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COMPREHENSIVE FRAMEWORK FOR DESIGN AND MODERNIZATION OF AVIONICS MANAGEMENT SYSTEMS

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Abstract**—***The efficiency and safety of civil aviation heavily depend on the robust performance of avionic systems, which provide essential communication, navigation, and surveillance capabilities for flight operations. To sustain the requisite level of reliability in these complex systems, a methodological foundation for their design and modernization is critical. This paper presents a comprehensive framework for the Avionics Management System, emphasizing systematic component analysis and developmental methodologies. This framework includes a multidisciplinary approach that integrates advanced principles, theories, models, and methods drawn from current achievements in information technology, artificial intelligence, mathematical statistics, and decision-making theory. It also considers societal needs, economic trends, and future developmental prospects. Proposed approach ensures that AMS not only addresses immediate operational requirements but is also adaptable to future technological evolutions, thus supporting the life cycle of avionic systems from conception through to utilization. The proposed framework is poised to guide the industry in achieving higher levels of system reliability and maintenance efficiency, with potential implications for the broader realm of civil aviation and its ever-advancing technological landscape.*

Index Terms—Methodological basis; operation system; avionics; design and modernization; life cycle; modern information technologies.

I. INTRODUCTION

In the rapidly evolving sector of civil aviation, which is an integral component of the global transport infrastructure, there is a paramount emphasis on the safety and efficiency of aircraft operations.

At the heart of this pursuit lies the complex domain of avionics – the electronic systems used in aircraft, artificial satellites, and spacecraft—which encompasses communications, navigation, the display and management of multiple systems, and the hundreds of systems that are fitted to aircraft to perform individual functions. These systems are the lifeline of modern aviation, ensuring operational integrity and safety.

This is facilitated through the utilization of complex ground and onboard avionic systems, encompassing communication, navigation, and surveillance functions. These systems, some operating interdependently and others autonomously, form the backbone of aviation safety, guiding flights through increasingly congested airspaces and diverse operational conditions.

Given the intricacies of these systems and their crucial role in aviation, Avionics Management Systems (AMS) are established to assure sustained reliability and performance. These systems are architecturally complex and hierarchical, forming the operational core that supports avionic functions throughout the entire life cycle of the equipment.

The AMS, with its intricate design, demands a methodological approach for its development and modernization. The methodology must encapsulate a spectrum of principles, theorems, and axioms that govern its systematic design and assessment. Approaches, models, and methods must be grounded in advanced computational techniques, data analytics, and decision-making processes, aligning with the latest developments in operational technologies, artificial intelligence, and mathematical statistics.

The framework serves as a blueprint and methodological basis for both the conceptualization and the perpetual enhancement of avionic systems. In an industry where obsolescence is swift and the cost of failure is measured in human lives, a methodological approach to engineering and evolving these systems is not merely beneficial but essential. This framework ensures that avionic systems are not only designed to meet current demands but are also adaptable to emerging technologies and future requirements.

This paper aims to delineate a comprehensive framework for the AMS, addressing its conception, evolution, and continual improvement. The methodology formulated herein will be robust enough to account for the societal imperatives, economic conditions, and strategic state developments, ensuring that the AMS remains at the forefront of aviation technology, adapting to the exigencies of the present while preparing for the innovations of the future.

II. LITERATURE ANALYSIS

Society demands from scientists, engineers and state regulatory bodies new results and achievements aimed at collecting, processing and using statistical data from all components of the transport system. Such a strategy will allow taking into account the real state of affairs and relevant indicators, as well as forming optimal structures for the control of life cycle of avionics.

The life cycle of equipment includes four main stages: design, development, operation and utilization [1], [2]. The longest stage of the life cycle is operation, where the equipment is used for its functional purpose [3]. A systematic review of the processes that occur at these stages of the life cycle can allow to optimize the resources expenses while using the equipment [4], [5]. Among the processes that take place during operation, in addition to the use of equipment, maintenance, repair, control, monitoring, resource extension, data processing, personnel training, and provision of physical, information and cyber security are important [6], [7].

