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Creation of an information system for managing the processes of testing technical systems At Military Testing Grounds

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Abstract

There are military testing grounds on the territory of the Republic of Kazakhstan (RK), which are intended not only for conducting full-scale exercises of all types of military units and other formations, but also for testing samples of weapons and military equipment. In this regard, it is necessary to substantiate the requirements and develop an interactive database, with the help of which it is possible to simulate the preliminary conduct of comprehensive studies of military equipment with further justification for improving and/or creating an analytical center for testing weapons and equipment of the Republic of Kazakhstan (ACIViT). The creation of such a center with an information management system and equipped with all the necessary technical means will provide information on a comprehensive assessment of the tactical and technical parameters and characteristics of the tested samples of military equipment in conditions close to combat and in various natural and climatic conditions.

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Key-words: information system, management, database, technical system, architecture, military test site, analysis

1. Introduction

The modern level of technological, technical and comprehensive material equipment of enterprises of the Military-Industrial complex (MIC) of any state, the availability of appropriate quality systems and certification on them, as a mandatory and necessary condition for licensing their activities in the development, production and repair of weapons and military equipment (IWT) in accordance with the requirements of the relevant GOST, formulate requirements for reliability and quality of any defense or dual-use products. In accordance with the requirements

of the "National Standards", the samples of military equipment produced at the enterprises of the Defense Industry of the Republic of Kazakhstan require obtaining a large amount of information about their use in conditions close to combat, and determining operational tactical and technical characteristics and parameters. In addition, during full-scale tests of military technical systems of the Armed Forces of the Republic of Kazakhstan (Armed Forces of the Republic of Kazakhstan), it is also required to establish their compliance with the declared samples of military equipment, which are produced at the factories of the Defense Industry of the Republic of Kazakhstan or supplied under contracts from other countries. Currently, at the stage of the creation of military technical systems, for their comprehensive testing, both the experimental and testing base of the defense industry enterprises of the developers of samples of military hardware and the technical means available for these purposes of some military test sites are mainly used [1-5].

It should be particularly noted that the main problems in the Armed Forces of the Republic of Kazakhstan affecting the provision of comprehensive tests at military ranges of developed and modernized samples of military equipment in the Armed Forces of the Republic of Kazakhstan are:

the absence of domestic hardware and software measuring systems that meet the requirements of accuracy and informativeness of the data obtained, which in their parameters and characteristics would be comparable with the best innovative foreign samples;

there is not full compliance with the required nomenclature of means of jamming complexes and means of objective control of the jamming situation, allowing to comprehensively simulate samples of weapons of a potential enemy and methods of their combat use;

Insufficient automation of the processes of management and control over the field tests;

timely improvement of innovative means of information interaction between management bodies and military testing grounds for automation of planning processes and conducting comprehensive tests of samples of military equipment;

improvement of existing and creation of domestic innovative technologies used to improve the efficiency and technical level of means to ensure comprehensive testing of samples of military equipment in the process of landfill testing.

The results of the review and analysis of the world experience in the creation of military test sites and the state of the material and technical base of the military test sites of the Republic of Kazakhstan allowed us to establish current trends in their development and improvement. In connection with the above, ATSIVIT RK is a complex organizational and technical system equipped with all the necessary means to ensure a comprehensive assessment of the tactical and technical parameters and characteristics of the tested samples of military equipment in conditions close to combat and in various natural and climatic conditions. The rationale for the

creation of ACIViT is based on the implementation of organizational transformations related to [6, 7]:

1) comprehensive integration of the experimental and testing base of the military ranges of the Armed Forces and the corresponding base of the enterprises of the Defense Industry of the Republic of Kazakhstan, which will eliminate duplication when purchasing test equipment and, thereby, reduce the cost of maintaining individual test sites;

2) the creation of several large interspecific military testing grounds with appropriate testing equipment and providing analytical processing of the data obtained during the testing of the same type of samples of military equipment of various types of armed Forces and branches of the Armed Forces of the Ministry of Defense of the Republic of Kazakhstan.

