of advanced electronics was further exacerbated by Western sanctions in the wake of the Russian annexation of Crimea in 2014. Several spacecraft development projects were reported to be delayed due to a newly introduced ban on the supply of sensitive technologies to Russia.

At the same time, Western sanctions reportedly gave the Russian military and aerospace industry the strongest incentive to date to build up self-reliance in electronics and optics. It remains to be seen whether this effort is successful.

The personnel problem has also persisted for three decades and is unlikely to be resolved in the near future, under the present conditions of rampant corruption and nepotism. Those conditions are inseparable from any illiberal political regime in general and from the current Russian state in particular. In a recent internal industry document, the management at a major space contractor told Roskosmos that the average pay rate at the company would have to be raised in order to attract and retain qualified specialists.

[68] RedStar.ru, Mar. 13, 2019.

The same applies to the complex and expertise-demanding process of developing and testing high technology, including spacecraft, although the Russian industry has been trying to upgrade its testing infrastructure.

To make matters worse, the recent budgets for space—or at least the budget for its publicly known civilian part—suffered considerable cuts in the post-Crimean period. The new increase was promised beginning in 2018,[69] but the extent to which it will materialize remains to be seen.

[69] *TASS*, September 2018, https//tass.ru/kosmos/5583584

Conclusion

The Russian military potential in space presents a mixed picture. Clearly, Moscow has been investing heavily in military and dual-purpose spacecraft projects in recent years and has successfully rebuilt some of the Soviet-era capabilities.

The Russian space industry also achieved some progress with the development of the new-generation dual-use and military spacecraft, such as the communications and remote-sensing satellites Elektro-L, Resurs-P, Bars-M, and Kanopus. However, the jury is still out concerning the quality of products delivered by these systems and the effectiveness of the management and distribution infrastructure on the ground, which ultimately determines their effective use.

The purely military space systems, such as electronic intelligence and early warning satellite constellations, are also re-emerging, but, clearly, they are still years away from full operational deployment.

One orbital network which has been fully deployed in recent years is the GLONASS navigation constellation; however, the Russian government is apparently still working on ensuring a wider use of the system on the ground. The long-promised replenishment of the GLONASS network with new-generation satellites should demonstrate the ability of the Russian space industry to resolve the overarching problem with the supply of foreign components.

Given the pace of current Russian space activities, it is probably safe to assume that Moscow will continue its gradual buildup of orbital assets, aiming first of all to fully deploy already-introduced satellite constellations. One important performance indicator to watch for in the Russian military space systems will be future launches of the new satellites for early warning of missile attack and for electronic intelligence. Both of these strategically important systems are known to be years behind schedule, and their successful deployment would be the clearest sign yet that the Russian space industry can overcome serious challenges in the manufacturing and testing of highly sophisticated systems.

The radar imaging satellite is a brand new satellite system whose long-delayed introduction can also be seen as a litmus test for the maturity of the Russian space industry. The successful deployment of the orbital all-weather remote-sensing system would indicate major progress for both military and civilian space sectors in Russia.

However, across the board, it will not be the launches themselves that will demonstrate real progress; rather, it will be the clear evidence of success in the year-after-year operation of these new satellites and the effective use of their products and services.

Another telling trend in Russian military space over the next decade will be the pace of the new and exotic activities in space, such as orbital inspections, electronic warfare, and antisatellite tests that use kinetic systems and other means of destroying or disabling enemy spacecraft.

Finally, it is known that the Russian military has long wanted to reintroduce nuclear power in space, which could be crucial for such energy-demanding systems as satellite communications and radar-carrying spacecraft. A decade-long effort to develop a nuclear-powered, electrically propelled space tug is years behind schedule. Therefore, the introduction of at least an experimental spacecraft powered by a nuclear power source in the next decade would constitute a major technological breakthrough for the Russian space program in general and for military space in particular.

Barring major collapse of oil prices or other economic or political calamity, Moscow will likely continue robust funding of the Russian military and its space component, which should afford a slow but steady buildup of space assets. There is also hope that the "growing pains" of the Russian space industry in the post-Soviet period will eventually be resolved or at least mitigated, allowing more effective use of available resources, cutting the development time, and producing more reliable systems. Still, the problems of corruption, mismanagement, and low morale in government-funded programs might simply be unavoidable under the conditions of the illiberal political system. As a result, the continual, endless restructuring of the Russian space industry in the hope of producing a more efficient mechanism without transparency, a fair legal system, and the incentive for the rank-and-file employees to innovate, has so far amounted to rearranging chairs on the deck of the Titanic.

Figures

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This report was written by CNA's Strategy, Policy, Plans, and Programs Division (SP3).

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