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25th Anniversary of the Federal System of Air Space Reconnaissance and Control of the Russian Federation: Evolvement and Development Stages

The Federal System of Air Space Reconnaissance and Control (FSASRC) makes a considerable contribution to the military security of the Russian Federation and the safety of air traffic over the country. Guiding documents on conceptual issues related to building of Air and Space Defence (ASD) of the Russian Federation define full-scale deployment of FSASRC as one of the basic and top-priority activities aimed at creation and further advancement of the ASD system.

25 years ago, on January 14, 1994, a Russian Federation Presidential Decree was issued, which laid the foundation for the Russian Federation FSASRC. This significant event in terms of military and civil use of air space was preceded by more than fifty years of development of various means of observation over air environment, starting from binoculars, sound detectors, searchlights and ending with high-tech radar stations and complexes, which today are the basis of FSASRC. Numerous studies and publications are dedicated to the history of radar engineering in Russia. It is summarized in the anthology "Weapons of Victory's Heirs" (in particular in the article by G. P. Bendersky "Air space reconnaissance and control system in the Russian Federation") issued co commemorate the 70th anniversary of the victory in the World War II.

It should be noted that radar equipment was created and used not only for the purposes of national defence. Above all, such equipment is the basis for the system of surveillance over aircraft flights of the Air Traffic Management Unified System (ATM US) of the Russian Federation. Herewith, before 1990s, radar equipment and systems created for military and civil purposes were developing in fact independently, without harmonization of equipment types and technical characteristics, which hindered achievement of the maximum saving of financial, material, and other resources. Starting from 1994, the general area of development of radar equipment and systems for the Armed Forced of the Russian Federation (RF AF) and the Ministry of Transport of the Russian Federation is uniting of their efforts and capabilities within FSASRC for information support of efficient solution of tasks related to air defence (AD) and air traffic control (ATM). Further on, as FSASRC creation and refinement activities were carried out, three other Russian Federation Presidential Decrees were issued to determine the areas and procedure of the system development.

FSASRC is a combination of interrelated forces and facilities of radio location, automation, and communication of various departmental identity, consistently interacting in space and time and consolidated in a unified information and management system to obtain (receive), collect, process, and issue data on air environment to consumers on a real time basis.

The following forces and facilities are engaged to solve tasks imposed on FSASRC:

- all electronic intelligence subdivisions and units within different branches and services of RF AF, including dual-purpose electronic intelligence subdivisions;
- dual-purpose radar positions of the Federal Air Transport Agency (FATA).

RF AF electronic intelligence subdivisions and units are the basis of FSASRC. They solve tasks on protection of the state border

of the Russian Federation in air space, radar support of command posts (CP) and command facilities (CF) of the Armed Forced of the Russian Federation within the framework of air defence, radar support of state aviation aircraft flights, supervision of compliance with the Russian Federation air space management procedure. In addition to the above mentioned tasks, dual-purpose electronic intelligence subdivisions (DP EIS) are involved in radar support of ATM US centres of Russia to solve ATC tasks.

Dual-purpose radar positions (DP RP) of FATA supply radar data on aircraft (airborne vehicles) to ATM US centres and are involved in radar support of CP (CF) of RF AF to solve FSASRC tasks.

The system of radar data management, collection, and processing within FSASRC is formed based on the existing electronic intelligence subdivisions' CP (CF) technical facilities, as well as AD units. Besides, to solve FSASRC tasks properly, this system includes the systems of information and technical interaction (ITIS) of ATM US centres and AD (ASD) controls.

Three stages can be distinguished in FSASRC development, differing in the contents of activities aimed at creation of FSASRC and its information and technical basis, as well as in basic principles of their building and functioning (Fig. 1).

The first stage (1994–2005) laid the foundation for creation of FSASRC organization structures and formation of a Unified Radar System (URS). A principle of coordinated application of radar equipment of the Ministry of Defence of the Russian Federation and the Ministry of Transport of the Russian Federation in the regions of joint deployment was designated as the basis for FSASRC building in accordance with the regulatory legal documents effective at the time. This principle was implemented by way of centralized (unified) planning of radar equipment application in the air defence areas (locations). At that, exchange of information about air environment between DP EIS of RF AF and regional centres of ATM US, as well as between DP RP of FATA and electronic intelligence subdivisions of the Russian Ministry of Defence was mainly non-automated.

