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INFORMATION AND ANALYTICAL COMPONENTS IN MODERN APPLICATIONS

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The potential of an information system is determined by a combination of the information and economic-mathematical models implemented in it. These models serve as a basis for the information and analytical components. They fulfill various functions: the information component corresponds to the information content and access to data, while the combination of economic-mathematical models of the analytical component determines the intelligence of the data processing. With the development of distributed systems and cloud technologies, the need arises to examine the two components separately. The need to distinguish these two components arises especially acutely in large-scale projects such as the creation of a government infrastructure. Under the conditions of industrial data delivery, when the majority of the participants in an economic activity are acting in the role of producers and consumers of information, standardization of how the data are presented and of the methods of processing them becomes essential. This article handles the two components of an information system as two independent subsystems, the separate stages of creating models are described, and the logic of their interaction in the system is shown. The interrelationship of the components is presented in the form of a reflection of the separate activity logic elements on the information level and further on the program level, as well as the feedback from the applications onto the information and logic of the activity. The description of the components is focused on subject matter experts whose role is growing at the present level of informatization. Most local and simple elements of activity have passed the stage of primary informatization and the task of establishing interaction among the systems and integrating them is becoming urgent. These tasks require a deep understanding of the subject domain in order to embody them in integrational information systems. The training of economic-mathematical and cybernetics specialists is frequently limited by the disciplines of economic-mathematical modeling without proper presentation of these models in information models and applications.

Keywords: information modeling; economic-mathematical modeling; transaction systems; integration systems; methods of data processing; methods of data integration

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ИНФОРМАЦИОННАЯ И АНАЛИТИЧЕСКАЯ КОМПОНЕНТА В СОВРЕМЕННЫХ ПРИЛОЖЕНИЯХ

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Потенциал информационной системы опеделяется совокупностью реализованных в ней информационных и экономико-математических моделей. Эти модели служат основой для информационной и аналитической компонент. Они выполняют разные функции: информационная компонента отвечает за информационное наполнение, доступность данных, а совокупность экономико-математических моделей аналитической компоненты определяет интеллектуальность обработки данных. С развитием распределенных систем, облачных технологий возникает необходимость рассматривать две компоненты отдельно. Особенно остро необходимость разделения двух компонент возникает в масштабных проектах, таких как создание инфраструктуры электронного правительства. В условиях индустриальной поставки данных, когда большинство участников экономической деятельности выступают в роли производителей и потребителей информации, необходимым становится стандартизация представления данных и методов их обработки. Мы две компоненты информационной системы рассмотриваем как две независимые подсистемы с описанием отдельных этапов создания моделей и показом логики их взаимодействия в системе. Соотношение компонент представлено в форме отражения отдельных элементов логики деятельности на информационный и далее на программный слой, а также обратной связи от приложения на информацию и логику деятельности. Описание компонент ориентировано на экспертов предметной области, роль которых на современном уровне информатизации возрастает. Большинство локальных и простых элементов деятельности прошли стадию первичной информатизации, и становится актуальной задача установления взаимодействия между системами, их интеграции. Эти задачи требуют глубокого понимания предметной области для воплощения в интеграционных информационных системах. Зачастую подготовка специалистов экономико-математической, кибернетической направленности ограничивается дисциплинами экономико-математического моделирования без надлежащего представления этих моделей в информационных моделях и приложениях.

Ключевые слова: информационное моделирование; экономико-математическое моделирование; транзакционные системы; интеграционные системы; методы обработки данных; методы интеграции данных

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Introduction. With the development of information technologies, economic-mathematical modeling is acquiring additional possibilities for applying models to real data. Data providers have accumulated huge volumes of information in various fields of economic activity. Using economic-mathematical models on real data assumes building applications that process real-time data and historical data supplied.

The analytical and information components are two of the fundamental subsystems of an application which are not often considered separately from each other in the literature. GOST 34 (Rosstandart 1990) provides for separate description of information and mathematical software, but it contains only the most general technological features.

The purpose of this article is to present separately the two components of information systems, information and analytical. In describing the information component, a division of information models into transactional and integrational is presented, and a brief description of each of the categories is given. The analytical processing section includes a categorization of data processing methods. The final section shows the interaction of the information and analytical components.

The applied aspect of statements described in the article consists of their application in implementing large-scale models and constructing distributed systems such as the model of interagency interaction laid out in the work «An Information Model of Interagency Communication Based on Distributed Data Storage» (Lipuntsov, 2016).

The infrastructure of the electronic government (e-government) assumes creating an information and computer parts of the infrastructure. The complexity and dynamics of automated activity must include solutions of various forms, a large portion of which are found in the distributed environment. Therefore, standardization of methods and models for integration of both data and computer models is required.

Creation of an economic-mathematical model that operates on real data includes three elements: the economic-mathematical model, the information model, and the application. Each of the three elements has its own levels of abstraction, its own set of models, and interrelationship of abstract with applied models is based on various principles. Several models can be built on each level, in order to describe the system from different points of view and to present its complexity. The levels of abstraction allow to determine the models' boundaries, show their connection, and describe its nature.

An application and information and economic-mathematical models can have different levels of development. One of the variations for presenting a level of development is the V diagram which reflects the sequence of stages in the form of enlarged sections: *decomposition and implementation* of components and *integration* of components into a system. The creation of the information system as a whole as well as its separate elements, the information and the economic-mathematical model, can be described in the form of a V-diagram.

I. The stages in developing an information system. Let us examine the sequence of creating a large-scale information system that unites several lower-level systems. The creation of the system is initiated by a client who has certain expectations. **Decomposition:** the expectations are worked out in detail in the form of requirements; the requirements are the fundamental tasks for creating the components. Contractors create the separate components, which are then integrated into a full-fledged system.

