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Original article

# The network of the Aerospace Forces of the Russian Federation

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**ABSTRACT**

The article attempts to present how the modern concept of organizational networks is used to implement the command system in the armed forces. The paper aims to describe a network of units and information ties that are part of the Aerospace Forces of the Russian Federation. Special attention is drawn to the identification of individual elements (entities) forming the network and the information flow system.

**KEYWORDS**

networks of entities, organizational networks, aerospace forces



## Introduction

The application of the network approach in the organization of the Aerospace Forces of the Russian Federation results from the specificity of their activities, but also is a derivative of technological and geographical approach, and above all is a consequence of the political situation that in recent years has significantly affected the organization of the Armed Forces first of the Union the Soviet Socialist Republics and later the Russian Federation. On August 1, 2015, the Aerospace Forces (VKS) were formed, consisting of three types of troops:

– Air Force,
– Space Forces,
– Aerospace Defense Forces.

Consequently, the VKS joined the other branches of Armed Forces of the Russian Federation: Land Force, Navy, Strategic Missile Forces, and Airborne Forces.

During a press conference, Minister of Defense of the Russian Federation, Sergey Shoygu, said: "The formation of the Aerospace Forces through merging air force and aerospace defense forces is the best solution to improve the air and space defense system. This make it possible first to concentrate in one hand all responsibility for estab-

lishing a military and technical policy for the development of forces, secondly, to integrate them more closely in order to increase efficiency, and thirdly – to ensure the steady development of the country's air defense. General management of air and space defense will continue to be carried out by the General Staff of the Armed Forces of the Russian Federation, and directly – the High Command of the Aerospace Forces" [1].

After having analyzed the tasks carried out by the Air Force (established on July 16, 1997, as a result of the merger of the Air Force and the Air Defense Forces) and the Aerospace Forces (established on December 1, 2011), the Ministry of National Defense of the Russian Federation concluded that the effect of creation of the combination of the above components into a single, common system called the Aerospace Forces, would be much larger than the sum of the effects of the actions taken by individual components working separately, thereby achieving the phenomenon of synergy. The delineation between space and air defense systems and aviation is impossible, and they must be closely synchronized with one another to accomplish partial tasks within the framework of ensuring safety in the air space so that the objectives set out for the superior level are pursued. The creation of a new branch of armed forces is explained in Russia by the need to integrate all forces and measures under one command and to establish new control and command system structures responsible for ensuring Russia's security in the space environment. This is to be the result of shifting the gravity center of warfare to the so-called "air-space area".

The article aims to present a network of units and information ties that are part of the Aerospace Forces of the Russian Federation.

## 1. The concept of network

The essence of the network approach is the overall relationship of the subject with the environment, which form a network of connections [2] on the ground of the general systems theory that was created by L. von Bertalanffy. This theory demonstrates the need to integrate social and natural sciences and prefers a network approach based on the interaction of elements forming the system [3]. Everything that surrounds a human can be seen in terms of systems. Great importance is particularly attached to natural and artificial systems. The first of them are composed of living beings possessing intelligence and the ability to self-organize, the aim of which is to optimize behaviors. Artificial systems are deprived of them. The system was defined as a complex of elements remaining in mutual interactions [4]. These mutually connected elements functioning as the entirety has the capability to generate numerous synergistic effects[1]. The basics of the methodology of network thought were proposed by P. Gomez, G. Probsta and H. Ulrich [5]. Their concept is based on the following elements: a part and a whole (the system is a dynamic whole made up of parts that merge to form a whole hierarchy of the system), network (there are numerous interactions between systems that cause growth

[1] The synergy effect occurs when two or more cooperating systems bring more effects than the sum of the effects of each system would be if they worked separately.

(shrinking or stabilizing the system), openness (mutual and multilateral interactions occur within the system, as well as in relations with its environment), complexity (systems can take a lot of different states at a given time), order (the formula of the system can be saved and interpreted, and the existing rules limit the freedom of the parts and the whole), conduct (the ability of the system to self-control i.e., control and regulation), and development (making changes under the influence of assessments). The essence of the network approach is based on the idea of exchange and mutual trust, which are the foundation for system flexibility and enhancement of competitive advantage [6]. The issue of relations with a network nature is also the subject of M. Porter's considerations, who formulated the theory of cluster. The clusters are geographical clusters of interlinked enterprises, specialized suppliers, companies operating in similar sectors and industries, and related institutions that compete or cooperate with each other. They can create vertical links and take the form of a cooperative system, or horizontal links characteristic of competition relations [7]. The clusters provide access to the necessary resources through transactions carried out within the framework of established social networks.

