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APPROACH TO DESIGN AND DEVELOPMENT OF SERVICES IN INFORMATION SYSTEMS OF TELECOMMUNICATIONS PROVIDERS

Abstract. The problem of design and development of services in the information systems of telecommunications providers is considered, taking into account evaluations of the effectiveness of services, trends in the development of the IT industry and analysis of user needs from various sources. The problem is considered at the levels of service design, the development of the provider's service catalog, the provider's service package for the consumer company, and the development of the provider's services. When solving problems of design and development of services at each level, in addition to traditional parameters, new evaluations of service efficiency, development trends of the IT industry and analysis of user needs from various sources are used, including the use of consumer feedback on social media.

Keywords: service; telecom provider; social media; social media; service lifecycle; service design; catalog of services.

Introduction

Information technology (IT) is successfully used to improve the efficiency of enterprises in high-tech industries, such as the provision of telecommunication services. Competition forces companies and enterprises to look for new ways of using IT to gain competitive advantages. Today, the development of business is significantly influenced by the tools of cooperation between business units and IT services.

The most common approach to the implementation of IT to support the activities of enterprises is the service approach. This was initially facilitated by the effective use of services based on the SaaS, IaaS, and PaaS models. The experience gained allowed providers to provide services according to developed models, for example IPaaS [1], managed services (Managed Services) [2]. But services based on the E2E model, when design, implementation, delivery and provision of services to production, trade and other companies and enterprises are undertaken by IT companies, turned out to be especially

convenient for business support. First of all, this model is implemented through the support of information systems of production, trade and other companies and enterprises within the IT infrastructures of the providers [3]. New classes of providers have appeared, such as MSP, competition in classes is growing, and the range of services has expanded. Accordingly, the problem of effective support of the life cycle of services that providers provide to their clients has arisen [4]. Taking into account the differences of business consumers, the diversification of business processes of client companies that require support, it is advisable to build the appropriate classification of consumers, services and their providers and develop technologies to support the life cycle of services for classes of consumers, services and providers, taking into account the peculiarities of business, the state of IT development - industries, accumulated experience and important information from other sources.

This is especially true for providers in such high-tech industries as the provision of telecommunications services. They provide a wide range of services to wide classes of consumers, among whom medium and large business companies occupy an important position, since in addition to telecommunication services, it is already a matter of supporting the business processes of enterprises, software services, etc.

Creating tools to support the life cycle of services for such providers turns into a complex problem. To increase the effectiveness of service support tools at all stages of the life cycle, it is necessary to find and use additional knowledge, for example, evaluations of users of the provided services in social media.

In work [4], the concept of a platform for supporting the life cycle of services in the information systems of communication service providers is proposed, the architecture and implementation of the specified platform are described. As part of the creation of the components of the service life cycle support platform in the information systems of communication service providers, it is necessary to conduct research, develop models and methods for the implementation of individual processes of the stages of the service life cycle. Based on these models and methods, it is possible to create technologies for effective support of all stages of the service life cycle. The same applies to the processes of designing and developing services in the information systems of telecommunication service providers.

The report considers the approach to the design and development of services in the information systems of telecommunications providers, taking into account evaluations of the effectiveness of services, trends in the development of the IT industry, and analysis of user needs from various sources.

The problem of designing and developing services in the information systems of telecommunications providers

The importance of effective tools to support the service approach is determined by a number of factors. First of all, the economy of developed countries is oriented towards services. Second, many services are complex, and their delivery requires the integration of organizations, people, technology, and information to meet consumer needs. The third, but not the last, is related to the fact that each person is a consumer of many services.

Therefore, it is important to understand what the purpose of these complex service systems should be, how they should operate to achieve the purpose, and to define a systematic approach to the effective delivery of services according to customer requirements. This requires combining knowledge from the fields of business, human behavior sciences, decision-making, and information technology to formulate new concepts, views, and approaches that will contribute to the development of a service approach.

It is necessary to give answers to many new questions regarding the improvement of efficiency, productivity and reliability of service provision. New approaches based on a unique combination of skills, knowledge and experience should create a basis for coordination of available resources of all kinds in the provision of services, innovative development of service systems.

Philosophically, the aspect of transition from product-oriented thinking to service-oriented thinking is important for implementing a service approach. There are many commonalities and differences here. Thus, in relation to both products and services, the concept of the life cycle is used, which primarily includes the design, development, delivery, provision and development of the product or service. But the product actually realizes the possibilities that the consumer needs, and the service combines the provider and the consumer as a form of realization of these possibilities under certain conditions, primarily the price and requirements for the level of service.