Currently, the main control actions during operation, which are performed by operational personnel, are mostly formed without the use of modern information technologies [8], [9]. At the same time, the person-operator uses his own experience, knowledges and skills to make decisions about the objects of operation state. The development of information technologies within the Industry 4.0, the doctrine of data-driven decision-making makes it possible to process large data sets, implement more complex and advanced processing algorithms in areas of human life. This became possible due to:

- rapid development of ideas, scientific and practical results obtained by scientists, practitioners and researchers in the field of synthesis and analysis of new and more efficient statistical processing algorithms;
- the development of technical aids, in particular, increasing the volumes of information stored on data warehouse and making them cheaper, high-speed computer technology and reducing the calculation cost;
- increasing the number and accuracy of measuring sensors that can be connected to the Internet of Things with the possibility of transmitting information through the fifth-generation networks;
- development of artificial intelligence technologies, in particular, machine learning methods for classification algorithms, deep learning using neural networks, and others [10], [11].

The research [12] details the LAMBDA (Laboratory of Aircraft Multidisciplinary Knowledge-Based Design and Analysis) framework, developed in MATLAB R2022a, for designing, analyzing, and optimizing civil aircraft. Featuring a modular architecture that supports various methods and fidelities across disciplines like Aerodynamics, Engine Performance, and Cost, LAMBDA allows for both built-in and custom user-defined methods.

The paper [13] presents a new mathematical model for digital avionics maintenance, which addresses the high cost associated with No Fault Found events, primarily due to intermittent faults. By analyzing key maintenance effectiveness indicators such as average availability, mean time between unscheduled removals, and expected maintenance costs for both single and redundant systems, the model evaluates the impact of permanent failures and intermittent faults under exponential failure distributions. It also examines how spare unit availability affects system availability. Through numerical examples, the study explores different maintenance management strategies to reduce avionics maintenance costs effectively.

The paper [14] introduces a comprehensive framework that integrates Model-Based Safety Assessment with model-based systems engineering and multidisciplinary design analysis and optimization for aircraft conceptual design. The framework incorporates elements of the safety assessment process, tailored for early design phases, and introduces a novel safety-based filtering approach to manage large design spaces.

The paper [15] introduces a versatile tool for the economic and operational assessment of aircraft and related products, utilizing a discrete event simulation to model the entire product lifecycle from order to disposal. Modular architecture and default methods of the framework enables comprehensive analysis of physical products, operational procedures, maintenance strategies, and decision-making algorithms, assessing their effects on an aircraft's or system's lifecycle.

The paper [16] proposes a formal framework for developing avionics integration capability, reflecting the evolution of avionics systems from standalone units to interconnected systems due to advances in electronics over the past three decades. It incorporates the V-model of development model, detailing the workflows essential for the technical execution of avionics integration.

Despite the extensive research on AMS, there remains a significant gap in the comprehensive integration of advanced technological principles with practical operational strategies. Previous studies have extensively documented individual components and principles of AMS, yet there is a lack of holistic frameworks that systematically combine these elements with modern advancements in technology such as artificial intelligence, data analytics, and predictive maintenance. Existing literature often overlooks how these integrated systems can adapt to the rapidly evolving demands of the aviation industry while maintaining compliance with international safety and regulatory standards.

The paper fills the identified gap by linking theoretical principles with practical applications, offering a comprehensive guide for the design, implementation, and evolution of AMS that aligns with both current needs and future trends in aviation technology.

III. PROBLEM STATEMENT

We will perform the mathematical formulation of the task at the level of generalized functionals. We believe that the purpose of developing and implementing a methodological framework is to optimize resources at all stages of the equipment life cycle. Then the generalized efficiency indicator can be defined in the form of resources $\operatorname{res}(T_\Sigma)$, i.e.

$$Ef = \operatorname{res}(T_\Sigma),$$

where T_Σ is the duration of the avionics life cycle.

Resources are needed to ensure the implementation of tasks at various stages of the life cycle. Since the main focus of this paper is on AMS, we will limit ourselves to operation stage. At this stage, the resources are determined by the AMS content $\overline{AMS}$, components of the methodological framework $\overrightarrow{MF}$ and mechanisms of its implementation $\overrightarrow{MI}$. So

$$Ef = \operatorname{res}(T_\Sigma) = \psi\left(\overline{AMS}/\overline{MF}, \overline{MI}, \vec{L}\right),$$

where $\psi(\cdot)$ is some function that connects the parameters of the AMS components with the elements of the methodological framework and the mechanisms of its implementation, $\vec{L}$ is the function of limitations, which characterizes possible limitations in the resource provision of project decisions providing, their implementation, requirements for equipment reliability, and others.

