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THE SPECIFIC FEATURES OF THE NATIONAL SCHOOL OF RADAR SPACE CONTROL SYSTEMS

Introduction. *Ukraine has a space monitoring system implemented based on the Dnieper radar that provides continuous space monitoring.*

Problem Statement. *Radars of this type are large complicated high-tech engineering systems. The novelty of applied R&D solutions, long terms of radar station design and manufacture make impossible applying the existing development and production standards and, therefore, require creating new ones.*

Purpose. *The purpose is to analyze and to summarize the features of development and manufacture of space control systems based on national radar facilities.*

Materials and Methods. *The systematic analysis of the peculiarities of the Ukrainian school of radar control systems for outer space has been applied using the R&D groundwork and the Chief Designer documentation for more effectively solving specific problems related to creating new generations of radar stations.*

Results. *It has been shown that in order to realize the information received by the existing radar, it is necessary to ensure its competitiveness in the growing market of such services, which is possible through both upgrading the existing facilities and developing new ones. Taking into consideration the specific features that inevitably manifest themselves at different stages of the radar life cycle, the sufficient R&D groundwork and the experience of creating radars of both the current and the future generations, a number of proposals on effective solution of problems concerning the space monitoring with radar facilities have been presented.*

Conclusions. *To ensure the integration and to supply domestic science-intensive radars to international structures for monitoring outer space (MOS) is impossible unless the existing R&D groundwork is effectively used and the capacity of existing facilities is permanently built up, taking into account the MOS radar specific features. The outlined peculiarities of possible problems and ways of their effective solution can be useful to designers of complex high-tech systems.*

Keywords: radar, space control, Chief Designer design documentation, and open architecture.

New radar technologies underlie the most developing approaches to solving various problems related to space surveillance. Their rapid growth has led to obsolescence of conventional solutions. At the beginning of the 21st century, the nomenclature of radio equipment for detecting and ranging ballistic and space objects has been widened significantly and included *Volga* (Russian Federation, 2002), *GRAVES* (France, 2005), *Voronezh-M* (Russian Federation, 2006), *AN/TPY*-2 (USA, 2006), and *Voronezh-DM* (Russian Federation, 2009) [1].

Thanks to having a *5H86 Dnieper* (*Hen House*) space surveillance radar station (SSRS), Ukraine has been involved in the development and use of outer space through implementing both its own projects included in the National Space Program and international ones [2].

Continuous monitoring of outer space is a very relevant task and, given a rapid development of rocket and space technologies in many countries, its importance is tending upward. Continuous monitoring, regardless of the time of day, weather conditions, etc., can be implemented by 5H86 type radar only.

Radar is a science-intensive information system (SIS) that monitors more than 60% of the total number of trajectories of space objects. Out of these trajectories, 40% are low-orbit and 50% are located in geostationary orbits.

The value of the information received from the existing SIS makes it clear that there is a need to ensure competitiveness in a growing market for such services. The only way to do this is to improve the technical characteristics of existing radar systems and to reduce the cost of information retrieval. Information on space objects and the situation in the near space, which comes from the radar station is characterized by rather fast variability, which forces designers and constructors to constantly adapt the radars to these changes on a tight schedule of works related to the development of new generations of SSRS.

Therefore, no approach to the study of such radar systems can be based exclusively on a practice-oriented factual framework and the cut and try method and be reduced to an eclectic set of individual technological design solutions any longer. Instead, it should represent a dialectical unity of the advanced R&D theory and modern scholarly research methodology.

The duration of complete cycle of development of documentation for the product, including its final adjustment and commercialization, essentially depends on the labor input and, above all, on the knowledge intensity of the production. The radar stations designed for space surveillance have always been based on concentrated state-of-the-art developments. Each new radar represents a new generation of radio electronic equipment with a new component base that uses cutting-edge technological solutions. For example, while designing the *Daryal* VHF-band radar, a 100 MW energy potential and UHF microstrip products of almost all functional series have been used for the first time in the world practice.

One of the peculiarities of designing such science-intensive systems is that according to the canonical model, the design works take about 7—10 years. A specific feature of the radar station design is a small number (up to 4) of involved designers working at design bureaus (DB) and manufacturers. The share of these designers and manufacturers in the total design and manufacture works accounts for 70—80%. Given the fact that the transmission system, for example, of the *Daryal* radar, consists of over 1,200 transmitting and over 4,000 receiving modules, it is evident that the design and manufacture of radio detecting and ranging equipment (RDRE) are very labor-intensive processes.