There are several approaches to determining the stages of the life cycle of services, which embody different views on the nature of services, take into account the peculiarities of business processes of consumers, and other factors [5]. Accordingly, there are a number of options for selecting processes that are required for each of the stages of the service life cycle. The classification of tools is usually based on the selection of processes of life cycle stages, the support of which is provided by the

information systems of providers and client companies. The process selection option, which is the basis of the organization of the research carried out in the report, is given in the article [4]. The architecture of the platform, which provides comprehensive support for all processes of the life cycle of services in the information systems of information and communication service providers and the conceptual approach to its implementation, is given in the same article. The most important are the processes of design and development of services. The location of the problem in the list of service life cycle support processes given in [4] will be important for its understanding. The approach refers to Service Design and Change Management processes.

The purpose of this article is to develop models, methods and technologies for designing and developing services in the information systems of telecommunications providers. It is necessary to perform an analysis of critical factors, describe the structure of information communication services provided by providers, develop models, methods and technologies for designing and developing services. Such a choice of services in the IT industry is determined by the fact that in such a high-tech industry there is a place for the most important classes of services - technical, cloud, and software.

The peculiarity of the study is that it is necessary to take into account the influencing factors characteristic of the current state of development of the industry. Here, first of all, it is important to take into account all available sources of information useful from the point of view of effective implementation of processes, for example, it is advisable to use the feedback of users themselves in social media for the design and development of services.

Secondly, when designing and developing services, it is necessary to take into account the economic aspects of the service approach, ensure the competitiveness of services taking into account the experience of performing operations, managing the resources of providing services with monitoring and quick response, implementing the possibility of providing services by several organizations, etc.

Thirdly, since it is important for providers of information and communication services to transition to providing services based on the E2E model, it is necessary to describe in an integrated manner the scenarios of E2E operations related to the processes of design and development of services, to clearly define milestones, inputs and outputs, roles, scope objects of special attention in order to avoid loss of time and resources, disagreement and isolation of requirements for systems and services.

Fourthly, the developed tools, and accordingly the models, methods and approaches on the basis of which they will be created, should form a fully functional complex of integrated solutions. The developed solutions for the design and development stages of services, which are based on E2E work scenarios, should cover the basic volume of scenarios and templates of service design and development operations, provide the possibility of reviewing and clarifying scenarios and processes, manual and automated preparation of versions, provide advanced tools for analysis and automated determination of requirements and their impact on the design and development of services.

Fifth, service design and development tools provide an opportunity to take into account consumer requirements. For this, the context of the application of models, methods and technologies for supporting the stages of the life cycle of services in different conditions should be related to the financial aspect, the value created through services. The rationality of the design and development of services based on the minimization of the price/quality ratio will allow creating a complete catalog of services, choosing the appropriate package of services for each consumer, rationalizing services, making them available to the widest possible range of customers.

Analysis of existing approaches

In the research and technological spheres of the IT industry, the problem of designing and developing services in the information systems of information and communication service providers is positioned as a high-priority problem.

An IT service is a complex, knowledge-based activity aiming to provide customers with defined service [6]. Thus, IT services should be provided properly to support ongoing business processes. A set of processes and procedures that are performed to ensure the usage, improvement and design of IT services is defined as IT Service Management (ITSM). The recent ITSM literature has studied benefits, challenges, opportunities, and practices for ITSM implementation [7-10].

In [11], the authors conducted qualitative research study and developed a modular service design framework as a set of design principles for information-technology-enabled services (ITeS). The authors show how different ITeS design elements, and their combinations impact the outcome-driven design of service experience. The presented service design method adopts design principles to create effective modular ITeS designs by service designers and managers.

The authors of [12] proposed to adopt ITSM and ITIL best practices to work with a specific environment of enterprise. They compare challenges and advantages of organizations with different degrees of implementing IT service management frameworks executing defined processes at different levels. The proposed approach allows to reduce issues during operation processes.

The model of Fuzzy ITIL proposed in [13] allows to identify the maturity level of continual IT service improvement by measuring maturity level using best practice of ITIL v3 to condition before and after of improving process. For this purpose the authors propose a questionnaire for obtaining the value of the maturity level for each cycle within ITIL. The proposed approach results in increasing the level of maturity in each ITIL cycle which is confirmed by the case study.