The information system being created will function in the operational environment and have an effect on several communities. The term communities here means teams of specialists working on various levels of management or in contiguous subject domains that fall within the boundaries of the project. Each of the communities forms its own view of the system, attitude and expectations, however, all of the communities will have to interact with regard to that system. Having various views, the communities can use different terms to designate the same objects, or can construe the same terms differently. Therefore, a necessary element in creating an information system is *documentation,* which is accompanied by a schematic reflection of the processes of activity, data collection and processing, and a description of the services to be implemented. This includes information models on the conceptual and logistical level; the technological solutions and interfaces of the interactions of the components are also determined here. At this stage, the system requirements are transmitted to requirements for its separate components.

After all the details of the components have been determined, the stage of implementation follows. The separate elementary components are created first, and then they are integrated into the system's modules. At the stage of implementation, the logic of real-world activity is embodied in the components of the information system and is implemented in data models or in application code. **Development** of the components of an information system depends, on the one hand, on the data model that has been designated to deliver data; and on the other hand, on the economic-mathematical model. The economic-mathematical models presented in the form of an algorithmic description are converted into data processing procedures. The set of stages for information system processing in the form of a V-diagram is shown in Fig. 1.

Integration of the components in the system requires constant verification and validation. *Verification* compares the components being created with the requirements and standards, while *validation* checks the extent to which the system being created meets the requirements of the end users and corresponds to the extent to which the right system is being created.

Verification of the individual components entails *tracing* the component requirements with technical requirements and tracing the system requirements with the expectations of the end users. This is reflected by the horizontal lines in the diagram. The inclined lines reflect the connection of the system-level requirements with the requirements for separate components, as well as the set of tests that can verify the system and its components.

II. Information models. The basic purpose of the information model is to reflect the subject domain in the data layer. The stages in creating an information model in the shape of a V-diagram are described in (Lipuntsov, 2015). Let us focus here on a brief categorization of information models.

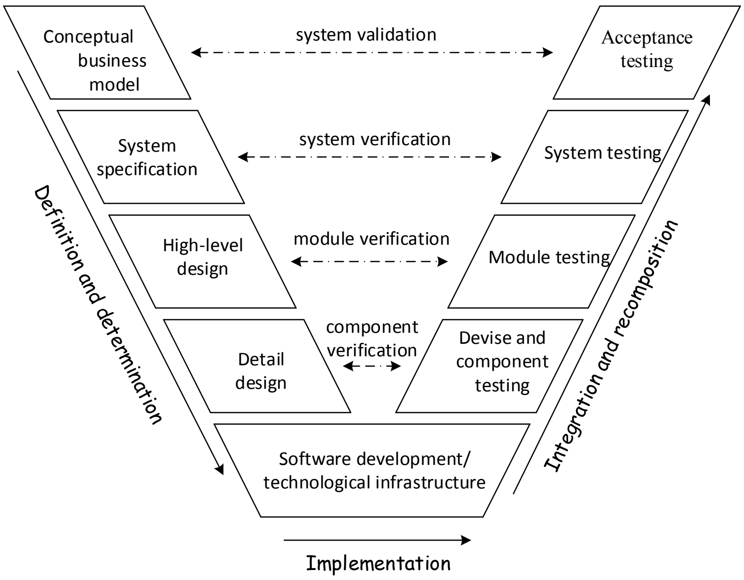

Fig. 1. V-diagram for developing an information system. Source (Shamieh, 2014)

Information models can be divided into two categories based on type: information models of transaction systems, and information models of integration systems. Such a classification corresponds to the following categories of information systems described in (Landon, 1988): transaction information systems (IS), management IS, decision-making support systems, and IS for top management. Elementary actions are fixed in the transactional systems, while data integration and data processing is carried out in higher-level information systems. The higher the level of the system, the more complex are the models for integration and processing.

Information models of data integration. Let us first examine the models for integration, and then we will briefly dwell on the principles for creating models of those transaction systems. The models for data integrating may be roughly divided into two classes: a hypercube, or the Data Vault model (Inmon et al., 2014) which is based on a graph of basic entities and connections between them.

The hypercube consists of a multidimensional generalization of two- and three-dimensional tables for multidimensional data sets, with the presumption that data may have an arbitrary number of dimensions. For example, calculation of financial data in a company is possible by product, time periods, regions, etc. Sales, profit, expenditures, budget, prognosis, and other indicators will appear as cells in the cube. Data in the hypercube is stored in the form of a star or snowflake network. The values are located in a central table of facts, while a description of various measurements is given in the form of references.

In contrast to the hypercube, the Data Vault allows to store data coming from various local systems with tracking of the history of their changes. This is achieved by a two-level storage structure: on one level the basic components and the connections between them are presented, while data storage is managed on the second level. Such a storage model allows not only to look through current and historical data, but also to ensure expandability of the model and its resistivity.

The ontology of the subject domain is a basis for creating a data model for this type of repository. One of the variants of the methodology for composing the ontology for a data repository of this type is described in the author's work «The Principles of Creating an Ontology for a Data Repository. The Example of 'Higher Education'» (Lipuntsov, 2016). The methodology includes a separation of all entities into primary and derivative. Each of the entities has a content key; the key for the derivative entities is formed as their composition, which allows to create transaction keys in terms of the primary entities.

The information model of a distributed system can be implemented in the form of a federation, in which case a system for exchanging messages of standardized data is implemented in the center. A second variation is organizing a data repository into which data from local systems are loaded. As a rule, most large-scale corporate systems, such as bank systems, use as data repository variants.

Information models of transactional systems

Let us discuss briefly the information models of transactional systems. Six perspectives can be separated out in the models of these transactional systems (Hay, 2006):

- basic information objects,
- transactions,
- roles,
- time,
- location,
- motive.