The scope of design documentation (DD) for SSRS is so large (over 0.5 million A4 format sheets) that designing in accordance with the existing system of standards puts in question both the competitiveness and the feasibility of creating such a radar. Therefore, within the framework of this research, the specific features of designing and manufacturing this radar that represents a piece production based on research-stage documentation have been generalized.

Currently, there are no standards in Ukraine's regulative framework, which enable these features to be taken into account, so these systems can be designed in accordance with standards that are established by the designer itself and are compulsory for all involved in the creation of such systems, which is a necessary and sufficient condition for design and manufacture of the mentioned type of radars. The standards should specify the peculiarities of designing, manufacturing, testing, and commissioning of the radar station, with all peculiarities taken into consideration.

Proceeding from the experience of designing many generations of SSRS, *Design, Manufacture, Testing ... Based on the Design Documentation of the Chief Designer* standard has been developed. It is a normative document that is mandatory for

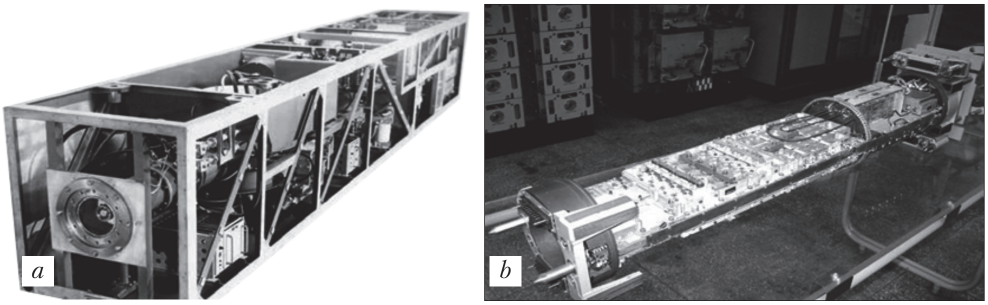

Fig. 1. General view of transmitting modules without protective enclosures in the analog (*a*) and in the solid-state (*b*) versions

all developers and manufacturers of SSRS, a sort of supplement to the existing standards for design and commencement of production. The main difference between the design works based on Chief Designer design documentation (CDDD) and the conventional ones is the cancellation of majority of the established stages of design, when the manufacture is based on research-stage documentation, and the design works start with developing working drawings, skipping out developing design documents for industrial prototype. In addition, designing any radar has a specific feature that the use of CAD system can be effective only if the CAD developer has in-house development that is continuously adapted to the technical specifications of new generation and to the planned level of implementation of new scholarly research results. For example, the creation of the 4th generation radar was accompanied by the development and application of 3 new CAD generations. Also, this design specificity is explained by the fact that only TOP-5 countries (USA, Russian Federation, China, France, and Ukraine) have in-house technologies for creating radars of this type and either do not make known any data or disclose them fragmentarily — with respect to the first generation radar systems.

The peculiarity of design works based on in-house CAD is that designing starts with solutions for stand-alone systems containing dozens of block slots, and structural functional modules for radar stand-alone systems (transmitting, receiving, antenna systems, etc.) are immediately manufactured based on the developed CDDD. The implementation of modular structure principle depends on the technology used that, in turn, has a significant effect on the appearance of both the modules and the radar functional systems (Fig. 1).