In [14], the authors propose a step-by-step approach to model the guidance of different ITSM frameworks, such as ITIL, ISO/IEC 20000, MOF, and FitSM using standardized model types and model elements eliminating the differences in presenting guidance on particular processes. Consequently, the resulting models can then be compared with relative ease.

Service-dominant economic processes impact nearly all domains of human activity. This recent trend results in transition from a product-centered to a service-centered business model switching to servitization [15]. The term “servitization” is widely spread among both product companies and agencies that provide services [16]. The recent service-centered literature has studied servitization and digitalization that are two business model innovations allowing product companies to radically transform their business model [17, 18].

In [19], the authors incorporated professional input of scholars, practitioners, and reviews to identify service research priorities focusing on four service research priorities related to managing and delivering service. They revealed an opportunity for the interdisciplinary field of service to build service ecosystems and perform transformative service research addressing important macro-level problems that will influence critical societal and environmental outcomes.

The authors of [20] provide qualitative insight for exploring the possibilities of digital transformation for better understanding where opportunities for digital service innovation lie, how to create and capture value, and readiness of the enterprise to implement digital changes. A number of connected areas are highlighted: the challenges and opportunities of digital transformation at a strategic level, the customer

experience that affected by a digital service strategy, influence of data-driven business models on service transformation.

In the research [21], a systematic literature review of 89 published studies was conducted to analyze the mutual relation between digital transformation and sustainability at a firm-level. The authors propose a research framework that considers digital transformation as a driver and a predecessor of sustainability. The focus was made on digital capabilities enhancement while balancing economic, environmental, and social impacts. With the active participation of users, the integration both digital and sustainability transformations will successfully influence the improvement of business efficiency and productivity.

The hybrid approach in smart product-service system (PSS) development is presented in [22]. Main conclusion of the paper is that the core task in the development of smart PSS is continuous evolution of the modules/components in products and services for better user experience. The authors adopt the knowledge graph technique and concept-knowledge model to propose the evolutionary design approach. A case study of a smart nursing bed fulfilling multiple personalized requirements shows an insightful guidance to industrial organizations in their development of smart PSS.

Unfortunately, the entire spectrum of the listed problems has not yet been fully resolved. In particular, there is a need for models and methods of analyzing user messages in order to determine the characteristics, functions and elements of services that are important to them, methods of determining service evaluations based on information in social media, models and methods of restructuring services in order to meet the needs of users. At the same time, the integration of statistical methods, methods of applied linguistics, decision-making theory, artificial intelligence, first of all, neural networks with deep learning are promising.

Statement of the research problem

In the report, the general emphasis is placed on the problems of creating effective tools for such important stages of the life cycle of services as their design and development. In particular, the greatest attention is paid to the following tasks:

1. Designing services provided by telecommunications providers.
2. Maintenance of the catalog of telecommunications provider services.
3. Formation of a package of services of a telecommunications provider taking into account the specifics of the consumer.
4. Development of services provided by telecommunications providers.

We will begin the characterization of these problems with the first one, which, in fact, is one of the key problems of supporting the life cycle of services, as it is related to the design of the subject of attention of most other processes - the actual services provided by telecommunications providers to consumer companies. This problem consists in structuring services, determining their constituents - components and other services, using all the available capabilities of the IT infrastructure due to scaling, balancing, parallelization, replication to ensure a certain level of performance, efficiency, reliability and other characteristics of services. In general, it is advisable to divide the solution of this problem into two steps. First, it makes sense to build an architecture that is potentially capable of providing the above properties of the service and will provide the required functionality of the service. Recently, we are talking about a microservice architecture with advanced components for organizing their interaction, such as a service registry, a security component, a balancer, a logging component, and others. The second step is to add components to this architecture that use the resources of the IT infrastructure to provide the specified functionality while complying with the entire set of customer requirements. Here we can talk about the use of components, means and technologies of replication, consistent hashing, sharding, distributed systems, clusterization, synchronization, cache and others. Here we can talk about tools that allow the telecommunications provider to form services in such a way that in the event of failure of one of the components of the structure based on the principles of consensus, losses can be quickly compensated due to other components and their interaction. When solving this problem, it is important to combine solutions in the form of patterns, components capable of taking uncertainty into account, leaving room for non-standard solutions. In addition to tools aimed at professional architects of providers and IT companies, when solving this problem, it would be desirable to develop tools, perhaps somewhat simplified, mainly based on the use of patterns, for consumers to implement their own vision of the services that will be provided to them.