Basic information objects and transactions are the most important from the above-mentioned three perspectives in reflecting the activity and subsequent integration of data. The roles represent a transformation of the organizational structure and are intended to provide the authority for working with data in local systems. The space-time extent is presented either in the form of regulatory and reference information, for example in the form of an address system, or in the form of transaction characteristics. The motive is the result of connecting an organization's goals with processing the data of an operational activity.

The separation of perspectives and standardization of the format for presenting basic objects and transactions in transactional systems is an important strand to which attention should be dedicated when developing systems. This will allow to create templates for data models in subject domains and will facilitate integration.

The principle of separating the integrational component from the transactional is important from the perspective of the information model. Most projects for data integration, including those on the governmental level (Fowler J., 1999), use an integration platform for implementing the transactional services of e-government. These two areas are spaced apart in the model according to (Lipuntsov, 2016). The integration platform is intended for gathering data from transactional systems. The platform prepares the data for downloading to the repository, historical or noncurrent data are marked, and all transactions are carried out by external systems. In addition, transactions not implemented in the external systems are reproduced in supplementary applications. The architecture, including the transactional and integrational parts, makes the information model transparent and allows to implement the complex activity logic without any conflicts.

Concluding the description of the information component, it should be noted that efforts should be made within the framework of the information infrastructure of e-government to create an environment that makes it easy to obtain data from various sources of the external environment and integrate them with the native data for joint processing.

Fig. 2 show a conventional operating diagram with the data sets describing the connection of data sets from three sources and the result of integrating them is presented as one combined data set ready for analytical processing. Operations with data used in the IBM Mashup Center v3.0 application were used in Fig. 2.

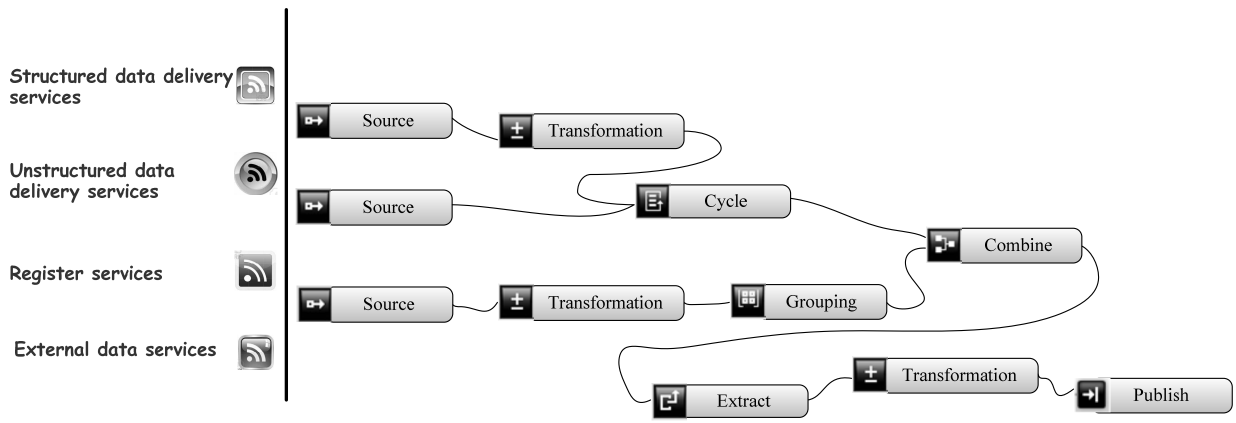

Fig. 2. Diagram of mashup application

III. Economic-mathematical models of analytical components. The ability of an organization to adapt effectively to changes is the key factor in success in the quickly changing economic environment. "Smart software", with which a company or institution will be able to work out new models of activity, is a tool that allows timely reaction to changes. Development of an analytical component is based on information systems which are developyd taking into account the goals of the company or institution.

Let us examine the analytical IS component from this point of view, the creation of which can be considered as a consequence of models of various levels of abstraction from the general systems theory (Mesarovich et al., 1978). In systems theory, the following levels of abstraction are considered: linguistic, theoretical-multiple, abstract-algebraic, topological, logical-mathematical, theoretical-informational, dynamic, and heuristic. The first five model categories describe movement from the general to the particular.

Models of the *linguistic* system level determine the totality of objects under study and the relationship between them, as well as the boundaries of the project. A macroeconomic model at this level of abstraction includes such objects as the government, a firm, household, market of goods and services, financial markets, etc. The relationships among the objects are described by the such terms as income, taxes, consumption, savings, etc. Such models are built both for the macro and micro levels (Gracheva et al., 2013).

The *theoretical-multiple* level of abstraction encompasses the ability to describe the hierarchy of a subject domain. A set of indicators is an example from macroeconomics: gross domestic product, net domestic product, national income, etc. The hierarchy of indicators on the micro level includes concepts such as income – expenses – profit – distribution into dividends, etc.

On the next level of detailing, abstract-algebraic, the system is described through functions, parameters, and other artefacts. Examples of such models are production functions, models of national income distribution by production factors, etc. Apart from the models themselves, the mathematical apparatus of data processing is described. Mathematical models may be considered in the context of the information system developed as a kind of models in which the legend, the description of the notations and mathematical symbols used represents an informal ontology of the modeled subject domain. In this ontology, the connections determined by the resources of the mathematical language are used. The form in which the ontology is presented is determined by the mathematical modeling apparatus used: linear algebra, differential or integral equations, matrix game theory, linear and nonlinear programming, infinite game theory, and other methods (Allen, 1963), (Carlin, 1964). In addition, econometric methods that study the properties of estimates and tests are used.

Topological models consider the location of economic subjects in space. Examples of topological tasks include models of the "linear city" and the "round city", i.e., models of spatial differentiation of the market "in a line" and "in a circle".