Systemizing the network is not a simple and unambiguous element. P.B. Schary, T. Skjott-Larsen, suggest splitting the network into [8]:

- a stable network – created based on long-term relationships grounded on mutual connections, common work creating most often systems reminiscent of vertical integration, with strong leadership on the client's side,
- an internal network – collects all operations within the leading company, and the transfer price is artificially set (transfer price),
- a dynamic network – often creating a virtual system with high flexibility. "This is a short-term system, functioning for a single undertaking, although the created structure can survive and be used to implement another undertaking at a later time."

Among network systems, P. Boulanger distinguishes [9]:

- Integrated networks – created by dispersed entities legally or financially belonging to one economic organism,
- Contract networks – their basis is an agreement concluded between independent entities,
- Federated networks – created by entities that are aware of the unity of goals and needs as well as the possibilities of their implementation,
- Networks of direct relations – related to personal relationships, using direct contacts.

J. Witkowski proposes to systematize them due to hierarchical systems and the dominant type of organizational ties between the participants of the network or the type of the coordinators' activity [10, p. 27]. Therefore, within two network groups the author indicates: polycentric networks and hierarchical networks.

With regard to polycentric networks with a large number of entities participating in the project, it is possible to identify the project leader who, due to his/her social and market position, the specificity of the processes carried out, organizational involvement in

a given project, acquires a kind of privileged status among other entities participating in this project. As regards hierarchical networks, a coordinator/integrator appears who, due to his/her market power and customer relationship, is entitled to make managerial decisions. Following the assumption that the basis for the functioning of the supply network is efficient and effective implementation of the adopted objectives, and the prerequisite for this is the synchronization and coordination of flows between individual participants of the net, there must appear entities that will take on the role of coordinator and representative of the system.

In network forms, the allocation sources are not placed in individual entities but in the relations that they establish. Their primary goal is to create opportunities for network participants to better adapt to changing conditions and opportunities to share benefits and costs. Mutual expectations are subject to changes along with switching conditions, and each party has knowledge that is shared within the created communication system. The latter is based on complementarity and mutual facilities.

A particular value of the unit being a part of the network is the dependency system, available resources, and access to resources. "Each network has its own power structure, in which individual participants of the game have a variety of relative strength, which is the basis for their actions and influencing other participants' actions. This structure of power, including conflicting and common interests, affects the development of the network" [8, p. 69] as well as defines the mutual positions of individuals relative to each other in the network.

## 2. Hierarchical networks as a new structure in military systems

When taking into account the elements of system theory and system analysis, it can be stated that the Aerospace Forces of the Russian Federation is a system of elements (forces and measures) in mutual interaction. It is worth mentioning that the entire VKS system prioritizes the Aerospace Forces command subsystem, which is "a set of organized elements in the form of command bodies, command assets, and information and decision processes coupled through command relationships with the entire infrastructure of combat and logistic support, cooperating with each other according to previously adopted principles and requirements" [11, p. 61] responsible for ensuring Russia's security in the airspace environment.

The information and decision structure, which should be understood as a qualitatively and organizationally defined order of spatial and temporal relations associated with the exchange of various information, especially orders, ordinances and decisions as well as reports, statements, data about the enemy, its combat capabilities and tactical and technical parameters of the combat means used, is decisive for the quality and manner of information flow within the designated subsystem needed to make decisions at particular levels of command in the Aerospace Forces. The circulation of this kind of information between hierarchical command organs and elements forming task forces operating at certain levels of command takes place employing communication and information technology. The information and decision support subsystem within the

hierarchical networks of individual entities included in the Russian Aerospace Forces is strictly connected with the command system, organizational structure, the system of decision-making centers, division of labor, hierarchical and functional ties. The subsystem is organized in a structure of communication channels included in the organizational structure connecting senders and recipients of information used in the command process [11].

The large number of components (entities) present in the structure of the Aerospace Forces of the Russian Federation cause that there are strongly developed information links, both internal and external, which can be defined as information flow paths between elements of a given command or between a given command and the superior system and the environment necessary to integrate and coordinate activity.

Table 1 presents a network of selected units (tactical formations, departments) setting up the hierarchical network of the Aerospace Forces. The network of selected VKS units is linked by internal and external ties at all levels of command to coordinate the effort in time and space of individual branch of troops included in the VKS for the most effective execution of the task.