It has been established that the main problems of some military test sites are the absence of [7-10]:

• industrial power supply lines with an appropriate load;
• permanent water supply;
• buildings of the administrative and economic zone and educational facilities;
• integrated process automation (CAP) and automated control system (ACS);
• access roads;
• modern simulators and simulators in military educational institutions and training centers.

In accordance with global trends, specialized training settlements are being equipped at each military training ground in a separate direction for improving the training process of military units and training personnel in conducting combat operations in urban conditions.

So, for example, for the training and preparation of PSpN units for the implementation of peacekeeping missions abroad, work is currently underway to create a training ground, including [2, 6]:

• administrative and economic zone (headquarters, barracks, park, warehouses);
• sports and engineering towns, town of radiation, chemical and biological protection (RCBZ);
• a training complex (locality) and a training venue for classes at a checkpoint (checkpoint);
• a refugee camp and two operational base camps (peacekeeping bases);
• 3-storey academic building and 7 summer classrooms.

Based on the review and analysis of the military testing grounds of the Armed Forces of the Republic of Kazakhstan, the following characteristic features have been identified, taking into account which the classification presented in Figure 1 has been formed:

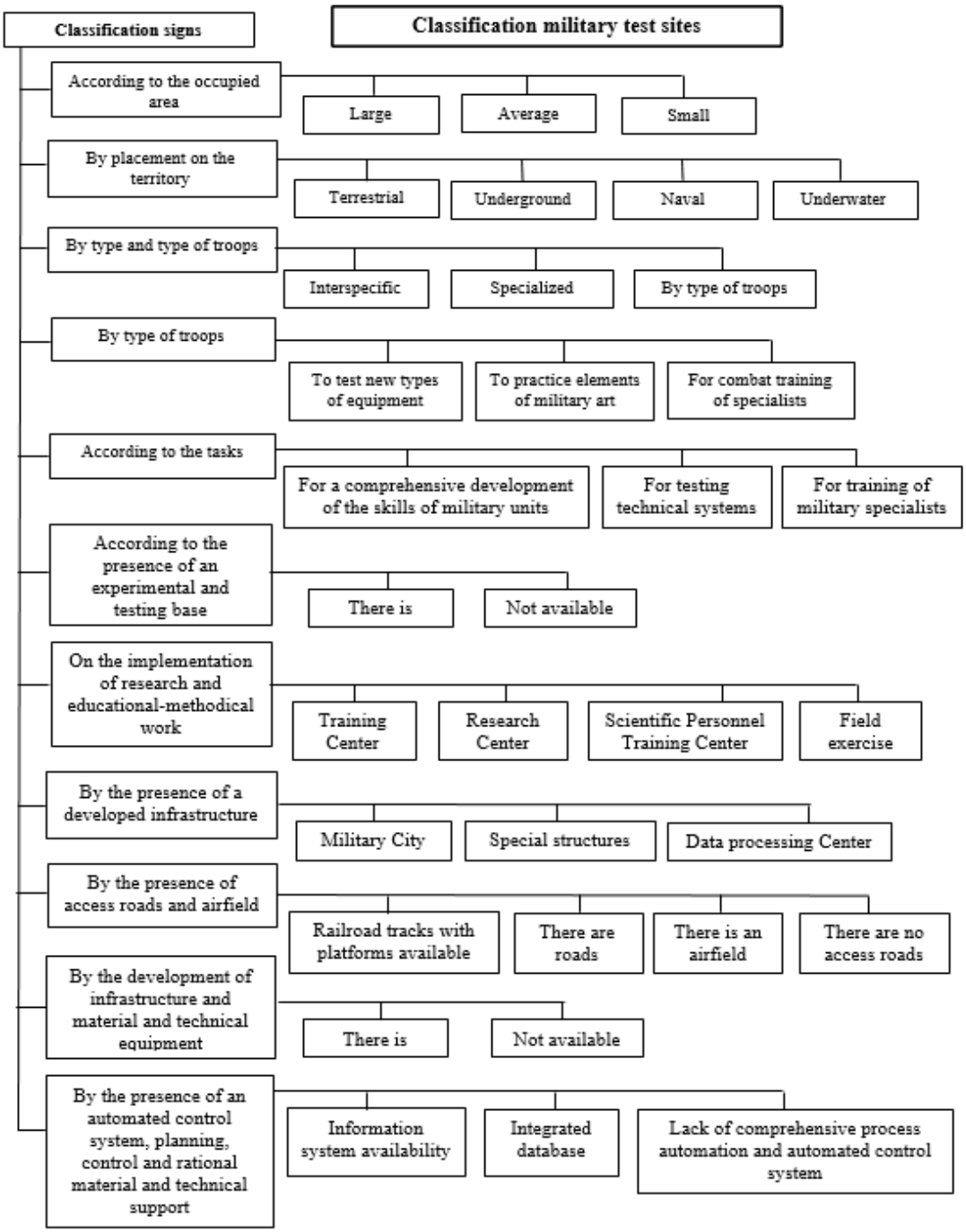

Figure 1 – Classification of characteristic features of military testing grounds of the Republic of Kazakhstan

1) by occupied area: large (from 0.5 to 10 million hectares); medium (from 200 to 500 thousand hectares); small (from 20 to 100 thousand hectares);

2) by departmental affiliation (Ground Forces, Air Defense Forces, Department of Engineering Troops, leased);

3) by territorial location and belonging to the regional command (RK): RK "Astana"; RK "East"; RK "West"; RK "South";

4) by type: specialized (for example, for testing missile weapons), interspecific (for example, for testing unified interspecific automation of command control points);

5) as intended: for testing new types of full-scale systems; operational-tactical and tactical purposes, combat training of military specialists (for example, BTT crews, for testing elements of combat operations in various types of operations, testing of military equipment in conditions close to combat);

6) according to the tasks set for the training ground: comprehensive development of skills in conditions close to real combat operations; for testing technical systems; for training military specialists, conducting exercises;

7) by the availability of an experimental and testing base and specialized equipment for conducting exercises (provision of information and computer systems for the training process, availability of modern simulators and simulators in military educational institutions and training centers);

8) by the presence of a developed infrastructure for practicing combat operations in urban conditions;