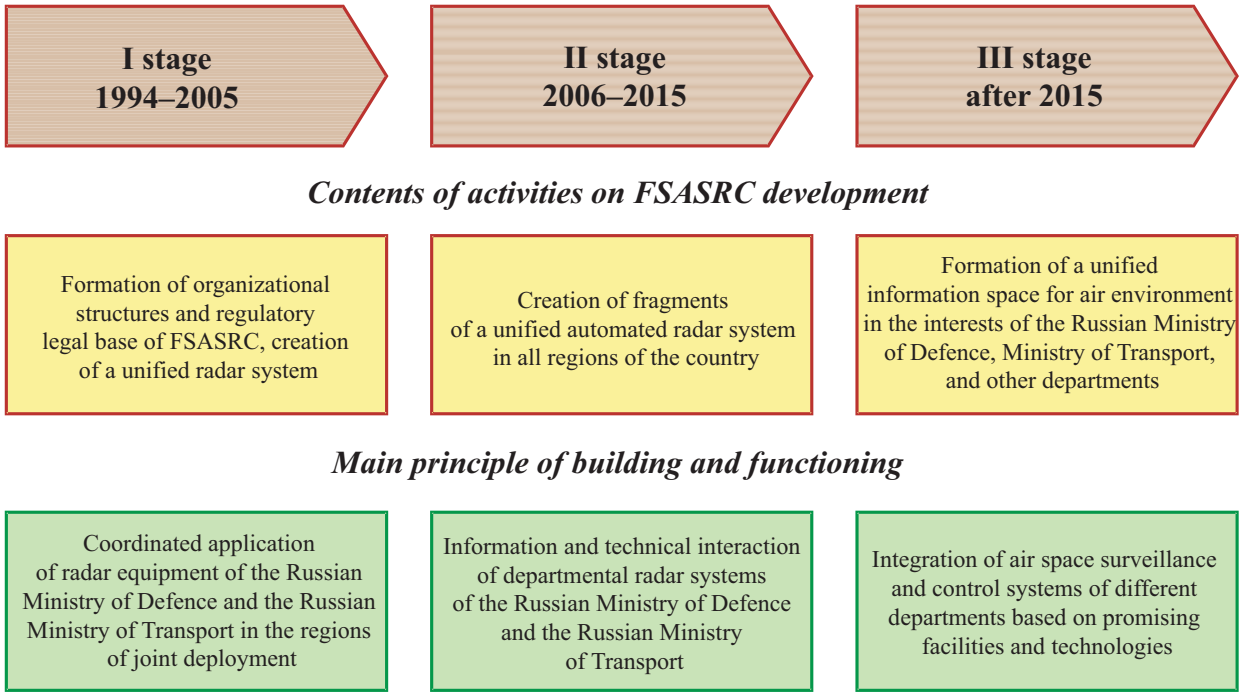

Fig. 1. Main stages of evolvement and development of FSASRC of the Russian Federation

The source of financing of the activities related to creation and application of dual-purpose subdivisions and positions were the funds received by the Russian Ministry of Transport as air navigation fees and the funds allotted by the Russian Ministry of Defence for RF AF building and upkeep. Lack of any mechanism for target financing of actions on FSASRC creation prevented organization of the use of information about air environment from ATM US radar positions located in areas where the forces of the Russian Ministry of Defence in charge of air defence have no radar field. Due to this factor, as well as lack of information and technical interaction (interface) between automated systems of ATM US and AD bodies, FSASRC functioning efficiency failed to show considerable growth.

The second stage of FSASRC creation and development featured state support of actions on FSASRC deployment under the auspices of the federal special-purpose programme (FSPP) "Refinement of the Federal System of Air Space Reconnaissance and Control of the Russian Federation (2007–2015)," approved by Russian Federation Government Decrees No. 345 as of June 2, 2006, and No. 98 as of February 21, 2011.

The main goal of the Programme was creation of a material and technical base of FSASRC in different regions of Russia. To achieve it, systems of information and technical interaction with AD control bodies were deployed in most of larger and a number of regional ATM US centres and about 70 radar positions of FATA were reconstructed to include dual-purpose functions. It allowed to create fragments of the Unified Automated Radar System (UARS) of FSASRC in the Central, Eastern, Northwestern, and Southern regions of Russia. UARS was built based on the principle of information and technical interaction of departmental radar systems of the Russian Ministry of Defence and the Russian Ministry of Transport. In so doing, exchange of information about air environment between AD (ASD) and ATM US bodies equipped with ITIS became automated and most of the reconstructed positions saw deployment of dual-purpose en-route radar complexes (DP ERRC) including equipment of the unified state radar identification system and facilities for measurement of altitude of the surveyed airborne objectives.