**Table 1.** The network of selected units (tactical formations, departments) setting up the hierarchical network of the Aerospace Forces Command of the Russian Federation

| Units subordinated to the Command of the Air Forces | Units subordinated to the Command of Space Forces | Units subordinated to the Command of Aerospace Defense Forces |
|---|---|---|
| **Long-range aviation** composed of:<br>63rd independent communication center,<br>676th command center for long-range aviation,<br>22nd bomber aviation division,<br>326th bomber aviation division,<br>40th mixed aviation regiment,<br>203rd independent tanker aircraft regiment,<br>27th mixed aviation regiment.<br>**Transport aviation** composed of:<br>12th transport aviation division composed of:<br>334th transport aviation regiment,<br>117th transport aviation regiment,<br>708th transport aviation regiment,<br>566th transport aviation regiment, | **15th Special-Purpose Aerospace Forces** composed of:<br>820th the main center of missile attack warning,<br>1127th detached radio-technical center/eastern command post of a unified space detection and command system,<br>916th detached radio technical center/ western command post of a unified space detection and command system,<br>1383rd alternate command post,<br>514th command post,<br>487th communication and information transmission center,<br>57th detached radio technical center,<br>49th detached radio technical center,<br>378th detached radio technical center,<br>474th detached radio technical center,<br>571st detached radio technical center,<br>818th detached radio technical center,<br>36th detached radio technical center,<br>821st the main airspace reconnaissance center, | **1st Air Force and Ani-Aircraft Defense Army** composed of:<br>5th antiaircraft defense division composed of:<br>549th anti-aircraft missile regiment,<br>629th anti-aircraft missile regiment,<br>606th anti-aircraft missile regiment,<br>614th anti-aircraft missile regiment,<br>9th radio technical regiment.<br>**4th anti-aircraft defense division** composed of:<br>584th anti-aircraft missile regiment,<br>210th anti-aircraft missile regiment,<br>93rd anti-aircraft missile regiment,<br>612th anti-aircraft missile regiment, |

| Units subordinated to the Command of the Air Forces | Units subordinated to the Command of Space Forces | Units subordinated to the Command of Aerospace Defense Forces |
|---|---|---|
| 196th transport aviation regiment,<br>144th long-range aircraft aviation regiment (radiolocation surveillance aircraft),<br>463rd signal battalion of transport aviation,<br>transport aviation division (formed in 2017-2018).<br>**Support units**:<br>8th special-purpose aviation division,<br>4th combat training and retraining center for aviation personnel,<br>344th combat training and retraining center for aviation personnel,<br>92nd instructor-research squadron of special-purpose helicopters,<br>610th combat training and retraining center for transport aviation personnel,<br>185th preparation and combat training center for Air Force,<br>116th combat training center,<br>357th Air Force training center,<br>834th Air Force training center. | „analytical and information point",<br>145th airspace control center,<br>857th detached radio technical center,<br>1109th detached optoelectronic center,<br>153rd main research center,<br>794th central communication center,<br>48th detached measuring complex,<br>65th detached measuring complex,<br>46th detached measuring complex,<br>76th detached measuring complex,<br>13th detached measuring complex,<br>14th detached measuring complex,<br>15th detached measuring complex,<br>20th detached measuring complex,<br>18th detached measuring complex,<br>17th detached measuring complex,<br>40th detached measuring complex,<br>26th detached measuring complex,<br>1373rd research center,<br>863rd research center,<br>7th detached scientific and research center,<br>43rd detached scientific and research station.<br>**Education**:<br>Air and Space Defense Academy,<br>Military-Space Academy,<br>150th teaching process support regiment,<br>9th military school of junior specialists. | 799th anti-aircraft missile regiment,<br>25th radio technical regiment.<br>**9th anti-missile defense** composed of:<br>900th anti-missile defense command center,<br>482nd independent radio technical center,<br>572nd independent radio technical center,<br>164th information processing post, command and calculation post with the "Elbrus" system,<br>102nd an independent anti-missile center,<br>50th anti-missile complex,<br>15th anti-missile complex,<br>49th anti-missile complex,<br>16th anti-missile complex,<br>89th anti-missile complex,<br>34th communications regiment,<br>1876th technical base,<br>590th detached radio technical center for detecting air targets,<br>54th communication center,<br>1786th central measurement technology base. |

*Source: Own study.*

It is worth noting that the Aerospace Forces Commander has under command also five Air Force and Ani-Aircraft Defense Armies, which are part of four military districts and one Joint Operational Command "North" in time of peace, which transform into the Joint Operational and Strategic Command during wartime:

- 6th Air Force and Ani-Aircraft Defense Leningrad Army that is subordinated to the Western Military District,
- Air Force and Ani-Aircraft Defense Army that is subordinated to the Southern Military District,

– 45th Air Force and Ani-Aircraft Defense Army that is subordinated to the Joint Operational Command "North",
– 14th Air Force and Ani-Aircraft Defense Army that is subordinated to the Central Military District,
– 11th Air Force and Ani-Aircraft Defense Army that is subordinated to the Eastern Military District.

