A study of problematic issues in information resources integration in Russia

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Abstract. The introduction of computer, information and telecommunication technologies has radically changed the capabilities of management processes in all spheres of life of modern states. Large-scale automation of a wide variety of processes, monitoring of the state of objects and processes, comprehensive support of activities for preparation and decision-making in close to real time mode, allowed for a significant expansion of the scope for increased efficiency in management. Further integration of information management and telecommunication systems has made it possible to manage even more complex objects distributed geographically, due to a substantially decentralized structure and heterogeneous by its nature both in the composition of hardware and software, and in the composition and structure of information resources. Over the decades, the goals of integrating computing and information resources have gradually transformed, showing a significant dependence, on both the capabilities of computer hardware and communication systems, and additionally on the capabilities of software, up to the level of development of information technologies. Often ahead of integration opportunities, practical needs determine the need to manage increasingly complex facilities. The evolution of command and control facilities began from private processes of ensuring daily activities (or combat command and control), passing through similar processes at the level of territorial entities, ministries and departments, and in our time has led to the emergence of objects combined into a single complex structure, distributed throughout the state and intended for solving state tasks of strategic importance.

The problem of integration of information resources in a certain sense has existed for more than half a century. Back in 1963, Charles Bachmann developed integrated data warehousing and was awarded the Turing Prize for his achievements [1]. For over 50 years, the goals of integration have constantly and significantly changed, showing significant dependence on the capabilities of existing hardware (computing and communication) and software, as well as the level of development of information technology (IT). At the same time, the ideology of integration remained unchanged (figure 1). The integration of hardware, software and information resources is carried out on the basis of automation of
the processes of everyday activities, financial, managerial and other processes. In turn, integration provides a new quality of management, allowing at times (in some cases - up to 1-2 orders of magnitude) an increase in the efficiency of decisions, primarily through the rapid collection, synthesis and presentation of significant amounts of necessary information, the use of support tools decision making, the possibility of solving real-time optimization problems, and predicting the consequences of choosing alternative options.

![Figure 1. General ideology of information systems integration.](image)

In the USSR, in the development of information systems (IS), it is conditionally possible to distinguish several stages, which to a large extent determined the directions of their integration (table 1) [2]. It is only natural that in the early stages, the development of IP was constrained by the capabilities of existing computer technology and data transmission tools, while starting from the 2000s, information technology (IT) capabilities became decisive.

| Stage no. | Period, years | Information systems integration goals |
|-----------|---------------|--------------------------------------|
| 1         | 1952 – 1961   | a)                                   |
| 2         | 1962 – 1972   | a), b)                               |
| 3         | 1973 – 1990   | a) – d)                              |
| 4         | 1991 – 1996   | a) – e)                              |
| 5         | 1997 – 2001   | a) – f)                              |
| 6         | 2002 – 2010   | a) – h)                              |
| 7         | since 2011    | a) – i)                              |

Designations:
- a) - Exchange of information to coordinate management
- b) - Organization of the interaction of geographically distributed departmental centers
- c) - Organization of unified data banks
- d) - Decision making
- e) - Consolidation of information resources at the departmental and / or regional level
- f) - Consolidation of information resources at the federal level
- g) - Integration of information systems to the level of “locality”
- h) - Creation of ”electronic government”
- i) - Combining existing and promising information systems in Russia

At the first stage (1952-1961), the practical needs of creating an automated missile defense system (ABM) led to the development of a whole series of electronic-calculating machines "BESM-1", "Diana-I", "Diana-II", M-2, M-40, M-50, "Setun", "Arrow", "Ural-1", etc. The main purpose of the computing means of the automated missile defense system was to conduct computational tasks to calculate the trajectory of the rocket. The integration of computing resources was carried out mainly with the aim of exchanging information to coordinate the use and functioning of missile defense in the country. The possibilities of integration during this period were limited by the state of development of communication tools [3]. Along with this, in the 50s of the XX century, domestic electronic computers (computers) were widely used in solving design problems in scientific research organizations of the USSR Academy of Sciences.
The period 1962-1972 characterized by the beginning of serial production and operation of domestic semiconductor computers "Spring", "Snow", "M-222" and others, and then computers on integrated circuits. "Gnome" in 1965, and the "fastest" in the USSR and in Europe, the BESM-6 computer (1 million operations per second) in 1966. In the early 1970s, Elbrus and Elbrus-2 computers were created, which were widely used in nuclear centers, in the missile defense system, and in various defense industries. The use of computing tools in these years was carried out with the aim of organizing the interaction of geographically distributed departmental centers, operational collection, primary processing and transmission of necessary information, as well as automation of departmental level processes. A sufficiently illustrative example of IP integration during this period is the creation in 1972 of a railway system for the integrated automation of ticket and cash operations (ACS Express). The system successfully existed until 2005, uniting as of 2000 31 centers in 11 states [4].