The second of these problems is related to the formation of the provider's place in the services market and consists in the constant updating of the service catalog, taking into account the traditional aspects of the analysis of trends in the development of the industry, analysis and forecasting of the market development, and taking into account modern concepts of the development of the industry, primarily evaluations in social media. Here we can talk about tools that allow a telecommunications provider to maintain and expand its market share, taking into account ratings in social media by adding new services, removing services, improving services or replacing services.

The third of these problems is related to the regular clarification of specific service packages that the provider provides to specific client companies in the service market. Here we can talk about tools that allow a telecommunications provider to analyze customer service packages and reformat them taking into account the update of the service catalog, the history of the customer's use of services, evaluations in social media and the features of the state and prospects of the customer's business.

The fourth of these problems also belongs to the key problems of supporting the life cycle of services and is related to the development of services provided by the telecommunications provider to client companies, and consists in the constant development of the services themselves, taking into account the traditional aspects of the analysis of trends in the development of the industry, analysis and forecasting of market development and taking into account modern concepts of industry development, primarily evaluations in social media. Here we can talk about tools that allow a telecommunications provider to develop the structure of services, for example, by adding new functions and components, restructuring services in order to improve their productivity, efficiency, reliability and other characteristics, taking into account ratings in social media.

When solving each of the problems, evaluations in social media are used. Obtaining ratings based on user feedback is a separate problem that, in turn, requires several sub-problems.

First, it is a selection of sources and messages useful from the point of view of forming evaluations of services in social media.

Secondly, determining the positive or negative color of messages.

Thirdly, calculation of ratings of services and their components based on user reviews in social media.

Here, possible estimates can be the number of new customers of the services provided by the telecommunications provider. In addition, it seems useful to use a feedback scale.

A general approach to solving the problem of designing and developing services in the information systems of telecommunication providers

This section of the report discusses the models and methods that will be used to solve the problem of designing and developing services in the information systems of telecommunications providers, taking into account the above trends, conditions, concepts and limitations.

Models and methods of development of the catalog of telecommunications provider services

Let's start by considering the models, methods and technologies of updating the catalog of services. As mentioned above, we will take into account both traditional aspects of the analysis of trends in the development of the industry, analysis and forecast of market development, and modern aspects (concepts of the development of the industry, evaluations in social media).

First, let's consider the features of the catalog, in which service providers define the services provided to customers. In general, the catalog for each service traditionally describes its attributes, SLA parameters, terms of service provision and service prices. Common parameters of services are the category and name of the service, description of the service, functions of the service, time frames for providing the service, etc.

The consumer can view the catalog of services to compare the available services, their functions and other parameters, the price, and choose the most beneficial services for the consumer. The catalog of services is the basis for ordering services in the order of self-service.

But for this, service providers must define, publish and manage the catalog of services using the appropriate tools.

Mathematical formulation of the problem:

Let $X = \{x_1, x_2, \dots, x_n\}$ – the set of all services, n – the number of services, $Y = \{y_1, y_2, \dots, y_m\}$ – the set of all providers, m – the number of providers. It is necessary to establish a mutually unambiguous mapping between these sets $X \rightarrow Y$. That is, we must match each service with the provider that provides it. In this way, we can combine all services provided by one provider.

Reasoning:

In fact, the formulated problem is reduced to a classification problem. We have n objects (services) and m classes (providers). To solve it, it is recommended to use neural networks or decision trees (Card algorithm, ID3, Random Forest). You can also use the Naive Bayesian classifier.

Classification accuracy can be monitored using the Recall and Precision metrics (Fig. 1).