## 3. Tasks of the Aerospace Forces of the Russian Federation

Conducting the combat duty on the command post of the VKS by: on-duty forces and means of aviation, anti-aircraft and anti-missile defense, the so-called space systems of "the Russian orbital group" and missile attack and space control systems were recognized as the symbolic moment of starting a new type of armed forces (VKS). The General Staff of the Armed Forces of the Russian Federation, as the central institution, manages, among others, air-space defense, while the VKS's main command is responsible for the direct management of the VKS [12].

The VKS consists of three types of troops: Air Force, Space Forces, Aerospace Defense Forces (Air Defense and Ant-Aircraft Defense Forces).

The Air Force are tasked with:

– repulsing aggression in the aerospace sphere,
– protecting from air attacks the control points of the highest state and military control, administrative-and-political centers, industrial-and-economic areas, the most important economic facilities, the country's infrastructure and the groups of troops (forces),
– destruction of enemy objects and troops using both conventional and nuclear ordnance,
– providing combat troops of other armies and armed services with air support [13].

The tasks of Space Forces include:

– monitoring space objects and identification of potential threats to the Russian Federation in space and from space, prevention of attacks as needed,
– carrying out spacecraft launches and placing into orbit, controlling satellite systems, including integrated ones (intended to be used for both military and civilian purposes) in flight, and using separate ones towards providing the Russian Federation Armed Forces with the necessary information,
– maintaining both military and integrated satellite systems with launching installations and assets of control in the workable order, and many other tasks [14].

The Air Defense and Ant-Aircraft Defense Forces perform a wide range of tasks, the main ones of which are:

– repulsing aggression in the aerospace sphere,
– protecting from air attacks the control points of the highest state and military control, administrative-and-political centers, industrial-and-economic areas, the

most important economic facilities, the country's infrastructure and the groups of troops (forces),
– destruction of the enemy's front parts of ballistic missiles launched to impact important state facilities.

## 4. The disintegration of the Air Defense System of the Union of Soviet Socialist Republics (USSR)

The collapse of the USSR resulted in the disintegration of the most powerful Air Defense System in the world at the time. The said system in the last quarter of 1980 included 70 fighter air regiments with 2.6 thousand fighter aircrafts, about 190 first echelon, anti-aircraft brigades and missile regiments, equipped with not less than 7.6 thousand anti-aircraft missile launchers and S-75, S-125, S-200 and S-300 missile sets, as well as about 60 first echelon regiments and radio technical brigades with a total of approximately 10 thousand multi-purpose radiolocation stations. The manning of the USSR Air Defense System was about 500,000 soldiers. After the total collapse of the USSR two detached Air Defense Armies – the 2nd in Belarus and the 8th in Ukraine remained outside the Russian Federation. They consisted of the following corps: the 11th in Belarus and 28th, 49th, and 60th in Ukraine.

Before the collapse of the USSR, the main task of the forces of the 2nd Air Force Army was to provide a strategic cover for the Russian Federation towards the west and for strategic and military facilities located on the territory of Belarus. It was to be carried out by preventing the enemy air force from reaching deeper into the country, more precisely in the vicinity of Moscow. Due to this fact, air defense troops dislocated in Belarus were amongst the first ones that were equipped with the latest weapons. It is worth noting that on the basis of those air defense units, state tests of the automated command systems "Vector", "Rubiez" and "Seniaz" were also performed. In 1985, the air defense units were provided with modern equipment. The anti-aircraft missile brigade was equipped with S-300P missile sets, while the MiG-23 and MiG-25 aircrafts from the 61st Air Fighter Regiment were replaced by the Su-27P. In total, the following air defense units were deployed in Belarus: two fighter air defense regiments equipped mainly with MiG-23MLD interceptor aircrafts, three anti-aircraft missile brigades and three anti-aircraft missile regiments with S-75, S-125, S-200 and S-300 missile sets, the 8th Brigade Radio Technical, and the 49th Radio Technical Regiment responsible for airspace control. After the withdrawal of the command and part of the equipment of the 19th and 12th Detached Air Defense Armies from Russia, a significant part of it went to the new countries of the Transcaucasia and Central Asia. The 27th Air Defense Corps and the 14th Air Defense Division were withdrawn from the Baltic region on the territory of Russia. Finally, after the transformations, about 2/3 of the forces and measures that could be used by the Armed Forces to defend the air space of the USSR was left within the Russian territory [15]. Over time, due to financial problems, changes in geopolitical conditions and the appearance of other external threats caused by the policy conducted by the new leadership of Russia, certain restrictions were imposed on the Air Space Defense Forces of the USSR. In the end, the Russian Air Space Defense System ceased to exist. Many regions and centers, mainly in Siberia and the Far East were left without protection from the air attack.