In the mid-1960s, the USSR Ministry of Radio Industry headed for the creation of unified computers utilizing large-scale standardized software and peripheral equipment. It was decided to take the architecture of the IBM System / 360 system, widely distributed in the West, as the basis of the new generation of domestic computers [5]. The integration of ES computers was carried out mainly within the framework of automating the tasks of geographically distributed departmental organizations, summarizing the results of solving design problems, as well as organizing the storage and efficient use of large amounts of information resources. Simultaneously with the creation of the ES computer under the auspices of the USSR Ministry of Instrument, more than 30 institutes and enterprises from Bulgaria, Hungary, the German Democratic Republic, Cuba, Poland, Romania and Czechoslovakia, from the mid-1970s, were engaged in the development and serial production of small computer hardware systems (SM computers). SM computers are widely used in various fields of the national economy and in industry. Some series of computers were issued for solving the specialized tasks of designing, accounting, forecasting, equipment management, and determining the need for the development of unique special software. It was the use of SM computers that caused the revolutionary development of computer-aided design systems in the country.

The period 1991-1996 was characterized by a massive transition to personal computers using completely foreign hardware and software. There was a massive “adaptation” of previously developed software tools for solving specialized tasks for new general software (operating systems and databases). At the same time, the emergence in Russia in the early 1990s of the global Internet, as well as modern foreign communications, stimulated the rapid growth of first local area networks of organizations, followed by the development of integrated departmental IP. At this time, databases of electronic documents, the regulatory framework for organizing electronic document management, are being created. The foundations of future unified state information resources arise - all kinds of electronic libraries, archives, directories, registers, catalogs of funds. The main goal of the integration of computing resources is the creation and organization of the effective use of information repositories of structured electronic documents at the departmental and regional levels. The first experience of information interaction appears at the interdepartmental and interregional level. In the future, the integration capabilities will cease to be limited by the parameters of hardware and software of computer technology and communication tools, and will began to be determined entirely by the level of IT development.

The period 1997-2001 saw, a spasmodic growth in the development of all elements of IP. The hardware of computer complexes is rapidly developing along the path of increasing speed and reliability, reducing weight and size characteristics and cost. Mobile (wearable) computing devices appeared that were not inferior in characteristics to stationary personal computers. In turn, this has caused widespread use of computer technology in airborne and simulator complexes, determining the rapid development of various diagnostic tools in the healthcare system. Telecommunication facilities and systems are also being improved, providing new opportunities for pairing computing systems and networks that are significantly heterogeneous in terms of the hardware and software used. A software revolution is taking place. Procedural programming languages have been replaced by object-oriented ones, with rich capabilities of built-in procedures, libraries, and visualization tools. Hierarchical databases have been replaced by relational ones, defining essentially different possibilities of collecting, storing, structuring
and presenting large volumes of information. The era of "digitalization" has begun, along the appearance of fairly simple "designers" of data warehouses, sites, and online stores. The creation of 3D-modeling tools has made possible a reduce by an order of magnitude in the time and cost of development, refinement, and transportation of products, significantly facilitating the development of products with new properties. In aggregate, the speed of computing and data transmission tools and, new software capabilities have determined the emergence of “network” IT in the field of data transmission, storage and visualization. As a result of this, new mobile tools have appeared that combine various components of new technologies: e-books, navigators for various purposes, digital cameras and camcorders, compact mobile communications and much more [6].