Data processing using the mathematical apparatus is considered on the *logical-mathematical level.* Tasks involving financial planning, management of material resources, purchasing, sales, orders from consumers, etc., are solved on the level of enterprises. To implement such tasks, algorithms capable of taking specific problems into account are used (Kogalovskiy, 2002), including the simplex method, transportation tasks, problems from graph theory and network optimization, etc.

The description of the automation functioning including the representation of incoming and outgoing signals, state of the system, and its transition function may be considered one of the variants of the model on this level.

The economic-mathematical model in the form of an algorithmic description is **implemented** in the form of program components at the stage of *theoretical-information models.*

The object approach is often used for algorithmic data processing; the task of this stage is reduced to connecting the entities of the data model with the object model. Various tools of the ORM (Object Relational Mapping) class may be used for this, such as Hibernate and ADO.NET Entity Framework. As an alternative option, a resource description in the Recourse Definition Framework (RDF) format may be considered.

Application of data processing methods in an information system is predetermined by the degree of environment control. Delivery of all required data is possible within a controllable environment.

Methods of simulation modeling are used in a semicontrollable or uncontrollable environment.

In a controllable environment, problems of operational activity and planning are solved in the framework of one organization; in a manufacturing enterprise the problem is control of resources. Higher-level problems include prediction and assessment of production capabilities, bookkeeping tasks, staff management, and others. An expansion of this ideology is including suppliers and consumers into the activity process. Similar processes exist in government agencies, where the production process is replaced by the development of management decisions and the logistics of material flows is represented as a rule by the movement of various types of documents.

The methods for solving these problems can include modern modifications of econometric methods that are oriented at industrial supply of data, describing processes with a large number of characteristics and allowing implementation of topological and logical-mathematical models.

The next step in the development of numerical models are simulation models which reproduce a change in the system over time. Three types of simulation models are distinguished: event models, agent models, and system dynamics models. *Event models* implement the discrete-event approach describing an activity as a discrete sequence of events over time (discrete-event simulation, DES). An extension of this model is modeling the actions performed on a schedule.

The parameters for simulation models can be presented on the basis of econometric assessments, while the information systems of enterprises can serve as the suppliers of data (Moon, 2005). Smart devices possessing intelligence are becoming a substantial portion of information systems: signals from sensors and processing of data from knowledge bases allow smart devices to make decisions, adapt to the environment, etc.

Agent modeling is a more complex variation of simulation modeling which considers actions of autonomous, decentralized agents (Makarov et al., 2013). The behavior of the agents is modeled by applying methods of game theory, the theory of complex systems and their emergence, mathematical sociology, and a number of other methods.

A higher level of system integration is implemented by the methods of *system dynamics* and is used primarily for problems of the strategic level. System dynamics is the methodology and technique of mathematical modeling for constructing top-level models.

The final level for describing systems is the set of *heuristic* models. These models are created for making managerial decisions in systems where human beings act as structural components. Formalized models are created on this level for making managerial decisions that include such elements of human activity as creative and unconscious thinking. The methods of that level of abstraction are knowledge management, expertise, expert assessments, training, gaining experience, etc.

The sequence of economic-mathematical models of the abstract level and their implementation and integration are shown in Fig. 3 in the form of a V-diagram. The growth of information assets promotes transferring more and more abstract models into the class of numerical ones.

Analytical services in the corporate sector are implemented in ERP-class systems and the theory of data supply from local systems to the discrete-event model and the process-simulation models is worked out (Robertson, 2002).

IV. Implementation of the information model and the economic-mathematical model in application. Economic-mathematical and information models find their embodiment in life in information systems. The models can be of two types: abstract or practical. Abstract models help form system perception, while practical ones help detect transactions, simulate reality, and predict the behavior of a system. To transfer economic-mathematical models to the class of applied models, industrial supply of data based on information models is required, as well as adaptation of data-processing methods.

The translation of activity in an information model and data processing procedures are shown in Fig. 4 presenting the basic layers of the architecture of a transactional system. An activity described by using the organizational structure and processes reproduces the logic of the activity. The processes are divided into two categories, operational and managerial activities, which are carried out by separate elements of the organizational structure. Managerial activities are presented in more detail in the integrational component.