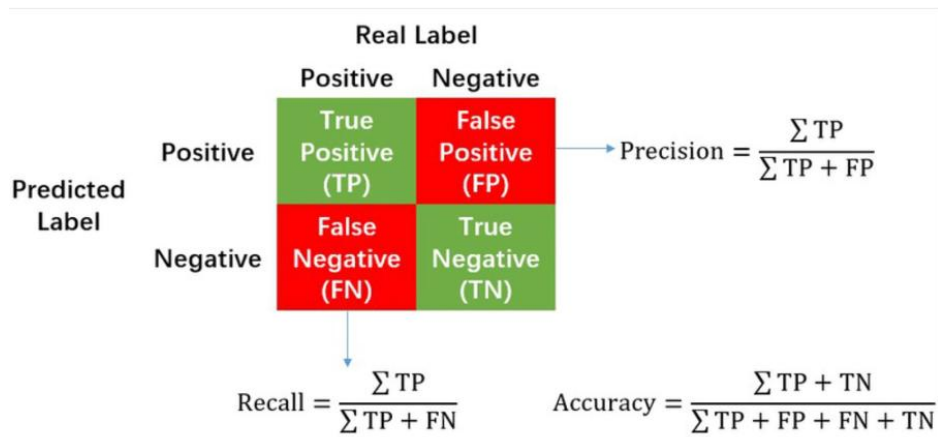


Fig. 1. Calculation of Precision, Recall and Accuracy in the confusion matrix [23].

Since the catalog of services can be represented as a set of services, the following operations apply to it:

- 1) adding an element to a set;
- 2) removing an element from the set.

Accordingly, we are talking about adding or removing a service (a group of services).

Therefore, the problem arises of determining the expediency of implementation or the expediency of service support.

If information is known about the number of users who ordered a certain service for a fixed period of time, then with the help of time series it is possible to forecast the number of service orders in the next period of time [24]. In addition, it is possible to apply the ATAPSN algorithm (algorithm taking into account posts in social networks) [25] for more accurate forecasting of the number of service orders. Thus, it is possible to determine the popularity of the service and make decisions about the feasibility of its support.

If information is known about the profit from the implementation of the service or the costs of its implementation for a certain period of time, then this service can be represented as a random variable. Thus, by calculating the mathematical expectation and variance of a given random variable, it is possible to determine the average expected profit (average cost) and the risk of not getting it (root mean square deviation). Based on these data, it is possible to draw a conclusion about the expediency of implementing a new service or the expediency of supporting an existing one.

If you conduct a survey of users regarding the quality of a particular service, you can calculate the ratio of favorable reviews to the total number of reviews. It is also advisable to

calculate the ratio of disapproving reviews to the total number of reviews. These parameters will allow you to monitor the opinion of users about the quality of the service.

It is also recommended to conduct a survey of potential users for the purpose of introducing a new service. In this case, you can also use similar parameters.

Based on such studies, decisions will be made about adding or removing services. Thus, the catalog of services will contain services that are popular among users and will help the provider to improve their quality.

Models and methods of development of a package of services of a telecommunications provider

Now let's move on to consider the models, methods and technologies of updating the catalog of services. As mentioned above, we will take into account both traditional aspects of the analysis of trends in the development of the industry, analysis and forecast of market development, and modern aspects (concepts of the development of the industry, evaluations in social media).

Mathematical formulation of the problem:

Let $X = \{x_{1j}, x_{2j}, \dots, x_{ij}\}$ – the set of all services provided by the provider, i – the number of services, m – the number of providers. It is necessary to select some subsets of services X_q from the set X , q - the number of subsets. We will consider these subsets as packets.

Reasoning:

Subsets X_q are formed on the basis of the principles of establishing hidden regularities between services from the set X . The following principles can be considered:

1. Similarity of interests or needs of users.

The interests or needs of consumers can be determined by analyzing their profiles in social networks. In such a case, the problem is reduced to a clustering problem, where a cluster is a group based on interests (needs). For implementation, the K-means algorithm is recommended, in which the recommended number of clusters can be calculated using the "Elbow" method.

Analyzing the social graph, in each cluster it is possible to additionally determine a social network user who will influence the opinion of his friends or like-minded people (that is, if he uses a service, his friends will also want to use it). In this way, such a user can be chosen if there is a need for effective distribution of service advertisements. Moreover, if a certain user uses several services at once, then they can be recommended to form a package of services, which will be based on the common interests (needs) of a certain social group of users.

It should also be added that the service package may include services provided by different providers.

2. Similarity of service characteristics.

If a list of service characteristics is formulated, then each of them can be represented as a vector of 0 and 1 (1 – the service corresponds to this characteristic, 0 – it does not). Thus, we can calculate similarity coefficients (Jaccard, Sorensen, Simpson, Otiai, Brown-Blanquet, etc.) between pairs of services. It is possible to recommend adding such services to the package of services that have the value of the given coefficient above the indicated minimum threshold (preferably closer to unity).

