Airport vulnerability model in civil aviation

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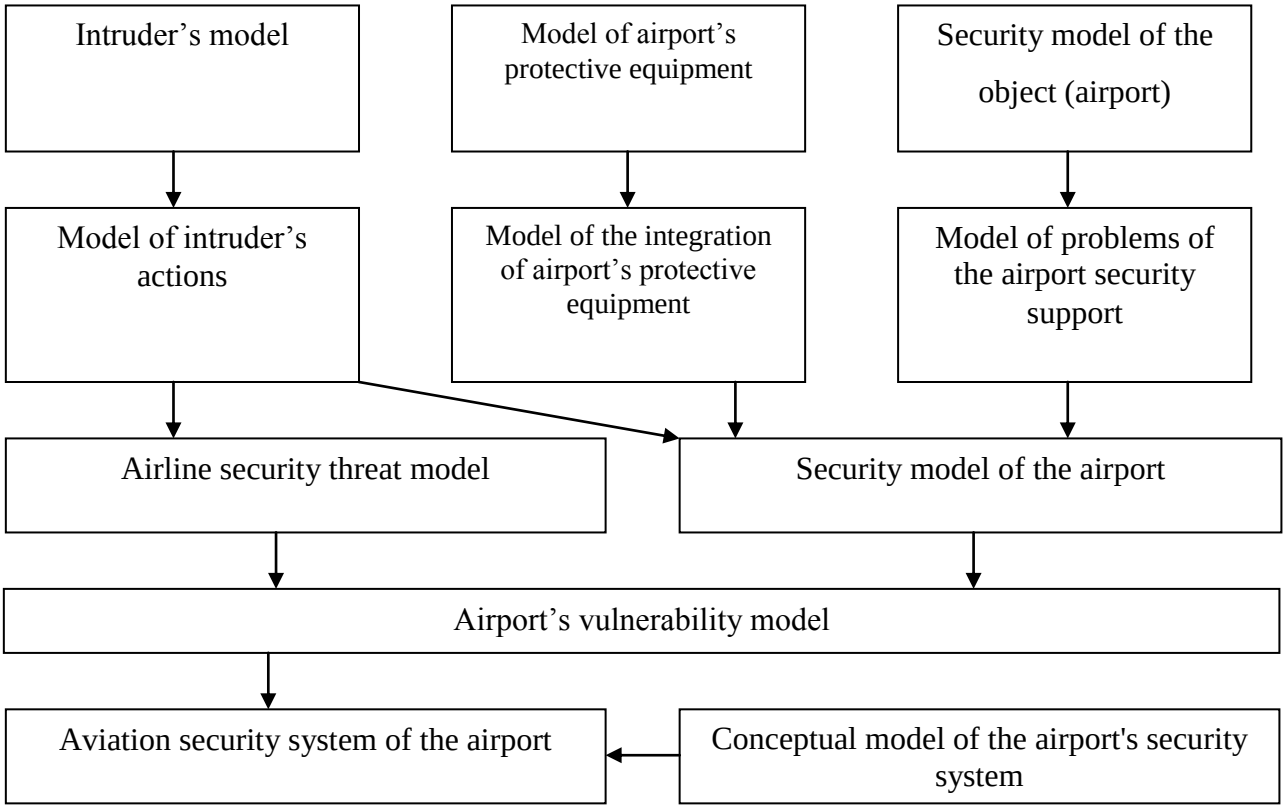
Abstract: *The work presents the author's view on one of the most important problems of civil aviation in modern conditions – the problem of ensuring the aviation security of civil aviation facilities. Problems of security and problems of aviation security management are investigated and addressed in the assessment approach through the creation of integrated systems for aviation security and the concept of vulnerability. The concept of vulnerability is determined by the degree of protection of transport infrastructure objects from unauthorized interference in their activities. The work proposes the airport vulnerability model as an object of transport infrastructure. The proposed methodology includes a system of views of the authors on the problem of aviation security based on the concept of vulnerability.*
KEYWORDS: *CIVIL AVIATION, TRANSPORT SECURITY, VULNERABILITY MODEL, VULNERABILITY ASSESSMENT METHODOLOGY.*

INTRODUCTION

The issues of aviation security (AS) support and the level of aviation security management are under investigation, they are solved within the framework of the validation approach and through the creation of the integrated aviation security systems. The concept of vulnerability is defined by the degree of security of transport infrastructure and transport facilities (TF) from tampering into their sphere of action. Vulnerability assessment process is supposed to have specified assessment techniques, procedures and parameters of the object. They can be implemented and obtained unless and until the object identification to which they were applied. In other words, the object needs to be investigated and structured. For this purpose, the object's technical, technological, operational characteristics, critical components, potential threats and the ways to implement them should be specified. On this basis the protection system management is developed.