Therefore, it is necessary to develop such a methodological framework and a mechanism for its implementation, in order to obtain the minimum of resources expenses for the AMS defined structure.

IV. ELEMENTS OF THE METHODOLOGICAL FRAMEWORK

Let’s consider the main components of the AMS framework as methodological basis.

For comprehensive understanding of AMS, it is imperative to explore its foundational structure, which is built upon a series of interdependent modules and principles. These components not only facilitate the day-to-day management of avionic operations but also ensure that the system can adapt to future technological advancements and changes in the aviation landscape. From theoretical foundations to practical applications, the AMS framework encapsulates a range of main components:

- Theoretical foundations – core principles that underlie the AMS, including adaptability, functional completeness, and consistency, which guide its design and functionality.
- Analytical models, which are used to understand and predict the behavior of the avionics systems, addressing aspects like reliability and performance over time.
- Data analytics – a data-driven component crucial for monitoring, predictive maintenance, and decision-making based on real-time and historical data.
- Decision-making algorithms, which provide the logic for making informed choices regarding system maintenance, upgrades, and responses to anomalies.
- Technology integration principles – guidelines that facilitate the seamless incorporation of new technologies into the existing AMS infrastructure.

- Human-machine interface design, which focuses on optimizing the interaction between the AMS and its users to improve usability and reduce errors.
- Lifecycle management strategies, which encompass the entire lifecycle of avionic systems, from design to decommissioning, with an emphasis on sustainability and adaptability.
- Regulatory and compliance guidelines for ensuring that the AMS complies with international standards and regulatory requirements.
- Innovative practices for encouraging the adoption of cutting-edge technologies and methodologies within the AMS to stay at the forefront of avionic advancements.
- Risk assessment and mitigation – strategies and procedures to identify, evaluate, and mitigate risks associated with the AMS operations.
- Performance metrics and benchmarks, which establishing criteria to evaluate the AMS's effectiveness and to guide continuous improvement.

Let's define the AMS main principles.

Adaptability principle emphasizes the system's ability to adjust effectively to new, unforeseen, and changing conditions, states, and situations. It is particularly relevant in the context of intelligent information systems that leverage artificial intelligence, suggesting that the system should have internal parameters that are capable of dynamic modification in response to environmental factors.

Systems approach principle emphasizes the consideration of the AMS as an integral and complex entity, which functions as part of a larger aviation ecosystem. This principle dictates that the AMS should not be viewed or managed in isolation but rather as an assemblage of interrelated and interdependent components that work together to achieve the overarching goals of avionic safety, reliability, and efficiency. It requires a holistic understanding of how individual system components interact within the AMS and how the AMS interacts with external systems and the operational environment.

Functional completeness principle entails a comprehensive description of all the functions performed by the system, including their objectives, indicators of achievement, models, methods, efficiency criteria, and algorithms for data processing and decision-making, among others.

Principle of consistency suggests the use of a hierarchical structure in the design and analysis of the system, ensuring coherence across various levels of governance and operation.

Process principle advocates that all processes within the OS should occur under controlled conditions, with clearly defined inputs, outputs, resources, and control influences.

Aggregative principle aims to standardize design processes, representing them in a systematic form, which includes defining the input, output, resources, control influences, states of the process, transmission characteristics, and a model for state change.

Innovativeness principle involves considering current trends in science and technology and maintaining constant feedback with scientific institutions and specialists to quickly adopt and implement new developments.

Productivity principle focuses on achieving maximum effectiveness with minimal resource expenditure and involves detailed analysis of system components to identify areas of inefficiency for improvement.

An important element of the methodology is the models that describe the dynamics of processes, the states of the AMS components during the life cycle, the models of the equipment functioning in terms of reliability indicators and defining parameters. The fundamental principle is the hypothesis regarding the stochastic nature of AMS processes throughout the life cycle. Therefore, it is necessary to use probabilistic and statistical models. However, a deterministic approach is also appropriate in certain situations and established controlled modes.