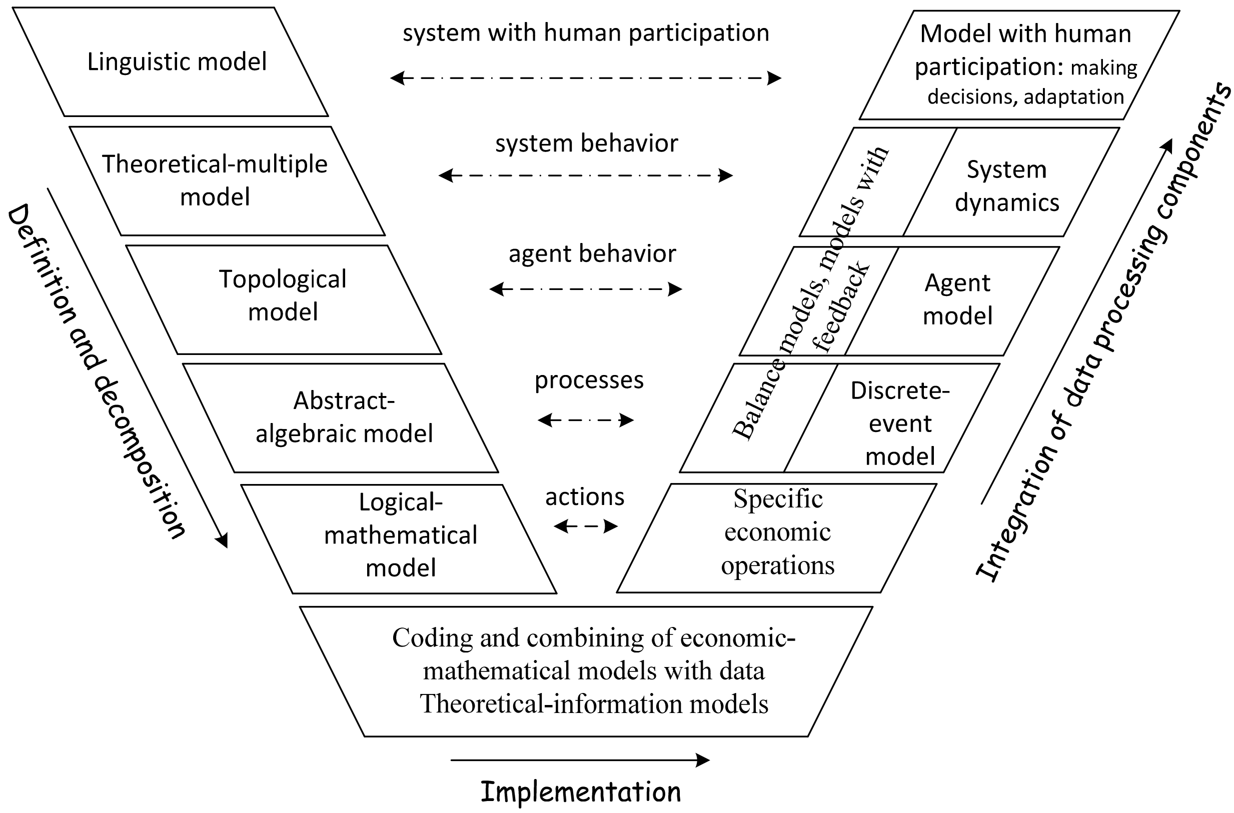

Fig. 3. V-diagram of economic-mathematical modeling

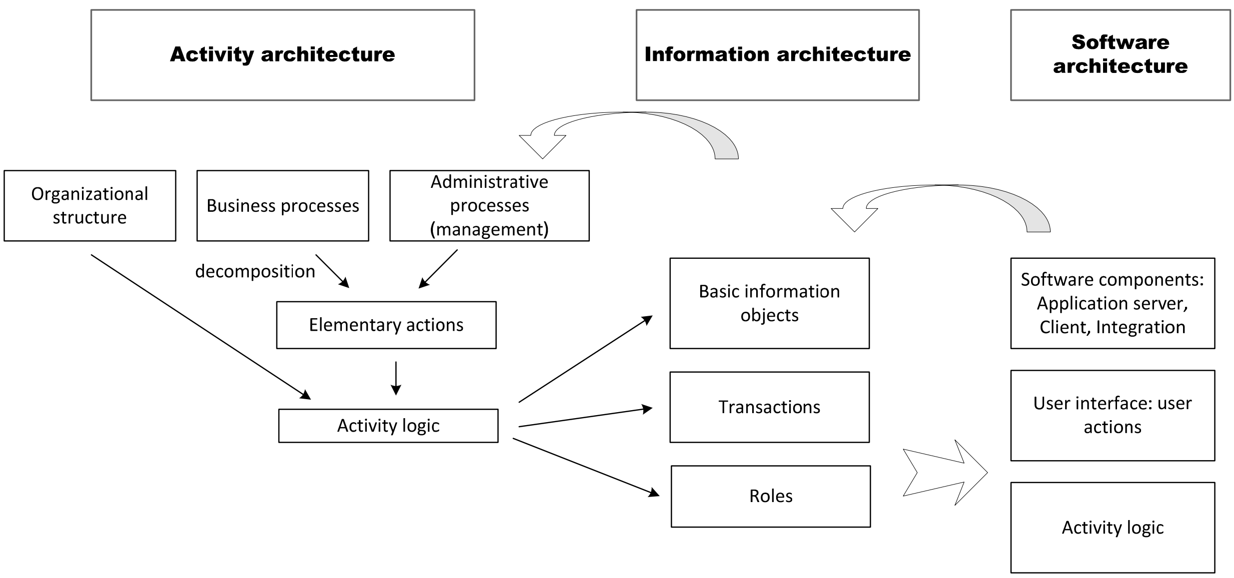

Fig. 4. Basic components by architecture layers

The information layer is represented by the basic information objects and transactions reflecting the transformation of basic objects. The organizational structure of a real-world enterprise is transformed into a set of roles in an information system.

The software layer is aimed at organizing a set of interfaces for interactions with users, and at implementing separate elements of activity logic that were not reflected in the data model. Human-machine interfaces are shown as a separate element of the layer allowing to enter new data and edit existing data.

Integrational systems constitute a second class of systems. Let us examine an integration model using the example of the information model of interagency interaction (Lipuntsov, 2016), entailing the arrangement of the interagency interaction through a data core. The data core represents a three-layer structure: the general core, the subject domain core, and the object-oriented portion of the core. The layers are able to interact by using the model of inter-level connections. The application of this model for collecting and analyzing data in the stock market is described in the article (Lipuntsov, 2016). The analysis of stock data assumes that information is available from various sources: tax agencies, statistics agencies, the national accounting depository, stock exchanges, and other sources.

In the information infrastructure of e-government, integrational systems are an element for presenting data and the technologies of analysis. Integration of governmental data is a necessary solution for satisfying the information demands of interdepartmental processes from various state and corporate systems. The structure of the basic elements of the integrational platform of the infrastructure of the e-goverment of the Russian Federation is shown in Fig. 5.