When applying amplitrons, klystrons, and similar things as active elements, the main characteristics (range, height, etc.) are realized due to large structural dimensions of the modules (5.0 × 0.7 × 0.7 m, weight: 1500 kg, *Don* radar station, Fig. 1, *a*), by ensuring high precision manufacturing requirements (≤ 2 mm at the mentioned length), applying complex manipulators for their automatic installation on phased array antennas (PAA). The introduction of solid-state technologies has enabled to significantly reduce the dimensions of transmitting module (*Volga* radar, Fig. 1, *b*). The modularity principle makes it possible to significantly simplify the structure of active PAAs (Fig. 2). For Ukrainian and foreign radars, the detection of targets at long distances (≥ 2000 km) is ensured by high potentials (1.5 MW for 5H86 radar; 2.5 MW for *AN/FPS*-126 radar; 32 MW for *AN/FPS-85* radar; 100 MW for *Daryal* radar), which becomes possible due to the stationary version, in which the radio electronic equipment is located in the premises of cyclopic dimensions that are determined, in particular, by implemented construction technologies. For example, the building for the *Don* radar has dimensions of 144 × 100 × 35 m, the size of the receiving active PAA of the *Daryal* radar is 100 × 100 m, that of the transmitting system is 40 × 40 m, and the *AN/FPS-85* station is mounted in a 13-storey building that is 44 m high and 97 m long.

The application of new technologies and element base, as well as modern design principles has enabled to significantly reduce the size of structures and active PAA (36 × 36 m, for *Volga* solid-state radar). The reduction in the total number of types of technological equipment required for the creation of radar (for example, the *Daryal* radar station contains 4096 types of equipment versus 20—23 types used in the *Voronezh* radar station) has made it possible to abandon bulky stationary radars and to advance to a more compact, all the way to mobile versions.

According to the CDDD standard, the manufactured modular products are delivered to the deployment site, with stand-alone systems and radar as a whole formed during the installation and checkout works, directly on the site. In spite of the continuously increasing complexity, dimensions of equipment and knowledge intensity, the application of CDDD standard has enabled to reduce the scope of preproduction works by 30—40% on average, and to the duration of commissioning from 10 years (*Dnieper* and *GRAVES* radar) to 5—6 years (*Don* radar) and even down to 2—3 years (*Voronezh* radar).

Traditionally, Ukraine has good positions in UHF electronics that, however, represents only a narrow specialized segment with in-house specific technologies (for example, GaAs technology [3, 4]), while modern technologies have been focused on gallium nitride (GaN), which complicates the application of Ukrainian electronic devices. The most logical scenario of the development is to integrate into international specialization. As a member of the World Trade Organization, Ukraine has the opportunity to access the modern element base of world manufacturers, which ensures that the designed radars comply with modern world standards [5].

Each new generation of radars is developed on a new generation of element base, with the designer using the nomenclature of components included in the list of products manufactured and available for use, instead of developing these components by himself.

A distinctive feature of the modern element base, which is typical for all manufacturers, is rapid technological obsolescence as compared with a rather long (30—50 years) life cycle of modern integrated engineering systems, and this tendency is rather stable [6]. An example of such long-lived integrated engineering systems is the Ukraine-made *Dnieper* radar that has been operating for more than 40 years. Unlike it, *AN/FPS-49* was decommissioned after 40 years of operation [7], and the *GRAVES* radar that was put into operation in 2005 already needs repairing.

As you can see, the two indicators, the duration of design and the service life of radar station, clearly illustrate the capabilities of the Ukrainian SSRS design. However, long service life means that over time, the used electronic radio elements (ERE) get obsolete and the electronic systems functionally degrade relative to the capabilities that will be necessary in the middle of its service

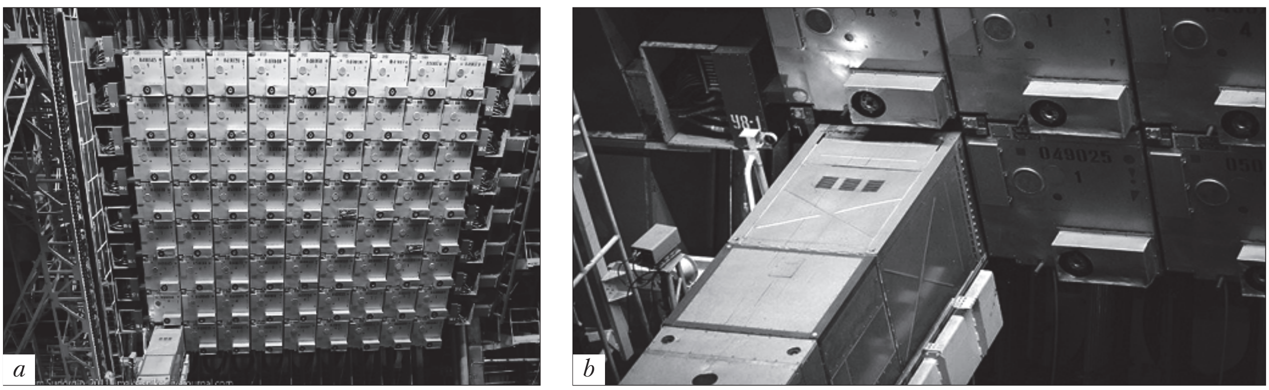

Fig. 2. General view of PAA (*a*) and inside view (*b*) of transmitting module installation in PAA

life (15—20 years), unless the systems can be upgraded while operating.