9) by the presence of access roads and an airfield: access railways with platforms for loading/unloading technical systems, a network of highways, an airfield.

10) on the development of infrastructure and material and technical equipment (availability of industrial power supply lines and permanent water supply: available, absent);

11) by the presence of shooting ranges (at 100 and 50 meters) for shooting from small arms AK-74 and PM (open, covered).

12) on the availability of integrated process automation (CAP) and automated control system (ACS), planning, control and rational logistical support for testing samples of military equipment (availability of an information system; availability of an integrated database; absence of CAP and ACS).

2. Problem statement

The main tasks of ATSIVIT of the Armed Forces of the Republic of Kazakhstan in ensuring the technological and technical processes of landfill testing of samples of military equipment are [8-10]:

• creation of a unified automated system of management, planning, control and rational logistical support of testing;

• operational control and automated analysis of the current material and technical condition of military test sites;

• selection of the most suitable military testing grounds for testing specific samples of military equipment and documentation of test results;

• economic analysis of the testing of samples of military equipment.

The provision of integrated automation of technological and technical processes of landfill testing is directly related to the deployment of automated systems at landfills capable of:

• data collection and analytical processing of all data obtained as a result of various types of tests of the IWT;

• automation of the planning of testing of military equipment with the possibility of operational management of functional complexes of the experimental testing base of the landfill;

• modeling of the processes occurring in the tested samples of military equipment, as well as combat and climatic conditions corresponding to the real conditions of their combat use;

• determination of the tactical and technical characteristics and parameters of the combat effectiveness of the tested samples of military equipment with ensuring the safety of all types of work at the landfill.

Automated complexes of technical means (ACTS) for providing landfill testing of samples of military equipment should include means:

• collection, processing, storage and timely presentation of measurement information;
• modeling, planning and control of the course of testing;
• hardware, software and analytical support for making rational decisions.

Based on the above, such ACTS should be developed taking into account the features of functional modules that have standardized information, metrological and operational characteristics that ensure system compatibility of all functional components of these complexes. When developing the ACS software, innovative methods of noise-resistant recovery and reliability control of recorded data based on the results of testing of samples of military equipment, as well as their processing and analysis of the information received should be used [7-10].