Another fundamental principle of AMS components functioning is non-stationarity of models and parameters. During the operation of radio equipment, examples of such non-stationarity are the processes of changepoint occurrence. This makes it difficult to solve the problems of synthesis and analysis of operational data processing, but it is an objective reality. Taking non-stationarity into account will make it possible to achieve the efficiency of the AMS functioning during the life cycle.

Approaches are an organic component of the methodological framework, which outline the main features and ideas regarding design processes and project tasks. The main approaches include:

- process approach;
- an approach to monitoring and control;
- an approach to the processing and use of statistical data;
- classical and sequential approaches;
- analytical-calculation and modeling approach;
- approach based on artificial intelligence.

The process approach can be used to build a process model for project decisions implementation.

Process models can be built at the level of structural and/or functional purpose. Such models make it possible to monitor information flows, to determine control points for monitoring the defining parameters of avionics and parameters of the AMS constituent elements. The presence of inconsistencies in the trends of the measured indicators can serve as a basis for corrective actions at the level of the determined process, that is, to eliminate drawback not for the entire system in general, but for a specific control point (output of a certain process).

The approach to monitoring and control involves a comprehensive coverage of all components of the designed AMS with the aim of visual representation of reliability indexes, determining parameters, performance and efficiency indicators. This approach involves the presence of sensitive elements (measuring devices) that are connected to specified control points. The collected data form datasets, which are further processed in real time or stored in the appropriate information warehouses. Therefore, monitoring is a way of obtaining primary information for further it's processing and decisions-making at all stages of avionics life cycle.

The approach to the processing and use of statistical data involves the utilization of advanced intelligent technologies to obtain explicit and hidden information in the collected datasets. This approach makes it possible to perform a transition from subjective management decisions based on the available experience of the responsible for the process person to objective decisions based on the real situation occurring in the constituent elements of AMS. The use of statistical processing methods provides more reasonable and effective solutions.

Analysis of theoretical results in the field of mathematical statistics and decisions-making theory shows that currently there are two fundamentally different approaches: classical and sequential. The classical approach to processing involves the use of fixed volumes of datasets. That is, this approach requires a certain time for the formation of sample sets, after which processing is performed for the entire dataset. The sequential approach assumes an a priori unknown sample size that accumulates with each new measurement. That is, there is no need to spend time to collect large datasets, and a decision can be made after each new measurement. It has been proven that the sequential approach is more economical and effective at the same levels of processing quality indexes. It should be noted that the sequential approach is analytically more complex during the analysis problem solving, but in general, all statistical classification and statistical estimation procedures should be sequential.

Another promising direction when using classical and sequential approaches is the application of processing technologies in the sliding window. This is a method of flexible tracking of non-stationary changes in data models obtained from monitoring results. The application of the scheme of sample sets formation within the sliding window technology makes it possible to reduce the time constant during decisions-making based on current data (within reasonable limits) at the time of observation.

A promising approach to conducting theoretical research is an analytical-calculation and modeling approach. This approach involves the following stages a specific scientific and practical task solving:

1) obtaining analytical ratios in those cases when it is possible to overcome the complexity of mathematical expressions;

2) performing calculations of numerical indicators efficiency and parameters of the studied process or algorithm using the description of the states changes dynamics within the tools of Markov and semi-Markov processes;

3) statistical modeling fulfillment to confirm the analytical statements veracity, calculation results (as an organic addition to the first two stages) and actually obtaining statistical estimates and characteristics of the obtained indicators in cases where it is difficult or impossible to apply the first two stages.

The approach based on artificial intelligence involves the use of modern machine learning methods to solve prediction and classification problems, deep learning methods based on the use of neural networks, and other heuristic and statistical methods. This approach also aims to form knowledge bases and databases for the implementation of expert systems for management decision support.

A methodological framework is also considered to include statements, hypotheses, axioms, and theorems. Therefore, during consideration of AMS in terms of design and improvement of data processing structures, it is necessary to form a number of conceptual provisions, statements and theorems.