VULNERABILITY MODEL AND ITS ASSESSMENT METHODS

The structural and logical basis of the airport's aviation security system is the vulnerability model (Pic.1). It is based on two models: the airline security threat models and the security model of the airport. These two models define the processes of confrontation in the aviation security system, where vulnerability is the main parameter. On the other hand, the threat model includes the intruder's model and the model of his actions, and the protection model consists of the security model of the object, protective equipment, a model of integration of the object's protective equipment and a model of problems.



Picture.1 *The question of airport vulnerability model's generation.*

There is no generally accepted methodology for assessing the vulnerability of TF today. At the same time, serious work is being done to investigate this problem.

The Markov process and chain apparatus can be used for this purpose [1,2]. Despite the seeming attraction of using Markov processes and chains to study the vulnerability of transport infrastructure and vehicles, it should be borne in mind that the process can be attributed to Markov only if it is an ordinary flow of events without aftereffect, the characteristics of which do not depend on the background, and the number of states is finite. In this case, it is very difficult to identify events in the airport's aviation security system that meet the listed requirements, which request the use of other approaches and methods of solution.

In some works [3,4,5], the concept of "vulnerability "is associated with some" weakness " of the object, allowing for the possibility of destructive effects. In relation to the civil aviation (CA) object, this "weakness" is a consequence of the presence of a certain set of factors of different physical content that contribute to the implementation of the *j*-th act of unlawful interference (AUI) in the activity of the *i*-th CA object.

The concept of "vulnerability" of an object is understood as the state of the CA object and the system for ensuring its AVSEC, allowing the possibility of committing AUI in its activities and implementing the threat of the CA object.

In symbolic form, this vulnerability definition can be written as follows:

$$f_{ij} \epsilon F \quad (1)$$

I=1,2,…I; j=1,2…J; λ=1,2,…Λ; l=1,2,…L,

where F - multiple vulnerabilities of CA objects;

u_{ije} – the potential amount of damage of the l-th type for the i-th CA object due to the implementation of the j-th AUI in its activities;

U – the set of all damage values that are characteristic of this CA object.

It follows that the vulnerability is characterized by a multipara metric dependency

$$f(t) = f\left(\Phi(t), B(t)\right) \quad (2)$$

where t is the lifetime of the CA object.

In relation to the fixed characteristics of the aviation security system of the i-th CA object as a basic quantitative indicator of vulnerability, we can consider the probability of Wi (bj) implementation of the j-th AUI in the activity of the i-th CA object in certain conditions and the vulnerability indicator

$$fij = Wi(bj) \quad (3)$$

The vulnerability assessment is based on a set of indicators that are likely in nature. Quantitative evaluation of these indicators is assumed in the framework of some simulation model. The simulation model, depending on the specific object of the CA and the system for ensuring its AS, may include a set of interrelated elements of various mathematical content: algebraic, transcendental and differential equations, models of the dynamics of averages, probabilistic models in continuous and discrete form, and models of statistical tests. The work suggests a general procedure for developing a simulation model, and this is the end of the study, which does not allow us to draw any conclusions about the possibility of practical use of this model.

Thus, the analysis of the proposed methods shows significant difficulties in their practical use for solving the problem of assessing the level of security of TF objects.

It is proposed to assess the vulnerability of TF objects using a qualimetric approach, i.e. to base the assessment on the quality category [6,7].

The airport vulnerability model, based on the principles of qualimetry, is shown in Pic. 2. The principal difference between the model and the known ones is the use of the "quality" and "risk" categories as vulnerability assessment criteria. Quality is understood as the degree to which inherent characteristics meet requirements. The concept of risk is used in the conventional sense as an assessment of the probability of event's occurrence and an assessment of the magnitude of the expected damage. There are determined the two sides of the confrontation:

1. the subject of illegal activity, which should be understood as a set of negative factors, including people, equipment, weapons, ammunition, etc., aimed at the implementation of unauthorized interference in the activities of civil aviation, including the implementation of acts of illegal interference and terrorist acts;

2. an object protection system that includes people, machinery, equipment, methods and procedures combined within an integrated aviation security system. Based on the study of these two sides, the vulnerability assessment is determined as the level of security of the object.

It is important to note two circumstances: the assessment must be obtained in a quantitative form, the vulnerability assessment is not a constant value and changes when the parameters of the parties to the counteraction change.

Therefore, it is necessary to identify not only the object of protection, but also the subject of illegal activity, i.e. it is necessary to determine the threat parameters and protection parameters. Taking into account the dynamics of threat parameters, we can talk about the corresponding dynamics of security parameters.

Hence, taking into account the dynamics of threat parameters and protection parameters, we can talk about dynamic integration, that is, such integration of aviation security tools that ensures the formation of the structure of the aviation security system that is adequate to the currently operating threat at the object.