## 5. The organization, means and measures of the Air Force of the Russian Federation (RF)

After the dismissal of the Minister of Defense Anatoly Serdyukov in November 2012 and the appointment of Sergey Shoygu to this position, a new phase of reforming the Air Force began.

In the years 2013-2015, the basic directions for the reorganization of the Air Force and Anti-Aircraft Defense Forces of Russia referred to:

- reconstruction of the structure of the "air division-air regiment" starting from December 1, 2013. However, it is worth adding that in fact this was accomplished by reforming the air bases and aviation groups created up to that time,
- reconstruction of army aviation regiments and beginning of the formation of army aviation brigades,
- reconstruction of the Air Force and Anti-Aircraft Defense Forces armies instead of commands (while maintaining their structure) in the years 2014-2015,
- partial change of dislocation of the Air Force units along with the extension of the airport network,
- partial return of naval aviation to the composition of the Maritime Fleet,
- inclusion of the Air Force in the newly established Aerospace Forces (VKS) on August 1, 2015.

The purchase of new aviation equipment was one of the priorities of the State Armament Program for the years 2011-2020, approved on December 31, 2010 (on May 18, 2017, Vladimir Putin held a meeting devoted to the development of the Air Force, Navy and strategic missile forces. Those are the key directions of the SAP for the years 2018-2020. After the briefing, the amendment was introduced and the New State Armament Program of the Russian Federation for the years 2018-2025 was finally developed). The total cost of the program is approximately 2.7 trillion rubles, of which 19.4 trillion rubles has been provided for purchases for the needs of the Ministry of Defense. It was suggested that the amount of 4.7 trillion rubles of these funds would be allocated for the purchase of aviation equipment. As part of the State Armament Program, it has been planned to equip all branches of forces with over 600 aircrafts and 1,100 helicopters. To date, the Program has been implemented quite consistently.

The above resulted in a rapid increase in the supply of aviation equipment to the Armed Forces. The Ministry of Defense received only four combat aircrafts from 2000 to 2008; nevertheless, in 2009, the Air Force were equipped with 33 combat and training-combat aircrafts. True, 31 of them were MiG-29SMT/UB fighter planes, which Algeria had given up. From 2010, the delivery of serial combat and training and combat aircrafts was commenced as ordered by the Ministry of Defense. In 2010, 19 aircrafts were delivered, in 2011 – 24, in 2012 – 35, in 2013 – 51, in 2014 – 102 and in 2015 – 91, and about 100 machines in 2016.

The Ministry of Defense concluded a contract for the delivery of 387 combat aircrafts for the frontal and naval aviation (12 Su-27M3, 20 Su-30M2, 80 Su-30SM, 129 Su-34.98

Su-35S, MiG-29SMT/UB, 24 MiG-29KR/KUBR) as well as 101 Jak-130 military training aircrafts with the date of execution in July 2017. There have been already delivered 234 (12 Su-27M3, 24 Su-30M2, 56 Su-30SM, 74 Su-34, 48 Su-35S, 6 MiG-29SMT/UB, 24 MiG-29KR/KUBR) and 79 Jak-130 aircrafts.

In addition, by mid-2017, the Air Force of the Russian Federation received one new strategic Tu-160 bomber aircraft and four reconnaissance and surveillance aircrafts (two Tu-214ON and two Tu-214R) [16].

The most important program of combat air force was to create a forward-looking frontal aviation set (PAK FA Perspective Aeronautical Complex of Frontal Aviation) – the fifth-generation Russian fighter aircraft T-50. Five prototypes of T-50 aircraft have been created since 2010 to date and have passed tests, and in 2016 four more prototypes were passed for testing. On January 24, 2010 the taxiing tests of the first prototype were carried out. The first test flight of the fighter took place on January 29, 2010 at the KnAAPO factory airport in Komsomol-na-Amure. The PAK FA aircraft is factory-marked Sukhoi T-50. In 2017, the Russian air forces gave it the Su-57 designation.