ACTS for conducting landfill tests of samples of military equipment should be created on the basis of domestic computing and telecommunications equipment, as well as on the basis of both newly developed and applied special software designed for modeling, data processing, analysis and presentation of information about the results of tests at the ranges of the Armed Forces of the Republic of Kazakhstan.

3. Processing

A review and analysis of the requirements for testing technical systems at military testing grounds of the Armed Forces of the Republic of Kazakhstan revealed the main criteria for the creation and implementation (improvement) of ACIViT, which, based on the automation of control processes, the availability of highly efficient unified means of ensuring testing on a new experimental base and using advanced innovative technologies, will create an effective system for complex automation of testing of samples of The Armed Forces of the Republic of Kazakhstan. In this case, reliable information will be provided based on the results of the assessment of the tactical and technical characteristics and indicators of the combat effectiveness of a promising military equipment in various natural and climatic conditions of the combat situation.

In the process of developing an information system, requirements relating to attributes, properties and qualities are imposed on it. At the same time, the architecture of such software should reflect the main design decisions of the software product formation, which are aimed at creating its rational system [11, 12]:

• meeting the functional requirements;
• allowing to reduce labor costs for its creation;
• ensuring its appropriate follow-up support and, if necessary, further improvement.

The information system is a web application and includes four modules:

• Module 1 - a search system for military testing grounds, defense industry plants, laboratories and centers for testing samples of military equipment according to specified criteria;
• Module 2 – an interactive database for modeling the testing of samples of military equipment at military testing grounds of the Armed Forces of the Republic of Kazakhstan;
• Module 3 is an economic module designed to determine the costs of testing samples of military equipment and improving military testing grounds, laboratories and centers for testing samples of military equipment;
• Module 4 is an electronic database that includes information on previously performed scientific research within the framework of Program and targeted funding and grant funding for projects of the Ministry of Education and Science of the Republic of Kazakhstan.

4. Theory

4.1 Modules of the information system for managing the processes of testing technical systems at military testing grounds

Let's highlight the main requirements for each component of a web application [13].

Module 1 – Polygon/Factory/Laboratory search system.

Access to the module is carried out through a special form that provides access to information only to persons who have the appropriate permission. After entering the correct credentials, the user gets to the main page. The main page is a map on which polygons, factories and laboratories on the territory of the Republic of Kazakhstan are marked with flags. By clicking on the checkbox, you can get detailed information on the landfill, plant, laboratory. Next to the map there is a cloud of tags / criteria, choosing which you can narrow the search by any required parameters, the number of polygons, factories or laboratories.

Module 2 is an interactive database for modeling the testing of samples of military equipment at military testing grounds of the Armed Forces of the Republic of Kazakhstan.

Access to the module is carried out through a special form that provides access to information only to persons who have the appropriate permission. After entering the correct credentials, the user gets to the main page. The main page is a map on which polygons, factories and laboratories on the territory of the Republic of Kazakhstan are marked with flags. The interactive database is a software product that can function independently of Uncharted Waters Online. Information on existing military test sites contained in this program is limited to data that the operator adds as they become available.

By clicking on the flag of an object, you can not only get detailed information about it, but also upload its virtual 3D model with a demonstration of its profile, natural and climatic zone and the capabilities of the material and technical base placed on it.

One of these features of the virtual 3D model of the landfill is the search for the most suitable for testing a particular type of military equipment or technical system: the software product will form a proposal in which regions of the Republic of Kazakhstan it is most rational to conduct full-scale tests. It is planned that most of the interface points of the software product will be available only to specialists responsible for making decisions about conducting tests at military testing grounds.

In order to expand the functionality of the interactive database, the most common tasks available to users responsible for the reliability of the information entered will be included in it, for example, such as:

• adding information about the testing of the IWT and changes in the material and technical base of the landfill;

• assessment of changes in the cost of various components of military equipment and consumables used in the process of testing at landfills;

• ability to select the desired map scrolling mode.