The diagram shows the supply of data from governmental and commercial information systems. The current data of the universal core and of subject domains are generated based on the information supplied. These two core layers serve as the basis for generating the object-oriented core portion aimed at supplying information for the operational activity.

The second equally important task of the integration platform is supplying data for management purposes. Data marts and the results of data mining act as the data suppliers in this case, and all three core layers serve as data sources. This portion is where the economic-mathematical models embodied in the analytical component are implemented. The simulation models, which assume modeling the behavior of separate system elements or the system as a whole, are located in a separate module.

A decision support platform of data integration and analytical processing makes it simpler to conduct analysis and publish the results, and offers new analytical opportunities and facilitates data exchange.

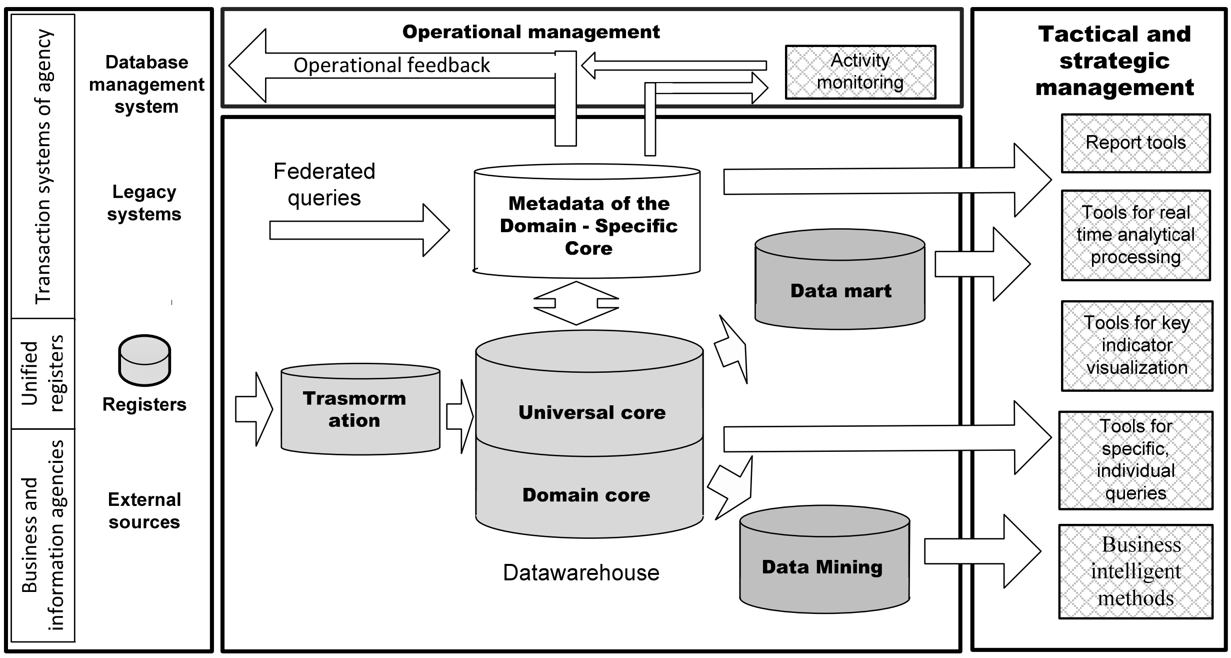

Fig. 5. Framework model of the structure and information flows of a platform for government data integration

Large-scale data integration models have already been implemented in various branches of the commercial sector. As an example of a large-scale integration system, we can look at the Global Distribution System (GDS) (Travel technology, 2016). The GDS consists of a network for booking airline tickets, hotel rooms, car rentals, and other tourist services. From the technical point of view, it is a collection of interconnected portals of travel agencies, internet booking sites, and major corporate systems. The basic suppliers of services for the ultimate clients are travel agencies integrating data from the systems for booking airline tickets, hotels, and cars. The GDS system is built on the basis of corporate systems such as Amadeus, Galileo, Sabre, and Worldspan (Ian Clayton, 2016). They belong to joint ventures of airline companies, car rental companies, and hotel groups.

If we look at the history of GDS development, a predecessor version was the Pegasus information system, in which initially all data were entered manually. Using a large number of employees occupied with data entry, the system had to be operated in India. The data entry process was labor-intensive and error-prone.

After the GDS information system was created, it became substantially faster to perform transactions. However, the process of launching and fine-tuning the GDS was not simple since all the corporate systems that needed to be connected were different. The need for standardization arose; protocols and standards were worked out. The corporate systems contained very rigid business rules which did not always allow the use of standards. Information transmitted to corporate systems should be accurate and correspond to rules of implemented business logic. Even years after the GDS has been launched, errors cropped up that could lead to a simple quotation marks resulting in system failure with catastrophic consequences and damaging of data integrity.

Currently, most travel services are purchased electronically, including in the form of a package of consolidated services in the three travel sectors: booking airline tickets, booking hotels, and car rental. In parallel with development of the GDS, corporate systems rendering similar services without intermediaries underwent improvements.

However, let us return to the infrastructure of the e-government of the Russian Federation. If we examine the infrastructure services from the point of view of GDS development stages, then the multifunctional centers (MFCs) correspond to the transitional stage of development. The MFC currently performs the functions of data entry, obtaining electronic data and transforming them to print form, transmission of data from system to system, and other functions. An extended version of the MFCs should include standardization of data by subject domains, typification of processes, and the use of the developed standards in departmental systems. In order to obtain government services at a level comparable to the current development of services for purchasing tickets and booking hotels, much work remains to be done, especially in the field of standardization of information turnover.

Basic registers should become a separate element of the infrastructure of the electronic government of the Russian Federation being created. In the GDS, the primary element of the system framework is the Passenger Name Record (PNR). In the model of interdepartmental interaction, a general core and a subject domain core are used as such framework, while the object-oriented domain of services is built using the federal principle.