In general case, AMS contains a large number of constituent elements. The state of some elements may contain a certain level of uncertainty due to a number of reasons. Since the main operation process is the use of the object of operation for its functional purpose, let the information measure for decision-making be the probability density function (PDF) $f(t)$ of operating time between failures.

As mentioned earlier, unknown parameters $\vec{\zeta}$, may be present in AMS and creating a certain level of uncertainty. Then it is obvious that the following theorem can be formulated.

Theorem regarding the increase of operational informativeness.

Procedures of statistical processing of data in AMS regarding measurement and evaluation of unknown parameters $\vec{\zeta}$ related to the main process of operation increase the quantitative measure of information, while reducing the level of uncertainty.

Proof.

Let ζ_1 is the unknown AMS parameter, relative to which statistical data processing procedures are performed. At the same time, in the general case, random variables ζ_1 are t dependent. The measure of information about $f(t)$ can be defined as

$$H(f(t)) = -\int_{-\infty}^{\infty} f(t)\log_2 f(t)dt..$$

As a result of the definition (statistical data processing), the measure of information $H(f(t))$ for ζ_1 changes. Due to the change in uncertainty, $f(t)$ the unconditional measure of information $H\left(f(t)\right)$ is replaced by a conditional one $H_{\zeta 1}\left(f(t)\right)$. Therefore, as a measure of the quantity of information about $f(t)$, which can be obtained as a result of processing values ζ_1, we can choose the difference between unconditional and conditional entropy

$$\Delta H\left(f(t)\right) = H\left(f(t)\right) - H_{\zeta 1}\left(f(t)\right).$$

At the same time, the expressions for unconditional and conditional entropy using mathematical expectations are

$$H(f(t)) = -m_1\left(\log_2 f(t)\right),$$

$$H_{\zeta 1}(f(t)) = -m_1\left(\log_2 f(t/\zeta_1)\right),$$

where $f(t/\zeta_1)$ is the conditional PDF of operating times between failures. We will get from here

$$\Delta H(f(t)) = -m_1\left(\log_2 f(t)\right) + m_1\left(\log_2 f(t/\zeta_1)\right) = m_1\left(\log_2 \frac{f(t/\zeta_1)}{f(t)}\right).$$

It is known that the conditional PDF can be represented in the form

$$f(t/\zeta_1) = \frac{f(t,\zeta_1)}{f(\zeta_1)},$$

where $f(t,\zeta_1)$ is the two-dimensional PDF of the operating times between failures and the unknown parameter ζ_1.

Then

$$\Delta H(f(t)) = m_1\left(\log_2 \frac{f(t,\zeta_1)}{f(t)f(\zeta_1)}\right).$$

In the integral form, we can get

$$\Delta H(f(t)) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(t,\zeta_1)\log_2 \frac{f(t,\zeta_1)}{f(t)f(\zeta_1)} dtd\zeta_1.$$

Using the natural logarithm, we get

$$\Delta H(f(t)) = \frac{1}{\ln 2}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(t,\zeta_1)\ln \frac{f(t,\zeta_1)}{f(t)f(\zeta_1)} dtd\zeta_1.$$

Let's use the inequality

$$\ln x \ge 1 - \frac{1}{x} \quad \text{for } \forall x \ge 0.$$

From here

$$\Delta H(f(t)) \ge \frac{1}{\ln 2}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \left(f(t,\zeta_1) - f(t)f(\zeta_1)\right)\ln dtd\zeta_1 = \frac{1}{\ln 2} - \frac{1}{\ln 2} = 0.$$

Therefore, $\Delta H\left(f(t)\right) \ge 0$, that is, the quantity of information about $f(t)$, obtained as a result of statistical processing of the unknown parameter ζ_1, associated with the operating times between failures, cannot be negative.

The theorem is proved.

Consequence.

If the failure occurrence process is not related with an unknown parameter ζ_1 (random variables ζ_1 and t are independent), then $\Delta H\left(f(t)\right) = 0$.

Therefore, the statistical data processing in AMS reduces the level of uncertainty. It should be noted that in an ideal case it is necessary to reduce the level of uncertainty to zero. The more the level of uncertainty tends to zero, the more precisely the task of optimizing design decisions can be solved while maximizing (minimizing) the selected efficiency indicator.

