

SOFTWARE IMPLEMENTATION OF EXCHANGE PROCESSES IN A DISTRIBUTED NETWORK ENVIRONMENT OF TRANSMISSION AND PROCESSING OF INFORMATION

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Abstract:

The work is devoted to the development of scientific and methodological basis for increasing the functioning efficiency of distributed computer networks and systems through the organization of an info communication network environment for the transmission and processing of information on the basis of implementation of models and mechanisms of associative interaction in a computing environment.

Keywords: *Information exchange process, data transfer and processing, distributed network environment, decision support*

1. Introduction

The development, implementation and use of information and communication technologies (ICT) are an essential feature of modern society and are important for its economic growth and development. The emerging ubiquitous information society is based on ICT, enabling new technological opportunities and increasing the efficiency of economic activity, preserving the role of the most important factor of economic growth and social development. In 2003–2009 ICT have created about 5 percent of the global gross product, in 2008, 5.4 percent, Mackenzie experts expect to grow to 8.7 percent by 2020 [1]. According to Gartner, in 2010 the volume of the world ICT market on expenses made 3.4 trillion USD in growth by 5.3% compared to 2009, the cost of IT services by users amounted to 821 billion. On computers – 353 billion (5.7% growth), software, 232 billion (5% growth), on telecommunications, 1.9 trillion dollars [2]. In general, the turnover of foreign trade in ICT and information services increased 2.5 times in the period 1990–2010.

As technically interconnected innovation industries, ICTs are being integrated into different areas, shaping the global information services market and generating information flows that reflect the global economy development trends. It is worth noting that for Big Data, as one of the fastest growing areas of ICT, the total amount of data received and stored is doubled every 1.2 years. For example, for the period from 2012 to 2014 the amount of data transmitted monthly by mobile networks increased by 81%. According to Cisco estimates, in 2014 the volume of mobile

traffic was 2.5 Exabyte per month and in 2019 it will be equal to 24.3 Exabyte. In February 2016, Synergy Research Group published the results of the global cloud services market, which is growing at a steady pace: the Cloud infrastructure services market (including IaaS, PaaS, and also private and hybrid cloud solutions) grew by 52% in 2015, reaching 23 billion dollars. As Gartner predicts, the volume of the global market of public cloud services in 2016 will reach 204 billion USD, which is 16.5% more than in 2015 [3-5].

In this regard, systems of distributed information processing and management, which are of fundamental importance in various fields and fields of ICT, are currently being subjected to research by many groups of the world community. These studies are stimulated by the growing role and increasing development of various networks and technologies (such as semantic Web, Grid-computing, cloud computing, the Internet of things, etc.) each of which has its own principles and peculiarities implementation, but in general, behind all these technologies lies the idea of creating a single environment that allows the user to receive services anywhere and anytime. However, in many areas the possibilities of computing are limited due to the nature of information processing and management of the computational system (for example, in the field of image recognition, solving problems with incomplete information, forecasting the results of proposed action and the development of control, the dynamics of processes in real time, etc.). Current opportunities of information technologies imply realization of new approaches to processing of the information, combined by common properties of associative or intuitive processing the information, giving the possibility to process knowledge, to carry out logical conclusion and, thus, allowing intellectualization of computational systems [6,7].

Today, despite the existence of a sufficiently strong theoretical and practical basis for study distributed systems, the tools of describing evolution in time both of distributed systems and populations are still not developed programme structures. This is due to a number of reasons, among which, first of all, heterogeneity of composition and dynamics of behavior of components, including the presence of changing unpredictable structures. Existing methods of description and research of distributed systems, as the analysis of modern domestic and foreign works shows, is mostly unable to answer many questions in this direction, in particular, how the

functioning in distributed systems and networks software structures can be formed to effectively interact with components and create a single distributed environment. In this connection, it is necessary to solve problems of efficient organization of distributed computations, to expand corresponding functionality and to improve interaction mechanisms of many elements (components), taking into account functional internal and intersystem processes, as well as complex infrastructure linkages caused by network and system architectures [8].