After 2020, the first results of the next two programs concerning the creation of new aircraft are expected – a perspective set of long-range aviation (PAK DA, new strategic bomber aircraft) and a prospective set of transport aviation (PAK TA, heavy transport aircraft). In anticipation of PAK DA, it is planned to resume the production of the modernized strategic Tu-160M2 bomber aircraft, and in anticipation of PAK TA, the production of the modernized Il-76MD-90A transport aircraft, 39 items of which were ordered for the Ministry of Defense, was transferred from Tashkent to Ulyanovsk. In addition, it is planned to purchase new Il-78M-90A tanker aircrafts on their basis.

Furthermore, the modernization of a part of the combat aircraft park has been an important direction. By 2020, a total of 100 Su-27 fighter aircrafts, 150 MiG-31 fighter aircrafts, 180 Su-25 attack aircrafts, 30 Tu-22M3 bomber aircrafts, 60 Tu-95MS and Tu-160 strategic aircrafts should be modernized. The modernization of the A-50 early warning aircraft park and the construction of such a new generation A-100 aircraft has commenced.

Particularly stormy modernization takes place in the army aviation. In the last few years, the number of new helicopters delivered to the Ministry of Defense exceeds 100 machines per year. More than 450 new Mi-28N, Mi-35M and Ka-52 helicopters were contracted until mid-2017, 250 of which have already been delivered. The purchase of new Mi-17 series helicopters is being carried out; for the time being, 18 new Mi-26 transport helicopters and more than 70 Ka-226 and "Ansat" light helicopters have been bought. Since 2012, a wide range of new guided equipment has been obtained for the Air Force, including medium and short-range air-to-air missiles.

Special attention has been given to the modern radio technical combat measures of basing of Air Force. WRE L-175W "Hibiny-10B" aircraft sets (for Su-34 aircraft), L-265 "Hibiny-M" (for Su-35S aircraft), "Hibiny-U" (for Su-30SM aircraft) have been accepted for the equipment. In addition, specialized Mi-8MTPR-1 helicopters with the built-in "Rychag-AW" active interference station were adopted. Such measures provide protection

against the detection and radiolocation fighting of enemy guidance systems, which means that anti-aircraft missile sets and enemy fighter aircrafts are deprived of any possibility of detecting targets and guiding missiles of different classes targeted at them [16].

## 6. The organization, means and measures of the Air Defense and Anti-Aircraft Defense Forces of the Russian Federation

The active arming of anti-aircraft missile regiments with S-400 "Triumph" sets is underway. Since 2014, the Russian Federation has received two-three S-400 anti-aircraft missile sets per year at an increasing pace. The purchase of 28 S-400 sets (56 squadrons) by 2020 has been planned.

The tests of the S-500 "Prometheus" set, whose main task is to fight medium-range ballistic missiles, independent interception of such missiles from a firing distance up to 3,500 km, and if necessary – also sea ballistic missiles at the final stage of the trajectory and, in certain intervals, in the middle stage, will be soon completed. In addition, the set's task is to destroy supersonic winged rockets, airplanes and unmanned aerial vehicles, supersonic rockets at a speed of 5 m and more, as well as fight low-orbit satellites and space-borne means of destruction from supersonic aircrafts, assault supersonic flying apparatus, and orbital platforms. The testing of A-235 "Nudol" anti-missile that is to replace the A-135 set is underway. The A-235 "Nudol" set is capable of maintaining kinetic and nuclear combat readiness and is designed to combat ballistic missiles and low-space space apparatus.

## 7. The organization, means and measures of the Space Forces of the Russian Federation

The creation of a unified space detection and targeting system that will consist of space detection devices: 14F142 "Tundra" missiles, radar space control station, as well as modernized command points securing the command of the orbital group, acceptance and processing of information in an automated regime.