One of the distinctive features of creating advanced radar systems is the need to implement a lot of new in-house solutions based on in-house developments.

The design of almost all generations of high-power radar systems requires the development of a wide range of components not included in the list. This concerns not only ERE, but also other elements. For example, because of the lack of industrial version of high-voltage (40—45 kV) high-capacity capacitors, for the modulating pulse formation lines, it was necessary to design and to make them of primary materials directly at the radar factory. To provide a dead load of the modulator cascade (40 kV) — a 120-ohm non-inductive resistance — in-house designed water-cooled resistors with a dissipation power of up to 300 kW were developed. Since cooling with air (0.8—1.0 W/cm^2) is much less effective than with water (20.0 W/cm^2), the dissipation of such a large power inevitably affects the weight and dimensions of both resistors and devices based on them.

The virtual design methodology [8] enables to solve problems that arise not only while creating a sophisticated system, but also in the course of its evolutionary development — the emergence of a new generation of element base created on the basis of in-house research, engineering, and economic resources of the designer and the manufacturer. While designing the radar station, it is necessary to simultaneously solve the problems related to the provision of high-energy potential, on the one hand, and the required temperature conditions, on the other hand. In the first generations of radars, stainless steel pipes of different diameters were used for connecting the water-cooled elements, which caused, in addition to the cost and technological problems, the problem of decoupling the water-cooled vacuum-tube anode (35 kV and more) [9]. In order to solve the problem of cooling the powerful transmitters, it was necessary to develop a new technology that made it possible to replace the stainless pipes by polyethylene hoses reinforced with layers of lavsan. The polyethylene structure was normalized by irradiating the hoses with a strong electrostatic field.

A high integration of digital devices (more than 3000 integrated circuits in cabinet) and a high-speed performance of the element base resulted in an increased density of heat fluxes inside the cabinet, so, the provision of temperature conditions was a serious problem. The experience of creating different generations of SSRS has shown, the difference between the printed circuit board and the printed board assembly tends to smear out, and in the future, the printed circuit boards will obviously merge with microelectronics products into a single whole. For example, slots of the *Don* radar computing device are made on multilayer printed circuit boards (up to 18 layers for the installation of about 200 chip cases and 6 layers on ceramics for microwave board slots). To provide the required temperature conditions for digital devices, it was necessary to use a liquid cooling system on water-cooled bases [10]. It should be noted that the technology of liquid cooling has been used by modern developers. In the *AN/TPY-2* THAAD complex, the temperature conditions of transceiver modules based on gallium arsenide are realized in a similar manner.

The distinctive feature of temperature conditions of such radar systems is that they not always can be achieved by the use of only one type of cooling systems — either air or liquid one. Realizing the temperature conditions of generator lamp of *Don* radar's transmission module (35 kV) can be an example of using a combined cooling system: the anode was chilled by a liquid cooling system, while the cathode (with a tube filament current of 3000 A) was made cold using an autonomous air cooling. At the same time, it was necessary to make an in-house design of a fan (air velocity of 20,000 rpm, impeller diameter of 40 mm), since no fans with the required parameters were produced by the domestic or the world industry. To maintain the temperature conditions for active elements of the transmission system only, the difference in temperature at the inlet and the outlet of the cooling system should not exceed 15 °C at a pressure of 3—4 kg/cm^2 in the system and a flow rate less than or equal to 1 l/min per 1 kW. The liquid cooling system that provides temperature conditions of radar requires the creation of a closed system of water treatment and water exchange.