2. The Task of Software Implementation of Exchange Processes in a Distributed Network Environment of Data Transmission and Processing

Scientific and technical publications in the field of distributed systems and networks cover a wide range of research of information interaction processes, peculiarities of intersystem and inside system data interchange, including taking into account the rapidly growing information flow involved in transmission and processing, when the multitude of streams generated as a whole in the network, forms a kind of space that has the structure and principles of the organization. Many scientists aspire to solve this problem by means of development of different models, ways of interaction of information, at various levels of the network, research of quantitative changes of information, representation of a network as a large information store etc. That can become self-governing in the future, depending on the change in information. These models are largely developed from the point of view of information exchange, allowing to trace formal procedures, whereas for detailed research of information technologies tasks, including their analysis, it is required to study the space specifications (in terms of information technology specifications, standards, profiles, scenarios), as well as technology implementation space (in terms of systems, products and services), which requires a different approach to research.

Principles of organization of distributed systems, realization of interaction of system components and modeling of distributed computations are devoted to works of domestic and foreign scientists, as E. Tanenbaum, J. Foster, K. Kesselman, V.V. Toporkov, A.G. Tormasov et al. Research of questions of mathematical maintenance of computational machines and management of computational processes is the basis of works of R. Kalman, A. Shiryaev, R. Bellman, L. Pontryagin, V.K. Kabulova, F.B. Abutaliev, F.Th. Adylovoj, etc. Some questions of organization of effective information processing and information exchange in computational systems and networks are considered in works of K. Petri, S. Hoare, J. Neumann, V.A. Mizina, Y. Zlotnikov, D. Cobackgammon, D. Melnikov, E. Nelson, and also T.F. Bekmuradova, S.S. Kasimov, M.M. Musayeva, etc. In works V.V. Lipaeva, M. Lipova, E. Nelson, D. Nessler, T. Tejera, and also M.M. Kamilov, D.A. Abdullayev, etc., the issues of increase a functionality of means and systems

of information exchange are addressed. Interlevel interaction in protocols of information exchange means for services is considered in works N. Anisimov, S. Proteins, V.N. Turchenko, A.D. Ivannikova, etc. The tasks of artificial intelligence in the field of development of components of intellectual environments and application of fuzzy sets in control models and the use of unclear set are important in the field of research of artificial intelligence, which are reflected in the works of L. Zadeh, E. Mamdani, D.A. Paspelava, R.A. Aliyev, as well as R.N. Usmanov, D.F. Muhamedievoj and others. At the same time, the issues of efficient organization of distributed computations in the task of expansion of corresponding functionality and improvement of mechanisms of interaction of many elements (components) are not sufficiently investigated, taking into account functional processes of internal and intersystem character, the presence of a wide variety of environments, platforms, technologies, as well as complex infrastructure links, caused by network and system architectures.

3. Research of Information Interaction and Distributed Network Structures

The analysis of information transformations is made on the basis of distributed network calculations: it is shown that there are special rules, algorithms, protocols, etc., used in the functioning and development of different areas and technologies of distributed calculations, and for each of them the tasks of analysis of interrelations, relations and mutual coordination of components and resources are actual, which, in turn, are determined by the principles of management of information processes, realizing each of the concrete destinations [9]. The main form of representation of distributed network computing is the representation on the basis of (distributed) objects of software engineering: it is caused by an important property of the object to hide the internal structure from the outside world through a strictly defined interface. This approach makes it easy to replace or modify objects, leaving the interface unchanged. In addition, the key feature of an object is that it encapsulates data called state and operations on that data, called methods, while access to methods can be obtained through an interface. In this way, access or object state manipulation is the use of methods that are accessed through the interface of the object (in turn, the object can implement many interfaces) accessing. This partitioning on the interfaces and the objects that implement them is accepted by the main element of the distributed associative interaction.