A typical ITIS includes:

• a complex of software and hardware means for collection, processing, and exchange of radar data on air environment (CSHM);

• remote sets of subscriber equipment (RSSE);

• communication and data transfer equipment (CDTE).

CSHM are built based on technical means of Air Traffic Management Automated Systems (ATM AS) "Alfa", "Sintez", "Topaz", ATC MS. They are installed in ATM US centres, function in the modes which exclude any influence on ATC loop operation, and ensure collection, processing, and exchange of radar and estimated information between automated systems of the interacting ATM US centres and AD CP.

RSSE are built on hardware and software platform of article VIP-117M3 and its further modifications. RSSE are installed on AD CP (CF) and ensure reception from ATM US objects, processing, display, and output of information on unified functional interaction protocols on a real time basis.

CDTE ensures organization of data and voice information exchange directions between ATM US objects and AD control bodies. CDTE in exchange directions includes technical means for distribution and switching of communication channels, terminal equipment for information exchange via digital and analogue communication channels, digital radio relay stations, fixed satellite communication stations, operational-command communication equipment.

ERRC "Lira-T", improved ERRC "Utyos T" and DP RC "Sopka-2" developed specifically for these purposes were used at this stage as DP ERRC in reconstruction of dual-purpose positions.

Three-dimensional fixed DP RC "Sopka-2" is intended for fitout of DP ERRC of FATA and DP EIS of the Russian Ministry of Defence. The complex includes a primary surveillance radar (PSR) with solid-state transmitting device, a monopulse secondary radar (MSR), and a ground-based radio interrogator (GBRI) of the unified system of radar friend-or-foe identification (US RFFI).

DP RC ensures: detection of airborne objectives (AO); measurement of AO range, azimuth, and elevation (angle of altitude); AO friend-or-foe identification; reception of additional (flight) information via US RFFI channel; determination of coordinates and reception of additional (flight) information transmitted by onboard transponders as per RBS standard; compilation of radar data received via PSR, MSR, and RFFI channels; automatic and semi-automatic modes of AO tracking; information selection and issue to consumers via agreed protocols; recording and documenting of processed and issued information; collection, processing, display, and issue of information about technical state of equipment and complex readiness.

DP RC "Sopka-2" is characterized by the following distinctive features:

• application of a solid-state transmitter with modular structure and high reliability;

• use of phased antenna arrays without active elements;

• digital shaping and digital processing of radio-frequency signals, high degree of integration of digital processing devices;

• use of a rotary support device with direct drive;

• possibility of RC functioning without maintenance personnel, using remote control and technical state control;

• 100 % redundancy of RC equipment (except for antenna module);

• low operating costs.

RC equipment is mounted in two mobile units of "Universal" system with all facilities required for equipment and personnel operation.

Actions taken within the framework of FSPP "Refinement of FSASRC (2007–2015)" contributed to a significant increase of air space controlled by the Russian Ministry of Defence, reduction of consumption of radioelectronic equipment resources of the Russian Ministry of Defence, and assurance of the required level of air traffic security by more than three-fold reduction of catastrophe risks. At the same time, implementation of information and technical interaction of departmental radar systems of the Russian Ministry of Defence and the Russian Ministry of Transport fails to allow high degree of their integration, which in the long run leads to significant limitations of spatial and functional capabilities of the unified system.

For this reason, the main activities related to FSASRC development on today's **stage three**, which has begun in 2016 and covers short- and medium-term horizon, consist in organization of a unified information space for the status of air environment (UIS AE) to solve tasks pertaining to use and control of air environment by the Russian Ministry of Defence, the Russian Ministry of Transport, and other ministries and departments (EMERCOM, MIA, FSB, FCS of Russia, etc.).

It should be noted that at the present time FSASRC development trends are strongly influenced by reforms of RF AF organization structures, above all by creation of aerospace forces and deployment of the Russian ASD system, which includes forces and facilities of reconnaissance and control of air space. It manifests itself in detailing of the contents of tasks to be solved and in specifying a number of qualitatively new requirements to FSASRC by the

Russian ASD system. While earlier the main FSASRC efforts were aimed at solving tasks of air space control in peacetime, at present the focus is put on the tasks of warning about air attacks and information support of combat operations meant to counter the air attack weapon (AAW) strikes.