The radar-located targets being characterized by small effective deflecting surfaces and space velocity of flight, it is crucially that the time for radar maintenance should be as short as possible and, consequently, the radar operation must be completely automated. The advanced radars must operate exclusively in an automatic mode, in accordance with the working algorithm. It is advisable to make computing equipment for primary and secondary processing based on a computer with open-source real-time information processing architecture. For advanced radars, the performance should be about 100 billion operations per second (in the 20th century, data processing speed of the *Volga* radar was 18 billion operations per second).

One of the basic principles for designing advanced radar systems is multifunctional integration that is realized by stand-alone structure, when different functions such as reception of reflected signals (radiation), conversion, digital processing, control, energy supply, etc. are performed by one self-contained packaged (receiving, transmitting, etc.) module. For example, for realizing the performance function, the *Volga* radar receiver module contains a set of amplifiers, filters, processors, controllers, analog-to-digital converters, digital-to-analog converters, sources and power stabilizers, sensors, etc. manufactured in one technological process.

Functional and technical control should be implemented through embedded peripheral coprocessors integrated with the CPU via a high-speed interface. The SSRS performance functions are realized by a variety of different functional systems based on different schematic design and technological frameworks, which makes it impossible to apply conventional approaches and technologies for building a control system [11]. The concept of radar control system design should be built on the principles of multiple application, multilevel integrity, and complete automation based on a super-fast computing system that has a speed for processing information comparable with that of product designed. Control of the radar station operation is impossible unless a simulating model that generates the signals for organizing both internal and external control and the signals indicating the status is designed. In the control process, the reference and current characteristics are compared with automatically formed status statement. In the case of a negative result, the control system generates an address command for the manipulator (in the case of PAA) to replace automatically the respective module and to generate messages about the address results of monitoring of other systems. As part of radar software, a control cycle must be provided.

The experience of creating radar based on solid-state technologies has shown that in order to implement the adopted concept of building a control system for advanced radar, it is necessary to take into account the fact that the required characteristics are related to the micro and nanodimensionality of the elements used and, consequently, to equip the production with very high-precision machining tools applying lines of machining centers, an automated warehouse, and a system for automated control of technological processes. One of the main requirements for the means of machining is the availability of its own built-in tool shop and its own control system for both the tool and the quality of all ongoing technological operations while manufacturing the product.

The necessary condition for ensuring the required manufacturing parameters is the use of paperless documents, when an electronic document for performing one or another technological operation is sent via physical lines to a specific processing center.

Given the evolutionary trend in designing large systems, "innovation through modernization," the creation of advanced radar systems is impossible unless the open architecture technology is used [12]. It should be noted that the previously used principle of functional and parametric redundancy in the radar design had some features of open architecture, providing a step-by-step build-up of new functional capabilities.

The traditional content of advanced radar design should be supplemented by the concept of architectural design, with the complete set of radar DD should including "architectural structure". The architectural design should be the zeroth stage of design, which is compulsory for all hierarchical levels (from the top down) of the designed product and precedes the development of terms of reference (TOR). One of the decisive factors influencing the level of implementation of open architecture technology is the availability of in-house research and technological groundwork (RTG). The initial stage and the content of architectural design should be analyzing the existing RTG and choosing a structure-forming framework for all hierarchical levels. For example, in the United States, the level of RTG readiness for key systems and elements is mandatorily examined and assessed. For instance, the RTG created while developing the *AN/FPS-115* radar became the basis for making *AN/FPS-120, 123, 126,* and *132* radars. Today's science and technology progress makes it possible to include in each structure-building framework such a set of engineering innovations that would enable to provide the required characteristics in the best way. For example, to ensure approximately the same characteristics in the *Daugava* and the *Volga* radar systems, over 1000 transmitting devices were used in the PAA, in the first case, and only 280 ones, in the second case.

An analysis of the possibility of using one or another existing architecture at the zeroth stage of design aims at ensuring that the architecture chosen for the development is duly flexible and adaptable. Traditionally, the architectural aspects associated with the structural scheme design were dominant, while the aspects related to software were either an independent task or a secondary issue. As a rule, software developer (SD) selects a proper architecture by the code and fix method, but as the complexity of modern software systems grows, it becomes impossible to create high-quality architectures using the code and fix approach. The advanced radars are unthinkable without software technology, so the use of open architecture software is as important as the design-related tasks and must be solved in parallel.