Despite the obvious advantages of the widespread introduction of electronic document management in various spheres of the life of the state, huge efforts to create several thousand databases of electronic documents in the first years did not bring the expected effect. This is due, first of all, to the interdepartmental fragmentation of IS, as well as to the absence at that time of regulations for the interaction of ministries and departments on various issues.

The period 2002-2010 was characterized by the mass integration of IS in Russia within the framework of the implementation of the state-funded complex of federal target programs:

- “Development of a unified educational information environment” (2001-2005) [7];
- “Creation of an automated system for maintaining the state land registry and state registration of real estate objects” (2002 - 2008);
- “Development of informatization in Russia for the period until 2010”;
- “Electronic Russia” (2002 - 2010).

In these years, systems of distance and additional education, information and reference support for teachers were created. An integrated infrastructure of e-government has been formed. The foundations have been laid for the creation of systems for monitoring priority national projects and managing budgetary resources, multifunctional centers, regional portals and registers of state and municipal services.

The modern period (since 2011) is under the auspices of the state program "Information Society (2011-2020)". The tasks being solved within the framework of the state program are interconnected with the activities carried out in the framework of the implementation of the Federal Law No. 172-ФЗ “On Strategic Planning in the Russian Federation” and Presidential Decree No. 537 “On the National Security Strategy of the Russian Federation until 2020”. Thus, activities have been launched on a state scale to create and integrate information resources of, without exception, all federal bodies of state power, bodies of state power of the constituent entities of the Russian Federation, local governments and relevant public, scientific and other organizations. The need for the centralized management of an integrated system of this scale determines the need to create an extensive hierarchical network of relevant control centers, or “situational centers” (SC). Since the beginning of the 2000s, in Russia, in fact, an exponential increase in the number of SCs has been observed.

One of the main questions when creating a multi-level integrated system of SCs is traditionally the choice of the direction of integration: “from above” or “from below”? In the first case, the procedures for unification of hardware and software, formats and structures of information storages, maintenance and modernization of information systems, bringing regulatory and reference information, and operational data collection are greatly simplified. The main disadvantages are due to the weak flexibility of the structure - the adaptation of the integrated IS to the ongoing administrative reforms, which leads to changes in the structure of the links themselves, the order of their interaction, and the list of tasks to be solved, which as a result becomes significantly complicated. In addition, the scenario for practicing typical functional tasks implemented “from above” in some cases does not take into account the specific needs of users of territorial IS and reduces the efficiency of the entire system.

Integration “from below” is distinguished by the flexibility of a unified system that fully takes into account the needs of consumers and allows for a quick and painless adaption of structural and functional
changes during administrative reforms. Multiple problems are associated with a significant heterogeneity of the hardware and software used, reducing the possibility of operational interaction of IP and determining the excessively high cost of operating and upgrading segments of the integrated environment.

Russia has chosen the generally accepted way of integration "from above" in international practice when first creating an "electronic government", and later on when implementing the state program "Information Society". Moreover, the integration of information resources should be carried out at all levels of government, up to the federal.

The general scheme of an integrated system using the example of the Information Society program being created as part of the implementation is shown in (figure 2). In the accepted designations, ISs are territorial (municipal), –regional, or –federal (departmental) ISs. In some cases, departmental systems for operational issues can be coordinated by systems belonging to various Services, Committees, Departments, Agencies created under the Government of the Russian Federation. The amount of IS at each level substantially depends on the structure of the federal executive bodies. The possible number of type ISs is 3 ... 8, type - 12 ... 20; type (IS regional level) - 50 ... 85, type (level "IS settlement", "regional IS") - several thousands.

![Figure 2. General scheme of integration of information resources in Russia.](image)

Each individual IS in the general case should interact both at its own level, for example, using cloud technologies (figure 3), and with a higher IS - as a rule, according to a hierarchical scheme (figure 4). Type ICs can interact with violation of strict hierarchy rules that are executed for all other types of IS (watch figure 2).

![Figure 3. Interaction of information systems of the same level.](image)

![Figure 4. Interaction of IS of nearby levels.](image)
In accordance with this, the mechanisms for organizing the interaction of systems at various levels will vary significantly. With an increase in the level of IS aggregation, the algorithms for processing, summarizing, and presenting information will noticeably become more complicated, while the requirements for the reliability of all elements of information and telecommunication systems and for information security will steadily increase.

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