By using an object-oriented approach when creating distributed systems, you can consider system components at different levels of abstraction as objects, each of which would have a certain line of behavior. It is shown that the middleware software provides the functional completeness of the requirements for distributed systems when performing calculations. It can be implemented on the basis of

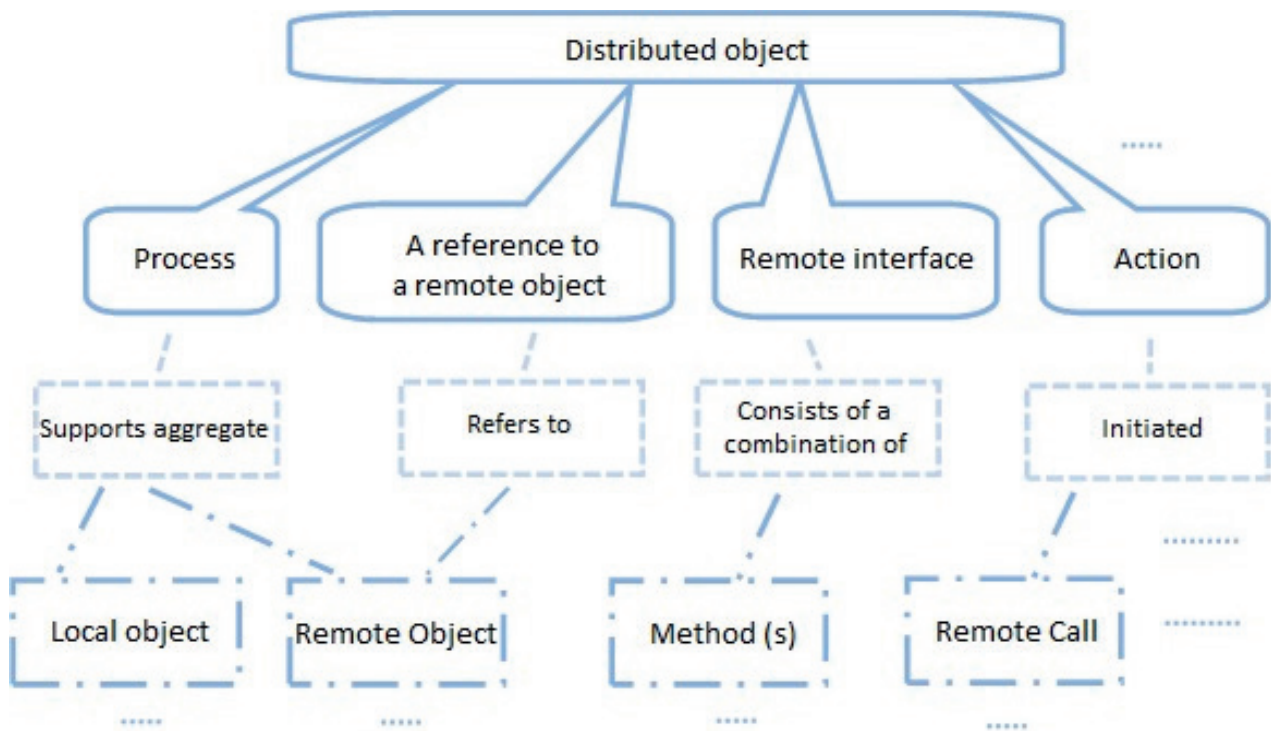


Fig. 1. The elements of distributed object model

different architectures (models) of networks; In this case, the exchange of information between components of the distributed system can be organized using different technologies. The choice of a specific technology depends on requirements of the distributed system.

In general, at the intermediate level is the most appropriate option for the interaction of components of the distributed system and in this chapter postulated that the principles of the organization at the intermediate level can be used to develop models of info communication network environment of transmission and information processing.

Development and integration of distributed applications provides that the main part of the intermediate software is based on a certain model defining the distribution and communication, i.e. on the model of distributed objects (Figure 1). The idea of which is that each object implements an interface that hides all the internal details of the draft from its user, i.e. the interface contains the methods implemented by the object. In the concepts of object-oriented programming, this model represents the basis of modeling in a distributed environment and correlates with the work methodology when considering the functioning of distributed components in a view staging environment. The interoperability processes of distributed components can be categorized according to the functions performed and the affiliation to different object classes [10].

Interaction of application modules and reflection of service relations with corresponding application processes in many cases there are difficulties connected with peculiarities of application implementation and work of mechanisms themselves in distributed environment. The paper offers a distributed application model and a system model for the software compo-

nent, which can be used by formal procedures to record relationships for different requests on the part of certain processes. Based on the procedures of building a system model of software components it is expedient to formalize the processes of information exchange in a distributed network environment that allows investigating and developing specific solutions for distributed systems and networks of varying complexity.