Sources of uncertainty in the general case can be:

- a sudden (random) change of AMS components states, including the object of operation (changepoint in the trend of the determining parameter or reliability indicator);

- hidden inconsistency in the AMS component (including incompetence of service personnel, regulatory documentation absence, low accuracy class of control and measuring equipment, etc.).

Statement.

With the complication of the hierarchical structure of the operated equipment, the fulfilment of the operation processes should be associated with higher hierarchical levels.

Indeed, during the maintenance of avionics the level of detail known as "down to the resistor" today is no longer required. Such detailing only leads to unnecessary operating costs of both material and time resources. In addition, this approach leads to quantity reduction in service personnel. Operating processes are becoming more intelligent, while implementing the principles and approaches of artificial intelligence systems.

Therefore, the considered theorem and statement confirm the necessity for comprehensive control of AMS components, collection of relevant data on determining parameters and reliability indicators, statistical processing of these data, and making informed decisions based on the results of this processing. The main stages (types of work) during the AMS design and improvement are shown in Fig. 1 and Fig. 2.

IV. PROSPECTIVE ISSUES OF THE THEORY AND PRACTICE OF AMS DESIGN

Prospective issues of the theory and practice of AMS design are based on the advanced achievements of science and technology, the development of scientific knowledge methods, the development and needs of society.

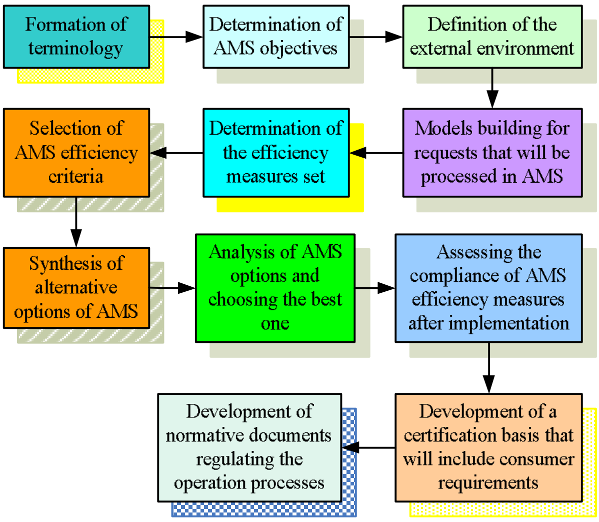

Fig. 1. The main stages during the AMS design

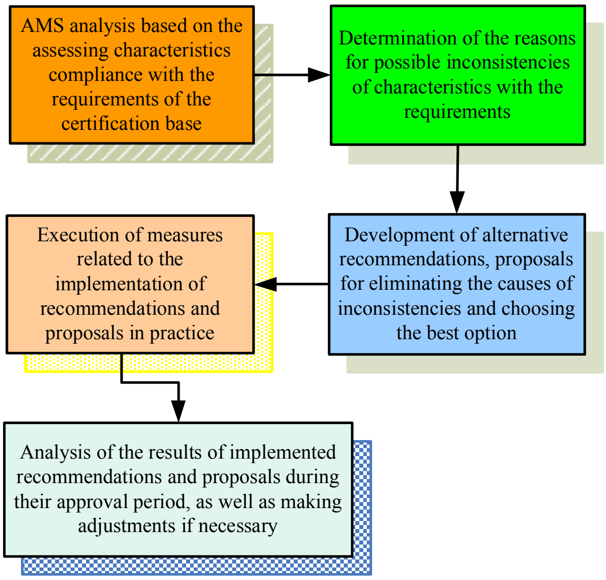

Fig. 2. The main stages during the AMS modernization

According to the given theorem, a priori uncertainty is an integral part of reliability indicators changes and determining parameters of equipment, indicators of AMS productivity and efficiency.

This leads to the fact that the data to be processed have a description in the form of non-stationary random processes with different periods of quasi-stationarity, which are also random. The causes of non-stationarity are uncontrolled changes of operating conditions, the presence of degradation processes in electronic and radio components, structural elements, connectors, wire connections, power supplies, etc. Thus, we will observe the effect of change point in data change trends. Taking into account change point during data processing is important for the theory and practice of operation, as it allows you to reliably determine the technical condition of the equipment, reliably determine the predictive values of states and measurement indicators, and minimize the risks of failures, damages and failures. Solving this problem requires the use of complex algorithms including model classifiers, change points detectors, parameter estimators, predictors, adaptive filters, etc. It is also necessary to develop a procedure for searching sets of algorithms in the space of possible variants of their construction.