Module 3 is an economic module designed to determine the costs of testing samples of military equipment and improving military test sites. The work of this module includes the preliminary determination of the following indicators:

• timing / execution of activities (orientation in the timing of work and receipt of planned results);

• definition of a list of works with a detailed description of them, taking into account each stage of the implementation of the project stages;

• formation of a budget for testing samples of military equipment and improvement of military testing grounds;

• evaluation of the intermediate and final results of the work performed (audit of the types of work performed in accordance with the program tests of the samples of the IWT and the establishment of the obtained indicators for compliance with the requirements of the terms of reference);

• determination of the list of works with a detailed description of them, taking into account each stage of the implementation of the stages for the improvement of military test sites (cost planning for the purchase of necessary technical systems and measuring instruments for testing samples of military equipment, re-equipment and maintenance of technical systems).

Module 4 is an electronic database that includes information on previously performed scientific research within the framework of the PCF and GF on projects of the Ministry of Defense of the Republic of Kazakhstan.

4.2 Features of information system development using the framework ASP.NET MVC

Since the requirements for a web application have a significant impact on its architecture, we will use one of the modern approaches to creating applications: using the scheme of dividing the application into three components of MVC (Model - View - Controller).

The MVC design pattern involves separating application data, user interface, and control logic into three separate components: model, view, and controller. Accordingly, each component can be modified independently (see Figure 2).

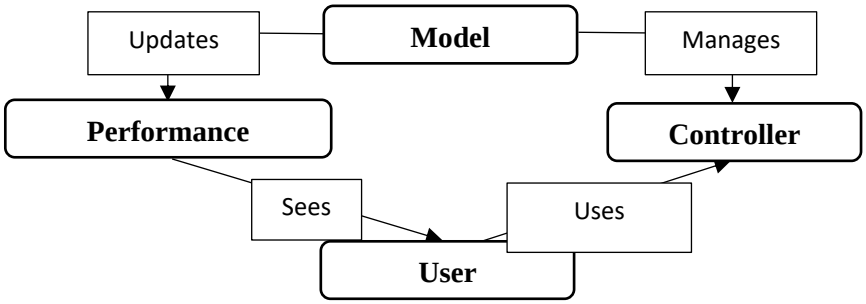

Figure 2 – The principle of functioning of MVC

Let's highlight the most general requirements for the model as a component of the web application of the information system for managing the processes of testing technical systems at military testing grounds [13-16]:

• modularity (organization of the program as a set of independent blocks);
• autonomy (independence from other structural components of the application);
• safety and reliability;
• documentation requirements (documentation of modules and developed parts of the program);
• system requirements (integrity, multiple use of data, quick search and retrieval of information, ease of updating;
• requirements for an interactive database (convenience of working with data with the possibility of their analysis, three-dimensional models of polygons and the possibility of using modes of movement and flight on them, interactive interaction with the test object and measurements with obtaining information about the object, printing the necessary information);
• data protection against unauthorized access to IP, distortion and destruction of information.

The view is responsible for displaying the data of the subject area (model) to the user, reacting to changes in the model. The representation forms the appearance of the software product being created and assumes its direct interaction with the user, has a connection with the model, requests data from it for their subsequent display [13]. The following requirements are imposed on the presentation as a component of a web application [14-16]:

• to the indicators of consistency, autonomy and purpose (performance, fault tolerance);
• to design and usability (convenience and usability, ergonomics).

The controller interprets user actions, notifying the model of the need for changes. The controller in web development is a link between the model and the view and is an action that executes a request, notifies the model, receives a response and transmits the requested data from the model to the view [13]. The requirements for the controller, as a component of a web application, are as follows [14, 15]:

• system requirements;

• modularity;
• requirements for assignment indicators.

Based on the above requirements and using the decomposition method [13] (separation of subsystems from the system under study, each of which is considered independently), at the design stage of the IC, we determine [14]:

• the necessary structural elements and interfaces of the modules from which our future system will be composed;
• the behavior of the system as a whole and its structural elements, their interaction with each other;
• possible directions for further improvement of the system (forming the property of development in it).

The main purpose of applying this concept is to separate (the model) from its visualization (representation, view). Due to this separation, the possibility of code reuse increases. The most effective application of this concept is in cases where the user needs to see the same data simultaneously in different contexts and/or from different points of view.