Position of FSASRC in the ASD system of the Russian Federation is shown in Fig. 2.

3) step-by-step creation of a dual-purpose integrated radar system (DP IRS) by evolutionary development of UARS.

The stated development trends will be implemented based on accomplishment of interrelated actions under the State Armaments Program (SAP) and State (Federal) Programs of the Russian Federation "Assurance of National Defence Capabilities", "Modernisation

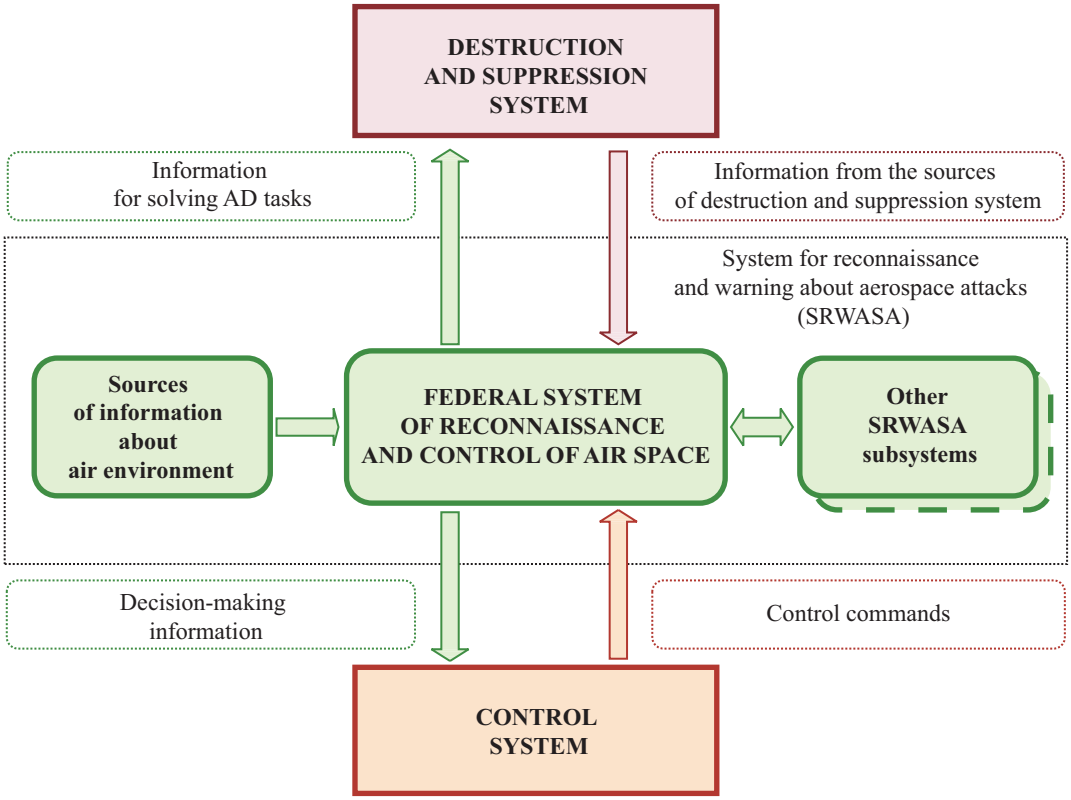

Fig. 2. Position of FSASRC in the ASD system of the Russian Federation

The article of G. P. Bendersky "Air space reconnaissance and control system in the Russian Federation" states that in light of the need to build UIS AE in the context of creation of the Russian ASD system, the main FSASRC development trends for the short and medium term are as follows:

1) completion of the full-scale deployment of FSASRC in the entire territory of the Russian Federation;

2) integration of FSASRC fragments currently operating in the AD responsibility areas into the ASD system;

of ATM US" and "Development of the Military-Industrial Complex of the Russian Federation".