Another promising direction may be the search optimal parameter values of data processing algorithms from the point of view of minimizing resource costs for the implementation of operational processes. First of all, maintenance and repair processes are meant. This aspect can be considered from the point of the number of possible states that can be distinguished during decision-making substantiation, the determination of risks that are possible due to the implementation of preventive and corrective actions, the calculation of the optimal periodicity of monitoring, control and prediction periods.

Among data processing algorithms, a promising direction is the synthesis and analysis of parametric and non-parametric methods of statistical classification and evaluation within the limits framework of two approaches to obtaining decisive statistics (classical and sequential). At the same time, attention should also be focused on carrying out comparative analysis procedures of the developed methods.

Modern trends and the development of innovations provide the comprehensive collection, analysis and use of statistical data processing results. Therefore, the creation of data hubs is relevant. Data hubs should include: a monitoring system for data collection, a warehouse system for data store, a pre-processing system for data regulation, an algorithmic support system for the implementation of complex processing procedures, a system for recommendations providing and decisions forming for operational control of the AMS constituent elements, the performance and efficiency evaluation system – to make possible adjustments during decision-making. So, data hubs are structures that functioning on the principles of adaptation to the environment.

VI. CONCLUSIONS

The paper has systematically articulated the formulation of a methodological framework essential for the design and modernization of avionics management systems. In dissecting the complex and hierarchical structure of AMS, study have underscored the necessity of integrating principles, models, and methods that are at the vanguard of scientific progress in operational technologies, information systems, artificial intelligence, and statistical analytics.

The framework presented herein not only aligns with current technological imperatives but is also forward-looking, accommodating future advancements and the evolving needs of the aviation sector. The methodological components identified are instrumental in elevating the reliability, efficiency, and adaptability of the AMS, ensuring that it can effectively manage the challenges of modern avionics operations and maintenance. The importance of findings extends beyond the academic realm, offering practical insights and guidelines for industry professionals and regulatory bodies. As such, the concepts developed within this paper have the potential to influence the strategic planning and implementation of robust, state-of-the-art avionic systems globally.

The consolidation of a methodological framework for AMS design and modernization represents a significant stride towards an era of smarter, safer, and more efficient aviation systems. The groundwork laid herein will catalyze further research and development, ultimately contributing to the enhancement of the aviation industry at large.

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О. В. Соломенцев, І. В. Кабашкін, М. Ю. Заліський, О. В. Зуєв. Методичний підхід до проєктування та вдосконалення системи експлуатації авіоніки

Ефективність і безпека цивільної авіації значною мірою залежать від надійності систем авіоніки, які забезпечують необхідні функції зв'язку, навігації та спостереження під час польотів. Для підтримки необхідного рівня надійності в цих складних системах критично важлива методологічна основа для їх проєктування та модернізації. У цій статті представлено всеосяжну структуру для системи експлуатації авіоніки, наголошуючи на систематичному аналізі компонентів і методології її розробки. Ця основа включає міждисциплінарний підхід, який об'єднує передові принципи, теорії, моделі та методи, взяті з сучасних досягнень у галузі інформаційних технологій, штучного інтелекту, математичної статистики та теорії прийняття рішень. Методичний підхід враховує потреби суспільства, економічні тенденції та майбутні перспективи розвитку. Запропонований підхід гарантує, що система експлуатації авіоніки не тільки відповідає безпосереднім експлуатаційним вимогам, але й адаптується до майбутніх технологічних розробок, таким чином підтримуючи життєвий цикл систем авіоніки від початкової концепції до використання. Запропонована структура готова керувати галуззю у досягненні вищих рівнів надійності системи та ефективності технічного обслуговування з потенційними наслідками для ширшої сфери цивільної авіації та її постійно прогресуючого технологічного середовища.

Ключові слова: методологічний базис; система експлуатації; авіоніка; проєктування та модернізація; життєвий цикл; сучасні інформаційні технології.

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