In this regard, the following tasks can be performed:

• several types of information representation can be attached to one model without affecting the implementation of the model as a whole. For example, some data can be presented simultaneously as a spreadsheet, a histogram, and a pie chart;
• without affecting the implementation of views, it is possible to change the reactions to user actions (mouse clicking on a button, data entry) - it is enough to use another controller for this.

The MVC Framework implements the MVC pattern and thus provides a much improved separation of concepts.:

• Model – common c# classes (or other supported programming language);
• View – active pages that include text or separated code inside, the Razor view engine, and other tools for creating views;
• Controller – classes that are descendants of the Controller class. Containing open controller methods – actions.

Before the platform appeared ASP.NET the development of web applications was implemented either by creating compiled applications or by using scripting languages. Both variants did not implement OOP (object-oriented programming), and were independent solutions unrelated to other web technologies.

The MVC Framework is integrated into a three–level architecture - a model of a software package that assumes the presence of three components in it: a client, an application server (to which the client application is connected), and a database server (with which the application server works), which simplifies the development of software packages and provides greater scalability (the ability of the system to increase the workload with increasing workload its performance) and configurability (due to the isolation of the hierarchy levels of the information system from each other) [13, 14].

The MVC design pattern involves separating application data, user interface, and control logic into three separate components: model, view, and controller. Accordingly, modification of each component can be carried out independently [6, 7].

5. Results discussion

5.1 Features of the architecture of the information system for managing the processes of testing technical systems at military testing grounds

Any architecture of an information system is a concept that defines the model, structure, functions performed and the relationship of its components to each other [16-20]. The components of the IC according to the functions performed can be divided into three components:

• presentation logic (user interaction);
• business logic (rules, algorithms, data processing rules);
• database logic (storage, selection, modification and deletion of application data).

In accordance with the developed information system in the form of a web application, which includes four modules, the general view of the architecture is presented in the following form (see Figure 3).