Distributed applications use a number of computers and processes that manage shared information (databases, files, objects). In this case, user programs, depending on the needs of the user, necessary information or modification of the stored (Fig. 2) [11].

The system consisting of the finite set of successive nodes (processes) p_1, p_2, \dots, p_n , is considered that interact through the finite number of objects $x \in X$. It is accepted that each object x can be accessed through a write/read operation (the write operation defines a new value for x ; the read operation allows the node to get the value of the object). The z value is assigned to the x object as: $w(x)z$ – for writing and $r(x)z$ – for reading. The turn to these computers and processes to obtain the implementation of a p_i process can be represented by a sequence of operations: $op_i^1, op_i^2, \dots, op_i^k$ where k is the index that defines the k -th operation of the p_i process. The sequence of operations (events) defines the s_i events for p_i .

If you take s_i as a set of operations implemented for p_i and a dependency vector as the directional ratio of the operations implemented by p_i (for example, s_i as a set (S_i, V_i)), you can accept the sequence $\tilde{S} = (S, V_s)$, and V_s to name the relationship “process-Request”, that is,

$$S = \bigcup_i s_i \tag{1}$$

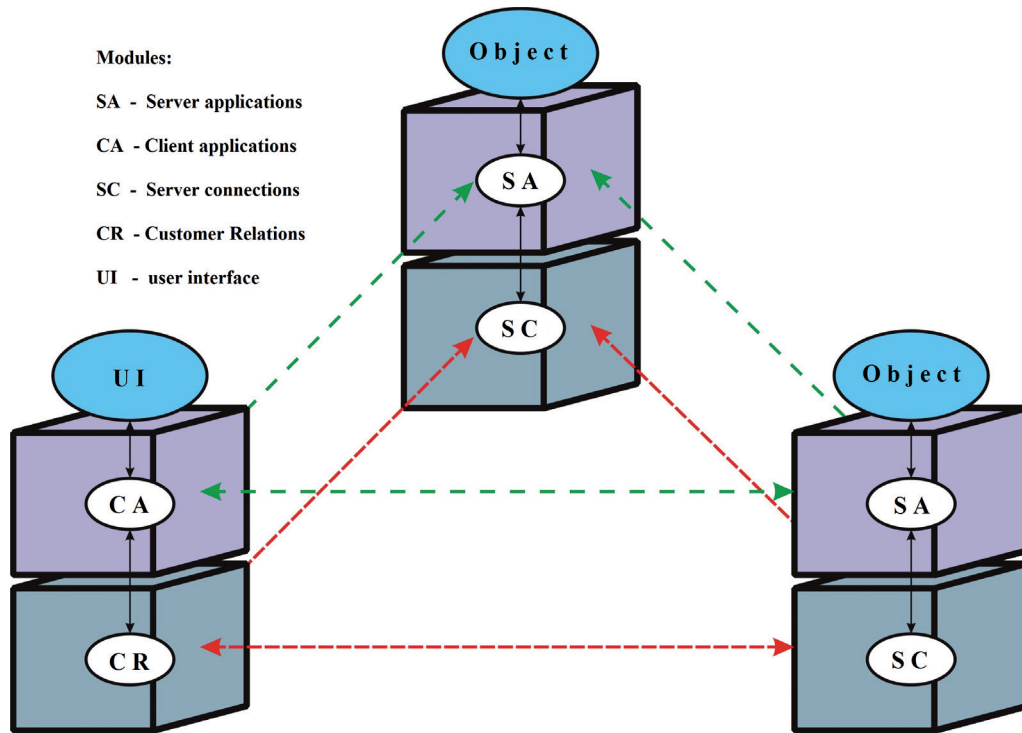


Fig. 2. The Distributed Application Model

$op_1 \bar{v}_s op_2$ (Request op_1 before execution of op_2), if:

$$1. \quad \exists p_i : op_1 \bar{v}_s op_2, \quad (2)$$

$$2. \quad op_1 = w(x)z, \quad (3)$$

$op_2 = r(x)z$, i.e. op_2 uses the information entered op_1 ,

$$3. \quad \exists p_3 : op_1 \bar{v}_s op_3 \text{ and } op_3 \bar{v}_s op_2. \quad (4)$$

These formal procedures can be used to record relationships for different requests from different processes.