The satellite designated "14F142" is to be the first element of the new satellite constellation, which will replace the currently used, increasingly ineffective, cosmic component of the Oko-1 early warning system. It is with its help that Russia tries to track countries with ballistic missile launchers and warn about the launch of intercontinental missiles. Probably its task will be to secure strategic emergency communications and detect the launch of ballistic missiles. It was disclosed that the detection systems were developed by the Kometa Corporation. The creation of a network of detached radio technical centers with over-the-horizon radiolocation stations "Voronezh" controlling the air space has been in progress since 2005. At present, combat alert duty is performed by 571 detached radio technical centers in Lechtusi (Leningrad Oblast) with the "Voronezh-M" radar and in the villages of Pionersky (Leningrad Oblast), Barnaul (Altai Krai), and Eniseysk (Krasnodar Krai) with the "Voronezh-MD" radar. In Armavir (Krasnodar Krai), there are two sections of the "Voronezh-MD" system (the 818$^{th}$ detached radio technical center), the observation sector – 240 degrees, and in Usolye-Sibirskoye (Irkutsk Oblast) – two sections of "Voronezh-M". The "Voronezh-M" station is being built in Orsk (Orenburg

Oblast), while in Pechora (Komi Republic) and Zeya (Amur Oblast) – "Voronezh-M" stations. The "Voronezh-WP" station will be in the Olenegorsk (Murmansk Oblast). All named radars should be completed in 2018, therefore a total radiolocation field aimed at warning against the missile attack will be created over Russia.

Apart from the "Voronezh" radiolocation stations, there are radars of the Soviet era in the equipment. "Dnieper" as transmission part for reception by the "Daugava" system is located in Olenegorsk (the 57th detached radio technical center). In 2014, the 808th detached radio technical center in Sevastopol, equipped with "Dnieper", returned to the Main Center for Missile Attack Warning. It is possible that it will be reactivated in order to create an additional radiolocation field in the south-west direction. Another "Dnieper" is located in Usolye-Sibirskoye.

There are two radars warning of a missile attack outside the Russian Federation. These radars "Volga" with a decimeter wave band are in Belarus near Baranavichy and near Lake Balkhash in Kazakhstan. The last creation of the Soviet era, namely "Daryal-type" radar, is situated in Vorkuta. This is the world's most powerful meter wave-band radar. It is planned to be modernized, as are other radars of the Soviet era, until its planned replacement with radar stations of high factory readiness.

In 2013, the development of "Container" over-the-horizon radar for detection of air targets commenced. The 590th detached radio technical center in Kowylkino was the first facility with that radar. The creation of the center will be fully completed in 2018. At present, the radar is working on the western strategic direction, however, there is a plan to extend its possibilities to the south. "Container" radiolocation stations are designed to work in the eastern direction in Zeya in the Amur Oblast. The completion of the works is set to be concluded in 2017. In the future, these stations will from a ring, which is to be able to detect air targets at distances up to three thousand kilometers. The "Container" center is designed to monitor the air situation, detect the nature of activities of airborne resources in the area of responsibility for the purpose of information security of military command organs, as well as detect the launch of winged rockets.

The Main Space Reconnaissance Center with the Central Command Point in Noginsk provides planning, collecting and processing information from individual centralized resources. The main tasks include running a unified information base, the so-called Space Objects Data Catalog. It contains information about 1500 characteristics of each space object (the number, feature, coordinates and others). Russia can identify in space the objects with a diameter of 20 cm. In total there are about 12,000 space objects in the Catalog.

The KA 14G6 "Moment" radio technical set for radiation control ensures the detection of satellites, as well as determining their types and target use based on the characteristics of on-board RF-emission systems.

The radio-optical/optoelectronic space reconnaissance set "Kron" is one of the basic means of the Main Center of Space Defense, which is located in Zelenchksky in the North Caucasus. This detached radio technical center works in the radio and optical range. It has the capability to identify the type of satellite and its affiliation at an altitude of 3500-4000 kilometers. The set has been on duty since 2000 and includes centimeter and decimeter

wave band radar stations and laser-optical radio-locator/locator. The radio-optical/optoelectronic set “Krona-N”, designed to detect low-orbit space targets, is being created in the area of the city of Nakhodka in Primorsky Krai (573rd detached radio technical center).

The 14C215 “Sazen-T”, 14C213 “Sazen-S”, 14C214 “Sazen-TOS”, 14C218 “Sazen-TM” and 14C212 “Sazen-TM-D” quantum-optical/optoelectronic stations are intended for searching and detecting space objects based on reflected solar radiation, measurement of photometric parameters of space objects (visible size, brightness) on the basis of reflected solar radiation and their changes in time, trajectory changes (precise determination of the orbit of a space object) by laser measurements of inclined distance and angle coordinates, among others the astrometric method.