Traditionally, referring to RTG implies structural scheme implementations, but in fact, the RTG should include the production technology aspects as well. In the case of changing the SSRS, the manufacturer's instrument production facilities accumulate many units of the equipment manufactured earlier, and there is only one way out of this situation that is to apply the open architecture principle to the supporting structures at all levels and universal devices (conductors, meters, prefabricated stamps, measuring and bench equipment).

Given the quasi-deterministic nature of the motion and the known characteristics of the space objects, when designing an advanced SSRS, it is necessary to use programmable control of potential in order to implement the control of operating conditions and to enable changing the radar energy consumption depending on control regime and equalizing the energy consumption in the operating sector of the station.

Thus, from the foregoing analytical review it follows that the only way for ensuring international integration and supplying Ukraine-made knowledge intensive products to international structures for outer space monitoring is efficient utilization and sustainable upgrade of capacity of the existing facilities based on RTG, with specific features of SSRS building in our country taken into consideration.

REFERENCES

1. Andreev, F. M. Statkus, A. V. (2013). Analysis of the possibility of using the analytical approximation to estimate the second and third derivative of the range. *Systemy obrobky informatsiyi (Information processing systems)*, 7 (114), 171—176 [in Russian].

2. Andreev, F. M., Kovbasyuk, S. V. (2009). Possibilities of a multiposition complex created on the basis of national radar systems for the above-horizon detection of ballistic and space objects. *Kosmichna nauka i tekhnolohiya (Space science and technology)*, 15 (5), 74—81 [in Russian].

3. Drobakhin, O. O., Plaksin, S. V., Ryabchii, V. D., Saltykov, D. Yu. (2013). *Technology and Semiconductor Microwave Electronics*. Sevastopol: Weber [in Russian].

4. Plaksin, S. V., Sokolovsky, I. I. (2006). *Physical basis for the construction of high-speed information-control systems based on semiconductor elements with hot electrons*. Sevastopol: Weber [in Russian].

5. Lavrich, Yu. N. (2018). Features of scientific support for the creation of promising samples of radio electronic equipment. *Nauka innov.*, 1, 15—25 [in Russian].

6. Danilin, N., Belosludtsev, S. (2007). Problems of applying the modern element base of foreign production in rocket and space technology. *Modern electronics*, 7, 8—12 [in Russian].

7. Nicholas J. Willis, Hugh D. Griffiths (2007). *Advances in bistatic radar*. New York: SciTech Publishing.

8. Lazarevich, E. G., Semak, Sh. B., Amzeev, E. G., Lazarevich, Yu. I. (2013). Virtual electronic component base of radio electronic equipment. *System analysis and applied informatics*, 1—2, 39—47 [in Russian].

9. Lavrich, Yu. N. (2015, May). Features of the thermal regime for powerful radio transmission systems. *Proceedings of the 16th Intern. scientific-practical. conf. «Modern informational and electronic technologies»*, Odessa [in Russian].

10. Lavrich, Yu. N., Plaksin, S. V., Pogorelaya, L. M. (2017, November). Features of designing systems for ensuring the thermal regime of REA in microelectronic design. *Proceedings of the 2nd All-Ukr. scientific-practical. conf. «Perspective tendencies in the electronics, informational and computer systems»*, Dnepr [in Russian].

11. Lavrich, Yu. N. (2012, June). Features of monitoring the reliability of the control system for high-speed ground transportation. *Proceedings of the 13th Intern. scientific-practical. conf. «Modern informational and electronic technologies»*, Odessa [in Russian].

12. INTERNATIONAL STANDARD (2011) ISO/IEC/IEEE 42010:2011(E)(E) Systems and software engineering — Architecture description

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ОСОБЛИВОСТІ ВІТЧИЗНЯНОЇ ШКОЛИ РАДІОЛОКАЦІЙНИХ СИСТЕМ КОНТРОЛЮ КОСМІЧНОГО ПРОСТОРУ

Вступ. Україна має у своєму розпорядженні систему контролю космічного простору, реалізовану на базі радіолокаційної станції (РЛС) «Дніпро», що забезпечує безперервний моніторинг космічного простору.

