DOI: 10.22213/2658-3658-2019-98-104

Formalization of the Problem of Building an Optimal Infocommunication Platform by the Criterion of the Effectiveness of Support for Business Processes

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Received: July 15, 2019

Abstract. The article presents a description of a general approach to solving a class of design for network tasks supporting the activities of small and medium-sized companies based on modeling their business processes. Optimization of the infocommunication platform is formulated as a linear programming problem. The interpretation of the parameters of the optimization model and their relationship with the company's business processes and the characteristics of the infocommunication platform are given. An interpretation of the linear programming problem of the infocommunication platform is given as an optimization task in predicting changes in the input factors of the constructed model.

Keywords: business process, business function, infocommunication platform, linear programming, design for network, network optimization

INTRODUCTION

Network design to support the activities of small and medium-sized companies has problem with finding the optimal ratio of attracted resources of computing and telecommunication networks and systems, software and applied cloud services. The problem is the need to determine a large number of basic properties and functionalities, such as the architecture and structure of the network, the list of supported services, the procedure for collecting, storing and processing user data, bandwidth of communication channels, methods of operation and management, economic indicators, etc. [1, 11-20]. It is also necessary to consider business development forecasts and trends in changing information and communication technologies used to solve the company's daily tasks. At present, expert assessments are mainly used for designing networks of small and medium-sized companies. The fact is that the task of designing infocommunications does not have a strict formalization, and this does not allow using the mathematical techniques to optimize systems and processes. This paper presents an approach to formalizing the problem of infocommunication designing to support the activities of small and medium-sized companies based on a linear programming mathematical techniques.

OPTIMIZATION PROBLEM

The task of selecting the above basic properties and functionality of infocommunication platforms can be solved as a result of multiparameter optimization by the criterion of the effective implementation of the company's business processes by the designed platform taking into account business development and telecommunication technologies forecast.

Correct formulation of a common optimization problem needs the definition of the following elements: [6-10].

- input factor set:

$$\bar{\boldsymbol{X}} = x_1, x_2, \ldots, x_m, \tag{1}$$

their values can be measured, but cannot be changed for management and optimization purposes;

- set of disturbing factors:

$$\bar{\boldsymbol{\Xi}} = \xi_1, \xi_2, \ldots, \xi_s, \tag{2}$$

they randomly change over time and affect the state of a system or process, but cannot be measured directly;

- driving factor set:

$$\bar{\boldsymbol{U}} = u_1, u_2, \ldots, u_n, \tag{4}$$

they change during the optimization process, which is why the optimization goal is achieved;

- set of output parameters (state parameters):

$$\bar{\boldsymbol{Y}} = y_1, y_2, \ldots, y_n, \tag{5}$$

they characterize the state of the system or process under consideration with the cumulative effect of input, disturbing and driving factors;

- optimality criterion (objective function):

$$R = f\left(\bar{\boldsymbol{X}}, \bar{\boldsymbol{\Xi}}, \bar{\boldsymbol{Y}}, \bar{\boldsymbol{U}}\right), \tag{6}$$

finding its extremum with varying driving factors $\bar{\boldsymbol{U}}$ is the ultimate goal of solving the optimization task;

- allowable set of driving factors

$$\boldsymbol{G} = \left\{\bar{\boldsymbol{U}} \middle| g_i\left(\bar{\boldsymbol{U}}\right) \le x_i, i = 1, \ldots, m\right\} \in \mathbb{R} \tag{7}$$

it is given by a set of limiting inequalities $g_i\left(\bar{\boldsymbol{U}}\right)$.

Determining the composition and setting these elements for a specific infocommunication platform is a problem of formalizing the optimization task. For its successful solution, it is necessary to find an acceptable interpretation of the factors, parameters and objective function of the optimization task on the basis the information and communication platform is optimized by the criterion of the effective implementation of the company's business processes by the designed platform taking into account business development and telecommunication technologies forecast.

NETWORK OPTIMIZATION

The infocommunication platform of a small or medium-sized enterprise is designed to support the following basic functions: [2, 3].

- customer management;
- management of activities;
- resource management;
- management of financial flows.

They are user-oriented infocommunication platform services. To implement them, it is necessary to develop business processes that determine the order of implementation and interaction of basic functions, and to design a support these business processes infocommunication platform.

Because the purpose of any infocommunication platform is to support the company's business processes, the solution of the network design task should begin with a description of the organization's business processes. [4].

The activities of a small or medium-sized company can often be described by a single business process, which is a set of business process structure business functions. The business functions and the relations between them determine the set of input factors $\bar{X}$, and the results of the implementation of the business process, that are the set of output parameters $\bar{Y}$, for the problem of optimal design of the infocommunication platform.

Must be define the following elements for designing business processes: [3].

1) Business functions that describe the actions of a business process. They are the input factors of the optimization model. It is necessary to take into account those business functions that require information and communication support for their implementation. Input factors for business functions is the data value that must be processed by the infocommunication platform during the implementation of these business functions, in the formation of limiting inequalities $g_i(\bar{U})$. Arguments of inequalities $g_i(\bar{U})$ are the intensity of use of information and communication platform technologies in the implementation of relevant business functions, and the inequality coefficients are the norms of using company resources in the implementation of business functions.

2) The defining moments of the launch and the results of business functions inbound and outbound events. They are the input factors of the optimization model. Since define the call flows and the intensity of the use of business functions it suffices to take into account only incoming events. To describe the incoming flows in the compilation of limiting inequalities $g_i(\bar{U})$, we will use the intensity of the call flow ψ [5], defined as the mathematical expectation of the number of calls of the corresponding business function arriving per unit time. Each input factor is determined by its value of flow rate. It is necessary to take into account only independent flows of incoming calls when describing incoming factors of this type. Flows that arise as a result of the occurrence of other events are not independent and are not used in building an optimization model of the infocommunication platform.