The measuring complex in the territory of the G.S. Titov Altai Optical Laser Center (Altai Krai, the locality of Zmeynogorsk – Savushka) has two terrestrial laser optics systems – with a 60 cm telescope (the 14C218 “Saz-TM” station), with a 3.12 m second-order telescope, which began performing on-call duty in 2017 and will be used to obtain detailed information about low-orbit space devices. In total, there will be four such systems in the Russian Federation – in Kaliningrad, the Far East, and the Crimea.

In Tajikistan near the town of Nurek, there is based the 1109th detached electronic optics center exploiting the set “Window” that has been on duty since 2004 for detecting space objects in the observation zone, determining parameters of their movement, receiving photometric data, and providing information about them. Last year, the center was modernized according to the “Window-M” project. Currently, the set allows for detection and identification of space objects as well as calculation of their orbits in an automated regime at the altitude of 2-40000 kilometers. Low-orbit flying targets will also not go unnoticed. The “Window-S” set is being formed in the area of the town of Spassk-Dalny in Primorsky Krai.

In the development prospects of the Main Space Reconnaissance Center is to establish a radar space control center in Nakhodke, develop the “Kron” set, create a network of the “Pricel” mobile optical observation and search sets, radar stations for location and control of small space objects “Razvyazka” based on the “Danube-3U” radar in Chekhov near Moscow. Facilites in Moscow and Kaliningrad Oblasts, Altai Krtai and Primorski Krai are created for the network of control sets of Sledopyt (Strider) radiation space devices. It is planned to put into operation a set of the fourth-generation computational resources for the exchange of “Elbrus-2”. As a result, by 2018, the Main Space Reconnaissance Center will be able to observe objects smaller than 10 cm.

The Main Experimental Space Center with a command point in Krasnoznamensk implements tasks related to providing support for the command of groups of orbital space apparatuses for military, dual, socio-economic and scientific purposes, including the GLONASS system. The Center’s duty forces carry out around 9,000 satellite control sessions on a daily basis. 80 percent of the Russian space devices of military, dual, socio-economic and scientific purposes is subordinated to the Center. Separated command and measurement sets with the “Taman-Baza”, “Fazan”, “Kub-Kontur” and “Saturn-MK” systems perform control and command of space devices.

The number of space optoelectronic reconnaissance devices working in the interests of the Russian Federation increased to 8 items (14F137 “Persona”, 14F148 “Bras-M”, “Resurs-P”), thereby the space reconnaissance capabilities grew. In 2019, the Ministry of Defense intends to start the development of an optoelectronic system that will be based on the latest space devices of the 14F156 “Razdan” type, which are to replace the 14F137 “Persona” satellites.

The radio technical reconnaissance tasks are performed by the 14F138 “Lotos-S”, the 14F145 “Lotos-S1”, and the 14K166 “Olimp-K”, altogether 6 space apparatuses.

Radar reconnaissance tasks are protected by the 14F133 “Condor” space instruments and in the perspective – by the 14F139 “Pion-NKS”, which together with the “Lotos” radio technical reconnaissance satellites will provide the basis for the “Liana” radio technical reconnaissance system [16].

## Conclusion

Although the Aerospace Forces were created in 2015, for the time being, the VKS’s status and development prospects are not fully clear. There are problems related to their functioning and further reforming. As of 2008, reforms aimed at the reorganization of the entire Armed Forces of the Russian Federation commenced, which significantly affected the instability of the organizational structure of the VKS over the past few years (continuation of reforms). The VKS were established to increase the efficiency of operations by integrating three components: the Air Force, the Space Forces, the Aerospace Defense Forces under one command. However, this idea has not been fully implemented, because many Air Force units have been subordinated to the operational and strategic command, which results in the regionalization of the Air Force’s potential, not its integration, especially in the absence of appropriate systems defining mutual relations. Due to the problems faced by the Air Force of the Aerospace Forces of the Russian Federation, which mainly include obsolete equipment (which generates difficulties related to operating and service life of aviation technical solutions), the low level of modern measures of reconnaissance and targeting, the lack of contemporary, precise means of destruction, the insufficient level of service’s familiarity with modern aviation equipment, and (in terms of conducting combat operations) divergent methods of using the Air Force at the operational and tactical level, the Air Force can be considered the weakest link of the Aerospace Forces. Although the application of the system networking concept gives the chance to develop uneven individual subsystems of the network, its rules must be clearly specified, and in the case of their absence the system remains as strong and functional as its weakest link.

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**Ethical statement**

The research complies with all national and international ethical requirements.

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**SŁOWA KLUCZOWE** sieci podmiotów, sieci organizacyjne, siły kosmiczne

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