The federal model was adopted as the primary model for organizing interagency cooperation in Decree No. 487 dated June 1, 2016 issued by the Russian Government (Government of the RF, 2016). As international experience including the above-mentioned GDS shows, the federal model should rely on the mainframes that are the suppliers of operational data. In the case of electronic government, which is functionally far more diverse than ticket purchasing, a format combining a data repository, federal rules for working with local systems would be a more appropriate variation.

Conclusions. Creating an application entails implementing an information model reflecting the logic of activity and determines the content of accessible data and economic-mathematical models that predetermine the intelligence of an information system and the level of data processing.

Such a division is important for large-scale projects, the information and analytical components of which are located in a distributed environment. Division into information and analytical models will allow to work out an ideology for creating construction kits for data collection and integration on the one hand, and, on the other hand, for implementing methods for analytical processing of these data. This is a large-scale task which should be solved for creating an e-government's information-analytical infrastructure. A construction kit is necessary for the end user (a civil servant, a citizen, or an employee of a commercial company), allowing to generate the required data set independently, and also to determine the data processing methods. Formulating the problem in this way entails the submission of the information-analytical infrastructure of the e-government as a set of information and analytical components. The configuration of modern applications should assume the addition of components that allow to obtain data from the external environment, as well as letting the user determine the data-processing methods and implementing user-defined data-processing scenario.

Further development of the information component is seen in a more complete presentation of the methods for creating models of those transaction systems, including creation of typical templates to reflect standard situations and a library of templates for subject domains.

In the section of data integration models, it would be reasonable to create an object description of the ontology in terms of classes and inheritances. That would be a good methodological foundation for improvement of information interaction model in the corporate and governmental sectors. Development of the theme of data integration will be continued in the form of the description of the methodology for data transformation (Fig. 4) that will be applied for integration projects, as well as for forming separate layers of the core of government data and for describing the methodology of connections between various layers.

A substantial amount of information-analytical products focused on solving specific problems is currently created by the efforts of companies and agencies. The Russian Government's Analytical Center is holding a competition for determining the best information-analytical tools (Analytical Center of the Government of the RF, 2016). It should be noted that the description elements of the products to be submitted to the competition do not pay enough attention both to the presentation of systems from the perspective of describing the tools for forming an information base, and to methods of analytical data-processing. Applications are presented from the point of view of solving functional problems. A solution to local problems, no matter how elegant it may be, does not always fit into the surrounding infrastructure, except for cases when this is done with a goal in mind.

For large-scale informatization projects, it is not enough to have all types of activities and performer roles in a formalized representation; it is also necessary to apply industrial methods, i.e., standardize the methods for data presentation and methods for their analytical processing. In this case embedding separate components into the information-analytical infrastructure of e-government could prove to be promising.

REFERENCES

[1] **J. Fowler, B. Perry,** Agent-Based Semantic Interoperability in InfoSleuth. SIGMOD, 1999 g.. 1 : T. 28.

[2] **D.C. Hay,** Data Model Patterns: A Metadata Map. Morgan Kaufmann, 2006.

[3] **Ian Clayton,** GDS NEXT GENERATION SEAMLESS. 2016 g. 10.03.2017 g. URL: http://axses .com/encyc/archive/arcres/arcrates/users2/globalmarketing_about_gds.cfm

[4] **W.H. Inmon, D. Linstedt,** Data Architecture: A Primer for the Data Scientist. [b.m.] : Morgan Kaufmann, 2014.

[5] **K.C. Laudon, J.P. Laudon,** Management Information Systems, 2nd ed. Macmillan, 1988.

[6] **Y. Lipuntsov,** An Information model of Interagency Communication Based on Distributed Data Storage, International conference electronic governance and open society: challenges in Eurasia. ACM (New York, N.Y., United States), 2016.

[7] **Y.B. Moon, D. Phatak,** Enhancing ERP system's functionality with discrete event simulation, (2005) : Industrial Management & Data Systems 105(9).

[8] **N. Robertson, T. Perera,** Automated data collection for simulation? Simulation Practice and Theory, (9) (2002) : [b.n.].

[9] **C. Shamieh**, Continuous Engineering. IBM : John Wiley & Sons, 2014.

[10] Travel technology Global distribution system. 2016 g. 10.03.2017 g. URL: https://en.wikipedia.org /wiki/Global_distribution_system

[11] **R. Allen,** Matematicheskaya ekonomiya [Mathematical economy], Izdatelstvo instrannoy literatury, Moscow, 1963.

[12] Analiticheskiy tsentr pri Pravitelstve RF. Konkurs «Luchshiye informatsionno-analiticheskiye instrumenty – 2016» [Analytical center for the Government of the Russian Federation. The contest «Best information and analytic tools – 2016»]. 2016 g. 10.03.2017 g. URL: http://itcontest.ac.gov.ru/an2016/.

[13] **M.V. Gracheva, Yu.N. Cheremnykh, Ye.A. Tumanova,** Modelirovaniye ekonomicheskikh protsessov [Modeling of economic processes], Yuniti-Dana, Moscow, 2013.

[14] **S. Karlin,** Matematicheskiye metody v teorii igr programmirovanii i ekonomike [Mathematical methods in the theory of games, programming and Economics], Mir. Moscow, 1964.

[15] **V. Kogalovskiy,** Proiskhozhdeniye ERP [The origin of ERP], Direktoru informatsionnoy sluzhby, 2002.