3) Representing input and output data Input and output documents are also the optimization model input factors. The formation of each of the documents is accompanied by the generation of a certain amount of traffic that is not included in the final document. Therefore, when describing inequalities $g_i(\bar{U})$, it is necessary to determine the average data volume of each document instance generated in the infocommunication platform, for each of the document type optimization parameter that represents the input parameter.

4) Representing the functional responsibilities of enterprise role employees. They are the input factors of the optimization model. The roles of employees are determined by the scope of the company. Roles are included in inequalities $g_i(\bar{U})$ as the number of employees of the

respective roles, and the coefficients of these inequalities determine the intensity of use by employees of infocommunication technologies.

5) Resources that are used to complete the business process. Are the input factors of the optimization model as well. The input factors of this type include various types of material and financial resources that are used to implement the business process. In inequalities $g_i(\bar{U})$ in the allowable amount of attraction of these resources are limited.

6) Used to quantify the metrics of the implementation of a business process metrics, for example, the required number of customers, annual turnover, etc. Represent a set of output parameters of the optimization model $\bar{Y}$. Output parameters are used to take into account the development trends of the company when solving the task of planning the development of the infocommunication platform. It is necessary to use only a set of independent metrics when determining output parameters, i.e. have no functional or statistical relationships between the metrics.

An introduction to the model of disturbing factors $\bar{\Xi}$ is possible when specifying the optimization task of the information and communication platform. Their use makes sense only with relatively large variations of the input factors and output parameters of the optimization model and the stochastic processes used to build the model.

The infocommunication platform for supporting small and medium-sized companies in general can contain the following components - office cloud and local services, network printers and scanners, e-mail, telephony and IP-telephony, video conferencing, data storage, information security subsystems, wireless and wired access networks , personal computers, cloud and local client management services, content management, video surveillance and security, accounting support, etc.

Different combinations of these components can give different options for building an infocommunication platform, each of which represents its own controlling factor u_i from the set $\bar{U}$. Each of the driving factors u_i is a set of infocommunication platform components necessary to obtain the corresponding metric from the set of output parameters $\bar{Y}$. It is necessary to determine the elements and technologies that should be used to obtain the target value of the metric y_i when building an optimization model. Numerical value u_i means the intensity of use of the corresponding set of infocommunication platform components. Variable factors u_i are set by a combination of components of the information and communication platform, providing a single intensity of their use, i.e. it is necessary to determine the used volume of technologies group u_i of the infocommunication platform that corresponds to a unit value of its metric y_i.

For the same output parameter y_i, various combinations of components of the information and communication platform can be used, i.e. different driving factors u_i may correspond to the same metric, which should be included in the general optimization model as independent elements representing independent options for building an infocommunication platform to achieve a given value of the corresponding metric

Since for small and medium-sized companies the total effect from their activities is most interesting, the objective function R can be a linear weighted sum of the intensities of using sets of technologies u_i, that ensure the achievement of the required values of the corresponding metrics y_i.

RESULTS

The above procedure for formalizing the task of designing an infocommunication platform to support the activities of small and medium-sized companies makes it possible to present the task of finding the best option design for network as a linear programming task:

It is required to find the values $u_1, u_2, \ldots, u_n$ delivering the minimum of the linear function:

$$R = f\left(\bar{\boldsymbol{Y}}, \bar{\boldsymbol{U}}\right) = y_1 \cdot u_1 + y_2 \cdot u_2 + \ldots + y_n \cdot u_n, \tag{8}$$

on a set of values $u_1, u_2, \ldots, u_n$ satisfying the constraints given by inequalities of the form:

$$\begin{aligned} a_{11} \cdot u_1 + \ldots + a_{1n} \cdot u_n &\le x_1, \\ \ldots \quad \ldots \quad \ldots & \\ a_{m1} \cdot u_1 + \ldots + a_{mn} \cdot u_n &\le x_m, \end{aligned} \tag{9}$$

y_i – means a set of company performance targets; x_i – resource support of the company's activities for the implementation of business processes with given target indicators $\bar{\boldsymbol{Y}}$; u_i are the intensity of use of the set of components of the infocommunication platform to achieve the corresponding target indicators y_i; a_{ij} is the utilization rate of the resource x_i when implementing the set of components of the infocommunication platform u_i of unit intensity; the objective function *R* shows the total intensity of the use of infocommunication resources used to achieve the specified target indicators $\bar{\boldsymbol{Y}}$.

Minimization of the objective function R will provide an optimal supporting infocommunication platform minimized by the intensity of its use. In turn, this will allow to determine the required amount of attracted resources of computing and telecommunication networks and systems, software and applied cloud services.

The definition of the necessary resource support for the company, expressed by the set of input factors $\bar{\boldsymbol{X}}$, is carried out by rationing the performance of individual business functions when it is necessary to achieve the target indicators $\bar{\boldsymbol{Y}}$.

Planning the development of a company's business processes ultimately leads to setting target values for $\bar{\boldsymbol{Y}}$ target indicators and solving an optimization problem for these indicators.

Accounting technological trends through the forecast for changing norms a_{ij}.

CONCLUSIONS

The proposed optimization model can be used to build an optimal infocommunication platform to support the activities of small and medium-sized companies, whose activities can be described by a single end-to-end business process, taking into account the company's development plan and trends in changing infocommunication technologies. The application of the proposed model involves the localization of tasks for a particular company and the definition of specific indicators of the model. As a result of solving the optimization task, an infocommunication network will be obtained with the minimum amount of hardware and software required for achieving the planned performance of the company, necessary for the implementation of the infocommunication platform with the required set of infocommunication resources.

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