Completion of the full-scale deployment of FSASRC in the entire territory of the Russian Federation implies the following:

• comprehensive technical refitting of electronic intelligence subdivisions and RF AF units with state-of-the-art and prospective radar and automation facilities, including provision of dual-purpose harmonized information sources (DP HIS) as stand-by radars;

• reconstruction of DP ERRC of FATA

according to the redefined schedule for assurance of their functioning within FSASRC;

• completion of ITIS deployment in all consolidated centres of ATM US and modernisation of operating ITIS using unified CSHM for replacement of equipment with expired specified service lives and for assurance of ITIS functioning within the new structure of RF AF;

• deployment of a system for coverage of air environment in the Arctic Region, including outfitting of electronic intelligence subdivisions with new generation of automatic radars equipped with autonomous power sources;

• modernisation of UARS to increase efficient of the use of radar, flight, and estimated information received by AD (ASD) bodies from ATM US bodies;

• implementation of methods of automatic identification of air objective according to the degree of danger they pose, based on comprehensive application of friend-or-foe identification facilities, secondary radar facilities functioning in the modes of *RBS*, *Mk-10* systems and the mode of discrete targeted request *S*, as well as ADS-B system facilities;

• creation of interagency systems for monitoring flights of unmanned aerial vehicle (UAV) and small aircraft in the lower air space over metropolitan cities (first of all in the Moscow Region).

The following main activities are deemed reasonable for the purposes of integration of the operating FSASRC fragments into the ASD system within AD responsibility areas:

• information and technical interfacing of FSASRC facilities, including subsystems for Arctic air environment coverage, with new ASD system facilities based on development and implementation of unified protocols of functional interaction;

• connection of qualitatively new radar information sources ensuring detection and tracking of all types of aerodynamic equipment, including hypersonic aerial vehicles (HSAV), as well as prospective types of ballistic targets;

• development of new regulatory documents (GOST, etc.) related to interfacing of information and control systems, to the unified system of air and space objective classification, and other issues.

Creation of DP IRS by evolutionary development of UARS is aimed at generation of a unified information space for the status of air environment (UIS AE) and information support of control bodies of the Russian Ministry of Defence, FATA, and other agencies to solve tasks related to the use and control of air space.

DP IRS will allow to eliminate departmental and system contradictions by implementing basic information technologies for observation and control of air space, application of modernised and prospective facilities of radiolocation, automation, and communication, first of all dual-purpose ones, as well as for pursuit of the unified engineering policy in the field of air space use and monitoring.

DP IRS will be an interagency information and telecommunication network uniting organizational and technical resources of departmental systems for observation and control of air space. From the system engineering point of view, DP IRS is an extradepartmental system built based on the territorial principle. From the organizational point of view, particular organization structures and engineering facilities of DP IRS retain their departmental identity.

The following subsystems will be included in the prospective DP IRS:

• a network of dual-purpose harmonized information sources (DP HIS) ensuring acquisition, processing, and issue of air environment information in accordance with the needs of control bodies of the Russian Ministry of Defence, Russian Ministry of Transport, and other agencies, to solve tasks related to use and control of air space;

• a network of territorial centres of joint information processing (JIP TC) dealing with the information on air environment, which will ensure formation and distribution of the unified information space for the status of air environment on behalf of the control bodies of the Russian Ministry of Defence, Russian Ministry of Transport, and other agencies;

• an integrated digital telecommunications network (IDTN) ensuring information exchange between DP IRS elements and UIS AE consumers in the Russian Ministry of Defence, Russian Ministry of Transport, and other agencies.

Unified computational, information, and telecommunication resources of DP IRS, including distribution of UIS fragment between users, shall be managed by a dispatcher of the unified information space, i. e. by a software and hardware complex functioning in the automatic mode.

Significant distinctive features of the DP IRS being created are as follows:

• implementation of a unified information space for the status of air environment meeting the requirements of various users;

• access for any UIS user to the information of any DP HIS or JIP TC taking into account the set access authority limitations;

• unlimited number of subscribers and directions of information and technical interaction within the system;

• aligned functioning of all DP IRS subsystems and elements according to a single algorithm;

• interdepartmental unification of engineering facilities, software, information support, and information exchange protocols.

The main elements of DP IRS, i.e. dual-purpose harmonized information sources and territorial centres of joint information processing, will be created taking into account new requirements to FSASRC from the ASD system of the Russian Federation.

Therefore, over 25 years of evolvement and development, FSASRC has formed as a complex engineering system indispensable for efficient solution of important tasks related to air defence and air traffic control. In the future one can expect further growth of the FSASRC role, first of all within the created ASD system of the Russian Federation.

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