Проблематика. РЛС подібного типу належать до великих складних і наукомістких технічних систем. Новизна застосовуваних науково-технічних рішень, тривалі терміни проектування і виготовлення РЛС виявили неможливість застосування існуючих стандартів розробки та постановки на виробництво і зумовили необхідність створення нового стандарту.

Мета. Аналіз і узагальнення особливостей розробки і виготовлення систем контролю космічного простору на базі вітчизняних радіолокаційних засобів.

Матеріали і методи. Використано метод системного аналізу особливостей вітчизняної школи радіолокаційних систем контролю космічного простору з використанням науково-технічного напрацювання та матеріалів Головного конструктора із забезпечення ефективного вирішення виникаючих специфічних проблем при створенні нових поколінь РЛС.

Результати. Показано, що для реалізації інформації, що надходить від існуючої РЛС, необхідне забезпечення її конкурентоспроможності на зростаючому ринку таких послуг, що можливо як за рахунок підвищення технічних характеристик наявних засобів, так і завдяки розробці нових. Виходячи зі специфічних особливостей, що неминуче виникають на різних стадіях життєвого циклу РЛС, наявності достатнього обсягу науково-технічного напрацювання (НТН) і досвіду створення як зазначеної, так і наступних поколінь РЛС, наведено низку пропозицій, спрямованих на ефективне вирішення питань контролю космічного простору (ККП) радіолокаційними засобами.

Висновки. Забезпечення інтеграції та постачання наукомісткої продукції вітчизняних радіолокаційних засобів у міжнародні структури ККП можливо лише на шляхах ефективного використання і стабільного нарощування потенційних можливостей наявних засобів на базі наявного науково-технічного напрацювання з урахуванням специфічних особливостей побудови РЛС контролю космічного простору. Викладені окремі специфічні особливості ймовірних проблем і можливі шляхи їх ефективного вирішення можуть бути корисні широкому колу розробників складних наукомістких систем.

Ключові слова: радіолокаційна станція, контроль космічного простору, конструкторська документація головного конструктора, відкрита архітектура.

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ОСОБЕННОСТИ ОТЕЧЕСТВЕННОЙ ШКОЛЫ РАДИОЛОКАЦИОННЫХ СИСТЕМ КОНТРОЛЯ КОСМИЧЕСКОГО ПРОСТРАНСТВА

Введение. Украина располагает системой контроля космического пространства, реализованной на основе радиолокационной станции (РЛС) «Днепр», обеспечивающей непрерывный мониторинг космического пространства.

Проблематика. РЛС подобного типа относятся к большим сложным и наукоемким техническим системам. Новизна применяемых научно-технических решений, длительные сроки проектирования и изготовления РЛС обнаружили невозможность применения существующих стандартов разработки и постановки на производство и обусловили необходимость создания нового стандарта.

Цель. Анализ и обобщение особенностей разработки и изготовления систем контроля космического прост-ранства на базе отечественных радиолокационных средств.

Материалы и методы. Применен метод системного анализа особенностей отечественной школы радиолокационных систем контроля космического пространства с использованием научно-технического задела и материалов Главного конструктора по обеспечению эффективного решения возникающих специфических проблем при создании новых поколений РЛС.

Результаты. Показано, что для реализации информации, получаемой существующей РЛС, необходимо обеспечение ее конкурентоспособности на возрастающем рынке таких услуг, что возможно как за счет повышения технических характеристик существующих средств, так и благодаря разработке новых. Исходя из специфических особенностей, неизбежно возникающих на разных стадиях жизненного цикла РЛС, наличия достаточного объема научно-технического задела (НТЗ) и опыта создания как данной, так и последующих поколений РЛС, представлен ряд предложений, направленных на эффективное решение вопросов контроля космического пространства (ККП) радиолокационными средствами.

Выводы. Обеспечение интеграции и поставки наукоемкой продукции отечественных радиолокационных средств в международные структуры ККП возможно только на путях эффективного использования и стабильного наращивания потенциальных возможностей имеющихся средств на базе существующего научно-технического задела с учетом специфических особенностей построения РЛС контроля космического пространства. Изложены отдельные специфические особенности возникающих проблем и возможные пути их эффективного решения могут быть полезны широкому кругу разработчиков сложных наукоемких систем.

Ключевые слова: радиолокационная станция, контроль космического пространства, конструкторская документация Главного конструктора, открытая архитектура..