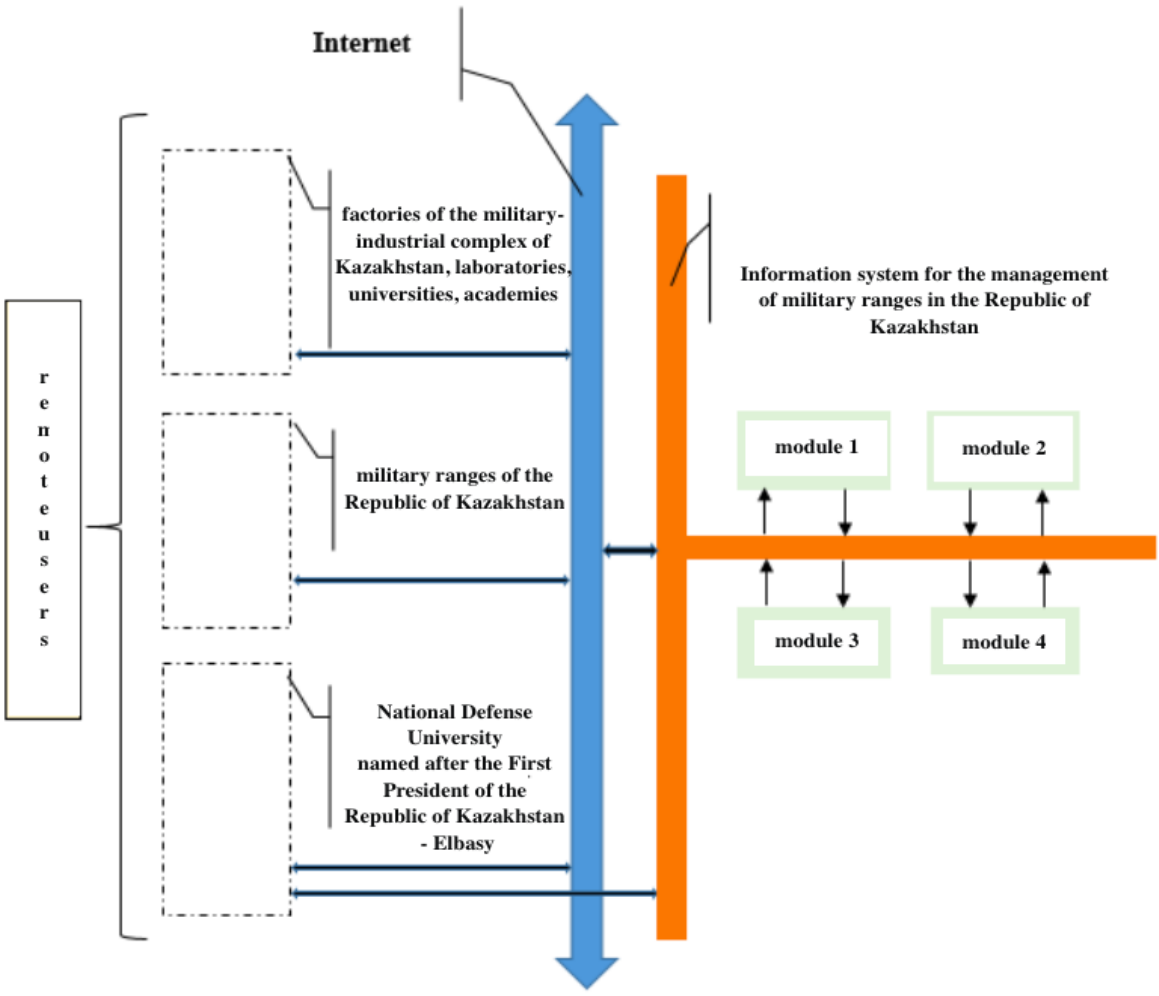

Figure 3 – Architecture of interaction of the system "Remote users – Internet – information management system of military ranges of the Armed Forces of the Republic of Kazakhstan (web application)

In our case, the architecture of the interaction of the components of the MVC template with the domain database is formed in the form shown in Figure 6.

Its implementation using the MVC framework can be conditionally divided into the following stages:

Development of models for working with data, creation of a database (user model (necessary for registering new users); map model (necessary for displaying, editing and storing information; separation of user roles, etc.);• creation of controllers providing the functionality of models (user authorization, editing and output of materials stored in the database, creation of data output filters, user redirection, etc.);