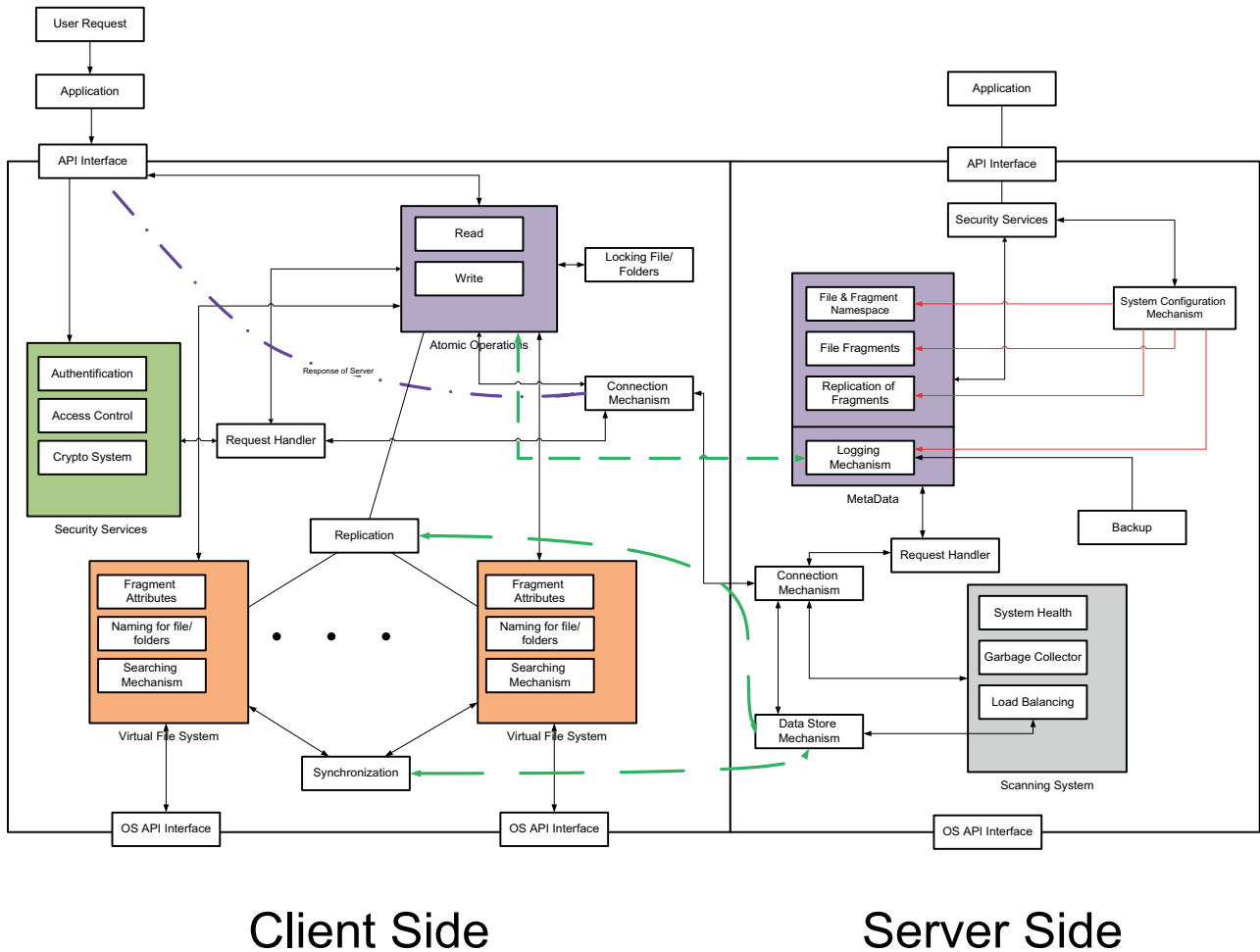
A distributed network structure is represented by a collection of interconnected nodes that sharing messages over the network; each node functions on its own algorithms of exchange, imposing certain restrictions on the general process of information exchange. Regardless of what kind of exchange, for a separate object (one service), when in exchange involved servers – direct and/or potential participants of exchange and clients – initiators of requests of objects at servers, or for many objects (Services), when servers can act as clients themselves for some objects, its implementation requires appropriate coordination between different services, the functional purpose of which is to fulfill certain requests of the client [12].