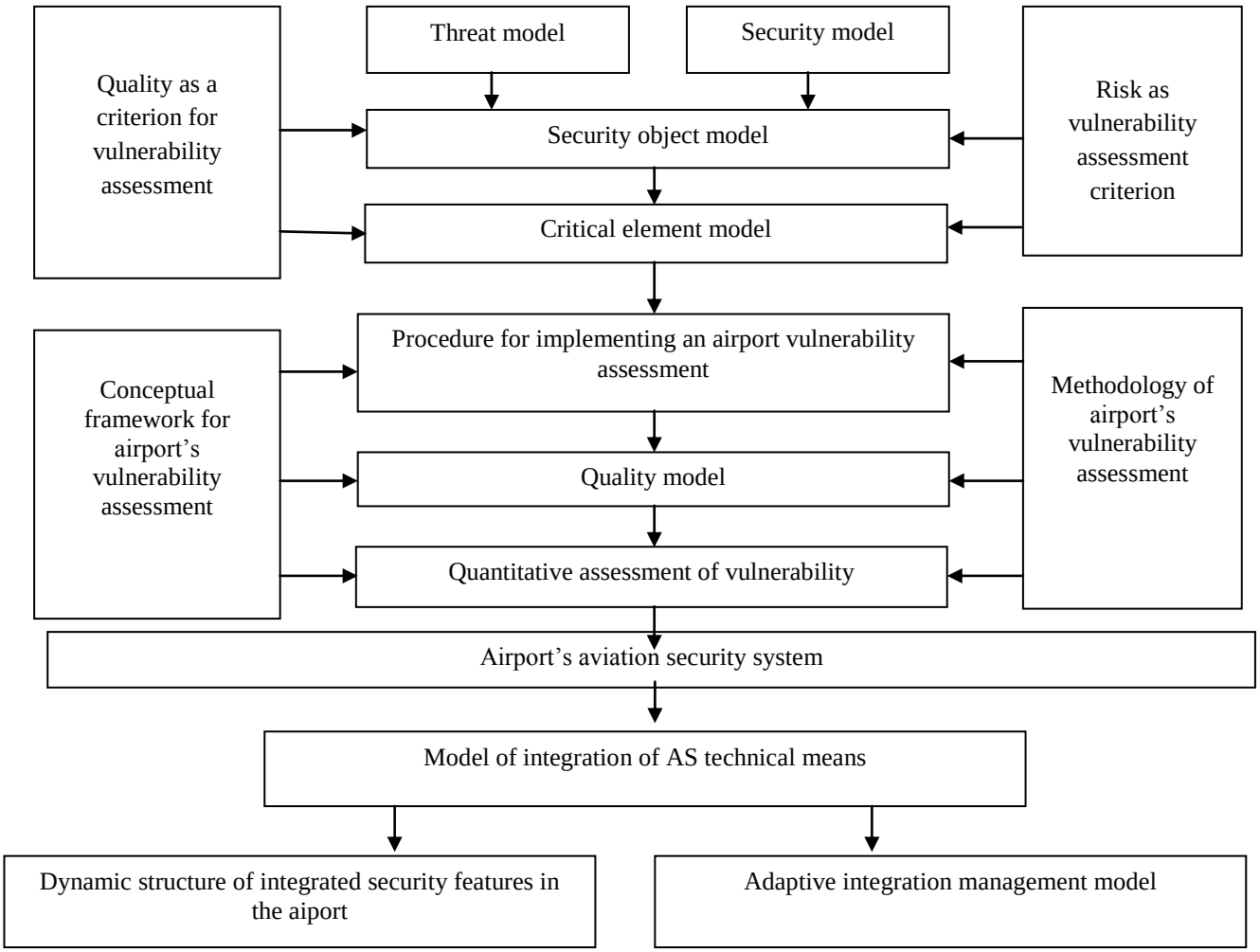
CONCLUSION

The concept of vulnerability of TF objects is based on the concept of dynamic integration of the aviation security system using the concept of vulnerability as a parameter for adaptive management of dynamic integration procedures.

Implementation of the concept involves identification of the security object in the form of a security object model and security tools in the form of a security model. On the other side of the confrontation, the subject of illegal activity is identified as the corresponding models of the intruder, the intruder's actions and threats. Based on the protection model and the threat model, the vulnerability model of the TF and the vehicles is formed.

The next aim is to select a vulnerability assessment method. The authors suggest using qualimetry methods for these purposes, since, based on the physical meaning of the concepts of vulnerability and quality and their definitions, we can talk about a sufficient degree of their coincidence.

Quantitative vulnerability assessments in the form of quality indicators can be used as integration management parameters. Using these parameters, there are implemented adaptive integration security's management system, what means there is implemented dynamic integration, correcting the structure and parameters of the AS system, which adjusts the parameters of the model of vulnerability, providing the parameters of the confrontation, adequate to the parameters of the current threats. Adaptability here should be understood as management that meets current requirements.



Picture. 2 *Airport vulnerability model.*

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