3. Statistical dependence of services.

If information is known about how many users ordered this or that service during the specified time period (month, year, etc.), it is possible to determine the degree of dependence between pairs of services. For this, it is worth using correlation coefficients (Pearson, Spearman, Kendall). Statistical significance between them should be established using the statistical t-test.

As a result of the conducted statistical analysis of each service for the specified period of time, it is also possible to determine the feasibility of implementing this or that service. This will make it possible not to consider services that are not relevant for a certain target audience of users.

4. If statistical information is known about which services a specific user orders at the same time, then associative rules can be applied to form a package of services: if the user ordered service X_k , he will also order service X_p .

A chain of services can be formed from such elementary rules, on the basis of which a package of services can be formed. APRIORI or ECLAT algorithm should be used to build associative rules. The accuracy of the obtained results can be monitored using metrics such as *supp*, *conf*, and *lift*.

It should be noted that the proposed principles of formation of service packages allow only to recommend services, on the basis of which service packages will be formed. The final decision on their formation must be taken by the provider(s).

It is also worth emphasizing that the choice of the principle of formation of service packages depends on the type of statistical data. The larger and more diverse the input datasets will be, the wider the range of principles for forming service packages can be offered. This will allow a more personalized approach to both the needs of the user and the needs of the provider.

Models and methods of development of a separate service of a telecom provider, taking into account social media

Support of the life cycle of services refers to services that are entered in the catalog of services. That is, the services must be designed, implemented, delivered, provided to consumers according to the parameters, conditions, prices specified in the catalog and, if necessary, developed. This involves, first, the implementation of common actions related to the construction of the service structure and the description of the work process of its provision, the implementation of the components of the structure and their interaction to provide the service defined by the user with the minimization of the provider's resources. Secondly, it also involves the implementation of certain processes specific to the services of certain industries, for example, service proposals, creating a contact for a service. For services that are specific to telecom providers, most often it is about defining a service template, creating an orchestration workflow.

In general, a service pattern is a set of interrelated hardware and/or software components that make up a service and interact during service deployment. Service templates are usually defined in the service directory. After receiving a service request, hardware and/or software resources are allocated, configured, and integrated according to a service template to create an instance of the service. Thus, a service pattern provides a standard for multiple creation of intended instances of a given service. From the perspective of consumers, the features of the service template help them understand the hardware configuration, software, and security mechanism for the service. From the provider's perspective, it provides guidance on creating workflows for service organization. Features of a service template typically include the following entities:

Service Structure: Defines the structure of the service, which includes the components of the service and their relationships. For example, a requirement for a SaaS service may be reflected in running a specific business application on a guest OS, deploying a database to support the application, and hosting the database and application on virtual machines.

Service Attribute: Defines configurations of service components. For example, the attributes of a virtual machine that is provided as a service component are: the number of processors of a certain computing power, the size of memory, and the number of attached disks of a certain size.

Service Operation: Defines management operations such as add, modify, start, and stop that can be performed in the service management interface.

Creating an orchestration workflow: After defining a service template, workflows for service orchestration are created in the orchestrator based on the template specification. These workflows enable the automated allocation, configuration, and integration of hardware and/or software resources for a service according to a service template.

Conclusion

An approach to the design and development of services in the information systems of telecommunications providers, taking into account social media, is proposed. Within the framework of the proposed approach, attention is paid to solving such tasks as designing services provided by telecommunications providers, maintaining a catalog of telecommunications provider services, forming a package of telecommunications provider services taking into account the specifics of the consumer, developing services provided by telecommunications providers.

The implementation of the approach is based on the creation of tools for the development of the catalog of services, the development of a package of services, the development of a separate service of a telecommunications provider, taking into account social media, based on models and methods within the framework of the service life cycle support platform in the information systems of telecommunications providers.

Based on the proposed approach, the report outlines models and methods for solving these problems, which integrate the apparatus of set theory, statistical theory, decision-making theory, and artificial intelligence. This allows users to make decisions in the processes of designing and developing services, maintaining a catalog of services and forming a package of services of a telecommunications provider, taking into account the accumulated experience, the state of development of the industry, and makes it expedient to use them in information systems aimed at increasing business competitiveness.

Further research is related to the development of models and methods of design and development of services in the information systems of telecommunications providers, oriented to use by professional architects of providers and consumers, which is very important for the realization by consumers of their own vision of services and the development of real services of telecommunications providers.

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