In the work on the basis of concepts of object-oriented programming the corresponding positions are substantiated and the possibilities of the object as element of the relationship implementing the program properties are demonstrated. The object has a single name, its own data and procedures. It can consist of several objects and, in turn, be part of a larger object. All actions in object-oriented programming are performed through messages, etc. In general, the concept of an object is defined by key features such as encapsulation, class-example relationship, inheritance

property, passing messages. Thus, information exchange procedures may be characterized as follows: (a) data and procedures are merged into program objects, (b) messages are used to ensure interconnection between objects, (c) similar objects are grouped into classes, (d) data and procedures are inherited by the class hierarchy. These characteristics have been considered in terms of analyzing information transformations in a distributed environment and showing how the object-class-message model is used for object-oriented software development. Language interface and built-in set of classes as a tool to implement the principles of object-oriented programming.

The mechanisms and procedures of the information exchange, realized by means of the developed software, demonstrate possibilities of use of associative interaction at exchange of the information of the distributed objects and are very convenient means for display processes. The corresponding software implements algorithms of information exchange at intermediate level of distributed environment, has convenient user interface, allows to display information processes on the basis of modules work (as for Client and Server software). In particular, the algorithm of information exchange in distributed systems based on client-server architecture is implemented by developed software, which allows tracing functional relationships of system components in the basic architecture.

For the detailed study of the principles of organization of links in the system and research of interaction of components of distributed system with the purpose of definition of effective mechanisms of information exchange, the tasks of analysis of functional interaction of components in a network on the basis of peer (peer-to) links. These capabilities are justified by developed software that implements the



Client Side

Server Side

Fig. 3. Software modules and their interaction when implementing a query in the file system

functions of the kernel Task Manager in the distributed system.

The capabilities of developed software that implement the features inherent in the distributed file system are reflected in Figure 3 (logical representation of shared resources for easy administration and load balancing; creating multiple alternative shared resources, which enables the organization of fault-tolerant data storage schemes; maintain the availability of data when you move network shares, which provides high network performance when a user accesses a specific logical name).

The algorithms of interaction between the components of distributed network, realized by means of developed modules of the software, can be used for creation of high-performance systems of distributed data processing in various fields of science and technology.

On the basis of generalization of problems of information interaction and possibilities analysis, realized on the basis of associative processes in mechanisms of information exchange, systematized and categorized aspects of interaction concerning executed in them processes and components that are based on distributed computing or applications.

The work justifies the need for special mechanisms of resource management in heterogeneous distributed environments with the purpose of their coordination and integration. The schemes of organization of the distributed computations are studied, from which

it is obvious, that for management the new principles of planning of computational works and allocation of resources are necessary with definition of classes of tasks of analysis of processes of information exchange in distributed network structures. In addition, the analysis of the distribution of functions by levels and layers, as part of a possible decomposition of the distributed media and information processing, has shown that they can be grouped (by criterion of affiliation to level or layer and use in functional architecture of network structures) [13,14].

4. Conclusion

The set of public defense scientific provisions of reviewed work ensured the development of concepts, principles and scientific and methodological bases of the decision of theoretical and applied aspects of the implementation of associative interaction in modern communication network structures of computational systems.

The methodology proposed and substantiated by the authors of the study of communication network structures allows to describe complex functional and informational relations of inter and inside system character on the basis of the unified framework concept and confirms the competence of the initial hypothesis of the executed research: mechanisms of

associative by the nature of interaction of composite components of computational networks and systems, realized on the basis of principles, methods and algorithms of software engineering at implementation of the postulate of separation and sharing of the potential of distributed information and computational resources in the area of their harmonization and coordination, allow effective interaction of nodes and components of communication network structures and optimal management of real-time computing resources, significantly expanding the potential of automated management and functionality of computing systems.

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