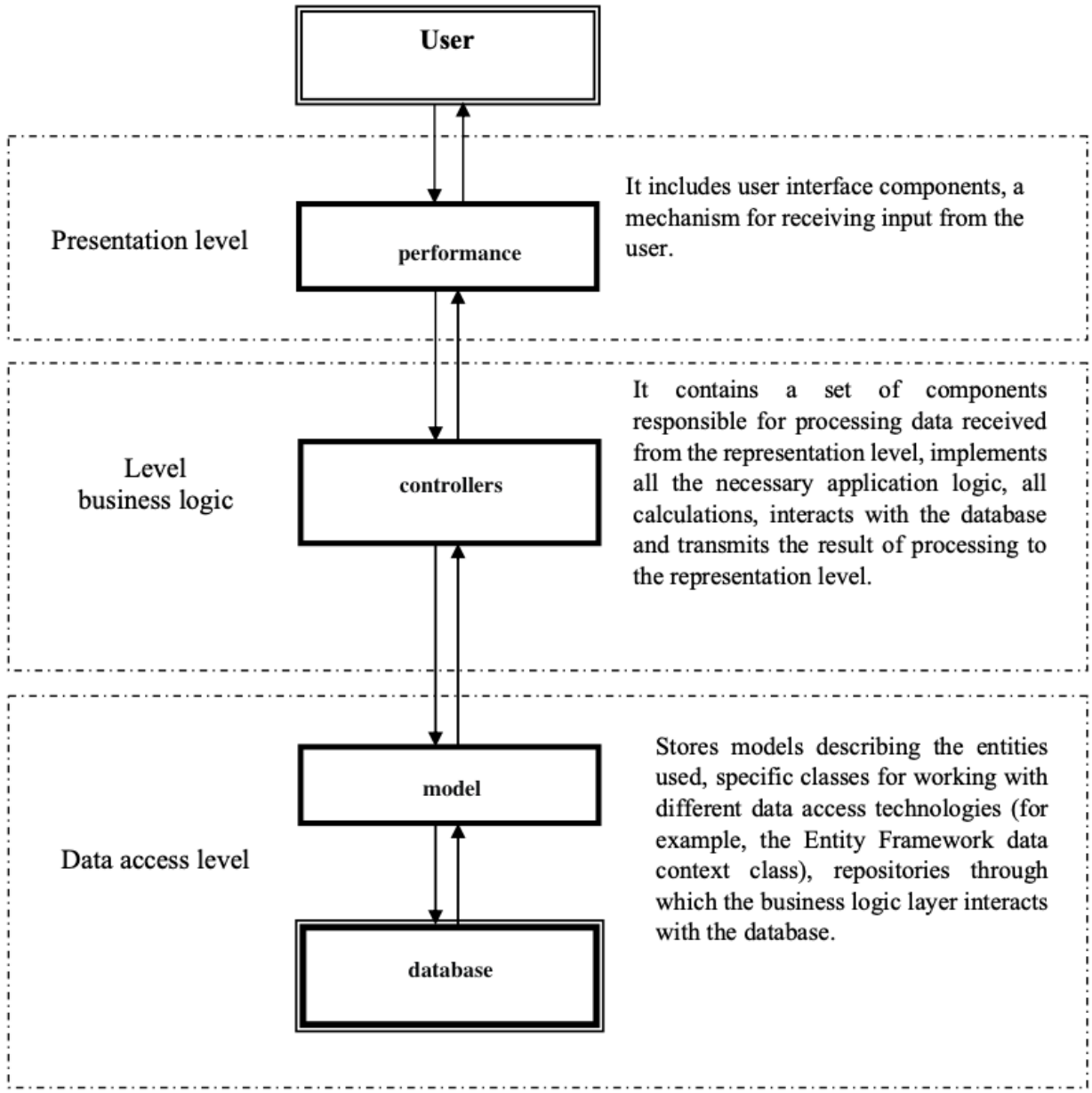

Figure 4 - Architecture of interaction of the main components of the MVC template with the domain database

Formation of external representations of the model to the user (html pages that provide data output, as well as their input by the user; creation of partial representations (partial representations are used to embed them in other conventional representations), etc.).

6. Conclusions

The analysis of the existing modern testing centers of weapons and military equipment and training of military specialists established in the Republic of Kazakhstan allowed to identify their main classification features, on the basis of which the classification of military testing grounds was developed.

This analysis will serve as the basis for the development of a model of a military testing ground for weapons and equipment on the territory of the Republic of Kazakhstan using innovative methods for testing reliability during operation of military technical systems and resistance to external factors in conditions close to combat, which will eliminate losses associated with the release of low-quality military products, will ensure technical control of its quality, will allow to test not only new technical systems coming from factories, but even after performing medium or major repairs with them.

The identified requirements for conducting comprehensive tests of military equipment are the initial data for the implementation of the process of developing and improving military test sites of military equipment on the territory of the Republic of Kazakhstan and the creation of ATSIVIT, which will eliminate losses associated with the production of low-quality military products, will ensure technical control of its quality, will allow testing not only new military technical systems coming from factories, but also and after performing medium or major repairs on them.

The structure of the information system has been formed, which includes four modules that allow the selection of the most preferred polygons with their material base, ensuring the required tests of the IWT, the formation of a database of completed reports and the preliminary determination of the costs of conducting the tests of the IWT:

Module 1 – Polygon/Factory/Laboratory search system.

Module 2 is an interactive database for modeling the testing of samples of military equipment at military testing grounds of the Armed Forces of the Republic of Kazakhstan.

Module 3 is an economic module designed to determine the costs of testing samples of military equipment and improving military test sites.

Module 4 is an electronic database that includes information on previously performed scientific research within the framework of the PCF and GF on projects of the Ministry of Defense of the Republic of Kazakhstan.

The architecture and a variant of the web application model of the information system of the military testing grounds of the military industrial complex in the territory of the Republic of Kazakhstan in c# have been developed, which is one of the possible solutions that a developer may encounter when using the MVC framework, and which clearly shows how the model, controller and representation are created, as well as how they interact with each other

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