[16] **Y. Lipuntsov,** Primeneniye informatsionnoy modeli mezhvedomstvennogo vzaimodeystviya dlya sbora i analiza dannykh po fondovomu rynku [Application of information model of interagency cooperation for data collection and analysis on the stock market], Sovremennyye informatsionnyye tekhnologii i IT-obrazovaniye, Fond sodeystviya razvitiyu internet-media, IT-obrazovaniya, chelovecheskogo potentsiala Liga internet-media, Moscow, 3 (12) (2016) 240–246.

[17] **Y. Lipuntsov,** Printsipy sozdaniya ontologii dlya khranilishcha dannykh. Primer «vyssheye obrazovaniye» [Principles of creation of the ontology for the data store. Example of «higher education»], Biznes. Obrazovaniye. Pravo, (3) (2016).

[18] **Iu.P. Lipuntsov,** The information modeling stages, St. Petersburg State Polytechnical University Journal. Economics, 6(233) (2015) 196–205.

[19] **V.L. Makarov, A.R. Bakhtizin,** Sotsialnoye modelirovaniye – novyy kompyuternyy proryv (agent-oriyentirovannyye modeli) [Social simulation – a breakthrough new computer (agent-oriented models)], Ekonomika, Mowcow, 2013.

[20] **M. Mesarovich, Ya. Takakhara,** Obshchaya teoriya sistem: matematicheskiye osnovy [General systems theory: mathematical foundations], Mir, Moscow, 1978.

[21] Pravitelstvo RF O pervoocherednykh merakh, napravlennykh na sozdaniye gosudarstvennoy informatsionnoy sistemy «Yedinaya informatsionnaya sreda v sfere sistematizatsii i kodirovaniya informatsii» [The government of the Russian Federation On priority measures aimed at the creation of the state information system «Unified information environment in the sphere of systematization and coding of information»], Postanovlenii Pravitelstva RF № 487 ot 01.06.2016 g., 2016.

[22] Rosstandart GOST 34.602-89 Informatsionnaya tekhnologiya. Kompleks standartov na avtomatizirovannyye sistemy. Tekhnicheskoye zadaniye na sozdaniye avtomatizirovannoy sistemy [Rosstandart GOST 34.602–89 Information technology. A set of standards for automated systems. Technical task on creation of automated system], 1990.

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СПИСОК ЛИТЕРАТУРЫ

[1] **Fowler J., Perry B.** Agent-Based Semantic Interoperability in InfoSleuth. SIGMOD, 1999 г. 1 : Т. 28.

[2] **Hay D.C.** Data Model Patterns: A Metadata Map. Morgan Kaufmann, 2006.

[3] **Clayton Ian.** GDS NEXT GENERATION SEAMLESS. 2016 г. 10.03.2017 г. URL: http://axses.com /encyc/archive/arcres/arcrates/users2/globalmarketing _about_gds.cfm

[4] **Inmon W.H., Linstedt D.** Data Architecture: A Primer for the Data Scientist. [б.м.] : Morgan Kaufmann, 2014.

[5] **Laudon K.C., Laudon J.P.** Management Information Systems. 2nd ed. Macmillan, 1988.

[6] **Lipuntsov Y.** An Information model of Interagency Communication Based on Distributed Data Storage // International conference electronic governance and open society: challenges in Eurasia. ACM (New York, N.Y., United States), 2016.

[7] **Moon Y.B., Phatak D.** Enhancing ERP system's functionality with discrete event simulation. 2005 : Industrial Management & Data Systems. Т. 105(9).

[8] **Robertson N., Perera T.** Automated data collection for simulation? // Simulation Practice and Theory. 2002 : [б.н.]. Т. 9.

[9] **Shamieh C.** Continuous Engineering. IBM : John Wiley & Sons, 2014.

[10] Travel technology Global distribution system. 2016 г. 10.03.2017 г. URL: https://en.wikipedia .org/wiki/Global_distribution_system

[11] **Аллен Р**. Математическая экономия. М.: Изд-во иностр. лит., 1963.

[12] Аналитический центр при Правительстве РФ. Конкурс «Лучшие информационно-аналитические инструменты – 2016». 2016 г. 10.03.2017 г. URL: http://itcontest.ac.gov.ru/an2016/

[13] **Грачева М.В., Черемных Ю.Н., Туманова Е.А.** Моделирование экономических процессов. М.: Юнити-Дана, 2013.

[14] **Карлин С.** Математические методы в теории игр программировании и экономике. М.: Мир, 1964.

[15] **Когаловский В.** Происхождение ERP // Директору информационной службы, 2002 г.

[16] **Липунцов Ю.** Применение информационной модели межведомственного взаимодействия для сбора и анализа данных по фондовому рынку // Современные информационные технологии и ИТ-образование. М.: Фонд содействия развитию интернет-медиа, ИТ-образования, человеческого потенциала Лига интернет-медиа. 2016. Т. 12. № 3. С. 240–246.

17. **Липунцов Ю.П.** Принципы создания онтологии для хранилища данных. Пример «высшее образование» // Бизнес. Образование. Право. 2016. № 3.

[18] **Липунцов Ю.П.** Этапы информационного моделирования // Научно-технические ведомости СПбГПУ. Экономические науки. 2015. № 6(233). С. 196–205.

[19] **Макаров В.Л., Бахтизин А.Р.** Социальное моделирование – новый компьютерный прорыв (агент-ориентированные модели). М.: Экономика, 2013.

[20] **Месарович М., Такахара Я.** Общая теория систем: математические основы. М.: Мир, 1978.

[21] Правительство РФ О первоочередных мерах, направленных на создание государственной информационной системы «Единая информационная среда в сфере систематизации и кодирования информации» // Постановлении Правительства РФ № 487 от 01.06.2016 г. 2016 г.

[22] Росстандарт ГОСТ 34.602–89 Информационная технология. Комплекс стандартов на автоматизированные системы. Техническое задание на создание автоматизированной системы, 1990.

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